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IN THIS ISSUE

36

44

48

52

54

58

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Rising stars: Xpeng gives Tesla a run for its money

President Brian Gu shares how EV start-up Xpeng is setting the bar on automated, zero-emission driving. By Megan Lampinen

Competition remains fierce in the global automotive market as incumbents and newcomers alike jostle for leadership in an increasingly smart, connected and clean mobility ecosystem. Not all brands will survive, as investment demands are high and betting on the wrong technology pathway could prove fatal.

In 2014, Xpeng emerged on the scene in China with a skeletal team and the promise of an electric, highly automated line-up. A busy eight years followed, during which it launched three vehicles, expanded into Europe and arguably set the bar for automated driving. The company was recently named one of Kantar BrandZ' Top 20 Rising Stars in Chinese Global Brand Builders Report. Brian Gu, Vice Chairman and President of Xpeng, is positioning the brand as "a technologically advanced future mobility explorer."

Brian Gu,
Vice Chairman and President, Xpeng

store or a factory." Today it operates several factories and has close to 20,000 employees, 1,000 charging stations, and 400 stores and service

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In China, people know us as one of the smartest–if not the smartest– vehicle on the road

"When I first joined Xpeng in 2018 we employed a few hundred people, mostly focused on developing the first prototype," Gu tells *Automotive World*. "We didn't have a model or a

centres. It has a dual listing in the US and Hong Kong, and boasts a market capitalisation of US$20bn, though that figure was closer to US$50bn in early 2022.

That's a huge jump from the start-up days, but Gu insists Xpeng remains "very entrepreneurial" in some ways: "We treasure a direct, simple business culture. Decisions are made at the senior level very quickly, and there's an open dialogue in terms of technology, business, and structure. At the core, we're still a young company."

Standing out

China has a multitude of electric vehicle (EV) start-ups. When Gu joined, *Bloomberg* put the figure at about 200. Gu attributes the brand's survival in such a competitive environment to its market positioning around 'smartification' of the vehicle. "At the very beginning we set out to invest in the soft side of the business: in the software, the internet, the autonomous driving, the AI, the voice recognition, the smart cabin, the electronic architecture for the main controls," he says. This focus also ties in with the DNA of its founder. Like Elon Musk, He Xiaopeng was a successful internet entrepreneur before he became involved in the automotive sector.

Xpeng is pushing hard on autonomous driving

Xpeng G9

Xpeng's current P7 model offers Highway Navigation Guided Pilot (NGP), which can handle sections of driving autonomously. The next stage of its evolution will be City NGP. Users simply enter their destination, initiate navigation, and then sit back and let the car drive to their destination along urban roads. The company claims City NGP expands the existing NGP function to cover 90% of a driver's needs. Notably, this feature will make Xpeng one of only two companies to have developed and mass-produced autonomous cars with this level of complexity. The company points to comparison results from user scenario tests that show City NGP can negotiate more complex urban conditions than Tesla's Full Self-Driving.

"In China, people know us as one of the smartest–if not the smartest–vehicle on the road," says Gu. "Autonomous driving capability is at the forefront of that smart positioning." From the start, Xpeng knew it wanted to develop its own technology, rather than using a third-party approach. "We work with our own architecture, our own software stack, our own sensor fusion capability," he emphasises. Xpeng believes this allows it to better control the development pace and customisation capabilities.

Chinese consumers are repeatedly shown to be the most interested in and willing to adapt self-driving technology. A report by Boston Consulting Group and the World Economic Forum found that 81% of surveyed consumers in China were willing to try autonomous cars. Similarly, 80% of consumers polled by McKinsey stated that autonomous driving will be a key factor in their decision-making when they buy their next car. However, at the moment China does not allow production vehicles to showcase SAE Level 3 autonomy or above. Legally, automakers are not permitted to advocate or market this ability, and

there must still be a human behind the wheel who is alert and ready to take control. But Xpeng will be ready when that changes. "Capability-wise we can already demonstrate a high degree of autonomous driving," adds Gu.

The upcoming G9 model, scheduled to make its debut in China from September 2022, promises 5G connectivity, firmware OTA upgrades and Xpeng's operating system Xpilot 4.0, which enables full-scenario assisted driving. It will also be China's first model implementing a Gigabit Ethernet communications architecture.

China and EVs

China is the leading EV market in the world and has witnessed tremendous segment growth over the past few years, up about 140% in 2021. The market penetration of EV sales as a percentage of new car sales had been growing slowly but steadily, with a dramatic acceleration occurring in recent times. "We are at an inflection point," says Gu. "It took the market over a decade to go from zero to 10% of market penetration, but it's now headed from 10% at the start of 2021 to 30% by the end of 2022."

This has been assisted by a variety of model choices, charging infrastructure rollout and government subsidies. While the cost of building EVs remains higher than their internal combustion engine equivalents, Gu is bullish that cost parity is nearing. He anticipates another year of hyper growth for the domestic EV market, and while subsidies have been falling, they will continue to play a role. "The subsidy still helps the economic equation for EV purchases, and for supporting companies and their cost structure. The percentage of these subsidies as

Xpeng's Netherlands store

part of the overall purchase price has come down dramatically, and they will probably end in a year. For now, it helps tilt the purchase decision slightly in the EV's favour."

As for the battery swap vs plug-in charging debate, Xpeng comes out firmly in the charging camp and has subsequently been investing in fast-charging networks. The G9 SUV will feature an 800-volt SiC platform and a peak DC charging power support for up to 480kW; a five-minute charge will give a range of up to 200km. "This really changes the efficiency of charging," notes Gu. "As for battery swap, we don't believe it is feasible commercially and it is not something we will try to adopt ourselves."

Going global

While its roots are firmly in China, Xpeng has its sights set on a global presence. It has opened stores in Norway, Sweden, Denmark and the Netherlands, and deliveries should soon follow. It also has offices in Germany and an R&D centre for autonomous driving in California's Silicon Valley.

A notable recognition on this front came with being named a Chinese Global Brand Top 20 Rising Star. "We just started globalisation, so it is a bit early to be calling us a global brand," he concedes. "That said, we have presented the world with an exciting future on e-mobility."

Could the cognition Goldilocks zone solve the challenge of semi-autonomous driving?

NewTerritory design experts have developed a multi-sensory experience to provide the optimum level of driver engagement. Megan Lampinen hears more

In-vehicle infotainment systems have revolutionised the user experience over the past decade. Today's drivers have become accustomed to high-resolution touch-screens, smartphone pairing, and advanced driving assistance features. Increasingly, they are also becoming familiar with automated driving. SAE Level 2+ and Level 3 vehicles are making their way into the market, introducing new levels of convenience–and new design challenges.

Sharing responsibility

A car that drives by itself all the time is one thing; a car that drives by itself some of the time is something else entirely. With the latter, designers and engineers need to address the handover of control, i.e. when the vehicle passes driving control back to the human. If someone has been napping or reading, how do you quickly alert them that they need to take over–now–and fill them in on the current road situation?

It's a big challenge, and one that some players are keen to avoid altogether. Back in 2016, Ford notably announced that it planned to bypass Level 3 autonomy because of this handover challenge, with Raj Nair, then President of North America, stating: "We abandoned the stepping-stone approach of driver-assist technologies and decided we'd take the full leap to deliver a fully autonomous Level 4-capable vehicle."

While the automaker has since adjusted its stance, these early concerns are an indicator of the challenge of engaging drivers in semi-autonomous driving situations.

The cognition Goldilocks zone

NewTerritory may just have the solution. The design experts have created a prototype multi-sensory metaverse virtual reality experience specifically geared at mitigating engagement concerns in semi-autonomous situations. Research conducted in collaboration with University College London developed the idea of a 'cognition Goldilocks zone'. This is the point where a driver is at the perfectly balanced level of stimulation for safe driving: not over stimulated (think busy intersection, screaming kids in the back) and not under stimulated (think long stretches of empty motorway at night). It has applications in all driving scenarios but will become particularly important in semi-autonomous situations.

Automotive World was treated to a tour of the research test rig for the 'Green Dinosaur' programme at NewTerritory's London studio. "Green Dinosaur represented an opportunity for me to demonstrate to the business as to what can happen if you merge creative technologies with physical spatial environments," explains Tim Smith, Design and Creative Tech Director at NewTerritory. "It was also with the aim of solving a particular problem in the automotive space."

The setup deploys the latest virtual and augmented reality to provide a fully immersive experience with the aim of pinpointing this cognition Goldilocks zone. Researchers looked at biometric data and human physiology to understand if volunteers were either under stimulated or over stimulated. They

then used a multi-sensory experience to bump them up or down, back into the Goldilocks zone, which in theory would make them a safer driver. This multi-sensory experience covers all five senses. For instance, fans were used to simulate air conditioning and open windows; spray bottles released either stimulating or calming scents; vibrations in the seat could arouse or calm occupants; even lollipops were used to engage taste.

Testing was short and sweet, running over ten days. "This is all very prototypical," Smith tells *Automotive World*. "That's how we work at this stage: technology is built fast, we learn fast and fail fast, that sort of thing. It's not about creating a beautiful end product; it's about testing a hypothesis with real users as quickly as you can. The idea is you iterate and evolve into the perfect solution."

depending on when we gave these multi-sensory interventions, so it did seem to have an effect, and that was encouraging. It's a rudimentary way of gathering levels of excitement, but this was Version 1.0," notes Smith.

Heading to market

This technology remains in the early stages of development and is very much at a prototype level. NewTerritory is currently in talks with an unnamed "major American OEM", though details of that are being kept quiet for now. In theory the potential applications are numerous. "Imagine you are in a car that's been driving by itself but you suddenly have to take over," says Smith. "Maybe the system issues a minute's warning and initiates Green Dinosaur for that minute. It could be

> " I wouldn't want to copy the X-Box experience into the car; sticking Halo in there would be missing the opportunity to harness the unique environment of the vehicle

Volunteers were given an experience without stimuli interventions, and then the same experience again with interventions. There was a marked difference in their heart rate, suggesting the interventions had the desired effect. "We were able to get them a bit more excited or a bit less excited when we wanted to,

that the system only gives back control once it recognises the driver's cognition is at the right level (the Goldilocks zone)."

