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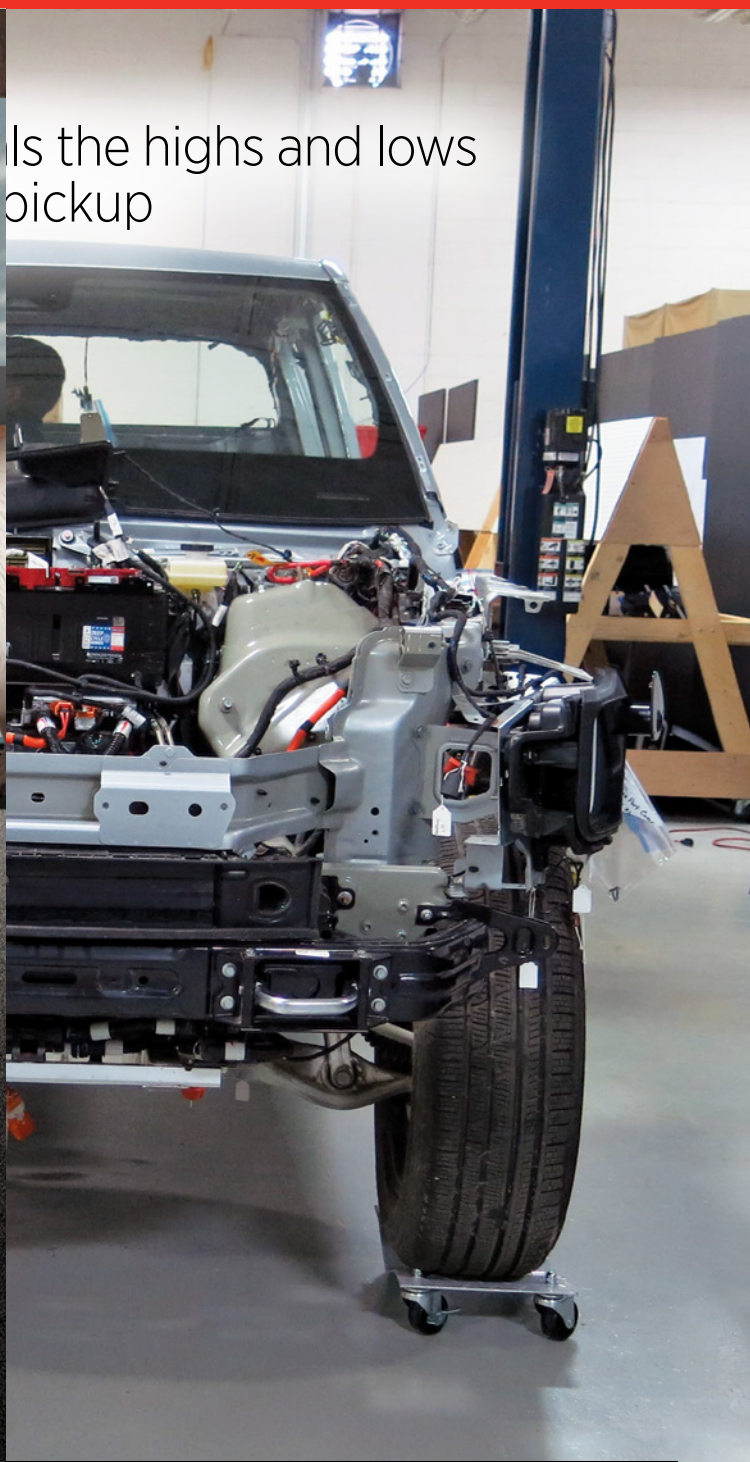

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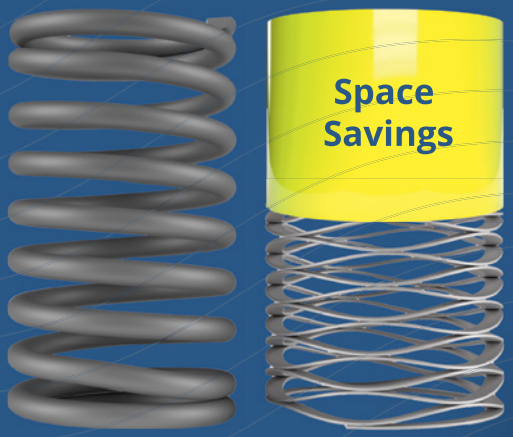

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CONTENTS

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ON THE COVER

Stripped of its unique front end and signature oval headlamps, Rivian's R1T is undergoing a comprehensive teardown at Munro & Assoc. in Auburn Hills, Mich. The teardown team leaders share their early insights into the innovative electric pickup's design, engineering and manufacturability in our cover story on page 14. (Lindsay Brooke photo)

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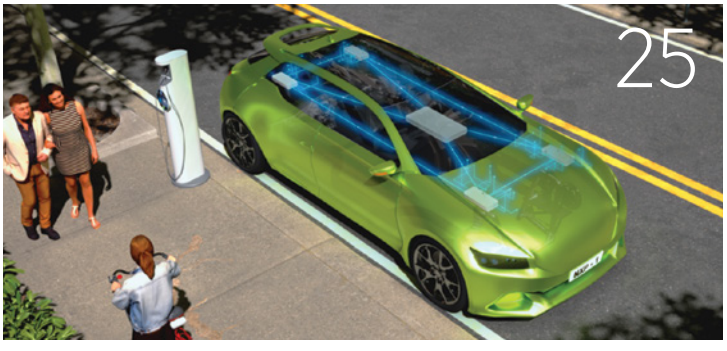

REGULARS

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EDITORIAL

Unreliable electronics are the new Prince of Darkness

Younger engineers may be unfamiliar with Joseph Lucas Ltd., the infamous Tier-1 supplier of British automotive electrical and electronic woes. Lucas helped institutionalize, fairly or not, the sub-par reliability reputations of British car and motorcycle OEMs. Jokes including "The Lucas lighting switch has three settings: Dim, Flicker, and Off" became part of the lore for dozens of classic marques. Those who lovingly restore Brit vehicles today refer to company founder Joe Lucas as "the Prince of Darkness."

I once missed a reporting assignment in the mid-1980s because the lovely new Jaguar XJ6 in my driveway, on loan from the company's press fleet, failed to start due to a Lucas-related malady. At least that's where Jag PR put the blame. When a flatbed arrived to recover the car, the driver-side electric window regulator failed. Would a fire be next?

In truth, "The Prince" did make some genuinely robust stuff. But unfortunately for vehicle owners, Lucas' product specs typically were determined by OEMs' ruthless cost-downs. And component reliability was at the mercy of poorly designed wiring, shoddily assembled connectors, heat and vibration.

Hopefully, past will not become present. The industry has entered an ominous new era of E/E-related vehicle issues, driven by the sheer breadth and complexity of software-defined vehicle electronics. Faster and faster development cycles play a role here. So do over-the-air updates. OTA has become rationale, in some cases, for less-than comprehensive initial testing and validation of software. I'm told that a new panacea, born in the consumer-electronics world, says: "Let's get that new module out the door now. We'll fix the glitch (i.e., driveability or functionality) later with OTA."

I'm not convinced.

When I spoke recently with a veteran dealership service manager, he pointed to a new EV being prepped for delivery. "Electric vehicles," he said, "have potential to cause more quality issues and headaches than any MG owner ever suffered back in the day." There are few problems worse than mysterious, intermittent electrical issues, we agreed.

Since the 1970s, electronics have gone from about 5% of the bill of materials (BoM) in an average vehicle to over 35% and are projected to rise to over 50% by 2030, according to Statista. Meanwhile, overall vehicle quality has dropped to a 36-year low, reported J.D. Power in its latest survey of 2022 model-year vehicles. Problems per 100 vehicles (PP100) rose 11%, 18 PP100 worse than last year. And a troubling finding: Owners of battery-electric and plug-in hybrid vehicles cited more problems in their vehicles when compared to owners of ICE-powered models.

The industry has entered an ominous new era of E/E-related vehicle issues.

Of course, the industry is only beginning to produce EVs in volume amidst labor and supply shortages. So perhaps it's expected that new offerings — including the Audi E-Tron, Tesla Models X and Y, and the Volkswagen ID.4 — ranked poorly. Their Achilles heel is complex electronics, the report said. All have a high rate of problems, mostly in electronic and software-related areas.

Can this nascent, threatening trend be reversed? Craig Hillman, the director of software development at Ansys, posted a valuable blog on his company's website titled *Overcoming Automotive Electronics Reliability Engineering Challenges*. In it, Hillman details the 'multiple stress conditions' that make autos perhaps the toughest E/E environment. No single solution yet exists for ensuring bulletproof-reliable electronics. But closer collaboration between Tier-1 designers and integrated-circuit creators, he counsels, is a good place to start. With so much invested in electrification (and automated-driving tech), the industry cannot tolerate another Prince of Darkness in its future.

Lindsay Brooke, Editor-in-Chief

EVs pressure supplier value-add

Across every tier of the global supply chain, heads are spinning from the pace of change being driven by vehicle electrification. While they grapple with semiconductor and materials supply, labor availability, the cost of developing new technologies and inflation issues, suppliers are finding that devoting time to mapping the road ahead is a challenging priority. Nonetheless, the EV transformation is underway. Norms of how we address the business, which have been built up over several decades, are being tested.

Obvious to many is the competition for engineering and technical talent that currently is most acute in software and electronics design/engineering but eventually will also be felt in service bays across the dealerscape. In my conversations with supplier leadership, concerns over placing capital at risk and the shift of the relative importance of various component subsystems are increasingly clear.

As I've noted here previously, the decline/elimination of combustion engine, transmission, fuel and exhaust systems from OEMs' bills of material is far from being counterbalanced by growth and opportunity in propulsion battery, e-drive, thermal and electrical systems. The cold reality is this: Not everyone with ICE-legacy business will be capable or willing to make the transition.

Beneath the waves, however, are numerous other factors with potential to alter the business model for the supply base.

For decades, the North American industry has centered on five-year major revision cadence or 10-year all-new design cadence timing for ICE-based products. Depending on what type of component/system sourced, suppliers could count on dividing tooling, design and machine costs by five years. While the U.S. domestic OEMs were not always on a five-year regimen, strong competition to keep up with the Japanese OEMs and the need to improve fuel economy drove more frequent investment. Battery-electric vehicle platforms are changing the game here.

Michael Robinet
Executive Director, Consulting, S&P Global Mobility

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BEVs will stretch the time between major design revisions to 7-8 years, altering suppliers' risk equations.

I expect that BEVs will stretch the time between major design revisions (those that impact vehicle architecture) to 7-8 years, due to the flexibility of making modification in battery chemistry and e-drive packaging. Amortizing fixed costs over a longer period alters the risk equation for suppliers.

The larger OEMs are using the ICE-to-BEV transformation to adjust their value-add equation versus the supply base. In the ICE world, the supplier value-add averages 65-70% of the vehicle value. This climbed over several decades as OEMs spun off non-strategic operations. But as the BEV format rises, OEMs are seeking new modes to protect technology, guarantee supply and drive differentiation for their products. They are adopting design and production of new systems, and in the process, they're becoming more vertically integrated — bringing in-house competencies such as battery cell manufacturing, production of e-drives and in some cases, electric-charging content.

A key issue for suppliers going forward: OEMs also are increasingly controlling software. These trends are putting supplier value-add under increased pressure.

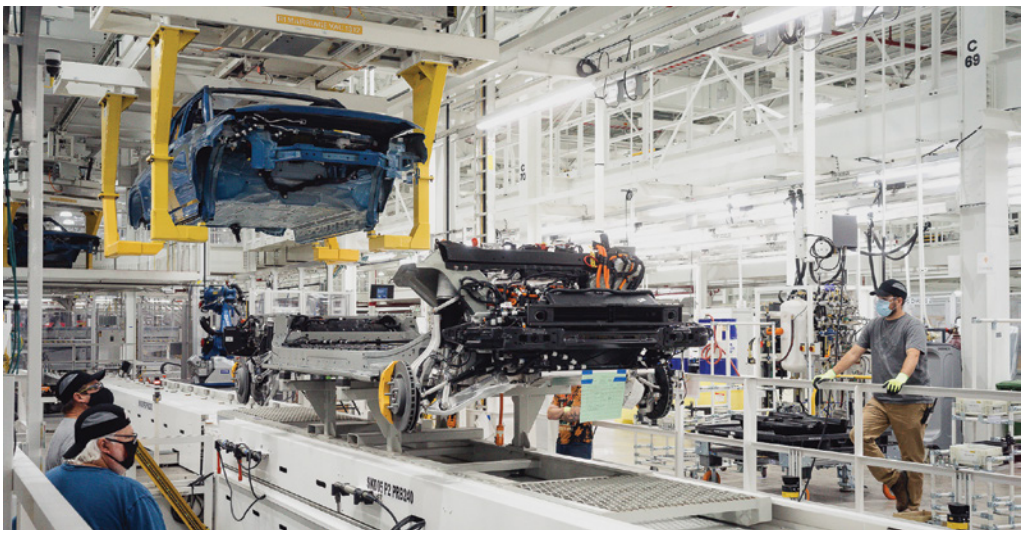
Gone are the days when OEMs had a platform/architecture for every vehicle size, propulsion format or vocation (role). Some mass-market vehicle makers had more than 10 platforms active at any one time. This added to the required engineering support — driving complexity and dragging on initiatives to reduce part count. In the emerging BEV world, OEMs are rethinking this approach.

It now is apparent that even the largest mass-market OEMs will have three to four BEV architectures with increased commonality in the battery and e-drive space. BEVs offer an increased flexibility to alter vehicle wheelbase and tread width without major platform tear-ups. Customer-facing content in the 'top hat' can be changed faster and more efficiently.

Suppliers will be in the spotlight as the entire industry undergoes profound changes related to electrification and automated-driving technologies. Understanding and effectively navigating these impacts will be critical. ■

NVH

Electrification forces fresh perspectives on vehicle NVH



The increasingly common "skateboard" architectures of EVs create unique NVH challenges; here, the chassis of a Rivian R1T pickup is married to the bodyshell at Rivian's assembly plant in Normal, Illinois.

RIVIAN

The quietness of EVs is, for many, a compelling selling point. But vehicles becoming inherently quieter overall hasn't translated into making the job of noise abatement any easier — the job's just different, asserted several NVH engineering experts at the Autotech conference in Detroit in early June. These NVH experts underlined a primary point of what's now understood about the "new" quietness of EVs: the drastic reduction of powertrain-related noise, vibration and harshness (NVH) largely means vehicle occupants now can hear and feel other NVH sources.

"A little squeak becomes more prominent" in EVs, said Jian Pan, senior director of engineering at **Auria Solutions**. And although this seems self-evident, Pan added that EVs can open up new or unfamiliar frequencies to occupants — and some of those frequencies can be particularly displeasing. Certain frequencies emanating from EV drive motors, for one, can be distinctly annoying, Pan said, and are quite different from the "noise signatures" of combustion engines. Meanwhile, those relatively minor squeaks and squeals coming from seat-adjustment motors and power windows, in the absence of "masking" noise from an IC powertrain, now are prominent noise sources, he added.

