With pressure to deliver more complicated, fine-tolerance components and systems, the efficiency of EOL testing is under scrutiny – and it could even be eliminated in the future

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# LINE MANAGEMENT

The focus within end-of-line testing today is on prevention rather than cure

Managing the influx of technology coming into the automotive industry is proving to be a steep learning curve for the entire supply chain. Growing demand for electrification, connectivity and automation in new vehicles is putting pressure on end-of-line testing, and there is a need for even greater efficiency as that evolution gathers pace.

Rockwell Automation supplies EOL test equipment to OEMs and Tier 1s, focused on interior components and notably seating. Andreas Schlipf, the company's commercial manager for Central Europe, says advances in camera vision, robots and automated platforms have helped reduce manual processes and error rates in factories. Thin client solutions – simple terminals connected to a central management system – are also helping to streamline implementation.

"Customers are asking for more cost-effective solutions, more diversification and flexibility in the solution," he says.

"The main reason is the constant cost pressure and need to achieve operational savings. The growing demands in user experience and comfort also play a vital role. Finally, there are technological reasons, with the integrated digitalization in the final product and its components."

## ADAS and electrification challenges

Interior functions and personalization options have become a key differentiator for new vehicles, Schlipf adds, and these have created more diversity in testing. Thankfully, technological advances have reduced manual processes. Seat testing can be almost fully automated, only requiring operators to connect a device at the start, and future generations can be optimized to make this even easier.

"On seat manufacturing, for example, the production lines, test stations and even the final product are still made for manual assembly and operations, and not for robot-based testing. While designing a seat, the manufacturing and testing challenges are still playing a very minor role – there's a big potential here for cost savings by design."


***"The challenges for lidar end-of-line testing will be implementation of an efficient test technology"***

*Andreas Himmler, senior product manager for hardware-in-the-loop testing systems, dSpace*

Electrification is influencing NVH analysis. Dr Alex Balvedi, solutions development manager for HBK's Discom NVH analytical system, notes a step change since his first auto engineering and R&D roles in the early 2000s. Whereas only a sample of combustion engines would have been assessed due to the time required for hot and cold testing, this isn't an issue for e-powertrains. Factories can and are now expecting to NVH test every unit, as well as pumps, actuators and power steering systems.

"The acoustic quality of different systems has become more critical than ICEs. Once you have a very quiet powertrain that probably just has a whistle from the electric motor, you start noticing other noises. This is likely to become a major quality complaint issue for the OEMs, and they are very, very cautious about testing 100% [of what's coming off the line]. If you're testing 100%, you probably need more end-of-lines," he says.

"From an NVH perspective, the machines need to be more robust because they are covering a higher speed and torque range," he continues. "Customers are starting to look at the repeatability between end-of-lines because the tolerances are getting tighter, so you have to make sure that every single end-of-line is giving the same result."

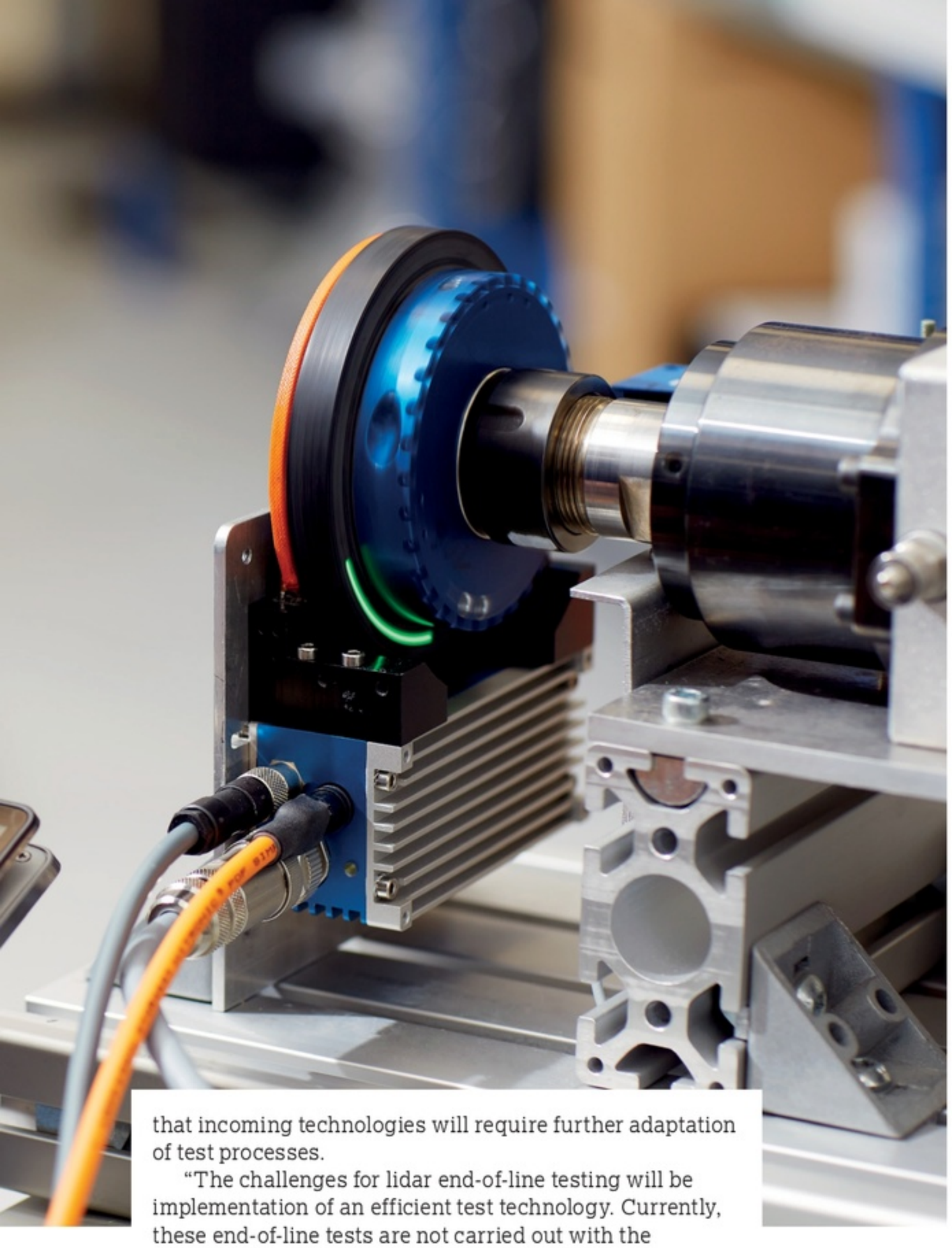
Accelerating demands for ADAS are also adding to the challenges. Andreas Himmler, senior product manager for hardware-in-the-loop testing systems at dSpace, observes a growing need for high-throughput, high-accuracy radar and lidar testing to meet the volume and cost requirements of a competitive, safety-critical market.

