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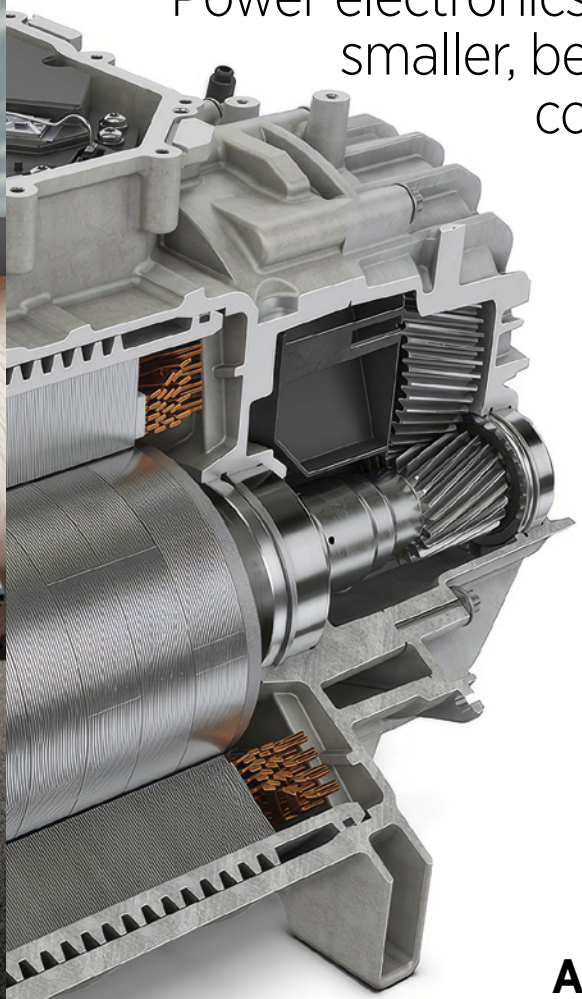

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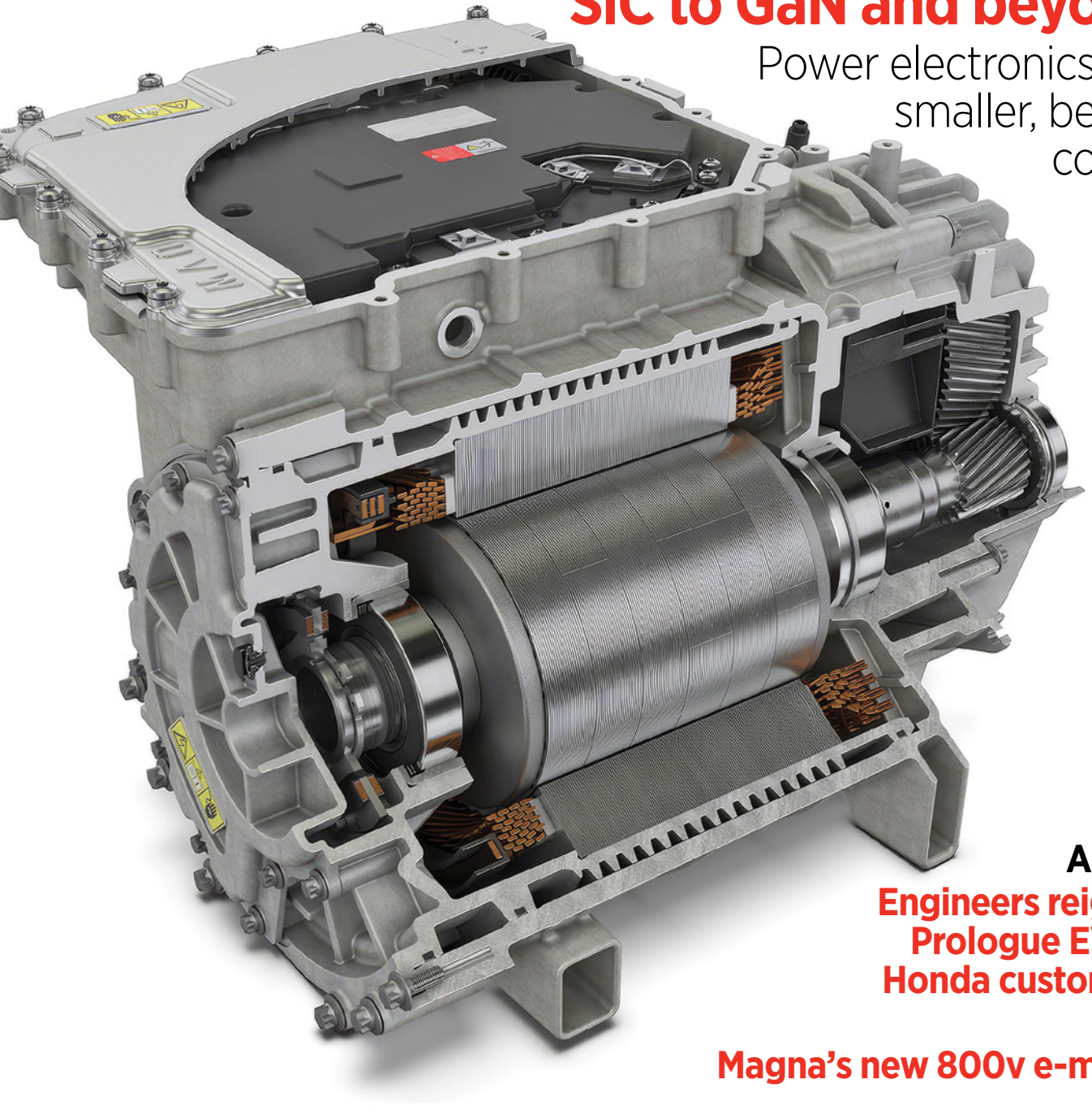

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EDITORIAL

Lots of news amid the dark matter, if we can find it

The Chicago Auto Show rolled through the Windy City in early February, bringing unseasonably warm weather and another chance to reconsider what actual, real-world auto shows mean in 2024. Given the past few tumultuous years, the show felt like finding a way to the new normal. Organizers strongly defended the show's focus on bringing in people — car fans, potential customers, the generally curious — and not as much on news announcements. That's great for the people of Chicago who wanted to test drive an EV on the small track inside the convention hall. It's also understandable from a media perspective if you think about how news travels these days and how automakers and suppliers calculate ROI for new product announcements or other important updates.

Before I get into my larger point, the idea that there's some sort of dark matter holding the news environment together these days, I should say that there were, of course, interesting tidbits in Chicago. Kia introduced a hybrid Carnival. Tesla was there with a Cybertruck you could sit in. Nissan brought Chris & Julie Ramsey along. This husband and wife adventure team drove an all-electric Ariya from the 1823 Magnetic North Pole down both American continents and then to the South Pole. Speaking in Chicago, the duo described unexpected charging assistance from firefighters in Central Asia during a previous adventure drive from London to Mongolia and the need to have their support team bring generator-based EV chargers with them to Antarctica. The Ramseys drove more than 18,641 miles (30,000 km) over ten months last year, and we will publish a story about their journey on sae.org by the time you read this.

Which brings me to this dark-matter idea, a way to understand how we get our news these days. One challenge I have as the new editor is to filter through the many emails, LinkedIn postings and other sources to find the bits of information you'd like to read. I think of these items as the bright stars that poke through the chaos of an information-overloaded world: the unseen forces that impact email lists, the random encounters that mean I'm connected with this person but not that one, the fact that my view into the possible universe of news was created by and for me, digitally and organically.

Let's compare the automotive news stars with one of my other loves: music. As an insatiable but aging music fan, I sometimes feel adrift in the sea of new artists. There are so many universes where I could find new music: TikTok, YouTube, any of a zillion streaming music platforms, or recommendations from people I trust. A varied music landscape opens the door to smaller artists getting well-deserved attention, but it also makes reaching the ceiling a huge challenge. We don't have rock stars the way we used to because we don't have the media we used to.

We don't have rock stars the way we used to because we don't have the media we used to.

When I look at automotive news through this lens, I feel the need to hang out with the "fans" — read: engineers — more, the people who can tell me what rocks. In concrete terms, I would appreciate any help you might feel inspired to give that would point me toward these lights. If you're an engineer working on an exciting project — the kind that you'd like to read about on our pages if someone else was doing it — please get in touch with me (if allowed) or ask your company's PR department to send me a note. Together, we can cut through the dark matter and focus on the lights.

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History is a great teacher

History is a great teacher. There are lessons from the past that we should never forget. Lessons that are often the difference between success and failure in business. In the auto industry, some of the oft-forgotten constructs are capital intensity and long lead times. History's lesson is that optimizing capacity utilization and flexibility are core to survival.

Back in 1989, this author worked on the first detailed compilation of a North American light vehicle production capacity study. Researching the JPH (jobs per hour), shift structures and labor constraints in addition to each plant's production capacity was ground-breaking. At the time, it was becoming apparent that the Detroit Three's North American production was being augmented by Asian OEMs locating new capacity (solely or through joint ventures). As the domestic players were losing market share, adding capacity was going to pressure profitability. Understanding utilization rates by each OEM and vehicle build structure (unibody vs. full frame) was key to early identification of emerging issues.

Many vehicle and powertrain facilities closed before and after the 2009 GM and Chrysler bankruptcies. Iconic though underutilized facilities such as Chrysler-St. Louis, Ford-Twin Cities, GM-Shreveport and more were taken offline. The ability to strengthen the core and ensure any capital investment was better focused on raising productivity and manufacturing flexibility was key.

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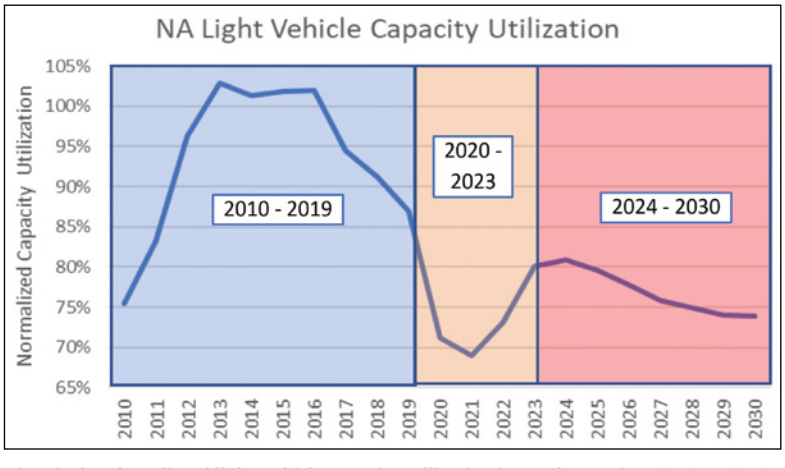
As the industry invests billions to electrify their vehicle portfolios, capacity utilization will face new challenges.



Historical and predicted light-vehicle capacity utilization in North America, 2010 to 2030. Data compiled February 2024 from S&P Global Mobility.

Rising demand and the ability to employ three-shift and three-crew setups allowed OEMs to improve productivity with fewer facilities. The chart below utilizes the SP Global Mobility North American Light Vehicle Production Forecast to understand utilization rates. Examining capacity utilization at a normalized level (assuming the highest possible line rate of two shifts and five days per week), levels eclipsing 100% were reached over the last decade. Additionally, higher capacity utilization enabled the industry to focus elsewhere, placing utilization concerns on the back burner. Several years of record production levels of over 17 million units diverted our attention.

The onset of COVID-19, chip scarcity and other supply-driven constraints lowered capacity utilization, cratering utilization rates to the point where they have not yet rebounded to pre-2020 levels. As the industry invests billions to electrify vehicle portfolios, capacity utilization will face new challenges.