Building on those points, Brent Dreher, CAE engineer – NVH & Durability at **Faraday Future**, pointed out that many current and coming EVs are built on "skateboard" chassis architectures that tend to use hollow extrusions as their primary structural elements, rather than conventional steel unibodies or body-on-frame architectures of most all internal-combustion vehicles. Hollow structural elements tend to transmit and augment noise more readily than cast steel structures, Dreher stressed.

Mirrors to gears

Structural challenges are just the beginning. Because of EVs' comparative general quietness, conventional vehicle components are under fresh NVH scrutiny. Jeff Hodgkins, senior application NVH tech expert at **VI-Grade**, a Germany-based developer of software simulation tools, told conference attendees that side-view mirrors may become a flashpoint for NVH in EVs. Side-view mirrors have recently been the focus of aerodynamicists seeking to reduce vehicle wind resistance by replacing bulky conventional mirror assemblies with sleeker units housing cameras. But Hodgkins said the silence of EVs has made the wind rushing around side mirrors markedly more noticeable in the cabin. "It's right around the driver's ear," he added, advocating for camera mirrors that would help reduce wind noise in this vital area.

A related solution could be increased use of specially laminated "acoustic" glass, many on the panel agreed. Already seeing increased use in IC-powered upscale vehicles or as part of

"We're not trying to kill the sound, we're trying to design the sound."

Electrification and NVH panel at Autotech 2022, from left: Jeff Hodgkins, Brent Dreher, Lee Rodgers, Jian Pan.

premium-equipment packages, acoustic glass might see increased fitment in EVs to stifle road and wind noise. But some panelists said cautious application might be required; if the vehicle's entire greenhouse isn't comprised of acoustic glass, it can create undesirable, unbalanced sound zones within the cabin.

Faraday Future's Dreher said EV quietness "has put a lot more pressure" on transmission parts and the suppliers who make them. "Before, you never heard the transmission," he said, but in EVs, which for now generally have comparatively simple integral transmissions, gear-related noise is discernable in much the same fashion as certain drive-motor frequencies. He said polymer-material gear technology has advanced, but the generally higher amount of torque in EV traction motors, as well as the wider-rpm operating range, is more demanding on gear materials. Higher torque levels also increase the need for tighter tolerances, Dreher added, which typically adds cost.

Faraday Future has experimented with "noise-canceling" tires made by **Pirelli**, Dreher said. The tires, which have a polyurethane "sponge" inserted around the perimeter of the tire cavity, absorb vibration and certain sound frequencies, Pirelli claims, reducing "perceived noise by half."

SAE MEDIA

Side-view mirrors have emerged as serious wind-noise sources for occupants of EV cabins. Many OEMs are considering replacing bulky exterior assemblies with sleeker camera-mirror housings.

Lee Rodgers, principal engineer, **Drive Systems Design**, added that incumbent automakers with considerable vertical integration are likely to find NVH management more difficult if they now look to suppliers for major EV components such as traction motors, transmissions and even battery packs. The situation is likely to place more emphasis on whole-vehicle and component simulation models.

Sim is a win

VI-Grade's Hodgkins said increasingly sophisticated simulation software can create sound-signature models that can allow suppliers to compare components head-to-head, but also for their contribution to whole-vehicle NVH. These simulations can be critical in determining if there's justifiable customer value in choosing a more-expensive, NVH-optimized component, he said, adding that human determination of sound differences — at many levels of development and even by customers in clinics — can be difficult to quantify. Hodgkins said "acoustic amnesia" can render back-to-back comparisons ineffective, even if they occur in a short timeframe.

The best use of simulation models is to help inform design changes, added Auria's Pan, saying that some OEMs are branding sound signatures that provide developers with guidance for tailoring NVH for an EV. Faraday Future's Dreher perhaps best summarized the panel's discussion by saying, "We're not trying to kill the sound, we're trying to design the sound."

Bill Visnic

ELECTRIFICATION

Wireless road charging for EVs to debut mid-decade

Roadway-embedded wireless charging for electric vehicles is coming to a stretch of urban highway in Detroit, marking a pilot-program first on a U.S. public road. "Our electric vehicle receiver units are modular and compatible with passenger vehicles and with light-, medium- and heavy-duty commercial vehicles," said Oren Ezer, CEO of **Electreon**, based in Tel Aviv, Israel. Michigan is expected to operate the first electrified roadway in early 2025.

Electreon's patented wireless in-road EV charging technology already is in use with various European demonstration projects, including a 0.7-mile (1.05-km) intercity toll road in Italy and a 1-mile (1.65-km) public road in Sweden. Sweden's policymakers aim to have 1,243 miles (2,000 km) of electrified roadway in operation by 2030. Detroit's electrified roadway will be near Michigan Central, a mobility-innovation district under development by **Ford** Motor Co.

"The wireless charging infrastructure will support a suite of use cases involving various vehicle types, including autonomous vehicles, and it will support partners, like Ford," noted Jim Buczkowski, the company's executive director of Research and Advance Engineering.

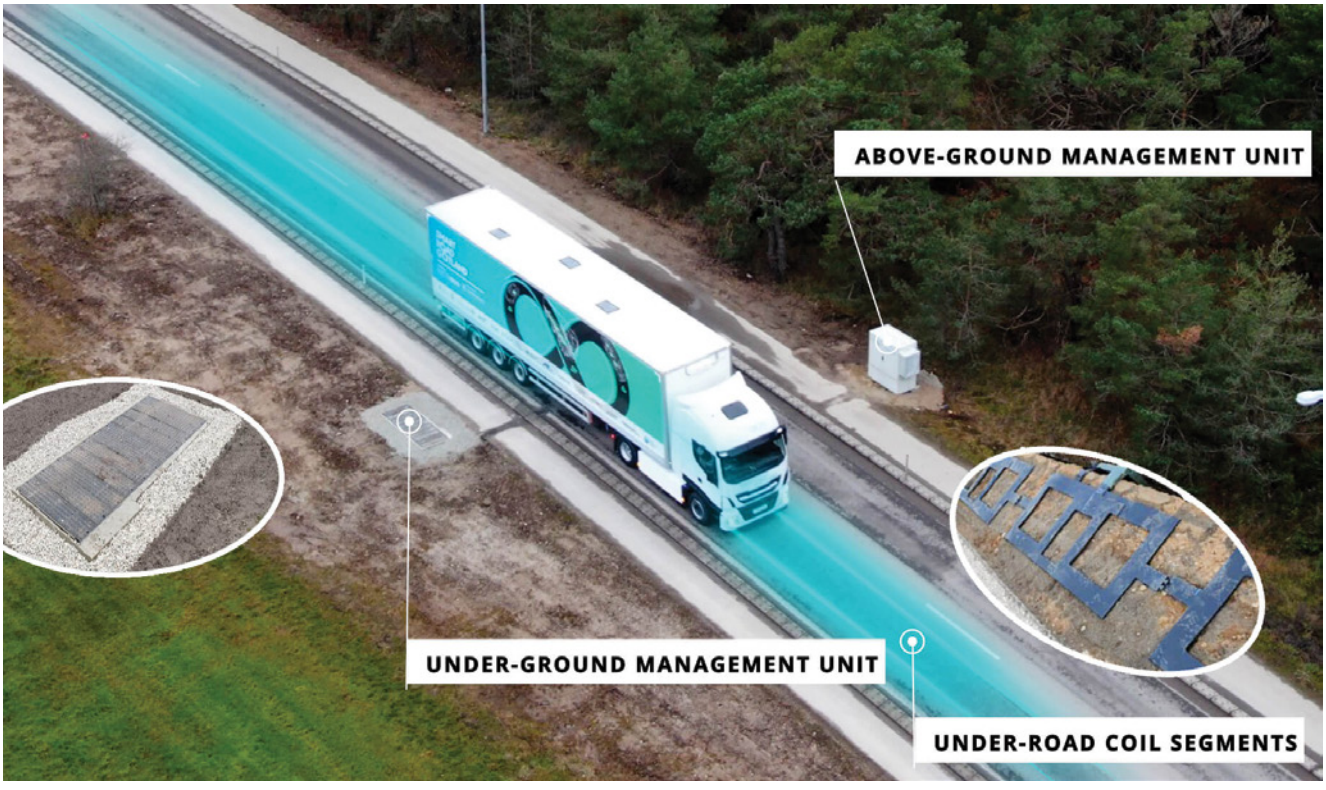
Cloud-based system monitoring

The $1.9 million-plus Michigan project involves one lane of public roadway for a minimum of one mile (1.6 km). As of mid-May, the **Michigan Dept. of Transportation** (MDOT) was doing a feasibility study on electrifying a section of Michigan Avenue and/or 14th Street in Detroit's Corktown district. After the existing road surface is removed, rubber-coated copper coil segments will be buried 3.15 inches (8 cm) under a new road surface. "Non-electric vehicles are able to use the roadway as usual without any disruption," said Dr. Stefan Tongur, Electreon's VP.

The roadway's coil segments transmit power to an EV undercarriage-mounted receiver via magnetic resonance induction as the EV moves or is

Electreon has integrated its technology at the "Arena of the future" project in Brescia, Italy. Shown are an Iveco electric bus and a Fiat 500-e being charged while driving.

FROM TOP: HONDA; ELECTREON



An electric truck is being wirelessly charged in Gotland, Sweden as part of Electreon's "Smartroad Gotland" project. Image includes technology overview graphics.

parked directly above the coils. A power-management unit located either underground or above-ground near the roadside will transfer the energy from the electric grid to the roadway's copper-coil infrastructure.

Electreon's technology solution has 19 patents covering various proprietary aspects, including the engineered system architecture and the communication mechanism between an EV fitted with a power receiver and the embedded roadway coils. "The intellectual property of our vehicle receivers will be released to OEMs for free," Ezer promised.

Both the battery size and the number of receivers connected to an EV influence the charging time. "The driving speed has a negligible effect on the charging performance," Ezer explained. He said to date, Electreon has tested its receivers up to a speed of 49.7 mph (80 kph). As an example, if a commercial truck with five receivers is traveling at 37 mph (60 kph), 37 miles (60 km) of electrified road is needed to fully charge the battery. If the vehicle is traveling at 12.4 mph (20 kph), 12.4 miles (20 km) of electrified road are needed to fully charge the battery.

Larger vehicles can support multiple Electreon receivers. For instance, Class 8 trucks can be fitted with up to seven undercarriage receivers. Buses could have three receivers, while passenger vans might have two receivers. "The number of receivers on an electric vehicle depends on the use case, the vehicle size, and the vehicle type," Ezer said. Each Electreon receiver for heavy-duty EVs is capable of supplying up to 25 kW to the battery. Based on the power transfer rate requirements of light-duty passenger EVs, Electreon offers 7 kW and 11 kW receiver options.

Four-season testing

The Detroit demonstration project will provide a four-season venue to test hardware and performance objectives. Electreon's Tongur said that based on findings from ongoing projects in Europe, weather won't be an issue. "Since the (wireless) infrastructure lies beneath the roadway, the energy transfer is not affected by snow and ice. The road can be maintained — plowed, salted, etc. — as usual without affecting the coils beneath the asphalt," Tongur said.

Wireless charging of EVs isn't new to America, as the largest fleet of all-electric transit buses in the U.S. use a patented wireless charging system from Salt Lake City, Utah-based **WAVE** (Wireless Advanced Vehicle Electrification). Forty-eight of Southern California's Antelope Valley Transit Authority's 54 **BYD**-built buses are fitted with WAVE undercarriage receivers. Additionally, wireless charging of EVs via a non-public electrified roadway is an ongoing R&D and testing endeavor of **Utah State University**'s Electric Vehicle & Roadway (EVR) facility and test track.

Kami Buchholz

ELECTREON

NEW MOBILITY

Hyundai engineers a multi-modal electrified mobility future

Here's a **Hyundai** vehicle that you're likely not familiar with: It has LED headlamps at the front, a lithium-ion battery to drive its motor, a digital interface and is designed with a compact footprint.

It's an electric scooter weighing 17 lb. (7.7 kg) and is configured so that it can be readily folded for carrying or be fitted into a Hyundai vehicle with four wheels rather than two. It has a 10.5-Ah battery and a 20-km (12.4-mile) range. By comparison, the Ioniq 5 is offered with either a 58- or 77-kWh lithium-polymer battery and has an EPA-estimated range of 303 miles (487 km).

But as Trevor Lai, senior manager, product planning, Hyundai Motor America, points out, the e-scooter as a "last-mile" mode of transportation is in keeping with the company's efforts to transform itself from a traditional automobile manufacturer to a "smart mobility solutions provider."

Beyond the norm

While that is the sort of thing that plenty of auto OEMs are saying nowadays, Hyundai is showing a serious strategic commitment to this undertaking. It has established a joint venture with **Aptiv**, called **Motional**, to develop driverless technology. Motional is currently partnering with **Lyft**, **Via** and **Uber Eats**.

Motional is almost an example of table-stakes in what is going on as OEMs work to have some level of autonomous capability (e.g., **GM** and **Cruise**; **Ford** and **Argo AI**). Hyundai goes one better with Supernal, its advanced air mobility operation that intends to have electric vertical takeoff and landing (eVTOL) craft in service by 2028. That goes far above what other OEMs are doing (e.g., at the 2019 CES, **Cadillac** showed VTOL concepts — but they were just that, concepts).

Still, the primary focus at Hyundai is on traditional vehicles, but even there it is focusing on alternative powertrain setups, as in hybrids, plug-in hybrids and battery-electric vehicles, Lai points out. It also has the Nexo fuel cell electric vehicle in its lineup, as well as the Xcient FCEV Class-8 truck.

Hyundai Motor Co. is investing $16.2 billion globally on electrification with plans to have a full portfolio of EV models available by 2030.

Portfolio approach

At present, Hyundai has engineered a wide offering of electrified vehicles that are currently available, from the previously mentioned Ioniq 5 BEV and Nexo FCEV to other offerings. The company has just done a refresh of the Kona Electric, which has a 64-kWh **LG Chem** lithium-ion polymer battery. The compact crossover has a claimed range of 258 miles (415 km) and a traction motor rated at 150 kW at 3,600 rpm.

Hyundai has developed what it calls its TMED (Transmission Mounted Electric Device) architecture for hybrid/plug-in hybrid applications in its crossovers. In this setup, the electric motor is located between the engine and the transmission, with a clutch between the engine and the motor.

Hyundai's Supernal advanced air mobility operation intends to have electric VTOL craft (concept shown) in service by 2028.

To be a "smart mobility" solutions provider takes more than cars and crossovers. Hyundai's e-scooter features a tri-folding design and a manageable curb weight of 7.7 kg.

