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Go big with rFpro's new digital LA map

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The sensor market is a busy as ever. Is it ready for Level 3? (Image: Shutterstock/Summit Art Creations)

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SAE INTERNATIONAL®

EDITORIAL

Sensitive subjects

You've got regulations, cost and personal preferences all getting in the way of the next generation of automated vehicles. Oh, and those pesky legal issues about who's at fault should something happen. Under all these big issues lie the many small sensors that today's AVs and ADAS packages require. This big/small world is one topic we're investigating in this issue.

I won't pretend I know exactly which combination of cameras and radar and lidar sensors works best for a given AV, or whether thermal cameras and new point cloud technologies should be part of the mix. But the world is clearly ready to spend a lot of money figuring these problems out.

For example, the overall automotive lidar market will grow to $9.5 billion by 2034, with the market focusing on "beam steering technologies, performance improvement, and cost reduction in lidar transceiver components," according to IDTechEx. Similarly, Allied Market Research predicts that by 2032, the automotive smart camera market will grow to $27.2 billion, up from $3.4 billion in 2022. The leader here will be the complementary metal-oxide semiconductor (CMOS) segment, which "contributed nearly four-fifths of the total revenue in the global automotive smart camera market in 2023," and Allied expects CMOS to "maintain its dominant position throughout the forecast period." The radar zone will be busy, too, finding the patterns in all mankind. Fortune Business Insights predicts that the global automotive radar market will grow from $4.74 billion in 2023 to $5.11 billion in 2024 and then to $11.23 billion by 2032. The growth here will be driven by stringent government safety regulations and an increasing overall demand for passenger vehicles, especially in developing countries.

The lidar market will grow to $9.5 billion by 2034, radar to $11.23 billion by 2032.

As fascinating as future sensors are, some of the sensors installed in today's vehicles are already hard at work making tomorrow's AVs better. I listened to a presentation by Mobileye's senior director of ADAS business development, Yoni Epstein, at AutoSens in Detroit this spring, and he pointed to his company's use of crowdsourcing to improve its Road Experience Management maps. Mobileye's idea here is to let cars on the road send continuously updated information to Mobileye in order to create maps that other AVs can use.

"By the end of last year [2023], we collected nearly 50 billion kilometers (31 billion miles) of road data, almost 80 million kilometers (50 million miles) being harvested daily," Epstein said. "The crowdsourcing fleet was composed of 5.5 million cars. These are the figures from last year, so you can assume that these numbers are just going to keep growing over the coming years as more and more OEMS join the REM fleet."

Mobileye has various chips installed in over 800 models worldwide, representing over 187 million chips. By 2032, Epstein said, the company expects to have chips in over 300 million vehicles. "These are life-saving technologies, and 300 million cars around the world that have these technologies is a great achievement that we're very proud of," he said.

Our cars are getting hungry for more sensors, and OEMs and suppliers are all rushing to serve up just the right package. With all of the tech advancements being announced and more money in the pipeline, it's an energizing time to be into sensing. But let's not forget the capabilities of the sensors that already exist.

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Planning with a scenario mindset

Across the industry, strategic planners from OEMs and suppliers alike are scratching their heads. The number of strategic directions they currently face is unprecedented. Combine global trade friction (China tariffs), high interest rates, a pausing EV transition, new OEM players and the U.S. political environment – one could build scenarios all day to cover the possibilities.

Given this rocky environment, a new approach is required. Trusting one forecast as a basis for all strategic decisions may be inadequate in capturing the major vehicle market possibilities. A quick examination of the key variables underscores the challenge.

Variable 1: Outcome of the U.S. federal election in November

One can feel that there are several significant capital and strategic decisions that may alter the direction of several strategies. Additionally, it is not a case of whether the Democrats or the Republicans control the U.S. presidency, but how. Does the ruling party have a majority on both sides of Congress? What will U.S. foreign policy be from a tariff perspective? How will emissions and fuel economy legislation change, and when? What is the future of the California Air Resources Board (CARB) exemption? Lastly, what happens to commercial and consumer incentives under the Inflation Reduction Act (IRA)? Billions in capital hang in the balance and, as such, scores of decisions will wait until November.

Variable 2: EV growth rates

Partially dependent on variable 1, how will consumers and the industry adjust to EV acceptance that's seemingly on the flat end of the 'S' curve? While any new technology experiences volume gyrations, the recent issues impacting EVs have been more extreme than expected. With many OEMs delaying EV introductions and capital outlays, suppliers are left in limbo. There are a couple of examples of viable internal combustion engine (ICE) and hybrid vehicle plants that have been idled for two-plus years as they wait to transition to producing EVs. Unheard of in our industry. Other decisions, such as continuing ICE vehicle output alongside new hybrids – plug-in or standard gas-electric models must be weighed. Can OEMs and suppliers cover the capital costs and outperform alternative strategies? How and at what rate will the industry drive scale in EVs to bring MSRPs down?

Michael Robinet
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Given the rocky environment, a new approach is required.

Variable 3: China's growing BEV position

This one has several layers and is integrated into variables 1 and 2. Many Chinese OEMs have ramped up their EV design and production capabilities. Even a cursory view of the progress made with respect to cost, packaging, design and scale is head-snapping. While this author is apprised of most industry shifts and their relative impact, a recent review of the progress of Chinese-made EVs underscores the challenges the balance of the market faces. No matter what happens with tariffs or protectionist measures instituted by various governments, the competitive structure is set. As several Western OEMs have outlined, they need to learn to compete.

Variable 4: Relatively high interest rates and vehicle affordability challenges

While we have faced high interest rates before (these will eventually fall), experiencing these in the midst of several new EV offerings (with higher prices) has challenged retailers. Add in the lack of used vehicles coming off three-year leases thanks to the COVID impact and you can understand why OEMs will need to sharpen their pencil with respect to costs and incentives to drive volumes for the next couple of years.

There are more variables to consider. Some may be internal to a vehicle subsystem or a specific company. Whatever these are, suppliers need to start planning with a scenario mindset. Understanding the impacts of several "what ifs" may be more important than ever. Planning will require greater flexibility and speed. Welcome to the new automotive reality. ■

AUTOSENS & INCABIN

rFpro reveals 'massive, complicated' LA model

RFpro's new LA map includes over 12,000 buildings, 13,000 pieces of infrastructure (signs and lamps) and 40,000 plants.

Simulation company **rFpro** has already mapped over 180 digital locations around the world, including public roads, proving grounds and race circuits. But the company's latest is by far its biggest and most complicated. Matt Daley, technical director at rFpro, announced at AutoSens USA 2024 that its new Los Angeles route is an "absolutely massive, complicated model" of a 36-km (22-mile) loop that can be virtually driven in both directions. Along these digital roads – which were built off survey-grade LIDAR data with a 1 cm by 1 cm (1.1-in by 1.1 in) X-Y grid – rFpro has added over 12,000 buildings, 13,000 pieces of street infrastructure (like signs and lamps), and 40,000 pieces of vegetation.

"It's a fantastic location," Daley said. "It's a huge array of different types of challenging infrastructure for AVs. You can drive this loop with full vehicle dynamic inputs, ready to excite the suspension and, especially with AVs, shake the sensors in the correct way as you would be getting if you were driving those real roads."

The new digital map covers an area in southwest LA that includes Highway 110 from the harbor up to Carson, going through industrial areas, dense residential areas in Torrance, and suburban Rolling Hills. The variety is what makes this new model so valuable to companies that want to simulate various tests, especially for new automated driving systems.

"We are now able to give autonomous vehicles the ability to test in all of these different types of environments, junctions, and road types that they're going to experience in day-to-day life," Daley said, adding that there are railroad crossings, gas stations, intersections, and highway on- and off-ramps in the data set.

"The grand challenge of autonomous development is that you need so much diversity available to you," Daley told SAE Media. "It's extremely difficult to get in the real world, because you have to go so many different miles, so many places, and really drive so much volume in order to create it. It's a slightly different challenge in simulation, because we can create diversity and let people create second levels of diversity inside existing maps."

Not just for human drivers

RFpro started in 2007 in the driver-in-the-loop market. In 2015, the company started to think about how to integrate ADAS testing.

"We realized that the amount of investment that we got in providing a solid simulation platform and infrastructure, as well as our technologies and abilities to build 3D models, we could add additional layers," Daley said. "We knew it wouldn't be the same product, we had to keep adding additional functionality because it was no longer just humans that were looking into this. We had to add digital eyes, and cameras are not human eyes. They are different in the

rFPRO

way that they sample the world over different time periods. And then [we needed] lidar and radar models as well, so we created the sensor API system to allow plugins to be modeled, and to come and sit in as additional channels in the simulation."

No matter if a human or a digital driver is viewing the scene in an rFpro map, it uses the same geometric world, Daley said, including what all the materials are made of. Humans will see the virtual world displayed with an eight-bit RGB color per pixel, but a simulated camera might process a "higher-bit image that gets passed on through a perception system down the chain," Daley said. "The fundamentals of the world and how you calculate the physics in the world are still the same. It all comes down to how do you present that onwards in the correct format for how the sensor needs to see."

rFPRO

A scene from rFpro's new Los Angeles map, which is a 36-km (22-mile) loop that can be driven in both directions.

AB Dynamics PLC, which also owns rFpro, acquired **Ansible Motion** in 2022. Ansible provides 3D full-motion platform hardware and can do full integrated solutions, Daley said. "We have other partners and other resellers that integrate [our maps] onto their own hardware," he said. "A lot of our customers do it themselves as well. I was a customer at Ferrari back in 2014, when we converted an in-house simulator they

The LA map data set includes a variety of real-world variables, like railroad crossings, gas stations, intersections, and highway on- and off-ramps.

Matt Daley, technical director at rFpro, at AutoSens USA 2024.

had and brought rfPro onboard and upgraded an existing system with a higher fidelity world. And why does this matter? Well, it's the virtual playground that allows our customers to create hundreds of 1,000s of different tests of different edge cases and to recreate some of the known hazardous events that can happen in the real world in a highly accurate model of a real-world location, with the real world complexities that are there."

Daley said rFpro's system also allows customers to "generate things that didn't happen, that you couldn't find by doing real-world drives, because you simply do not have enough time, money, resources, vehicles, or the pure luck of finding the combination of weather and vehicles and pedestrians all doing the edge case scenarios that you need. Because [the LA map is] a real-world location, you can also correlate, you can do matching tests in your simulation and your real-world location to build your level of confidence in the simulation that really helps you to exploit the power of using synthetic training data."

Rfpro's new LA route can be driven in real-time with a human-in-the-loop driver or used in a simulator with full-fidelity ray tracing to generate complicated high-fidelity sensables, providing tens of thousands of tests in a short time. Digital cameras can also simulate edge cases, with nuances that come from having motion blur in an image or with full rolling-shutter effects that each OEM can define for each of their sensors. "It produces the highest fidelity training data to go into autonomous systems, and it's built on top of and alongside industry led sensable integrations," Daley said.

Overall, the LA map is rFpro's best example of a map based on the real world that can provide automated driving tech companies with confidence that what they find in the simulator will match what might happen in the real world.

