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CES 2023 moves from concepts to commercialisation

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Automotive World
1-3 Washington Buildings
Stanwell Road, Penarth,
CF64 2AD, UK

www.automotiveworld.com
T: +44 (0) 2920 707 021
support@automotiveworld.com

ISSN: 2634-9531
Registered number: 04242884
VAT number: GB 815 220 173

CEO & Managing Director:
Gareth Davies

Editor at Large:
Megan Lampinen

Contributors:
Neil Alliston
Chris Eyte
Will Girling
Ian Graig
Diana Grishina
Jasper Konings
Alexandr Melnik
Michael Nash
Arturs Smilkstins

Production:
Anmol Mothy

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CES 2023 moves from concepts to commercialisation

Megan Lampinen reports back from one of the world's most influential technology events

As the consumerisation of the automotive industry accelerates, CES 2023 attracted a solid showing from companies keen to spotlight their mobility solutions to a diverse audience. According to the Consumer Technology Association (CTA), which produces CES, factory-installed automotive technology revenues are on track to grow 4% year-on-year to US$15.5bn in 2023. With more companies than ever competing for a slice of the pie, the stakes are high. Most of today's players agree the industry is heading towards a connected, autonomous, shared and electric (CASE) future, but everyone has a different take on the best route there and the technologies that will pave the way.

On display

"Several new players are moving into the automotive space and had a big presence at CES," notes Martin Kellner, Associate Partner at McKinsey. That includes new OEMs like VinFast and the Sony-Honda joint venture, as well as technology companies like Amazon/AWS and Google, and chip companies like Qualcomm.

Overall this year's event saw a huge focus on battery electric technology, with big hitters like Mercedes-Benz outlining plans for a global own-brand charging network and Ram unveiling a concept version of its upcoming all-electric pick-up. After sending shockwaves through the industry with its Vision-S concept

three years ago, Sony was back to show off its latest electric vehicle (EV) prototype. The Afeela, a product of its joint development work with Honda, lays the groundwork for a future production vehicle that will inevitably show off its technology and entertainment expertise.

Ivan Drury, Edmunds' Director of Insights, suggests that the bulk of automaker announcements this year "don't seem much different from what one might expect to see on the Detroit, New York or LA auto show floor." He goes on to note that most automotive brands "appear to be leveraging CES as a platform to simply launch EVs or EV development partnerships in the same manner that they would at any regular auto show–instead of pushing the envelope a bit further to showcase more revolutionary advancements in transportation that are not typically expected within legacy automaker portfolios."

Stephanie Brinley, Associate Director, Research and Analysis, S&P Global, was similarly underwhelmed by the Sony Honda Mobility concept in particular. "While significant for Sony and Honda, there was little of the

© Mercedes-Benz

Mercedes-Benz announced plans for a global charging network while also highlighting new automated driving capabilities

© Sony Honda Mobility

Sony Honda Mobility unveiled the new brand Afeela at CES

concept that wasn't an idea expressed previously," she tells *Automotive World*.

Automaker EV announcements aside, this year's event saw considerable attention paid to software-defined vehicles and the capability for on-demand features like Harman's Ready on Demand. As Brinley points out, "automakers expect that [these] will deliver massive margins over time." Suppliers, including Aptiv and Continental, were also making a big push with their software platforms and keen to position themselves as partners in software development.

There was no shortage of autonomous driving updates, with Zoox, Motional, Hyundai-Mobis, ZF and Holon all active on this front. Kellner suggests this year saw a "shift to autonomous driving use cases with potential earlier time to market, from robotaxis to delivery robots, autonomous trucks, and roboshuttles." Brinley, meanwhile, saw SAE Levels 3 and 4 take "lower priority" at the show while "Level 2+ is seeing increased near-term production and execution, compared with prior conceptual demonstrations." She points out that Here Technologies and Google also had HD mapping news, "both of which can help enable near-term automated driver assistant system enhancements."

The Tesla Loop was also a disappointment to some. Here, fleets of zero-emission Tesla models offered free transportation between three locations across the vast conference grounds via underground tunnels. While the setup represents an early start of what Elon Musk envisions as a "3D highway", it fell short of a stunning technology showcase. The route remains very limited and the vehicles are entirely human driven, with a maximum speed of 35mph. One attendee from Pittsburgh, accustomed to seeing and using fully autonomous ride-sharing on her local roads, summed it up with the observation that there really wasn't "much to see here."

The message for 2023

CES 2023 attracted more than 3,200 exhibitors spread across nearly 2.2 million net square feet. There's a lot of noise and competition for visitor attention. For Brinley, there was a general feeling of growing from concept vision to production reality. She points to the idea of the "vehicle as a companion and software at your service" being explored and debated for years but now "growing closer to execution and commercialisation. With the broad target established, it's simply time to figure out how best to execute."

That's exactly what many players were showing. "Our message is pretty simple," says Arcady Sosinov, Founder and Chief Executive of charging technology innovator FreeWire. "People need charging; we deploy charging faster. That's it."

Infinitum has a similar message. "Everyone needs a more efficient, smaller, lighter, quieter motor, and we offer that," says Ben Schuler, Founder and Chief Executive. The company's liquid cooled Aircore Mobility motor extends the range of battery electric trucks and slashes the raw material requirements. It was recognised with a 2023 CES Innovation Honoree award.

Harman Ready Care measures a driver's eye activity, cognitive load and vital signs

Mobility software specialist Ivee was demonstrating an immersive passenger experience for ride-hailing in collaboration with Toyota Boshoku. "The rides of the future that you see here are starting today," emphasises Chief Executive Alex Giannikoulis. "They're here and running. We have the vision for 2030 but we also have the vision for 2023."

"It's all about market-ready products, not demos," emphasises Armin Prommersberger, Senior Vice President of Product Management at Harman International. All of the technology at Harman's Explore event is poised to launch in production vehicles this year. "Normally Harman is known for this massive [vision] but the metric has changed in the last two or three years. The consumer wants things now; they have become used to that with electronics. Apple is not showing you an idea of an iPhone 20 today. If there is an iPhone 14, you know about the iPhone 14."

Alistair Weaver, Edmunds' Editor-in-Chief, suggests CES offers a platform for companies to "prop up their products as innovative for the future", and those that do "stand a good chance of separating themselves from the pack." He concedes that there has been debate around the value of traditional automotive shows, but adds that "CES is becoming a must-go destination."

War in Ukraine shapes policy debate in Washington

The conflict has intensified the Biden administration's commitment to policies aimed at strengthening domestic manufacturing and supply chains. By Ian Graig

The war in Ukraine has had a significant impact on debates in Washington over public policy issues with important implications for the automotive industry. In many cases, the Ukraine war helped solidify shifts in public policy that began during the pandemic or as part of the growing competition between the US and China. Those policy trends will continue in the year ahead, regardless of the future direction of the war in Ukraine.

launched a six-month review of how to reduce dependence on foreign suppliers in six key sectors, including advanced batteries, critical minerals, and semiconductors. Pandemic-driven shortages of semiconductors, which had a significant impact on automotive production, increased interest in supply-chain issues.

The Russian invasion of Ukraine served to heighten such interest, expanding support for policies to

> “Non-defence spending programmes like those providing support to the automotive industry could face severe competition for funds

Most notably, the war has intensified the Biden administration's commitment to policies aimed at increasing domestic manufacturing and strengthening domestic supply chains. Many of those policies were launched early in the administration, before the Russian invasion of Ukraine, with a focus on competition with China.