The company's compact antenna test range (CATR) systems, which use a reflector to reduce the size of the chamber, offer reproducible and automated testing. The systems feature up to four targets that can be varied for distance, speed and size to test different scenarios, and enable fast changes between the units under test.

"CATR setups enable significant reductions in the size of end-of-line chambers for modern automotive radars that would otherwise require distances of 5-7m because of their large far-field distance," Himmler comments, adding

**ABOVE AND RIGHT:** Next-generation analytics solutions are making data-driven product improvement accessible to all

**BELOW:** Experts believe EOL testing could be eradicated in the future



that incoming technologies will require further adaptation of test processes.

"The challenges for lidar end-of-line testing will be implementation of an efficient test technology. Currently, these end-of-line tests are not carried out with the same efficiency as radar end-of-line tests. However, the corresponding technology is under development and dSpace has ongoing projects in this area."

### End of the end-of-line

However, one emerging trend is toward reducing the role of EOL testing in the first place. With supply chains becoming increasingly connected, Acerta's LinePulse system uses multivariate analysis with machine learning and AI to predict faults earlier in the production process and issue actionable insights to correct them. The goal is more cost- and time-efficient end-of-line testing while avoiding increasingly expensive scrap.

***"How do we make sure that we keep the quality good, even without looking into the end-of-line station?"***

*Sergey Strelnikov, director of data science and ML engineering, Acerta*

## Future foundations

**Efficiency challenges are only the tip of the iceberg for end-of-line testing**

In a rapidly evolving technological landscape, Acerta's Rob Plumridge (right) notes that suppliers are being asked to deliver solutions that are ready for not just incremental product improvements but wholesale technological change.

"The other challenge with electrification is that we don't have all that empirical knowledge," he says. "I can go into an engine line and say I expect a certain value to be this – say, a leak rate or response of an ignition signal. We've been making electric motors for centuries, but in that final package there's still a lot to learn.

"You have to make sure you have end-of-line testing that can learn and adapt as you learn new failure modes and what else is going to cause problems."

However, those changes are happening while familiar challenges are still present, as Hottinger Brüel & Kjær's Dr Alex Balvedi (right) adds: "There is huge cost pressure on end-of-line manufacturers. It's getting tougher when you get competitors from China, and many of the traditional car manufacturers in Europe still have to supply diesel and gasoline engines and also invest in their EV development. That puts pressure on their suppliers."

Sergey Strelnikov, Acerta's director of data science and ML engineering, explains, "Over the past decade, end-of-line testing moved from good practice to something that everybody wants, and wants to be done quickly. Nobody is satisfied with post-mortem analysis, everybody's looking backward and saying they don't want failures to happen in the first place.

"We're shifting this concept from just having end-of-line, to how do we prevent this in the first place?" he continues. "How do we make sure we keep the quality good, even without looking into the end-of-line station?"

LinePulse automatically keeps track of elements that are closest to tolerances and learns which would contribute the most toward a failure during EOL testing. That change is enabled by the trend in Tier 1s and OEMs pushing suppliers to collect more data in an increasingly (though not yet completely) standardized form. Eventually, adds LinePulse product manager Rob Plumridge, this could also link to data from connected vehicles, spotting in-use failures and tracing them back to manufacturing.

"The long-term goal would be that we don't need EOL testing," he says. "We can test as we're building it, know that this is the probability of it being good or bad, and make the decision based on that, as opposed to having an extra test stand that doesn't add value to that part.

"I think there will be times when end-of-line is essentially eliminated,"he adds. "When that is, I'm not sure, but we're trying to make that happen for our customers right now. We have projects underway, saying how can we stop having to do this, or make it just a formality as opposed to something we're relying on." ❮