"You can only get to that position if you have confidence in your simulation," Daley said. "It's pretty impossible to correlate your simulation if that thing is not a real location, if you're just making up a location. Having real world locations is hugely valuable to actually give you that confidence to scale."

Sebastian Blanco

AUTOSENS & INCABIN

Nodar's plan to make park assist tech better, cheaper, cleaner

Park assist technology seems like low-hanging fruit in the assisted and automated driving space, but anyone who's attempted to use one of these systems might have quickly realized that current solutions aren't as easy to use nor as functional as they could be.

Speaking at AutoSens USA 2024, **Nodar** CEO and founder Leaf Jiang said drivers have been complaining about self-parking features for years, but it remains a $2 billion market that is expected to grow at 17.5% CAGR between 2023 and 2030. That's one reason why Jiang wants Nodar to repurpose its Hammerhead stereo camera ranging technology to work with park assist technologies.

"I feel that folks that are using these systems today wish they could be better," Jiang said. "I think that most of us using them, maybe the car can park itself one out of two times."

While Nodar uses automotive-grade CMOS cameras with Hammerhead, a park assist software version would instead utilize a vehicle's built-in surround-view cameras as stereo pairs to estimate 3D point clouds. The software required to use these untethered, independently mounted cameras in this way would require three main features, Jiang said: advanced calibration (which Nodar writes and can calibrate the cameras frame-to-frame), perspective distortion and the ability to gather information from low-texture environments like asphalt.

Jiang showed a video of two wide-baseline, five-megapixel cameras generating 50 million points per second. "A nicely reconstructed point cloud makes it a lot easier to do path routing with object detection and understanding generally what's around the vehicle," he said. "Stereovision algorithms in the past have not been able to generate such clean point clouds."

Nodar has been working with an unnamed OEM to pair up common cameras around a vehicle, cameras with

FROM TOP: rFPRO; SEBASTIAN BLANCO

either 180- or 120-degree fields of view. The cameras are used as five stereo pairs that together create a 360-degree field of view around the car: two pairs that use the front-facing camera and one from each side mirror, one pair on each side using a camera in the B-pillar and the corresponding side mirror, and the last pair in the back that uses a camera on the rear roof along with the lower-mounted back-up camera.

"You don't need to have horizontal cameras; you don't even need to have them in the same plane," Jiang said. "You could have these sort of arbitrarily mounted, and those five zones are put together to generate this particular point cloud, showing a nice reconstruction of the asphalt with the lane lines and the cars around it. And it goes out to about 12 meters (39 ft) of range." Current ultrasound sensors used with park assist systems are typically limited to 2 to 4 meters (6.5-13 ft), he said.

When aggregating data from cameras running at 25 frames per second, the result is an aggregated point cloud that shows where the car can park. Jiang said the system has submillimeter accuracy within 4 meters and "millimeter-ish" accuracy out to 12 meters.

"With this kind of resolution, this kind of density, it's a super easy problem," Jiang said. "I can see very clearly where everything is, and I know what's standing above the ground. This, hopefully, will make it very easy for the path planner to decide where to park."

Nodar's untethered camera solution would work with Level 2 park assist systems that rely on a human driver paying attention and could be used with Level 3 and above automation when paired with redundant sensor packages, like camera-plus-radar or camera-plus-ultrasound or something else.

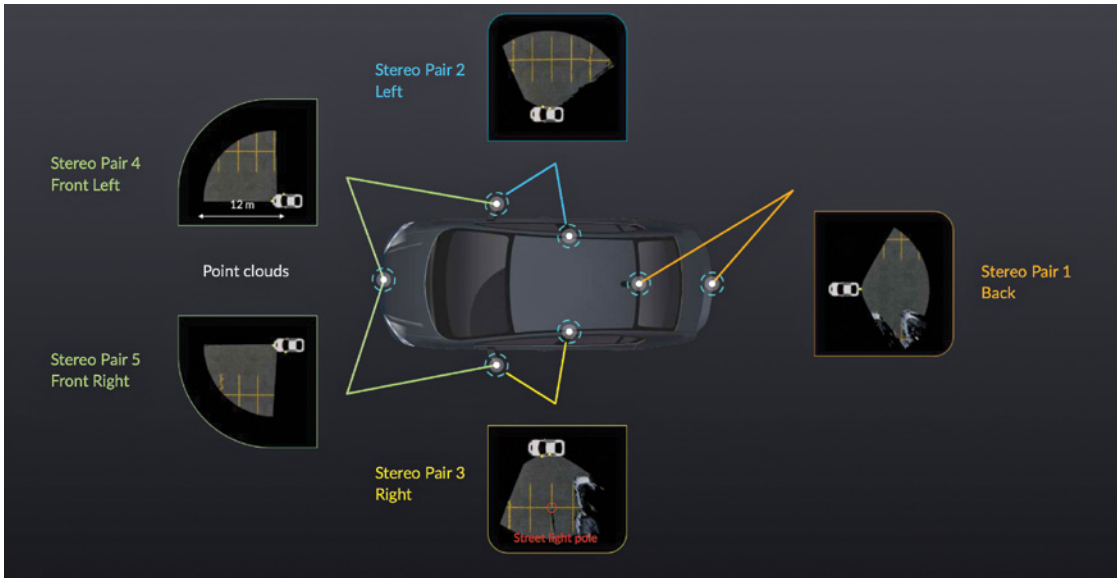
Nodar, which stands for "native optical distance and ranging," was founded in

Nodar CEO Leaf Jiang speaks at AutoSens USA 2024 about using untethered cameras as stereo pairs to make park assist systems cheaper and better.

SEBASTIAN BLANCO

2018. The company has raised $14.5 million from groups like **New Enterprise Associates** and **Rapsody Venture Partners**. At AutoSens USA, Jiang said the company will soon open an office in Germany.

Using untethered cameras to define park assist capabilities would also eliminate another complaint people



Nodar's software would use a car's built-in cameras as five stereo pairs to create detailed, close-up point clouds with 360-degree coverage around a vehicle.

have about current systems. Many of today's systems use eight to 12 ultrasonic sensors that often get "dirt drips" around them, Jiang said, something customers do not like. Nodar's system is also more reliable than monocameras that need to be moving to get their Structure-from-Motion (SfM) capabilities to work and are often inaccurate, he said.

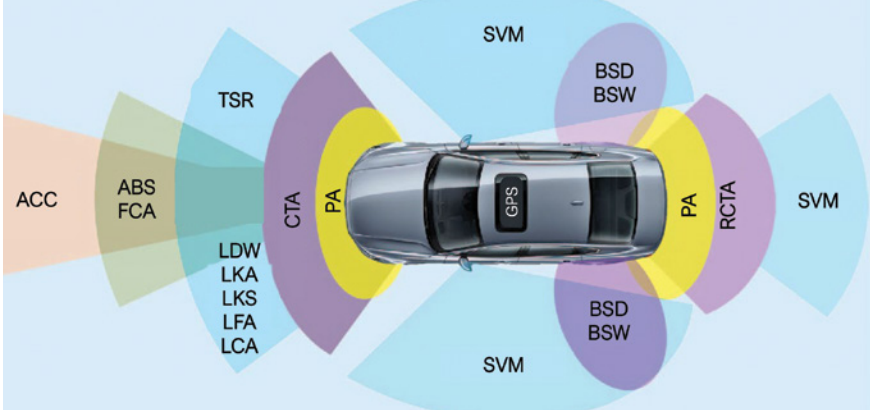
The other main option for future park assist systems is lidar, which does well with distance but is "problematic in terms of bill of materials and costs," Jiang said. Radar is useful for distance measurements as well, but since park assist needs to be able to see lines painted on the ground, it has limits and would require vision cameras to be part of the package.

Sebastian Blanco

AUTOSENS & INCABIN

UX work underway to make alphabet soup, control icons easier on drivers

At the InCabin USA vehicle technology expo in Detroit, **Ford** customer research lead Susan Shaw said that the sea of letters around ADAS features and control and indicator icons that vary between vehicles are often confusing to drivers. Shaw pointed out that the following all represent features related to driving lanes: LDW, LKA, LKS, LFA, LCA. These initialisms (groups of letters that form words) are not the only ways the industry refers to these technologies, as some OEMs have their own names for similar things. It all contributes to what can be dangerous assumptions on the part of a driver. "It's shocking how many people think their vehicle will apply the brakes in an emergency, when the car has no such system," she said.



When looked at in an overview, the number of initialisms used for various ADAS systems could easily overwhelm some drivers.

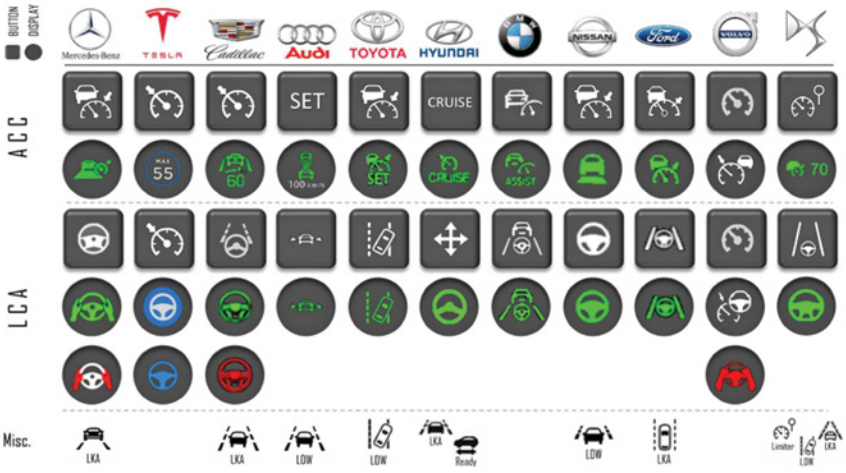
As an overview to the subject of control and indicator iconography, Shaw began with an introduction to user experience research by talking about a classic example: Norman is the author of "The Design of Everyday Things." A so-called Norman door is any door that is confusing or does not open or close as a user expects it to. For instance, an unlabeled door that a user does not know whether to push, pull or slide to

FROM TOP: NODAR; FORD/SUSAN SHAW

gain entry. And labels or icons don't necessarily help things.

Shaw, a member of the SAE committee on controls and display standards, said one of the group's goals is to standardize – as much as possible – across OEMs. One problem, she said, is that "OEMs want to have their own design. You want to get in a car and know it's a Mercedes or know it's a Ford. You don't want to be confused between the two. It should look different. It should feel different. But can we make these icons and buttons [more recognizable]?"

Shaw cited cruise-control buttons and indicators as one example. "All of them seem to have a speedometer icon, except for two. And then one of them has what I call a lollipop. It's actually a traffic sign. One of them has a car a couple have arrows. All of these are the button you use to turn on cruise control, BlueCruise, Super Cruise, whatever cruise you're working on, adaptive or not. And then when you get into the screen, they all show you something different." And then, some of them mean cruise is on and engaged, and some indicate the speed that is set. "They're mostly all different," she said. "If you're getting in a rental car, do you know that the feature is engaged?"