It can be easy to boil overall industry utilization to single number. The reality is that beneath the topline, OEMs are often dealing with capacity focused solely on BEVs or ICE propulsion offerings or unibody versus full-frame architectures with little to no ability to flexibly build these in the same facility. As fleets are electrified, it may not be cost-effective to build extreme manufacturing flexibility into every facility. Unless the industry fully understands the rate at which the fleet will transition to BEVs, which seems unlikely, capacity utilization will be in a trough for years to come. It's yet another unintended consequence of electrification.

As this lumpy transition continues, winners and losers will emerge throughout the value chain. From OEMs on down through the supply tiers, this ongoing production imbalance will lower overall industry utilization and drive winners and losers. With the high production levels from the past behind us, volume will not mask this issue. We'll need to get used to low utilization rates and the resulting impact on OEM competitiveness, their suppliers and the viability of others in the ecosystem. ■

EV CHARGING

Putting a new 'charge' in EV recharging

In late 2023, Mercedes-Benz opened the brand's first Charging Hub in North America at a location near Atlanta, Georgia. The hubs are meant to provide a "premium" charging experience for drivers of any EV brand.

MERCEDES-BENZ

Automakers and EV charging services know time is running out on reversing widespread cynicism regarding the state of EV public-charging infrastructure. Despite billions of dollars of already dedicated and planned investment, the spottiness of the nation's charging ecosystem consistently is cited as the chief reason for flagging EV sales and consumer consideration.

Although there is contentious debate about whether sales of light-duty EVs are declining rather than just growing more slowly, there a few who will argue that the current state of the EV charging network is far from ideal. According to **J.D. Power** data from the third quarter of 2023, nearly 20% of public-charging attempts failed. "What we've learned is that the infrastructure is at the top of reasons for rejection of EVs," Steve Kosowski, manager of strategy at **Kia America**, told the Los Angeles Times in a story about California's EV infrastructure issues.

The infrastructure's macro problems largely are now understood and acknowledged, said panelists speaking in the "Enhancing the Light-Duty EV Charging Experience" session at SAE International's 2024 Government/Industry Meeting in Washington, DC in January 2024 — and there's an emergent blueprint centered on closer industry collaborations and other initiatives to hasten improvement. Almost all the session's speakers agreed that EV charging access — and equally important, reliability — has to improve.

Niels Bohn, head of powertrain and electromobility at **BMW of North America**, said the company has been assessing the "end-to-end" charging experience with cross-country test drives. It also uses data gleaned from vehicle onboard systems to monitor charging sessions and quality, among other analyses. As with other speakers, he said BMW recognizes an immediate need for the infrastructure is ubiquitous "plug-and-charge" functionality to eliminate the chaos — and related charging-session failures — common in today's complex payment environment. Some automakers and charging providers are underway with plug-and-charge arrangements and Bohn said BMW has initiated plug-and-charge starting with its new i5 EV.

Erika Myers, executive director, Charging Interface Initiative North America for the CharIN consortium, said there is an "evolution in the sophistication of communications between EVs and chargers. Nonetheless, she said that only about 30% of current EVs support plug-and-charge capability. She did not provide a figure for plug-and-charge compliant charging networks.

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Sarah Hipel, program manager, standards and reliability, at the **Joint Office of Energy and Transportation**, acknowledged that the current matrix of charging apps often required for a long EV trip isn't ideal — and suggested that enhancing the reach of plug-and-charge technology may address some of the problem — but probably not all. She said there are "convening areas" of market implementation that must be explored to expedite the payment process.

"We want the charging experience to be better than the gas-station experience," asserted Emily Durham, VP, Legal and Government Affairs for charging giant **Electrify America**.

Expanding collaborations

To achieve the reliability and interoperability that replicates the liquid-fueling infrastructure, the auto and charging industries have embarked on a variety of collaborations, but the session's speakers said more — and more cohesiveness — is necessary. Hipel said increased collaborative effectiveness is the goal of the Joint Office's National Charging Experience Consortium, or **ChargeX** in shorthand. Launched in May, 2023, ChargeX is led by U.S. Dept. of Energy National Laboratories and its expanding membership numbers some 75 entities that include the Detroit Three automakers, BMW, **Tesla** and numerous charging companies, including **Chargepoint**, Electrify America and **EVgo**.

The ChargeX Consortium, Hipel said, continues to frame its work on improving the charging infrastructure in three problematic aspects of the charging experience:

- payment processing and user interface
- vehicle-charger communication
- diagnostic data sharing

"Our standard is 'charge first time, every time,'" Hipel stressed. The Joint Office also manages the often-referenced National Electric Vehicle Infrastructure (NEVI) program charged with spending $5 billion between 2022 and 2027 to install 500,000 public EV chargers. The first NEVI-funded charging

BMW said its i5 is the first EV model to support plug-and-charge protocols.

BMW

EV charging "oasis" proposed by fast-food giant Subway includes playground and other facilities to make the best use of time while EVs recharge.

Sarah Hipel, program manager, standards and reliability, at the Joint Office of Energy and Transportation, speaks at SAE's 2024 Government/Industry Meeting.

station became operational in December 2023.

The NEVI program, Hipel said, includes $100 million for routine maintenance and repair, a vital component of assuring high levels of charger uptime and delivering the "first time, every time" experience. Low uptime is frequently noted as a pain point for the existing infrastructure.

There currently is a complex patchwork of sometimes overlapping automaker-guided charging initiatives. Tesla in 2023 arranged with multiple automakers to grant those brands' EV customers access to the coveted — and highly reliable — Supercharger network, but BMW **General Motors**, **Honda**, **Hyundai**, Kia, **Mercedes-Benz** and **Stellantis** joined for an announced $1-billion collaboration to install some 30,000 public chargers. Mercedes-Benz, however, also said it plans to invest more than $1 billion in a joint venture with **MN8 Energy** to install a total of 2,500 chargers at some 400 charging hubs across North America by the end of the decade.

Electrify America's Durham said the service is the only current plug-and-charge compatible charging network and its 900-plus stations and more than 4000 chargers are seeing increased usage. She said the network averages 250,000 weekly charging sessions, but asked rhetorically, "Where do we go now that chargers are in the ground and vehicles are on the road?"

Although there have been questions about the continuing consumer uptake of EVs, BMW's Bohn said at the conference that the robustness of the charging network is the key to achieving consumer acceptance. "We are not concerned about EV adoption," he said. "Once we improve the reliability of the EV charging network, we will see the increase in adoption."

The Joint Office's Hipel said the charging experience must improve for consumers to embrace EV technology. "We have [charging infrastructure] reliability challenges. The strategy is to demonstrate that we can do this — we need to prove it. We have a lot of work to do."

Bill Visnic

BATTERIES

Battery-analysis pioneer Voltaiq partners with Siemens

Battery-analysis pioneer **Voltaiq** and **Siemens Digital Industries Software** announced a partnership they said is intended to help battery manufacturers speed up the iterative process of improving yield rates.

Some new battery plants, particularly those started by OEMs, begin with scrap rates as high as 90%, said Tal Sholklapper, CEO of Voltaiq. Voltaiq's enterprise battery intelligence platform can reduce that number by tracking thousands of data points during the manufacturing process and helping factories intervene on bad cells sooner. The companies stated in a news release that the industry is forecasting a 14-fold increase in battery demand through 2030 but only a five-fold increase in battery cell production through 2030 for EVs alone.

Speaking to a group of journalists that included SAE Media, Sholklapper said it has taken some battery plants "four years, at a cost of billions of dollars, to achieve a 10% scrap rate." He

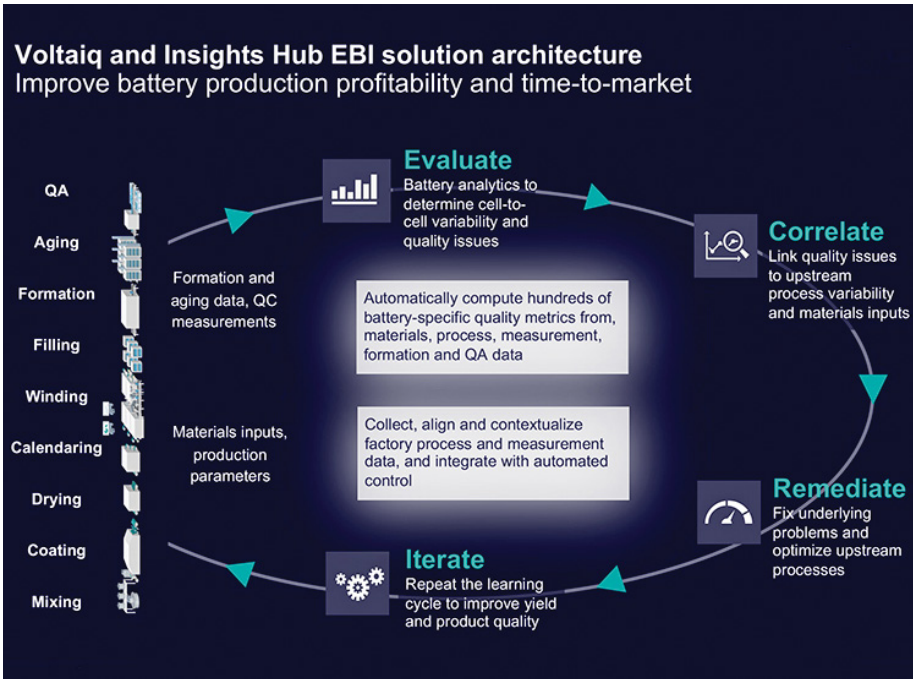
Raymond Kok, of Siemens, called the scrap rates of some battery factories "disastrous."

FROM TOP: SUBWAY; SAE/BILL VISNIC; SAE/CHRIS CLONTS

added that at that point, a few percentage points of yield improvement can mean hundreds of millions in revenue. Siemens brings its deep experience in systems that monitor and control manufacturing processes, such as with programmatic logic controllers (PLCs). Such controllers can automatically make small adjustments in the chemical and physical processes of building battery cells and packs based on Voltaiq's data analysis.

What it all translates to is being able to halt and fix a problem earlier in the manufacturing process, resulting in less time and money lost. "We'll take the insight from Voltaiq and put it into the control process, making it a fast iterative loop," said Raymond Kok, Siemens' senior vice president of cloud application services.

Sholklapper said Siemens' reach and stature in the business could more quickly help make more manufacturing plants better. "They have the scale to help this go global," he said. The companies said the partnership would help in five areas: quality control/consistency, increased production, process efficiency and waste reduction and high costs.



The list is a look at the manufacturing steps of EV batteries. The cycle depicted is the cycle of analysis and process improvement that ultimately leads to low scrap rates and more profitable yields for factories.

Unlike most manufacturing, where there can be a "set it and forget it" approach to production, batteries are incredibly complex, almost like living things. "Battery making is dozens of processes that have extremely narrow tolerances," said Eli Leland, Voltaiq's chief technical officer. Leland also said that these long new-factory learning curves are not new. "It took us 125 years to get the internal combustion engine to run for hundreds of thousands of miles without problems," Leland said, adding that there just isn't a ton of modern battery expertise, particularly at some OEMs. "The core competency here is learning how to learn," he said. Why greatness takes so long Sholklapper said that the manual process of testing newly manufactured batteries takes too long. "Batteries are made, charged and discharged multiple times, and then put in a hot room for up to three weeks. "If the voltage drops, there's a short somewhere in the batteries, which means you have to fix it. And as you've been making batteries for three weeks, then they all may have to be scrapped."

Voltaiq CEO Tal Sholklapper and CTO Eli Leland speak to journalists in Las Vegas at CES 2024.

FROM TOP: VOLTAIQ/SIEMENS; SAE/CHRIS CLONTS

The goal of the partnership is to marry Voltaiq's and Siemens' software to allow corrections to be made more quickly, before three weeks or a month of manufacturing time and money is lost.

Chris Clonts

EV WORKFORCE DEVELOPMENT

Program to train EV charger techs graduates first class in Detroit

Officials from **SAE International**, **ChargerHelp**, **Detroit at Work** and more partners gathered recently to celebrate the first graduating class of a new training and certification program for electric vehicle supply equipment (EVSE) technicians and discuss the importance of these jobs amidst the ongoing push for electrification.

