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AUTOMOTIVE ENGINEERING®

Manufacturing complexities

Considering paint overspray,
factory coatings
and LFAM

AI, machine learning help BMW
build the next generation of EVs

Stellantis exec asks 'What's wrong with diversity?'

WCX 2025: Dumarey's engines,
GM's Hydrotec EV charger



What's inside this
all-digital issue?



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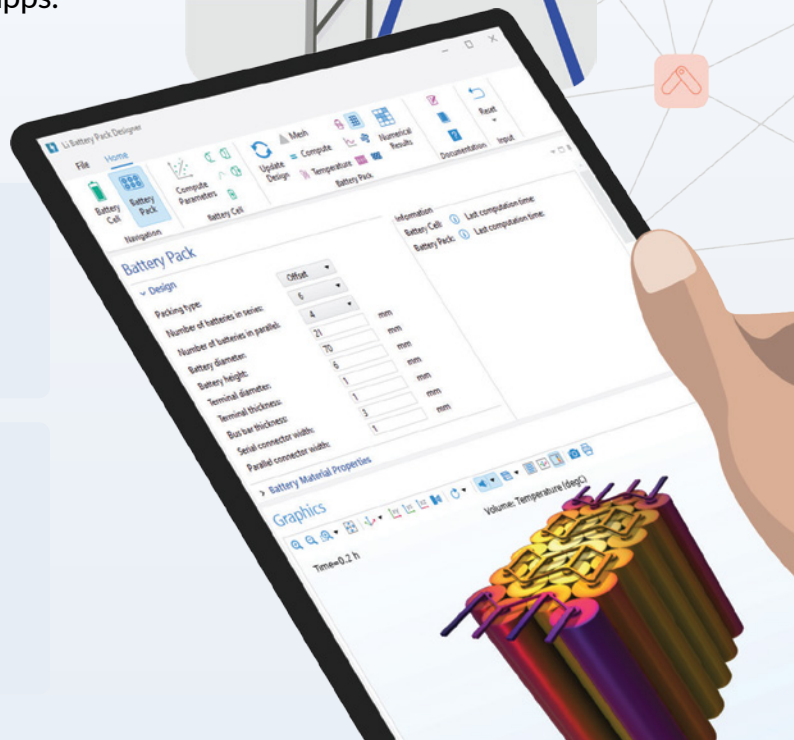
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FACTORY AUTOMATION

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An EV production line in an advanced automated smart factory. (IM Imagery/Shutterstock.com)

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EDITORIAL

Watch this

Welcome to the third all-digital issue of *Automotive Engineering*, this time with a focus on manufacturing. I'm writing this while covering the New York International Auto Show, which has been more interesting than might be expected given the state of U.S. auto shows over the past few years.

Some of the debuts at the show (look for more complete coverage on sae.org) include the 2026 **Subaru** Solterra and the company's more Subaru-ized Trailseeker EV. **Hyundai** unveiled the 2026 Palisade, now with a 2.5-L hybrid powertrain and a new XRT PRO trim for better off-roading. **Kia** launched the new K4 hatchback and the EV9 Nightfall edition. But this isn't the place to go through these details. Instead, I wanted to offer a quick guide through our written and digital content this year, whether that's about AI or cobots. After all, you can't sell a shiny new vehicle seen on the show floor unless you have a factory outfitted with the latest engineering tools and software able to build it.

This issue, we visit **BMW's** Battery Manufacturing Competence Center in Parsdorf, Germany, to see next-gen battery packs put together. We consider the impact that wall and floor coatings have on auto production. And we look at ways to reduce paint overspray and reduce costs. In this issue, though, we aren't limited to just telling you all these things. We can show you. Throughout these digital pages, you'll see a play button on some images. Click on them, and you'll be taken to a related video, sometimes a company explainer of the technology, sometimes a more detailed

SAE video that digs into the background and other issues.

Putting this digital-only issue together reminded me that there's a simple pleasure in watching machines and humans working together to build other machines, even as the politics behind these factories make everything more complicated than it needs to be. Naturally, we're focused on the engineering details of automotive manufacturing here, but I wanted to acknowledge that it's impossible to discuss the topic these days without feeling pangs of uncertainty about where we're headed and a lot of

compassion for everyone whose life will be upended when the changes hit.

At some point, we will slide out of reverse into drive. Until that time comes, we can maybe take a break to enjoy the ... whatever it is that's undeniably fascinat-

ing about modern car factories. My first experience realizing this truth from an editor's perspective happened a decade or so ago when I was working at Autoblog, a consumer-focused automotive website fueled by equal parts "do anything" enthusiasm and Internet goofiness. At some point, we posted some videos that were not much more than endless hours of production footage. We thought they were interesting, and our readers thought so, too, according to our engagement metrics at the time. I doubt the *AE* audience would be quite as giddy to watch an 8-hour stream like that, but I hope you enjoy the more tailored clips we found for you here. Please poke around, check out the videos, and let us know how we can make next year's digital issue even better.

Sebastian Blanco, Editor-in-Chief

We aren't limited to just telling you all these things. We can show you.

EDITORIAL

Sebastian Blanco
Editor-in-Chief
sebastian.blanco@saemediagroup.com

Chris Clonts
Senior Editor
chris.clonts@saemediagroup.com

Ryan Gehm
Associate Editor
Ryan.Gehm@sae.org

Matthew Wolfe
Assistant Editor
matthew.wolfe@saemediagroup.com

Amanda Hosey
Editor, Custom Content
amanda.hosey@saemediagroup.com

Contributors

Kami Buchholz
Detroit Editor

John Kendall
Europe Editor

Don Sherman, Paul Weissler

DESIGN

Lois Erlacher
Creative Director

Ray Carlson
Associate Art Director

SALES & MARKETING

Joe Pramberger
Publisher
joe.pramberger@saemediagroup.com

Kaitlyn Sommer
Marketing Director
kaitlyn.sommer@saemediagroup.com

Martha Tress
Recruitment Sales Manager
+1.724.772.7155
Martha.Tress@sae.org

REGIONAL SALES

North America

New England/Eastern Canada:
CT, ME, VT, NH, MA, RI, QC

Brian Hines
+1.647.296.5014
brian.hines@saemediagroup.com

Mid-Atlantic/Southeast/TX:
TX, OK, LA, AR, MS, AL, TN, FL, SC, NC, GA, DC, WV, VA

Ray Tompkins
+1.281.313.1004
ray.tompkins@saemediagroup.com

NY, NJ, OH:
Ryan Beckman
+1.973.409.4687
ryan.beckman@saemediagroup.com

MD, PA, DE:
John Murray
+1.973.409.4685
john.murray@saemediagroup.com

Midwest/Great Lakes:
IN, MI, WI, IA, IL, MN
Chris Kennedy
+1.847.498.4520, x3008
chris@didierandbroderick.com

Midwest/Central Canada:
KS, KY, MO, NE, ND, SD, ON, MB
Bob Casey
+1.847.223.5225
bobc@caseyreprs.com

CA, WA, OR, AZ, NM, Rocky Mountain States:
Tim Powers
+1.908.892.2838
timothy.powers@saemediagroup.com

International

Europe:
Sven Anacker
+49.202.373294.11
sa@intermediapro.de
Sabine Schoett
+49.202.373294.13
ss@intermediapro.de

Integrated Media Consultants

Patrick Harvey
+1.973.409.4686
patrick.harvey@saemediagroup.com

Todd Holtz
+1.973.545.2566
todd.holtz@saemediagroup.com

Rick Rosenberg
+1.973.545.2565
rick.rosenberg@saemediagroup.com

Jason Setti
+1.973.874.0271
jason.setti@saemediagroup.com

Chris Tsakonas
+1.973.409.4762
chris.tsakonas@saemediagroup.com

SUBSCRIPTIONS

+1.866.354.1125
AUE@OMEDA.COM



Cotronics Corporation

131 47th Street
Brooklyn, NY 11232
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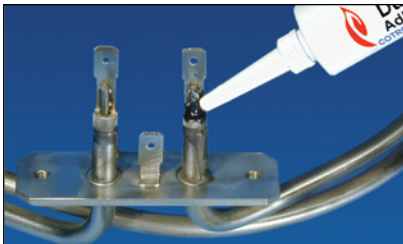
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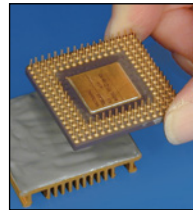
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Sourcing re-evaluation underway

The events of the last few months (re: tariff structures) underscore that the world is becoming more insular. Last month's column (on re-regionalization) outlined that major markets like China, the U.S. and the EU already have or are increasingly building a moat around their markets. Whatever the economic strategy, OEMs and suppliers have to adapt and thrive in this emerging ecosystem. This new operational reality impacts several facets of the business: sales, production, design and sourcing. As an extension, this new dynamic has us questioning the future number and relative scale of OEMs on a global basis.

In multiple cases over the decades, global OEMs have been born from a home-grown company that extended its reach to markets abroad to increase volume and diversify demand. Often, to drive jobs, there was a federal or regional government that offered support through incentives or trade assistance for the establishment and subsequent growth of a home-grown OEM and its surrounding supplier ecosystem.

The list is long of OEMs that can trace their lineage back to some level of governmental support that allowed for the enterprise to reach the next level. Over the years, several of these OEMs expanded beyond their home region to grow sales and production abroad. Through this process, many OEMs could utilize a variant of the hub and spoke model – building high-volume vehicles abroad while filling in their global portfolio of lower-volume variants with production. Larger OEMs such as **Toyota, Volkswagen Group, and Hyundai Group** employ a strategy of building most of their requirements in the regional market, then augmenting the portfolio with lower-volume entries built in scale back home. This model worked for decades, but the emerging insular economic approach in the U.S. is now challenging the underlying structure.

While larger OEMs may be able to efficiently diversify their sourcing strategy for a major



Michael Robinet
Vice President,
Forecast Strategy
Chair, Global
Forecast Council

SAE Foundation
Trustee

*michael.robinet
@spglobal.com*

**How do
global, lower-
volume, mass-
market OEMs
and luxury/
performance
brands compete
in this
environment?**

market through co-located production in-region and sprinkling in low-volume entries sourced from the home market, smaller OEMs and distinct global brands face a different challenge. How do global, lower-volume, mass-market OEMs and luxury/performance brands compete in this environment? While the dynamics may be different in these cases, several questions need to be posed:

Do we have enough scale economies to co-locate a plant outside our home market, build 1-2 of our high-volume vehicles there, and augment the portfolio from our home market and be competitive?

Is it possible to collaborate with a larger OEM already in-market to build select variants and escape most of the tariff impacts?