While designers want buttons and icons to be distinctive enough to hint that you're in, for example, a Mercedes and not a Chevrolet, there is room to communize them to promote universal understanding of what they mean, said Ford's Susan Shaw, a certified professional ergonomist.

FORD/SUSAN SHAW

Susan Shaw, Ford's customer research lead, works on an SAE committee on controls and displays that is working to communize buttons and icons as much as possible.

Shaw also mentioned the byzantine nature of some vehicles' ADAS settings menus. For instance, while it might take two button presses on one vehicle to adjust the sensitivity of forward braking, it can take far more on another. And they may be behind different menu names, such as "driver assistance" or "additional settings."

Shaw advocated for all OEMs to include deep UX expertise and experience on their development teams, including near-constant user testing, even for things that appear to be "just common sense." "We find repeatedly that common sense isn't common," she said, quoting Voltaire. For an example of iconographic confusion, Shaw pointed to her 78-year-old father "English is not his native language," she said. "And he told me there's a button on the steering wheel he's never touched because he thinks it's the Wi-Fi button. Well, it's the voice recognition. It's got the same arcs as the Wi-Fi thing at home does. I'm like, 'Well, those go up, these go out.' But to someone who's 78, that's not enough of a distinction. He's afraid he's going to have to pay for Wi-Fi, so he refuses to touch the button."

For older drivers and those new to driving, Saw recommend the website "My Car Does What?" which is managed by the **National Safety Council**. But, she emphasized, with commonization, the need for such a site would be reduced. In addition to helping reach a common understanding of vehicle controls and indicators that work, Shaw said a good user experience researcher will attempt to balance not only language issues but also regional and ethnic cultural differences that could lead someone to misinterpret or misuse a vehicle feature. Especially in an era in which OEMs are producing more "global cars" than ever.

Chris Clonts

QUALITY CONTROL

SkillReal says inexpensive camera and math add up to faster, better inspections

A company says that its digital twin alignment system, incorporating a sophisticated AI algorithm and an off-the-shelf camera, has the potential to revolutionize the auto industry, potentially saving it up to a staggering $20 billion in the effort to detect defects on the manufacturing line.

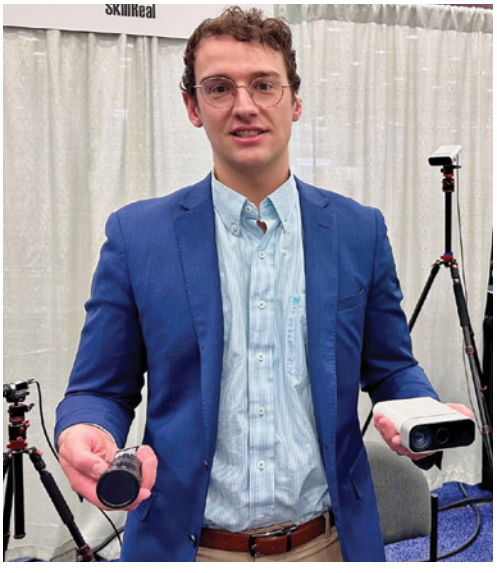
Generally, such inspections of spot welds, bolt holes and the like are handled one of three ways:

- Slow manual inspections that can have high error rates.
- Even slower inspection with coordinate-measuring machines (CMMs) that can take hours to inspect 150 spot welds.
- Tremendously expensive technology, such as lasers, that still aren't perfect.

SkillReal, an Israeli company that just exited stealth mode after proving its technology at **Volkswagen**'s Wolfsburg plant, says that using a roughly $1,000 camera and a gaming laptop, its software can compare a photo of a part with a digital twin, highlight problems and be completed in mere seconds.

That's in contrast with what some OEMs and suppliers do, which is essentially hand an inspector a Sharpie and a PDF showing weld locations and other features. The inspector then visually compares them and marks the part for deficiencies.

Pete Grabowski, SkillReal's chief operating officer at its North American headquarters in Livonia, Michigan, said the costs of these inspections can really add up because of OEM demands involved in safe launches, in which suppliers are made to pay up to $50,000 a month to third-party companies to ensure parts meet OEM and any regulatory standards. That adds up quickly when a supplier has dozens or hundreds of parts going to multiple vehicle programs.



Peter Grabowski with the part of the tech that, combined with its algorithms, can improve the speed and accuracy of parts inspections.

BOTH IMAGES: SAE/CHRIS CLONTS

The system results in a standard two-dimensional photo before sub-millimeter comparisons are made.

He said that what sets SkillReal's system apart is not just detecting features represented in a CAD that have an XYZ co-ordinate, but how accurate the system is. "We can pinpoint the exact location of those features with submillimeter accuracy. And we do that in seconds." The system is forgiving, too, able to account for positional variations of the photographed test object. One test of the system that Grabowski called "our John Henry versus the machine" was conducted at a Detroit area stamping and assembly plant. The test pitted SkillReal against the plant's best marker auditor in a daunting challenge: evaluating welds and other items on the entire underbody of a vehicle involving multiple photos. The plant's operator finished in 90 minutes. "We were done in less than 10," Grabowski said.

At the VW plant in Wolfsburg, the results were even more dramatic. Grabowski said VW had two operators working entire eight-hour shifts checking spot welds, while SkillReal's software covered the same ground in 15 seconds. "They put us through the wringer for two years," he said. "We want to make sure that these measurements are really sub-millimeter, that you're really right in saying where they are. So they take parts, measure it with their system, our system, then they put it on a CMM. We got it commercially viable and then launched in the States through our group NorthStar Vision, and now we're adding more features."

The key to efficiency and cost control for the suppliers and manufacturers, one Skillreal adviser said, is to detect the problem before the next part is built or sub-assembly completed.

The SkillReal software can support up to eight cameras from the same PC running an **NVIDIA** graphics processing unit. Workers can be trained to use the system in a single eight-hour shift, Grabowski said.

SkillReal's founder and CEO is Shai Newman. Before Skillreal, Newman founded Compedia, a company that helps publishers transform their content into virtual 3D educational environments. The idea for the 2D-camera inspection technology was born when Siemens approached Compedia in its own search for

SAE/CHRIS CLONTS

A slide from a SkillReal presentation shows the digital twin at left and the company's inspection photo.

a system that it hoped would power some kind of augmented reality glasses for the manual line inspectors.

Asked to detail the inner workings of the math, Grabowski said the algorithm does "billions of hardcore computer-vision calculations" that actually break the 2D image up pixel by pixel. "It does the same thing with a 3D model for that perfect overlay," he said. "And then we layer the AI on top so we can know where to look." In a nifty compute-saving trick, the system only scans where the components are supposed to be. In other words, there's no need to waste processor power analyzing locations that don't include features to inspect.

Grabowski said the company does see more future uses of the technology. "The automotive body in white is our bread and butter for the time being," he said. "But we see expansion into final assembly of automotive interior trim panels and more. There are so many different avenues that we can use this in automotive alone. No one's doing this type of ultra-fast, sub-millimeter accurate dimensional check."

He said the company believes its first-mover advantage and series of patents protect it against potential competitors.

Chris Clonts

SKILLREAL

PROPULSION

Toyota, Mazda, Subaru agree carbon is 'the enemy' with new internal combustion engine announcement

Toyota, **Mazda** and **Subaru** announced a new technological effort to create new internal combustion engines and ways to use them in the electrification era, specifically for hybrid and plug-in hybrid vehicles. The companies said at a joint press conference in Japan that they would encourage increased use of petroleum alternatives like biofuels and eFuels in their effort to create carbon-neutral vehicles. A joint statement from the three OEMs claims this push for new and better ICEs comes with a focus on "carbon as the enemy" as they develop engines that can better work with electric motors, batteries, and other electric drive units. Toyota, Mazda and Subaru made clear they are not getting rid of EV-only vehicle plans.

Here's how each company will approach the new ICE+EV era (quotes provided in English by on-site interpreters).

Prototype Subaru Crosstrek equipped with next-generation hybrid system.

Toyota: smaller, better engines

Toyota will develop new, low-displacement inline four-cylinder engines, Toyota president and CEO Koji Sato said, with an emphasis on increased efficiency and more compactness by combining the engine with an electric power unit.

"Based on the concept of adding an engine onto an electric unit, we are refining our technology to achieve higher efficiency than before by leveraging the areas in which each electric motor and engine excel," Sato said. "By optimizing engines for electrification, we will make their structure more competitive and compact, which will lead to more flexibility in engine installations in cars."

From left to right: Atsushi Osaki, Subaru president and CEO; Tetsuo Fujinuki, senior managing executive officer and CTO, Subaru; Koji Sato, Toyota president and CEO; Hiroki Nakajima, executive vice president and CTO, Toyota; Masahiro Moro, Mazda president and CEO; Ichiro Hirose, senior managing executive officer and CTO, Mazda.

BOTH IMAGES: TOYOTA

Toyota's chief technology officer, Hiroki Nakajima, said that the company's new, naturally aspirated 1.5-L engine would be 10% smaller in both volume and height, while offering better fuel economy and around the same power output. The new 1.5-L turbo engine would be similarly smaller (a 20% volume reduction and a 15% height reduction) compared to the current 2.5-naturally aspirated engine and will trade slightly worst fuel-efficiency for a 30% improvement in horsepower. Finally, Toyota's new 2.0-L engine will, compared to the current 2.4-L turbo, be 10% smaller and shorter, with better efficiency and, again, around 30% higher hp.

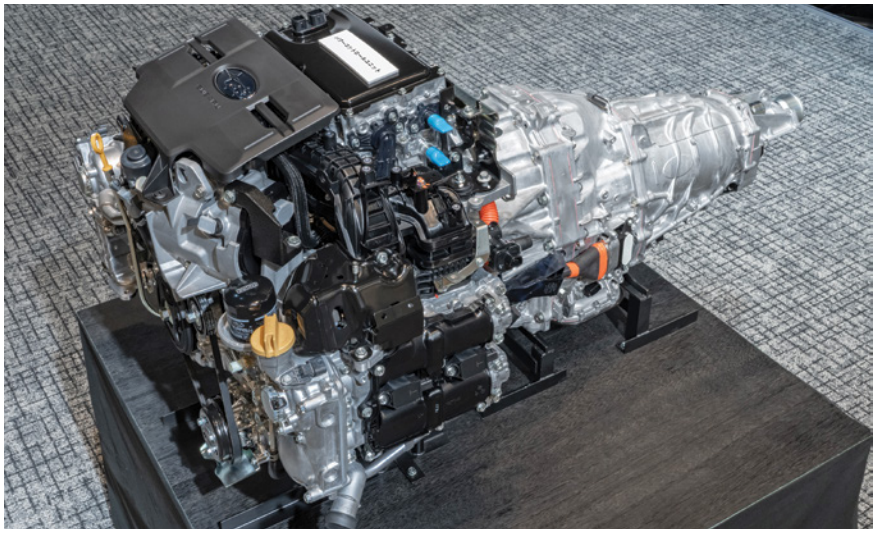
Mazda: rotary to the future

Mazda is looking to the past when it comes to finding the correct future for ICEs by considering using the rotary engine for the new HEVs and PHEVs.