The program is the first of its kind and teaches safety above all else while focusing on seven domains of theoretical and practical knowledge. The SAE Electric Vehicle Supply Equipment Certification will be granted to participants who complete a certified course and pass a standardized test administered by **SAE ITC Probitas**. The Detroit participants have completed the coursework and will sit for the certification exam. The exam rolls out nationwide in April.

The event was held at Michigan Central, the 30-acre innovation zone that reclaimed the former Detroit Book Depository and turned it into a sleek, tech-friendly startup incubator. Clarinda Barnett-Harrison, Michigan Central's director of skills, lauded all members of the partnership for working to ensure opportunity for all. "As technologies continue to evolve, especially in black and brown cities, the people in those cities are often not part of that experience," she said. "And they're not able to take advantage of economic opportunities that come with the advancement of that technology."

Teams of EVSE trainees complete a capstone project prior to graduation. Graduate Marcus Long presented his teams look at the state of charging in Detroit.

To qualify for the four- to six-week program (depending on class frequency — coursework is 120 hours), aspiring technicians must live in Detroit, have a high school diploma or GED and be able to read at a ninth-grade level. The course is offered at no cost to the participants. Fifteen people graduated from the initial class, and the program hopes to train 100 more before the end of the year.

Michael Paras, SAE manager of business development, partnerships and sales, outlined what drove the organization to take part in creating the certification standards. "The industry wants a mechanism for certifying that technicians possess the requisite skills and knowledge to be working on EVSE [electric vehicle supply equipment]," he said.

Frank Menchaca, president of S**AE Sustainable Mobility Solutions**, emphasized the need for thousands of technicians. He also said the organization envisioned an upwardly mobile series of jobs beginning with the EVSE techs. "We think about this certification training, we hope this is step number one, and the scaffolding career where people can come in from nontraditional backgrounds, and learn this, then take it to the next step, whether it's software or what have you, we see a pathway in new energy vehicles. Because it is not just in the charging stations. Instead, it's the whole infrastructure, they filter out to support that. And we're going to need people to work in these jobs."

SAE International's Michael Paras said that the training program – and the need for curriculum and testing requirements — are meant to directly address the industry's need for new workers.

Marcus Long, a graduate of the first class, presented his team's capstone project, which was a survey of the charging landscape in the city of Detroit. The team found chargers in a variety of conditions, from pristine and working to non-functioning and even potentially dangerous. "Just the other day I went to three different locations and none of them worked," he said. That is not terribly surprising, as recent studies have said that at any given time, up to 30% of public chargers in America aren't functioning.

Long said he was driven to go into the business for two reasons: The employment opportunity but also the chance to be working in an industry that is helping fight pollution – which disproportionately affects minority communities. "I want to be part of making the world better," he said.

Chris Clonts

BOTH IMAGES: SAE/CHRIS CLONTS

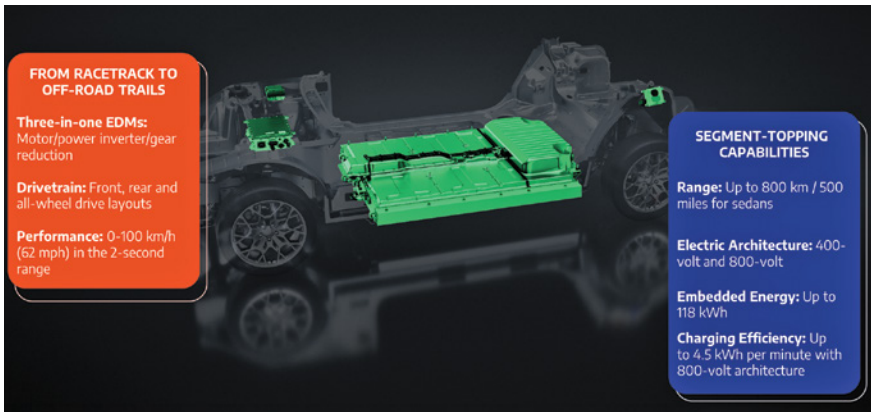
MANUFACTURING

Stellantis unveils STLA Large platform for D, E segments

Stellantis in January unveiled its STLA Large platform, which will be the basis for eight new EVs from sedans to Trail Rated SUVs by 2026.

The STLA platform was first announced in 2021 when the company introduced the coming set of global BEV platforms that also includes STLA Small, Medium and Frame. All are designed to use Stellantis' next-gen electrical architectures and software-defined vehicle technologies such as STLA Brain, STLA SmartCockpit and STLA AutoDrive.

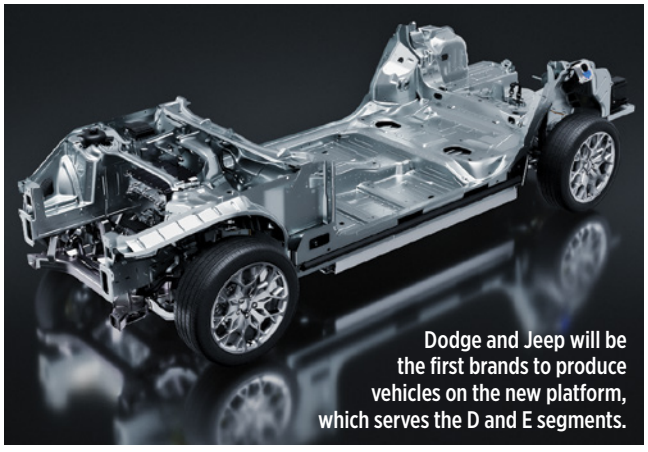
Stellantis CEO Carlos Tavares touted the flexibility of the STLA platforms in a news release. "Creating a family of vehicles from a well-engineered set of components that is flexible enough to cover multiple vehicle types and propulsions, outperforming any of our current products, will address each of our iconic brands' customers," he said, adding that the platform "will be a driving force in the shift to electrification in North America."



The company said the platform was capable of a 0-62 mph time in the 2-second range.

STELLANTIS

STLA Large will be used to build vehicles for the D (large family/mid-size) and E (executive/full-size) segments,



Dodge and Jeep will be the first brands to produce vehicles on the new platform, which serves the D and E segments.

with the first vehicles to launch for **Dodge** and **Jeep**, followed by **Alfa Romeo**, **Chrysler** and **Maserati**. The company said brand-specific product announcements would begin this year.

Stellantis' release highlighted the platform's following capabilities:

- Charging efficiency of 4.5 kWh/minute
- 0-to-62 mph (0-to-100 kph) acceleration in the "2-second range"
- Flexibility to use 400-volt and 800-volt electrical architectures

Engineers and designers will be able to adjust the platform's wheelbase, overall length, overall width, height and ground clearance. Modular suspension systems and powertrain cradles can be used to support different ride, handling and comfort characteristics. "Engineers can adjust key dimensions such as the front spindle to the driver's foot, front and rear overhang, or the passenger compartment floor," the company's release said.

Powering the vehicles will be three-in-one electric drive modules that include motor, inverter, and gear reduction. The inverter uses silicon carbide technology to minimize power losses. The system can accommodate front-, rear- or all-wheel drive and can be upgraded via over-the-air (OTA) updates.

The company said the platform targets an overall range of 500 miles (800 km) for sedans and is built to accept different battery technologies when they are ready. "Overall, the platform has the potential to carry extreme power that will outperform any of the existing Hellcat V-8s," the release said.

The platform's dimensional range:

- Length: 187.6-201.8 inches (4,764-5,126 mm)
- Width: 74.7-79.9 inches (1,897-2,030 mm)
- Wheelbase: 113-121.1 (2,870-3,075 mm)
- Ground clearance: 5.5-11.3 inches (140-288 mm)
- Max tire diameter: 32.6 inches (858 mm)

The company clearly emphasized STLA Large's EV applicability, but did say that it also can accommodate ICE and HEV powertrains.

Chris Clonts

BATTERY MANAGEMENT

Kymco's new Ionex BMU, BaaS to boost EV scooter adoption

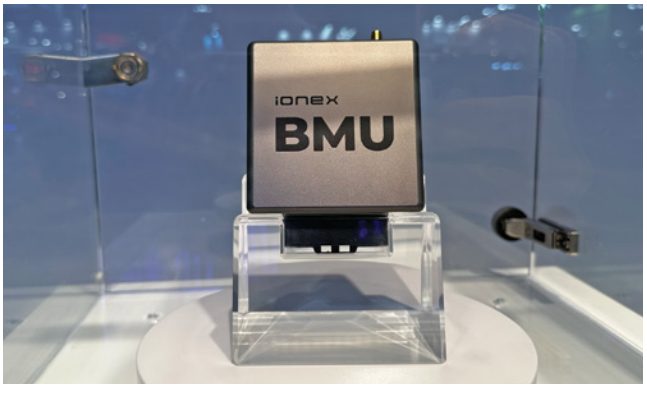
Taiwanese powersport company **Kymco** believes society has entered the time of the EV. During the 2023 International Motorcycle and Accessories Exhibition (EICMA) held each year in Milan, Italy, Kymco chairman Allen Ko repeatedly mentioned "the inflection point of the electric era" as he introduced three new technologies for electric mobility.

Kymco has been at these supposed crossroads before. The company started in 1964 as a parts supplier for Honda but started building scooters in the 1970s. In the 2010s, BMW used Kymco motors as the range extenders for its i3. In 2018, Kymco introduced the Ionex brand of electric scooters with swappable batteries and big dreams. The Ionex brand is a, "game-changing electric scooter solution that eliminates all barriers to go green," the company said at the time.

It's a new generation of these scooters, with an upgraded Ionex platform and associated EV powertrain advances, that Ko believes will expand Kymco's e-scooter sales and turn the corner — or at least a corner — on electric mobility. At EICMA, Kymco introduces the Ionex Battery-as-a-Service (BaaS) solution for energy companies, the Ionex Battery Metering Unit (BMU) for EV manufacturers, and the Ionex Energy Station for Battery-swapping network operators.

"The vision is still the same," Ko told SAE Media at EICMA in November. "We want to bring the true arrival of the electric era. That's what we wanted to do five years ago. That's what we want to do today. The only difference was that five years ago, we had this vision, and then we launched the Ionex [scooters] and said it's an open platform. But then we realized that it's actually a very difficult process."

Ko said that one of the keys to success this time will be the new BMU and the Ionex Common Battery. The BMU connects to compatible batteries and can distinguish where the energy in the pack came from. Ionex scooter batteries can be charged using a stand-alone home charging unit or an on-board charger. The batteries can also be swapped with a fully



Kymco's new battery metering unit (BMU) is key to the company's electric scooter expansion plans.

FROM TOP: STELLANTIS; SEBASTIAN BLANCO

charged unit from an Ionex Energy Station, battery vending machines placed at appropriate locations. The Ionex system can then charge riders the appropriate amount based on the service, simplifying payments for drivers and companies.

Keyless for cheap

Kymco's Ionex BMU has a low-energy Bluetooth connection that can connect with a smartphone and turn any electric scooter into an EV with keyless start capabilities. Just as any company can use the Ionex Common Battery in its electric scooters, Kymco will offer the BMU to other manufacturers so they can sell electric scooters with these technologies at a lower cost.

"It's important [for the BMU] to do a lot because it offers value for the EV manufacturer, not just a connected battery," he said. "Think about the cost savings. If you have a BMU, you can have keyless, and you get OTA firmware upgrades and things like that. So [the BMU] comes with a lot of features that the traditional EV manufacturer would otherwise require a lot of resources to develop. That gives them more incentive to use the Ionex BMU."

Sebastian Blanco

Kymco displayed the I-One, S6 Rex and i-Tuber Carry electric scooters at EICMA 2023.