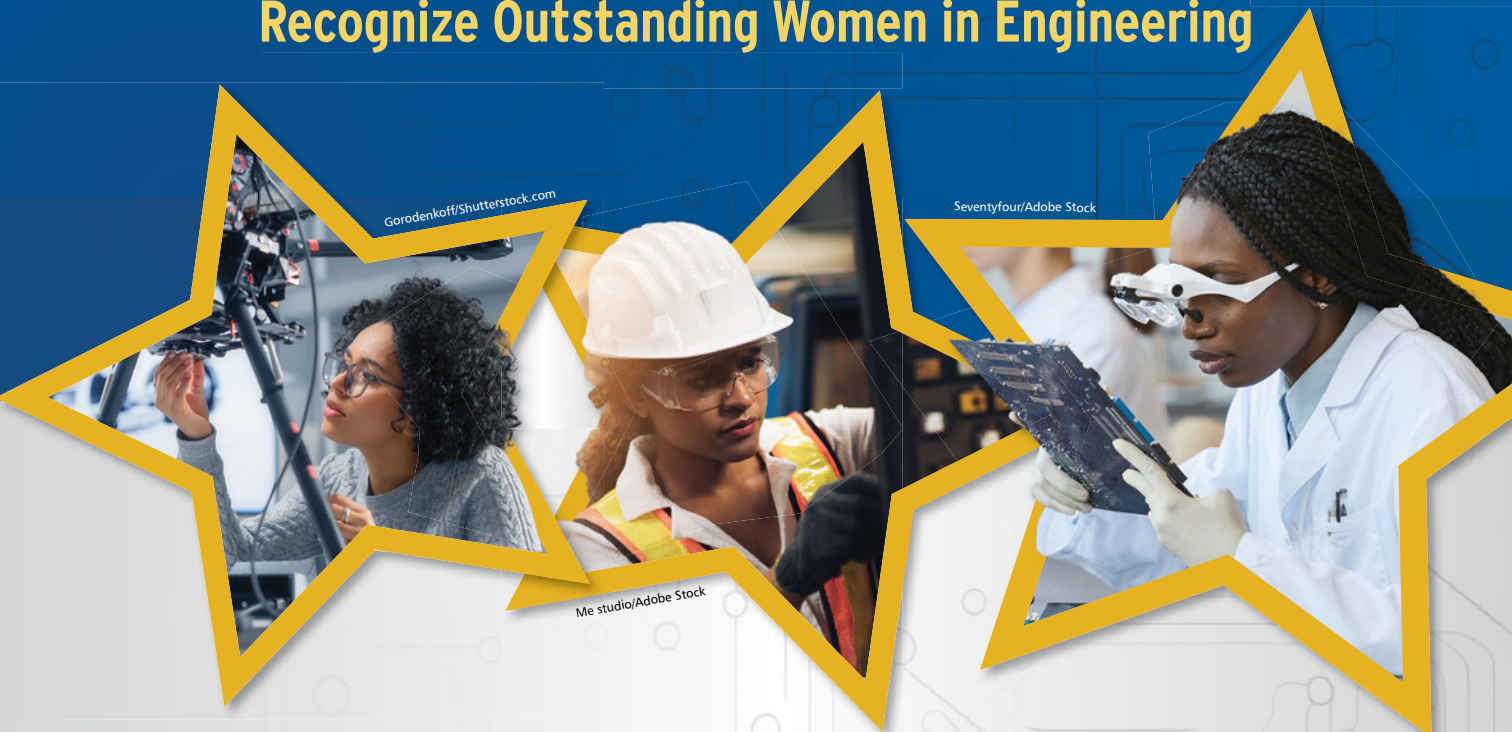
Will we need to pare our portfolio outside our home markets due to competitive dynamics and our relative cost position?

These and many other issues need to be investigated as the industry conforms to whatever longer-term trading dynamic exists for automotive in North America. From the supplier side, tough decisions also emerge. Co-location offers several challenges, the benefits of diversifying the regional and global customer base, while taking currency shifts and tariffs out of the risk equation has its benefits.

Nonetheless, smaller OEMs and distinct global luxury/performance brands will need to think out of the box if increased tariffs in the U.S. are part of the long-term equation. Decisions of automotive sourcing and portfolio size cannot be knee-jerk in nature. A long-term expectation for a trade structure and economic environment is critical to success. OEMs and suppliers are ill-advised to make important sourcing decisions requiring capital and resources unless a stable structure is forecast. This is especially important with smaller OEMs where more is at stake. Yet another challenge facing our beleaguered industry. ■

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WCX 2025

ICE and hybrid-electric propulsion show staying power



The 2025 Ram 1500 Ramcharger has a 92 kWh battery pack, a 130 kW on-board generator and two electric drive modules (EDMs), with output of 250 kW (front) and 238 kW (rear).

The internal combustion engine. Hybrid-electric. Full-electric. Plug-in hybrid electric. Pick one, two, or more for the product portfolio.

“We’re going to be very flexible,” Micky Bly, leader of **Stellantis’** propulsion engineering team, said about the automaker’s move to multi-energy platforms during the closing panel discussion at WCX 2025 in Detroit this month. “I’ve been very vocal that I need more ICE capacity in our multi-energy strategy.”

Stellantis’ third scalable multi-energy platform – the STLA Frame unveiled in November 2024 – can underpin full-size body-on-frame pickup trucks, light commercial vehicles and SUVs. Vehicles riding on the STLA Frame can be powered by ICE, hybrid-electric, hydrogen, battery-electric or range extender EV technologies.

The all-electric 2025 **Ram** 1500 REV pickup truck and the 2025 Ram 1500 Ramcharger range extended electric pickup truck are the first vehicles to debut the STLA Frame. Stellantis unveiled its multi-energy platform for STLA Medium in July 2023 for cars, crossovers and SUVs in the C and D segments, and in January 2024 unveiled the STLA Large for cars, crossovers and SUVs in the D and E segments.

Propulsion versatility enables the automaker to address regional needs and wants around the globe. “South of the equator, we see ICE for a very, very, very long time,” Bly said. “We’re heavily investing in [the South American] market, which we dominate.”

The 2004 U.S. introduction of the industry’s



The Chevrolet Volt on display in 2009, highlighting the plug-in hybrid’s 40-mile all-electric range.

first hybrid-electric SUV, the Escape Hybrid, was a technology stage-setter for **Ford**.

“Having that hybrid foundation allowed us to lean very quickly into EVs as a lot of that technology is very transferable. Now, with the learnings that we’ve taken from our electrification work, we’re feeding that back full-circle into our hybrid propulsion system,” said Charles Poon, Ford Motor Company’s director of electrified propulsion, during the panel.

Hybrid vehicles accounted for approximately 40% of **Toyota’s** total U.S. sales in 2024. “For us, hybrid is a core, foundational block,” Jordan Choby, group vice president of powertrain for Toyota Motor North America R&D, said at WCX. In addition to hybrids, Toyota’s electrified propulsion system portfolio in the U.S. includes plug-in hybrid, fuel cell electric, and all-electric options.

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In 2010, the **Nissan** Leaf grabbed the title as the auto industry's first mass-market, mass-produced battery-electric car. Fast forward to 2025 and every major vehicle maker has an all-electric vehicle. Although vehicles produced by China's **BYD** aren't sold in the U.S., the automaker was the top seller globally of electrified vehicles – including hybrids, BEVs and PHEVs – in 2024.

“Would [BYD's] products work in this market? I think the answer is absolutely yes,” Mike Anderson, **General Motors** vice president of global battery and propulsion engineering, said at WCX. “At General Motors, we're ready to compete. We know what [BYD is] doing, and we know what we're doing.”

GM ceased production of the Chevrolet Volt PHEV in 2019, but the automaker's electrified vehicle portfolio will once again include a PHEV model in the future. Anderson said that PHEV technology is a “great long-term solu-



The WCX 2025 April 10 propulsion panel from left to right are GM's Mike Anderson, Stellantis' Micky Bly, moderator Hannah Lutz, Toyota's Jordan Choby, Ford Motor Company's Charles Poon, and Nissan's Chris Reed.

tion,” providing EV-only driving and ICE-only driving capabilities. “It's more than a stopgap, it's part of the family,” Anderson said about PHEV technology.

All automotive companies must address various operational impacts, including global regulations and economic influences like trade tariffs. The U.S. implemented 25% tariffs on imported

vehicles on April 3, and tariffs of 25% on certain automotive parts are slated for May 3. There are also tariffs on steel and aluminum as well as reciprocal tariffs, even as automakers attempt to plan for the future. “Powertrain cycles are longer than Presidential cycles,” Toyota's Choby said.

Kami Buchholz

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· Vehicle Coupler
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WCX 2025

Intel's Weast says China leaping ahead due to focus on innovation



Jack Weast, vice president and general manager of **Intel Automotive**, told an audience at WCX 2025 that China's automotive industry is advancing quickly due to fierce competition, an innovation-first focus and more efficient organizational structures.

Weast's keynote discussion today in Detroit peeled back the curtain into the mindset and organizational nature of Chinese auto companies. Weast would know, as he's been in China for the past year, observing and working with many segments of the country's booming auto industry.

"In China, there are 150 active vehicle brands," he said. "It's the world's largest car market. It's the world's fastest growing car market, and China is now the largest net exporter of vehicles, having overtaken both Japan and Germany, who held those spots for a long time."

Weast also briefly addressed a common misperception – perhaps not held by executives but the general public – that China is not a modern country. "You can get anything you want delivered in

15 minutes," he said, citing his wife's beloved Dairy Queen order that arrives "colder than if we got it in person." He said the society, at least in the cities he's seen, is largely cashless and cardless, with all transactions being conducted via smartphones and QR codes. He was particularly impressed that there are many battery-swap stations for EVs in the country, something that was promised by Tesla in America and other start-ups around the world, but never came to fruition.

Heavy pressure to innovate

On the innovation front, he said that unlike many automakers that begin to design a new model with an eye on a price point, a typical Chinese automaker begins thinking about innovation first. The cost management comes later in the process. The size of the market also creates a life-or-death imperative to keep innovating, he said. "Everyone is constantly trying to be the first at something and out-innovating others. Once one automaker does it, then everybody else has to follow, and some-

body else is going to jump above that," he said. "It creates this insane competitive spiral across those 150 brands that forces the whole industry to move at China speed quickly, at getting innovations to market as fast as you can. There is intense competition there that we haven't seen in the rest of the world in a long, long time."

Communication: Fewer boundaries

He said this design-to-production process is helped along by a culture that encourages constant communication and near-constant work. The term "996" comes up frequently. Though Weast says it is not an official state policy, it is accepted that many employees work 9 a.m. to 9 p.m. six days a week. "It is all in office. There's no hybrid, there's no remote, there's none of these kinds of things that that are more common in the rest of the world. It speaks to the intensity and the commitment of the employees to out-compete with their competition."