"From an early stage, we have explored the environmentally friendly potential of these engines, including burning hydrogen in the 1990s," Mazda president and CEO Masahiro Moro said during the press conference. "Rotary engines are compact and lightweight, and yet have a high output. The structural characteristics make them omnivores with respect to fuels. What's more, though not widely known, their compact size and relative freedom in the layout of auxiliary parts allow for high space efficiency and easy mounting of electric devices, offering a great advantage for innovative packaging and design."

Moro said the inherent benefits of a rotary engine, specifically the quietness and low vibration, give it a "singular value."

"We believe that the rotary engine holds great potential for providing new value in the age of electrification and we are devoting all our energies to overcoming the current challenge of emission compliance for our rotary engines," he said.



Subaru's next-generation hybrid powertrain system.

Subaru: EVs with AWD will keep the "Subaru difference"

Subaru is not giving up on the Boxer engine. New ICE-plus-electric powertrains from the company will keep the brand's symmetrical all-wheel drive layout for future hybrid and PHEV models, but Subaru president and CEO Atsushi Osaki said his company remains open to all different kinds of powertrain options.

"At Subaru, we are navigating this period of a great transformation by focusing on flexibility and expandability," he said. "At Subaru, internal combustion engines mean horizontally opposed engines. The company's pioneers regard longitudinally mounted, horizontally opposed engines as the logical and ideal source of power for automobiles. This has developed into Subaru's unique symmetrical AWD system with a superior packaging that takes advantage of a symmetrical powertrain layout and the features of a horizontally opposed engine: lightweight, compact, low center with gravity reduced vibration and the safety in collisions."

Subaru's new powertrain layout, still with AWD, will be a series-parallel system that uses an ICE that will either directly power the wheels or send power to a generator, which will in turn power a battery that moves the motor and then the wheels. The car will decide where to send ICE energy by choosing the most-efficient path.

Subaru's future hybrid and PHEV models will likely have fuel tanks that are the same size as a gasoline-only car, Subaru said, but it won't need to be filled with a petroleum product. "Subaru is also eager to collaborate in efforts to promote the adoption of a carbon neutral," Osaki said. "The challenge of creating a carbon neutral society needs to be tackled and not just by the three companies here, but by all of the Japanese industry and society."

Subaru said it will start producing transaxles for the next-generation hybrid system in the fall of 2024 at its Kitamoto Plant in Saitama Prefecture, Japan.

Sebastian Blanco

Prototype vehicle with 1.5-L in-line 4-cylinder engine in development by Toyota Motor Corporation.

BOTH IMAGES: TOYOTA

EXPERT Insight

Expert Insight Interview with Jonathan Drew of TÜV SÜD

TÜV SÜD is a global testing and certification organization based in Munich, Germany. In this edition of Expert Insight, we speak with Jonathan Drew, senior director of TÜV SÜD Transportation Testing Group in North America, about how the company's labs interact and how TÜV SÜD looks to the future. Drew has more than 30 years of experience in the automotive industry. For the last eight years, he has worked in the testing industry, supporting automotive, truck, power sports, construction, agriculture, and aerospace.

Expert Insight: **Let's start with the various testing services that TÜV SÜD offers. You support customers throughout the automotive value chain as they develop and validate their components and systems, right?**
Jonathan Drew: Yes, our expert testing group works from components all the way through full vehicle-level testing. We're focused on four main areas:

- First, TÜV SÜD is the global expert in EV battery testing. We do development, performance and safety/abuse testing at the cell, module and pack level for all series of transportation industries, in both the Detroit and Toronto areas.
- Environmental testing of mechanical and electrical components, including vibration, hot and cold temperature and humidity testing, corrosion, altitude, and moisture and dust protection. We have a long history of this testing and currently have the largest and most capable vibration and multi-axis simulation testing in the country.
- Next, we have two electromagnetic compatibility/interference (EMC/EMI) labs in Detroit and Minneapolis, working on component level, system level and full vehicle, including a vehicle paired with an EV dynamometer.
- The final scope of testing is vehicle buzz-squeak-rattle (BSR) testing. Our team has over 150 years of combined experience in identifying and solving vehicle BSR issues – those rattles and sounds that drive you crazy when you hear them on your new car. We work with numerous vehicle OEMs at their assembly plants, including with a portable environmental 4-poster we call mCREST – the only independent company in the world with such a capability.

Expertise Matters: Since 2009, we've been the leading independent lab for EV battery testing in North America.

Expert Insight: **How does TÜV SÜD adapt its testing capabilities to address new technologies? Do you have specific testing methodologies or protocols that you've developed to evaluate the safety and reliability of these technologies?**
Drew: TÜV SÜD is 160-year-old global testing company with automotive expertise in North America, the UK, Germany, Italy, Korea, China, and Japan, just to name a few. We have a number of global working groups put together to ensure that we're sharing the latest developments, specifications and test protocols. One example is our German team developing the testing capability for the hydrogen delivery systems to ensure safe, leak-free components, especially at ultra-high pressure. This modular system was perfected in Germany and can now be deployed in other regions, including North America, as the fuel cell and hydrogen combustion engine markets develop.

I want to go back to our BSR expertise and the mCREST portable 4-poster. The industry did not have this particular capability and TÜV SÜD developed it, deployed it and are now in discussions with multiple OEMs about expanding our capacity with additional portable units.

Expert Insight: **How does TÜV SÜD share knowledge, both within the company and your testing teams and with industry partners or regulatory bodies, to keep updating your automotive testing capabilities?**
Drew: That's a really strong benefit of our community within TÜV SÜD. Not just that we have strong technical leaders in our industry, but we have it in multiple regions of the world because as, as we all know, different regions develop certain technologies or focus on those technologies earlier than other regions.

TÜV SÜD is global and we have experts in all of those regions. We can use that expertise regionally with the customers, develop that capability locally and then deploy with customers in other regions as they're looking to expand. We like to be in the same areas as our customers and it's worked out really well because, I mean, let's be honest, most of our key customers are global, just as TÜV SÜD is.

Expert Insight: **Finally, how does TÜV SÜD support the industry's sustainability goals?**
Drew: In addition to TÜV SÜD's global pledge toward carbon neutrality, clearly our EV battery testing is supporting a green industry. Even in the design of our new Auburn Hills lab we took this to heart, sourcing 100% of the electricity from green energy, as well as protecting the environment from corrosive and toxic battery emissions through the use of a wet scrubber and filtration system. I'm really proud of TÜV SÜD's commitment to sustainability, to our customers, to the region and to the environment. ■

Watch the full interview with Jonathan.

Tackling the Elements With the Ineos Grenadier Quartermaster and Wagon

Spinning up a new car company in the 2020s typically means there's a new electric crossover being unveiled that may (or may not) come to market sometime in the next four years. British petrochemical company **Ineos** went in another direction.

The company's petrol and diesel-powered Grenadier lineup resembles the Defenders of the '70s and '80s. An homage to a time before fuel injection, touchscreens and backup cameras, the Grenadier lineup has all of those features but still looks like something from the time before CDs.

Ineos knew that trying to build many of the elements required to create a modern vehicle would be capital- and time-intensive. So, the company went shopping. Under the hood lies the award-winning B58 **BMW** 3.0-L turbo inline-six engine, paired with the same ZF 8-speed transmission that BMW uses in its vehicles.

The engine itself has been tuned specifically for the Grenadiers outputting 281 horsepower and 331 pound-feet (449 Nm) versus the B58's default 382 hp and 369 lb-ft (500 Nm). This is to match the off-road focus of the vehicle, which uses an actual mechanical shifter next to the BMW-sourced automatic transmission lever to shift the vehicle to lower gearing.

The Ineos Quartermaster was built for the off-road life, and suffers slightly on asphalt.

This is where those who have driven off-roaders from the '70s, '80s, and early '90s will enter the nostalgia zone. Ineos wanted to reduce the number of ECMs in the vehicle to reduce cost. The company also wanted to recreate the off-roading vibes of long ago – and has succeeded. As I shifted (more like crammed with a satisfying thud) the vehicle into low ahead of some rock crawling during a recent test drive, memories of doing the same thing in my youth flooded back, and I immediately understood why someone would purchase a Grenadier.

On a triple-digit day on a dusty trail in Joshua Tree, I drove both the Quartermaster pickup and Grenadier Station Wagon. While from a new company, both felt extremely capable of tackling the rocks, ruts, and sand of the desert course. With a locking center differential and optional front and rear locking differentials, the vehicles were never overwhelmed by the terrain. Even during extreme articulation, where I sat shotgun, the off-roader never strained. I complained about the lack of drama to the driver who then descended "quicker than normal" to appease my need for excitement.

One of the more interesting decisions Ineos made was to use a recirculating ball instead of the more common rack-and-pinion steering. The

Rear view of the new Ineos Quartermaster Station Wagon.

BOTH IMAGES: INEOS

reasoning is fair. Recirculating ball technology is more robust and less likely to be damaged during difficult off-road sessions. It also allows for a more incremental steering experience while tackling the environment. There's also the benefit that the steering is less likely to snap back while on rough terrain.

Frequent off-roaders typically keep their thumbs out of the inside of the steering wheel to reduce the chances of their thumbs being injured when a snapback occurs. Because the Grenadiers' steering ratio is so high, this is less of an issue. It all sounds great, but...

On asphalt, this design could present a problem for some potential owners. Both vehicles experience quite a lot of play in the steering. There's also a lack of self-centering. It's a feature, not a bug. But for those coming out of, say, a new **Land Rover** or **Toyota**, it's an entirely different steering experience. Greg Clark, executive vice president of Ineos Automotive, told SAE Media that new customers often require a bit of a learning curve to adjust. After about 20 minutes, new owners typically become accustomed to the difference, Clark said.

In my time behind the wheel, I found it to be not great on-road but also not a deal breaker. It'll never be a back-roads carving machine. On tight corners at high speed, well, this is not the vehicle for high-speed cornering. Ineos is upfront about this. Enthusiasts who have purchased or pre-ordered the vehicle likely understand the tradeoff. Those looking for something different to impress friends and their community will just have to prepare themselves for a new experience.

The interior experience mirrors the exterior. Instead of the touchscreen taking care of all features, it's mostly there for the speedometer, gear and fuel information, off-roading attitude details and connecting your phone to handle music and navigation.

Large, satisfying-to-push buttons below the screen handle volume control, climate adjustments (including defrost) and even parking assistance. On the ceiling you'll find controls for differential locks and a series of aux switches

The Ineos Quartermaster loaded up for off-road and overlanding duty.


The new Ineos Grenadier has a retro vibe to match the powertrain that uses a BMW 3.0-L turbo inline-six engine.

for lights, winches, or whatever else an owner wants to install and power on the vehicles. Again, these are all controlled by large buttons. Besides the aesthetic appeal, there's value for those who live in colder climates as these can be operated while wearing heavy gloves.

While Ineos is a bit of an outlier bringing an ICE vehicle to market while other startups are going all-in on EVs, there is electrification in its future. The Fusilier is slated to land in 2027 as a BEV or a series hybrid. Ineos has been mum on most of the details about the vehicle, but it'll be interesting to see if the interior continues with the automaker's analog-centric aesthetic.