During his first week in office, for example, President Biden signed executive orders designed to increase the use of federal financial assistance and procurement to boost production of key technologies in the US. He

reduce US exposure to global supply-chain disruptions or volatility in global markets for key minerals and materials. Given the Biden administration's strong support for vehicle electrification, a significant goal of those policies has been to increase domestic production of electric vehicles (EVs) and components, including batteries. The impact of the war in Ukraine on global energy markets and prices has added to the administration's support for boosting domestic production and sourcing of electric vehicles, batteries, and critical minerals, while serving to increase domestic EV demand.

One notable impact of the Ukraine war, for example, has been to raise prices for nickel, platinum, palladium, lithium, cobalt, aluminium, copper, and other minerals used in production of EVs, batteries, solar panels, smart-grid infrastructure, and wind turbines. In response, President Biden in March invoked the *Defense Production Act* (DPA) in an effort to increase domestic production and mining of critical minerals needed to manufacture batteries and other renewable energy technologies. The DPA allows the president to use emergency authority to place orders of a product or expand productive capacity and supply. The White House said the administration seeks to reduce dependence on Russia, China, and other sources for these key materials.

Efforts to boost domestic investments in clean-energy technologies and vehicle electrification were also at the heart of the *Inflation Reduction Act* (IRA), which was signed by President Biden in August. The IRA includes tax incentives and other provisions that aim to increase investments in clean-energy technologies, including wind, solar, nuclear, and hydrogen, as well as energy storage and domestic production of critical minerals and energy components.

The IRA contains several provisions related to vehicle electrification, including extension of the federal EV tax credit, creation of new clean-vehicle tax credits for used and commercial vehicles, and extension of tax credits for EV-charging and other alternative-fuel refuelling infrastructure. Many of these provisions, including the extended EV tax credit, add new North American or domestic content requirements designed to boost domestic production and reduce reliance on global supply chains. These provisions have raised concerns among US trading partners who argue that the IRA's tax provisions, including those related to EVs and batteries, discriminate against foreign producers. Addressing these issues will be a major challenge for the Biden administration in the coming year, particularly since Congress seems unlikely to rewrite the law to ease the content requirements.

The war in Ukraine also helped advance Congressional consideration of the *CHIPS and Science Act*, a bipartisan bill that was signed into law by President Biden in August. The law provides more than US$52bn in incentives for investments in semiconductor manufacturing facilities and equipment in the US, creates a new 25% tax credit for investments in US semiconductor manufacturing, and authorises nearly US$170bn in R&D funding across federal agencies. The bill includes a US$2bn fund for the more traditional semiconductors that automakers and suppliers use. Support for such efforts to increase domestic semiconductor production and create a resilient domestic technology supply chain, initially driven by the goal of reducing dependence on China, received added support in the aftermath of the Ukraine invasion and its impact on global technology supply chains.

While the war in Ukraine has boosted support for policies to expand domestic supply chains for EVs and other products, it has also created challenges for funding those efforts. The war is already having a significant impact on budget debates in Washington by increasing support for higher defence spending at a time when the federal government already

faces severe deficit and debt challenges. As a result, non-defence spending programmes like those providing support to the automotive industry could face severe competition for funds in the absence of higher revenues.

designed to support the automotive industry and speed development of advanced vehicle technologies.

Looking ahead, the Biden administration will continue efforts to expand domestic automotive

> “In many cases, the Ukraine war helped solidify shifts in public policy that began during the pandemic or as part of the growing competition between the US and China

This is particularly true since future defence needs will come in conflict with potentially slower economic growth and higher energy prices and borrowing costs. The war in Ukraine thus likely sets the stage for more intense budget debates in the coming fiscal years, with lawmakers looking to find ways to control future deficits and debt while increasing defence spending–all in a time when higher interest rates are adding to the cost of servicing the federal debt. This will put a great deal of pressure on the non-defence ‘discretionary’ spending, including on R&D, loan-guarantee, and other federal programmes

production and strengthen domestic supply chains for EVs, batteries, and other key components and materials, as the US moves to reduce its exposure to global supply-chain disruptions and market volatility. Passage of major new legislation may be more difficult in the incoming Congress, with partisan control split between Democrats and Republicans, but the administration can use executive actions and recently enacted programmes to advance its policy goals. The Ukraine war and its impact on global energy and critical-minerals markets have helped solidify support for such policies.

Ian Graig, Chief Executive of the Washington-based public policy consultancy Global Policy Group, has written for AutomotiveWorld on a wide variety of US public policy trends and their implications for the automotive industry

Antimony-based LIDAR may resolve cost and performance issues

R&D conducted by Sheffield University and Phlux suggests that using the semi-metal antimony could give LiDAR significantly more value. By Will Girling

LiDAR is among the key sensor technologies underpinning the automotive industry's quest to make fully autonomous vehicles (AVs) a reality. Capable of creating 3D digital representations of a vehicle's environment, LiDAR is invaluable for obstacle detection and safe navigation.

Grand View Research estimates the technology's global market value will rise 160% from US$1.8bn in 2021 to US$4.7bn in 2030. Some LiDAR manufacturers, such as Innoviz, go so far as to suggest that the sensors' proliferation will underpin future growth and consumer trust in AVs. However, notable detractors like Tesla Chief Executive Elon Musk continue to dismiss LiDAR's importance in favour of alternatives.

"LiDAR is a fool's errand," he told attendees of Tesla's first Autonomy Day in April 2019.

Detractors commonly cite reduced performance when driving in adverse weather conditions and expensive ownership costs as evidence for its unsuitability. For LiDAR to secure its legacy in the push for more ubiquitous SAE Level 3 and 4+ self-driving capabilities, it will need to address both challenges.

Tech from telecom

Ben White, Chief Executive of Phlux, tells *Automotive World* that the company's recent breakthrough experiments with antimony, a semi-metal element, could hold a solution. A spin-out venture from Sheffield

University, Phlux was based on ten years of research on infrared sensor technology. “Research into antimony first focused on the telecommunications industry, which is also where LiDAR itself came from,” explains White. “Both applications are focused on emitting and detecting light in the most efficient way possible.”

> “By increasing the detector’s sensitivity with antimony, we can downgrade the laser and save a significant cost while also maintaining high performance

In 2019, staff published a research paper on antimony structures and found growing interest among companies developing advanced driver-assistance systems and LiDAR. This was because Phlux’s proposition suggested that antimony could simultaneously reduce the cost and boost the performance limitations. Subsequently, the company raised £670,000 (US$815,000) in a 2020 pre-seed round and another £4m in November 2022 to put its highly sensitive sensor solution into production. “The sensitivity is important because it determines how far a LiDAR can see, the pixel density, and the system’s required overall size,” adds White.

Enhanced, cheaper LiDAR

The problem with current silicon semiconductors, says White, is that they result in “high noise” data when used in a LiDAR, which distorts the 3D mapping AVs use to navigate. Combined with the additional data noise caused by weather like rain and snow falling on the sensor, this had led some automakers to explore alternative technologies–perhaps most notably Tesla’s camera-based solution. Instead of creating a 3D digital representation of the vehicle’s environment, Tesla processes the video feed from eight onboard cameras through a neural network that ‘teaches’ the system to drive autonomously over time.