For the Santa Fe and Tucson powertrain setups (they are both the same), the hybrid has a 44.2-kW traction motor and a 1.5-kWh high-voltage battery, while the plug-in uses a 66.9-kW traction motor and a 13.8-kWh high-voltage battery. In both cases there is a 1.6-L turbocharged 4-cylinder engine that produces 179 hp (133 kW) and a 6-speed automatic transmission that is optimized for hybrid applications. The vehicles also have a 13-kW hybrid starter-generator. The system output for the hybrid is 226 hp (168 kW); the plug-in generates a claimed 260 hp (194 kW).

Lai notes the TMED architecture as well as the E-GMP (Electric-Global Modular Platform) that underpins the Ioniq 5 will be used for other yet-to-be-introduced BEVs. "Modularity is important. It helps protect for the future," he said. Clearly, the future is something that Hyundai is creating right now.

Steve Macaulay

BOTH IMAGES: HYUNDAI

SOFTWARE

Data boom drives Bosch to hire 10,000 software engineers in 2022

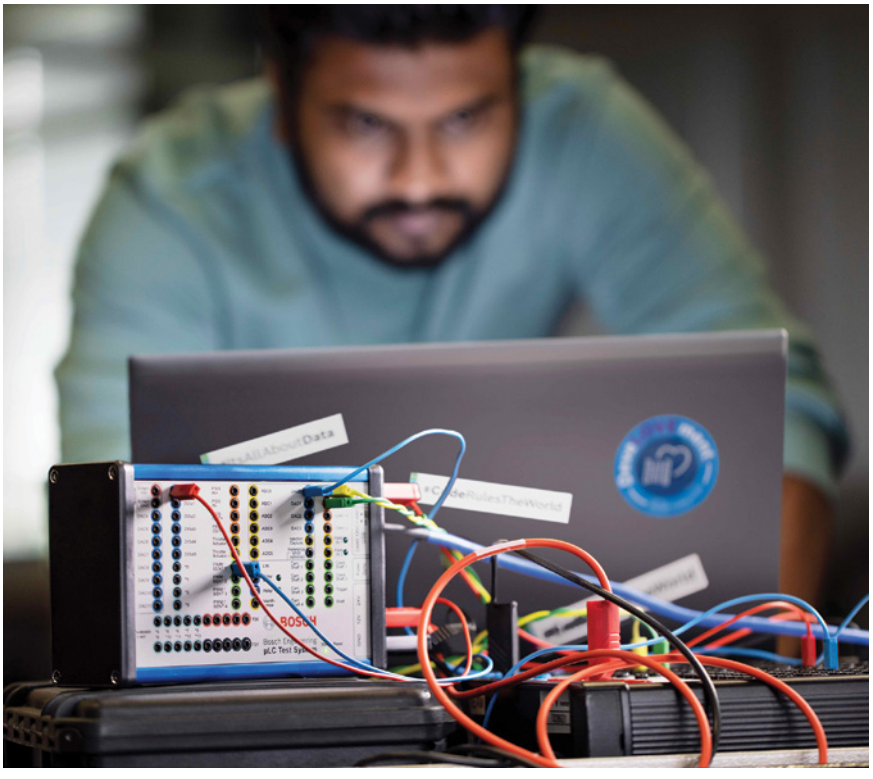
Ten thousand. That's how many software engineers **Bosch** plans to hire worldwide in 2022. The Tier 1 giant needs software specialists as electrified, automated and connected vehicles start to shake the dominance of ICE propulsion.

"Talent scarcity is something we're concerned about and if we just sit back and do nothing about it, then all we're doing for the next four or five years is complaining about a lack of talent," Paul Thomas, executive VP of mobility solutions for Bosch in the Americas, said during an interview with SAE Media.

The search for software specialists led Bosch to take an instructor's seat. "Our IoT apprentice program teaches the fundamentals of software engineering through a tried-and-true apprenticeship model," explained Mike Mansuetti, president of Bosch North America. That program, which started in 2020, now has its first graduates, none of whom had a background in software.

Arin Minasian, one of five individuals in the inaugural IoT apprenticeship program, moved from California to Michigan, leaving behind a job in finance. "The IoT apprenticeship program was a one-year process, so I had time to digest software concepts and explore the areas that interested me," Minasian said about the program that emphasized C++ and other computer languages and software concepts. The 37-year-old now works full-time at Bosch as an associate application developer responsible for bench-testing the supplier's fleet-management software before release to commercial-vehicle customers.

"We're starting the process to recruit our next group," Mansuetti said, noting that North American operations intends to hire 500 software engineers this year. In addition to its IoT apprentice program, Bosch's Mission to Move initiative helps workers in the supplier's powertrain solutions division learn the basics of software and artificial intelligence. "This effort provides new skills to associates as we experience the shift to electrification," said Mansuetti.



Bosch engineers note that the number of data channels in a brake system has grown from about 1000 a few years ago to more than 60,000 data channels being computed today.

Software played a major role in the upgrade of one of Bosch's premier product lines. "All of our new brake systems are 100-percent connected and IoT-ready," said Rich Nesbitt, head of product management for Bosch chassis systems control in North America. According to Nesbitt, a connected braking system enables faster product development, brings product-development quality upfront via specification refinement and validation and allows for continuous development with over-the-air updates.

"With connectivity, we can add even more value to our brake systems and bring safety to these vehicles in an enhanced way," he explained.

The ongoing explosion of data is the main byproduct of connectivity. A few years ago, brake systems typically had between 500 and 1000 data channels. "We're now looking at north of 60,000 data channels being computed on these new brake systems," Nesbitt said. More data means more knowledge and that information can be uploaded to the cloud. "In the next few years, we're really going to see an explosion of data and connectivity," said Nesbitt.

Other Bosch products are making connections via Internet servers. The software-based Battery in the Cloud product enables continuous monitoring of an electric vehicle's battery. "The Battery in the Cloud gives you a dashboard view of how the battery is performing," Thomas said about the product being developed in the supplier's powertrain solutions group.

"We're leveraging connectivity in the cloud to develop solutions to extend battery life," said Thomas, noting the product could reduce battery aging by up to 20%.

Kami Buchholz

BOSCH

Cadillac Lyriq spearheads GM's EV assault

The 2023 Lyriq has low-roofed wagon cues and a unique silhouette, but there's no "frunk" under the broad hood.

The 2023 **Cadillac** Lyriq isn't the first of **GM**'s new-age EVs to use the company's all-encompassing Ultium lithium-ion battery "system" and all-new family of traction motors. That distinction goes to the **GMC** unit's Hummer EV, but the Cadillac's first-ever EV arguably is more important than the outsized and outlandish Hummer. Lyriq is vital to demonstrating GM's vision for scaling EV batteries and modular vehicle architecture for a wide range of models, from mainstream to luxury.

There's another angle to Lyriq's impact in the market, though. Cadillac itself needs to prove it's got the goods to take on the rapidly expanding universe of luxury EVs, led, of course, by **Tesla**. For now, better judge the Lyriq strictly on its competitive merits, however: Cadillac refuses to discuss production volumes from its Spring Hill, Tenn., assembly plant. Although executives said 2023 models are sold out and 2024 ordering was opened in late June, **LMC Automotive** reportedly projects a total run for both model years of just 22,000 units.

All chips wagered on Ultium

Jamie Brewer, Lyriq's executive chief engineer, said the 2023 Lyriq boasts a near 50/50 front/rear weight distribution. The body and chassis structures are integrated with the battery. The solidity of this unified approach, which also leverages a variety of mixed materials, she added, "Goes right into precision handling."

Brewer told SAE Media that in the course of hundreds, if not thousands, of CAD-based simulations of the body over the course of the car's four-year development, the body structure was almost completely done before any physical parts were created. All avenues of lightweighting were explored, including strategic use of so-called "quiet steel" (a specialty material developed and branded by **MSC**) and "the most-advanced acoustic materials." Program engineers did not sacrifice driving feel or structural performance in their drive to reduce mass, however. At 5610 lb. (2545 kg) and a 121.8-in. (3024-mm) wheelbase and 196.7-in. (4996-mm) overall-length footprint, the base RWD Lyriq is no featherweight, although like many EVs, the grunt of electric propulsion often masks plump curb weight.

If you're looking for the much-coveted EV "frunk," there isn't one. Brewer said when initially laying out the Lyriq's modular architecture, the choice came to a limited-area frunk and tighter dimensions for the rear cargo area — or a roomier traditional rear cargo area with no frunk.

Tim Grewe, GM's director of electrification and strategy, said the Ultium battery chemistry of nickel-cobalt-manganese-aluminum (NCMA) relies on aluminum in the cathode to help reduce the loading of rare-earth materials such as cobalt; the anodes are blended graphite. Grewe reminded that Ultium cuts cobalt content by some 70% compared to current batteries used by GM. The flat, pouch-shaped Ultium form factor incorporates the battery electronics in the cell modules, which engineers said eliminates nearly 90% of battery pack wiring.

As recently as 2016, "we couldn't imagine this cell," said Grewe. He reiterated that the Ultium design is "prepared for upgrades" as chemistry or hardware and software improvements invariably happen.

The Lyriq's twelve modules, each containing 24 of the pouch-type cells,

Charting Cadillac's approach for the EV era, designers insisted the Lyriq cabin feature no corporate parts-bin pieces.

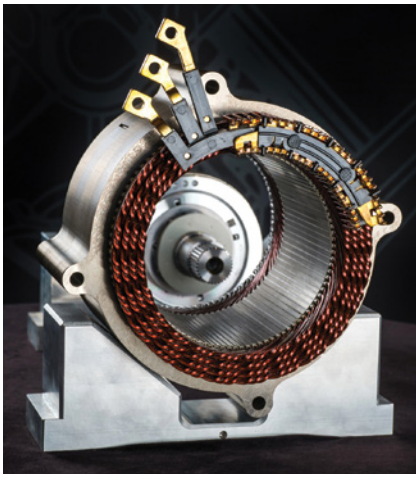
BOTH IMAGES: GM

yield 102 kWh of capacity. (By comparison, the Hummer EV effectively adds another layer of modules to double battery-pack capacity.) The rear-drive Lyriq uses one permanent-magnet variant of the Ultium traction motor lineup to generate a peak 340 hp and 325 lb-ft (441 Nm). The all-wheel drive Lyriq adds a PM motor at the front axle for total system output of 500 hp, with torque rating yet to be finalized at the time of the media introduction.

At the pavement, it all amounts to a driving range up to 312 miles (502 km) for the rear-drive Lyriq, which seems adequate, if not extravagant. Charging times for 240V Level II charging are roughly 37 miles' range per hour using the base 11.5-kW onboard charger and 60-amp capability. The RWD Lyriq is fitted with a 19.2-kW onboard charger that, combined with a special 100-amp household circuit, can provide a max of 52 miles' range per charging hour. As part of its go-to-market strategy, Cadillac is providing buyers with a $1500 credit with charger-installer partner **Qmerit**. Meanwhile, public DC fast-charging yields up to 76 miles' range in 10 minutes of charging.

Slinky suspension

The 2023 Lyriq has a new short/long-arm 5-link suspension attached by a solid-mount front cradle. Its design, said engineers, effectively is a double-wishbone "with an extra link." We'd like to say it makes magic for the car's handling, but low-speed cornering and steering response feels ponderous. At higher speeds, feedback is at best muted and benign. At the rear is another 5-link independent layout on an isolated cradle. All corners feature what Cadillac is calling "Passive Plus" dampers with frequency-dependent tuning meant to provide optimum response in challenging frequency ranges without the complexity and expense of adaptive dampers — which may come in the future, engineers admitted.



Lyriq's GM-engineered traction motors are designed as a single family to suit a range of 20 EVs by 2023.

BOTH IMAGES: GM

Is there a reminiscence of GM's former Saab brand in the Lyriq's C-pillar and rear window?

Driver-adjustable "one-pedal" driving enhances the deceleration experience and of course determines how much regenerative energy is returned to the battery. And Cadillac has innovated on the steering-wheel-paddle regen actuation introduced for the **Chevrolet** Bolt by making it a proportion-based action determined by how much the paddle is pulled, with deceleration ranging from 0.23g to 0.35g. It's an engaging function that's superbly executed.

Another driving-experience upgrade is acceleration-based. Brewer said engineers wanted to avoid the slam-bang acceleration feel common for EVs and the instant maximum torque from their motors. For the Lyriq, accelerator-pedal mashing produces determined thrust, to be sure, but it does seem more "metered" and fluid than some high-powered EVs. Cadillac doesn't quote a 0-60 mph (0-97 km/h) acceleration time, but this developmental facet may marginally blunt the hard numbers in favor of a more luxury-prioritized experience.

The Lyriq's cabin's showcase feature is its 33-in. (838-mm) continuous "free-form" LCD encompassing the area of the traditional gauge cluster and the center stack. Well-regarded gaming developer **Unreal Engine** provides the 3D graphics and the operating system (OS) is from **Google**. Look elsewhere for haptic feedback from touch interfaces, which Cadillac formerly tried without much approval. Although the graphics indeed are striking, many vehicles at the media launch suffered from various degrees of software and UX malfunctions. Engineers were quick to say that the test vehicles were in need of updates. And although the tactile surfaces are generally high-quality — Cadillac's interior designers noted they were determined that their first EV would have no GM parts-bin interior pieces — there is a smattering of less-than-ideal minor trim.

The 2023 Lyriq is a roomy package with a unique profile. The new-age exterior styling blends many mostly attractive cues — and genuine presence. We wonder whether its appearance (more on the wagon than SUV side of the profile spectrum) will be enthusiastically embraced, but the Lyriq has class-competitive performance and features. Cadillac seems to have learned from past lessons about premium pricing: the 2023 Lyriq seems aggressively priced at its $62,990 base price for RWD, with AWD adding $2000 — even if Cadillac did concede many features and options have yet to be introduced.

Bill Visnic

Hyundai puts the 'N' in performance

Just a decade ago, the idea of **Hyundai** challenging the industry's established performance brands would have elicited snickers from many executives and engineers. Hyundai's best effort in the sports car segment to that point, the Genesis coupe, was a solid effort. But it didn't break new ground, nor did it have the staying power to see a second generation. Then in 2014, Hyundai announced that it would be launching a performance brand under the N moniker.

To prove N was a serious effort, Hyundai hired Albert Biermann as executive VP and head of vehicle testing and high-performance development. Biermann, who had been with **BMW** since 1983, was one of the leading lights for the brand's vaunted M division. He is intimately familiar with the practice of taking ordinary production cars and turning them into track monsters with reasonable road manners. Though he retired from Hyundai R&D in 2021, his fingerprints can be seen on Hyundai's full line of N cars today.

The Elantra N shares its 2-liter turbocharged inline-four with the rest of the N lineup.

Hyundai's current North American N lineup consists of three models: the Veloster, Elantra and Kona. The Veloster hatchback first appeared stateside in 2019 and was billed as Hyundai's foil to the **Honda** Civic Type R. The Elantra N sedan and Kona N crossover made their North American debut in 2021 with the same powertrain as the Veloster, a 2.0-L I-4 with direct injection, a twin-scroll turbocharger and variable valve timing. Output for the Veloster N stands at 275 hp and 260 lb-ft (352 Nm). The Elantra and Kona N are slightly more potent, with stated outputs of 276 hp and 289 lb-ft (391 Nm).