He said much of business discussions take place in WeChat, an instant-messaging analog of WhatsApp here in the United States. "When you go have dinner or you meet the CEO, you exchange WeChat information. You text directly. There are no boundaries from a communication standpoint, negotiations happen on WeChat. The expectation is, when you get a message on WeChat, you respond immediately, even if it's 11 p.m. on a Friday night." He said there are few meetings. Issues are resolved in real-time with that instant communication.

Organization: One leader, one product

Weast cited the old joke that you could tear down an American-made vehicle and determine the organizational structure of the company because so many different teams work on individual systems.

Not so in China, he said. "In general, one technical leader is responsible for



Weast said business culture is one reason China has advanced electric cars so far so quickly. It is accepted practice for employees to work 12 hours a day six days a week.



Hendrick Motorsports Director of Technical Partnerships and SAE board member Alba Colón moderated the session with Weast in Detroit.

the entire end-to-end architecture, and all the teams are under that person. So, the powertrain is not a separate powertrain organization from the infotainment, it's the same team. It's one team under one leader with one goal, to build the best vehicle they can." He said it makes it far easier and faster to make trade-offs during the design process.

Those three key areas, he said, are why, in China, a company can bring a car to market in 12 to 18 months rather than the three to four years it can take in the West.

The session was moderated by Alba Colón, director of technical partnerships at Hendrick Motorsports, a member of the SAE International board of directors and VP of automotive. She asked Weast what else American companies could change to compete with China's culture of rapid innovation.

"We've just got to get that [competitive] hunger back ourselves. There's nothing like competition that drives us as companies or as individuals to want to be better," he said.

Chris Clonts

WCX 2025

Nira Dynamics' sensor-free tire pressure tech eyes new opportunities

You can learn a lot from the sensors found in anti-lock braking systems, even if you don't really care about the brakes. **Nira Dynamics**, for example, has been using information gathered from these sensors for almost 20 years and has learned how to interpret the signals in order to better understand what's going on under the car: to determine if a wheel is loose, tire pressure, tread wear and even road conditions.

Nira, based in Sweden, introduced its TPI UX in 2006. Today, the tech meets the FMVSS 138 (U.S.) and R141 (European) safety regulations and is used in over 120 million vehicles globally, including 15 million in the U.S. and around 40% of the vehicles in Europe, including models from **Volkswagen, Audi, Volvo and Honda**. The software-based system collects around two dozen signals – including wheel speed, rolling radiuses, various frequencies – from the ABS to identify tire and road conditions. A similar technology called Sensing Core that uses software installed on the brake ECU was announced by **Sumitomo** at CES 2024.

Without actual pressure sensors, Nira's system relies on the driver telling the car that the tires are correctly inflated when freshly filled up to display the tire pressure percentage, but the other information – road surface details, tire looseness – can flow even without that original baseline. Currently, there is a preference for actual sensors in the tires among U.S. OEMs, but political realities might force them to rethink their stance, Nira's sales and business development manager, Gregory Weber, told SAE Media at WCX 2025.

"All those pressure sensors are going to die," he said. "It's not if they're going to die, it's when. It's usually about four or five years, because the battery is going to wear out, and then you got to



At WCX 2025, Nira Dynamics showed how its road surface alert technology was able to identify road problems in real time in the Detroit area.

buy another one, which is \$100. NHTSA just issued a report on this, especially people with older vehicles, they don't have 100 bucks to throw at that. So

they ignore it. Ours never dies because it's in the anti-lock brakes. So as long as that thing works - and if it doesn't work, you've got bigger problems - it'll work."

What was that about tariffs?

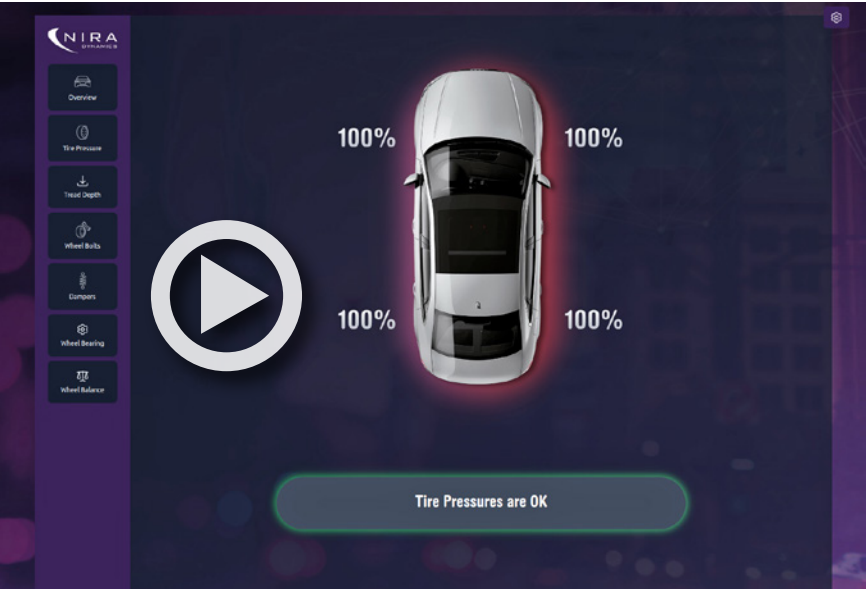
Around 15 million cars are on the road in the U.S. with Nira's tire sensing technology today, but the ongoing political chaos might open up more opportunities. That's because all the hardware required to install actual sensors drives up cost.

"All the hardware, the pressure sensors and all that, we conservatively estimate a \$20-per-vehicle cost saving," Weber said. "And in the automotive industry, if you can save pennies, it's usually a big deal."

That \$20 number might be rapidly changing, too.

"We've solved all the [technical] problems, I think," Weber said. "And what's really cool is it's just software. We get embedded in someone's controller somewhere, and we're good to go. And now it's kind of relevant. We can take away a lot of hardware that's produced in China that is now subject to an extra 25% or whatever the hell it is, 105% today, tariff, and all the logistical problems."

Sebastian Blanco



Nira Dynamics has developed a user-friendly interface to display notifications from its TPMS-free tire pressure indicator UX, which is AUTOSAR compliant and fulfills all current TPMS legislation, the company said.

WCX 2025

Study shows safety top priority of potential vehicle-to-everything consumers

A study released at an SAE World Congress (WCX) Learning Lab indicated that when it comes to vehicle-to-everything (V2X) technology, consumers place far greater priority on safety than on transactions and entertainment. The research was sponsored by SAE International, automotive research hub Mcity at the University of Michigan and Poco Labs. It was completed in December. The findings could influence the future of V2X deployment in three key areas.

Safety features

Safety was the most wanted, frequently cited and most valuable item to consumers. More than half of the survey respondents said safety was their No. 1 priority. For example, road hazard identification topped the list, followed by pedestrian warnings and emergency vehicle notifications. These priorities applied roughly equally across all demographic groups.

Efficiency

Efficiency use cases, such as a vehicle being able to influence the timing of traffic signals and awareness of construction notices, were generally more valued by consumers than the transaction use cases frequently cited by OEMs.

Traffic signal timing was of most interest to respondents living in the suburbs. Collaborative driving, how-



Thomas Pavlak,
Poco Labs founder
and president.

ever, appealed more to urban dwellers and early adopters, who tend to drive more highway.

Transactions

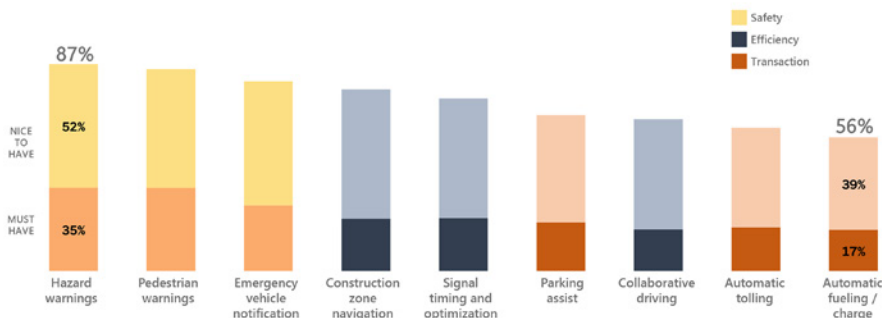
The least-desired V2X features surrounded transactions, such as automatic parking locator and payment and auto pay at gas stations. There was interest among younger drivers and early tech adopters. EV owners also showed intense interest in auto pay at charging stations, pointing to a market of possible revenue growth for that kind of transaction support.

SAE Media spoke with Thomas Pavlak, founder and president of Poco Labs, ahead of his presentation. He said that while transactions were low priorities in the minds of consumers, other developments, such as wide adoption of V2X safety tech, might change their perceptions. "Safety is the foundational pillar of a lot of other experiences that can actually be monetized," he said, adding that it's widely known that OEMs want more revenue streams from the vehicles they sell.

He said that after this report, two natural areas in which to do more research are how much people would pay for various features, as well as regional differences in people's attitudes toward V2x technologies. "A driver in Peoria is going to have a different set of needs than a driver in Los Angeles," he said.

Pavlak said that at least one area was a hard "no" from consumers, and that was the possibility of V2X tech detecting construction zones and taking control of the car from the driver, even if it meant increased safety. People were loving the idea of construction zone help, but stopped short of saying 'yes, take over my car,' " he said.

Q: how interested would you be in having this feature on your next vehicle?

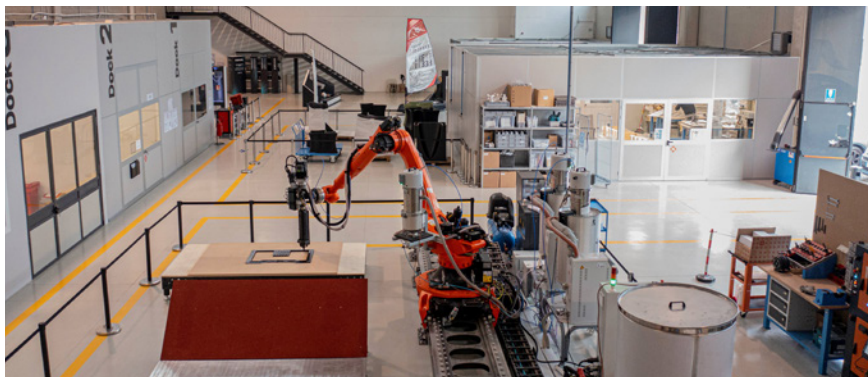


An overall look at consumers' priorities in various V2X use case categories.

Chris Clonts

MANUFACTURING

The transformative power of large-format additive manufacturing for automotive



The Caracol Production Center in Barlassina, Italy.

In the dynamic landscape of automotive manufacturing, innovation has focused mostly on delivering greater efficiency, automation, sustainability and flexibility. An innovation contributing to this transformation is large-format additive manufacturing (LFAM), which promises to revolutionize vehicle prototyping, manufacturing and customization. There are five advantages and five primary applications of LFAM within the automotive industry.