While innovators like Sensible 4 are using software and techniques like probabilistic mapping to fix the data noise issue of LiDAR after the fact, Phlux claims that its use of antimony-based chips produces “clean, low noise” data in the first instance. Furthermore, the design increases sensor sensitivity ten-fold and boosts detectable range by 50%.

“We want to see the mass adoption of LiDAR in the automotive industry,” states White. However, he concedes that cost has been a historical bottleneck to achieving this goal. This is not to say that the price of LiDAR hasn’t fallen significantly in the last 15 years. John Krafcik, former Chief Executive of Waymo, stated in 2017 that the company’s self-produced LiDARs shaved 90% off the original US$75,000 purchase price Google’s

sensors had commanded eight years prior. However, White believes further progress can still be made.

"Cost is directly related to how you build these systems, from the bill of materials to how components are integrated," he continues. "The lasers used for wavelengths around 1,500nm are currently incredibly expensive at volume. By increasing the detector's sensitivity with antimony, we can downgrade the laser and save a significant cost while also maintaining high performance." Although White could not provide *Automotive World* with an exact cost of Phlux's solution, which varies depending on range and field of view, he states that US$500 per system remains an industry objective.

LiDAR—the best approach?

White believes that antimony is well placed to enter the AV market at a crucial time in its development. 2022 saw OEMs like Hyundai, Kia, and Mercedes-Benz make progress integrating Level 3 features, while legislative changes in China are enabling trials of Level 4 robotaxis on public roads in Shenzhen. It is not inconceivable that 2023/24 could produce significant paradigmatic changes for autonomous mobility, even if progress will not be as meteoric as previously hoped.

"From a regulatory perspective, developments taking place in the short term will be very revealing. The industry appears to be heading towards a 'no accident' tolerance," says White. Crashes throughout 2022 involving Tesla vehicles and an ongoing lawsuit over whether the nomenclature of its Autopilot and Full Self-Driving products constitutes false advertising could discredit its camera-based vision system. Ultimately, White suggests that the automotive industry's aversion to risk will lead it to adopt the safest overall technology, which he considers LiDAR.

A crystal of antimony—Phlux suggests the semi-metal could simultaneously reduce the cost and boost the performance limitations of LiDAR

"Making LiDAR cheap enough to put on every car and capable of enabling Level 3 reliably will give it a significant value proposition," he concludes. With Phlux's new architecture capable of being mass produced, which standard LiDAR currently cannot be, the company is primed to capture ramped-up demand. Whether or not investor scepticism about AV development can be overcome, as well as the automotive industry's historical unwillingness to unite behind a single technology, will determine how quickly antimony-augmented LiDAR can scale up and make a difference.

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What technologies are reshaping the ownership experience?

Cars are becoming more adaptive to their environment, opening up a wide range of new possibilities for automakers and owners.
By Megan Lampinen

Vehicle ownership is moving from a static experience to a much more dynamic one, with over-the-air updates, customisable features and an ongoing relationship between automaker and driver. The product versus service debate continues to play out not only in the form of ride-hailing and car-sharing but also with in-vehicle features and subscription offerings. What a driver wants or needs during the week could be very different from what they are looking for on the weekend—are automakers ready to respond to those changing preferences?

Technology advances suggest they could be. Prashant Gupta, Senior Vice President, Automotive & Manufacturing at digital technology strategy company DMI, shares his vision for the evolution of the ownership experience and the digital developments behind it.

Where do you see vehicle ownership fitting into the wider concept of mobility today?

Based on where we are, and how things are changing with automakers, we're seeing a paradigm shift towards a customer-first mentality. Globally, customers want to have a sense of ownership and in the next generation of vehicles, we'll see heavy use of subscription-based models to customise the vehicle ownership experience. Customers will be able to pick and choose useful applications and other uses of their data to tailor their experience accordingly. Vehicles are becoming more and more akin to computers—think of it like a smartphone. Instead of leasing or buying the next model year, the expectation will be to update the software of your existing vehicle to the next generation.

What technologies and trends are reshaping the future of vehicle use versus ownership?

From a technology and trend perspective, what we're seeing is a heavier use of data. Cars will be more adaptive to their environment and provide real-time feedback to drivers through the use of artificial intelligence and machine learning. This isn't necessarily pointing towards full autonomy, but the car will be intelligent enough to understand what is going on around it.

> "We're seeing a paradigm shift towards a customer-first mentality

Coinciding with this point, cyber security is going to be a huge focus of future vehicle ownership. A user's number one priority with a vehicle is safety and security—and all of these connected factors add to the potential attack surface. Automakers will really need to key in on securing these environments, especially considering vehicles will be tied to user's financial data for things like automatic payment at charging ports.

Another trend is the customisation of applications to tailor your particular ownership experience. Next generation vehicles will focus less on trim-level

packages at the initial buy and more on the subscription-based features that can be added at will, such as in-cab wi-fi or upgraded navigation capabilities.

How has COVID impacted the way personal vehicles are used?

COVID has caused an increased sticker-shock and a downtick of miles driven. Personally, my yearly mileage has dropped significantly since the beginning of the pandemic and that trend can be seen at a global level. Couple that with higher gasoline prices, and people have become more cognisant about costs associated with vehicles and if it is truly necessary for everyone to own one.

While studies have shown that car buyers today are still attuned to owning their own vehicle, I predict that the next generation of drivers will see heavier use of public transport and ride-sharing, as well as a focus on attaining a family-use vehicle with all the safety and convenience features they desire. Personal vehicle ownership will still be alive and well, it will just be more cost-conscious; people will be less likely to spring for the extra vehicle if they can avoid it.