The Veloster and Elantra N can be spec'd with either a 6-speed manual transmission or an eight-speed wet-clutch automated manual, while the Kona is offered only with two pedals.

The Veloster N launched the sub-brand in North America.

Gear ratios and final drives are the same across all three vehicles, which also share the same electronically controlled LSD. DCT models are equipped with the N Grin Shift system, which can provide up to 20 seconds of overboost via a button on the steering wheel. Peak output when the system is functioning is raised to 286 hp and claimed peak torque is increased by 7%.

Hyundai invited journalists to test the fleet of N cars at Atlanta Motorsports Park in Dawsonville, Georgia. Even at the relatively slow speeds of the autocross course Hyundai set up at AMP, the Elantra felt the most stable of the three both in transition from one corner to the next and under throttle. But the Kona was the surprise of the event on the autocross course.

The Elantra N also features a unique integrated drive axle, an innovation taken from Hyundai's WRC rally cars. Hyundai claims that by integrating drive shaft, wheel hub and bearing into a single unit, engineers were able to achieve a weight reduction of 3.81 lb. (1.72 kg); DCT models feature a front-mounted tube-and-fin-type transmission cooler. The brakes feature high-friction pads with integrated cooling ducts in the brake dust covers. The vehicles' front fascia also features air guides to keep the front pads and rotors cool. After a full day of abuse at AMP, not one driver complained about brake fade.

Matt Wolfe

BOTH IMAGES: HYUNDAI

Lotus breaks out with new Eletre electric SUV

Lotus Cars recently revealed its first SUV, which is itself a radical step for the purist British sportscar brand. But the new battery-electric Eletre also breaks ground in being Lotus's first 5-door production vehicle and is likely to be the company's first product to sell in significant volume. The Eletre will be built at a new production facility in Wuhan, China, and features an aluminum body.

Known internally as the Type 132, Eletre will use Lotus's new Electric Premium Architecture (EPA), which has been designed to be easily adapted to accommodate batteries and powertrain components for a range of vehicle sizes from C+ to E+, as well as intelligent driving technologies. The Eletre is the first of these models and will be joined by two others built at the Wuhan plant. One of these is expected to be a smaller electric SUV. Lotus expects to sell around 100,000 Eletres annually, with principal markets in China, Japan, Europe and the U.S. Still headquartered in Hethel, England, since 2017 Lotus Cars has been majority-owned by **Zhejiang Geely Holding Group**.

Eletre will be powered by two electric motors, one driving the front wheels and the other driving the rears. Each motor is integrated with a controller and reducer, designed to make the unit lighter and smaller. Power output will start from 600 hp (447 kW), powered by a 100-plus kWh battery pack housed in the vehicle floor. Maximum range on the WLTP driving cycles is expected to be 373 miles (600 km). The SUV will be equipped with rear-wheel steering.

The Lotus Eletre's flexible architecture includes a rear-wheel steering package.

As a high-performance EV, Eletre earns another Lotus milestone: It will be the company's heaviest vehicle ever — by a long shot. Target curb weight, at 4400 lb. (1995 kg), is roughly 1400 lb. (635 kg) heavier than the Esprit V8 of 2004. But Lotus's engineers expect it to be significantly lighter than other EV performance cars.

"The big thing, at the very start, was that it was a completely new platform to us," Gavan Kershaw, Lotus's director, Attributes and Product Integrity, told SAE Media. "We knew it was going to be fully electric. It was going to have a lot of power, and we wanted it to be dynamically engaging. It didn't have to be aggressive and frantic, but it had to be everything you wanted from it."

Those basic performance metrics, set nearly four years ago, established the Eletre's chassis hardware set: electric all-wheel drive with torque vectoring; active independent rear-wheel steer; double-wishbone front suspension; multi-link rear; air suspension with twin-chamber CDC dampers; active roll control and de-coupled brake systems.

Peter Horbury, whose five decades in automotive design includes noteworthy periods at **Ford** and **Volvo**, is Lotus's senior VP and executive advisor, Design. He explained the challenges and opportunities of creating the new Eletre. "We're dealing with a global market and cultures and things are so different, still to this day, that we might be talking about an age group in America of 45, 50, 55 years of age. In China, we might be talking about 25," Horbury said. "If you design a car not to upset anybody, you'll never excite anybody."

John Kendall

Lotus designers created the Eletre's cockpit and HMI to retain its purist-sportscar customer base while attracting a new demographic.

BOTH IMAGES: LOTUS CARS

R1T EXPOSED!

New Rivian R1Ts at the company's Michigan engineering facility.

A comprehensive teardown of Rivian's pioneering electric pickup reveals praiseworthy build quality, innovative thinking...and some lapses in manufacturability.

by Lindsay Brooke

Rivian's R1T is in big demand by both the public and the industry. OEMs are still scrambling to acquire their own examples of the pioneering, innovative electric pickup for competitive analysis and testing, typically paying brokers hefty premiums over the retail price. The hot-ticket trucks are in short supply; Rivian has for a variety of reasons struggled to ramp up its Normal, Illinois, plant (capacitized for 150,000 units annually when it was owned by Mitsubishi). The facility, which also builds the R1S SUV and the new, battery-electric **Amazon** delivery van, only achieved its first full 10-hour-shift day of uninterrupted production in early June. Line rate improved greatly by July.

Vehicle design plays a significant role in assembly efficiency as well as in build quality and customer delight. So, how does the R1T stack up in its DfM (design for manufacturability)? And what compelling technologies lurk underneath the sheetmetal? For a look deep inside the truck, SAE Media recently visited **Munro & Associates**, a leading product teardown, analysis, costing and lean-design consulting firm based in Auburn Hills, Michigan.

Prior to the R1T's launch, company founder Sandy Munro hunted down two R1Ts for sale and purchased both, one from Rivian and one via a broker. One of the trucks is the subject of a comprehensive nut-and-bolt teardown by Munro's engineers, whose detailed observations and data go into a series of commercially available reports.

The second vehicle became Munro's daily driver and a touchstone for the teardown activity. The truck has performed beyond his expectation, including in regular off-road exercises. "It's hands-down superior to the hybrid [**Jeep**] Wrangler Rubicon and the **Land Rover**s that I've owned," Munro asserted.

Meeting Munro in his facility's Rivian teardown area, he noted that his business now is almost entirely dedicated to the scrutiny of EVs, their subsystems and components. "For the most part we're finished with ICE-related work," he said. "There is enormous industry-wide interest in EV technology and design," he said, "and we aim to be the go-to." He pointed to two **Tesla** teardowns nearing completion and said **Ford** F-150 Lightning and **Chevrolet** Silverado EV projects are in queue.

'A bear to assemble'

A typical vehicle teardown takes roughly three months to complete, and according to Susan Smith, a veteran industry engineer with extensive automotive metals, seating and manufacturing experience who serves as program manager on the Rivian project, Munro's team was about three weeks into the R1T when SAE Media visited. "We typically deploy a team of 12 on each teardown," she explained. Around us, groups of engineers and technicians wielding hand tools and micrometers were methodically dismantling the truck's interior and cargo areas. Components and subsystems are measured and weighed, their material content and function are assessed, the parts

LINDSAY BROOKE

A nearly stripped R1T cabin reveals electronic controller locations, NVH mastics on the floorpan and the innovative HFH cross-car beam.

Sandy Munro (center) with Munro electrification director Tom Prucha and Rivian teardown manager Susan Smith.

BOTH IMAGES: LINDSAY BROOKE

are tagged, then organized on display boards for further analysis. Engineers on laptops at an adjacent table were busy calculating part cost and labor hours using Munro proprietary software.

Smith and Munro compared their initial observations about the Rivian with their assessment of the Tesla 3 early in its 2018 teardown. "The Model 3 had fit-and-finish issues galore, and issues inside the cabin. The Rivian has no fit-and-finish issues whatsoever," Munro said. "It's far superior to where Tesla was at the same stage of that company's production, relatively speaking. Of course, Rivian's overall [manufacturing] volumes currently are much lower."

"What I'm seeing is a really well-made vehicle," Smith commented. "Fit/finish is first-class. Paint is beautiful. However, my impression is the R1T is very difficult to build. The design and engineering do not lend themselves to manufacturability. It looks to be a bear to assemble."

Looking into the teardown vehicle's increasingly skeletal body structure, the experts highlighted the various areas in which Rivian has much to learn about DfM. They pointed to excessive sealant applications and evidence of a lot of hand finishing and manipulation of the sealants and adhesives. Smith noted places that could enable water intrusion. NVH countermeasures, particularly bake-on mastics, appear to be more extensive than those used in other EVs. "The designers clearly wanted to ensure a quiet cabin, so may have gone a bit overboard to hit their interior dB targets," Smith said.

A troubled marriage

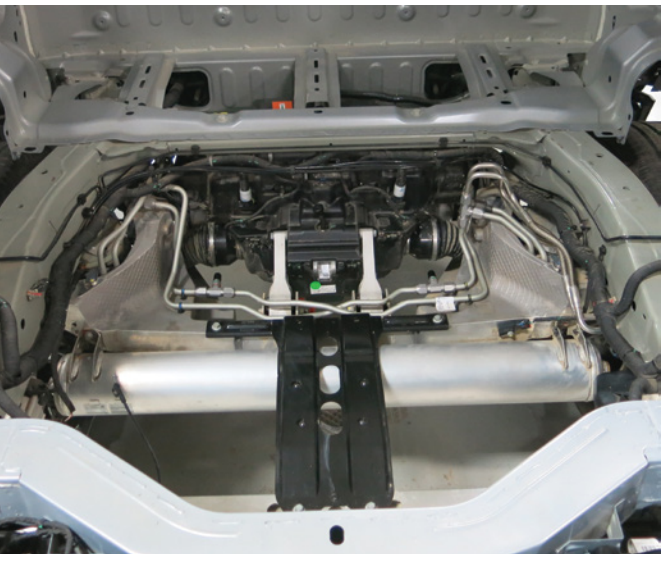
While the R1T displays commendably tight body-panel gaps and tolerance consistency in all areas visible to the customer, it's a different story underneath. The assembly workers responsible for marrying the body and chassis modules at Normal have a needlessly tough job, one that could go much more smoothly with design changes, Munro and Smith concluded.

"There are places on this vehicle where subsystems are being married, such as in the body decking operation and in introducing the IP into the front structure, where the operators must literally squeeze in between the sections to connect up the harness wires during the marrying process," Smith explained. "It looks possible to accomplish at a slow assembly-line rate." However, she cautioned that Rivian's ability to ramp up to its projected line speed at Normal (and at the recently announced second plant in Georgia) will be hampered by gaps that are excessively close in critical areas.

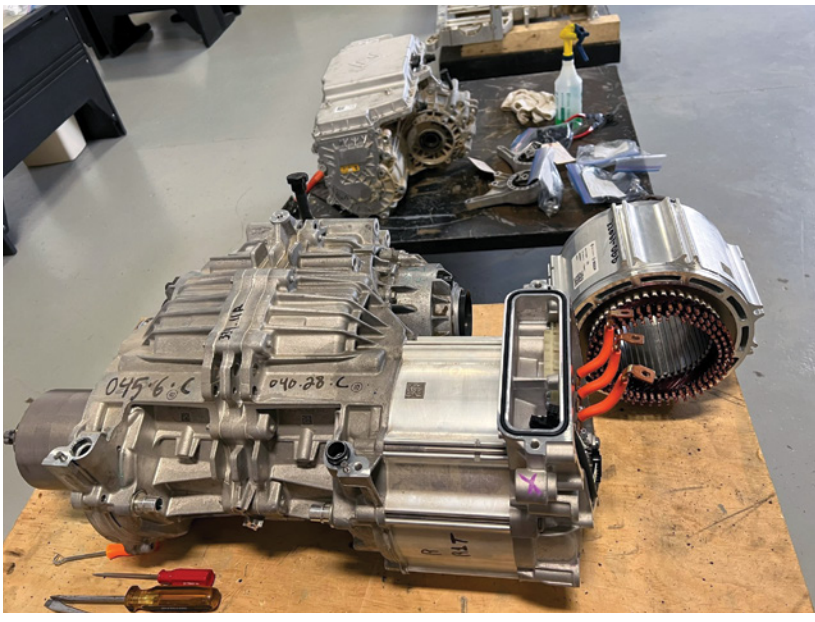
"They've got to get their tolerances to where the assembly workers will have freedom to assemble this vehicle fast and without error," she noted. "On this current design, everything is too close. In the decking process they're dealing with extremely small clearances. This unecessarily complicates the assembly process."

Added Munro: "Body marriage on the R1T appears to be really, really tough," he said. "Besides rethinking some of the tolerances, I'd probably put electrical connectors in different places versus where they are now. As it stands, this is not a vehicle design that allows operators to get their jobs done in a hurry." He suggested that with minimal modifications, his team could "take a significant amount of labor hours out of the vehicle."

Other observations from the early phase of Munro's R1T teardown: The design of the "gear tunnel" closures unfortunately has a protruding corner — like a blunt spear — that can be a leg-bruiser when the doors are deployed. The truck has an overabundance of bracketry, the functions of which could be consolidated to save complexity, labor time, cost and weight, Munro reckons. Smith noted that in some areas of the Rivian's body structure, the weldments are overly massive.



With its composite cargo floor removed, the R1T's rear gearbox, air-suspension components and mixed-materials construction are visible.



The robust Bosch e-drive units feature hairpin-type motor windings. The motor does not have a heat exchanger/oil pump — it is directly cooled via coolant circulating through channels in the stator housing.

And in some locations on the structure, the Normal body shop is applying both spot welds and MIG welds. "Considerable redundancy," Munro commented. "Overall, they need to get their body welding and sealing processes sorted out to eliminate this. They also need to get those processes up to speed in terms of ensuring water tightness."

Subtle innovations

In an all-new vehicle that is clearly loaded with smart, customer-delight features, the Munro experts noted many subtle design and engineering elements that impressed. The R1T's non-exotic materials mix features a plastic composite cargo bed, and cleverly employs double leaf springs to hold up the tambour door over the cargo space.

Smith is impressed by the cross-car beam supplied by Germany-based **ElringKlinger**, as well as the adjacent HVAC ducting that uses various plastic materials to address different loads and conditions. The cross-car beam is produced using hydroformed hybrid technology (HFH). The polymer-metal hybrid involves a mold tool combining two processes — hydroforming and plastic injection molding — in a single step. According to ElringKlinger, a robot places an extruded, thin-walled metal tube into the mold. After the two halves of the mold are closed, the interior of the tube is filled with cold water at 600 bar (8700 psi), which causes it to expand and assume the desired shape. The injection-molding process then begins in the same mold cavity.

Molten plastic is injected into the mold at 300 deg. C and then solidifies in the cavity between the mold and the reshaped tube, again at 600 bar. Internal counterpressure ensures the aluminum tube does not collapse during the injection process, the company maintains. Once the part has cooled and is dimensionally stable, the hybrid part is removed by a robot and transferred to downstream processing where various vehicle-specific plastic elements are added.