Advantages of LFAM for automotive manufacturing:

Scale and size capability: LFAM enables the creation of large-scale automotive components that were challenging to produce using traditional methods. Industrial LFAM technology can produce large-scale monolithic automotive components starting from 1m³, including complex geometries. The platform can 3D print automotive parts on a scale that can go beyond 10 to 15

meters in length as a single, monolithic piece. This eliminates the need for part assemblies, reducing manual operations and lead times while enhancing performance by minimizing weak points.

Speed and efficiency: LFAM significantly accelerates the production cycle and overall project lead times, cutting lead times by 50% to 70%, on average. By directly translating digital designs into physical parts – without the need for multiple assembly steps, molds, or tooling – manufacturers can rapidly iterate prototypes and produce final parts in a matter of hours, compared to the weeks sometimes required in conventional manufacturing.

Cost-effectiveness: LFAM technology often requires a large initial capital equipment investment compared to traditional manufacturing machines. Over time, it guarantees increased efficiencies by reducing material used and waste, tooling requirements and

streamlined production workflows contributing to lower operational costs. There are also initial investments needed for training to build the required knowledge on process and engineering for these technologies, changing the approach to traditional engineering.

LFAM, particularly robotic LFAM, enables the creation of intricate geometries and designs that are otherwise difficult or impossible to produce with traditional methods. This flexibility allows automotive engineers to optimize parts for strength, weight reduction, and performance while also reducing material usage and waste.

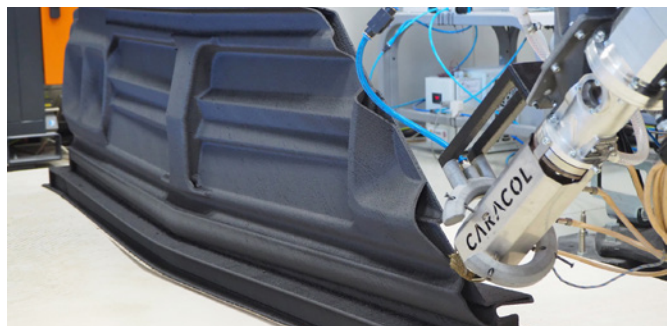
Material variety: LFAM supports manufacturing with a wide range of materials for automotive applications, including high-performance polymers, composites and several metals. This versatility enables the production of functional mock-ups, tools, jigs and fixtures, as well as end-use parts.

Five LFAM applications in the automotive industry:

Prototyping and tooling: LFAM expedites the prototyping phase, allowing automotive engineers to quickly test and refine designs before committing to costly tooling. Additionally, LFAM produces durable, customized composite tooling such as jigs, fixtures, autoclave cure tools and molds, enhancing manufacturing efficiency.

Customized components: Automotive manufacturers increasingly use LFAM to produce bespoke and low-volume parts tailored to customer preferences. This personalization extends beyond aesthetics to functional components, such as lightweight brackets and interior trim.

Exterior and interior finished parts: LFAM is employed in manufacturing large and precise body parts and custom components like body panels, bumpers and fenders and custom car interiors. By leveraging lightweight materials and optimized designs, automakers can achieve extreme customization, superior strength-to-weight ratios, enhancing



Heron AM is Caracol's integrated and modular all-in-one 3D-printing platform.



Caracol LFAM systems can print a wide range of high-performing polymers and composites.

vehicle performance and fuel efficiency.

Spare parts production: LFAM enables on-demand production of legacy or discontinued automotive parts. This enables automotive manufacturers to significantly reduce inventory costs associated with maintaining a vast stockpile of spare parts and ensures timely availability for customers through enabling localized, on-demand production.

Innovative vehicle concepts: LFAM opens avenues for revolutionary vehicle designs, including electric and autonomous vehicles. Its ability to fabricate complex shapes and integrate functional features directly into components facilitates the realization of next-generation automotive concepts.

Large-format additive manufacturing represents a paradigm shift in automotive manufacturing, offering unmatched design freedom, production agility, and material versatility. As automakers strive for sustainable practices and accelerated innovation cycles, LFAM emerges as a transformative technology poised to shape the future of mobility.

By harnessing the full potential of LFAM, automotive manufacturers can expedite time-to-market, reduce costs, and unlock unprecedented opportunities for vehicle design and performance. Robotic LFAM platforms can be used to realize automotive composites applications, including autoclave tools, functional and aesthetic mock-ups, car's prototypes and customized finished parts.

Mattia De Santis

WCX 2025

Vicor's new power modules arrive with 48V

The Vicor BCM6135 offers 2.5kW of power and weighs 65 grams (0.14 lbs).



As the automotive industry debates the merits of a 48V power network compared to keeping legacy 12V power networks, Vicor presented some of its newest high-power-density DC-DC converter power modules at the SAE World Congress Experience (WCX) 2025 in Detroit in April. The company said these new power modules offer a modular solution for automakers considering converting their high-voltage battery voltages direct-to-load (48V and 12V).

That was also the topic of a presentation given by Vicor's automotive principal field application engineer for North America, Patrick Kowalyk, titled "Optimize High Voltage to SELV Performance While Eliminating a 48V Battery and Super Caps." The session explained "how bi-directional, high power density DC-DC converter power modules, using soft switching topology at frequencies > 1.4 MHz, can downsize the power delivery network, enhance efficiency and improve overall system performance."

In March, Vicor expanded its DCM37xx series of regulated 48V-to-12V DC-DC converters. These high-density modules, called DCM3717 and DCM3735, range in power levels from 750W to 2kW. Vicor said the modules have a power density of 5kW/in³ and can be installed in an array configuration of up to four units.

They have an input range of between 40 and 60VDC, a trimmable output range of between 10.0 and 12.5VDC and PMBus-compatible telemetry.

Vicor originally released the DCM3735 in October 2024, one of three automotive-grade power modules for 48V electric vehicle systems Vicor released at the time. These modules can be arranged in over 300 configurations, which allows automotive engineers new ways to reduce a power system's size and weight, and will be used in automotive OEM and Tier One production in 2025. All three of the modules – BCM6135 and PRM3735 in addition to DCM3735 – use AEC-Q100 certified Vicor-designed ICs and have completed the Production Part Approval Process (PPAP) with automotive customers, the company said.

"Vicor has set a new standard for power density in the automotive industry with these scalable and flexible miniature power modules," said Patrick Wadden, VP of the Vicor Automotive business unit. Our power modules make it easy to convert from the primary battery (800V or 400V) to 48V and down to load. They are very versatile, and our customers are using the modules to improve efficiency while also removing size and weight from their power systems."

Sebastian Blanco

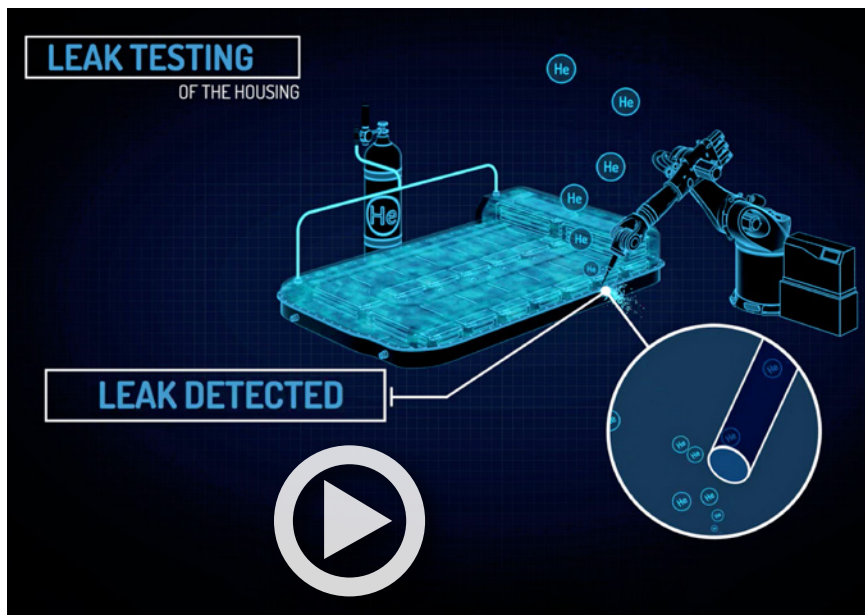
SAFETY

SAE J3277 covers leak testing for every EV battery

North American EV battery manufacturers currently do not test 100% of the cells they assemble into Rechargeable Energy Storage Systems (RESS, or battery packs) for electrolyte leakage. This can lead to missed defects, high warranty costs and reputational damage. Until SAE J3277_202404 described an evaluation methodology to ensure battery pack integrity, there were also no standards for leak testing of assembled battery packs.

SAE Battery Standards Testing Committee sponsor Hemi Sagi of Advanced Test Concepts wrote recently that hurricanes Ian and Idalia “demonstrated that current EVs aren’t well protected against water ingress into the battery pack.” Various manufacturer’s vehicles, an estimated 3,000-5-000 EVs, experienced water ingress and approximately 600 EVs were a total loss. Of those, an estimated 36 EVs experienced thermal run-down (fire).

“Every battery cell, prior to assembly into a module and again after module fabrication, should be leak tested to prevent water vapor ingress,” said Thomas Parker, **INFICON** automotive sales manager and committee member, told SAE Media. “Cells and modules require testing at multiple stages, and once assembled into a completed battery pack, that pack should be tested to



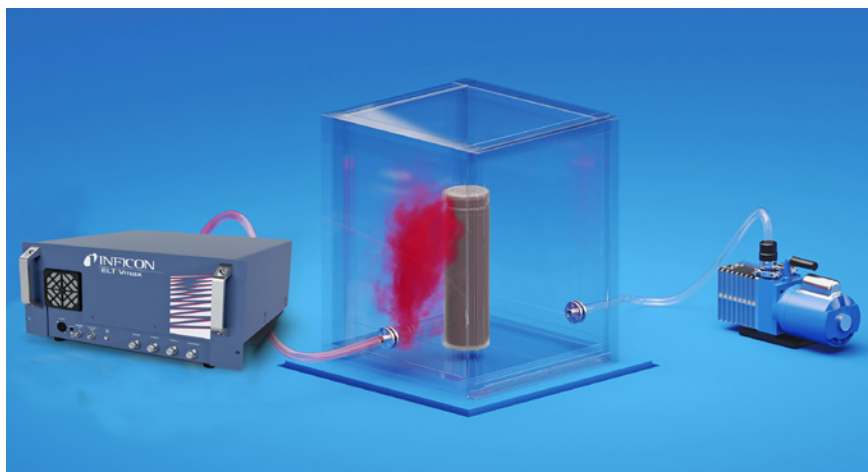
Robotic sniffer leak detection swiftly and accurately detects leaks in completed battery packs. The internal cooling circuit may be tested prior to or after pack lids are attached.

prevent liquid water ingress. Before attaching the lid to the battery pack, the internal glycol cooling circuits should be leak tested to a level that prevents that cooling liquid from leaking into the pack from the inside. Leak testing to the correct levels is critical to the battery performance and safety.”