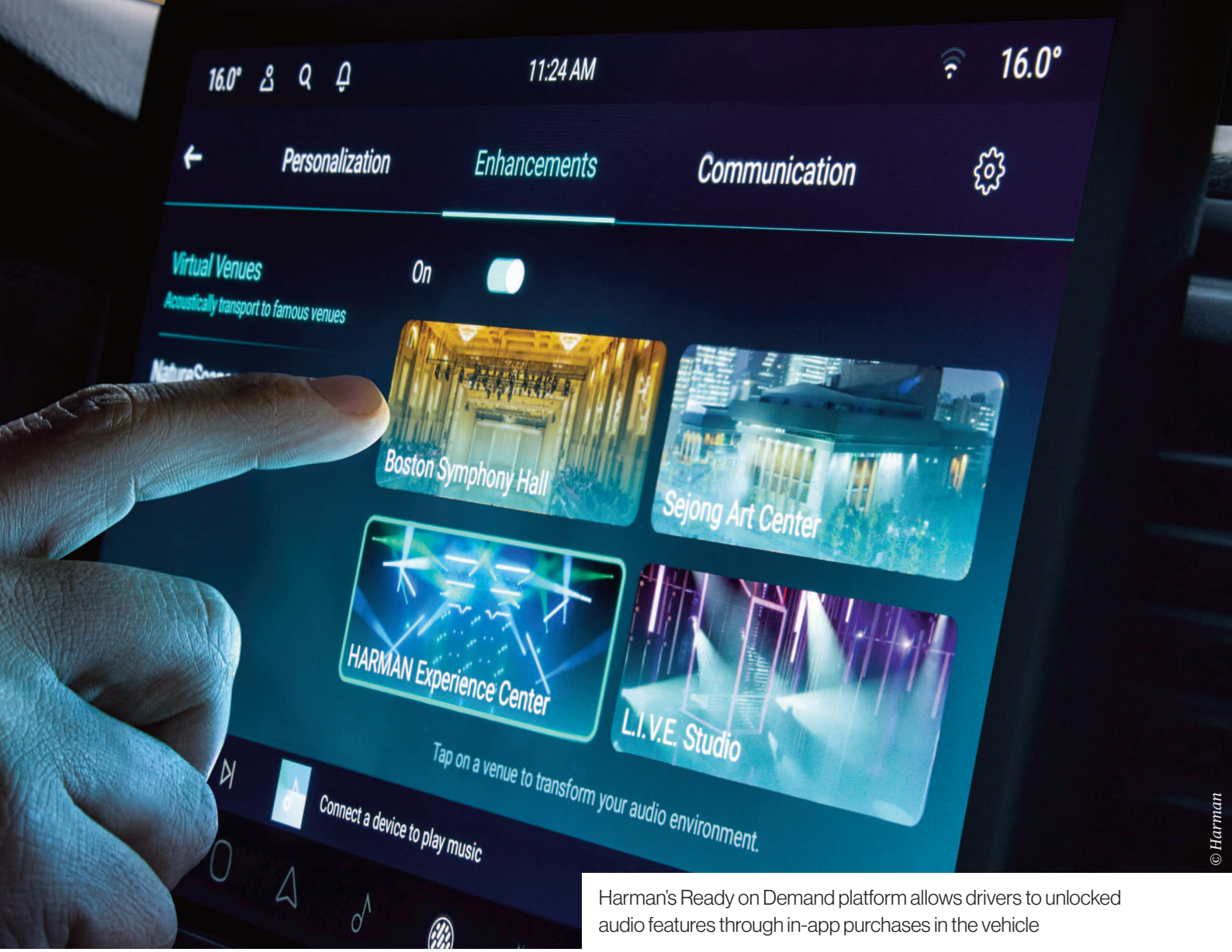
What developments can we expect around subscription-based features?

From a vehicle perspective, we'll see two main types of subscriptions. There will be a multitude of applications that come with your vehicle straight from the OEM, and owners will utilise these in varying degrees depending on their vehicle use and habits. The other type of subscription is a concept called features on-demand. Say you're

headed for a family trip; you may opt to purchase a week-long upgraded navigational package to better find restaurants, charging stations, etc., for the duration of your vacation, but you don't need it in your day-to-day life.

What are the pros and cons of these subscription offers?

OEMs must understand that they need to focus on customer desires and ease of use. If they can channelise the way subscriptions are handled, they'll be ready for the market and a big pro to consumers. A potential con would be if users don't want or need the subscriptions that come with the vehicle, and short-term subscriptions could easily



Harman's Ready on Demand platform allows drivers to unlocked audio features through in-app purchases in the vehicle

become costly. This process needs to be completely customisable and affordable to be realistic. On the OEM side, there will be a ton of configuration management and back-end maintenance for this technology, so infrastructure must be in place for this type of model to succeed.

Do you expect to see ride-hailing or another alternative to traditional ownership eat away at overall new vehicle sales numbers?

Part of this will heavily coincide with the market in which a customer resides. If you are living in the city, then I would say yes–overall vehicle sales will likely decline gradually as public transportation and ride-sharing increase in prevalence and sophistication. That said, new vehicle sales will still be relevant. The impact will be in the delivery of subsequent models/operating systems/updates that are applied to next generation vehicles. Instead of buying every new model year to attain the latest technology, many of the changes will be applied to your existing vehicle through automatic updates, much like a computer. This will likely bolster used vehicle sales, which we are already starting to see. We predict that the next generation of vehicle owners will be significantly less enthusiastic about consistently purchasing new vehicles, but rather opting to hold on to their existing cars as long as possible.

Cummins: hydrogen ICE to take off from 2024

The engine specialist shares its outlook for hydrogen-powered internal combustion engines in heavy trucking. Megan Lampinen hears more

The global trucking industry is exploring a wide range of technologies to clean up emissions. Battery electric and hydrogen fuel cell systems have been dominating headline space, but there is also scope for alternatives like natural gas or the hydrogen internal combustion engine (ICE) along the way.

Engine specialist Cummins is closely monitoring the trends at work and maintaining a range of solutions for its commercial vehicle customers. While the supplier takes a powertrain-agnostic approach to emissions reduction, it falls to Jim Nebergall as General Manager of the Hydrogen Engine Business to steer its global efforts in commercialising hydrogen-fuelled ICE specifically. “There is interest here because the technology is low cost in nature and represents a zero-carbon option,” he says. “On the whole, it offers a significant boost for the decarbonisation of commercial vehicles with a technology that customers understand.”

Familiar technology, new fuel

Over the past century, fleets have grown accustomed to vehicles powered by an engine and a transmission. These vehicles are supported by a well-established network of technicians with a deep understanding of how these systems work. That disappears with battery electric and fuel cell setups; but with hydrogen ICE, the only new element is the fuel.

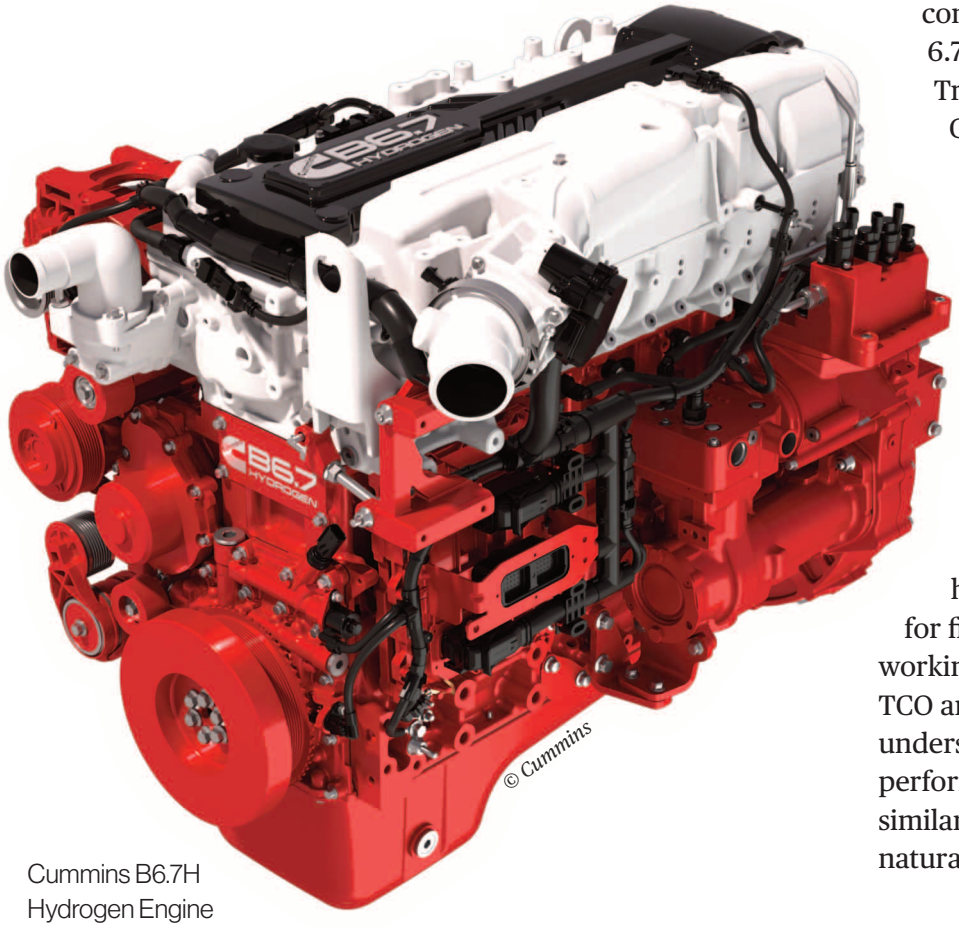
However, some investments must still be made in the supporting servicing facilities to manage the move from diesel to hydrogen. “Service support is critical for any new technology,” says Nebergall. For instance, a service shop would need to upgrade its lighting to remove any potential ignition source and install hydrogen detection sensors to monitor for gas leaks. Notably, he adds, these types of investments are also required for servicing natural gas vehicles but require different sensors.