Any OEM installation would take some time to find its way into production models and need to be incorporated into the design and
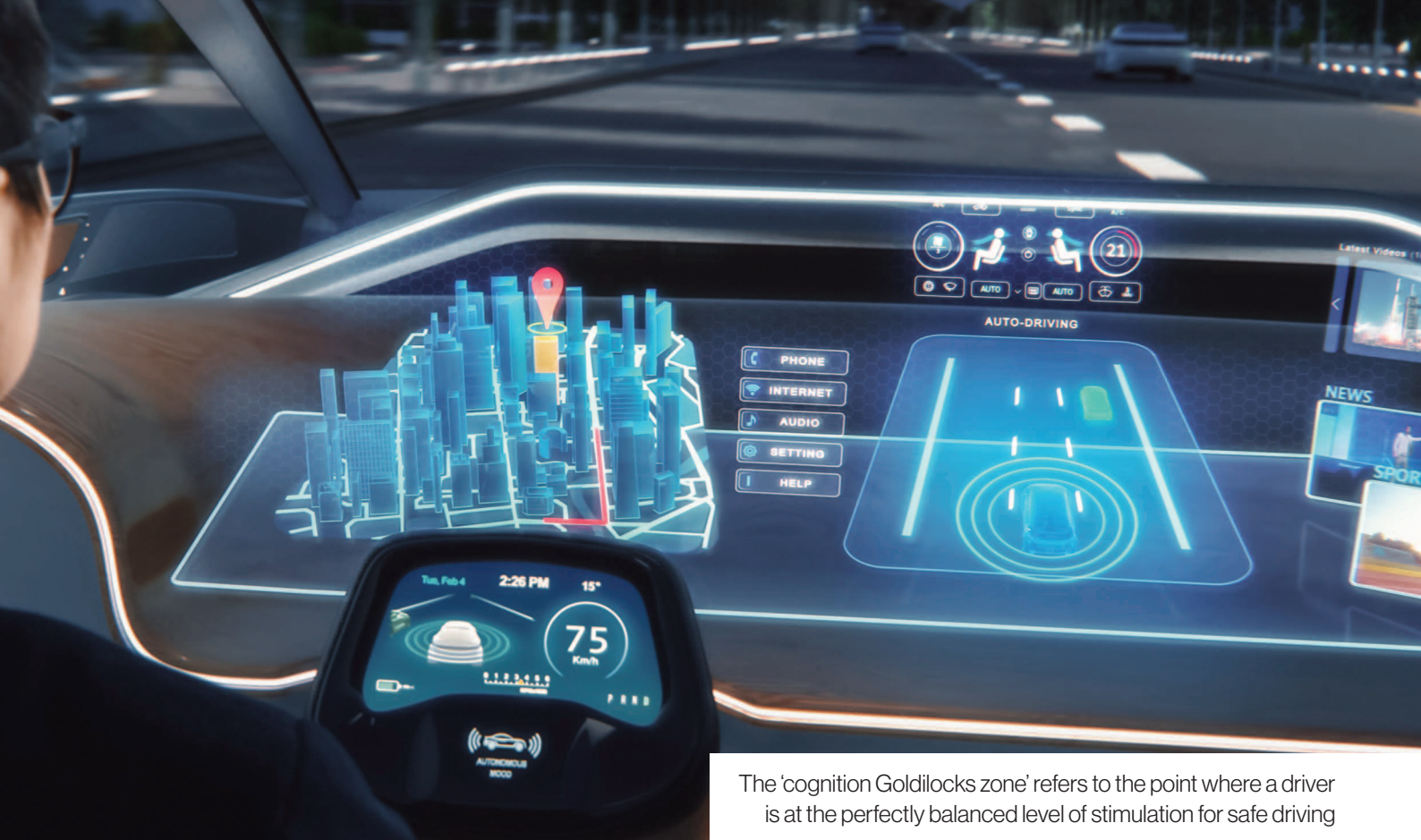
The 'cognition Goldilocks zone' refers to the point where a driver is at the perfectly balanced level of stimulation for safe driving

manufacturing process. "We would like for this to be installed by default in cars, but we need to be five years ahead of planning to make that happen," he notes.

There is another option: plans are underway for an aftermarket version of Green Dinosaur, something that could be easily installed into vehicles already on the market. This solutions would consist of a suite of peripherals that could pick up the necessary biometric data and provide the multi-sensory experience. "You can take this entire experience and just plug it into any car and have it work," he says. "This is a way to get it into vehicles now."

No more driver

Green Dinosaur is currently all about driver cognition, but as autonomous driving accelerates and the car takes over all of the driving tasks, it becomes much more about the

passenger experience. The challenge for Smith and his team is to develop a unique, multi-sensory experience for the car that can only be delivered in the car. And for that, he's inspired by the gaming industry and the potential to tie in gaming with the format and the movement of the vehicle.

"I wouldn't want to copy the X-Box experience into the car; sticking Halo in there would be missing the opportunity to harness the unique environment of the vehicle," he says. "What can we do with the format of the car and the fact that it's moving?"

Smith has tons of ideas on how to harness that and he and his team will be fleshing them out in the coming months and years. What *Automotive World* viewed at the studio represents the first step into what will become the future of UX. "We will be able to prove it out a bit more going forward, but this is just the sketch on the notepad," he promises.

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Regulatory patchwork threatens autonomous freight progress

In the US, each state sets its own policy around self-driving vehicles. Megan Lampinen explores the implications of that approach

Autonomous driving is on the cusp of a technological frontier, promising numerous benefits across several different use cases. For the trucking sector, it could offer dramatically more efficient and safer freight movement. But as with many new technologies, regulations could make or break its success. In the US, arguably the leading market in terms of self-driving truck pilots, there is a decided lack of federal regulations across the states.

Today, autonomous trucks can run in specific areas within 29 states, but each state has its own approach and its own rulebook. The rules that apply in one state may not be the same rules that apply when the vehicle crosses the border. Such a fragmented strategy has some industry watchers concerned, particularly on the legal ramifications. For new players entering the sector, or established players keen to extend their roadmap, navigating the complex legal requirements may require outside help.

That's where Justin Savage and Allison In come in. They are part of the Automotive and Mobility sector team at law firm Sidley Austin LLP, advising companies and organisations on the autonomous driving requirements for any state in which they operate, the risks they may face under the US law and management techniques to mitigate those risks.

"Some states may require a permit to test on the roads. On top of that there are reporting obligations for the National Highway Traffic Safety

Alterra Property and Embark want to set up autonomous-trucking hubs across the US

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Administration (NHTSA)," notes Savage. "A new market entrant might be looking for high level advice on risk management. Other clients may need guidance on how a NHTSA regulation works for AVs or advanced driver assistance systems (ADAS), or how to deal with an open enquiry or investigation from NHTSA."

In the absence of a federal approach, the risk of getting it wrong could be significant. Allison In views the biggest safety-related liability concern around the question of who takes

Autonomous freight

Regulatory concerns for autonomous freight, as opposed to autonomous passenger vehicles, have an added layer of complexity. In the US, there is a federal statute called the Federal Aviation Administration Authorisation Act (FAAAA) that essentially prohibits states and local governments from regulating the rates, routes or services of any freight forwarder or broker, or anything having to do with a price, route or service of a motor carrier. "This is a broad federal pre-emption

> " Having a potential patchwork of state product liability laws might be counterproductive to the development of new ADAS and AV technologies

responsibility in the event of a crash, particularly one involving a fatality. "Here we have many different requirements based on different case law and the regulations that are written in different states," she tells *Automotive World*. "That includes California, which keeps changing its view on who's liable and which type of technology is subject to the regulations."

The Sidley team fields questions on all forms of autonomous driving, but freight is a particularly complex sector.

statute that overlays freight shipments," explains Savage. There has not yet been a case applying that statute to ADAS or autonomous driving technologies, but he flags it as an interesting aspect to watch.

Notably, there's an exception in the statute for the safety regulatory authority of states. Recently, the Ninth Circuit in Miller v. C.H. Robinson Worldwide held that the safety exception did apply to a negligence claim against a freight broker for failing to select a competent motor carrier. There, the Ninth Circuit panel

Daimler Trucks is investing more than €500m in autonomous trucking

noted the congressional intent to preserve the states' broad power over safety in enacting that exception, which includes "the ability to regulate conduct not only through legislative and administrative enactments, but also through common-law damages awards." As a result, the negligence claim was remanded to the trial court to proceed as filed. The US Supreme Court denied the broker's petition for rehearing on 27 June 2022.

So how does that framework apply to AV or ADAS? Savage simply suggests that it at least gives companies another argument to push back against state product liability suits. "There's a recognition within the industry that having a potential patchwork of state product liability laws might be counterproductive to the development of new ADAS and AV technologies," he tells *Automotive World*.

The SELF DRIVE Act

The SELF DRIVE Act, originally introduced in 2017, could provide some guidance if it is ever put into force. It calls for the establishment of a federal, uniform regulatory safety framework for self-driving vehicles. "It would be a good idea to balance safety and technological development by having a single standard," says Savage. "There is some pre-emption case law out there under the Motor Vehicle Safety Act and the Federal Motor Vehicle Safety Standards but it's less clear than what the SELF DRIVE Act would provide."

However, five years later, developments remain sluggish. "Every calendar or congressional year it's been reintroduced, and it was sometimes renamed as something else, but it is still not gathering the

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widespread support we saw when it was introduced back in 2017," In points out, suggesting this is due to an element of reticence on the part of the government. "NHTSA has been passively but intentionally holding back on issuing something really progressive," she adds.

"At a high level, not much gets done in Washington DC these days," quips Savage. "It's a stereotype that unfortunately has some force behind it."

Good advice

When looking at liability issues for self-driving, developers and operators need to be aware of the requirements for all regions in which they are running vehicles. As mentioned previously, some states require permits in order to operate AVs. The Society of Automotive Engineers puts out constantly evolving standards governing these new technologies, serving as a touchpoint for

developers. Savage also urges the importance of transparency and establishing a relationship with state regulators so that there is a clear understanding of what a company is trying to do from both a compliance and safety perspective.

There's also an educational role for companies, helping policymakers understand the benefits of these technologies and ideally providing greater certainty. But what happens if an autonomous truck crashes today? Savage recommends companies take certain steps right away. The first is to determine whether or not the self-driving technologies played a role in the crash. It could be that the truck was sideswiped by another vehicle and the self-driving system had nothing to do with the incident. Second, companies want to have an engineering team conduct a robust root cause analysis into the causal factors that led to the crash. If there was an indication that ADAS or AV played a role, then the company would want to identify the risk-mitigants that it has in place, such as the specific tiers of insurance–primary, excess–and the commercial agreements between the supplier and the OEM or between other parties that stand behind the technology.

Sometimes a body like NHTSA or the National Transportation Safety Board (NTSB) will become involved in an investigation, and there are several such probes ongoing at the moment. In these cases, the companies involved also need a strategy for engaging in a transparent and robust way. "That needs to be based on the data, and [companies] must keep in mind the different precedents that might be set when regulators engage in that type of an investigation," elaborates Savage.

Risk-spreading

Some help for the burgeoning AV freight industry could be found in traditional risk-spreading measures, like insurance. Freight carriers, automakers, suppliers–everyone tends to use insurance. "There can also be commercial risk-spreading between different entities in the supply chains for an AV or an ADAS, whether those are indemnities, assumptions of liabilities or other contractual agreements about who will allocate and bear risks as between those parties," notes Savage.

they are clarifying their definitions and streamlining the pathways for new regulations to come in and be consistent with whatever is existing for conventional vehicles," she notes.

For instance, the regulations have moved away from definitions such as the 'driver's seat' and instead referring to the seating position, either front or rear. "There are certain provisions in the standards that are not applicable to AVs, and could be confusing in the future," notes In. "The agency is trying to eliminate those confusions in advance, even though they are not in

"

NHTSA has been passively but intentionally holding back on issuing something really progressive

Other popular options are joint ventures and corporate venture investments. These are particularly helpful in controlling the risks of the capital investments for technologies that may not have a reasonable payback period in the traditional corporate sense.

Approaches like these will remain pivotal in the absence of a unified strategy, but there are signs that the regulators are preparing in some ways. In points to the recent developments with the Federal Motor Vehicle Safety Standards, which clarify applications to AVs and ADAS technology. "These changes suggest

the position of formulating some more aggressive and proactive regulations and standards for these technologies."

At the end of the day, the US embraces its federalist system, in which there is a significant degree of autonomy in the individual states. But that same approach, in this instance, may serve as an inhibiting factor in the development and deployment of these technologies, at least as compared to other countries where there's a more centralised standard. "There is this technological race underway," says Savage. "We now need to ask, with these current parameters, how do we get there?"

Digital reality solutions ease the transition to e-mobility

Hexagon promises a faster, more integrated, sustainable approach to the design, development and production of EVs. Megan Lampinen hears more

Headwinds in business are nothing new: every sector faces them. But for the automotive industry, the scale of the challenge has arguably never been greater. The pressure is on to clean up, smarten up and speed up both operations and product.

Swedish technology company Hexagon specialises in what it calls digital reality software. It has found application in numerous verticals, but automotive–and particularly the move to electric vehicles (EVs)– is emerging as a sweet spot.

Hexagon claims that it touches 95% of the cars produced globally every year. That means that 95% of the new cars rolling out from factory lines feature at least one part that is designed or produced by a Hexagon solution. "That makes us responsible in a way for the success of the industry transition to new trends like electric propulsion and flexible manufacturing," explains Ignazio Dentici, Vice President for Automotive and eMobility Industry for Hexagon Manufacturing Intelligence.