At the time of our visit, the teardown team was just beginning its scrutiny of the R1T's battery pack, making that an article for another time. Initially, Munro is impressed with the pack design's "bottom-up" cooling strategy featuring a cooling plate between each pair of cylindrical 2170 lithium cells. The traction motor design is "robust," he said, with the **Bosch** electric machine using hairpin-type wiring.

Director of electrification Tom Prucha previously was with in-wheel-motor specialists **Protean Electric**, where he developed an acute assessment of EV driveline dynamics. He said he appreciates the Rivian's propulsion system architecture with its four separate drive motors. "It's best-in-class from a performance standpoint and demonstrates how an electric drive system can and should work," Prucha noted. "Having said that, I'm sensitive to driveline backlash. When I tip in and out of the throttle in the Rivian, I can feel four separate backlashes, one from each motor. I think it's inherent with four motors and four gearboxes.

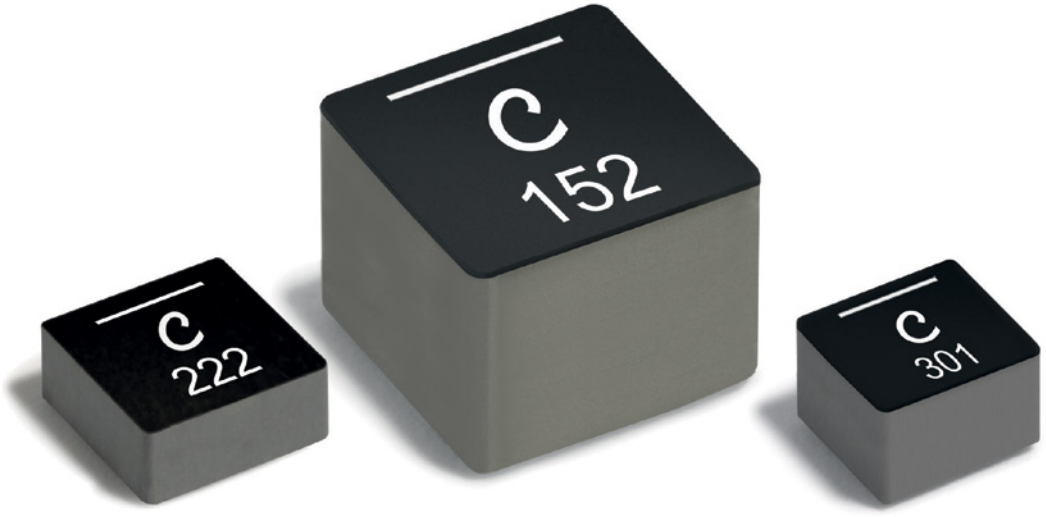
"Could they tighten that up? Probably," he said. "Would it affect vehicle efficiency? Possibly."

"For an all-new EV, the Rivian is an outstanding first effort," Sandy Munro affirmed. "But overall, it needs to be 'scrubbed'" — his term for a comprehensive culling of all extraneous parts and a rethink of key design areas that cause manufacturability issues.

"From what we've seen to date, I think Rivian could take a lot of money and many kilos of weight out of this truck — and make it a lot easier to build." ■

FROM LEFT: LINDSAY BROOKE; MUNRO & ASSOC.

The (lowest) Loss Leaders



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EVs drive NVH material innovations

NVH analysis is steadily incorporating more virtual tools and processes as EV development takes off.

Skateboard platforms, high-frequency motor noise push lower dB thresholds and new countermeasure solutions.

by Lindsay Brooke

The definition of a 'quiet' vehicle, as determined by the occupants' ears, is changing radically, as electric motors replace the internal-combustion engine. And electric vehicles are changing the technologies used to reduce, and eliminate, NVH — noise, vibration and harshness. Removing the piston engine, with its exhaust, intake and valvetrain/injector noises, unmasks a plethora of cabin sounds that occupants never heard before.

"ICEs generate at least 20 dB more noise at the cabin level," noted Vahid Mortazavian, Ph.D, global CAE leader at Ascend Performance Materials, in a presentation at the 2022 SPE Automotive conference. Tire and road noise become more prevalent in an EV. Even the heater fan is louder without engine noise to mask it. But EVs generate their own noises, including high-frequency buzz from the electric motor. These are among the new challenges facing development engineers and NVH specialists.

"Reducing and eliminating cabin noise in electric vehicles is now a significant focus for the OEMs," noted Arnold Braun, a veteran polyurethane systems engineer at Dow. Another challenge for the NVH analysis and materials communities is the speed in which EVs are being designed. "Everybody's in a race and have reduced their design cycles," added his colleague Selamawit Belli, Dow's automotive acoustics strategic manager, in an interview with SAE Media.

Dampening demand

Braun and Belli noted the dramatic change in vehicle architectures, with the "skateboard" layout for EVs emerging as preeminent, presents new challenges and opportunities for NVH engineers, as well as for their company's widely-used Betafoam product line. In an EV, with the flat floorpan and battery pack underneath, "we're now looking at body structures that have stiffer and stronger rocker systems than those in ICE vehicles," Braun explained. "We face the question of how to apply our NVH treatments into those areas so that the strength is retained along with the acoustic performance."

The water-blown polyurethane-based Betafoam is a family of two-component acoustic foam technologies featuring a >4000% expansion rate. When robotically injected into vehicle body cavities, the foam (both open- and closed-cell types) creates an effective, three-dimensional acoustic seal, according to Braun. Betafoam solutions have been industry workhorses in reducing tire/road noise — a longstanding cabin noise source for all vehicles — through the wheelhouse. It's also being employed on recent EV platforms to block electric motor frequencies (a new EV acoustics bogey) in an impressive dynamic range from 500 Hz to 10,000 Hz.

In their quest for cabin quiet, OEMs now are pushing suppliers for solutions with vibration dampening as well as sound-absorption qualities. "A lot of the new EV structures the OEMs are showing us have a closed plenum in the cowl section of the body. And we see growing interest in cast parts, not the welded sheet-metal fabrications used today," Braun noted. "There may not be areas where you can apply acoustic foams

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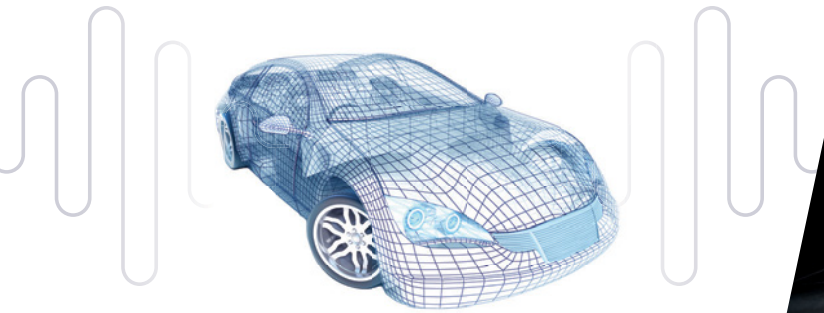

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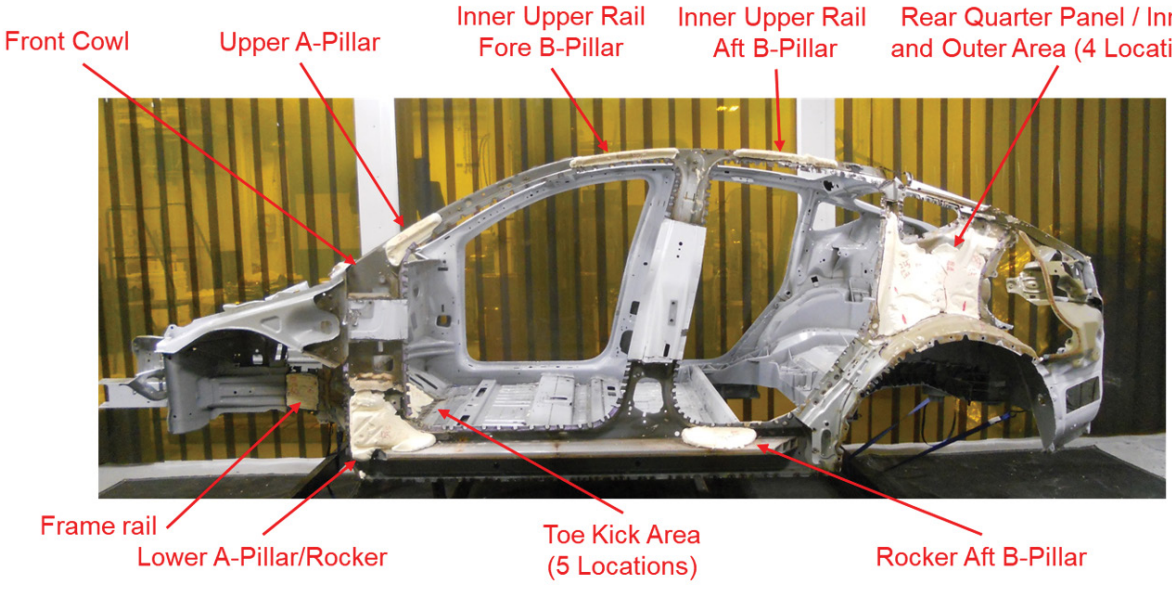
EVs drive NVH material innovations



Automakers might fill more cavities with NVH blocking material in a day than the world's dentists fill in a year.

Dow's Arnie Braun sees significant changes in the NVH battle driven by EVs. technologies.

in a castings environment, but they will need more resonance damping due to that type of construction."

He admits that because dampening is not a Betafoam top attribute, Dow chemists are working on innovative solutions that retain the incumbent material's ultimate flexibility for filling a wide variety of cavity geometries. OEMs deem this important as it obviates the need for redesign and tooling after sheetmetal changes. "Asking an OEM to move a [access] hole is costly and time consuming. In the assembly plant, we're shooting our foam anywhere from five to eight locations, per body side. Moving holes around is usually not feasible."

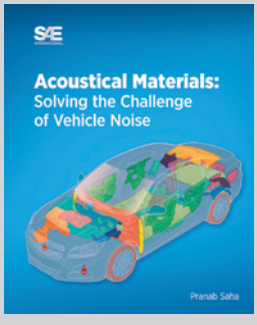
Dow R&D also is well into development of new liquid-applied coatings to address the high-frequency modes (from 800 Hz to 3000 Hz) excited by electric propulsion, noted Dow associate research scientist Dr. Ian Robertson, in a presentation at the 2022 SPE conference [see SAE Technical Papers 2021-01-1123 and 2017-01-1877]. The company's current Acousticryl line is a water-borne, sprayable co-polymer emulsion designed for acoustic dampening applications. Dow claims Acousticryl outperforms competiive NVH treatments including bake-on bitumen pads, epoxies or PVC.

Virtual analysis

Dow's NVH team receives body-structure CAD data from the customer two to three years in advance of vehicle launch. Braun works with the automaker's CAD engineers to study cavities, with an eye toward how

FROM TOP: DOW; LINDSAY BROOKE

An essential reference on NVH materials

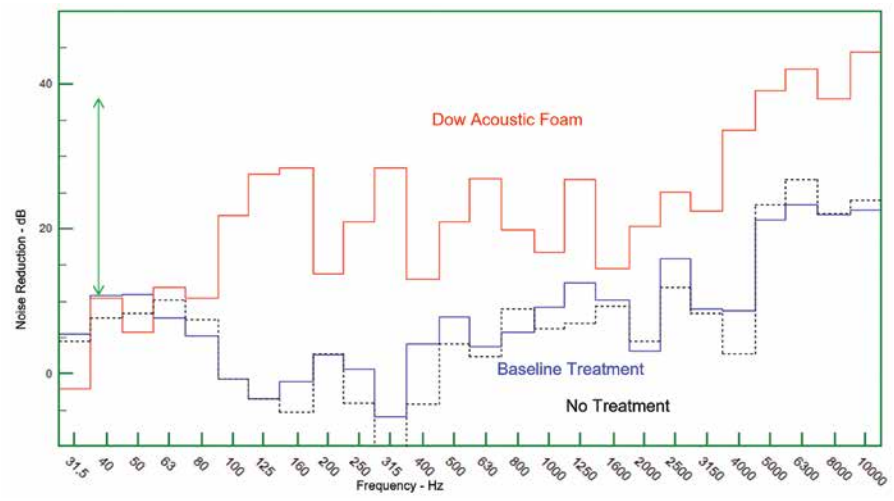


A thorough understanding of Noise, Vibration and Harshness, and the materials involved with generating and abating it, is vital as the auto industry transitions into electrified mobility. For engineers and technicians seeking that understanding, a new, award-winning book published by SAE International is an essential resource.

Acoustical Materials: Solving the Challenge of Vehicle Noise is the work of Dr. Pranab Saha, an SAE Fellow and globally-recognized expert on automotive noise, body interior systems and sound-package materials. His book details the basics of sound and vehicle noise sources and covers noise measurement and how vehicle passengers perceive sound. It offers practical solutions for identifying, reducing and abating cabin noise using various sound-package material approaches.

Acoustical Materials recently earned a Gold Medal from the Independent Book Publishers Assoc. (IBPA) in its annual Benjamin Franklin Award program, Professional Reference category. The book is available through the SAE website: https://www.sae.org/publications/books/content/r-442/.

Lindsay Brooke



Noise-reduction plot shows the performance of Dow's Betafoam versus the baseline.

the foam material would flow. "When there are areas of concern, we take that CAD data and 3D-print the parts long before release of any sheetmetal. We don't do any acoustic testing on them. 3D printing has been immensely helpful. The point is to simply understand how the material flows through that space. There are areas within vehicles, both ICE and EV, that have particular areas needing to be treated."

Dow uses a proprietary engineering methodology called 'Acoustimize' to evaluate and optimize the NVH performance of a vehicle as the driver's ear experiences it. "Acoustimize gives us the DNA of the vehicle body," Braun said. "It tells us how sound travels from front-to-back, back-to-front, side-to-side and corner-to-corner.

"We measure and introduce noise throughout certain areas in a microphoned vehicle that typically has about 32 microphones fitted," he noted. "We have six to eight locations where we introduce noise."

The Acoustimize process has enabled Dow engineers to speed development of robust sound packages for OEMs and tier suppliers by identifying manufacturing complexities, such as metal fit, sealer skips and pass-throughs which are not detectable by other methods. It also helps pinpoint noise communication between different segments of the vehicle.

The company claims that Acoustimize studies have demonstrated noise-reduction improvements of five to 20 dB in applications using Betafoam, compared to competitive NVH-attenuation treatments and designs.

Road/tire and wind noise remain an arch enemy of vehicle development teams, according to NVH engineers. As the tire industry investigates a new generation of non-pneumatic tire tech aimed at EV applications, new challenges and opportunities will emerge. Pass-by noise, initially for European vehicle applications, also is a focus of NVH material innovations for the wheelhouse area.