EBASTIAN BLANCO

CONCEPTS

Vinfast: New concept, award for MirrorSense

VinFast used its third appearance at the Consumer Electronics Show in Las Vegas to introduce three new electric vehicles, including a midsize pickup truck concept and a small CUV bound for the U.S. The Vietnamese automaker said it will begin selling the two-door VF 3 and the **DrgnFly** electric bicycle in the U.S. The two-wheeler will be available later in the first quarter of 2024, and a VinFast spokesperson confirmed to SAE Media that the VF 3 will be available in the U.S. but did not say when it would go on sale. The VF 3 will be available in Vietnam in the third quarter of 2024. VinFast currently sells one vehicle in the U.S., the electric VF 8 SUV.

The Wild is VinFast's first new pick-up truck design and, as a concept, technical details are slim. They include the Wild's exterior dimensions – 209 inches (5324 mm) long and 79 inches (1997 mm) wide – and the fact that a power-folding mid-gate increased the bed length from 60 to 96 inches (1524 to 2438 mm). When the mid-gate is engaged, the rear seats can fold down automatically. All four seats in the Wild's Alcantara interior can be shifted forward and backward on an integrated rail system. The infotainment system uses an updated interface.

When the power-folding mid-gate is down, the Wild's bed length goes from 60 to 96 inches (1524 to 2438 mm).

VinFast developed the Wild concept with help from Australian design studio Gomitiv with what the automaker calls a "Fluid Dynamism" aesthetic. VinFast previously worked with **Pininfarina** for its VF 8 and VF 9 SUVs. Sean Ackley, VinFast's head of charging and energy, said the Wild's design was inspired by the movement of a superhero's cape in the wind. The concept has four doors, including two rear-hinged doors in back. Black wheel arches are echoed by design touches in the cabin.

The VinFast Wild truck concept uses rear-hinged doors for back seat passengers.

Small and boxy: the VF 3

The VF 3 was designed with Vietnamese drivers in mind. The small, two-door EV is approximately 123 inches (3,114 mm) long, but VinFast claims it has "sufficient interior space to accommodate up to five people." The VF 3 fits in with VinFast's other EVs, including buses, scooters, bikes and larger SUVs. The company has built up its own EV charging infrastructure in Vietnam, is building an EV manufacturing facility in North Carolina, and has announced it will build production facilities in India and Indonesia. Speaking at CES 2024, VinFast's chairwoman of the Board of Directors (and former CEO) Le Thi Thu Thuy said the company's vehicles are built with a mission.

"At VinFast, we envision a green future where everybody can access and enjoy sustainable transportation," she said. "We strongly believe that electric mobility can belong to everyone, and it doesn't need to be linked to a social status, age, income or gender. As you have heard us say many, many times, our mission is to make EVs accessible to everyone."

Tech award

VinFast's MirrorSense was named a CES 2024 Innovation Award honoree. Ackley said that MirrorSense is the first commercially available AI-powered auto mirror adjustment feature and could be integrated into any smart vehicle with a driver monitoring system camera. Jointly developed by VinFast and VinAI, another member company of the VinGroup that specializes in AI technology, MirrorSense "can precisely detect the driver's head and eye gaze within 10 millimeters of accuracy and automatically adjust all mirrors," he said. The MirrorSense technology could be extended to automatically adjust seat settings or head-up displays, VinFast said.

Sebastian Blanco

BOTH IMAGES: SAE/CHRIS CLONTS

2024 Lexus GX ready for off-road adventure with new platform, E-KDSS

Engineers designing the 2024 Lexus GS, shown here in Overtrail trim, wanted to leave no doubt as to its overlanding bonafides.

Once **Toyota** finally updated the Tundra to its third generation in 2022 after 15 years on the last-generation platform, the next model that would logically contend for an overhaul was the **Lexus** GX. Last given a generational overhaul in 2009, the new GX has been a long time coming. Chief engineer Koji Tsukasaki said the updates are more than just overdue, they're for overlanding.

"We were going to build a Lexus that had never existed before, a true authentic offroader that would be held as the reference point for everything moving forward, and we boldly changed the positioning of the vehicle when starting development," Tsukasaki told SAE Media, as translated by an interpreter provided by Lexus.

The chunky new GX doesn't hide its new identity. Thick lines keep the boxy shape from being just another Land Rover, even if that's the obvious territory the designers were playing in. The signature Lexus grille is still huge, but the bottom of it has been moved up the fascia, and a protective element was added to the lower half to prevent damage from road debris. The lower section is even removable on the GX's off-road-focused Overtrail trims. In short, the GX's new look implies better off-road performance, but to clinch the deal, the engineers needed to do more than improve the exterior.

As part of the repositioning, Tsukasaki said, Lexus developed a three-prong strategy for its large SUVs. The new GX 550 became the "true offroader," while the LX became the flagship model and the TX the best option for three-row SUV buyers. To make the GX perform better off-road, Lexus decided to base it on the new TGNA-F platform. While the older Toyota Tacoma and FJ Cruiser use the F2 variant, the GX, the LX and the new Toyota Tundra and Land Cruiser use the F1, which has a higher off-road performance capability than the F2.

"We determined at early stages that we were going to switch from the F2 platform to the F1 platform, the ones shared by the Landcruiser and LX because we wanted to create the true offroader package of the vehicle," Tsukasaki said.

Fuel efficiency across all trim levels of the new GX is 17 mpg combined. There will only be one engine option available in the 2024 GX: Toyota's reliable 3.4-liter V6 that produces up to 349 hp and 479 lb-ft (649 Nm). Depending on the configuration, the 2024 GX can tow up to 9,096 lbs (4,126 kg) in the Overtrail trim. The new GX can go from 0-60 mph (97 kph) in 6.5 seconds.

Off-roading with E-KDSS

Lexus' off-roading history goes back at least to the LX 450 in the mid-1990s. The first GX, the GX 470, debuted in 2002, and the new Kinetic Dynamic Suspension System (KDSS) became available for the GX in 2003. KDSS improved stability by electronically controlling the sway resistance of the front and rear suspension anti-roll bars. Two decades later, Tsukasaki and his team improved the off-road capabilities of the new GX by introducing a new available feature: Electronic KDSS (E-KDSS).

The original KDSS decoupled the swaybar stabilizers using a hydraulic system, while E-KDSS uses electronic control. The engineering team knew decoupling the stabilizers was the best way to get extra articulation because it offered a way around the physical limits of continuously connected stabilizers.

"Creating an electronic system allowed us to solve one of the demerits of

The 2024 Lexus GX offers 24 inches (621 mm) of articulation thanks to its electronic Kinetic Dynamic Suspension System (E-KDSS).

BOTH IMAGES: LEXUS

a hydraulic system, which was that the front and the rear systems were linked," Tsukasaki said. "Now we're able to independently control the front and the rear separately, so that's how the electric system brings in a better advantage."

The E-KDSS offers 24 in (621 mm) of articulation on the new GX, an improvement over the 22-in (559 mm) articulation in the new GX versions with standard KDSS and 21-in (535 mm) articulation in previous GX models with KDSS.

Electronic control was also a lower-cost solution and allows the GX to control the coupling and decoupling at more precise rates for better ride quality, he said. When on paved roads, the GX monitors steering angle, vehicle speed and lateral Gs to decide when to engage and disengage. The E-KDSS stabilizer is also thicker than it would be if it weren't always being disconnected, which further minimizes body roll and increases body structural rigidity.

Turning the 2024 Lexus GX away from the ease of paved roads proves Tsukasaki and his team have improved the SUV's off-roading chops to tackle modest trails and hills. Whether on the trail or a freshly paved suburban cul-de-sac, the new GX delivers a quiet, comfortable ride, especially given the body-on-frame structure at work.

Toyota and Toyo Tires co-developed 33-inch (838 mm) all-terrain tires for the new GX that give the SUV an extra 0.2 inches (5 mm) of ground clearance on the Overtail and Overtrail+ trims.

There's plenty here to help beginning off-road drivers, too. The Multi-Terrain Monitor uses visual feeds from the front, side and rear cameras to show what's under the massive front end on the dashboard's 14-inch display. An electronically controlled locking rear differential works with Downhill Assist Control (DAC) to keep the GX from accelerating out of control when on an incline. DAC can even be used in reverse gear if you're attempting a trail that turns out to be too much.

The interior of a 2024 Lexus GX Premium.

BOTH IMAGES: LEXUS

Tires, too, with Toyo

Lexus is offering new 33-inch (838 mm) specially designed tires for the new GX. These all-terrain tires come standard on the Overtail and Overtrail+ trims and give the SUV 8.9 inches (226 mm) of ground clearance. The standard GX without the special tires rides a little lower, with 8.66 inches (220 mm) of clearance.

Toyota and **Toyo Tire** began working on these tires three years ago, Tsukasaki said, and engineers were focused on three main factors: reducing road noise, cooling performance, and aerodynamics. The tires' side tread pattern was crucial in improving aerodynamics.

In addition to the GX, Toyota will use these new tires, or something very similar, in the new Land Cruiser, including the next 4Runner.

Toyota will start building the new GX at its Tahara plant in Japan in February 2024 and said it expects to sell more than 33,500 units in calendar year 2024. Whatever the sales numbers, Tsukasaki already sees success when he looks at the SUV. Despite the many challenges this team faced during the development process, they managed to reposition the GX how they wanted.

"When I look at the different parts of the vehicle, the faces of the engineers that worked on it pop up into my head," he said.

Sebastian Blanco

2024 Honda Prologue is a cautious invitation to drive electric

Despite the inherent potential of electric motors to offer blazing acceleration, **Honda** decided to smooth things out for its first serious all-electric vehicle for North America. During a recent test drive of the 2024 Honda Prologue, SAE Media found the midsize SUV to be a clean and spacious vehicle that doesn't necessarily take full advantage of its electric powertrain. Honda believes this choice — and it was indeed a choice — will be key to convincing buyers to switch to an EV.

The 2024 Honda Prologue in North Shore Pearl. The two-motor Elite AWD version produces 288 hp and 333 lb-ft (451 Nm).

"We didn't want to give them some shocking power delivery," Prologue development leader John Hwang told SAE Media. We wanted something more consistent and something more natural feeling. It makes the transition easier."

There is a sport mode with a slight performance bump. Hwang said the team's main mission was to deliver Honda's signature driving dynamics like steering effort and damper and spring tuning.

Driving through the hills around California's Napa Valley, the Prologue's realness came through. Quickness is not its strong suit. The $59,295, top-of-the-line Elite trim (price includes destination) uses a permanent-magnet traction motor and a single-speed transmission at each axle to provide AWD capability, with the twin motors combining to produce 288 hp and 333 lb-ft (451 Nm). Single-motor Prologue trims were not available to test, but they generate 212 hp and 236 lb.-ft. (320 Nm). All versions use multi-link front and rear suspensions. The modest output numbers, plus the inescapable weight of the vehicle's battery and powertrain, meant the SUV consistently felt heavy but never cumbersome. No one will call the Prologue nimble, but it also wasn't challenged by some slightly enthused driving through the forested curves. Honda's mass-market audience will almost certainly approve.

Honda released initial technical details for the 2024 Prologue last year, but the company didn't get to decide all of those numbers itself. The Prologue was created with help from **General Motors** and uses that automaker's Ultium platform as part of a co-development project announced in April 2020. Other Ultium-based vehicles include the **Acura** ZDX, **GMC** Hummer EV and **Cadillac** Lyriq.

Hwang said the codevelopment meant Honda could take extra care with the Prologue's interior, and it shows. Spacious with clean lines, the cabin felt open and practical. There are no showy features, but most things are where you want them to be. One counterexample is the required deep dive into infotainment-screen menus to adjust the regenerative braking level.

Hwang, who also worked with GM engineers on the Cruise Origin autonomous-vehicle development project, said Honda dynamics engineers moved from Japan and Ohio to Michigan to be near the GM Proving Ground. While working on the damping system, for example, Hwang said, the Honda team was joined for weeks by GM dynamics engineers and engineers from the damper supplier.

"We were just driving, modifying, driving, modifying — iterating to get to that sweet spot of what we wanted," he said. "It was a really collaborative effort.