“The nice thing is that the service infrastructure—that same sensing network and lighting—will also be needed for a hydrogen fuel cell,” points out Nebergall. “Someone can make the investment and add this capability, but it will work for both propulsion types. Fuel cells will need additional investment around the high-voltage batteries, which means more training for technicians, but this marks an incremental step along the way.”

Coming up

Cummins has only been testing hydrogen ICE technology since 2021 but progress has been significant. In May 2022 it debuted its 15-liter hydrogen engine—the X15H—at ACT Expo in Long Beach, California. Built on the company’s new fuel-agnostic platform, this version is expected to enter production in 2027. Then there’s the B6.7H hydrogen ICE offering up to 290hp and 1,200Nm peak torque. In September 2022, the company revealed a medium-duty concept truck powered by this 6.7-litre unit at the IAA Transportation exhibition in Germany. The B6.7H is designed for applications across the ten-to-26-ton gross vehicle weight category and has an expected range of up to 500km.

“We are in the R&D phase, running 6.7- and 15-litre engines today in test cells,” Nebergall clarifies. “We don’t have any in customer hands for field tests yet, but we’re working very closely with them on TCO analysis, making sure they understand the costs. The performance attributes will be similar to what they have today with natural gas or diesel trucks.”



Cummins B6.7H Hydrogen Engine

H2-ICE concept truck

A number of fleets have signalled their interest in these units. Truck and trailer provider Transport Enterprise Leasing plans to integrate the X15H into its heavy-duty fleet. In September, transport and logistics giant Werner Enterprises signed a letter of intent for 500 hydrogen-fuelled ICEs. In November, top Indian truckmaker Tata signed a deal to work with Cummins on the design and development of low and zero-emission solutions for commercial vehicles, including hydrogen-powered ICE, along with fuel cells, and battery electric vehicle systems. Hydrogen ICEs are also destined for the agricultural segment. Buhler Industries plans to integrate the X15H in its Versatile-branded tractors.

The best use case, suggests Nebergall, would be high asset utilisation applications: “Heavy-duty trucks that are doing typically more than 300 miles a day will certainly benefit from it. It’s also great for extreme ambient conditions, really hard duty cycles and cold weather–that’s where this technology works well and where we are seeing considerable interest.”

While less expensive than fuel cell or battery setups, and potentially more durable, there are limitations. Nebergall estimates that, at a vehicle

level, a fuel cell will be about 15% more efficient than a hydrogen ICE. The lower initial purchase price for the latter may still be enough to lure buyers. In certain segments, he concedes, hydrogen ICE may simply serve as an interim technology but not for all: “For some applications it will be a stepping stone to get customers into hydrogen fuel. There are also other applications where we don’t necessarily see fuel cells as the final solution. We don’t see hydrogen ICE as a temporary phenomenon and then it goes away. We see long-term applications that still will benefit from the technology.”

It all starts in 2024

The short fuelling times, the long range capability (potentially 500 miles), and ability to cope with extreme ambient conditions are enough to convince Cummins that hydrogen ICEs represent a key technology in the path to decarbonisation. But it may take time. “I doubt we will see much around the hydrogen engine in 2023 but sales will really start to pick up starting in calendar year 2024,” Nebergall predicts. “Multiple OEMs are likely to have offerings from that date onwards.”

Volume uptake, though, will be closely linked to infrastructure. “Each region will be different, but by the end of this decade hydrogen ICE will still be pretty limited,” he says. “In Europe we see a lot of movement in infrastructure for hydrogen fuelling. The US has seen positive movement with the Inflation Reduction Act and the Infrastructure Bill. Now we need to see more progress, more filling stations opening, but it’s going to take a while to roll out.”

> “Almost every engine manufacturer in the world is doing some level of research on the hydrogen ICE

In the meantime, competition among suppliers could be heating up. Nebergall observes that “almost every engine manufacturer in the world is doing some level of research on the hydrogen ICE.” Such a high level of interest could indicate the market potential, but Nebergall admits that in the near term it will likely remain niche. “Diesel should remain dominant for a while, but these additional technologies–the battery electrics, fuel cells, natural gas, hydrogen engines and propane engines–will all start to gain ground and we will see more diversity. They will chip away steadily at diesel sales moving forward.”

Harman: automotive grade answers to consumer expectations

Megan Lampinen reports back from the Harman Explore event, where solutions to key transformational challenges were on display

The automotive industry was once again out in force at CES 2023, showing off various responses to the massive mobility transformation underway. Products, business models and customer expectations are evolving rapidly, and players are quickly realising the importance of partnerships. "Nobody can do this transformation alone," asserts Christian Sobottka, President of Harman's Automotive Division. "The final shape of future mobility is pretty clear to everybody. The challenge is how to get there. How long will it take, and how much does it cost?"

Automotive World caught up with Sobottka and his leadership team at the Harman Explore event in Las Vegas, an extensive showcase designed to answer—in part—those very questions. The company, along with most suppliers, wants to position itself as the partner of choice for smart, safe, personalised cars that exceed customer expectations at an accessible price point. For automakers, its solutions offer a means of differentiation, future-proofing, and even potential cost-savings.

The future is now

All of the technologies on display at the event are market ready and poised for launch in the coming months. These include the company's Ready Vision set of Augmented Reality (AR) head-up display (HUD) hardware and AR software products. They are designed to provide immersive audio and visual alerts to drivers, conveying important information at the right time, and in a way that does not distract. "It's all about helping drivers better understand their surroundings while keeping eyes forward," says Armin Prommersberger, Senior Vice President of Product Management at Harman International.

Ready Vision displays turn-by-turn directions on the windshield and harnesses computer vision and machine learning for 3D object detection to support collision and blind spot warnings, lane departure, lane change assist, and low speed zone notifications. But there's more to safe driving then simply keeping your eyes forward: a driver can be staring ahead but daydreaming or worrying about something. That's where Ready Care comes in. The feature draws on radar, camera, machine-learning algorithms and in-depth neuroscience research to evaluate a driver's cognitive load. "This is what we call 'mind on the road' and it goes beyond what any of today's driver monitoring systems can offer," says Harman's Ready Care expert Eric Theisinger.