Optimising design and production

The e-mobility team has been busy creating a suite of software and simulation tools that help customers develop and produce electrified vehicles, especially the batteries and battery systems that power them. "The overall propulsion system in an EV is completely different from the

traditional internal combustion engine system and that creates a lot of headaches for the supply chain," he notes. "Manufacturers need to transform their skills and their manufacturing plants to produce a radically different product."

One of the biggest challenges in EV manufacturing today is scaling up volumes. Of all the vehicles built in the world in 2021, just 5% were electric. While specific forecasts vary, some analysts are calling for production of 30 to 36 million

EVs by 2030. "We are fully convinced that the future is electric, even if it's not 30 or 36 million specifically," Dentici says. He estimates that between 2025 and 2030 the percentage of EVs in the overall production mix will be close to 30%. This means that the manufacturing lines installed today and the number of gigafactories online at the moment are insufficient–Dentici suggests they could be just one-tenth of what will be required.

"While battery and motor technology is constantly

evolving, we do at least have a technology identified for EVs. The problem is that the maturity of the manufacturing is not here yet," he cautions. "The real challenge is how to produce 20 or 30 millions EVs per year with the same level of quality."

The offering

That's where digital tools can assist. One way is to support developers in selecting the most appropriate propulsion system for a specific vehicle, taking into

consideration the requirements for metrics like power, torque and acceleration. Once that has been defined, the software can simulate responses around thermal management, ageing and system efficiency. Dentici estimates that developers can finalise about 90% of the requirements within the first round of powertrain design using this approach.

Hexagon also has a specific tool to assist with electric motor development. Electric motors are certainly nothing new; they have been around in industrial applications for a century, but their application in automotive is a completely different kind of challenge. "Hairpin forming and stator manufacturing represent one of the most capital expensive investments," Dentici tells *Automotive World*. Enter Hexagon's one-stop closed-loop solution

for stator manufacturing. It specifically supports the closed loop control and the statistical process control of the hairpin stage of production of the electric motor. The benefits include minimising cycle time and waste during the manufacturing process.

And then there is fuel cell technology, which may also play a significant role in an electric future. "The fuel cell investments coming out globally are not at the level that we see for battery, but at the same time we have customers extremely focused on specific applications for fuel cells," he observes. Here, Hexagon is supporting the production of bipolar plates for fuel cells, helping to set up the process and keep the production under control in order to maximise efficiency.

Flexibility by design

Another key problem for automakers today is production flexibility in light of market uncertainties. Real market demand for EVs hinges on numerous factors, spanning everything from regulations and charging infrastructure to model availability. That makes it all the more pivotal that EV production is flexible and responsive. Hexagon is currently working with automotive players to enable 'flexibility by design' in the manufacturing process.

"Together with our customers and partners, we have developed inspection equipment that's capable of inspecting different models on the manufacturing line. You can start with one model

and a few minutes later do another model with different tolerances or geometries, and all without changing any fixture or any line stop," he explains.

This becomes increasingly key for manufacturers that may need to adjust production plans, which many will. "If you listen to interviews from OEMs, it is clear is that flexibility and digital transformation are the buzz words in automotive manufacturing today," notes Dentici. "That's not just marketing. The reason is really that no one is sure about the volumes that the market will demand of a specific vehicle architecture or a specific model."

Volkswagen Group brand Skoda was an early adopter of this automated inspection technology. In 2018, Hexagon started supporting the automaker to reconfigure the inspection processes for 3D optical systems instead of tactile measurement. The initial project involved the modernisation of several installed coordinate measuring machines and the installation of two fully automated smart measuring cells for Skoda's measuring centre in Mladá Boleslav. The impact: a significant increase in measurement capacity and quality, as well as the digitalisation of outputs from measuring devices.

Factory of the future

Simulation and digital technology like those offered by Hexagon are positioned to play a starring role in future manufacturing operations. "We have the capability to leverage data from not just manufacturing but also the design phase, and simulate the manufacturing process with smarter solutions," Dentici asserts. "We can then make this data available for comparison and use it to improve the next generation of design or the current generation of manufacturing. It will be key in the factory of the future."

Infotainment: product differentiator and safety hurdle

Infotainment systems have emerged as a critical brand differentiator but doing infotainment right requires a heavy focus on usability and safety. By Sam Abuelsamid
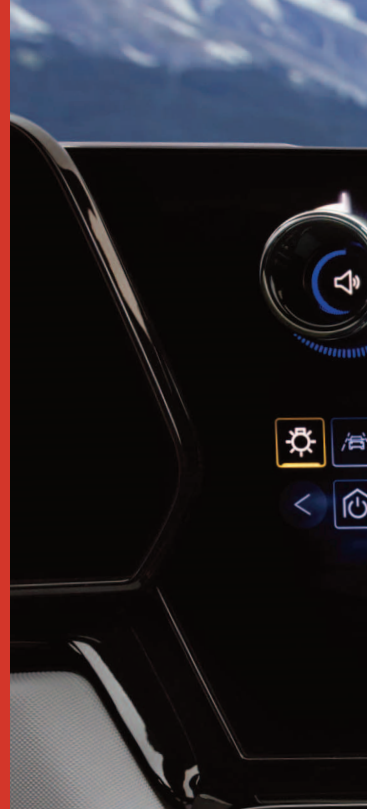
Back in the 1970s when I was coming of age, cars had radios with mechanical tuners and a handful of preset buttons. If you were lucky, they had both AM and FM bands and for those that really splurged, maybe a cassette or 8-track tape player. Computers were nowhere to be found and aside from a 12V power supply, it had no interaction with the rest of the car. Today, the centre of the dashboard is typically dominated by a large fully colour display that handles a myriad of functions and has come to be known by the portmanteau "infotainment."

As vehicles become increasingly automated and the seemingly endless feature list becomes increasingly padded, the information and entertainment–or infotainment–system becomes an ever more important aspect of the vehicle. In fact, the age of electrification makes a great infotainment system even more critical as a differentiator. But doing infotainment right also requires a heavy focus on usability and safety.

Making a product unique

For the past century, automakers have created differentiation between their products and those of competitors through styling, handling and the feel of the powertrain. Engines from different brands often had distinctly different characters such as sound, vibration and the nature of the power delivery. But electric motors all sound and feel pretty much the same. The importance of aerodynamics to maximising electric vehicle (EV) range also leads to some commodification of the shape that is further exacerbated by the market shift from cars to crossover utility vehicles.

Thus, creating a distinct user experience often comes down to how the human machine interface and particularly the infotainment looks and performs. Unfortunately, for many automakers, that poses a major challenge. Software is by no means a new thing in automotive. Electronic control systems for everything from engines to brakes have been de riguer since the 1970s. But that software was always deeply embedded in mostly low powered electronic control units (ECUs) with no direct user interface.

The world of infotainment has more in common with smartphone and tablet apps and operating systems than powertrain management. Automakers have really only started to aggressively recruit software developers and user interface designers with those skills in recent years. However, great, visually appealing and responsive software also needs a robust compute platform on which to run. Here again, the world of mobile comes to the rescue.

Design for functionality

Early attempts at rich touch interfaces in the car were at best hit and miss and in many cases complete disasters. Case in point was the MyFord Touch system launched on Ford and Lincoln vehicles in 2010. The user interface was bad, with small touch targets that were hard to hit with an outstretched fingertip while also trying to drive. Piling on the pain was the fact that even if a driver hit the target, sometimes it would take many seconds for something to happen. When things did happen, it wasn't uncommon for the result to be a complete system crash and reboot. Exactly what you don't want while trying to drive a car.

become substantially larger with 12-inch diagonal displays quickly becoming the minimum and screens that span the entire dashboard already available in China. That extra real estate allows for more map area to be displayed while driving, reducing the need for scrolling. Touch targets are much larger and easier to tap. The interfaces are also being flattened out, keeping the most common functions at the top level to reduce digging through menus.

Driving all of those pixels requires some substantial computing horsepower. Nvidia, which built its reputation with some of the fastest video game graphics processors in the industry, has ramped up its presence in automotive. Nvidia now uses its chip design expertise for graphics

While many automakers' in-house developed software has dramatically improved in recent years, it's still not always what users want. It seems most people today spend more time using their smartphones and tablets than driving their cars and they want a similar user experience in both including using many of the same apps.

Bringing mobile connectivity to the dashboard

Apple and Google, the companies responsible for the two dominant mobile operating systems, each offer a system that can project content from a paired smartphone to the screen in the vehicle. Apple CarPlay and Android Auto are now available in almost every new vehicle sold in North America and Europe. Both of these systems rely on a connected phone to run mapping, media streaming and messaging apps while driving. There are now multiple automakers shipping vehicles with the full Android Automotive operating system that eliminates the need to connect a smartphone and runs apps like Google Maps, Assistant and many others directly on the vehicle.

> " Modern infotainment has evolved into a safety critical system and must be treated as such by designers and developers

The roots of the problems could be traced back to a combination of bad interface design, poorly coded, running on silicon that was simply not up to the task being demanded of it. Now in the 2020s, the situation has vastly improved. The touchscreens have
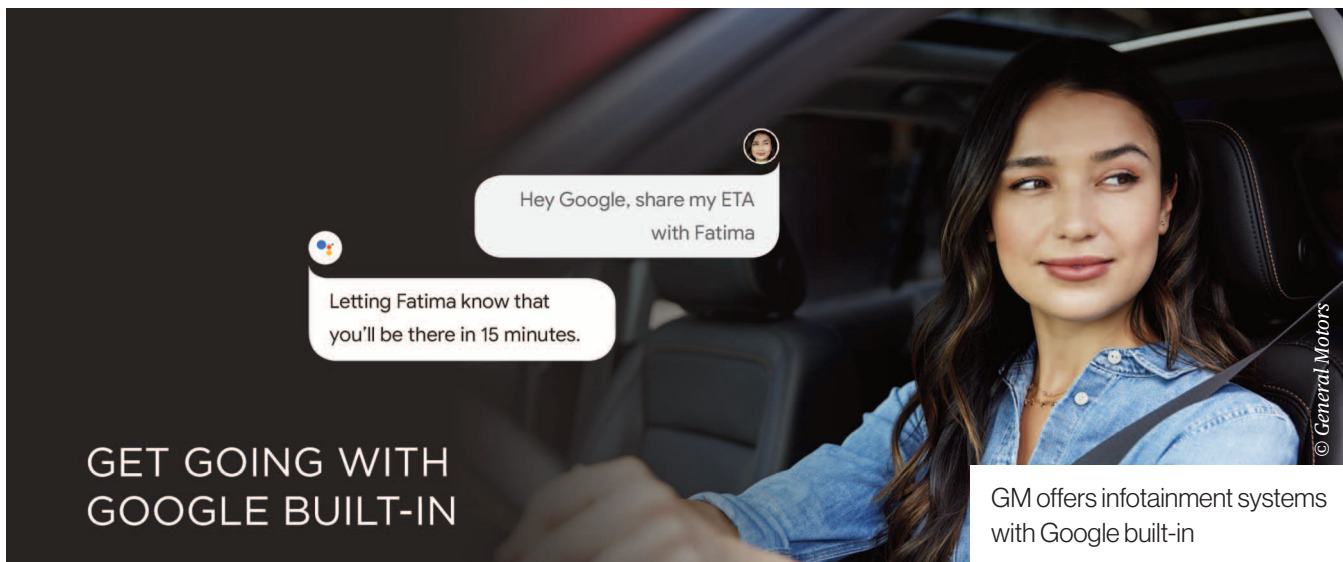
engines to drive the screens as well as neural processing units to power advanced driver assist systems. Qualcomm, the leading vendor of smartphone chips for smartphones not made by Apple, also has a growing market share in both of these sectors.