When asked about the electric future, Clark said he was confused by some of the hatred directed towards the powertrain and said that electrification is inevitable. Of course, for Ineos, the future is wrapped in nostalgia and purpose-built vehicles powered by both gasoline and electrons that are ready to tackle terrain with ease.

Roberto Baldwin

2025 Cadillac Optiq EV arrives with standard dual motors

Continuing its rollout of EVs, **Cadillac** revealed the 2025 Optiq SUV, the company's most affordable EV yet and a smaller sibling to the popular Lyriq that was introduced last year.

With a company-estimated range of 300 miles (482 km), the Optiq comes standard with dual-motor AWD, three years of Super Cruise hands-free driving, and what Cadillac officials say is segment-best cargo capacity and second-row space.

The Optiq's wheelbase is 116 inches (2,954 mm), six inches (152.4 mm) shorter than the Lyriq, the next size up in the EV lineup. Overall, the Optiq is 190 inches (4,820 mm) long, 84 inches (2,126 mm) wide, including mirrors, and 65 inches (1,644 mm) tall.

The shorter wheelbase and the 300hp (224 kW) combined power of the dual motors that generate 354 lb-ft (480 Nm), make what Optiq chief engineer John Cockburn called a "spirited driving experience" at a pre-reveal briefing attended by SAE Media.

Supporting that claim (media will get a chance to drive the Optiq before production begins in the fall) is a suspension comprising coilover struts at the front and a five-link rear with Passive Plus dampers, which have the self-adjusting valve system also seen on the Lyriq. Seventeen-inch (432 mm) disc brakes provide the stopping power on either standard 20-inch (508 mm) or optional 21-inch (533 mm) wheels fitted with low-profile, low-rolling-resistance tires.

Cockburn said the Ultium battery and its enclosure help give the Optiq "fantastic torsional rigidity."

Cockburn has a background that includes many GM performance models, including the **Chevy** Corvette, CTS-V Blackwing and the Escalade-V. He said Optiq's unique look stayed relatively unchanged from concept sketches through the engineering process "because engineers knew retaining distinctive traits was important."

FROM TOP: ROBERTO BALDWIN; INEOS

The 2025 Cadillac Optiq is the smallest EV in the company's lineup and will start at around $54,000.

The Optiq's 85 kWh lithium ion Ultium battery has an NCMA cathode and blended graphite anode. Using a 240V Level 2 charger with 7.7 kW AC, it can gain 24 miles (38 km) of range per hour of charge. Higher kW ratings gain more per hour, up to 55 miles (89 km) of range per hour at 19.2 kW. At a DC fast charger, it can add 79 miles (127 km) of range every 10 minutes.

Other driving features of the Optiq include:

- Regen On Demand, which lets the driver engage in regenerative braking via a steering-wheel-mounted paddle. The driver can bring the car to a complete stop if desired.
- One-pedal driving, a separate setting that lets a driver accelerate, decelerate and stop the vehicle using only the accelerator.
- Four drive modes: Tour, the everyday setting; Sport for enhanced road feel and improved steering; Snow/Ice, which controls wheelspin; and My Mode, in which braking response and steering feel can be customized.

All-in, the Optiq weighs 5,192 pounds (2,355 kg).

Cockburn emphasized the effort the development teams put into efficiency, especially with regard to aerodynamics. He said that's why the rear spoiler has two levels – the upper spoiler deals with high-velocity air while the lower helps shape the exit airflow. "There are hundreds of thousands of hours of computational fluid dynamics in [the exterior of] this vehicle," he said.

Exterior design flourishes

Exterior design lead Dillon Blanski said it was important to make the Optiq look both luxurious and athletic. "You get this sweeping line from the hood through the big windshield and along the glass roof" to the rear, he said. "Darker lower areas really give it a lean look, and we shortened the front overlays [compared to Lyriq] to get really dynamic proportions."

The Black Crystal grille includes Cadillac's signature vertical lighting and a unique laser-ablated geometric pattern across its entire face, and radar and other sensors are well-hidden. The headlights have various animations that can be programmed at startup. At the rear,

The Optiq's front lighting maintains consistent Cadillac themes while showing off the unique laser-etched geometric design across the entire grille.

BOTH IMAGES: CADILLAC

The 33-inch (838-mm) combined cockpit and infotainment screen, partially shown here, can display up to 1 billion colors.

CADILLAC

the taillights are in Cadillac's signature vertical orientation. The rear quarter panel window is a new design that Blanski called a "planted sail." It's a dark, horizontal piece of acoustic glass with an etched gray design meant to align with the company's Mondrian crest.

When a driver approaches the Optiq, the key fob initiates a choreographed lighting animation "as a greeting," Blanski said.

Inside: An enormous LED

The showstopper of the Optiq interior has to be the 33-inch (838-mm) diagonal curved LED display with 9K resolution and the ability to display more than a billion colors. It is highly customizable in two areas: the driver-focused area and the infotainment / general vehicle controls area.

Gary Mack, the interior design lead, said at the briefing that all display surfaces in the vehicle are angled toward the driver.

Bryan Nesbitt, executive director of Cadillac design, said that in addition to hitting goals for luxury and youthfulness (the target market is millennials 29 to 39 years old), the goal was to make the interior feel immersive.

Chief engineer Cockburn said sustainability and materials innovation were

The Optiq's rear quarter-panel glass features this design that the company says echoes its Mondrian logo.

CADILLAC

important goals for the design and engineering teams because it is not only the right thing to do for the environment but because it is increasingly important to customers. To that end, Cadillac's news release called Optiq's interior its most progressive. The EV's patterned accent fabric is made from yarn made up of 100% recycled materials, and the PaperWood veneer is a 50/50 blend of tulip wood and recycled newsprint.

Tech, and about those names

Other tech features of the Optiq include:

- Advanced radar, camera and ultrasonic sensors throughout the vehicle will "give customers enhanced views and sensing of their surroundings in everyday driving scenarios," Cadillac said in its news release.
- Cadillac-standard safety and assistance features, including adaptive cruise, Blind Zone Steering Assist, Enhanced Automatic Parking, Forward Collision Alert and more.
- Built-in Google compatibility, including **Google** Maps and Google Assistant.
- Standard 19-speaker AKG audio system with Dolby Atmos.

The Optiq will start at around $54,000, but precise details will be announced closer to the on-sale date. The U.S. version will be built in Mexico. Cadillac's Shanghai plant is already making models for the Chinese market.

Cockburn said that despite General Motors' rough launches involving the Ultium platform, the company has learned much. "We will not have Ultium-related launch problems," he said.

By the way, Cadillac officials would like to remind everyone that Optiq is pronounced "op-tik," not "op-teek," and that the last syllable is pronounced this way for most of Cadillac's EVs such as the Lyriq, Celestiq and the coming Vistiq. The only exception is the Escalade IQ, for which the last two letters are pronounced, well, like the last two letters.

Chris Clonts

ARE TODAY'S SENSORS READY FOR *next-level automated driving?*

The Mercedes-Benz EQS sedan can use Drive Pilot on major freeways in California and parts of Nevada.

A look at who's doing what when it comes to sensors for an L3 world.

by John Dinkel

SAE Level 3 automated driving marks a clear break from the lower levels of driving assistance since that is the dividing line where the driver can be freed to focus on other things. While the driver may sometimes be required to take control again, responsibility in an accident can be shifted from the driver to the automaker and suppliers. Only a few cars have met regulatory approval for Level 3 operation. Thus far, only **Honda** (in Japan), the **Mercedes-Benz** S-Class and EQS sedans with Drive Pilot and **BMW**'s recently introduced 7 Series offer Level 3 autonomy.

With more vehicles getting L3 technology and further automated driving skills being developed, we wanted to check in with some of the key players in this tech space and hear the latest industry thinking about best practices for ADAS and AV Sensors.

Towards More Accurate 3D Object Detection for Robots and Self-Driving Cars

Researchers from Japan's **Ritsumeikan University** have developed DPPFA-Net, an innovative network that combines 3D LiDAR and 2D image data to improve 3D object detection for robots and self-driving cars. Led by Professor Hiroyuki Tomiyama, the team addressed challenges in accurately detecting small objects and aligning 2D and 3D data, especially in adverse weather conditions.

DPPFA-Net incorporates three key modules:

- Memory-based Point-Pixel Fusion (MPPF): Enhances robustness against 3D point cloud noise by using 2D images as a memory bank.
- Deformable Point-Pixel Fusion (DPPF): Focuses on key pixel positions for efficient high-resolution feature fusion.
- Semantic Alignment Evaluator (SAE): Ensures semantic alignment between data representations during fusion.

The network outperformed existing models in the KITTI Vision Benchmark, achieving up to 7.18% improvement in average precision under various noise conditions. It also performed well in a new dataset with simulated rainfall.

Ritsumeikan University researchers said this advancement has significant implications for self-driving cars and robotics. It could lead to reduced accidents, improved traffic flow and safety, and enhanced robot capabilities in various applications. The improvements in 3D object detection are expected to contribute to safer transportation, enhanced robot capabilities, and accelerated development of autonomous systems.

AEVA

Aeva has introduced Atlas, the first 4D lidar sensor designed for mass-production automotive applications. Atlas aims to enhance advanced driver assistance systems (ADAS) and autonomous driving, meeting automotive-grade requirements.

The company's sensor is powered by two key innovations: the fourth-generation lidar-on-chip module called Aeva CoreVision that incorporate all key lidar elements in

MERCEDES-BENZ

Drive Pilot can operate the vehicle when on approved freeways with clear lane markings and in moderate to heavy traffic at speeds up to 40 mph (64 km/h).

a smaller package, using silicon photonics technology, and the new Aeva X1 new system-on-chip (SoC) lidar processor that integrate data acquisition, point cloud processing, scanning system, and application software.

These innovations make Atlas 70% smaller and four times more power-efficient than Aeva's previous generation, enabling various integration options without active cooling. Atlas uses Frequency Modulated Continuous Wave (FMCW) 4D lidar technology, which offers improved object detection range and immunity to interference. It also provides a 25% greater detection range for low-reflectivity targets and a maximum range of 500 meters (1,640 ft).

Atlas is accompanied by Aeva's perception software, which harnesses advanced machine learning-based classification, detection and tracking algorithms. Incorporating the additional dimension of velocity data, Aeva's perception software provides unique advantages over conventional time-of-flight 3D lidar sensors.

Atlas is expected to be available for production vehicles starting in 2025, with earlier sample availability for select customers.

Aeva's co-founder and CTO Mina Rezk said that Atlas will enable OEMs to equip vehicles with advanced safety and automated driving features at highway speeds, addressing previously unsolvable challenges. Rezk believes Atlas will accelerate the industry's transition to Frequency-Modulated Continuous-Wave 4D lidar technology, which is increasingly considered the end state for lidar due to its enhanced perception capabilities and unique instant velocity data.