The Prologue will be built at the GM Ramos Arizpe factory in Mexico. All versions use an 85-kWh lithium-ion battery pack that has an official range estimate of 273 miles (439 km) for the Elite trim and up to 296 miles (476 km) for the single-motor FWD versions. All trims and powertrains will be available at launch.

Sebastian Blanco

The Prologue's uncluttered interior feels spacious and has enough physical buttons to make most comfort adjustments easy to accomplish while driving.

FROM TOP: SEBASTIAN BLANCO; HONDA

Ford refines interior, exterior of 2025 Explorer

The silver accents on the gloss black grille mark the Platinum 2025 Ford Explorer.

The **Ford** Explorer will celebrate its 35th anniversary for the 2026 model year, and it is highly likely that America's best-selling SUV will meet the occasion with a complete redesign. Ford introduced the current generation in 2020, making it ripe for a major update.

The company revealed the refreshed 2025 Ford Explorer today, with bolder exterior features and a redesigned interior that offers more tech to the driver and passengers. It also continues Ford's effort to simplify trim-level lineups to make manufacturing and purchasing easier.

"We have refined almost every part of the new Explorer — focusing on a redesigned interior, additional technology like BlueCruise and special editions like the 400-horsepower Explorer ST," said Andrew Frick, president of **Ford Blue**.

On the outside, the entire 2025 Explorer lineup has larger grilles, sleeker all-LED headlights, front skid plate and lower, wider air curtains that, Ford says, lower the vehicle's visual center of gravity. For Platinum, ST and ST-Line models, a black roof is optional. Out back, the liftgate has LED taillights that extend from the corners to a stretched horizontal nameplate.

The grilles are unique to each trim level. Platinum models have an ebony grille in a wing design with satin chrome. ST and ST-Line have honeycomb gloss black grilles with a black mesh insert. The Active has a sawtooth design with a black mesh insert with chrome bars.

Consolidated powertrain lineup

Ford's continuing effort to simplify its trim-level offerings results in just two distinct engine options for the 2025 Explorer. Both come with rear-wheel drive standard and available 4WD. Powertrain choices by trim level:

- Platinum: 2.3-liter EcoBoost inline-4 turbo generating 300 hp and 310 lb-ft (420 Nm) as standard. Optional is the 400-hp, 415-lb-ft (563 Nm), turbocharged 3.0-L EcoBoost V-6.
- ST: 3.0-L EcoBoost.
- ST-Line: 2.3-L EcoBoost.
- Active: 2.3-L EcoBoost.

Inside: detail focused

The redesigned interior includes added details, surfaces and colors, including wrap-and-stitch soft-touch surfaces on the center console, door panels and new dashboard. Also included are silver mesh accents and optional ActiveX synthetic seating material.

Designers pushed the dashboard forward, creating more room for the driver and front-seat passenger. A tray below the 13.2-inch (392-mm) touchscreen has an available wireless charging pad plus USB-C ports.

Kelley Clark, chief engineer on the Explorer, said customers were satisfied with the driving dynamics (Ford did recalibrate the 10-speed automatic transmission for the 2025 models). "So, we focused on improving other areas, including redesigning the interior with new materials, textures and colors."

In addition to standard Apple CarPlay and Android Auto, the company's new Ford Digital Experience infotainment system allows drivers access to apps and services from **Google** and **Amazon**, controlled by Google Assistant voice commands or Amazon's Alexa. While parked, Explorer passengers can watch YouTube, Amazon Prime Video and surf the Web using the Vivaldi browser; 5G wireless tech supports up to 10 devices at a time.

Upper trims are equipped with Ford BlueCruise hardware for hands-free highway driving if bought as part of a subscription after a 90-day free trial.

Chris Clonts

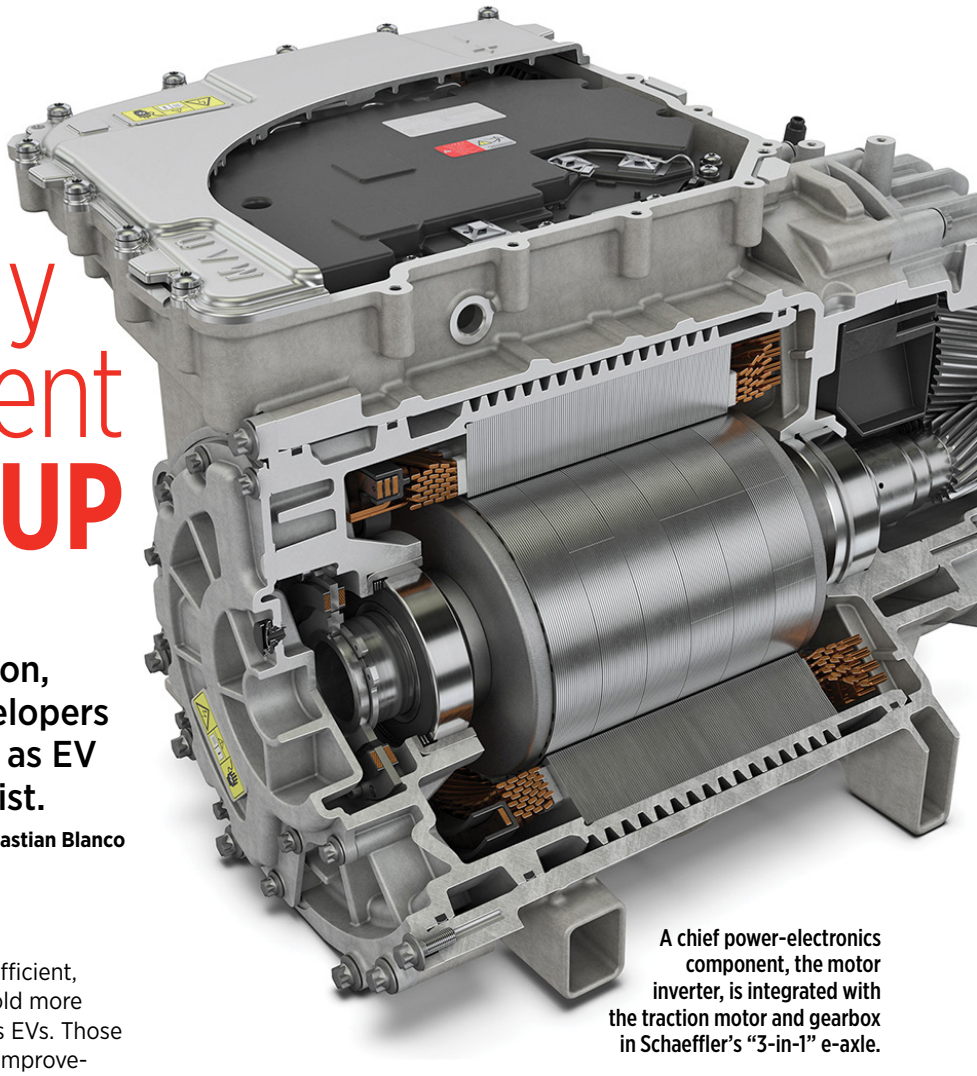
Platinum (shown), ST and ST-Line Explorers receive an ambient lighting system with seven selectable colors.

BOTH IMAGES: FORD

EV energy management POWERS-UP

Batteries get all the attention, but power-electronics developers lean into the cost equation as EV affordability concerns persist.

by Sebastian Blanco



A chief power-electronics component, the motor inverter, is integrated with the traction motor and gearbox in Schaeffler's "3-in-1" e-axle.

SCHAEFFLER

Future electric vehicles will be more efficient, more powerful and will be able to hold more energy in their batteries than today's EVs. Those big "mores" require countless small improvements beyond the headline component — batteries. One of the richest target areas is power-electronics technology and components used throughout the EV ecosystem. A new generation of power electronics will be found in tomorrow's EVs, charging stations and related infrastructure components.

Burak Ozpineci has a front-row seat to how better power electronics revolutionize the automotive industry. Now the section head of the **Vehicle and Mobility Systems Research Section** at **Oak Ridge National Laboratory**, Ozpineci has seen how technologies such as silicon insulated gate bipolar transistors (IGBT) were fundamental to both the GM EV1 and the **Toyota** Prius.

"[Those vehicles] happened because of the silicon IGBT," Ozpineci told SAE Media. "Then people used IGBTs because IGBTs became a household name for power electronics in many applications. Then, in the early 2000s, we started looking at silicon carbide, and in the early 2010s, everybody started looking into silicon carbide devices."

Tesla famously used a silicon carbide (SiC) drivetrain inverter in the Model 3 when it came out in 2017, and Ozpineci said it's expected in the industry that, after 2030, most EVs will use SiC devices. So-called wide-bandgap materials, specifically SiC and gallium nitride (GaN) offer marked efficiency improvements compared with silicon semiconductors.

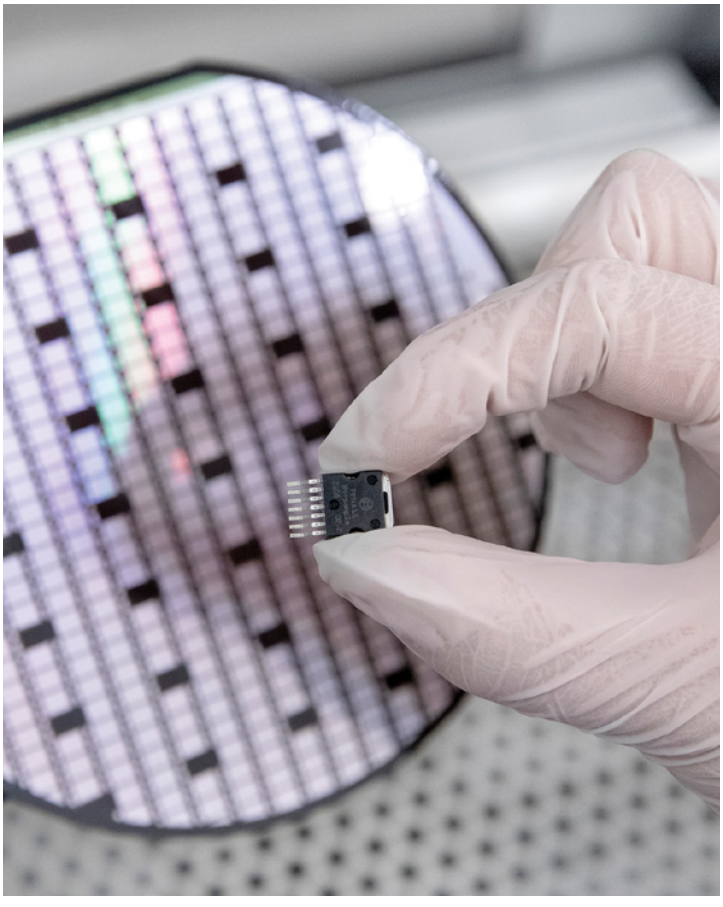
"When we first started in 2001, there were just a few devices available," Ozpineci said. "They were brand new, they were expensive. But with the introduction of the silicon-carbide MOSFET, maybe close to 10 years ago, people started looking at those devices more seriously." The race to improve continues. **Tesla** announced in 2023 that it is developing a SiC inverter that will use 75% fewer silicon-carbide (SiC) MOSFETs.

SiC is today's state-of-the-art

Vishnu Medisetty, director of power electronics for **Bosch** in North America, confirms that SiC devices are the mainstay of the company's power-electronics portfolio. Bosch began developing SiC semiconductors in 2001 and the first MOSFET prototype was available in 2011, he said in an interview with SAE Media, adding that the trajectory continues strongly upward.

"We are already on our second generation [of SiC]," Medisetty acknowledged. "We are working towards our third generation and there are generational improvements in the efficiency of the devices. So the device efficiency improves — but also, there's a huge cost driver behind EV applications. What we look at is trying to reduce the cost of the power-electronic device, be it a charger converter or be it an inverter that is driving the motor. We try to reduce the size of the die, the chip, extract more current out of it, need less cooling for it."