An important component of Android Automotive is access to the Google Assistant voice interface system. Embedded voice recognition has been the bane of automakers for two decades since BMW started relying on it as part of the original iDrive infotainment. These systems had

GET GOING WITH
GOOGLE BUILT-IN

Hey Google, share my ETA
with Fatima

Letting Fatima know that
you'll be there in 15 minutes.

© General Motors

GM offers infotainment systems
with Google built-in

limited processing power in a less than ideal acoustic environment, making lack of accurate recognition a constant frustration for drivers and a cause of poor quality ratings.

With the new generation of infotainment, automakers are relying on the connectivity that is now ubiquitous in new vehicles to enable cloud-based voice recognition like Google Assistant and Amazon's Alexa voice services. Many new vehicles now contain an embedded default voice control, Alexa and Google Assistant running simultaneously, allowing the driver to use the system of their choice by uttering the appropriate wake word.

Safety first, last and always

As vehicles become ever more feature-rich, the human machine interface (HMI) of infotainment has become not just a product differentiator but also a safety factor. A poorly laid out or non-responsive system can quickly become a distraction for drivers as well as a reason not to buy that brand again.

Just as Apple convinced Blackberry users that a physical keyboard wasn't actually needed for a phone, companies like Tesla have driven the expectation that everything should be embedded in a touchscreen interface. Unfortunately, driving is a very different task from using a smartphone. A user's eyes are on the phone screen while operating it. A driver's eyes should always be on the road (with occasional glances at the mirrors). Certain vehicle controls like audio volume and climate control should always be done with physical switches and knobs that can be activated by feel rather than virtual controls that require eyes on the screen.

A prime example of how this can go very wrong occurred to Randy Pobst and Blake Fuller.

Each was driving a Tesla Model S during the 2022 Pikes Peak Hillclimb. As they ran up the mountain, a thick fog caused their windshields to fog up and the defroster control is in the touch menu. Both drivers were wearing gloves which exacerbated the problem of just trying to find the control while racing up the side of a mountain at speeds up to 140mph. These drivers were lucky, but the results could have been tragic.

Modern infotainment has evolved into a safety critical system and must be treated as such by designers and developers. It's not enough to just make something that looks like a phone, it must be far more functional, reliable and secure. We won't be going back to the era of mechanical radio tuners and presets, but we do need a balance of physical, tactile controls and well laid out virtual and physical inputs that can be used without a second thought.

About the author: Sam Abuelsamid is Principal Analyst for E-Mobility at Guidehouse Insights

How is Nissan harnessing motorsport for mainstream electric cars?

Nissan's Global Motorsports Director and e.Dams Formula E-Driver discuss how cutting-edge technology could benefit passenger cars. By Elle Farrell-Kingsley

Motorsports teams invest billions into developing new technologies to give their team the winning edge on the track. It's not surprising, then, that manufacturers want to see some return on their investment by domesticating their innovations and turning them into technology applied to the passenger car.

One way innovation influences mainstream electric cars is through Formula E, motorsport's answer to a greener race, using 100% recycled materials and electric batteries. All Formula E open-wheel race cars are powered by the same batteries, electric motor, and chassis. McLaren Electronic Systems supplied the engine in its first Gen car in the opening season. Having the same specifications in its race cars means teams come together to pioneer the latest and most efficient electric vehicle (EV). Gen3 is the latest innovation, making its debut in the 22/23 season. Following further intensive development testing, both on and off the track, a series of design, performance, and sustainability innovations in the Gen3 car have been announced. Formula-E claims it will be the world's "most efficient racing car", with at least 40% of its energy produced by regenerative braking instead of fuel like Formula One, Two and Three.

The Gen3 formula car features an electric motor capable of delivering up to 350kW of power (470bhp), a top speed of 200mph (320 kph), and a power-to-weight ratio that is twice as efficient as an equivalent 470bhp internal combustion engine (ICE). In addition to this rear powertrain, it also features one at the front that adds 250kW–almost doubling the Gen2's current regenerative capability to a 600kW. Because of these additions, the car will not feature hydraulic brakes at the rear, although it will retain them at the front. Japanese automaker Nissan has partnered with Shell to help pioneer new electrification technology.

Maximilian Günther,
Shell and Nissan e.dams driver

Tommaso Volpe,
Nissan Global Motorsport Director

Shell and Nissan e.dams driver Maximilian Günther (MG) and Nissan Global Motorsport Director Tommaso Volpe (TV) talk to *Automotive World* about Nissan's participation in Formula-E, how the vehicles work, and, most importantly, how this technology can be utilised for road-going vehicles. German racer Günther joined Nissan e.dams ahead of Season 8 of the ABB FIA Formula E World Championship. Making his Formula E debut at 21, he became the youngest race winner in Formula E history when he claimed victory at the Santiago E-Prix in Season 6.

What brought Nissan to Formula-E?

TV: We joined Formula-E because Nissan is competing and pioneering in electrification. Some years ago, we were the first brand to launch a mass-produced EV. We have been a bit shy in promoting it, but we launched an EV before anyone else on the market.

Also, we have a firm commitment to the future: by 2030, all of Nissan's models will be electric, and by 2050 we will be 100% carbon neutral. Formula E is perfectly aligned as a platform in both areas. Of course, electrification is the most important aspect of electric motorsport, but it's also a carbon-neutral sport. That allows us to promote these two vital elements of our strategy for passenger cars.

But the important thing is that our involvement is also from a genuine technical perspective. For the Gen3 we developed the powertrain directly, with the involvement of advanced R&D from the labs in Japan on the innovative inverter, gearbox, and motor.

Nissan EV technology vision
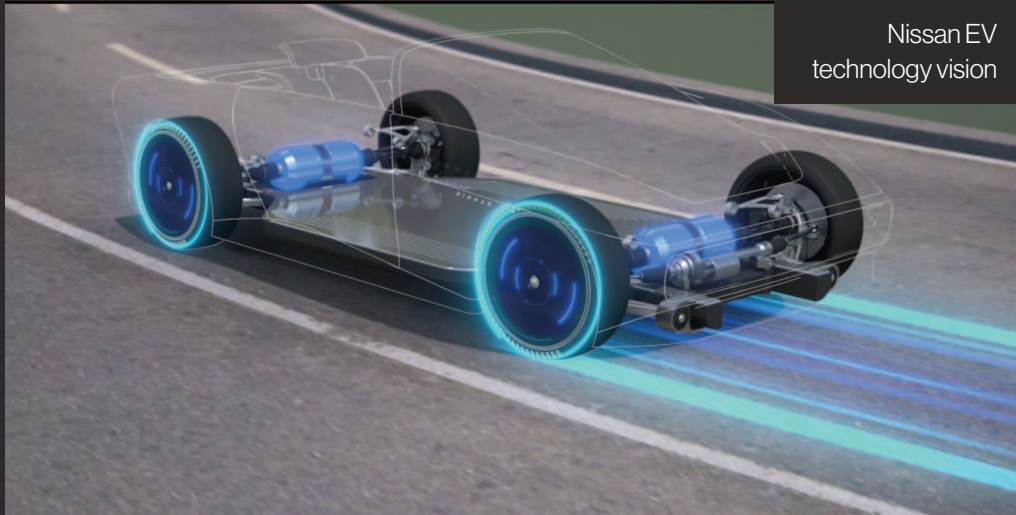
Is 'all-electric by 2030' a goal that Nissan has set globally?

TV: Yes, in all the key markets: Europe, the UK, North America, China, and Japan. Other markets will depend on local regulations. One limitation is that we don't know the state of the supporting infrastructure

As a race car driver, what are your personal highlights from using this technology?

MG: The Formula E cars are now the most modern race car you can drive. I have been racing Gen2 Formula E cars for four years with other teams and joined the Nissan team in 2022. The

> " In a couple of years–two to three– you will see the effect of these developments

for EVs in other markets, which doesn't necessarily depend on Nissan. That's why our commitment is to the key markets first.

challenges with the vehicle are enormous because racing always takes place on street circuits. It's very tight, narrow and bumpy.

How does the battery impact the car?

MG: The battery has 52kWh, which isn't enough energy to finish the race if you go full force every lap. You need to save some energy by coasting for the early laps instead of going full speed. This way, you distribute the energy throughout the race.

This opens up different strategies and tactics. You can be more aggressive at the beginning of the race, consuming more energy, but still being mindful of saving some for the end. Or you can do it the other way around. But, when you cross the finish line, you're always on zero. You just run out of energy before the line. This is the goal–to be the most efficient in the race.

Which elements of Gen3's innovations might influence passenger car systems?

TV: From the manufacturer's perspective, these are the two key performance differentiators: efficiency and energy management. In both areas, we learn how to improve our EVs for the future on the track. That's because it's crucial to have an efficient powertrain and very sophisticated energy management in passenger cars, too.

There are two main areas where Nissan and Shell transfer the R&D findings from race cars to passenger cars. One is the efficiency of the hardware–the motor, the inverter and the gearbox. This is about optimising their efficiency, not just the design but also aspects such as the materials we use.

In Formula E, the energy efficiency of the powertrain is in excess of 95%. From this, we can learn a lot about how

It's critical for drivers to maximise the car's braking system performance. At the front, there are standard brakes and carbon brakes, but the car's rear section can make the most difference with the control systems, the whole electric motor, and the regen. The control systems and regen work as energy recovery mechanisms and assist with energy conservation. Driving becomes very different during the race because you must prioritise efficiency and energy conservation. Before each lap, you push a regen button to recharge the battery, so it doesn't run out.

Nissan's COO Ashwani Gupta
with the Gen3 model

to reach much higher efficiency in the powertrain we employ for street use.

The other main area is energy management because, as Max said, it's an energy race. They all have the same power output. Despite the powertrains being different from one team to another, all the cars feature a spec 54kWh battery, and power is capped at 250kW by regulation. Ultimately, winning a race depends on how well the energy can be managed. As such, the software and tools used to regulate energy are the other crucial elements.

Furthermore, because it's software, it can be programmed. We can then apply the same codes to a standard car. Through effective energy management, we can extend the range of our passenger cars and that's the real benefit for consumers.

What went into developing the Gen3 car, and when might this technology trickle down into the mass market?

TV: The Gen2 was developed and launched in 2018. We took Nissan's 70 years of experience in the mass-produced vehicle market, as well as knowledge gained from EV prototypes, and transformed it into a race car. For Gen3, we did the opposite—we took what we learned about race car energy management and put it into the Nissan Leaf—our passenger EV.

We started developing the Gen3 car in 2021, with senior engineers from Japan and France working on it. These engineers are already transferring the innovations from this project to vehicles outside of motorsports. So, in a couple of years—two to three—you will see the effect of these developments.

eVTOLs are part of a "new era of co-existence" in mobility

eVTOL aircraft can play a valuable part in the much larger puzzle of reducing carbon emissions and urban congestion. By Will Girling

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4X-YHL

W ith transport contributing an estimated 23% of global CO2 emissions annually, decarbonising the sector is an important part of climate change prevention. The International Transport Forum warns that a lack of action in the 2020s could result in this share rising to 40% by 2030. This is according to statistical trends over the last 50 years, which indicate that transport-related emissions increase faster than any other sector.

However, according to the International Energy Agency (IEA), demand for mobility solutions has risen practically year-on-year for decades. The includes passenger road vehicles, road freight, and aviation. The first major dip–March 2020 caused by the COVID-19 pandemic– was called "unprecedented." This demand has also gone hand in hand with high levels of congestion in cities all over the world. Consumer tech company TomTom noted a drop from 2019's levels caused by the pandemic in 2020, but as of 2021, levels were steadily returning.

Unprecedented events like COVID-19 aside, the demand for transportation is unlikely to trend downwards in the future. Therefore, the industry must square lower emissions and less congestion with increasing customer demand. What's needed are solutions that can address all three issues simultaneously. As mobility redefines itself for a new era, one such innovation–electric vertical take-off and landing (eVTOL) aircraft–could have an important role to play.