Using in-cabin radar sensors, it picks up vital health parameters to determine an overall physiological state. "When your heart beats, blood goes through your skin," explains Theisinger. "It's not visible to human beings, but the infrared camera detects it." From that, the system derives heart rate and can determine if the driver is stressed. In these situations, it could adjust the amount or type of information it displays to the driver or propose a more relaxed route to the destination. This sort of functionality represents a huge advance from the earliest drowsiness detection features, such as the simple coffee cup image that would pop up. As Sobottka tells *Automotive World*, "We have surpassed that by factors."

© Harman

The Ready Upgrade suite of products promises to lower new feature time to market and cost for OEMs

And it wouldn't be a Harman event without premium audio under the spotlight. Ready on Demand is a software platform that allows drivers to unlock specific audio features through an in-app purchase. The idea is that this allows for greater personalisation and moves away from the trend of bundling together numerous features (think a combination of leather seats, alloy wheels and premium audio) under one price when the buyer may only want one. It also means drivers can add features as their budget allows. For automakers, it opens an additional post-sale revenue stream and fosters a closer, prolonged relationship with the end user.

Development cadence

Products like these help automakers provide the technological capabilities customers are increasingly demanding, but that's only part of the evolution underway. Sobottka points specifically to the product cadence of consumer electronic products compared to automotive, noting: "The former is generated every six months; the latter every three years. How do we bridge that?"

Like smartphones, vehicles will increasingly require regular software and hardware updates to ensure they provide the latest in security features and applications. But cars and their electronic systems have traditionally been complicated at the planning phase, leading to high-cost domain controller solutions that lack upgradeability. The industry has seen steady advances with over-the-air (OTA) software updates, but system hardware remains limited in supporting new features over any substantial period of time.

"We have become used to replacing mobile phones every two or three years after we max out their capacity. We simply buy a new one," notes Prommersberger. "But with a car, these things are integrated. You have to live with the constraints until you get rid of the car. That's no longer what the consumer wants and it's no longer how the massive investment made in a car should be represented in terms of technology."

Harman Ready Upgrade should help. It features three families of cockpit domain controllers, software, a range of pre-integrated features and a suite of low-code software development tools. The company expects this to extend the vehicle life cycle for consumers and keep pace with their expectations, while making it easier and faster for brands to launch new features.

Prommersberger expects to launch a new hardware unit every 18 to 24 months, and automakers can decide if they want to take every new generation or skip some. The controller can be introduced on the production line without any change needed to an existing car design.

Where to differentiate

Sobottka describes the suite of Ready products as building blocks for automakers to successfully position themselves for new mobility demands. "We have to reinvent not just technological elements but also our operational culture," he emphasises. Harman's mission statement is summed up under the phrase 'consumer experiences–automotive grade' and reflects its aims to reinvent the in-cabin consumer experience. Pivotal to that is focussing on those requirements that differentiate the brand but going with a standardised solution for the requirements that don't. Sobottka estimates roughly 20% of requirements could be brand-differentiated, with the remaining 80% standardised.

"You don't go into an iPhone store, put 12,000 requirements on the table and say I would like to buy a phone. You go in, buy a product, and then you differentiate it by connecting it to your digital ecosystem," he elaborates. "Differentiation comes when you download your apps and bring in your data." This is pivotal to speeding up OEM product cadence.

Harman's philosophy on this front is shared by plenty of other players today but still represents a fundamental break from tradition. As Sobottka drives home, "Some of the concepts we are proposing here are challenging the old paradigm fundamentally. Traditionally, it would be completely normal to take 36 months to develop an infotainment system. We are proposing that you only modify certain features and slash that development time to six months. This requires behavioural change."

Importantly, Harman's CES push this year is almost exclusively on production-ready products as opposed to futuristic sci-fi visions. But as Sobottka suggests, "Many people would consider a really excellent AR experience with an artificial intelligence orchestrator regarding the visual and audio content to be sci-fi. The fact that it's ready does not mean it's boring. The transformation of this industry is now. Visions are great, but we are here in an immediate situation of massive transformation and we need the answers now."

What does the semiconductor shortage mean for Europe?

Boston Consulting Group explores the implications for a prolonged shortage of chips for Europe's automotive industry

The semiconductor shortage is unlikely to disappear in the next few years. While Europe is slowly growing its semiconductor manufacturing capacity, it hasn't yet done enough to become fully independent from external supply. How did the industry get here, and what does a protracted shortage mean for Europe's automakers?

The semiconductor shortage pre-dates many of the supply crunches triggered by the pandemic. Since 2018, US sanctions towards China have disrupted the semiconductor supply chain. Initial tariffs targeted raw materials such as silicon wafers and became one of the factors contributing to the existing shortage.

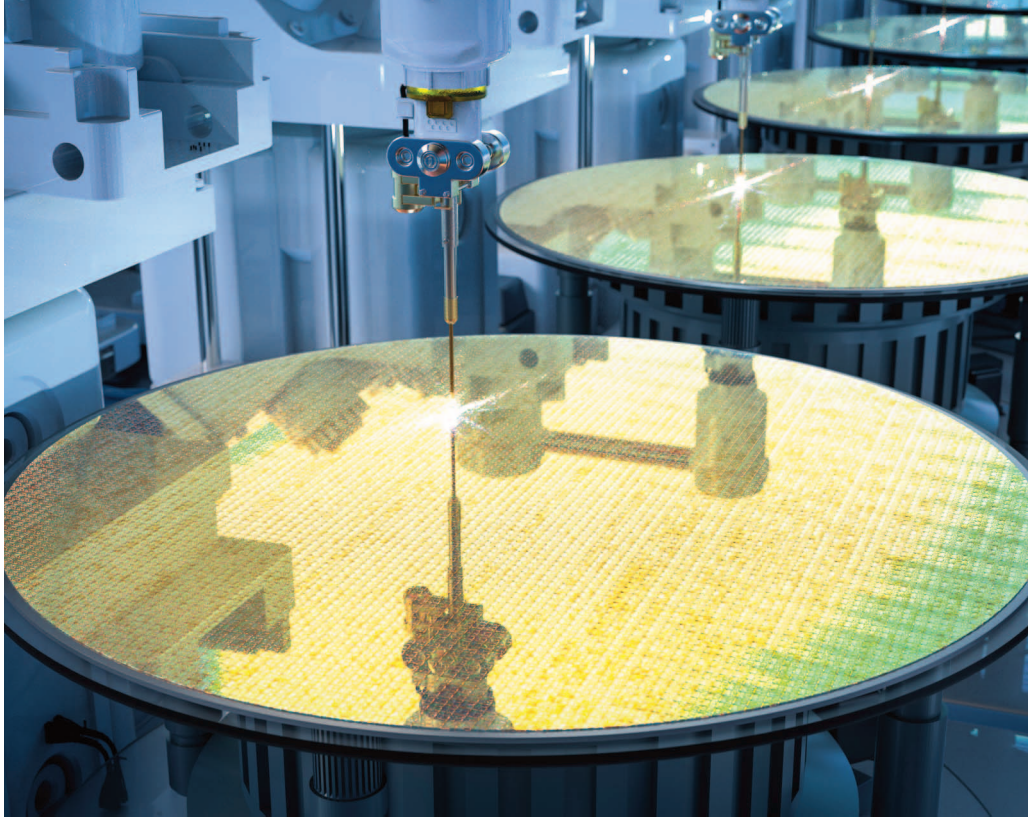
Exacerbating the crisis in the years since is a combination of both supply- and demand-side factors. At the beginning of the pandemic, initial semiconductor demand forecasts were low, driving relative decreases and shifts in supply investments. However, due to work from home policies and associated increases in demand for consumer electronics, overall demand levels remained steady. From the supply side, long lead times and COVID lockdowns resulted in low inventory levels. As a result, heavy CapEx investments will be needed to boost the manufacturing capacities and restore supply.