While Tesla hasn't specified just how it will reduce SiC devices in future powertrains, the industry also is working on replacing SiC



Silicon-carbide semiconductor produced by Bosch at its fabrication site near Dresden, Germany.

Burak Ozpineci, section head of the Vehicle and Mobility Systems Research Section at Oak Ridge National Laboratory.

semiconductors with gallium nitride once it can solve at least one challenge: the current moves vertically in SiC devices but laterally along the plane in GaN devices.

"There are no gallium-nitride vertical devices available," Ozpineci said. "The challenge with them is they're usually low-voltage, low-current right now. In a low-power onboard charger, or if you're looking at other DC/DC converters — again, low-voltage, low-power — you can use GaN, which will beat SiC at the power level. The vertical GaN devices, which actually will have better properties than SiC, are not ready yet — and they might not be ready for another ten years."

Bosch's Medisetty agreed, saying that for now, gallium-nitride doesn't have the performance needed by the transportation sector. "[GaN devices] are quite a bit lower-voltage, not readily suitable for automotive electromobility applications, but there are other gallium nitride approaches which are more similar to silicon-carbide devices," he said. "These have higher voltages, are more robust and more suited for electromobility applications.

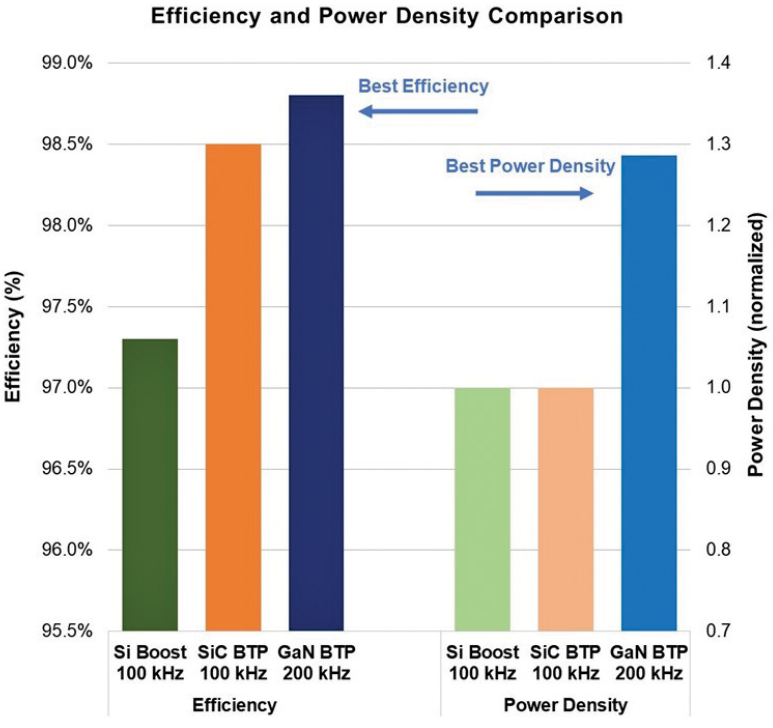
"Bosch is working extensively on gallium nitride that is more suitable for electromobility applications," he added. "We see a potential for it, but it's still further out and there is lot more ground to be covered on silicon-carbide optimization. There're generations before we get there."

Sandia National Laboratories, for example, started a development project in 2019 for better next-generation vertical GaN devices for high-power-density electric drivetrains. Testing both GaN JBS diodes and GaN MOSFET devices, the teams have so far discovered that the main problem is the low maturity of the two devices. Engineers have reached current limitations for both the MOSFET devices (where the problem lies with the current output) and the JBS diodes (where the limitation is in the reverse leakage due to the etch-and-regrowth process).

Sandia said in a summer 2023 presentation that it will conduct further tests once either a multi-amp device can be made (for MOSFET) or the leakage problem is solved (JBS). These new, vertical GaN devices, like so much of the research that the DOE supports, are being developed to hit three key targets. The DOE's power-density target for 2025 is 100 kW-per-liter for a 300,000-mile lifetime powertrain that costs, at most, $2.7 per kW. Ozpineci said that regardless of the technology the VTO is helping with, money is always top of mind.

FROM LEFT: BOSCH; ORNL

Vishnu Medisetty, director of power electronics for Bosch in North America.



In 2021, GaN Systems offered this comparison of gallium-nitride performance versus silicon and SiC semiconductors.

"It's always the cost," he said. "OEMs are focused on three important things: cost, cost, cost."

Ozpineci said he worked with a team in 2017 to develop a roadmap for 2025 targets, which included cutting costs by 50% compared to 2015. At the North American International Auto Show in Detroit at the beginning of the project, he noticed that many hybrid vehicles there had an extra box in the trunk, reducing cargo area.

"Talking to the OEMs, we heard about their interest in power destiny, too," he said. "At that point, it almost sounded like power density was as important as cost. So, we focused on improving the power density by eight times by 2025 compared to 2015. But over the years, though, any time I bring up power density, they always say it's the cost. Power density is really important, but cost is still the number one."

VTO looks for merit

The DOE's **Vehicle Technologies Office** (VTO) has a mission to support R&D efforts that "lower the cost and improve the performance of power electronics in electric drive vehicles." It funds and works on dozens of power-electronics projects to do that. A glance at the VTO's Annual Merit Review submissions shows the many ways companies and the government are working on these next-gen devices. Some are working on integrating more components — heatsinks, power modules, control circuits — into the inverter, with the benefit of reducing the overall size so it won't require as much space on an OEM's skateboard EV chassis. Capacitors in an inverter could also be made smaller. Some projects use AI to redesign heat exchangers to potentially cool devices better in smaller packages.

Since 2020, **American Axle & Manufacturing** has been working with the VTO to eliminate the need for heavy rare earth materials in its motors. So far, this project has designed a highly integrated 650-volt inverter to eliminate phase leads and has developed a sintering method to attach discrete SiC devices to heat sinks for better thermal efficiency.

Another approach could come from new ways to cool power electronics using dielectric fluids. In 2018, the DOE started a $1.6-million project to improve thermal management in EV power electronics as part of the DOE's Vehicle Technologies Program. The project's objective is to develop thermal-management techniques to help reach that 100-kW/L power density target. In mid-2023, the **National Renewable Energy Laboratory** said it had demonstrated that a new two-phase dielectric fluid concept, designed specifically for EV cooling, could perform better than more familiar water ethylene glycol (WEG) systems when used with a custom SiC module.

Bosch's Medisetty confirmed that advancing thermal-management techniques are critical to improving its power-electronics devices. "There is a separate group at Bosch that looks into thermal management — that's a vehicle-level thermal-management team. What I'm talking about is purely on the thermal-management side of the power electronics and there are other advancements that we are looking at,

FROM LEFT: BOSCH; GAN SYSTEMS

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but at the same time we are very cost-conscious. So this mass market acceptance of electric vehicles will depend on how we can drive cost out.

"We continue to look at how can we optimize the device to require less cooling but not add costs. We continue to drive to higher device temperatures, so the next generation of the device can handle higher temperature. That means you can have a smaller cooling circuit."

Medisetty added that development of higher-voltage EV platforms may help to literally take some heat off power-electronics cooling concerns. "Heat is a factor of the current that you're pushing. At 800 volts, you actually have a lower current; if all things being equal, the power levels are the same, the current is lower on the 800-volt side," he said. "Typically, you go to 800-volt because you are already at the limit of the currents that you can push through, so you want to go to higher currents. What we look at is to try to optimize the inverter design such that you can shrink the size of the inverter, the cooling circuit — and take cost out. That's what we are focused on."

To make a difference, research and eventual production-vehicle components have to find a home in vehicles people want. After decades of watching power electronics improve, Oak Ridge's Ozpineci said he knows who will be pushing hardest for change.

"There are some smaller and newer companies that are willing to adopt these technologies faster than traditional companies," Ozpineci said. "New companies showing up in the EV space, they don't have all these investments for the old technologies, and they said, 'Okay, well, there's this new technology that might be really beneficial. Why don't we start from there?'" ■

Additional reporting by Bill Visnic

BOSCH

Magna's e-motor can be rotated 90 degrees around the drive axis with no modifications. Both horizontal and vertical installations keep the coolant pump at the bottom, where it needs to be.

SAE/CHRIS CLONTS

MAGNA puts multiple innovations in new, more efficient 800v e-motor

Better cooling and more efficient chip placement are among the techniques used to hit a new company high for efficiency: 93%

by Chris Clonts

At the Consumer Electronics Show in Las Vegas, **Magna International** showed off a new 800-volt e-drive motor that it said sets new standards in efficiency, power-to-weight ratio and torque density.

Joerg Grotendorst, senior vice president of corporate R&D, included the announcement in an overview of Magna's recent focus on e-motors, improving ADAS and impaired-driver detection.

"Our response to the increasing cost-cutting demands of the OEMs is to work with (a philosophy) we call Magna Integrated Systems," he said, explaining that it is more efficient to produce a system for an OEM rather than just a component here and there. Which the company is still willing to do, of course.

The 258-kW peak-power unit can generate peak axle torque of 5,000 nM (3,688 ft-lb) while hitting a max of 20,000 rpm. It does this in a package weighing only 75 kg (165 lbs). It reaches 93% efficiency, an improvement over other Magna offerings' high of 91%. It's equivalent in capabilities to a five-liter hemi, one engineer said.

The enhancements driving that efficiency include the ability to route cooling fluid to the components that need it the most at any given time and a new way of embedding the controller chips.

Mike Dowsett, Magna's chief engineer for powertrain electrification, further detailed the motor's innovations, not the least of which is its ability to be used horizontally, typically when it's at the rear of a vehicle, or vertically at the front. The key is that when the motor is rotated 90 degrees, the pump for the coolant still is located at the bottom, where it must be to function properly.

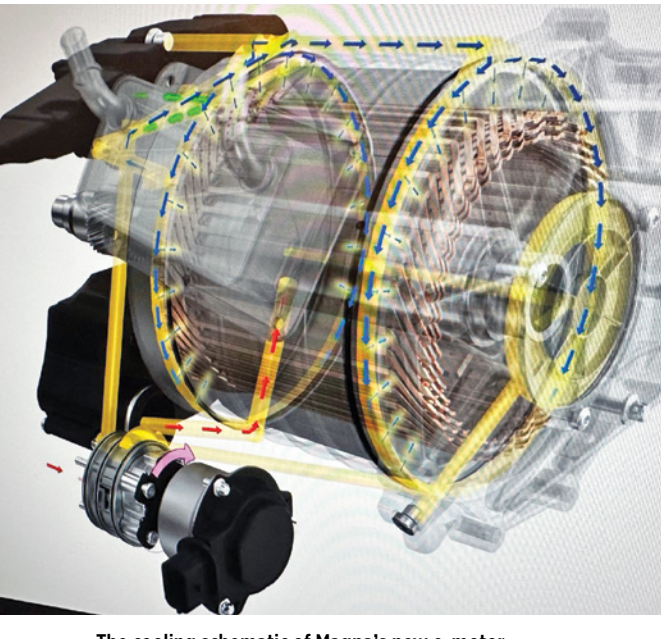
"This is active cooling fluid control," he said. "It increases efficiency by moving oil to different locations based on the power demands. For low-speed and high-torque situations, more cooling is directed to the magnets. For high-speed and low-torque, it is directed to the jacket and the windings, which are traditional non-braided windings."

Asked about whether Magna was considering printed circuit board (PCB) stators instead of windings, something being promoted by companies such as **Schaeffler** and **Infinitum**, Dowsett said the company didn't believe that today's power demands could be met that way.