The empty third dimension

Emerging in November 2009 as a concept from NASA, eVTOLs have started to build up significant momentum. In 2020, the global market was valued at US$1.1bn; however, by the following year, it had grown to US$5.4bn. Fortune Business Insights predicts that, assuming a CAGR of 23.13%, the overall value of eVTOLs could rise to US$23.21bn–a 2,010% increase in eight years.

© AIR

If this forecast is accurate, mobility could be on the verge of a significant transformation. Rani Plaut, Chief Executive and Co-founder of electric aviation pioneer AIR, informs *Automotive World* that the reason is simple: "If you look at transportation today, it's congested, and people are looking for something better and more sustainable. Meanwhile, the third dimension is empty and presents a significant investment opportunity." AIR's core product–the AIR ONE–has been in development since 2017 and successfully completed its first full-scale hover test in July 2022. With a top speed of 155mph and a range of 60 to 100 miles, initial orders are expected to commence from 2024.

© AIR

AIR's ONE has a top speed of 155mph and a range of 60 to 100 miles

This technology is the future, states Plaut, because it is applicable to all forms of mobility, including shipping cargo. "eVTOLs can lower the friction for air mobility since they're a safer, quieter, cleaner, and electrically propelled alternative." The latter two points are particularly important in the mission to clean up air transport–the IEA estimates that the fossil fuelled aviation industry contributed 1 billion tonnes of CO2 in 2019 alone, or 2.8% of the global total. A 2019 study from Ford and the University of Michigan found that, at journey distances of 35km or less, eVTOL greenhouse gas emissions were 52% lower than internal combustion engines (ICE) and 6% lower than battery electric vehicles (BEVs).

Removing friction points

A consumer survey conducted by Airbus UTM in 2019 found that safety ranked as the primary concern. With regard to how manufacturers can build trust in eVTOLs, Plaut reminds

Automotive World that the early days of the automobile were characterised by professional operators: "Today, a 'driver' could mean anyone because the processes have become so commonplace that they can even be automated." In the current aviation industry, piloting an eVTOL is still regarded as a skilled role. But, with time and investment, journeys will be increasingly automated and require very low skillsets to operate. He suggests that public perception might subsequently become more positive as flights become routine.

In the same survey, noise was also highlighted as an important consideration among consumers. A Boeing 737 cruising at 1,400ft emits 70.7 dBA–according to UK air navigation service provider National Air Traffic Services, this is 10 dBA louder than a busy office. To be appropriate as an urban transport option eVTOLs will need to be much quieter, and existing examples suggest they will be. "Electrification makes them quiet," says Plaut. "By removing the engine, you can reduce noise by

around 50%." Other market examples bear this out: a model designed by California start-up Archer has a noise spec of 45 dBA at 2,000ft, around the same level as a quiet conversation. This places it well below the World Health Organisations' recommended 55 dBA for daytime outdoor noise levels, although it is still higher than the 40 dBA for night.

However, assuming consumers were satisfied with eVTOLs' safety and noise levels, where would the aircraft be stored? The infrastructure required to accommodate eVTOLs remains largely unrealised today–only US$150m, or 3% of total investment, was spent on it in 2021. Nonetheless, Plaut enthuses its potential to change air transport's relationship with cities. "Traditionally, aircraft require a lot of infrastructure. They need a runway and a hanger, which means a large amount of real estate is needed to accommodate them. Consequently, the aircraft are located further and further away from urban areas. eVTOLs, because they take off vertically, require far less space and so can be brought closer to communities."

The era of co-existence

Despite all of the aforementioned benefits, Plaut concedes that eVTOLs are not a one-size-fits-all solution to the problems of congestion and decarbonisation. "There are no single solutions anymore," he states. "BEVs won't eradicate ICEs, and micro mobility won't totally replace cars. It's an era of co-existence." Cleaner, aircraft-based urban mobility holds a place of equal importance to cars in the new incarnation of global transport.

This message is clearly being received–in August 2022, official representatives from US President Joe Biden's administration expressed their support during the Advanced Air Mobility summit at the White House. Among the key takeaways were the need to maintain domestic aviation competitiveness and the significant value of new solutions (if sufficient public acceptance can be achieved).

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> BEVs won't eradicate ICEs, and micro mobility won't totally replace cars. It's an era of co-existence

"I think acceptance is already high and will only grow, but the change will be gradual," adds Plaut. Indeed, with the number of cars in the US totalling in excess of 276 million and eVTOL sales potentially only reaching 20,000 within the next ten years, consumer habits will not change overnight. Therefore, it's not likely that congestion on the roads will be diverted to the skies in the near future. However, if mobility truly is entering an epoch marked by a plurality of solutions, each doing its part to reduce the traffic caused by cars, the future of transportation could mean no congestion anywhere at all.

© Volvo Cars

Updating: 75% complete

Is there an expiry date for connected vehicle software support?

The IEEE flags some unanswered questions that need to be addressed in the move to connected vehicles. By Megan Lampinen

As the digital and AI revolutions gain pace, it becomes increasingly important that automakers develop and support their connected, autonomous vehicles in a secure and responsible manner. What that looks like is currently being threshed out in the form of best practice guidelines, standards and regulations.

Development guidance

Institute for Electrical and Electronic Engineers (IEEE) is just one of the many bodies helping to shape developments on this front. It has put together a draft standard, P2846, for assumptions of models and safety-related automated vehicle behaviour. Essentially, it sets out some minimum reasonable assumptions and foreseeable scenarios that developers should consider when creating safety-related models that are part of an automated driving system.

"This is intended as a standards document and to be technology neutral," explains Kayne McGladrey, a Senior Member of the IEEE and Cyber Security strategist at Ascent Solutions. "That means an engineer, an automaker or a regulatory body could take it up and confirm it represents a reasonable standard for automated vehicle safety."

This is currently in draft and will be subject to a comment period, so there's no clear date yet for an expected release. But in the long run, suggests McGladrey, the impact on the industry could be significant. "With standards, it really depends on whether or not individuals take it up," he tells *Automotive World*. "Just look at what the EU has done with WP.29."

This new regulation on cyber security (R155) requires all new car lines launched from existing electronic architectures to obtain cyber security system type approval as part of the process of whole vehicle type approval. This kicked in as of July 2022 and will apply to all new vehicles produced as of July 2024, in those regions which adopted it. "If the IEEE standard were taken up in a similar fashion, we'd probably see similar adoption rates and emphasis on automated vehicular security," adds McGladrey.

> **"**
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> If you're not paying for the product, you are the product

What's at risk?

Such guidance is increasingly important as vehicles introduce additional attack vectors for cyber criminals. Security risks to connected vehicles come in different forms. One category can be defined as kinetic attacks, which interfere with the way a vehicle behaves, usually until a ransom is paid. For example, a hacker could prevent a fleet of vehicles from moving at all, disrupting delivery services across a company or even a city.

© Audi

Connected infrastructure needs to be secured, as well as the vehicles

Another issue associated with connected vehicles is around the data they collect and transmit. "We have seen nation states that want to conduct surveillance, whether on their own domestic population or on foreign populations, use telemetry from hotels, airports, and rental car carriers to determine where individuals are moving," notes McGladrey. "If it is possible for a dedicated adversary to subvert that communications channel—either directly with a vehicle or by gaining a foothold inside of some telemetry aggregator service, probably the manufacturer—all of a sudden they can know where people are going within in a few feet. If you can associate a user's identity with their vehicle or location, you have a high degree of fidelity to conduct attacks."

Connectivity in the automotive space isn't limited to vehicles. It also touches infrastructure with sensors making their way into traffic lights and lampposts. Cyber security, then, needs to be ensured in these areas as well. "For a dedicated nation state that wants to conduct mass surveillance, it

doesn't matter whether the sensors are in lampposts, street signs, or cars," says McGladrey. "They can collect, aggregate and process data, and make inferences around the movement of interesting bits of the population. It all needs to be secured. They will go for the weak spot. If it's easier for them to shell a lamppost than it is to get a shell and successfully subvert an autonomous vehicle, they will do that."

The barebones minimum

To mitigate against such events, McGladrey advises developers to follow the standards and treat them as a baseline requirement.: "The specific cyber security mitigations that are laid out in WP.29—there are 23 of them—are a great barebones minimum associated with vehicles. But as we've seen in the larger cyber security industry, the threat doesn't just stop at the code that you're developing. Ultimately, autonomous vehicles are large computers that just happen to have wheels, and all of the code should be inspected."

Inspecting code is not new. There are both automated and manual tools that will inspect running and static code. But McGladrey urges closer inspection of open sourced code from places like GitHub: "If there's a vulnerability in a component that your company does not make, it's important to have a way to perform a quick patch. Threat actors are right now doing automated scanning of vulnerabilities that get raised." If someone picks up a vulnerability in an autonomous vehicle, they can sell that information on to a threat actor who could have a use for it.

Pay for privacy

The emergence of the software-defined car also raises questions around pricing and privacy. McGladrey envisions a future where vehicle pricing could be linked to the sharing of personal data. Essentially, the price point for consumers will depend on whether or not the car resells their data.

"Vehicle data can show where people are going," he observes. "There are companies that will aggregate and re-sell cell phone data that's sold by various apps on mobile devices. The autonomous vehicle becomes just another point of that telemetry that can be sold for profit by the companies to subsidise the sale of that vehicle." Don't expect AdBlock for the connected car, warns McGladrey. "This is a case of the old adage: if you're not paying for the product, you are the product."

Software vs vehicle lifespan

One of the biggest challenges around securing the connected car has to do with the vehicle lifespan. Cars can run for 15 years, and during that time their software will continue evolving, requiring updates and patches. But for how long will those updates and patches be released?

> " After the software support in a vehicle stops, who is at fault if there is a cyber incident?

The industry may look to operating system vendors like Apple or Microsoft as an example. These players have a development team that works on the current product as well as a team that provides support for older products. But only for so long. This sort of issue has already hit many consumers with printers, but it won't go down well on a US$50,000 vehicle.

"For autonomous vehicles, that's going to feel a little weird," he warns. "If you were to buy a 1960s car, it can still go places. With a connected car, would it still work? Are you required to turn the car in after 20 years and the period of support is over? After the software support in a vehicle stops, who is at fault if there is a cyber incident? We don't have good answers to these questions yet."

Smart charging practices are essential to EV battery health

Improper charging accelerates battery degradation. Smart home charging could make a difference, writes Will Girling

The growth of electric vehicle (EV) sales globally has created an increasingly valuable charging infrastructure market. According to research firm ReportLinker, the market was worth US$8.8bn in 2021, with the capacity to increase to over US$23.4bn by 2028–a CAGR of 15%.

In the years prior to 2020, China reportedly invested US$2.4bn in EV charging infrastructure, while other countries like the US, Japan, and South Korea were not far behind. The COVID-19 pandemic briefly slowed growth as workforce and supply chain disruption set in, but with EV sales increasing 160% in Q1 and Q2 of 2021, investment in EV charging has regained ground.

However, this focus on public charging points ignores the consumer reality: estimates suggest that 80% of all EV charging is done at home and overnight.

This makes home charging hardware integral to the electrification of the automotive industry. However, in this burgeoning sector, charging and its effect on battery deterioration should be a core consideration.

Causing a strain

Far from being static, the home EV charging market has undergone significant changes. Focused on the design, development, engineering, and manufacturing of smarter home charging solutions is UK-based Indra. Mike Schooling, Chief Technology Officer and Founder, recalls the pitfalls of the first-generation technology.

"When we got involved in 2017, everything was simple: you'd park your car at home, connect it to a charge point, and let it charge until it was full," he

explains to *Automotive World*. "That's bad for two reasons: charging to 100% is deleterious for lithium-ion (Li-ion) batteries, and everyone charging at the same time in the evening puts a big strain on the grid."

The scale and immediacy of both problems have been widely reported. Consultancy Ernst & Young (EY) estimates that EV uptake could cause energy blackouts and grid overloads in Europe by 2035. Li-ion batteries have an optimum temperature range between 15 and 35 degrees Celsius. Anything below this range will slow charging times appreciably, while temperatures above will increase decomposition of battery electrodes and create a fire risk. Despite ongoing research to find a mass applicable substitute for Li-ion, it remains the industry standard for EVs.