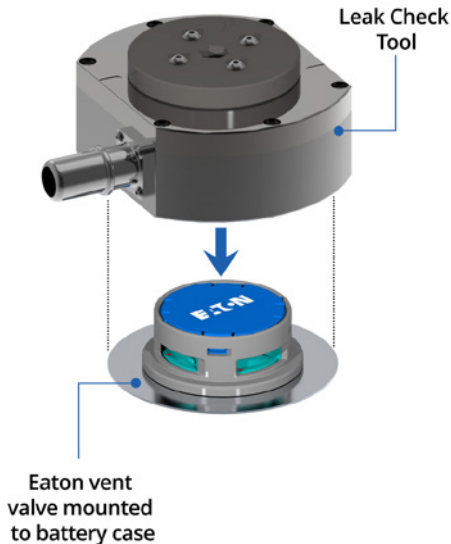
J3277 lists methods for leak testing every RESS to ensure that liquid water ingress prevention meets standards. It also suggests both water ingress test(s) and coolant ingress tests. Testing typically uses a test gas, helium or forming gas, as leak tightness specifications like IP67 – 30 minutes under 1 m (3.2 ft) of water – would be unworkable.

Currently, assembled RESS/battery packs are pressurized with test gas, and a robotic sniffer probe checks for leaks. Cooling circuits may be tested by pressure decay methods or with a test gas. While this ensures that battery packs are leak-free at the time of testing, pack integrity alone may not provide optimum safety as each metal-ion cell preferred for EV propulsion must be leak-free to prevent liquid or atmospheric moisture from causing dangerous degradation. SAE is currently evolving a new standard for cell package integrity and testing, J3337, to address cell-level electrolyte leakage.

The Work in Progress J3337 applies to lithium-ion (Li-Ion) and sodium-ion



When testing individual cells, cells are placed into a vacuum chamber, and a vacuum is established. Any leaking electrolyte can then be detected (the red cloud represents the escaping electrolyte).



Eaton said its new 3-in-1 battery vent valve is the first on the market to align with the new SAE J3277 standard, which is designed to evaluate non-destructive water intrusion testing.

(Na-Ion) cells regardless of construction and describes non-destructive testing, typically requiring a vacuum chamber(s) and spectrophotometer to search for any volatiles linked to the electrolyte. Using test gas also negates any material concern. For instance, there are significant differences in the leak rate, from $2.9E-6$ mbar $\cdot$ l/s for aluminum to $4.8E-3$ mbar $\cdot$ l/s for steel due to their different wetting properties (contact angles). Today, testing individual cells to the 10^{-6} mbar l/s range through the detection of escaping ethylene glycol is easily accomplished at full production-line speeds.

In March, Eaton announced a new 3-in-1 battery vent valve that would be the first to meet the new standard. The valve integrates passive and active venting, a battery case leak-check mechanism and a way to reseal the pack with a lower opening pressure. The new valve allows the battery to relieve pressure in an attempt to prevent catastrophic thermal runaway scenarios and allows engineers to conduct high-precision, non-destructive leak testing during production, Eaton said.

Thom Cannell

WCX 2025

GM's Hydrotec-based EV charger takes center stage



GM's mobile hydrogen power generation system was on display in Hall D at Huntington Place in Detroit during WCX 2025

In 2022, **General Motors** announced that it was exploring commercial applications for its Hydrotec hydrogen fuel cells. Those efforts have culminated in a mobile hydrogen power generation system that was on display at SAE WCX 2025 in Detroit.

The system was developed over the past year and consists of a pair of Hydrotec fuel cells providing 150 kW of DC power capable of DC fast charging up to two EV's simultaneously. The unit can run continuously when connected to a dedicated external hydrogen supply or in remote applications thanks to a built-in hydrogen storage system with up to 40 kg/700 bar of H₂. The total weight of the unit is approximately 10,000 lbs. (4,535 kg).

GM states that the unit can operate in temperatures ranging from -30°-55° C (-22°-131° F). There are about 30 units currently in the field being used for various tasks. GM themselves had a unit on hand at the 12 Hours of Sebring in March to supply onsite charging for a fleet of Cadillac EVs used for ride and drives.

"It's been a hard push with our team to get these from concept to the prototype

phase," said James Boswell III, Product Engineering for GM. "Between building the first unit from ground up and starting to develop them, it's been a challenge, but it's also been a lot of fun. We've got a great team that enabled us to bring all this technology to market and build this unit."

According to Boswell, the power generation system has found numerous commercial applications such as fire relief and mobile charging in locations where EV infrastructure is sparse. "One of the big drivers for this unit was originally for EV assembly plants," said Boswell. "EV plants don't necessarily have the infrastructure to charge. These can be placed onsite to alleviate that issue. We can bring these anywhere that needs supplemental charging."

The concept is also expandable according to Boswell. "We could expand the unit to carry maybe four cubes with additional DC fast chargers. The technology there and so is the capability. The payoff is that this whole idea is scalable to basically any size we want depending on what a customer needs."

Matt Wolfe

WCX 2025

Dumarey launches U.S. subsidiary for better ICEs

The **Dumarey Group** used WCX 2025 as the launching point for its new U.S. subsidiary, Dumarey USA. Dumarey, a Belgian family-owned company, announced the acquisition of Mahle Powertrain LLC in January and said in Detroit that the transition to Dumarey's new North American engineering and testing hub is now complete.

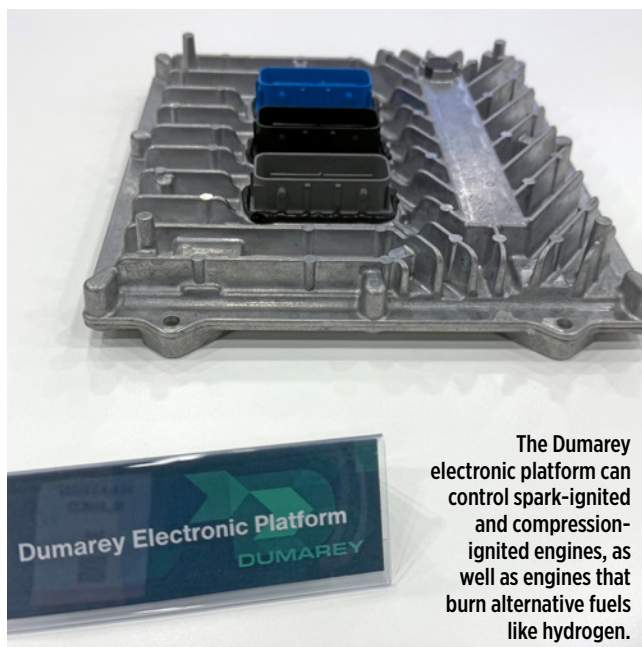
Expanding its North American footprint is the latest way the Dumarey Group is focusing on its main mission: preparing internal combustion engines for their last hurrah. In early 2024, for example, Dumarey acquired Vitesco Technologies Italy because of its experience with various injectors, bringing more injector engineers and product teams on board. The previous Vitesco plants are now producing gasoline urea injectors for Dumarey and, in the future, they will build injectors for hydrogen engines, according to Vincenzo De Carlo, Dumarey senior program manager and chief engineer. It's all part of the plan, even Dumarey isn't betting everything on H2.

"The target is to create what our boss is calling 'the product,'" De Carlo told SAE Media at WCX. "In his mind, the product is a final engine. All the acquisitions we are doing are linked with the product. In this moment, the main product is the hydrogen engine and, later, the fuel cell. The acquisition of Vitesco was to develop a hydrogen injector. The acquisition of Dumarey USA was to develop in the U.S. this kind of mentality. In general, we are working on all kinds of eFuels in general. Methanol, ammonia, hydrogen, whatever is coming, we are in a development phase for all of it."

De Carlo said Dumarey's target is to be producing nitrogen injectors by 2030, but that's only part of the challenge.



Dumarey's 250-kW, hydrogen V8 6.6-L port fuel injection engine at WCX 2025.



The Dumarey electronic platform can control spark-ignited and compression-ignited engines, as well as engines that burn alternative fuels like hydrogen.

"It was difficult to develop the software that would allow us to manage all the different fuels because each different fuel has to be driven by specific software," De Carlo said.

For example, when used with hydrogen, the injectors need to deliver H2 at low pressure, not more than 40 bar, De Carlo said. That's less pressure than gasoline injectors use and much less than the fuel storage tank. "The starting point is the 700 bar in the tank and then we reduce this in the line to achieve 40 bar, not more, because this is the market request," he said.

At WCX, Dumarey displayed its 250-kW, hydrogen V8 6.6-L port fuel injection engine alongside next-generation hydrocarbon injectors and liquid-cooled heavy-duty urea injectors that have been developed to address new EU7 emissions regulations. The Dumarey electronic platform, for example, is a scalable, multi-purpose 12-24V-capable controller for spark or compression ICEs as well as for alternative fuels like hydrogen.

Sebastian Blanco

BOTH IMAGES: SEBASTIAN BLANCO

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ALL (ROBOT) HANDS ON DECK



An example of one of the processes of aluminum going into the sand mold at BMW's electric engine housing production facility in Landshut, Germany.

BMW leverages advanced manufacturing, AI and machine learning to build the next generation of EVs — and vehicles of all powertrains.

by Abigail Bassett

For more than 100 years, **BMW** has been manufacturing vehicles in the heart of downtown Munich at a three-story plant that currently produces 1,000 cars a day. At the same time, the plant is in a state of being both torn down and completely rebuilt and retrofitted — to the tune of a \$4.3-million investment — to make way for the electrified future the company says it is deeply committed to.

To stay this course, in a time when there are increasing headwinds against electrification and EVs, particularly in the large U.S. market, BMW has had to continually retool, rethink, and reinvest in its manufacturing processes and leverage technology like advanced robotics, AI and machine learning, to build everything from internal combustion vehicles to hybrid, plug-in hybrid, and EV models on the same production line. The underlying philosophy of this approach, BMW says, is that it offers customers the choice of a wide variety of powertrains across the entire model lineup — from **Rolls Royce** to **Mini** — which will be key to the company's success for the next 100 years.

BMW calls this their “technology open” approach, and it's taken massive investment. The company has spent multiple billions of dollars upgrading its manufacturing plants around the world to integrate new manufacturing techniques. The company has leveraged everything from AI and machine learning and vision to clean-room techniques borrowed from the chip and tech manufacturing sector, and in-house tech development and innovation. The engineers faced a slew of challenges, from creating their own batteries to building the “Energy Master” with its “Heart of Joy” computer systems that control everything from power

management to ride and handling of future electric BMWs (and the company's sub-brands).