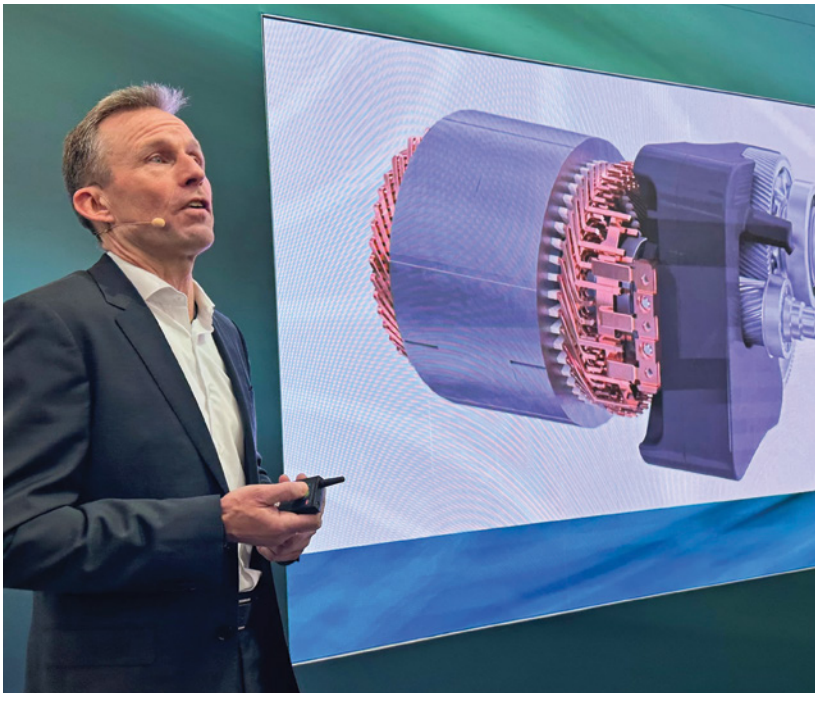
Dowsett said Magna has accounted for bearing current, a damaging phenomenon in which electrical current from the magnets finds its way to the bearings and exceeds the breakdown voltage of the lubricant. This causes pitting and fluting of the bearing races and can prematurely ruin a motor.

MAGNA puts multiple innovations in new, more efficient 800v e-motor

Magna Chief Engineer for Powertrain Electrification Mike Dowsett talked about the new motor and its entire line, including e-axles fit for off-road vehicle use.



The cooling schematic of Magna's new e-motor.



Joerg Grotendorst, Magna's senior vice president for R&D, talks about the next-gen traction motor. The cutaway image shows the motor's traditional copper windings.

Magna has accounted for bearing current, a damaging phenomenon in which electrical current from the magnets finds its way to the bearings and exceeds the breakdown voltage of the lubricant.

Dowsett said engineers employed the following bearing-current fighting techniques:

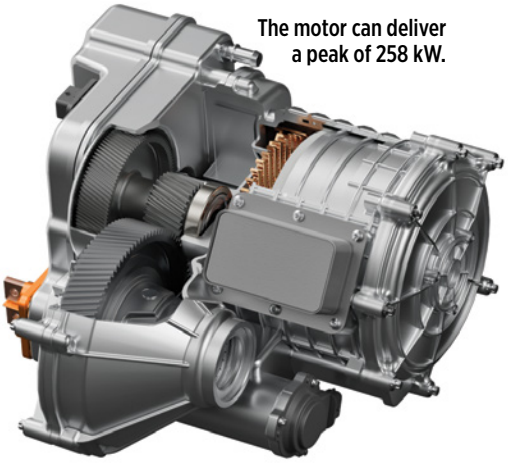
- Isolating the bearings
- A common mode choke, which works to filter out the current from being passed through the bearings
- A clamp that shorts the current to the ground

Without all three, he said, most electric motors are prone to premature failure — as early as around 50,000 miles.

Magna was already using silicon carbide chips, which are more efficient than silicon chips due in part to their low thermal expansion and high maximum current properties. For the next-gen motor, the chips, instead of being embedded in ceramic material, are embedded directly in the PCB. "This improves the switching losses, but it also improves the way that we interface with this. We won't see any large welded components and bond wires and all that." He continued: "It really simplifies things and allows us to cool these for one side only."

The motor also is run with optimized electrical pulse patterns to reduce noise with no accompanying power drop.The motor's sustainability features include a reduction in the use of rare-earth materials

CLOCKWISE FROM TOP LEFT: SAE/CHRIS CLONTS; SAE/CHRIS CLONTS; MAGNA



The motor can deliver a peak of 258 kW.

MAGNA

by 5% and an elimination of the need for terbium and reducing the dysprosium to 0.5%. The remaining material is neodymium.

Grotendorst, the company's R&D vice president, said that the company is also exploring the idea of making entire pieces of a car. For instance, imagine the efficiencies of "cutting a vehicle in pieces and manufacturing all of them in parallel."

Steven Jenkins, vice president of technology strategy, highlighted Magna's work on thermal imaging (now in 300,000 vehicles), ADAS and impaired-driving detection systems. SAE Media wrote about those and the company's e-axles (https://www.sae.org/news/2023/08/magna-tech-day-2023).

Magna's impaired-driver detection tech, gained in an acquisition of Veoneer last year, relies on a combo of passive detection of alcohol on a driver's breath and, if that raises a red flag, visual examination of eyes and their movement. What happens next in event of detection, such as blocking the car from starting or a simple audiovisual warning, will be determined later by regulators and industry groups.

Magna competitor **Bosch** also has discussed its impaired-driving systems and the current regulatory environment (https://www.sae.org/news/2024/01/bosch-in-cabin-ces).

In a possibility that would take a long time to develop, Jenkins talked about the possibilities of cars and infrastructure pieces (traffic cameras, security cameras on buildings) sharing data to and from the cloud to improve safety. Magna's vision of the system is called Connected Perception.

In one example, a vehicle whose vision, radar and lidar couldn't see an approaching cyclist due to being blocked by a large truck could be alerted to its presence by cameras, radar or other equipment on stationary pieces of infrastructure. ■

Deriving the maximum performance and efficiency from the proliferating number of vehicle sensors is driving sensor-fusion development trends.

Sensor fusion expanding in step with advancing VEHICLE SOPHISTICATION

An accelerating need to enable automated-driving and efficiency-enhancing features is driving sensor-fusion innovations.

by Lamar Ricks

When drivers of passenger vehicles change lanes, brake at stop lights, or accelerate on the highway, they're probably not thinking about sensors. Sensors monitor, regulate and alert on changes in fluid and component conditions, such as tire pressure, fuel and oil levels and engine temperatures. They also report on the position of motor components, wheel speed and antilock braking systems as well as monitor internal and external air temperature, helping to maximize passenger comfort.

The typical non-electric vehicle now is fitted with between 60 and 100 sensors, with 15 to 30 dedicated to managing the engine. Commercial trucks have up to 400 sensors, with up to 70 allocated to engine management.

The shift toward ADAS and automated driving is stimulating unprecedented demand for sensors. Future generations of EVs, particularly those equipped with autonomous or semi-autonomous functionality, may have two to three times the number of sensors as their comparable predecessors. What's more, the emergence of software-defined vehicles (SDVs) is set to further impact market demand, as they enable a new service delivery model. Instead of hardware determining the features a vehicle can offer, manufacturers will build basic, mid-level, and luxury vehicles with pre-integrated sensor-enabled functionality that can be turned on and off with software, encouraging standardization across the industry.

But that's not all. The expansion of autonomous capabilities extends to a variety of vehicle types, regardless of the power-source technology. Among these, hybrid vehicles, combining both ICE and electric propulsion and fitted with automated-driving features are likely to have the most significant sensor content. To support these industry advancements, original equipment manufacturers (OEMs) are pivoting from domain-based to zonal electrical architectures, which are homogeneous and bus-based.

Maximizing efficiency with sensor fusion

The more sensors a vehicle has, the smarter it can be. However, sensors take up space and become increasingly expensive as they offer greater functionality or higher performance. As a result, the solution for basic and mid-level vehicles is not always to deploy more sensors or the best ones — but to ensure they address the job at hand most effectively. Luxury consumers, on the other hand, may be willing to pay more for a vehicle with advanced sensor solutions that deliver a higher level of safety, comfort and convenience.

The methodology of integrating multiple sensors into one package or combining the output data of multiple sensors is referred to as sensor fusion. The goal of sensor fusion is to eliminate redundant packaging to minimize system cost or to combine the outputs of various sensors to achieve insights or decision-making abilities that would not ordinarily be possible with isolated sensor data.

While homogenous technologies can be easily integrated, sensors may use different substrates, making it an engineering challenge to combine them. For example, sensors on silicon substrates are not easily integrated with those on silicon-carbide or gallium arsenide substrates. To address this, component manufacturers are exploring new ways to develop multifunctional sensors that deliver added value, optimize the use of space and reduce costs. As an example, the market now offers an integrated module that merges

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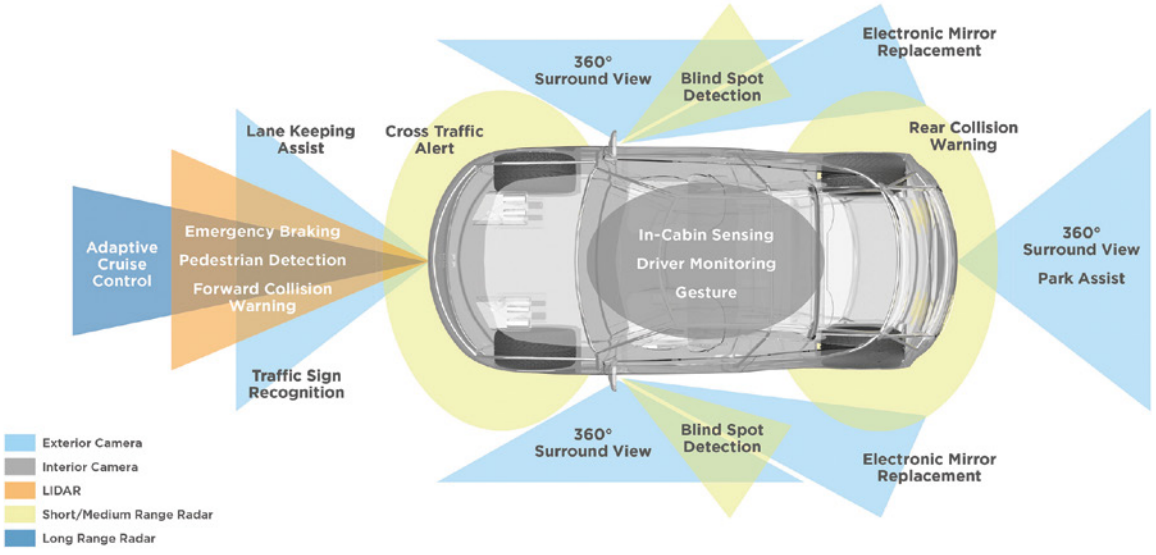


For vehicles employing the latest ADAS/AV technology, there may be from 60 to 100 onboard sensors, even if the vehicle has a conventional IC powertrain.

Vehicle-to-vehicle (V2V) and vehicle-to-everything (V2X) communications are another consideration in onboard sensor usage.

temperature and humidity sensors, enabling a vehicle HVAC system to automatically activate windshield defogging and wiper systems.

Sensor fusion also refers to using sensors, high-speed data connectivity, artificial intelligence and machine learning to provide situational awareness and act on changing environmental and operational conditions. For SAE Level 2 to Level 5 automated driving functionality, sensors help enable varying levels of automation. Lidar, cameras, radar and vision technology facilitate vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2X) communications, increasing process efficiency and reducing the need for sensors to 30 or fewer. Fully autonomous vehicles use sensor fusion to collect and integrate data, recognize patterns and automate a controlled response, such as determining the position and speed of a vehicle and swerving or braking suddenly to avoid a pedestrian crossing in front of the vehicle.

Exploring alternative sensing technologies

In addition to leveraging sensor fusion, OEMs and system suppliers are exploring the use of alternative sensing technologies to further reduce costs. Technologies using Eddy Current and xMR (magnetics) are emerging as potential alternatives for resolvers, a passive transformer technology traditionally employed for measuring rotary position.