Introducing smart charging

"There has been an interest in smart charging for some time, but there was no real consensus on what it meant," states Schooling. That started to change in 2019 when companies and governments worldwide began to collaborate on a solution. In that year, the International Renewable Energy Agency (IRENA) published a 16-page prospectus on the benefits of smart charging capabilities, including the standardised interoperability of charging hardware, cost reductions for consumers, and vehicle to grid (V2G) energy transferral.

Today, Indra's smart EV chargers for homes include features such as app-based control, scheduling based on customer use preferences, and
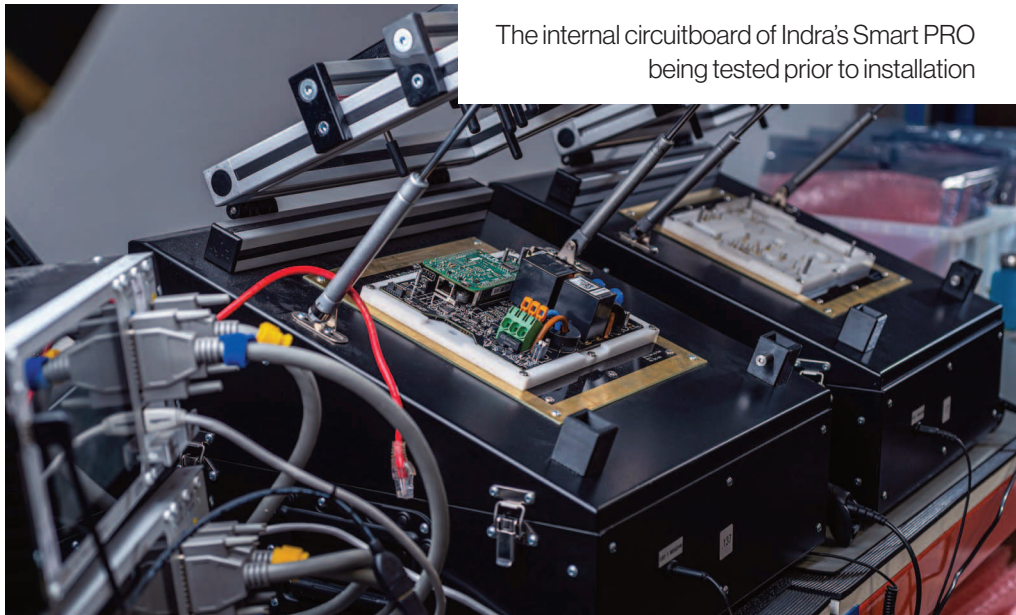
The internal circuitboard of Indra's Smart PRO being tested prior to installation

© Indra

automatic off-peak charging to minimise costs. Despite industry leaders like Xpeng developing ultra-fast charging units that can deliver a 200km range for its G9 SUV in five minutes, Schooling is sceptical about this practice's effect on battery health. "A battery that is not constantly kept at either 0 or 100%, exposed to high temperatures, or forced with heavy loads of energy will perform better in

> ## " A battery that is not constantly kept at either 0 or 100%, exposed to high temperatures, or forced with heavy loads of energy will perform better in the long run

the long run," he says. "It's better to charge a battery slowly overnight than ultra-fast."

The issue of fast charging has been a point of controversy in the automotive industry. A January 2022 article in the Financial Times reported that a driver damaged their Nissan Leaf's battery by using highway-based fast chargers multiple times a day. Subsequent analysis of the claims found that it was the Leaf's battery cooling system, not fast charging itself, that led to the deterioration. Still, while many consumers remain unfamiliar with the dangers and limitations of EV charging, a more cautious approach is warranted. "Clearly, there's no one-size-fits-all solution to the problem," adds Schooling. "Charging outside of the home has other considerations. But, in terms of the home charging market, gradual overnight charging is generally safer for batteries."

Challenges of scale

Home charging may be beneficial for EV battery maintenance in the long term, but there are still obstacles.

© Indra

Energy prices in Europe, for instance, have been characterised by unprecedented rises in 2022. As of July, the European Commission calculated a 318% jump for Italy, 336% for France, and 411% for Spain and Portugal. However, Schooling is confident that this won't impact the home EV charging hardware market. "All electricity costs are relative—using a fast charger on the highway is going to cost practically the same as the wholesale energy from a house." In fact, once the upfront cost of the hardware is accounted for, consumers can save money by scheduling their charging for cheaper, off-peak hours.

However, he concedes that the home charger market is susceptible to the same component supply chain and staffing shortages that the majority of automotive players are combating. Furthermore, due to the enhanced connectivity, smart chargers also present a distinct cyber security risk. The UK government has taken steps to mitigate this threat through new regulations—its Electric Vehicles (Smart Charge Points) Regulations

passed in December 2021 but will only come into effect from January 2023. "It's important that these measures are taken; you don't want someone to maliciously take over thousands of chargers and ruin vehicles and the grid," says Schooling.

From his perspective, solving the problem of battery deterioration through better home charging will be determined by the extent of this broad collaboration with regulators and companies. In July 2022, Indra finalised an exclusive hardware provider deal with ElectriX—a proposition from LV= General Insurance that deals with EV leasing, home charging, and EV-related insurance. Elsewhere, the company is targeting partnerships with Tier 1s and OEMs like Renault, which currently offers home chargers as part of new vehicle sales packages. "It's much easier to make an impact on consumers through these relationships than individual sales," Schooling states. As EV sales go beyond the early adopters, it will be vital to instil good battery health and charging practices as electrification truly takes over the mass market.

AVs will become mobile audio-visual experience centres

The rise of autonomous vehicles and in-vehicle infotainment means that transport could transform into an entertainment-based experience. By Will Girling

By 2028, the global autonomous vehicle (AV) market could be worth US$11bn, a CAGR of 31.3% from 2021's US$1.64bn. This is according to a June 2022 report from Fortune Business Insights, which also predicted Asia-Pacific's market dominance and heavy general industry investment in advanced driver assistance systems (ADAS).

The future of mobility, at least as far as light passenger vehicles are concerned, seems to be one where driver input is significantly diminished. Despite this, progress is still noticeably uneven across regions: General Motors' San Francisco-based self-driving taxi service, Cruise, is reportedly losing US$5m a day; meanwhile, the Chinese government has consented to full autonomous vehicles on the streets of Shenzhen from 1 August.

While the development journey is unlikely to be a smooth one, what does seem certain is that drivers' and passengers' experiences will fundamentally change. Beyond simply being a method of getting 'from A to B', cars could soon become mobile living spaces that transform the general understanding of work, play, and transport. Infotainment and AVs are the tech duo that will accomplish this new standard.

A new vehicle experience

"User experience is the key product differentiator and game-changer in tomorrow's mobility," states Guido
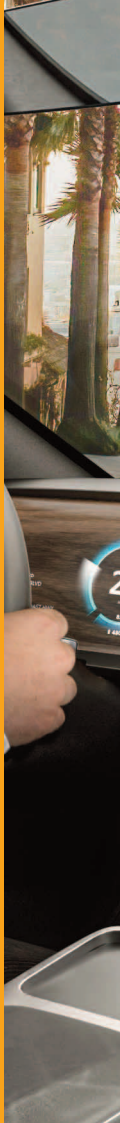
A depiction of Continental's ShyTech system in action

Meier-Arendt, Principal Expert for Human-Machine Interface at Continental. He suggests to *Automotive World* that customers are becoming increasingly less interested in features but rather the 'experience' of the vehicle. The global infotainment market is growing–forecast to be worth US$15bn by 2030, according to Grand View Research–and that experience is one that will be defined by enhanced connectivity.

The new era of connected mobility will not just be between passengers and the outside world, but also between them and the car itself. "With connectivity becoming standard for new vehicles, we can seamlessly integrate the digital lifestyle to which drivers and passengers are accustomed from using smartphones," he says. This could

include cloud-based personalisation settings for seat or air temperature, voice command control functions, and even an artificial intelligence (AI)-based "companion" that can anticipate the needs of the driver. The latter would be based on behavioural analysis and algorithms that measure engagement with available content.

Meier-Arendt considers the size and interactive potential of screens within vehicles to also be a significant trend–both aspects are likely to increase, which was also corroborated in Continental's 2022 Mobility Study. However, larger screens could introduce a safety hazard: "Too much information can easily lead to distraction and endanger the safety of all road users. Our ShyTech display technology addresses this by serving

the increased demand for large screen solutions, but only appearing when it is needed." This is an important consideration for now. However, as self-driving vehicles progress through the five levels of autonomy, the dynamic will change completely.

A mobile living space

If a car was capable of Level 5 autonomy–full autonomy in all conditions, at which point a steering wheel and foot pedals would be unnecessary–the concern of driver distraction would be eliminated. From this point onwards, audio-visual content could become fully immersive for all riders, with content streaming, gaming, video calls, and more becoming central to the

experience. "In this context, visual advertisements, shopping apps, and tourist guide applications will also become an option," adds Meier-Arendt. "Users could even continue their education during the drive and take foreign language courses with 'edutainment' applications."

In essence, the in-car experience will become almost indistinguishable from customers' lives outside the vehicle. This 'mobile living space' could be complemented with new interior concepts like rotating chairs, desks, and displays for displaying real-time data streams. The inside of a car could effectively become like a mobile working environment, with teams working together on the road with the efficaciousness of a standard office.

Regulations and limitations

In terms of regulation, Meier-Arendt indicates that infotainment's relationship with AVs will progress smoothly. Indeed, at least so far, this has proven to be the case. The United Nations Economic Commission for Europe's (UNECE) existing legislation for automated lane keeping systems (ALKS) on highways–established in 2021–is rated for Level 3 autonomy, meaning drivers can legally engage in secondary tasks like watching a movie while in transit.

integral part of the journey. "The most important thing regarding all these concepts is a continuous and natural dialogue between people and vehicles. Building user trust and delight is an imperative for AVs, regardless of whether they are private cars or autonomous taxi services."

According to a 2021 report by the European Commission (EC) concerning consumer trust in AVs, the concept of self-driving vehicles still causes consternation. Even though Honda's Legend–the first car certified at Level 3 autonomy–was released in March that same year, the EC found

> "
> # One of our biggest challenges will be the new role of drivers

Since autonomy is restricted to limited circumstances at Level 3, in-vehicle infotainment must be disabled when the driver resumes control. However, this will not be a problem as AVs become more advanced. "At Level 4 and Level 5 applications, the driver is not considered a fallback solution. Therefore, those regulations will probably not restrict the development of infotainment systems." As of Q2 in 2022, Germany and the wider EU are already introducing regulations concerning Level 4, Meier-Arendt confirms.

Building trust

There is no certain timeline for realising this new vision for mobility, but Meier-Arendt emphasises that building consumer trust will be an

that the majority of people still did not fully trust AVs. In fact, out of 7,000 people surveyed as part of Swedish National Road and Transport Research Institute's BRAVe project, 30% stated they would feel unsafe even crossing a street on which an AV was operating.

Despite this, the EC still expects around 18 million new vehicles sold in 2024 to have some form of autonomous capability. "One of our biggest challenges will be the new role of drivers," concludes Meier-Arendt. "Creating transparency and an awareness are highly relevant when it comes to developing new concepts for infotainment." Clearly, the race to settle public opinion is on. It is only by doing so that drivers and passengers will be able to place their complete trust in fully autonomous systems and truly enjoy the ride.