In mid-February, BMW invited media to see some of the early production results of those investment billions. First, at its Battery Manufacturing Competence Center (BMCC) in Parsdorf, Germany, the company showed off its bespoke battery chemistry and manufacturing method for its Gen6 battery pack, which will underpin the upcoming Neue Klasse platform that all future BMW EVs will be built on.

The company says the new chemistry and cylindrical design will offer improved battery efficiency, more range, more energy density, and faster 800-volt architecture. BMW says that the new chemistry and cylindrical batteries provide 30% more range, 30% faster charging, and 20% more energy density. The company also says that the new chemistry can recoup up to 300 km (186 miles) of range in just 10 minutes on a DC fast charger. BMW also said its in-house-developed batteries are 50% cheaper to build. The design will be shared with BMW's partners, **EVE Energy** and **CATL** in China, for manufacturing and will underpin the upcoming Neue Klasse vehicles that BMW plans to roll out globally starting late this year, beginning with the electric iX3. Neue Klasse is BMW's new electric platform that will underpin all future BMW EVs.

TOM KIRKPATRICK PHOTOGRAPHY/BMW



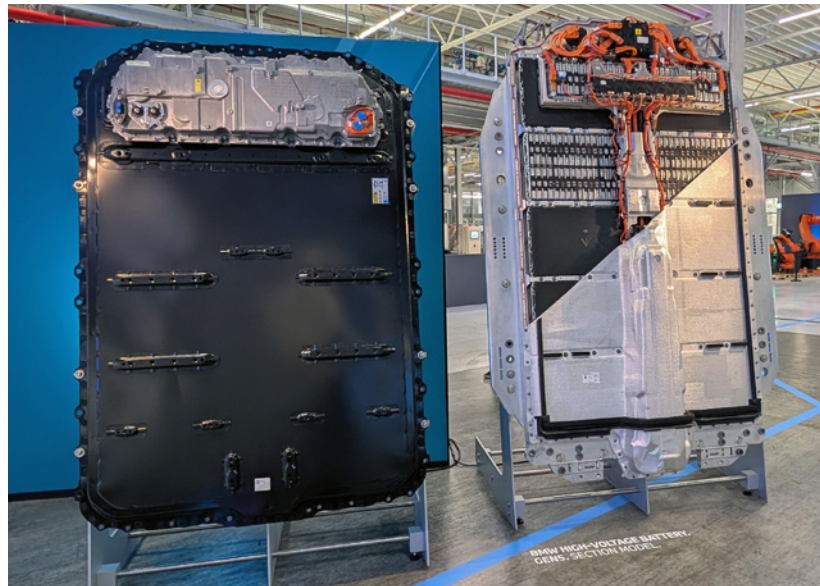
Each Energy Master includes a control unit, a relay box with 800v/400v actuators, cooling and an on-board power supply.

To manage the new battery pack, BMW once again decided to rely on its in-house technological know-how to develop a brand new “Energy Master,” a pent-house that sits on top of the Gen6 battery and handles everything from the high-voltage vehicle and drive-train systems (themselves controlled by BMW’s new “Heart of Joy” ECU, also developed completely in-house) to the low-voltage systems in the upcoming Neue Klasse vehicles.

Each Energy Master includes a control unit, a relay box with 800v/400v actuators, cooling and an on-board power supply. These are assembled and made at a plant in Landshut, Germany, about an hour from Munich, then shipped to plants around the world, including South Carolina, where most of the X3s are built. The manufacturing line in Landshut largely resembles something you’d see in Silicon Valley: a windowless warehouse populated by more robots than humans, working in wholly dust-free and clean environments.

In this space, BMW has leveraged everything from AI and high-tech robotics to machine vision and learning and flexible manufacturing lines to create these new battery controllers. The Energy Master parts are delivered and put into the line by a combination of human employees and robots, then assembled by 400 advanced **Kuka** robotic arms within the clean room. Cameras and AI track everything, down to the tiniest screws, to ensure there are no errors. All that digitized information is stored in a cloud-based manufacturing warehouse to detect anomalies before issues arise.

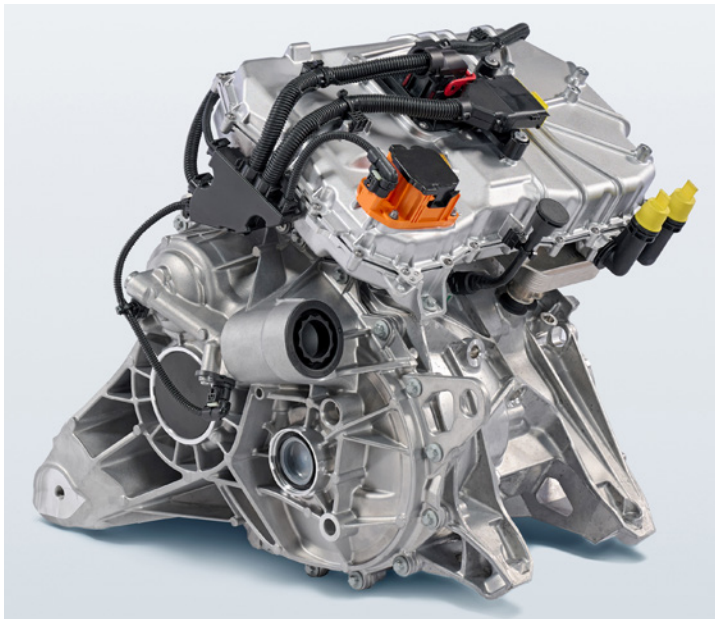
Once the robots seal the Energy Master, it passes out of the clean room and into a location where humans plug in the remaining wiring harnesses to complete



Comparison of BMW’s older Gen5 battery pack (right) next to the new Gen6 battery pack at a Tech Day Event in Germany.

the build. Then, the Energy Master is transferred to the final quality control, where human technicians use a wide array of technology to check to make sure that all the components function properly.

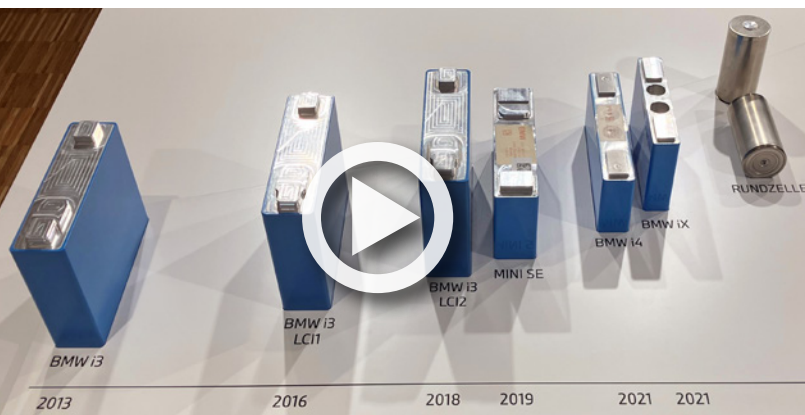
While robots are great at simple assembly and can do everything from welding and fastening screws to precisely tracking and placing small components, the one thing that they fail at is grasping and plugging in fiddly wiring harnesses. It’s one of the only two places where humans touch the Energy Master assembly, but it might not remain human-powered for long.



Updates to BMW's sixth-generation eDrive technology (Gen6) include a 30% faster charging speed and 30% increase in range, with certain models achieving even higher figures.



BMW will build the new Gen6 battery pack, which will underpin the upcoming Neue Klasse platform, at its Battery Manufacturing Competence Center (BMCC) in Parsdorf, Germany.



A display of BMW's battery cells from the past dozen years, including three generations of the prismatic cells in the i3 to today's cylindrical cells.

BMW is experimenting with smaller robotic arms, which are learning (very slowly) how to find and grasp the wires gently and plug them into the Energy Master in the correct orientation using AI, machine vision and learning. Currently, robots are remarkably slower at the process than human technicians, but as these technologies develop, it is likely that these tasks will be outsourced to robots.

BMW is also leveraging machine vision and learning at its Electric Engine Housing Production location next door to the Energy Master plant in Landshut. Here, melted vats of aluminum are poured by robots into freshly made (and reusable) quartz silica sand molds, then cooled, scanned for any faults, and handed off to human inspectors to be sure

that they meet BMW's high standards before being shipped to Steyr, for final assembly.

Computer tomography is used to verify the internal quality, and the company uses a virtual twin of every part they produce so they can slice through the whole part to see the quality and look at spots that they can't see with other technology. According to the company, AI and computer vision are also being leveraged to look at each individual part and ensure that standards are met. The company uses vacuum injector casting to control the temperature of the cast as it goes into the mold, and once the motor, inverter, and stator castings are cool and complete, a human visually examines the parts for anomalies or burrs that need to be taken off in final assembly.

With the advancement of robotics and growing AI implementation, it's safe to expect that BMW's Neue Klasse production will become more automated and rely more heavily on these kinds of advanced technologies. ICE vehicles and EVs are still rolling off the same line, one now largely now powered by robotics, even as the 100-year-old Munich Plant is undergoing renovation. It's clear that the penetration of these technologies into automotive manufacturing is only just beginning. It's an approach that BMW hopes will keep it nimble in the face of growing trade wars, increased pressure to regionalize production, and to stay adaptive to global customers' changing desires as the future of electrification continues to move forward. ■

DRIVING DOWN

the high cost of overspray in automotive paint processes

By designing automated paint systems with superior control behavior, OEMs can improve transfer efficiency and minimize overspray and its heavy costs for automotive companies.

by Christopher Logue

High-performance, pre-engineered and pre-programmed paint control solutions like this robotic paint arm panel from Emerson can ensure consistent, superior quality control for automotive manufacturers and add convenience for OEMs by simplifying sourcing and reducing in-house engineering.



Exterior paint application is an essential process in automobile manufacturing that both protects vehicles and increases aesthetic appeal. Yet, automotive body paint is pricey – and every vehicle requires multiple coats. What's more, based on industry averages, about 30-40% of this paint misses the intended surface and falls to the floor.

This overspray and its steep costs go beyond wasted media. It accumulates on the paint booth floor where it becomes paint sludge (PS), which requires expensive treatment and can affect a manufacturer's environmental impact.

While some overspray is inevitable, it's possible to optimize the automotive paint process in ways that can significantly minimize overspray and its heavy costs while improving application quality. Designing and implementing automotive paint systems that reduce overspray present a lucrative opportunity for automotive manufacturers and substantial cost savings over time.

Calculating the substantial cost of overspray

The media sprayed during automated paint processes is more than just paint. It's also compressed air, otherwise known as shape air. These two elements combine inside a robotic sprayer arm that then releases the mixed me-

dia stream. Overspray occurs when some paint particles are blown into the air rather than onto the surface of the vehicle. This is estimated to cost automotive manufacturers well over \$100 million a year worldwide.