Wind noise is the omnipresent tricky foe and while incremental noise-reduction improvements are being made in this area--vehicle designers would most like to eliminate exterior mirrors, replacing them with cameras — OEMs are focusing on the noise sources (road/tire, structural vibrations, e-motor frequencies) on the "lower end" of the body.

As to the future of NVH analysis and abatement strategies, OEMs increasingly want to see prediction modeling of foam behavior in cavities, Braun reported.

"They want us to provide flexibility and to keep pace with their faster and faster development cycles," he said. "More virtual testing solutions, to supplement and in some cases replace physical tests, also are on the way. OEMs are asking for virtual data more than ever." ■

DOW

Optimizing design for additive manufacturing

The rules for designing for DfAM require design engineers to take a different approach than used for traditional DfM.

Avoiding the pitfalls of 3D printing requires knowing the process limitations — and how to work around them. An expert at a leading AM specialist shares insights on getting it right.

by Nick Allen

As additive manufacturing (AM) technology and its applications expand, engineers are recognizing that different industrial 3D printing processes have different constraints that can affect designed parts in production. Some constraints are universal across the different processes, and some are more specific to the type of process used. It is thus essential to understand the technology you are working with to maximize its potential as a production method. With this understanding it is possible to design around the general limitations of AM as well as the specific process constraints that could impact a product or part.

While design for manufacture (DfM) is not a new concept, the rules for designing for additive manufacture (DfAM) require design engineers to take a different approach. This article is dedicated to sharing some of the most common pitfalls encountered when designing parts for the selective laser sintering (SLS) and multi-jet fusion (MJF) 3D printing processes and how to avoid them.

Wall thickness

Wall thickness is a critical consideration for parts being designed for AM both in terms of the part itself and any post-processing that may be required. We recommend a maximum wall thickness to prevent shrinkage deformation during cooling, while our minimum wall thickness is recommended to ensure parts withstand our automated post-processing techniques without damage.

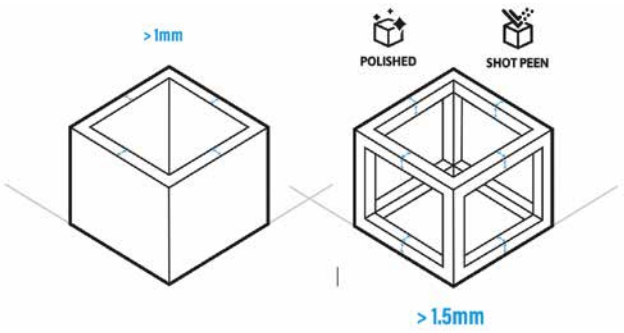
- 1 mm (0.039 in.) is our guaranteed minimum wall thickness for unfinished parts, but it is important to note exceptions where thickness should be increased. Exceptions include vulnerable unsupported structures, skeletal structures, weight-bearing walls and specific functional/performance requirements.
- 1.5 mm (0.059 in.) is our guaranteed minimum thickness for parts that will be post-processed using our polishing or shot peening options. Again, there are exceptions for vulnerable unsupported features, weight-bearing walls and performance requirements.
- Our recommended maximum wall thickness is 5 mm (0.196 in.). Anything beyond 10 mm (0.393 in.) may require the wall of the part to be hollowed out to prevent shrinkage deformation, build failures and excessive print times.

In most cases, 3 mm (0.118 in.) wall thickness provides a rigid part with a little or no flex, while 1.5-mm walls result in some flex depending on length and/or structural support.

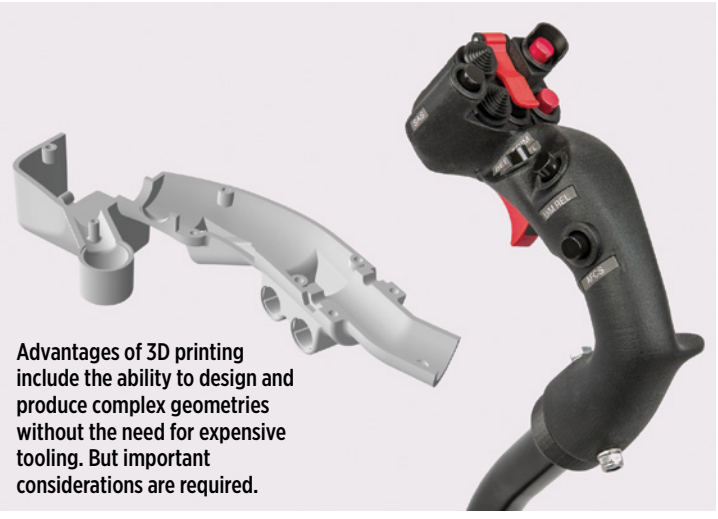
Surface details

The nature of the powder bed fusion (PBF) processes that **3DPrintUK** uses means that parts come off the printer with a granular surface, and sometimes layer lines can be visible. This is why post-processing options such as polishing or shot peening are often required, to achieve a smoother injection moulding-like

Designers must consider the complexities they design into parts, especially the holes and channels running through them.



Wall thickness is a critical consideration for parts being designed for AM both in terms of the part itself and any post-processing that may be required.



Advantages of 3D printing include the ability to design and produce complex geometries without the need for expensive tooling. But important considerations are required.

BOTH IMAGES: 3DPRINTUK

finish. With this considered, if specific surface details are designed into a product or part, certain design rules are pertinent here.

Surface details can vary depending on the surface to which they have been applied. The top side may include a raised burr of the laser around the outer edge, whilst the underside can appear more muted. Thus, for most parts the best outcome is achieved by applying the text on the side skins for the best and most consistent visibility. Other recommendations are as follows:

- Minimum 0.5 mm (0.019 in.) wide and deep. The same depth and width measurement results in superior clarity.
- Embossed text is safer than extruded text, as small details and edges can be vulnerable to break.
- Avoid embossing or extruding the surface details too far. Try to keep them to around 0.5 mm; further out can result in damage in post-processing and too deep can result in trapped powder.

Solid vs. hollow parts

Hollowing can prevent the part from deforming and achieve higher levels of accuracy and reliability. However, based on 3DPrintUK's experience working with PBF processes, the combination of powdered material and hollow parts can result in trapped powder within the sintered shell. When designing a hollowed part, there are a few design options that avoid trapped powder. These include designing in powder escape holes, removing unwanted surfaces altogether (i.e., bases), or including a locating lid.

For customers, we will automatically hollow larger parts before printing when above 15-20 mm (0.590-0.787 in.) on a case-by-case basis. For customers who do want it printed solid we advise accordingly.

Interlocking / mechanical parts

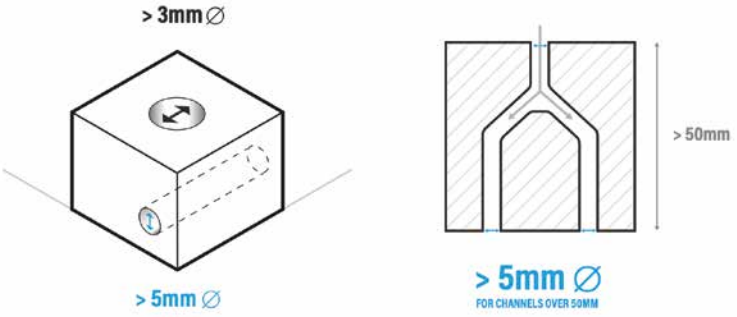
When designing interlocking or mechanical parts, including a clearance between parts is essential. This is because a gap between the sintered surfaces prevents them from fusing together and becoming a merged part. The tighter the tolerance, the more likely it is to fuse together. Some general design rules for this are:

- In nearly all cases, a clearance between moving parts must be at least 0.5 mm to guarantee a result.
- Contacting surfaces must be kept to 5 mm or below to guarantee them not fusing. Longer shafts are likely to be too difficult or impossible to free up.
- Think about how the trapped powder between the surfaces can be removed. Sometimes a little force is enough to remove the powder. Designing powder removal holes may also be needed.
- Dense volumes can refract more heat and harden the powder between the surfaces. This means that the clearance may have to be increased if this is flagged as a concern or if the part does not function as intended.

Holes and channels

One of the key advantages of 3D printing is the ability to design and produce complex geometries without the need for expensive or "impossible" tooling. However, designers still must consider the complexities

Optimizing design for additive manufacturing



Engineers working within the PBF process need to consider the impact of holes and channels in the part design and heat exposure during the build process.

they design into parts, especially when it comes to holes and channels running through them. The nature of the PBF process comes into play here, specifically the amount of heat that parts are exposed to during the build process. Thus, holes and channels with small diameters can result in fused powder within them.

To prevent this, the recommendation is to design them greater than 3 mm. For long internal channels over 50 mm (1.97 in.) the same problem applies. It can be difficult to remove all of the powder, therefore diameters greater than 5 mm are recommended for internal channel features. The same rule applies to curved holes.

Maximum build size

This might seem like an obvious, but all 3D printers — whether desktop, mid-range or full production systems — have a maximum build size. Remarkably this is often overlooked. Across 3DPrintUK's fleet of industrial-scale 3D printers our maximum build sizes are: 300 x 300 x 600 mm (for SLS PA12); 350 x 255 x 350 mm (for MJF PA12), and 180 mm x 120 mm x 120 mm (for SLS flexible TPU).

3DPrintUK will always position parts in a build to get the best possible outcome — no matter the original orientation of the file. The only exception to this is if a client locks the orientation while placing the order.

Designing for 3D printing is a vital facet of successful outcomes with the AM technology. Hopefully this overview will provide a useful primer for anyone coming to the technology for the first time or some fresh insight to anyone working with the technologies on new products or parts. ■

Nick Allen is managing director of 3DPrintUK, a U.K.-based specialist in low-volume production using powder bed fusion (PBF) 3D printing systems with polymer materials. The company bridges the void that exists between prototyping and injection molding. www.3dprint-uk.co.uk

3DPRINTUK

Real-time processors help drive the zonal E/E REVOLUTION

NXP said its S32 platform is enabled for rapid prototyping and embeds a high-performance hardware security engine.

NXP

With its new generation of software-compatible processors, NXP aims to accelerate systems consolidation and performance.

by Bill Visnic

OEMs face major challenges with their vehicle electrical architectures as they become more complex and unwieldy. They also want to speed their innovation cycles while supporting intelligent safety and functional upgrades. By developing software-defined vehicle architectures rather than the conventional hardware approach, OEMs can consolidate engine control unit (ECU) functionality into more powerful multicore processors that support software isolation and upgradeability.

So said Brian Carlson, **NXP Semiconductors** director of Global Products and Solution Marketing, who spoke with SAE Media about the company's newest automotive-targeted processors and the trends that drove their development. The NXP S32 automotive platform, he said, is central to addressing automotive's accelerating electrical/electronic (E/E) consolidation — both logically and physically and sometimes a combination of both. Logical consolidation, Carlson said, organizes functions into domains, while physical consolidation organizes functions based on their location within the vehicle into zones.

NXP's current S32G processors already are enabling vehicle networking and service-oriented gateways, and the S32K microcontrollers target remote actuation and zonal control in the body and comfort domain. However, with the higher levels of ECU consolidation accelerating, there is a need for higher performance to meet the deterministic demands of software-defined vehicle real-time control applications.

"Today, and historically, automotive architectures have been what we call a 'flat' architecture — where there's a lot of boxes that get added incrementally as new functions come into the vehicle. A lot of the innovations are new, are software-driven with the new boxes," Carlson said. "'Domain' is about centralizing these things more into 'functional.' Powertrain, body and comfort, infotainment, where all of those are grouped together from a software point of view, it's about software consolidation. You'll hear this over and over about 'software-defined vehicles.' I know it's overused," he continued, "but truly, it's where the market's going. The domain focus, that's the first step to consolidate software, not have modules all over the place that aren't directly working with each other."

Meanwhile, Carlson said, "zonal" architecture approaches, once projected for production beginning late this decade, are for a variety of reasons now on a quicker development pace. Zonal structures, he said, "are about simplifying the wiring, the architecture. Where rather than having 100 boxes all over the vehicle, I have maybe four or five boxes.

"I would say many of the major, high-volume OEMs are definitely moving fast [on zonal electrical architectures]," he stressed. "They're leveraging the zonal approach in the 2025, 2026, 2027 timeframe. If you look at the OEMs, they've been adding new capabilities, trying to make this all work, it's been a challenge. And they see that they're investing $20 billion, $30 billion-type numbers into EVs, that's the future where everything's moving. That's what really has driven this faster move to zonal."

Carlson said the transition to domain and zonal architectures is happening concurrently. "One's about

software, one's about simplification of wiring and hardware. Getting rid of two- or three-inch cables and moving to redundant ethernet networks and doing processing at the 'edges.' In some cases, some customers will go faster to zonal, some cases they'll be more domain with some overlay of zonal."

End-to-end consolidation

The recent introduction of the NXP S32Z and S32E processors, Carlson said, extends the S32 automotive platform to provide safe, high-performance real-time processing for safety, control and actuation applications. As noted in a technical paper NXP shared with SAE Media prior to our interview, the combination of the S32Z, S32E, S32G and S32K families enables end-to-end vehicle domain and zonal architectures with common software and tools, which is attractive to OEMs. NXP offers a scalable, compatible real-time roadmap that extends to 5 nm technology to design the consolidated and software-defined vehicles of the future.

Hosting propulsion domain control, electrification, and safety applications, NXP's scalable S32Z and S32E processors offer gigahertz performance, system integration and memory-expansion capabilities beyond today's automotive microcontrollers (MCUs). The S32Z processors target safe hosting of isolated, real-time processing; the S32E processors are software-compatible and add 5V analog and I/Os for actuation.

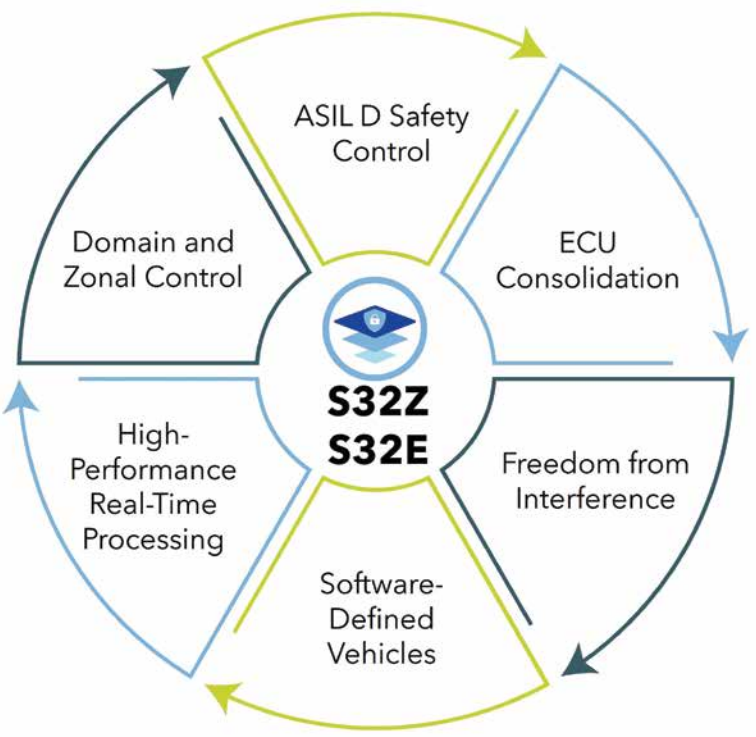
With integrated actuation support, the S32E system solution brings developers significant cost and PCB savings, according to NXP.