FCC SpaceX satellite ruling advances autonomous vehicle development

SpaceX Services has been given the green light to use its Starlink satellite internet constellation on vehicles in motion. Gabor Szecsi explores the implications

Marking a major regulatory milestone in the development of automated vehicles, on 30 June 2022 the Federal Communications Commission (FCC) granted SpaceX Services Inc. authorisation to use its Starlink system on vehicles in motion and Kepler Communication Inc. to use satellite services on vessels in motion. This regulatory approval allows the use of the low Earth orbit satellite constellation to provide high-speed, low-latency Internet connection to vehicles on the road for the first time. Usage of this technology is essential for the uninterrupted communication required for real-time decision-making by self-driving vehicles.

FCC decision

In this decision, the FCC authorised SpaceX to operate earth stations in motion (ESIM) on vehicles throughout the US and its territories, as well as on aircraft operating in American airspace, including those that are not registered in the US. Furthermore, SpaceX and Kepler Communications are authorised to operate ESIM on vessels in US territorial waters and throughout international waters worldwide.

The FFC stated in its decision that authorising a new class of terminals for SpaceX's satellite system is in the interest of the public and that this authorisation will "expand the range of broadband capabilities to meet the growing user demands that now require connectivity while on the move, whether driving an RV across the country, moving a freighter from Europe to a US port, or while on a domestic or international flight. Similarly, authorisation of the Kepler ESVs service will provide much-needed connectivity to vessels in the territorial waters of Hawaii and Alaska, and remote areas throughout the world, including the Arctic and Antarctic polar regions."

Companies are authorised to use Ku-band frequencies (11.7-12.7 GHz downlink and 14-14.5GHz uplink) for communication between the satellites and earth stations. So far, Ku band

frequencies have been used for satellite communications that are utilised for broadcasting satellite television. The FCC decision is not surprising as it follows international recommendations. The International Telecommunication Union (ITU) and the European Telecommunication Standards Institute have recommended allowing ESIMs to use Ku-band frequencies. However, satellite television service providers are concerned about the FCC's decision, arguing that the new class of terminal will cause interference between different satellite service communications.

Significance for self-driving vehicles

Geostationary orbit satellites (GSO) that have been used to provide Internet connections for aircraft and vessels allowed a high-latency connection. In this context, latency refers to the time it takes for a data packet to travel from one point on the network to another. In the case of self-driving vehicles, it is the time it takes for the data packet to travel between the vehicle and the satellite. Because GSOs are very far from Earth, over 22,000 miles away, GSO satellites have at least 250 milliseconds (ms) latency. By comparison, cellular network signal latency is about 10ms, which would seem adequate to

ensure safe operation for self-driving cars. However, the problem with relying on cellular networks for self-driving cars is that they do not provide 100% coverage, which would mean that self-driving cars would not function properly in rural areas with irregular service or in big cities, where tall buildings would disrupt cellular communication.

Conversely, low Earth orbit (LEO) and very low Earth orbit (VLEO) satellites have the potential to provide a signal latency of less than 10ms. In addition, a combined cellular-satellite network would provide sufficient coverage required for the safe operation for self-driving cars.

o ensure safe operation, automated systems must rely on real-time data to make driving decisions while on the road. The necessary information might be

gathered by the car using cameras and sensors. Other critical information might be transmitted through cellular or satellite networks. Since none of these methods alone could provide uninterrupted data transmission, the technical solution would most likely be an integrated network composed of low-latency VLEO and 5G cellular networks.

The immediate effect of the FCC decision is that SpaceX and Kepler can now provide onboard Internet service for airlines and commercial vessels. For the long term, the decision also opens new avenues to encourage the development of the combined satellite-cellular infrastructure that is crucial for the safe operation of self-driving vehicles. The decision will also help advance the development of Internet communication between cars and their manufacturer.

© SpaceX

SpaceX Starlink satellite dish

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Brand loyalty: automakers become relationship service experts

Medallia shares its outlook for the future of automotive customer experiences. By Megan Lampinen

The customer experience (CX) can make or break a brand. Get it right, and you secure buyer loyalty, bolster revenue and position the company for future growth. A 2022 study from PricewaterhouseCoopers (PwC) found that customers are willing to pay up to 16% more for a great experience. It also found that CX leaders can have up to five times higher revenue growth than CX laggards. At the same time, getting it wrong can have dramatic consequences. The study found that 32% of customers will walk away from a brand they love after just one bad experience.

Navigating the automotive CX journey against the backdrop of connected, autonomous, shared and electric (CASE) mobility is no easy feat, but Medallia is here to help. The company specialises in using operational customer experience management to provide companies with a competitive advantage. The key, says Jodi Searl, Vice President of Industry Solutions and Head of Automotive and Powersports, is to listen to your customers, analyse what they are saying and act on it in a way that improves their experience.

"One of the worst things you could do is solicit feedback from a customer and then not do anything with it," she tells *Automotive World*. "You are missing great opportunities to not only grow your brand but also grow your business." Medallia helps companies figure out how to listen at scale and then analyse that into actionable insights. 'Listening' can come in many forms and from many sources, such as a customer's engagement with a website or app.

Porsche Mission E Augmented Reality App

The purchasing journey

It's hard to ignore the acceleration of the digital revolution in the automotive space, particularly around vehicle purchasing and servicing. COVID-19 brought forward projects that might have been on a five- or ten-year roadmap, and saw them materialise in a matter of weeks or months. Suddenly, automakers and dealers alike were faced with the need to engage with customers in a new way.

One of the lessons learned early on in the auto sector's move to digital is that customers value a seamless experience across different touchpoints. Be it on a dealer website, an automaker app or in person at a retail location, shoppers want consistent information and personalisation. "Customers generally don't see a distinction between an OEM and a dealership; they look at the latter as an extension of that OEM," Searl notes. "They expect a seamless consistent experience from a digital and interface perspective all along the way."

It's surprisingly easy to get it wrong. Imagine this scenario: a shopper visits an OEM website to configure a vehicle

exactly how they want it. Then they receive a pop-up informing them that this particular vehicle is available at a specific nearby dealer location. The shopper then visits that dealer website and engages in a webchat, but finds that the chat is not monitored by a live person. They may ring the dealership and struggle to reach the right person or wait on hold for some time. They may make an appointment to visit the dealer in person, only to show up and then discover that the inventory was not updated and the vehicle is not even there.

All of these stages represent missed opportunities to surprise and delight the shopper. "There's great opportunity for a better integration between the different experiences," emphasises Searl. "It's very important to pay attention to the digital-first philosophy and where and how you can control and orchestrate those experience moments."

Looking outside the automotive industry could prove helpful to players in this effort. Searl highlights Amazon as an example of a company that excels at CX. She also points to the hospitality space as one that has numerous

BMW owners that resent paying a subscription for heated seats are turning to hackers

© BMW Group

synergies with automotive: both have parent brands alongside independently owned and operated properties. "Automotive can learn from a luxury hotel chain about how it manages the digital process with the various owners of not only hotel properties but also web properties," she adds.

Sale vs service

Brand interactions have traditionally been a 'one and done' situation wrapped up at the point of sale. But that's changing, and in a way that could prove lucrative for building the brand experience. Subscription features represent one avenue in which brands can delight their consumers, but they will need to do their research.

Traditionally, cars have offered extra features for an additional price; these were nearly all hardware upgrades– think leather seats. More recently, optional extras have taken the form of software-enabled features. "From a subscription perspective, we would recommend that OEMs make this an iterative process," advises Searl. "They

need to make sure that, in launching a programme, they are well grounded by market and customer research, and that the data indicates a decision is likely to be a success."

She also sees approaches like this as creating an opportunity for OEMs and dealers to work together for revenue generation with a vehicle that's already in service. "Strategically this could be a good move, but you have to do it in such a way that the customer doesn't feel like they're being nickelled and dimed for an already very expensive purchase."

BMW recently began selling subscriptions for heated seats. For about US$18 per month (with yearly or unlimited access options also available) owners can activate the feature, which is already installed in their vehicle but not made available until payment is received. Some owners, annoyed at the extra fee, have instead turned to hackers who can unlock the feature, off-the-books, for a lower price.

While BMW is currently dealing with black market hacks, Searl still sees potential for subscription features to

bolster the overall CX. "There could be pros, particularly around features that are region specific. These features might not resonate or sell in some markets, but it's easier to configure a vehicle that way when you're doing a bill of lading or a vehicle build."

Spotlight on Volvo

Volvo Cars is one automaker that has prioritised the customer relationship and listened to owner feedback. Its aim is to become more of a 'relationship services company'. To that end, it launched the One Voice programme, which consolidates numerous surveys and strategies around customer feedback into a more concise and efficient way of listening and responding.

"Volvo is doubling down on the ownership experience and figuring out how to solidify its relationship with customers on a daily basis," notes Searl. "It's a compelling story around the harnessing of data to deliver on brand promise and how to measure progress." The end game is to have such a strong relationship that when a customer needs a new vehicle, they don't even bother looking anywhere else; they just come directly back to the brand.

For all automakers, successful customer relationship management will increasingly rely on data operationalisation. "It's really about how you bring those insights to life in a meaningful way for customers that impacts your business health," Searl adds. "It's meeting the customers where they're at and delighting them at every step you can."

Many customers will walk away from a brand after just one bad experience

An inflection point

The mobility sector has reached an inflection point in terms of next-generation purchasing behaviours and the user experience. "In the next ten years, we will see a completely new narrative that's already being written," she states. "Companies like Lucid, Tesla and Rivian are using feedback in a meaningful way and they're establishing their direct relationships with customers."

This is a logical time for traditional legacy OEMs to take stock of current strategies and figure out how to contribute to this new narrative. "This inflection point is here. The ownership models are changing," says Searl. "There is that opportunity for automakers to influence the narrative, but they have to be paying attention to what customers want and respond accordingly."

What is the cost of cleaning up commercial vehicle diesels?

Enough diesel trucks will be built in the coming years to justify technology investment, says the ICCT. Megan Lampinen hears more

The commercial vehicle industry may be heading towards a zero-emission future, but that remains years–even decades–away. The International Council on Clean Transportation (ICCT) estimates that by 2035 most of the new vehicles registered will be zero emission, powered by battery electric or fuel cell electric setups. Until then, numerous new diesel trucks will be making their way to market. Will these volumes be enough to justify new investments into internal combustion engine (ICE) technology?

The last CV ICE standards?

Felipe Rodriguez, ICCT's Heavy-Duty Vehicle Program Lead, believes they will. That's in part down to regulatory actions. The UK aims to phase out new non-zero-emission heavy goods vehicles by 2040 and the ICCT expects a similar timescale in Europe. "2040 is still 18 years away," Rodriguez points out.

In the meantime, Euro VII could be the last ICE regulation the region introduces. The current standard, Euro VI, was implemented in 2014 and Rodriguez estimates it will be replaced by Euro VII in 2027. That would mark a 13-year sales run for both Euro VI and Euro VII.

Tremendous investment was poured into Euro VI, producing some very significant innovations. The same could happen again with Euro VII. "Euro VI was a revolutionary regulation, given that it demanded more from the emissions side while also creating opportunities to improve the efficiency of combustion engines," he tells *Automotive World*. Euro VI engines are typically more efficient than Euro V engines and significantly cleaner. "The numbers are there to justify new investment in these technologies on the way to the phaseout," he emphasises. "It's likely Euro VII is indeed the last new standard that will be set for ICE but it is there."

Potential levers

Truck, buses and coaches account for one- quarter of EU road transportation CO_2 emissions and 6% of total EU emissions. The first-ever EU-wide CO_2 emission standards for heavy-duty vehicles was adopted in 2019 and put in place targets for reducing the average emissions from new trucks for 2025 and 2030.

Rodriguez believes these can be met with ICE technologies. "I still expect to see many innovations in the run-up to 2030 and even beyond that," he notes. One of the more impactful could be higher peak pressures in the combustion engine, which have advanced from roughly 200 bar to 250 bar. This unlocks considerable potential for better efficiency. He also flags the move to 48-volt systems and the electrification of auxiliary systems, oil pumps, water pumps and pneumatic systems: "All of that can be electrified, reducing the friction on the engine. Low friction lubricants improve air handling and waste heat recovery systems can really improve

the CO_2 and pollutant emission performance of combustion engines. And those investments will be needed in the coming years."