The costs add up in two primary ways: excess material cost and waste treatment.

High-end cars, for instance, require three to four coats of paint, which can total up to \$7,600 per car. If 30-40% of paint becomes waste due to overspray, that's \$2,280 to \$3,040 in media waste per car.

Then, add waste treatment. Overspray results in about 3-5 kg (6.6-11 lbs) of PS per car. PS cannot be landfilled, which means that factories must treat it before disposal. This incurs extra labor and process costs that can vary depending on region. In the United States, for example, it's typically \$300 to \$500 per ton.

There were 85.4 million cars produced globally in 2022. If painting each of these automobiles results in 3 to 5 kg of PS, then paint processes generated approximately 341,000 tons of PS. If it costs \$300 to \$500 per ton on average to treat paint sludge for disposal, then the worldwide total for 2022 can be estimated at about \$136 million. Added to the cost of media waste, it's easy to see that minimizing overspray presents a great cost savings opportunity for automotive manufacturers.

Understanding technical factors that cause overspray

While the need to minimize overspray is evident, the best way to do it may not be. That's why it's important to understand what prevents paint droplets from being directed to and adhering to the intended surface.

DRIVING DOWN

the high cost of overspray in automotive paint processes



With a response time of 80 ms, the Emerson AVENTICS ED07 pressure regulator can respond to compressed air pressure and flow rate changes much faster than conventional proportional valve technologies.



Between material waste and paint sludge treatment, automotive manufacturers have a significant opportunity to reduce costs by minimizing overspray.

When painting automotive exteriors, automotive paint robot arms quickly move around the body to deliver paint. As the arm constantly changes position, the angle of delivery changes too. The paint must be directed toward the surface according to each angle. Otherwise, the paint droplets will miss the vehicle body and instead drift through the air. To direct the most paint toward the vehicle exterior, the atomizers in the arm must spray in a specific pattern according to each angle the paint is delivered.

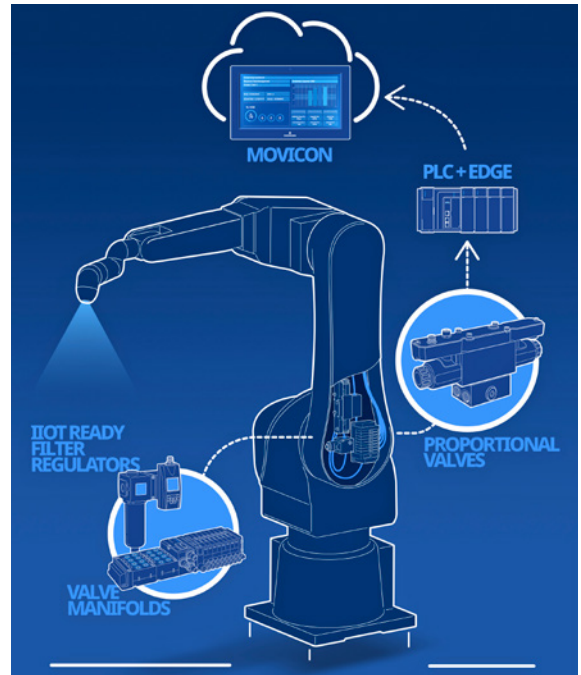
As previously stated, the spray itself is made up of compressed air combined with paint media inside the robotic arm. The flow and pressure of this shape air determine the spray pattern of the media. To achieve the necessary spray pattern each angle requires, proportional technologies in the sprayer arm must quickly change compressed air pressure and flow rates.

Transfer efficiency is the way to measure how efficiently automated paint systems use paint media. It's a ratio that describes how much paint adheres to an intended surface compared to how much paint was sprayed. High transfer efficiency results in a low amount of overspray, while low transfer efficiency results in a high amount of overspray.

The faster proportional technologies can control compressed air pressure and flow rate changes to match the spray pattern to the angle, the higher the transfer efficiency of the robotic arm.

Improving transfer efficiency

In automotive applications, automated paint systems with high transfer efficiency ensure that the paint that is sprayed effectively and coats the desired surface rather than become overspray. This



The Emerson plug-and-play paint arm panel solution includes all automation components, providing hassle-free installation.

minimizes media consumption and waste for automotive manufacturers and reduces their related costs.

To help automotive manufacturers maximize transfer efficiency and minimize overspray during automated paint processes, it's critical that automated paint system OEMs engineer robotic paint arms with highly responsive and consistent proportional technologies.

Most proportional technologies used in robotic paint arms have a reaction time of 130-150 milliseconds. However, there are now direct-acting pressure regulators with a response time of 80 ms. This higher level of sensitivity can respond to necessary compressed air pressure and flow rate changes significantly faster than conventional proportional valve technologies as robotic arms move around vehicle bodies.

What makes this level of shape air control possible is the regulator. It has double solenoid coils on both sides and is programmed with software that features a self-adapting control algorithm. The valve can directly connect to flow sensors that calculate the exact flow and pressure data that is coming through the valve. Using a self-adapting algorithm, the valve can immediately adjust. This closed feedback loop between the valve and sensors shortens the path that sensor data must travel, skipping the robot controllers altogether.

This closed feedback loop and level of responsiveness mean that paint robots equipped with these regulators are significantly more efficient at changing



Christopher Logue has 10 years of industry experience across a variety of disciplines, businesses and world regions within Emerson. He currently leads global business development activities for the Emerson Factory Automation and Transportation industries.

spray patterns to deliver the precise flow and pressure required for the angle of spray. Self-adapting control algorithms make it possible for robotic arms to detect and quickly adjust if flow and pressure rates deviate from what the process requires.

Some suppliers offer the advanced pressure regulator and flow sensors as part of a pre-engineered, pre-programmed panel. In addition to these components, the compact panel also includes a proportional valve for atomizer control and lightweight valve terminal with AES I/O. All components are attached to a metal

plate that machine builders can install inside a robotic arm and simply plug in pneumatic tubing and electrical connections.

By using plug-and-play offerings when manufacturing automated paint systems, OEMs can streamline component sourcing and minimize in-house engineering. This gives OEMs an advantage by speeding up production, getting to market faster and meeting demand.

Achieving superior media control

Whether cars, buses or planes pass through the paint booth, overspray is a challenge that results in multiple and expensive issues. It uses excess media, generates paint sludge that must be treated and results in inefficient processes. Precision automation technology can ensure the accurate application of paint with tight controls on material usage, significantly reducing sludge disposal costs, media costs and environmental impact while improving the quality of paint finishes.

By designing automated paint systems and robotic arms with superior control behavior, OEMs can help automotive manufacturers optimize paint processes and minimize overspray. Equipped with highly responsive and consistent proportional technologies, robots can monitor and adjust the paint process in real time, ensuring optimal material usage from start to finish. ■

Christopher Logue is global director of Business Development, Factory Automation and Transportation Industries at Emerson.

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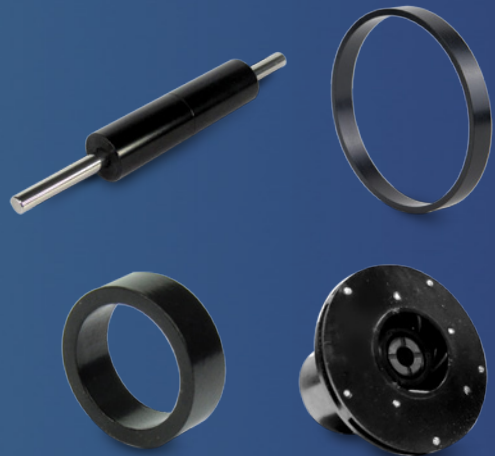
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EV battery tech advancements and facility coatings selection



Future EV battery manufacturing facilities may require more stringent cleanroom environments, stronger chemical resistance for facility floors and walls or modular designs that allow production lines to adapt to new chemistries quickly.

New battery chemistries and the rise of automated guided vehicles in EV battery plants will redefine what's expected from floor and wall coatings.

by Kristin Meyers

Over the last five years, the EV industry has undergone a dramatic transformation driven by consumer demand, ambitious OEM production targets and significant public and private investment. In response, battery manufacturing facilities have evolved from rebuilt legacy plants into purpose-built manufacturing facilities designed for scale, speed, and precision. These modern facilities no longer resemble the assembly lines of OEMs of the past. Instead, they are highly controlled environments optimized for automation, environmental control, new chemicals and materials and particulate-free clean manufacturing processes.

With the rise of next-generation battery formats such as solid-state, lithium-sulfur and lithium iron phosphate (LFP) chemistries, facility requirements have changed. These technologies often require tighter environmental controls, cleaner production condi-

tions, and more robust safety measures, all of which place new demands on facility flooring, walls, ceilings and roofs.

Now, more than ever, it's important for owners to select the right high-performance coatings that can meet the complex demands of EV battery manufacturing.

Battery chemistries and cell designs drive coatings choice

As EVs continue to gain market share, automakers are under pressure to improve performance, extend range, and reduce costs to remain competitive. That push has driven a wave of innovation in battery technologies, with researchers and manufacturers exploring new chemistries that can unlock greater energy density, faster charging, and better overall efficiency. To keep up with growing consumer expectations and to meet sustainability and supply chain goals, advanced chemistries like solid-state, lithium-sulfur, lithium-iron phosphate, and sodium-ion are being actively developed and tested.



Sherwin-Williams expects to move into its new research and development center in Brecksville, Ohio, sometime in 2025. Chemists, engineers, technicians and support teams will work in the center, part of company's Building Our Future project.

Before we dive any deeper, let's take a look at some of the key differences with these new battery chemistries.

- **Solid-state batteries:** These replace the traditional liquid electrolyte with a solid one, offering the potential for higher energy density, improved safety, and faster charging.
- **Lithium-sulfur batteries:** These are appealing due to their lightweight nature and ability to store more energy by weight than traditional lithium-ion, though they still face challenges around longevity and stability.
- **Lithium-iron phosphate batteries:** These are generally known for their longer cycle life and thermal stability, while using more widely available materials that make them more cost-effective without sacrificing safety.
- **Sodium-ion batteries:** On the opposite end of the spectrum, sodium-ion batteries are gaining attention for their potential to reduce reliance on critical minerals like lithium and cobalt, making them attractive for markets focused on low cost and raw material availability.

While nickel manganese cobalt (NMC) and nickel cobalt aluminum (NCA) are the most prominent chemistries used in EVs today due to their high energy densities, each of these emerging battery chemistries brings unique benefits and can help meet and even exceed the growing demands of the industry and consumers.