The S32Z and S32E processors have eight Arm Cortex-R52 processor cores running up to 1 GHz with split-lock support and dual-core lockstep Arm Cortex-M33 processor cores for system management. A floating-point vector digital signal processor (DSP) supports advanced math, predictive control algorithms and machine learning. The diverse, high-performance processing can enable vehicle innovations not possible with MCUs.

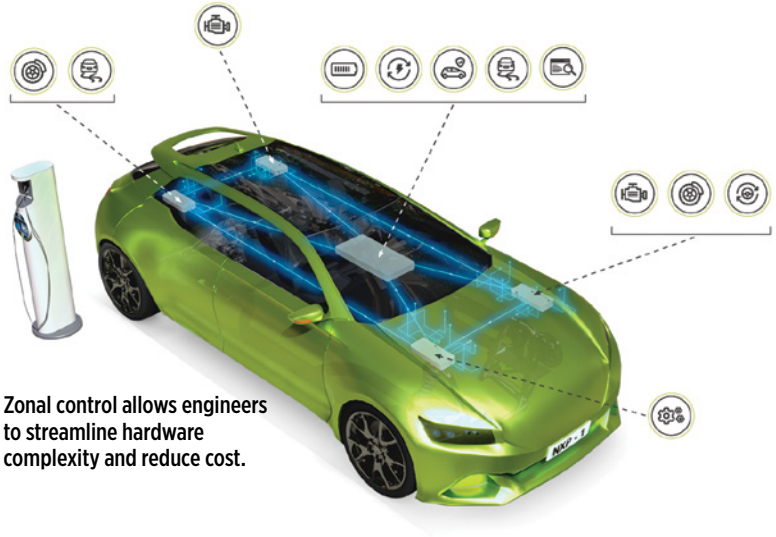
With "core-to-pin" hardware virtualization, the processors isolate independent applications and implement memory and peripheral hardware firewalls and provide Quality of Service (QoS) assurance, Carlson explained in the tech paper. This provides freedom from interference and a unique fault response for each isolated application, which allows operation to continue without a chip reset. It is critical for ECU consolidation and also allows parallel application development before integration.

With up to 64 MB of integrated non-volatile memory, as well as key LPDDR4 DRAM/flash expansion memory, the S32Z and S32E processors support execute-in-place (XiP), large, zero-downtime over-the-air (OTA) updates, and AUTOSAR Adaptive Platform applications. This enables support for larger, more complex real-time applications and future growth that is not possible with MCUs.

The S32Z and S32E processors help enable the automotive industry to accelerate the integration of diverse real-time applications. For instance, they can be used to implement a propulsion domain controller which consolidates the battery management system (BMS), engine management system (EMS), inverter control and power conversion

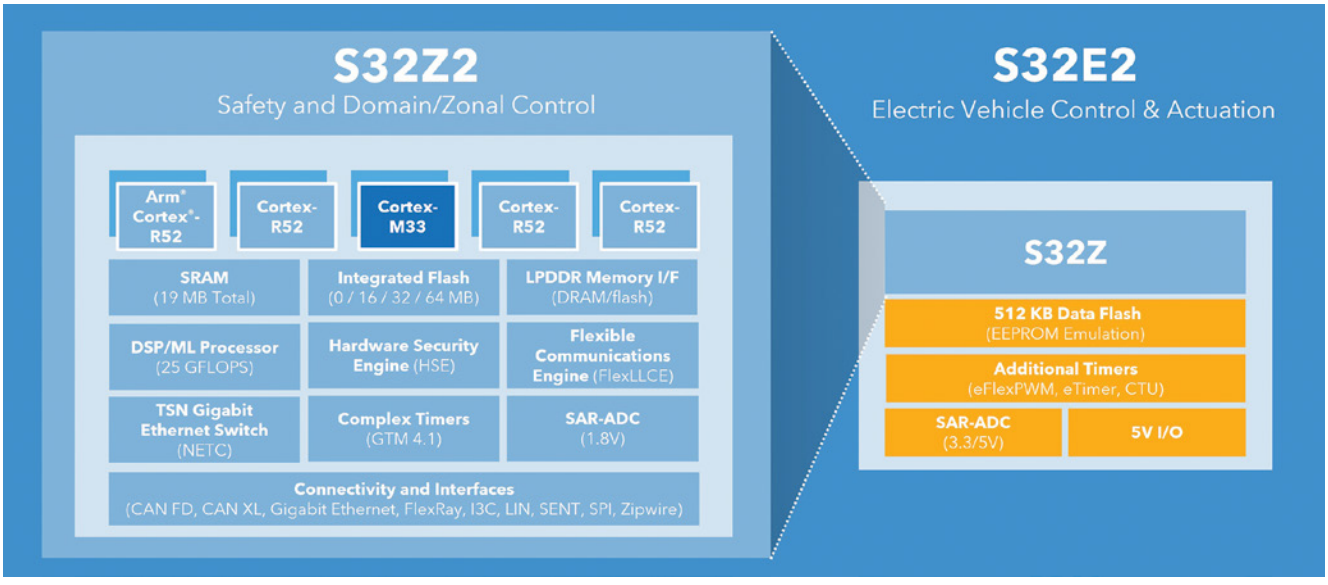


Functionalities enabled by the S32Z and S32E processors.



Zonal control allows engineers to streamline hardware complexity and reduce cost.

BOTH IMAGES: NXP



Relationship between NXP's S32Z2 and S32E2 real-time processors.

control. In a real-time zonal control application, they can consolidate vehicle dynamics, braking, steering and motor control within zones. Another key application is real-time safety processing such as in advanced driver-assistance systems (ADAS) and automated driving.

NXP's Brian Carlson: Going from 100 'boxes' per vehicle — to four or five.

"The industry is going through a major transition on both the software and hardware sides — it's like going through heart surgery and brain surgery at the same time."

Carlson sees new, high-capability processors that enable expanded use of domain and zonal architectures as vital to development of vehicles with increasing software-defined sophistication. Along with that, customer expectations won't let up, either.

Carlson, who's also had extensive experience in the telecom sector, said the auto industry is at something of an inflection point. "The industry is going through a major transition on both the software and hardware sides," he asserted.

"It's like going through heart surgery and brain surgery at the same time. This is a major undertaking and it's tens of billions of dollars per OEM that are investing to do this," he opined. "But they realize that they had to make this change. If they did not make this change, they could become irrelevant. I've seen this happen in the mobile [phone] industry."

Embedded security

The S32Z and S32E, like all other S32 automotive platform processors, Carlson said, embed a high-performance hardware security engine (HSE). The firewalled HSE is the 'root-of-trust' supporting secure boot, security services and key management with protection against side-channel attacks. The processors are certified to ISO/SAE 21434 for cybersecurity.

The S32Z and S32E processors provide fault-tolerance with fail-operational support for high availability across multiple applications and are certified for ISO 26262 ASIL D functional safety systems.

S32Z and S32E enablement

As with other processors in the S32 automotive platform, the new S32Z and S32E processors are enabled with hardware and software for evaluation, development and rapid prototyping. They include the company's GreenBox 3 development platform which integrates processing, peripherals, networking and connectivity interfaces in a robust enclosure.

The complete out-of-the-box system with advanced control applications includes example code, PMICs, Ethernet switch and transceivers, and CAN transceivers.

A wide range of value-add enablement software and tools, including the S32Z and S32E Vehicle Integration Platform (GreenVIP), help accelerate evaluation, development, proof-of-concept, and time-to-market.

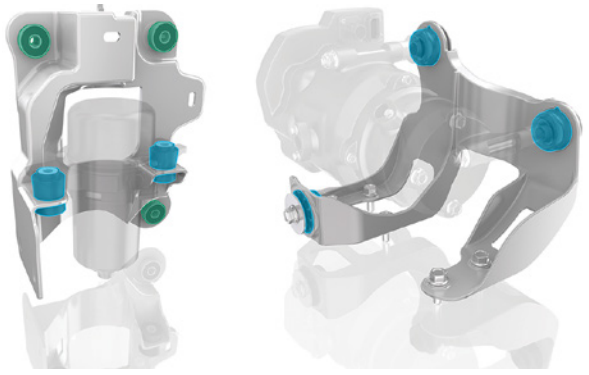
In addition, NXP has a broad and growing partner ecosystem to help accelerate customer designs, according to Carlson. ■

BOTH IMAGES: NXP

PRODUCT BRIEFS

SPOTLIGHT: NOISE & VIBRATION

Decoupling solutions

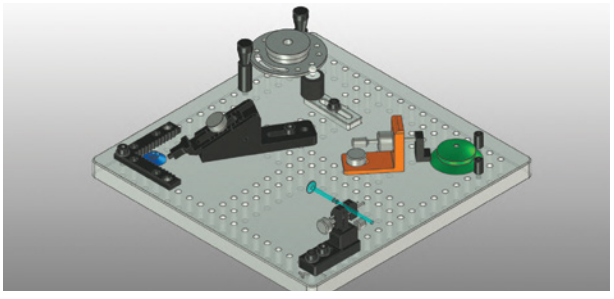


Vibracoustic (Darmstadt, Germany) is developing a range of decoupling solutions for auxiliary components in electric vehicles. The company states that its products will safely decouple auxiliary components from coolers and pumps to compressors to increase durability and driving comfort with options for single or double isolation layers. The company is also developing decoupling solutions for eCompressors — electronically-powered compressors that are used in EVs for requirements such as air conditioning and battery cooling. These components will feature specifically tuned mounts and optimized brackets to eliminate NVH generated inside the compressor and reduce NVH in conditions such as high-voltage fast charging.

For more information, visit http://info.hotims.com/82334-400

SPOTLIGHT: SIMULATION TOOLS FOR 3D PRINTING

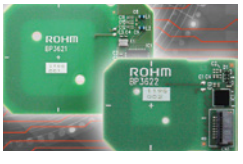
3D fixture-modelling



Renishaw (West Dundee, Illinois) announced FixtureBuilder 8.0, the latest version of its 3D fixture modelling software. The software reportedly allows users to design metrology fixturing setups without being near their coordinate measuring machines or other inspection devices. This reduces the amount of setup time and increases productivity of inspection machines. The software can be used with a CAD model of the part to be inspected, which is imported into FixtureBuilder, so that the fixture can be built around it. The entire fixturing apparatus and the part can then be exported into inspection programming software. FixtureBuilder 8.0 also enables users to model fixtures in Renishaw's QuickLoad rail system, which provides a secure work holding position when used in conjunction with QuickLoad base plates.

For more information, visit http://info.hotims.com/82334-401

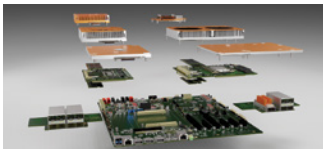
Wireless charger modules



ROHM Semiconductor (Kyoto, Japan) has developed compact wireless charger modules with an integrated antenna board. The BP3621 (transmitter) and the BP3622 (receiver) allow designers to add wireless power supply functionality to smaller devices such as smart tags/cards or PC peripherals. These 13.56 MHz wireless charging modules reportedly allow users to add wireless power functionality to thin and compact devices. They incorporate an optimized antenna layout which enables configuration of a compact wireless charging system to deliver up to 200mW. The board structure facilitates mounting in thin, compact devices – contributing to greater flexibility in chassis design in contrast to conventional solutions. The transmitter and receiver modules also can significantly reduce the development load for prototyping, adjustment, evaluation and other processes necessary to achieve high-efficiency wireless charging.

For more information, visit http://info.hotims.com/82334-402

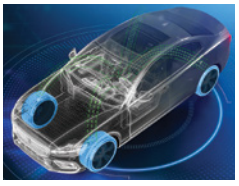
Carrier board design guide



Congatec (San Diego, California) released the COM-HPC Carrier Board Design Guide. The product enables users to develop fully compliant designs by picking their appropriate computer-on-module, add a COM-HPC Server or COM-HPC Client evaluation carrier and appropriate cooling solution, and install their application and run programming. It also features debugging and test routines on a new high-performance embedded computing standard. The COM-HPC is fully compliant to the entire range of new PICMG COM-HPC specifications, namely the COM-HPC Module Base Specification, new Carrier Board Design Guide, Embedded EEPROM specification and the Platform Management Interface specification. It is supported by all leading embedded computing vendors and according to Congatec, offers users best-in-class design security.

For more information, visit http://info.hotims.com/82334-403

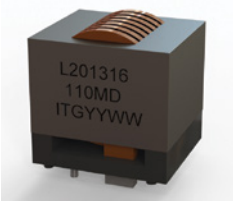
Tread-depth monitoring



Sensata Technologies (Swindon, United Kingdom), announced a new collaboration with **NIRA Dynamics** (Linköping, Sweden) to deliver a tire tread-depth monitoring system. The system features NIRA's tread-wear estimation software and gathers data from multiple existing sensors on a vehicle, including Sensata's tire-pressure sensors, to provide accurate information about tire wear-and-tear. The system uses an algorithm that monitors the tire tread's decreasing depth while compensating for a wide range of conditions. The virtual TDM can be integrated into existing ECUs and is compatible with a wide variety of tire and vehicle designs.

For more information, visit http://info.hotims.com/82334-404

Flat wire inductors



ITG Electronics (Elmsford, New York) introduced a line of high current flat wire inductors for industrial and automotive applications. The company claims that this series offers a superior power rating for inductance and current compared to conventional flat wire inductors and features denser magnetic materials, allowing custom-level power in a standardized product which reduces weight and space requirements. The ITG L201316Q utilizes exceptionally high power-density magnetics materials, is RoHs & HF compliant and has an operating temperature range of -55°C to 150 Celsius (-67 to 302 Fahrenheit).

For more information, visit http://info.hotims.com/82334-405

Hall-effect switches

TDK Corporation (Tokyo, Japan) upgraded its Micronas Hall-effect switch family, HAL 15xy, for automotive and industrial applications. TDK states that modules equipped with HAL 15xy can fulfill higher safety criteria in automotive applications such as brake fluid level sensing, seatbelt detection and brake light switches. The AEC-Q100-qualified HAL 15xy provides many diagnostic features, such as enabling deployment in ASIL A and ASIL B classified automotive applications. The HAL 15xy also features a unique power-on self-test. Customers can enable a full functional test of the sensors' signal processing path and output before starting standard operation to increase diagnostic coverage. The HAL 15xy provides a wide supply voltage range from 24 V to 2.7 V.