Recent BCG modelling quantified the global semiconductor supply-demand gap at 9%, which is projected to decrease slightly over the course of 2023. Despite this, it will be a long and difficult road to recover the supply-demand gap, especially for the automotive industry.

The automotive industry is expected to have the highest growth (11% CAGR) of all semiconductor segments through to 2026. For comparison, consumer electronics is projected to grow by 4%, while smartphones will see only 2%. At this rate, the auto semiconductor market will grow to US$84bn, representing 11% of the total semiconductor market (US$767bn) by 2026. To fulfil this demand, manufacturing capacities need to increase, which may take years.

Naturally, semiconductor manufacturers are responding to the shortages and planning to increase capacities. However, capacity development plans of semiconductor manufacturers differ between technology generations, also referred to as node size in nm.

According to SEMI projections, the largest installed capacity increases in 2023 are going to happen for technology nodes below 16nm, which are not



currently used in automotive industry. The relevant technology nodes, such as the 40nm node widely used in automotive MCUs as well as general purpose non-automotive MCUs, are only projected to increase by 4% in capacity next year. For comparison, a 25% capacity increase is forecast for advanced (5-7nm) nodes used in smartphones.

Looking to the situation in Europe, the semiconductor shortage has already heavily impacted the continent, with vehicle production dropping by 2.3 million units in 2021 against initial expectations. This loss accounts for 24% of globally lost vehicles and makes Europe one of the most impacted regions alongside North America, which accounts for 25% of the losses. Furthermore, Europe has exposed its high dependency on external players in the semiconductor market, namely China, Korea, Taiwan and the US. While the recovery from the shortage in principle can still happen with the status quo, that exposed vulnerability calls for action.

With the European Chip Act, European fabs expansions, and Intel's plans to build fabs in Germany (bringing €33bn (US$35bn) of Intel investments), there is hope that Europe may become less dependent on the external supply. However, fab construction and ramp up can currently take four to five years, so any new high-volume manufacturing (HVM) capacity from the constructed plants will only be seen in 2027.

Additionally, the Chip Act's €45bn investment might not be sufficient if Europe wants to build a more complete portfolio of fabs, including advanced technology nodes, front and back end. For reference, it takes more than €20bn for an established player to build one advanced fab and more than €5bn to build an expansion of the existing fab.

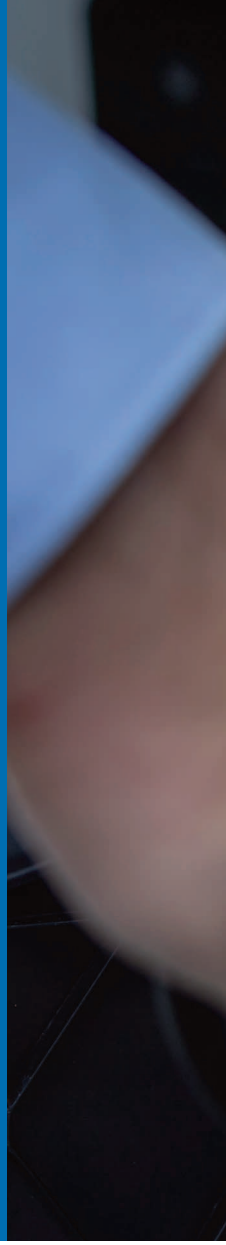
Another concern for Europe's semiconductor manufacturing is the potential energy crisis: sometimes a single advanced lithography system consumes 3,0000kWh per day. The share of energy cost in the total fab cost is already fairly high at around 10%, rising to 20% this year and leading to TSMC consuming 6% of Taiwan's entire power consumption. Can Europe afford such high energy consumption? The question is yet to be answered.

For European automakers this all has big implications. To secure sufficient supply to meet forecasted demand levels, automotive players will need to have a clear understanding of their future semiconductor demand. This will mean identifying specific areas of high risk down to individual semiconductors based on manufacturing capacity bottlenecks and purposely designing a futureproof and resilient semiconductor portfolio.

About the authors: Diana Grishina is Consultant, Arturs Smilkstins is Managing Director and Partner, and Alexandr Melnik is Partner at Boston Consulting Group

How can governments shift CVs towards e-mobility?

Jasper Konings shares key takeaways from Heliox's recent research into the electric truck industry



Governments play an essential role in closing the adoption gap between electric cars and electric commercial fleets. The European automotive industry has witnessed an undeniable boom in the e-transition, with 22% of all vehicles now eco-friendly in 2022. While this is a positive development, commercial fleets are still trailing behind.

Electric trucks (eTrucks) are the last road vehicle to join the switch as regulatory bodies have mainly focused on switching consumers before businesses. But now as large automotive manufacturers such as Volkswagen, Hyundai and Toyota are all battling for electric vehicle (EV) dominance, governments can shift their focus on closing this e-transition gap.

Why HDVs and LDVs are the last to join the e-transition

The "Electrifying the charge ahead" report from Heliox shows that 47% of trucking fleet managers in Europe believe light and heavy duty vehicles (LDVs and HDVs) are the last vehicles to make the switch to electric due to the challenges surrounding charging infrastructure. A further 41% of trucking fleet managers require readily accessible charging points that are affordable in the face of an impending energy crisis. This means that fleet managers will need EV schemes that are geared towards lessening their dependence on diesel powered vehicles.

In order to successfully transition to fully electric fleets, businesses will also need guaranteed access to charging depots. As of 2022, there are only 31,507 charging depots

© Daimler Truck

across the UK. Research shows that there is an average of 420,000 EVs on the road, highlighting an urgent need for charging infrastructure investment to keep up with demand.

The demand for charging depots is only set to increase as European countries strive for a net-zero future. Fleet managers are aware of this, but finding a solution that is within budget and feasible is proving to be a challenge. Governments now have an opportunity to change the course of direction and assist fleet managers in addressing their concerns.

How to address setbacks in local government EV schemes

A total of 20 European countries have subsidy programmes to help consumers and businesses alike purchase EVs. Commercial fleets need to make the most of all available funding as this is vital to securing a successful e-transition. However, almost two-fifths (39%) of fleet managers say their company has not taken advantage of available electromobility schemes in their respective regions. This is in part due to the lack of awareness of such schemes. In the Netherlands, the second largest EV nation in Europe, 45% of fleet managers are unsure if their companies are even aware of local subsidies, with a further 26% fully in the dark.

It is more important than ever for governments to make fleet managers aware of all available funding. In Germany, over half of fleet managers are aware of the incentive schemes offered and as a result, they recorded the highest number of eTrucks registered in 2021.

This awareness is crucial as reducing the total cost of owning an eTruck creates momentum in EV adoption. The International Council of Clean Transportation (ICCT) predicts that eTrucks will become more price competitive than diesel trucks by 2025 in the Netherlands and 2026 in the UK, but this can be accelerated with greater awareness of support mechanisms.