In addition to the battery chemistry, the rise of automated guided vehicles (AGVs), AMRs and other robotic systems built for speed and volume in EV battery plants will also redefine what's expected from floor and wall coatings. These machines move along repetitive paths in cleanrooms and formation areas, creating concentrated wear zones that can quickly degrade unprotected flooring. Impact-resistant, abrasion-tough coatings are required to handle constant traffic without creating dust or debris that could interfere with cell production.

Future EV battery manufacturing facilities may require more stringent cleanroom environments, stronger chemical resistance for facility floors and walls or modular designs that allow production lines to adapt to new chemistries quickly. For example, solid-state batteries may require tighter environmental controls, while lithium-sulfur batteries may introduce new solvents and chemical byproducts that

challenge conventional protective coatings. In addition, as manufacturing becomes more automated and precise, coatings must be equally advanced and engineered not only to protect but to perform as part of the facility's critical systems.

These facilities will continue to produce and use new chemistries, making it critical to have flexible coatings that can handle them now and the potentially more complex chemistries of the future. By factoring these emerging technologies into today's facility planning and materials specifications, owners and general contractors can ensure their operations are future-ready and can scale with innovation rather than be limited by it.

Building smarter: the role of modular construction

With tight timelines and complex project scopes, many EV battery facility owners and general contractors are turning to modular and offsite construction to streamline delivery. Cleanrooms, utility zones, and pre-coated steel assemblies can be manufactured offsite and arrive ready for installation.

This shift to modern shop-applied coatings processes brings clear advantages. High-performance coatings applied in controlled environments allow for consistent application and faster cure times as they remove common obstacles like weather from the process. This reduces the risk of project schedule delays caused by temperature, humidity or coordination conflicts during construction which, according to a recent research survey commissioned by Sherwin-Williams, are one of the primary drivers of construction delays based on responses from industry leaders.

With shop application, owners benefit from higher

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EV battery tech advancements and facility coatings selection

ADVANCED MATERIALS FEATURE



Kristin Meyers is the market segment manager, EV battery and automotive facilities, for Sherwin-Williams Protective & Marine division. Meyers holds a bachelor's degree from Cleveland State University and has completed executive management certifications and MBA coursework at the Weatherhead School of Management at Case Western Reserve University and John Carroll University.

quality assurance, fewer job site bottlenecks and safer conditions, especially in the critical process of structural steel, flooring, and wall system installation.

Where coatings matter most in an EV battery plan

Too often, coatings are seen as a final protective layer, something added at the end to make floors, walls or steel look clean and finished. But in advanced EV battery manufacturing facilities, high-performance coatings are a functional part of the facility itself.

Like automation equipment, production lines and HVAC systems, coatings directly impact how a facility performs. They help maintain cleanroom integrity, reduce static discharge risk, protect against chemical spills and even contribute to fire safety. Some of the most critical areas of a manufacturing facility include:

- **Battery formation areas:** Need chemical resistant high-performance flooring that withstands exposure to corrosive electrolyte solutions.
- **Cleanrooms:** Use conductive or ESD flooring systems to prevent electrostatic discharge that could negatively impact sensitive battery components.
- **Dry rooms:** Require seamless, moisture-resistant, high-performance coatings to maintain low humidity levels.
- **Manufacturing and assembly lines:** Depend on durable, high-performance coatings with increased durability that resist impact and wear from automated systems.
- **Logistics and warehouse areas:** Require impact-resistant, anti-slip coatings to keep automated material handling systems moving efficiently and safely.

High-performance coatings aligned with EV industry demands

Each section of a facility should have high-performance coatings designed for the unique challenges that that area presents. If not, owners run the risk of

increased project delays and suboptimal plant production efficiency. High-performance coatings help remove some of these roadblocks, with solutions that meet the unique needs of gigafactories. These might include:

- Advanced ESD and conductive coatings for cleanrooms and electronics-sensitive areas.
- Chemical resistant systems tested against common solvents like N-Methyl-2-pyrrolidone (NMP).
- High-performance coatings with fast curing properties to support offsite modular construction timelines.
- Fireproofing coatings that combine safety and efficiency through shop application.
- Anti-slip, impact resistant high-performance flooring for logistics and worker-heavy zones.

Whether applied in a controlled shop environment or on the construction site, these systems are engineered to keep modern gigafactories safe, clean, and efficient. In environments where uptime, product yield and safety are critical, the right coatings can mean the difference between a facility that runs efficiently and one that doesn't. When viewed as part of the operational system, coatings become more than just protection. They are part of the infrastructure that keeps production on track.

Future-proofing starts with the right specs

That preparation starts with selecting materials that are proven, flexible, and built to withstand the specific demands of battery production. High-performance coatings aren't just a finishing touch, they're a critical part of making facilities safer, faster, and simpler.

EV battery manufacturing will continue to evolve. New chemistries, automation technologies, and modular construction will raise the bar for performance, and facility owners must be ready. ■

Kristin Meyers is the market segment manager, EV battery and automotive facilities, for Sherwin-Williams Protective & Marine division.

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Stellantis design chief Gilles: What's wrong with diversity?

Gilles is one of the most recognizable designers in the automotive world. Respected for vehicles that include the iconic Chrysler 300 and for his longevity with the company (he has reported to 12 different CEOs), he casts a long shadow in a notoriously fickle industry.

At a WCX 2025 keynote presentation, past president of SAE Carla Bailo asked Gilles about his MBA, diversity and AI, among other things. The following are excerpts from that presentation.

Bailo: You're part of the Stellantis Global Diversity Council in the U.S. but now there's this big push to move away from DEI. How do we look at really balancing diversity in people, in thought, in the workplace, without being so over-riding?

Gilles: I never saw this coming. I didn't realize diversity was a bad thing. When you break down diversity, inclusion and equity, those are all good words. It's how you implement them. I think number one is competence. Competence should be over everything. If they're competent, giving a stepping stone is always a good thing. And I wonder sometimes: I go back when I was hired in 1992 by **Chrysler**. Was I a DEI hire? I knew full well my portfolio held up with anyone on the team, so it never came across my mind.

However, I could see that people tend to like people that look like themselves. It's just human nature to hire people like you, promote people like you. So, sometimes you just have to say, hey, wait a second. Let me consider that person. And that's what we've always been saying, by the way, just take a look at it. It doesn't mean you have to. We've never had a quota. I don't believe in quotas. It's more opening up your mind. But half of it's just mixing in with each other, then going to visit different colleges, not going to the same [one to recruit] all the time, and that's it. When you look at the fabric of America, your company should reflect that. That's just good business, right? You should reflect the market that you sell to. It's not rocket science.

Bailo: What led you to pursue your MBA [from Michigan State University]? How has it helped you?

Gilles: Chrysler had a fantastic Executive MBA Program, which I'm sure a lot of companies do. And I put my name up. I was one of the first designers to do that, after my mentor and one of my favorite people all time, Tom Gayle, who's also a designer, engineer and businessman. So, I asked what he'd think if I joined the program? He said, Oh, we're excited. Best thing I ever did. I learned so much.

Everything that was Greek is now English. I was able to sit in some pretty big meetings and understand what engineers were saying, what they needed. But bigger than that is understanding the global economics, really macro to micro, really understanding how literally, one drop can have ripples. So, it allowed better decisions, and it allowed me to really get consensus much faster, and we've been able to get some really cool stuff by trading. Design is constantly trading, trading costs for another thing that you may want to do.

Bailo: What about interior and exterior design? Have we gone as far as we can go?

Gilles: When you look at a typical SUV, we all have the same crash requirements. Their dynamics are very stringent. The crash racks are the same. For us designers, it's really tough, especially a company like us, where we have a platform that's feeding 20 different nameplates, trying to make sure people don't notice that the [same] platform is underneath all those squares, and give it our character, give it presence.

Whether you love it or hate it, [the **Tesla Cybertruck**] is a breakthrough. And I would give **Kia** some credit. They're trying everything right now. If you look at **Kia** design, they're going this way, that way, this way, trying to find the formula.

If you have a good brand. You don't necessarily have to mutate the car to the point of unrecognizability.

Chris Clonts



Stellantis design chief Ralph Gilles at WCX 2025 in Detroit.

“We’ve never had a quota. I don’t believe in quotas. It’s more opening up your mind.”

WEBINARS

ADVANCING AUTOMOTIVE MANUFACTURING WITH DIGITAL TWINS

Tuesday, May 20, 2025 at 12:00 pm U.S. EDT

Digital twins (DTs) are already enhancing the way automobiles are built. Artificial intelligence (AI) and machine learning (ML) improve product testing, worker training generally includes digital components, and vehicle designs can be made more efficient and aerodynamic through simulation. This 60-minute webinar from the editors of *Automotive Engineering* will discuss the various ways DT technology is impacting automotive manufacturing today and how it will impact tomorrow.

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HOW SIMULATION IS REVOLUTIONIZING AUTOMOTIVE DESIGN IN THE SOFTWARE DEFINED VEHICLE ERA

Wednesday, May 28, 2025 at 2:00 pm U.S. EDT

This 30-minute, live webinar recaps the 2025 ZERO Prototypes Summit hosted by VI-grade, held May 13-15, 2025, in Udine, Italy. Leading European OEMs and suppliers convene at this one-of-a-kind Summit to explore and share real-world case studies and breakthrough innovations in simulation-driven vehicle development. This is an opportunity to learn how the world's most innovative automotive minds are driving the shift towards ZERO Prototypes.

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OPTIMIZING ELECTRIC POWERTRAINS: ADVANCED MATERIALS FOR PERFORMANCE, SAFETY, AND EFFICIENCY

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As the transition to electric vehicles progresses, manufacturers continue to face challenges in balancing performance, safety, and lightweighting. This 60-minute webinar explores advanced materials and technologies designed to optimize powertrain efficiency, with a focus on e-motors, power electronics, and batteries. In this program, experts share practical insights and real-world examples to elevate EV powertrain designs.

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WEBINARS

SEAMLESS INTEGRATION OF SAFETY OPERATING SYSTEMS UP TO ASIL D/SIL 3

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All automotive ECUs depend heavily on operating systems (OS) to manage multiple applications and hardware components. Ongoing complexity of ECUs is on the rise and is increasing the OS complexity, especially in efforts to achieve safety requirements for ASIL-B and ASIL-C to ASIL-D use cases. This 60-minute webinar examines a key automotive solution for Classic AUTOSAR-driven ECUs QM to ASIL-B and ASIL-C to ASIL-D use cases including two operating systems that are optimized for either safety requirement pair.

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

Available On Demand

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

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MITIGATING RISKS, ENSURING RELIABILITY: DEEP DIVE INTO AUTOMOTIVE ELECTRICAL COMPONENT TESTING

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As the automotive industry increasingly shifts toward electric and hybrid vehicles, the significance of robust testing for electrical components has never been greater. This 30-minute webinar delves into the multifaceted realm of automotive electrical component testing, emphasizing the critical parameters that demand rigorous evaluation, including voltage, current, temperature, and efficiency.

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