The steering wheel of Drive Pilot-equipped Mercedes-Benz vehicles will display different color lights to indicate the system's status. It will pulsate red to warn the driver to take over, for example.

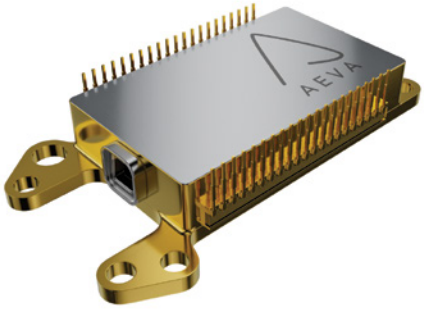
BOTH IMAGES: MERCEDES-BENZ

Luminar

Following several rocky financial months and five years of development, global automotive technology company **Luminar** is launching Sentinel, its full-stack software suite. Sentinel enables automakers to accelerate advanced safety and autonomous functionality, including 3D mapping, simulation, and dynamic lidar features. A study by the Swiss Re Institute showed cars equipped with Luminar lidar and Sentinel software demonstrated up to 40% reduction in accident severity.

ARE TODAY'S SENSORS READY FOR *next-level automated driving?*

The new BMW 7 Series is the first vehicle in the world approved to use a combination Level 2/Level 3 driving assistance systems.



The Aeva CoreVision lidar-on-chip module (left) and the Aeva X1 system-on-chip processor.

Developed primarily in-house with support from partners, including **Scale AI**, **Applied Intuition,** and **Civil Maps** (which Luminar acquired in 2022), Sentinel leverages Luminar's lidar hardware and AI-based software technologies.

CEO and founder Austin Russell said Luminar has been building next-generation AI-based safety and autonomy software since 2017. "The majority of major automakers don't currently have a software solution for next-generation assisted and autonomous driving systems," he said. "Our launch couldn't be more timely with the new NHTSA mandate for next-generation safety in all U.S.-production vehicles by 2029, and as of today, we're the only solution we know of that meets all of these requirements."

Mobileye

Mobileye has secured design wins with a major Western automaker for 17 vehicle models launching in 2026 and beyond. The deal covers Mobileye's SuperVision, Chauffeur, and Drive platforms, offering varying levels of autonomous capabilities from hands-off, eyes-on driving to fully autonomous robotaxis.

The new BMW 7 Series uses HD maps from HERE to power its Level 2+ automated driving capabilities.

All these systems will use Mobileye's EyeQ 6H chip, integrating sensing, mapping, and driving policy. The agreement includes customizable software to maintain brand-specific experiences.

CEO Amnon Shashua called this an "historic milestone" in automated driving, emphasizing the scalability of Mobileye's technology. He highlighted SuperVision's role as a bridge to eyes-off systems for both consumer vehicles and mobility services.

Initial driverless deployments are targeted for 2026.

BMW

BMW's new 7 Series received the world's first approval for a combination Level 2/Level 3 driving assistance systems in the same vehicle. This milestone offers drivers unique benefits from both systems.

The Level 2 BMW Highway Assistant enhances comfort on long journeys, operating at speeds up to 81 mph (130 km/h) on motorways with separated carriageways. It allows drivers to take their hands off the steering wheel for extended periods while remaining attentive. The system can also perform lane changes autonomously or at the driver's confirmation.

The Level 3 BMW Personal Pilot L3 enables highly automated driving at speeds up to 37 mph (60 km/h) in specific conditions, such as motorway traffic jams. Drivers can temporarily divert their attention from the road, but they have to retake control when prompted.

This combination of systems offers a comprehensive set of functionalities for a more comfortable and relaxing driving experience on both long and short journeys. The BMW Personal Pilot L3, which includes both systems, is available exclusively in Germany for €6,000 (around $6,500). Current BMW owners can add the L2 Highway Assistant to their vehicle, if applicable, free of charge starting August 24.

CLOCKWISE FROM TOP LEFT: BMW; BMW; AEVA

"The majority of major automakers don't currently have a software solution for next-generation asssisted and autonomous driving systems."

Mercedes-Benz

Mercedes-Benz's groundbreaking Drive Pilot Level 3 autonomous driving system is available for the S-Class and EQS Sedan. It allows drivers to disengage from driving in specific conditions, such as heavy traffic under 40 mph (64 km/h) on approved freeways under certain circumstances. The system uses advanced sensors – including radar, lidar, ultrasound, and cameras – to navigate and make decisions.

While active, Drive Pilot enables drivers to use in-car entertainment features on the central display. However, drivers must remain alert and take control when requested. Drive Pilot functions under the following conditions:

- Clear lane markings on approved freeways
- Moderate to heavy traffic with speeds under 40 mph
- Daytime lighting and clear weather
- Driver visible by camera located above driver's display
- The car is not in a construction zone.

Drive Pilot relies on a high-definition 3D map of the road and surroundings. It's currently certified for use on major freeways in California and parts of Nevada.

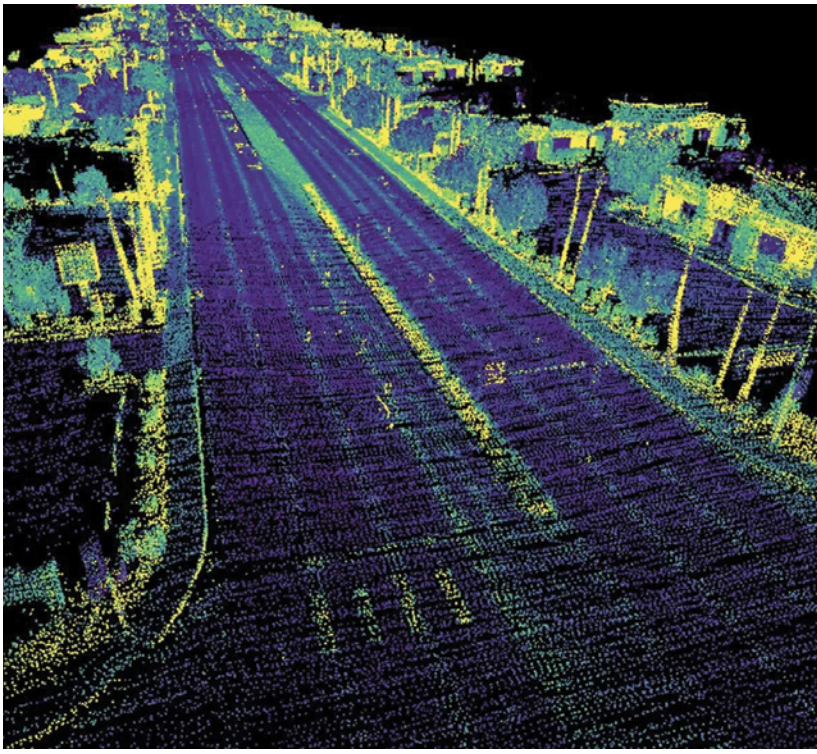
NPS

At CES 2024, **Neural Propulsion Systems** (NPS) demonstrated its ultra-resolution imaging radar software for automotive vision sensing. The technology significantly improves radar precision without expensive lidar sensors or weather-related limitations.

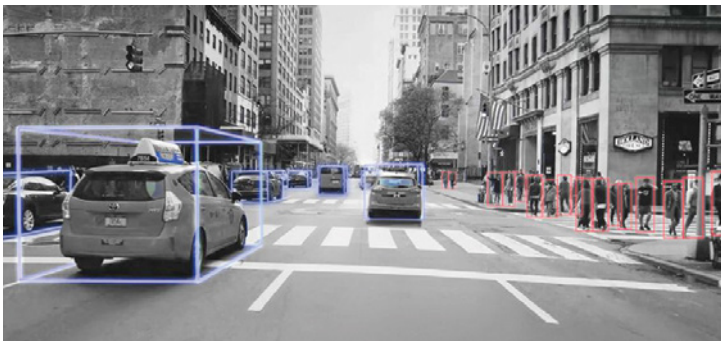
NPS CEO Behrooz Rezvani likens the improvement to enhancing automotive imaging from 20/20 to better than 20/10 vision. The software enables existing sensors to resolve to one-third of the radar beam-width, creating a 10 times denser point cloud and reducing false positives by over ten times, the company said.

The demonstration compared performance using **Texas Instruments** 77 GHz chipsets with and without NPS technology. Former **GM** R&D vice president and **Waymo** advisor Lawrence Burns noted that automakers can use NPS to enhance safety, performance, and cost-effectiveness of driver-assistance features using existing hardware.

NPS' algorithms are based on the Atomic Norm framework, rooted in magnetic resonance imaging technology. The software can be deployed on various sensing platforms and implemented on processors with neural network capability. Advanced applications of NPS software with wide aperture multi-band radar enable seeing through physical barriers like shrubs, trees, and buildings — and even around corners. The technology is poised to help automakers meet NHTSA's proposed stricter standards for automatic emergency braking, aiming to reduce pedestrian and bicycle fatalities on U.S. roads. ■



Luminar uses real-time, lidar-based HD mapping in consumer vehicles to develop its next-generation ADAS and autonomy technologies.



Mobileye claims its imaging radar has more detailed object detection capabilities than traditional radar systems.

FROM TOP: LUMINAR; MOBILEYE

PASSION FOR SAFETY–
A DRIVE FOR INNOVATION

ZF's latest safety advances open up, tighten up and DOUBLE DOWN

A prototype steering wheel with ZF Lifetec's new top-deploy driver airbag.

ZF rethinks safety with new airbags, belt tensioner.

by Sebastian Blanco

ZF knows that the steering wheel remains one of the most relevant components in an automotive interior, because this is where drivers have direct contact to the vehicle. As steering wheels become adorned with more functions than some drivers know what to do with, **ZF** put Marc Schledorn in charge of the teams rethinking how the driver airbag could operate in a world with ever-busier steering wheels.

The solution is a new type of steering wheel airbag that **ZF Lifetec** (ZF's renamed Passive Safety Systems division) announced in June. Instead of moving through a thermoplastic airbag cover mechanically fixed in the center of the wheel, Schledorn told SAE Media, the new design positions the airbag on the top side of the steering wheel and then expands through the upper rim of the wheel when needed.

"The frontal opening of a conventional driver airbag has limitations regarding design and material selection in the opening area," Schledorn said. "When those designs become more seamless, we might see a need for new materials. For instance, instead of using thermoplastic materials, [we might] use more polycarbonate materials. That's why ZF Lifetec began development of an alternative driver airbag concept."

Schledorn, officially the senior manager of steering wheel systems advanced development at ZF, said the new top-deploy airbag enables a higher degree of design freedom and allows engineers to integrate additional features into the steering wheel's front panel.

Meet the ACR8.S

In July, ZF Lifetec announced another new product designed to provide engineers with even more design freedom in a vehicle's interior. A variant of the fourth-generation ACR8 active belt tensioner, the new ACR8.S can be integrated into a seat for a cleaner look. The integration allows the restraint to reposition the seat occupants to be better protected in a possible crash and can tighten the seat belt if needed.