As for tackling pollutant emissions, other levers will be needed such as cylinder deactivation. He also sees notable impacts from a close-coupled diesel oxidation catalyst or a selected catalytic reduction catalyst, located very close to the engine in order to maximise the effectiveness. Rodrigues also has his eye on the electrically heated catalyst, which usually comes in combination with 48-volt systems. "That is to allow the high voltages and high power needed to electrically heat the catalyst for thermal management," he explains.

Then there is dual urea injection which involves splitting up the SCR system into two bits. In January 2021 Cummins introduced what it claims was the first dual-dosing architecture to the truck industry with a solution for the new Scania V8 range. "The dual injection of AdBlue, urea, diesel exhaust fluid–whatever you want to call it–provides a lot of flexibility in optimising the emissions performance," notes Rodriguez.

Like the Cummins dual-dosing offering, many of these technologies are in production. "Suppliers to the industry, the main manufacturers, are ready to really launch these products on a large scale," he emphasises.

Cost and effect

None of these technologies come for free and will boost the price of new vehicles. But by how much? This information is rarely released to the public, but ICCT has tried to conduct its own assessments to better

understand the cost involved. Overall, it estimates that the technology package for emissions control will boost the vehicle price tag by €5,000-€6,000. "Manufacturers are a little concerned that the total cost will be higher than that, but we are pretty confident of this estimate based on our conversations with suppliers."

mean the intervening years won't witness improvements. Pointing specifically to the SuperTruck programme in the US, which demonstrated some impressive results particularly around brake thermal efficiency, he adds, "There is a lot of progress still to be made."

> ## " It's likely Euro VII is indeed the last new standard that will be set for ICE but it is there

And importantly, these technology packages should allow automakers to meet upcoming emissions targets. For instance, at the World Congress Experience in April 2022, the Southwest Research Institute (SwRI) demonstrated the effectiveness of its CAT-DEF (Catalysed Diesel Exhaust Fluid) technology to reduce heavy-duty diesel engine NOx emissions to meet the California Air Resources Board (CARB) 2027 standards.

The key, cautions Rodriguez, may come down to calibrations: "It is not only about the technologies, but also about the right calibration. It is up to the manufacturers to invest resources into making sure that the technologies are correctly calibrated."

A false dichotomy

While Rodriguez does not expect the ICE to survive past 2040, that doesn't

However, most of that will be incremental. "The most dramatic innovation that has been shaping up for almost two decades is an opposed-piston engine," he notes. This has come from American company Achates Power, which has managed to develop an engine with good efficiency and low emissions, with the option to run on hydrogen.

"But there's simply no appetite right now for manufacturers to take that risk and invest in these types of new technologies, as they would only expand the life of ICEs by a few years at best," he observes. "Manufacturers are realising that the future is zero emission. There are no breakthrough technologies left in the combustion engine area. Everything costs effort and money, for small incremental improvements. I don't see anything really coming of that magnitude that would 'save' the combustion engine in the long-term."

Is 'Vision Zero' viable?

Chris Mason explores whether many industry safety goals are realistic or effective, and the difficulty of global standards and regulation

Over the last decade, the automotive industry has transitioned from hardware- to software-driven safety in the pursuit of 'Vision Zero': a widely recognised ambition aimed at eliminating all traffic fatalities and severe injuries, while increasing safe, healthy and equitable mobility for all.

First implemented in Sweden in the 1990s, the Vision Zero concept has proved successful in Europe and is gaining momentum across America. The introduction of hardware such as anti-lock brakes and crumple zones have been a driving force in enhancing road safety, but intelligent safety systems such as autonomous software and automatic emergency braking technology are taking the industry to new heights in terms of passenger, driver and pedestrian protection.

Danilo Teobaldi, Vice President of vehicle engineering at Nio, believes that the development of automated systems within the vehicle are a driving force on the path to Vision Zero. "The continuing evolution of autonomous technology aims to deliver even greater safety benefits than earlier technologies. Autonomous driving software has the benefits of reducing crashes, preventing injuries and saving lives. By reducing, and finally removing human errors, these technologies will help protect drivers and passengers, as well as pedestrians and cyclists."

However, the idea of preventing all accidents is a major challenge and, according to industry experts, is not entirely possible. Although Vision Zero is an end goal, it remains a concept and, as its name suggests, should operate as a vision and not an absolute certainty. In many respects, the journey itself is as important as the destination.

Dominik Schuster, Vice President of safety at BMW and part of the FISTIA intelligence safety working group, believes that there are many challenges on the road to Vision Zero. "In general, the measures which are currently discussed in the safety community bear the possibility to further reduce fatalities. However, on the road to Vision Zero, we must address the consequences and implications associated with it. Are zero traffic fatalities really achievable? What restrictions will society accept if zero fatalities are to become a reality? What methods are suitable for the implementation of new safety measures in the direction of Vision Zero? And what actions should be tackled next on our path to Vision Zero? These are the questions that the safety community and society as a whole must find an answer to."

Engineering collaboration

Over the next decade, intelligent safety solutions–which will feature prominently in the rollout of self-driving vehicles–will significantly reduce the number of road accidents and fatalities. The primary goal is to make these systems as safe as possible and understand the long and complex journey that will be driven by OEMs, suppliers, governing bodies and, most importantly, the evolving engineering
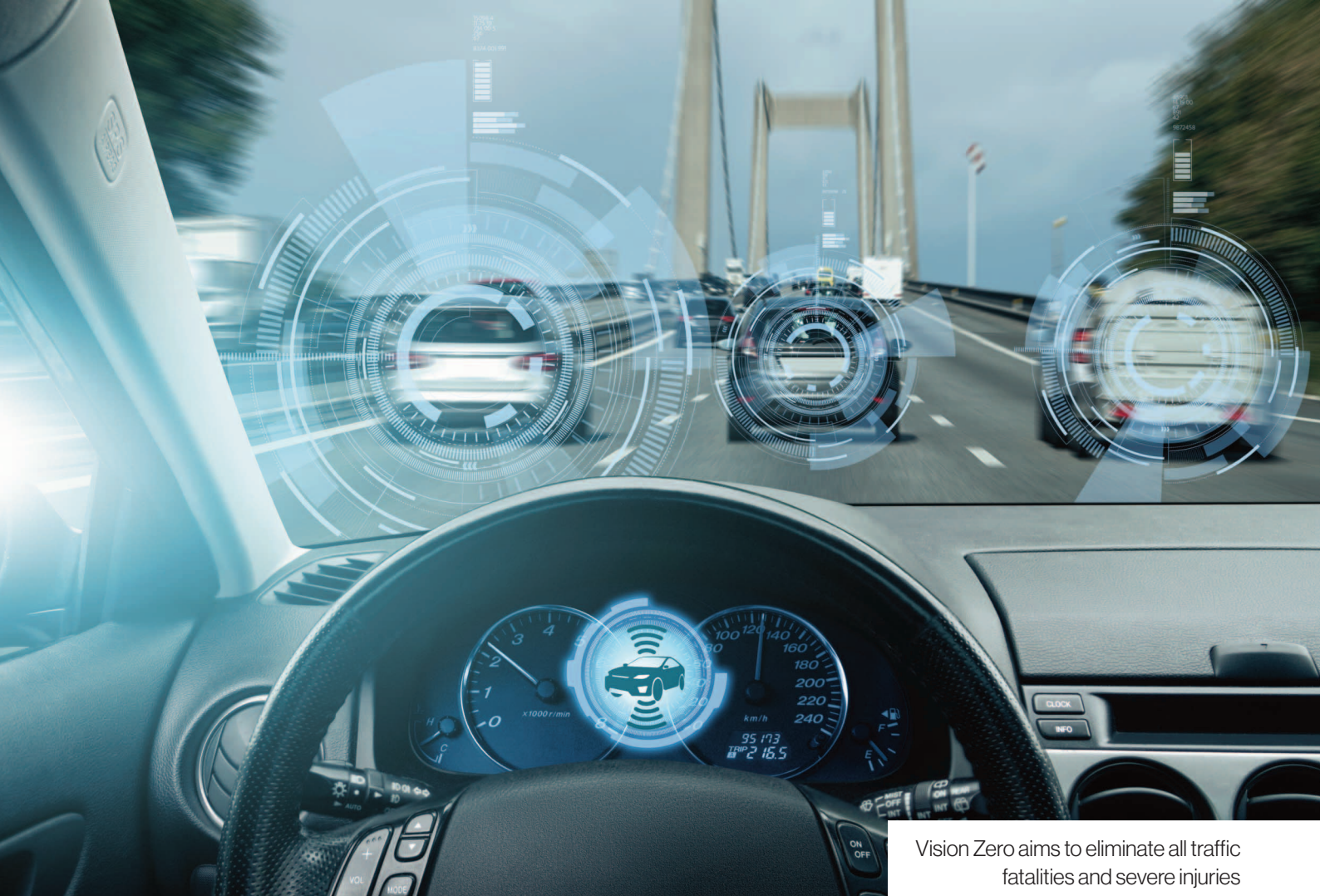
Vision Zero aims to eliminate all traffic fatalities and severe injuries

community. To reduce crashes as much as possible, the industry must collectively research and develop the most efficient and effective measures and technologies to ensure optimum safety for businesses and their customers, which can only be achieved with patience, collaboration and scrutiny.

Klaus Kompass, professor of vehicle safety and driver assistance at the Technical University of Berlin, and European executive board member for FISITA, says that although the Vision Zero approach is one which is widely accepted and adopted, it is often misunderstood: "We must set the bar high to mobilise the necessary energy towards improving safety, but the 'zero' is–and will remain–a vision." Another issue lies in the fact that the Vision Zero approach implies that

each and every chance to improve safety must be captured, which is currently impossible. "The available resources are limited and restricted, including vehicle weight, packaging, space, cost of ownership, development time, engineering capacity and consumer acceptance," he adds. "We as an industry have to carefully identify and select the most efficient and effective measures, and leave the less effective ones behind."

Standardising road safety

Intelligent safety is a holistic approach to overall road safety, encompassing measures taken by all stakeholders involved, including vehicle manufacturers, suppliers, mobility service operators and town planners.

Yet, around the world, there are still breakdowns in understanding and acceptance, which impacts the effectiveness of the software. For self-driving vehicles to drive the industry towards Vision Zero, it is essential that a standard is established by transport authorities and governments.

and collaborating with technology providers. He believes that autonomous functions will be present on all vehicles in the future, which will help propel new levels of safety: "Autonomous driving functions will soon become standard across the global car

> ## " Although Vision Zero is an end goal, it remains a concept and, as its name suggests, should operate as a vision and not an absolute certainty

However, for many, it is impossible to create such a global standard for autonomous vehicles. Despite this, Schuster remains confident that it is possible to establish processes on an industry-wide level that will significantly improve the rollout of intelligent safety systems and technologies: "While the standardisation of safety vehicle architecture from all OEMs seems unreasonable, standards that specify the underlying processes, such as the tools used, quality measures, safety of intended functionality analysis and positive risk balance, will accelerate the adoption of intelligent safety systems and increase public trust in them."

Teobaldi says that over the last five years there have been many successful examples of OEMs developing innovation on their own

market, especially in the segment where Nio competes. The competition–and therefore success–,will not be based on whether an OEM has self-driving functions or doesn't have self-driving functions. Instead, it will be based on the smooth execution and the quality of the experience when the driver hands over the controls to the machine."

The evolution of safety systems will always be guided by legal requirements, in addition to the outcome of consumer testing. To predict the next evolutionary steps of these safety systems and technologies, the industry needs to support an exchange between all stakeholders regarding the requirements to ensure it can get as close to Vision Zero as possible. Only then, can society truly begin a conversation about achieving that 0% target.

About the author: Chris Mason is Chief Executive of FISITA