The adoption of these alternatives will primarily be evaluated based on their cost-effectiveness relative to performance. Depending on the end application and performance requirements, these solutions may be adequate and, as a result, cannibalize existing business. For example, in systems where a secondary eMotor serves as a backup, the performance requirements may be lower than for the primary motor. In such cases, opting for a sensor technology that presents a moe cost-effective solution, even with a slightly lesser performance, could represent the better strategic and economical choice.

High-resolution wheel-speed sensors have four times the resolution of legacy wheel-speed sensors. Improved resolution increases vehicle-position accuracy in areas where GPS is unavailable and supports enhanced ADAS features such as lane keeping, lane departure and vehicle positioning. The improved accuracy facilitates quicker updates on vehicle movement, aiding in maneuvers such as automated parking in tight spaces. When it comes to eBraking, systems

BOTH IMAGES: TE CONNECTIVITY

historically have been hydraulic-based, offering wet-wet braking capabilities. However, by transitioning from pressure to force sensors, OEMs can enable full-dry electronic braking systems, which provide increased responsiveness.

Digital sensors to dominate

Vehicle architectures also are evolving to reduce power consumption and extend the range of EVs and autonomous vehicles. For example, analog sensors that were connected to electronic control unit microprocessors or circuitry and simply turned functionality on and off have gone by the wayside. With bus-based architectures, digital outputs capitalize on massive bandwidth to enable more functionality and ultra-fast response times. In addition, they are easier to plug in and plug out to reduce power consumption. As a result, digital sensors will predominate with new SDV architectures.

The development pace in the passenger vehicle market is advancing at lightning speed: from ICE to EV and from driver-assistance to high levels of automated driving. As the pace of innovation accelerates, the focus will continue to shift both to sensor fusion and alternative sensor technologies as they play an invaluable role in bringing new and advanced functionalities to market. ■

Sensor-fusion development isn't exclusive to passenger and commercial vehicles; for this Volvo automated hauler, sophisticated sensing assures safety and reliability.

VOLVO

Lamar Ricks is the Senior Director and Chief Technology Officer for Transportation Sensors in TE Connectivity's Sensors Group. He has 30-plus years sensors industry experience with technical leadership roles including sensing technology research & development, mixed signal IC and ASIC design and program management. He has 45-plus issued sensor-related patents and holds a BS in Electrical Engineering (BSEE) from Northern Illinois University.

PRODUCT BRIEFS

SPOTLIGHT: EV POWER ELECTRONICS

Pressure sensors

Melexis (Tessenderlo, Belgium) launched the MLX90830 pressure sensor. The sensor reportedly delivers a proportional analog output signal that can be integrated into the latest EV thermal- management systems. The MLX90830 features Melexis' Triphibian technology, which allows the sensor to provide accurate measurements considerably above 5 bar (72.5 psi) but also while in contact with liquid. The sensor is equipped with protective mechanisms against overvoltage (above +40 V) and reverse voltage (below -40 V) which makes it usable for both automotive and commercial-truck applications. Melexis states that compared to existing non-MEMS-based designs, the MLX90830 provides elevated accuracy, helping to optimize the efficiency of the vehicle's thermal-management systems and enabling increased range.

https://www.melexis.com/en

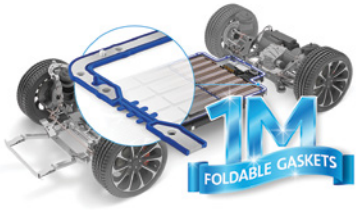
SPOTLIGHT: SOFTWARE

Design tools

Power Integrations (San Jose, California) (NASDAQ: POWI) and **SnapMagic** (San Francisco, California) announced that PI Expert, Power Integrations' online design tool, now features schematic and netlist export made possible by SnapMagic's new schematic export technology. Based on specifications input by the user, PI Expert automatically generates a complete power supply schematic utilizing Power Integrations' power-conversion ICs, including a custom magnetics design. Previously, the automated tool flow covered everything up to full circuit optimization, but required manual transcription into a CAD package to facilitate simulations and physical layout. The new export capability ensures a fast and seamless transfer of the design, including symbols, footprints, 3D models and electrical netlist into one of four popular PCB CAD tools.

https://www.power.com/
https://www.snapmagic.com/

Foldable battery gasket



Freudenberg Sealing Technologies (Plymouth, Michigan) offers a new foldable gasket for EVs. Freudenberg states that the gasket contributes to the reliability and longevity of battery systems.

The gasket consists of a segmented aluminum carrier with multiple sealing profiles on the outer edge. These reportedly provide strength while also integrating plastic retention fixtures. These are used to attach the gasket to the battery housing cover. The carrier segments are interconnected with a continuous sealing profile that is flexible so it can compensate for manufacturing tolerances in the housing. Freudenberg claims the foldable gasket helps make the battery system more reliable and durable and that its simple disassembly also makes it easy to service and repair the battery.

https://www.fst.com/

Intelligent tire management

ZF (Friedrichshafen, Germany) and **Goodyear** (Akron, Ohio) announced the integration of tire intelligence technologies with vehicle motion-control software. The collaboration delivers Goodyear SightLine, a suite of tire-intelligence technologies, into the ZF cubiX, a scalable vehicle motion-control software that coordinates all dimensions of vehicle dynamics. This provides further tire and road data into the chassis system and enables an improved driving experience with better comfort, control and efficiency, the companies said. Additionally, the synergy between Goodyear SightLine and cubiX capabilities can provide enhanced vehicle responsiveness, more direct and linear steering, improved turn-in response, increased stability, reduced controller workload and minimized intrusive interventions.

https://www.zf.com
https://corporate.goodyear.com

Temperature detection

Littelfuse (Chicago, Illinois) introduced its TTape overtemperature detection platform for management of Li-ion battery systems. Littelfuse states that TTape is suited for a wide range of applications, including automotive EV/HEVs, commercial vehicles and Energy Storage Systems (ESS). Its distributed temperature monitoring capabilities reportedly enable quick detection of localized cell overheating, thereby improving battery life and enhancing the safety of battery installations. Littelfuse states that TTape ensures that the battery pack remains serviceable for an extended period by initiating temperature management at an earlier stage. Multiple cells can be monitored, thus alerting the BMS sooner in case of overtemperature scenarios.

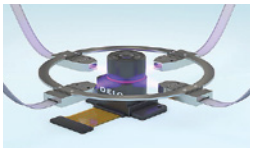
https://www.littelfuse.com/

Beamformer chips

EnSilica (Oxfordshire, United Kingdom) announced it is supplying VITES with a new beamformer chip for satellite user terminals. VITES will use the chip at the heart of its new ViSAT-Ka-band terminal. EnSilica states that the beam-forming chip is optimized to enable VITES' creation of power- and cost-efficient ground-based flat panel user terminals for satellite communication systems that can be used across a range of fixed and SatCom on the move (SOTM) applications. Its new ViSAT-Ka-band terminal is intended to be integrated into vehicles to track the movement of low earth orbit (LEO) and other non-geosynchronous (NGSO) satellites and allows users to access high-speed connectivity anywhere on the planet while the vehicle is moving.

https://www.ensilica.com/

Optical adhesives



Delo (Windach, Germany) launched an adhesive that has been optimized to meet the high optical requirements of modern driver-assistance systems. DUALBOND OB6799 is specifically designed for bonding and active alignment of ADAS cameras. Delo states that the epoxy adhesive has a linear curing shrinkage that is reproducibly less than one percent. The product also reportedly exhibits extremely low swelling behavior, even under changing temperature and humidity conditions, so that camera focus remains optimally adjusted and can permanently fulfill its safety functions. Delo's application-relevant aging tests confirmed the adhesive's high bonding strength to aluminum substrates.

https://www.delo-adhesives.com

UPCOMING WEBINARS

DIGITAL TWINS AND SIMULATION FOR ACCELERATED AUTOMOTIVE PRODUCT DEVELOPMENT

Thursday, March 21, 2024 at 12:00 pm U.S. EDT

Product-development simulation has emerged as a crucial component in cutting development time and cost, as well as helping to deliver superior quality and reliability. This 60-minute Webinar from the editors of *Automotive Engineering* examines the latest innovations in product-development simulation, including how digital twins are expanding into more areas of simulation and testing.

Speakers:

Michael Hoffmann
Senior Expert, Simulation-Driven Development, VI-grade

Nate Sladek
Vice President, Strategy and Product Management, Marelli

Keshav Sundaresh
Global Director, Product Management, Altair

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EV BODYSHOP METROLOGY: THE SAME BUT DIFFERENT

Friday, March 22, 2024 at 1:00 pm U.S. EDT

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

Speaker:

Paul Lightowler
APDIS Global Product Manager, Nikon Metrology

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Q&A

Axial flux e-motor maker progresses toward mobility, alters cooling design

SAE Media first introduced readers to Infinitum in a 2023 roundup of e-motor developments. The company claims it made a 50% smaller and lighter axial-flux motor by replacing all the copper in the stator with printed circuit boards that have etched copper conductors. The result is higher efficiency due to the elimination of core losses from eddy current, stator hysteresis and more.

Senior editor Chris Clonts stopped by Infinitum's booth at the Consumer Electronics Show in Las Vegas to see how the company has fared recently. Its strategy was to start building industrial motors to meet the world's biggest e-motor market before moving on to eventually building mobility solutions. We asked Chief Strategy Officer Bhavnesh Patel about that and more.

How is the plan going?
We have maxed out our production capacity on industrial and commercial motors. We're selling into a lot of data-center cooling applications, as the data centers generate a lot of heat [and are under increasing pressure to be more efficient]. We are also seeing a lot of pump applications and the investment from Rockwell Automation is helping us take this into material handling such as conveyors and luggage handling. And we're making progress on power-takeoff applications.

Still working toward mobility, though?
Yes. We have a number of partners that we are working with on a hybrid marine application and a truck application as well. We've come a long way in a year.

A rendering of Infinitum's Aircore Mobility Motor, which the company says is good for mobility, marine, construction and agricultural uses due to its efficiency and modular design.

Bhavnesh Patel, Infinitum's chief strategy officer, said the company modified its cooling tactics after seeing friction losses created by spraying coolant directly onto the stator.

"By eliminating or reducing significantly the number of interconnects we have, it makes it a lot more feasible to scale-up the technology to make it more commercially viable for various applications."

Mobility suppliers are starting to explore PCB stators as well. Are you concerned they'll capture that market before you can?
We're not too concerned on that front. For us, as a startup, we raised $185 million a couple of months ago [the company's Series E funding]. We must be able to turn that cash into actual progress and milestones.

With the PCB stator, I should also mention that there have been different ways of making this. Our approach is that there are multiple layers on the stator because every layer has a single phase or power — phase A, phase B, phase C — and layering those on top of each other. Previous approaches that I'm aware of have had those all on a single layer. And so, one of the challenges of that is you have to connect phase A on the first layer to phase A on the second layer to phase A on the third layer. Those interconnections, called vias, are the most unreliable and the most costly. By eliminating or reducing significantly the number of interconnects we have on ours, it makes it a lot more feasible to scale-up the technology to make it more commercially viable for various applications.

Since last year, has anything changed with your approach to this kind of e-motor?
In our first approach with the EV motor, we had a hollow shaft and we sprayed the stator directly to cool it. We have a fairly wide air gap between the rotor and the stator. We didn't expect the fluid to create frictional losses. In testing, it did result in some, so we've come up with other ways of reducing or removing that heat. Now we rely more on the cooling jacket, and we've also created fins on the inside that move air, which we're able to push over the stator and get the heat absorbed into the housing.

Are there any other improvements on the horizon?
We're talking to a lot of the automotive companies. One of the concerns with all motors is supply-chain risks. Something like 70% of motor magnets come from the same place. So, we've developed an approach that dramatically reduces the amount of rare earth magnets. We're not public with those details yet. ■

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