Within milliseconds of when the ACR8.S gets information from the vehicle's sensors that a crash will happen, the system activates a pyrotechnic belt tensioner to pull "the occupant's upper body back towards the seat backrest in a fraction of a second." Then, during the crash, the seatbelt tensioner guides the occupant towards the airbag. ZF Lifetec said this tightening, like the airbag it's in sync with, is irreversible and will only happen "in the event of a correspondingly serious accident."

The ACR8.S can also send tactile warnings through the seat belt to let the driver know something, like that they have to take over the steering wheel. This feature requires the OEM to choose one of the nine different modular setup combinations currently available for the ACR8.S that includes both the webbing motion sensor and the electric drive unit.

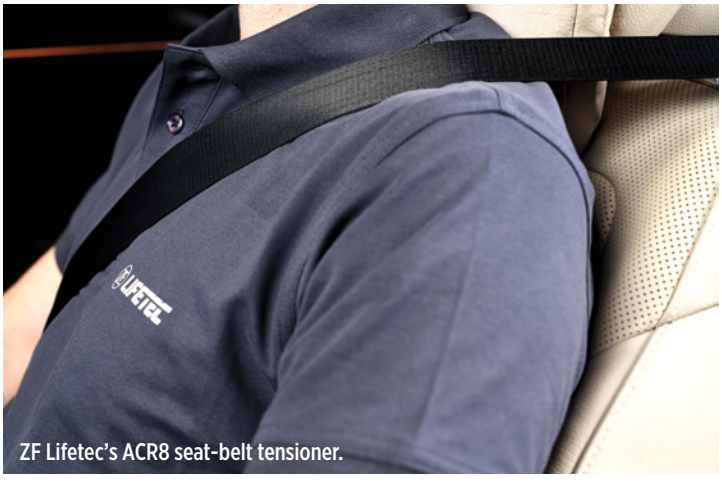
"In these situations, the belt system's pulses close to the body are more efficient warning signals than displays or LEDs and minimize the reaction time," Harald Lutz, head of development at ZF Lifetec, said in a statement.

Another optional function in the ACR8.S, this one for comfort, is a way to allow less tension in the seat belt when it is in normal operation and the ability to tighten slightly during "dynamic driving."

Providing a less restrictive belt feel and opening up space for designers to work are not the only driving

ZF LIFETEC

When needed, the top-deployed airbag expands out of the top of the center of the steering wheel and through the top rim.



ZF Lifetec's ACR8 seat-belt tensioner.

"Look far into the future. We need to start to think about how to design airbag solutions for that."

factors for some of ZF Lifetec's new safety announcements. Future automated vehicle provide their own challenges, which is where ZF's new dual contour airbag comes in.

Meet the dual-contour airbag

This airbag can deploy in one of two volumes, depending on the seat position of the seat occupant (it works on the passenger or driver side). In case of a crash, a dual-stage inflator engages one or both parts of an airbag that can thus cover the additional distance between the driver in a reclined position and the steering wheel, up to between 150 and 200 mm (6-8 in). Schledorn told SAE Media the dual contour airbag could be up to 190 liters (7 cu ft), compared to the average driver-side airbag today of around 60 liters (2 cu ft).

"When we release the tether, then we are providing a bit more additional volume to cover the additional distance," Schledorn said.

Just as with the top-mounted airbag, ZF Lifetec's trend monitoring helped it decide to design this two-stage airbag. Schledorn said it's obvious that some sort of new seating positions, including reclined seating positions, are on the way. There's also the possibility that steering wheels will retract into the IP.

"This is providing more roominess to the driver, and that then requires passive safety solutions to protect the driver in both scenarios," Schledorn said. "In case of a crash, a small separate pyrotechnic unit gets an electrical signal to release the tether to provide additional bag volume to cover this additional distance between the driver and the steering wheel."

ZF Lifetec's new dual-contour airbag can expand up to 190 liters (7 cu ft), more than three times the size of the average driver-side airbag today of around 60 liters (2 cu ft).

ZF LIfetec expects to go into production with the top-mounted and dual-contour airbags in 2027 or soon after. It would not disclose which potential customers it is working with.

Looking further ahead, ZF Lifetec spokesperson Knut Zimmer told SAE Media that while the Euro NCAP 2030 safety roadmap includes "Testing and assessment of assisted and automated driver support systems," it does not include requirements for future AV possibilities like fully rotating chairs. Still, Schledorn said ZF is already starting to play in this arena.

"Look far into the future, at what's happening in, I don't know, 2040 or whatever," he said. "We need to start to think about how to design airbag solutions for that. I know that we have some ideas on what to do when drivers are sitting in new positions, in rotated seats or whatever, but we need alternative approaches." ■

ALL IMAGES: ZF LIFETEC

MAGNA SAYS some hurdles of seat-reconfiguration system to be addressed by OEMs

The front row of Magna's new seating system can power-rotate up to 270 degrees, meaning they can fully face the second row. The Chinese OEM that bought the system will restrict that to when the vehicle is parked.

Some challenges, such as reworking airbags to meet all seating scenarios, will be solved by the OEM as the final system integrator.

by Chris Clonts

Rearward-facing front seats have generally been limited to concept cars that explore a far-away world in which SAE Level 5 autonomous driving has been perfected. **Magna** has rewritten that playbook, winning a contract with a Chinese OEM for a reconfigurable seating system that includes fully rotating front seats on long rails, creating an unusually flexible cabin.

Currently configured for vehicles with two rows of seating, the system features power-swivel seats along rails or tracks nearly two meters (6.6 ft) long. The front passenger and driver seats can rotate 270 degrees.

SAE Media asked Kai Zhao, Magna's senior director of engineering, about issues around power routing, safety, and who ultimately decides how the seating system would be used in production vehicles.

On the intriguing possibility of having the front row face rearward for fully autonomous driving, Zhao said that the OEM determines the parameters for various seating positions. "In partnership with the OEM, Magna can design structurally sound seats facing either direction," he said, "In the case of the vehicle launching in China, our reconfigurable seating system allows rearward facing only when the vehicle is parked, enhancing flexibility and comfort for stationary use."

It's not just the seats: passengers can also configure the center console, which shares the rail attachment/adjustment system.

"The seats aren't the only things that can be reconfigured: the center console also shares the rail attachment/adjustment system."

The seats have integrated safety belts designed to better cope with the strength and adjustment requirements in complex scenarios. So the seatbacks are likely stronger than standard auto seating since the seat belts aren't anchored to a pillar or the ceiling. Zhao said that, as with the orientation of the seats, "the integration and functionality of airbags and other safety systems are controlled by the OEM, who must consider all aspects of the vehicle's interior configuration and packaging."

Magna says the seatbacks have a universal magnetic interface that allows for different external devices, such as tablet computers or media players.

Despite the range of motion in a seat with so much potential rotation and a long track, Zhao said exotic power and data connections, such as inductive power, were unnecessary. "The magnetic power outlets integrated into the seat backs connect to a [traditional] wiring harness within the seat structure, ensuring reliable power delivery to

MAGNA

Both rows can be folded and moved very close together along the 2-meter track, creating storage space.

Twin 2-meter-long tracks are the key to the wide range of possibile positions of not only seats, but the center console as well.

Magna has disclosed neither the Chinese OEM that has bought the system nor the type of vehicle it could go into. But one can easily imagine a mini- or micro-van scenario.

the universal adapter in the seat back regardless of seat position," he said.

The reconfigurability of the seats, currently, is constrained by keeping them in the vehicle and on the rails. While removability can be designed into the system, it often presents practical challenges," Zhao said. "Removing seats can be cumbersome and may require multiple people, and storing the seats after removal requires additional storage space. One of the key advantages of Magna's reconfigurable seating is the ability to swiftly transform the vehicle interior from a passenger carrier to a cargo space without needing to remove seats."

Magna Seating president John Wyskiel said the engineering team worked closely with the Chinese OEM to explore future uses and respond to the local market. Some of the use cases included in the planning are parenting, long-distance travel, camping, and storage. Additionally, he said the key was being able to work quickly to provide a solution to the OEM. "With our strong R&D and innovation capabilities in China and around the world," he said, "we can create more localized, innovative solutions."

Zhao also credited previous teams' seating work, saying it was the basis for being able to create the reconfigurable seating system. "We have a long history in designing and producing complex seating systems. For example our power stow to floor, ZG Lounger, stadium cushion, and EZ Entry systems," he said. "Our methodology is to design seating solutions that adapt the vehicle cabin to consumer needs, rather than the consumer adapting to the vehicle cabin. As consumer needs change, our innovative reconfigurable seating system can solve various seating configuration use cases and needs."

Magna will manufacture the seating system in China. The OEM's production and assembly of the final vehicle should begin later this year. ■

ALL IMAGES: MAGNA

PRODUCT BRIEFS

SPOTLIGHT: NVH MATERIALS

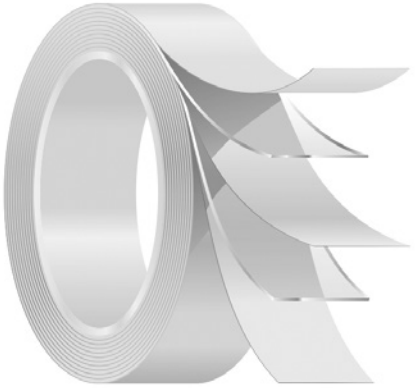
Adhesion compounds

KRAIBURG TPE (Waldkraiburg, Germany) launched new EPDM adhesion compounds designed for automotive exterior sealing. These compounds reportedly offer improvements in material technology, adhesion, durability and processability. The company states that they are specifically formulated for automotive exterior parts with UV resistance such as glass run channels and sealing profiles featuring molded corner joints and end caps. Kraiburg states that it has successfully tested the compounds in comprehensive trials since 2023. The compound features constant EPDM adhesion quality as well as optimized flow properties that provide a broad processing window and increased design flexibility in part and tool design while maintaining performance standards. Additionally, the compounds offer weathering resistance, color stability, low surface friction behavior and wear and tear resistance.

https://www.kraiburg-tpe.com

SPOTLIGHT: ADHESIVES & COATINGS

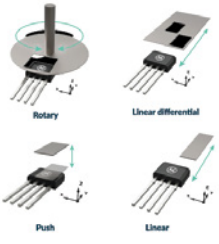
Vacuum conveyors



Piab (Hingham, Massachusetts) introduced the piFLOW am vacuum conveyor. The unit features Piab's COAX vacuum technology as well as a butterfly valve. Piab states that the butterfly valve is not sensitive to pressure fluctuations and is able to keep a material batch inside without the pump being mounted. It has a standard TC connection which makes it simple to integrate for the customer. Piab also claims the unit is easily integrated with any type or brand of 3D printer, sieve, hopper and other intermediate vessel. The product is controlled by pneumatic or electrical control units. The piFLOW am is made of stainless steel and can reportedly withstand a material temperature of up to 140' Fahrenheit (60' Celsius) The conveyor unit weighs 33 lbs. (15 kg) and reaches a maximum feed pressure of 101.5 psi (7.2 bar).

https://www.piab.com

Switches



Melexis (Tessenderlo, Belgium) announced its Induxis switch, the MLX92442, which is contactless, magnet-free and strayfield immune. Melexis states that the MLX92442 detects conductive targets and enables small module designs with reduced component count for improved safety and electrification. Uses include high-voltage interlocks, charging flaps, seatbelts, hood/trunk, gear tooth sensing or brake-by-wire applications. For traditional safety automotive latches and switches, ranging from door and boot/trunk handles to seatbelts and brake light switches, the standard design uses a mechanical contact or magnetic switch, like a push button, reed switch, or hall effect sensor. But, for such a solution to operate, the safety target's design must be modified, either to include a magnet plus holder or a physical protrusion to actuate a button.

https://www.melexis.com

Software solutions

TTTech Auto (Vienna, Austria) unveiled MotionWise Schedule, a software solution designed to manage workload management in the automotive sector. The system seamlessly maps tasks to CPU cores and defines the required network configuration for Time Sensitive Networking. According to TTTech, this enables optimized multi-CPU core and multi-SoC solutions. The system also manages time-triggered execution and provides a time-boxed isolation between tasks, enabling mix-criticality and composability. This results in lower testing and verification efforts for real-time tasks, determinism and execution repeatability, as well as faster system integration. The newly added support for dataflow-driven scheduling adds flexibility for developers and supports dataflow dependencies and allows dynamic switching between different data flows.