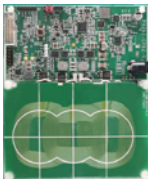
For more information, visit http://info.hotims.com/82334-406

Crankshaft and camshaft sensors

Allegro MicroSystems (Manchester, New Hampshire) announced two new giant magnetoresistance (GMR) crankshaft and camshaft sensors. The ATS16951 (crankshaft) and ATS16351 (camshaft) sensors reportedly provide manufacturers with a single-vendor solution for hybrid-vehicle engines. Additional use cases include two-wheelers, off-road vehicles and designs requiring extended air gap performance. According to Allegro, the ATS16951 features up to 40% better edge repeatability and lower amounts of jitter compared to competing and legacy solutions. It also features an air gap that's 50% larger than existing options. Allegro also claims that the sensor is extremely flexible in terms of mounting requirements and provides a level of immunity not currently available in legacy or competing solutions.

For more information, visit http://info.hotims.com/82334-407

Wireless charging reference



Renesas Electronics (Tokyo, Japan) released a new customer reference design for automotive wireless charging stations. Renesas states that the P9261-3C-CRBv2 includes the automotive-qualified wireless power controller with an MP-A13 3-coil reference design as the wireless power transmitter. It also reportedly offers a large active-charging area with high efficiency and high EMC/EMI performance. The design offers compliance to the Wireless Power Consortium (WPC) Qi 1.3 standard EPP (Extended Power Profile) for 15W charging. It also supports proprietary charging profiles, is capable of 50W power delivery and includes a Renesas RH850 automotive MCU as a host controller. This enables the system to provide functional safety features that comply with Automotive Safety Integrity Level B.

For more information, visit http://info.hotims.com/82334-408

EV battery gauging

Marposs (Auburn Hills, Michigan) announced the availability of its high-performance STIL MPLS-DM sensor for EV battery gauging. This non-contact sensor reportedly enables fast, high-resolution gauging of distance, roughness, thickness and shape of all materials, including transparent and polished mirror surfaces such as glass, plastic, silicon wafers, liquids and roll-to-roll transparent or non-transparent film as used in EV battery covers. The MPLS-DM provides working frequencies up to 2kHz in standard mode or up to 6kHz with a reduced range of the sensor. It is offered in five different models 180 measuring points aligned along a line ranging from 1-12 mm (.039-.472 inches) and minimum measurable thickness capability of 18µm to 300µm, depending upon the model.

For more information, visit http://info.hotims.com/82334-409

Vehicle integration platform

NXP Semiconductors (Eindhoven, Netherlands) launched the S32G GoldVIP for real-time vehicle integration platform for vehicles using S32G network processors. This platform reportedly offers features such as S32G processor evaluation, software development and rapid prototyping. Users can observe S32G performance in real-time and as well as perform resource monitoring. Pre-integration of NXP, open source and third-party software, including secure cloud connectivity and over-the-air (OTA) update services allows developers to create connected vehicle services instead of software infrastructure. When combined with the S32G Reference Design Board (RDB2) or GoldBox Service-oriented Gateway reference design, users can deploy rapid product prototypes for desktop, lab and in-vehicle applications.

For more information, visit http://info.hotims.com/82334-410

Voice coil actuator

Moticont (Van Nuys, California) released a new linear voice coil actuator. The new SDLM-0038-070-01-01M features high repeatability, 1.25 micron resolution, a continuous force of 14.5 N (3.2 lbs.) and a peak force of 45.8 N (10.3 lbs.). To operate at peak efficiency an integral temperature sensor provides data to achieve the highest possible throughput. Each end of the housing features threaded mounting holes on a 19.1 mm (0.75 in.) bolt circle for universal mounting. This high-speed, high-acceleration and deceleration, non-cogging, high 1.25 micron resolution, high force-to-size electric cylinder has a linear encoder mounted internally for closed-loop servo operation. The 6.4 mm (0.250 in.) non-rotating shaft has internal threaded holes for direct, zero-backlash connections to a load at each end.

For more information, visit http://info.hotims.com/82334-411

Electric turbocharger

Swoboda's (Wiggensbach, Germany) electric exhaust-gas turbocharger, the Cross Charger, offers vehicle manufacturers a solution for reduced emissions and fuel consumption for internal-combustion engines. According to the company, the Cross Charger enables gasoline, diesel and hybrid powertrains up to a 10% gain in efficiency with no turbo lag. The actuator features an electric media gap motor, energy recovery functionality and the modular add-on design for installation and is capable of temporarily increasing torque and power output by up to 80%. Swoboda claims that in testing, the Cross Charger consumed up to 10% less fuel and emitted 40% less nitrogen oxides (NOX). The company also states that this system will enable vehicles to meet the upcoming Euro 7 emission standards.

For more information, visit http://info.hotims.com/82334-412

WEBINARS ON DEMAND

ELECTRIC-VEHICLE DESIGN PRIORITIES: DRIVELINE TO TRANSMISSION

Available On Demand

The components that make up electric vehicle (EV) propulsion systems are critical to overall vehicle performance and efficiency. This 60-minute Webinar from the editors of *Automotive Engineering* presents unique engineering solutions, strategies and concepts to enhance EV propulsion and help OEMs and suppliers better differentiate EVs to the rapidly expanding global consumer base.

Speakers:

Jeremy Frenznick
Senior Director, Commercial Vehicle Engineering, Dana Incorporated

Jeff Prout
Vice President, Product Technology, Amsted Automotive

Chris Shamie
Vice President, Hybrid Systems and eAxles, Schaeffler

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SIMULATION AND TESTING: THE DRIVING FORCES FOR ENGINEERING THE VEHICLE OF THE FUTURE

Available On Demand

With electrification and advancements in ADAS technologies, vehicle development has become a complex integration exercise. The various platforms, model variants, concepts, and modular sub-systems are challenging engineering teams while simulation and testing are helping them accelerate decision-making and balance design choices.

This 60-minute Webinar explains how to manage complexity and use it as a competitive advantage. It also examines transforming your vehicle development process by enabling teams to simulate side-by-side. In addition, it compares agile and traditional V&V processes and discusses how the digital twin helps to break down barriers and maintain integration.

Speakers:

Katrien Wyckaert, Ph.D.
Vice President Strategy and Innovation, Simcenter, Siemens Digital Industries Software

Steven Dom
Director of Automotive Industry Solutions, Simcenter, Siemens Digital Industries Software

Fred Ross
Automotive Business Development Manager, Fluids and Thermal Domain, Siemens Digital Industries Software

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READER FEEDBACK

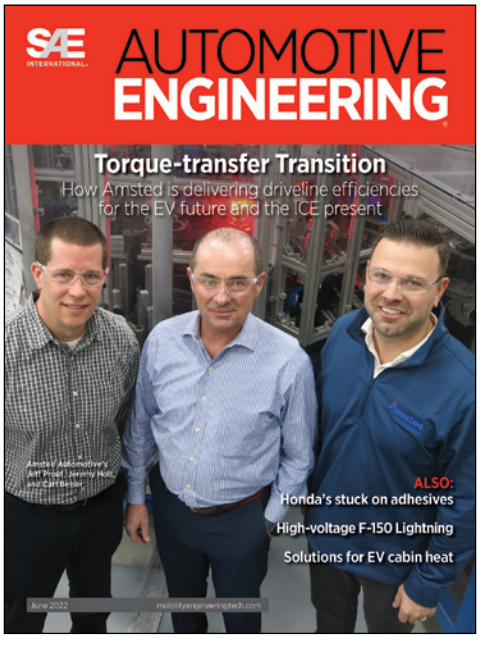
EV, give me heat!

Excellent editorial by editor Brooke on the heat-delivery dilemma in electric vehicles that the industry continues to downplay in its ongoing EV promotion. Range or heat? Currently you can only have both in one of the $100,000 luxury EVs that have an overabundance of battery. Heat pump tech isn't new, but further development is needed in this critical area if the public living in the cold-climate regions of the world are expected to "go electric."

Robert Oakes, E/E

The automakers seem to be building in the solution to the EV heater challenge: enormous batteries! Oversized energy storage in many of the latest electrics is not being engineered-in simply to provide a bottomless well of electrons for stoplight drag races and trailer towing. I've attended systems planning meetings where the question of "do we have enough battery for winter heat?" has been a discussion point.

Miriam Lang
Austin, Texas



It is indicative of the insanity of our times that all these "hi-tech" methods of providing heat in electric vehicles are being explored when a ready solution almost 100 years old is available: the gas-fired heater. A very small gas tank would suffice to provide heat for days and the resultant electric drive-gas-heat hybrid would solve the range anxiety issue when turning on heat.

I can't be the first or even the ten-thousandth person to think of this. The fact that such a hybrid design is discarded out-of-hand while gas/electric hybrid drives are swooned over goes to illustrate that engineering is being driven by insane social dicta.

Ken Javor

Editor's note: Well-known technical journalist and SAE contributor Paul Weissler, also a veteran of SAE's HVAC Standards committee, reminded me that the liquid-gas separator made its debut on the Toyota Prius Prime, a plug-in hybrid. – LB

Long-term quality

Ford has been in the news a lot lately concerning recalls. Back when they were still affordable, my parents bought a new 1969 Mercedes-Benz 230 sedan from a Pittsburgh, Penn., dealer. In its first two years, it suffered through two automatic transmission replacements (under warranty) and a shortage of qualified Mercedes-Benz factory-authorized mechanics.

The first transmission failure began on the way from Morgantown, West Virginia, to grandma's house in Uniontown, PA. We called the [Mercedes] dealer who luckily was open on a Sunday who told us to bring the car in. By the time we arrived at the dealer, only 1st gear was operable and the trans was slipping badly. It was 21 calendar days later before a new transmission arrived and our vehicle was fixed. Years later at 80,000+ miles, the engine self-destructed on Interstate I-79 and left my dad stranded.

Stan Serpento

The following note was received from an SAE reader in Australia who is developing a technology called CITS that is aimed at extending the emissions capability of internal combustion engines. He encourages interested readers to contact him at the link below. – Ed.

I am hoping that you and or Jim Szybist, senior research staff scientist at Oak Ridge National Laboratory, might help in getting the CITS technology to the eyes and ears of the leading engine developers. As detailed in the synopsis [www.citsengine.com.au], we have taken it to a running prototype, as far as our limited facilities will allow. Now it needs the latest fluid dynamic modelling and then to DFI and then to commercialization, being scalable from 50 to 2000+ kW in any V format from V-twin to V16. I look forward to hearing from readers and any questions.

Basil van Rooyen
Director, CITS Engineering PL.,
Sydney, Australia
Phone +61 (0)414494472
http://au.linkedin.com/pub/basil-van-rooyen/38/326/908/
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READERS: Let us know what you think about *Automotive Engineering* magazine. Email the Editor at Lindsay.Brooke@sae.org. We appreciate your comments and reserve the right to edit for brevity and clarity.

COMPANIES MENTIONED

AD INDEX

Q&A

Bosch tunes its business to new mobility challenges

Components and systems that make up the heart of combustion-engine powertrains have long reigned as a major profit center for **Bosch**, and the company's commitment to sustaining the ICE for as long as OEMs require is not vanishing. But as the industry swings toward electrified, automated and connected vehicles, new mobility solutions are needed. To help meet the current and future transit needs of customers, Bosch is in the process of hiring 10,000 software engineers and technicians worldwide in 2022, and is investing $420 million in its North American mobility business unit. Paul Thomas, executive VP of mobility solutions for Bosch in the Americas, recently spoke with SAE Media Detroit editor Kami Buchholz about new opportunities.

What is currently the industry's main mobility challenge?
The industry's near-term challenge is a scarcity of talent and a lack of stability relating to supply and demand. Over the next few years, that talent shortage will need to support both ICE-powered vehicles and electrified vehicles, the latter requiring infrastructure and investments to support increased production.

How is Bosch positioned to help provide solutions?
In the near term, we're trying to find fast solutions to increase supply. For the future, we're continuing to invest in our core products that exist today — ICE components, braking and steering systems, thermal management — and using those core business investments as a leverage to achieve new mobility solutions.

Among the mobility sectors, which is taking an R&D priority?
We've spent roughly half a billion dollars per year on electrification since 2016. We offer multiple options related to the electrical powertrain, including advanced steering and braking, charging solutions, cloud services and thermal management. Intelligent thermal management alone can increase the driving range of an EV by as much as 25%. EV thermal management products, like our flexible thermal unit, are important as the global market for this business is projected to reach $4 billion by decade's end.

We're also starting to increase our expenditures on the automated and connectivity side of the business. Bottom line: We will stay invested in all the PACE (powertrain, automated, connected, electrified) areas.

How does Bosch North America define mobility?
Mobility is no longer just about moving people. It's also about moving goods and forming partnerships. For instance, our partnership with Amazon Web Services is focused on developing a software-enabled logistics platform for the supply chain to help manage mobility. That product's launch is expected in late 2022. Anything that we can do to help improve the movement of people and goods, and complement that with associated services, is our mobility goal.


Collaboration can propel R&D, says Bosch's Paul Thomas.

We've spent roughly half a billion dollars per year on electrification since 2016.

How can collaboration help propel mobility R&D?
Bringing partners together with different backgrounds and different wants can be very beneficial. As one example, the Detroit Smart Parking Lab (DSPL) was founded by a real estate developer (Bedrock), a tier one supplier (Bosch), a global OEM (Ford) and a government agency (State of Michigan). Operated by the American Center for Mobility, the DSPL promotes a collaborative environment to test emerging technologies. All of the work being done is happening inside a parking garage.

On a recent project, each party had different views of what a first- and last-mile solution would look like. For that R&D project, we arrived at a solution that met the requirements of a diverse group of partners. The DSPL has different ongoing collaborative projects involving various companies, including startups. ■

BOSCH

CALL FOR NOMINATIONS

MOST INNOVATIVE USE OF PLASTICS AWARDS

The Automotive Division of the Society of Plastics Engineers (SPE®) is announcing a "Call for Nominations" for its 51st-annual ***Automotive Innovation Awards Gala,*** the oldest and largest recognition event in the automotive and plastics industries. This year's Awards Gala will be held Wednesday, **NOVEMBER 2, 2022** at the Burton Manor in Livonia, Mich. Winning part nominations **(due by September, 7, 2022)** in 11 different categories, and the teams that developed them, will be honored with a **Most Innovative Use of Plastics** award. A **Grand Award** will be presented to the winning team from all category award winners.

A special category has been added for the 51st-annual Automotive Innovation Awards: **EV and AV Systems,** to recognize innovative polymer components for Electric and Autonomous Vehicles.

SPONSORSHIP OPPORTUNITIES

This annual event currently draws over 800 OEM engineers, automotive and plastics industry executives, and media. A variety of sponsorship packages - including tables at the banquet, networking receptions, advertising in the program book, signage at the event and more are available. Contact Teri Chouinard of Intuit Group at **teri@intuitgroup.com**.

For more info and to submit nominations, go to: **www.speautomotive.com/innovation-awards-gala**

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We are witnessing a revolution—the electrification of human mobility.
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