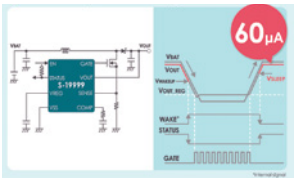
https://www.tttech-auto.com

Power transmitters

Microchip Technology (Chandler, Arizona) has released a Qi 2.0 dual-pad wireless power transmitter reference design. Powered by a single dsPIC33 Digital Signal Controller (DSC), the Qi2 reference design offers efficient control for optimized performance. A key feature of the new Qi2 standard, recently released by the Wireless Power Consortium (WPC), is the introduction of a Magnetic Power Profile (MPP) with support for magnetic alignment between the transmitter and the receiver. The DSC's flexible software architecture enables the support of a combination of MPP and Extended Power Profile (EPP) of Qi 2.0 with one controller. The dual-pad charger also meets automotive standards for reliability and safety.

https://www.microchip.com

Switching regulator controllers



ABLIC (Tokyo, Japan) launched the S-19990/9 series of automotive low EMI step-up switching regulator controllers. The new S-19990/9 series are 36V step-up switching regulator controllers that can secure operating voltage from 3V, making them an ideal IC for constructing backup power supply step-up circuits. The S-19990/9 Series is available with an oscillation frequency of 400kHz or 2.2MHz. These ICs are also equipped with a spread spectrum clock generation circuit which enables reduction of the conduction noise and emission noise emitted by the step-up circuit. These IC can also continue operation at a low consumption current of 60µA typ. during switching off.

https://www.ablic.com

Multiplexer modules

Pickering Interfaces (Clacton-on-Sea, United Kingdom) announced a new family of high-density PXI and PXIe multiplexer modules for high voltage applications. The 40-321-1xx (PXI) and 42-321-1xx (PXIe) are 1- or 2-pole multiplexers and are available with various bank quantities and channel counts. They are capable of hot or cold switching up to 1000 VDC or 1000 VAC peak and use high-quality reed relays throughout the range. The MUX range offers 20 different module configurations, with different channel counts between four and 48, bank quantities from one to six, and 1- or 2-pole switching options, allowing switching solutions to be tailored closely to test system requirements.

https://www.pickeringtest.com

Cameras

THine Solutions (Santa Clara, California) announced the new THEIA-CAM 13MP PDAF camera is now able to easily integrate advanced imaging capabilities into their systems. The THSCJ101 Kit is a Camera reference design kit for embedded camera applications using the NVIDIA® Jetson Orin NX or Jetson Orin Nano platform. It is based on THine's THP7312-P Image Signal Processor (ISP) and Sony's IMX258 13MP CMOS PDAF image sensor. THine's optimized ISP firmware provides autofocus using Phase Detection Autofocus (PDAF) technology. The Kit hardware includes all items required to interface with Jetson Orin carrier boards with a 22-pin MIPI CSI-2 input connector, including a Camera Board in an acrylic case and a Flat Flexible Cable. The Video4Linux2 (V4L2) driver for the THSCJ101 is also available to control various video functions.

https://www.thinesolutions.com

CNC Mills

Tormach (Madison, Wisconsin) introduced the Tormach 1500MX CNC Mill. The 1500MX is a three-axis, servo-driven mill on linear rails with an epoxy granite frame. Tormach states that the 1500MX offers faster feed rates, increased precision, superior vibration damping and higher horsepower at a fraction of the cost of competitive models. Equipped with a robust 4HP, 10K RPM BT30 spindle (with a maximum of 6HP), the 1500MX has sufficient torque for cutting through various materials and offers enough spindle speed to take advantage of modern carbide tooling. Additionally, every 1500MX is thru-spindle coolant ready, facilitating seamless integration of TSC for enhanced drilling efficiency, smoother finishes, part consistency and extended tool life.

https://tormach.com

Q&A

Three's not a crowd when it comes to ADAS sensors

To round out this issue's cover story, we spoke with Clement Nouvel, Valeo's chief technical officer for lidar, about Valeo's background in ADAS and what's coming next. Nouvel leads over 300 lidar engineers and the company's third-generation Scala 3 lidar is used on production vehicles from European and Asian automakers. The Scala 3 sensor system scans the area around a vehicle 25 times per second, can detect objects more than 200 meters (656 ft) away with a wide field of vision and operates at speeds of up to 130 km/h (81 mph) on the highway.

In 2023, Valeo secured two contracts for Scala 3, one with an Asian manufacturer and the other with a "leading American robotaxi company," Valeo said in its most-recent annual report. Valeo has now received over 1 billion euros (just under $1.1 billion) in Scala 3 orders. Also in 2023, Valeo and Qualcomm agreed to jointly supply connected displays, clusters, driving assistance technologies and, importantly, sensor technology for to two- and three-wheeled mobility efforts in India. Valeo's R&D director in charge of strategy, Geoffrey Bouquot, called the company, "currently the only player on the market mass producing an automotive lidar system." Valeo first installed its first- and second-generation lidar sensor systems into autonomous vehicles in 2021. These were the first AVs in the world authorized to drive at Level 3 autonomy, the company said.

Let's start with Valeo's background in ADAS.

We started investing in lidar, which we call Scala for "scaling lidar," about 13 years ago. And we were first to the market with Level 3 technology. Our first was a Japan-only, 2021 Honda Legend with five of our first-generation Scala units.

The second is the recently released Mercedes-Benz S-Class, which is operating at Level 3 in Germany and in Arizona and California. So, yes, we can say that Level 3 is enabled only by Valeo and we have a big head start in the industry.

Our latest-generation Scala lidar offers higher [12 times better] resolution, three times better range [now more than 200 meters] and a wider viewing angle [2.5 times wider]. [Valeo claims the first-generation Scala system could map 44,000 points per second, increasing to 260,000 for Scala 2 and to 12.5 million points per second with Scala 3, creating point clouds that are as sharp as a photo.]

Valeo is a believer in all three ADAS technologies: lidar, radar and cameras. But some companies aren't.

Clement Nouvel, Valeo's chief technical officer for lidar.

"That's the bottom line. Today, Level 3 requires lidar."

The key here is what technologies do you need to enable the delegation of the driving process to the car. That's what we call Level 3, and if you look at the industry, there is large consensus that this requires a tech triple: lidar, radar, cameras.

Each technology has its pros and cons and, if I use a camera only, then you would have issues at night or when you're blinded by the sun. Radar has its own shortcomings, and the same is true of lidar. Those who are not opting for lidar are actually not delivering Level 3. That's what we need to keep in mind. The main question is: do you want to read books or watch a video? If you really want the machine to be responsible, then you cannot do that with the right level of reliability and safety without lidar. That's the bottom line. Today, Level 3 requires lidar.

How is Valeo different from its competitors?

There are a lot of startups investing in lidar. There's a large wave of lidar coming from Chinese technology and investments. But it requires a huge investment to get lidar up and running and make it profitable. For the newcomers, it's extremely difficult to keep up the pace.

Valeo is already at our third generation of lidar. We've acquired a lot of experience. We are probably the only company in the world able to make progress while not having to invent new lidar technology, or make massive investments. We are doing it step-by-step and that's what sets us apart today.

John Dinkel

VALEO

WEBINARS ON DEMAND

IMPROVING EV PERFORMANCE, EFFICIENCY, AND RANGE WITH MULTI-FUNCTIONAL SHIFT SYSTEMS

Available On Demand

Electric vehicle (EV) drivetrain systems are being redefined — creating next-generation propulsion systems as the EV market rapidly grows. These systems will need to be further optimized for function, efficiency, battery range, and cost as the EV market scales. This 30-minute webinar explores new solutions for multi-speed shift systems that can provide novel and flexible system solutions that allow for simplified controls and increased shift performance.

Sponsored by: Amsted™ AUTOMOTIVE

Hosted by: SAE INTERNATIONAL

For additional details and to register visit: www.sae.org/webcasts

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LEVERAGING TODAY'S EXTRUSION TECHNOLOGY: HOLLOWS AND MORE!

Available On Demand

Modern extrusion technology offers manufacturers a chance to create more complex profiles that "put the metal where it is needed." Complex hollow shapes, especially multi-void hollows, can be engineered for a combination of crush resistance, strength, light weight, thermal management, and more. This 60-minute webinar addresses how to leverage complex profile creation to meet particularly demanding vehicle applications and explores complex hollow shapes with a focus on multi-void hollows.

Sponsored by: AEC ALUMINUM EXTRUDERS COUNCIL

Hosted by: SAE INTERNATIONAL

For additional details and to register visit: www.sae.org/webcasts

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EV BODYSHOP METROLOGY: THE SAME BUT DIFFERENT

Available On Demand

Electric vehicle (EV) technology has followed a long and winding road, but in 2024, it's clear the industry has made it to the fast lane. New chassis designs, larger casted parts and complex assemblies are now on the factory floors and have the same high quality requirements as traditional ICE vehicles. This 60-minute webinar discusses the changing world of automotive production metrology, exploring the pioneering generation of laser radar metrology solutions that are suited for the challenges of EV manufacturing.

Sponsored by: Nikon

Hosted by: SAE INTERNATIONAL

For additional details and to register visit: www.sae.org/webcasts

Advanced Magnetics for ADAS

From high-current, high-efficiency power inductors to filter components for a variety of communications buses, Coilcraft has the magnetics for all of your Advanced Driver Assistance Systems

Coilcraft offers a wide range of AEC-Q200 qualified products engineered for the latest advanced driver assistance systems, including high-temperature, high power density power inductors for radar, camera and LiDAR applications.

Our compact Power over Coax solutions offer significant board-space savings while providing the high signal performance needed for today's high-resolution and high- speed cameras.

Also choose from our broad selection of common mode chokes and filter elements for a variety of communications buses.

To learn more about our advanced solutions for ADAS and other automotive/high-temp applications, visit us at **www.coilcraft.com/AEC.**

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