> “Reliable and accessible charging point infrastructure can only develop with robust policies and consistent investment

To aid fleet managers’ understanding of the cost of owning a eTruck, greater awareness around the potential energy consumption of truck fleets can also help. An analysis of the industry outlines four different energy requirements depending on the businesses operation. A distribution only operation, with light good vehicles used in last mile delivery, requires 1 kWh/km of energy. A full-service distribution operation, with light and two-axle heavy goods vehicles with heavier freights consumes 1.3 kWh/km of energy. General highway operations, with long-haul and heavyweight trucks. requires 1.7 kWh/km of energy. Waste collection operations, with waste trucks that possess high additional power consumers, require 2.5 kWh/km of energy.

As fleet managers are currently feeling the financial effects of owning regular diesel trucks, this is the perfect opportunity for governments to demonstrate the full benefits of transitioning to EVs by offering tax relief incentives as well as toll-free transport and charging grants.

Spotlight on Germany

Out of the 1,394 eTrucks registered in 2021, 800 were German, revealing the Deutsche nation as leading the trucking e-transition within Europe. The only other countries keeping up with Germany are the UK with 333 registered eTrucks and the Netherlands with 216. Germany has managed to achieve successful fleet electrification through three key pillars: the shift away from diesel powered trucks; strong awareness of governments electromobility programmes; and investment in public charging options.

To shift away from diesel powered trucks, the HoLa project (high-performance charging in long-haul trucking) was launched by the German Federal Ministry of Transport and Digital Infrastructure (BMVI) in 2021. This innovation cluster of eco-friendly truck driver technology aims to bring industry-wide change to the forefront of the German market. The effect of the HoLa project has been increased collaboration between various manufacturers and policy makers to bring about further standardisation in the location of charging plugs.

In bringing awareness to electromobility programmes, Germany's Umweltbonus (environmental bonus) programme offers grants of up to €9,0000 in EV purchases that are proven to resonate amongst those in charge of electrifying fleets. We see this with over 50% of German fleet managers being aware of subsidy schemes offered by their government with a further 60% taking advantage of this.

By investing in public charging options, Germany is leading the way with impressive tax relief and toll-free options for eTrucks, whilst funding 80% of infrastructure costs. With this approach, local German authorities are positioned perfectly to effectively push for top-down reforms, becoming powerful climate advocates as they implement the three key transition pillars.

Scania offers charging solutions as well as eTrucks

The power lies in the governments' hands

The automotive industry is undergoing a deep technological shift where environmental concerns are shaping the direction of policy and innovation. Now that European automotive powerhouses are pivoting towards GHG reduction, budgeting for change will be a key strategy for all European governments as most companies plan to fully electrify their fleets by 2040. As things stand, only 12% of businesses are on track to reach full electrification by 2030.

To achieve the ambitious yet attainable goal of net-zero emissions by 2050, plans for mandatory targets related to charging point infrastructure are essential. Rapid charging infrastructure will be the fundamental backbone in supporting commercial fleets whilst also facilitating other eco-friendly transport services—something the industry is already seeing with the recent EU legislation that requires member states to build EV charging points every 60km on motorways.

Individuals with decision making power at the national and regional level are in a prime position to future-proof the EV industry. Reliable and accessible charging point infrastructure can only develop with robust policies and consistent investment, placing the acceleration of electrification in the hands of the government.

About the author: Jasper Konings is Director of Commercial Vehicles and Fleets at Heliox

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Is vehicle data monetisation providing value to customers?

How automakers use vehicle data could emerge as an important differentiator as ownership paradigms change in the wake of CASE trends. By Will Girling

In-vehicle infotainment systems, navigation systems, and third-party insurance apps are just some of the technologies collecting customer data regularly–ranging from destinations and the average distance driven to music played during the journey. With consumer behaviour patterns now more transparent than ever, automakers and suppliers have gained a valuable foundation to build future product strategies.

According to analysis conducted by ReportLinker, the automotive Big Data market is expected to grow 136% to US$9.9bn between 2022 and 2027. However, as electrification and digital technology supplant internal combustion engine vehicles, Big Data and its usage is becoming an increasingly pertinent industry question.

But what should be the limits of data monetisation and are customers in agreement with developments in the pipeline? Ian McVicar, Senior Director at NTT Data, emphasises to *Automotive World* that conversations around data privacy must urgently be addressed. Part of the multinational NTT Group, NTT Data is an IT and business services innovator and consultancy working to help various industries adapt to the digital age.

Data: where is the value?

"People were already conscious of how their data is being used more generally, but there is growing concern around automotive because of the volume of data being generated," says McVicar. "NTT Data's own consumer research found that 86% of people aren't happy with their data being shared with third parties." According to McKinsey & Co, the volumes of data generated by various devices: a mobile phone streaming a high-definition movie generates 869MB per hour, while a car with contemporary connected devices generates around 25,000MB. This is by no means the limit–new sensor applications are constantly being trialled–and discussions surrounding who ultimately owns the data are inconclusive. Indeed, a survey conducted by the Automotive Industries Association of Canada found that only 28% of drivers declared an understanding of how their vehicle data was produced and handled.

As such, McVicar believes the market value of in-vehicle data must be carefully balanced against what consumers themselves will find equitable. "Customers are the ones providing the input for vehicle sensors," meaning they're the ones driving the vehicle and making decisions that can be collated for future marketing and R&D purposes. "However, they're arguably not receiving much value from many of the use cases being developed," he says.

For example, Ford patented a sensor for projecting advertisements from roadside billboards onto vehicle infotainment screens in 2016, the details of which were published in 2021. While the concept itself was scrutinised by industry commentators for its potential to distract drivers, McVicar highlights that innovations in this vein must always be considered from a customer perspective. While this concept might be advantageous for OEMs and advertisers, where is the value for drivers?

Data use as a differentiator

By not taking this into consideration, automakers run the risk of customers feeling exploited by new in-vehicle features. Subscription models, such as BMW's heated seat function for US$18 per month, have proven controversial for apparently 'nickel and diming' the vehicle purchaser. McVicar contends that it is the messaging of subscriptions that draws ire: BMW's heated seats can still be bought outright, and the subscription is simply intended to allow for greater customisation and flexibility. "New economic models are always confusing, because customers won't be familiar with them," he says. "Therefore, the messaging needs to be exact."

> "People are increasingly conscious of how their data is used across all industries, not just automotive

As trends in electrification and autonomy continue to redefine the core in-vehicle experience, infotainment is becoming a new arena for brand differentiation. How an automaker chooses to use customer data could become yet another. "The way OEMs use connected car data should be tailored to meet their distinct values. Companies in the tech space already compete in this way–for instance, Apple took a highly protective stance on data security," states McVicar. The company's clear emphasis on this point, he continues, implicitly made other manufacturers appear less security-focused by comparison.

A report by McKinsey & Co–Unlocking the Full Life-Cycle Value from Connected-Car Data–found that 37% of global consumers would switch car brands for improved connectivity services. Some markets, such as China, recorded even higher general interest (56%), as did the overall premium OEM range (47%). "Given connectivity's increasing importance, OEMs that fail to meet the bar risk losing customers," McKinsey concluded.

Creating value

Fundamentally, McVicar says, automakers' utilisation of connected vehicle data will underpin the continuation of ownership itself. He supposes that less meaningful brand-based experiences will drive shared mobility instead of ownership. "The subtlety here is that because mechanical performance will become homogenised across brands, the overall experience could become more important. While on the one hand there may be a drive toward shared mobility, luxury OEMs may

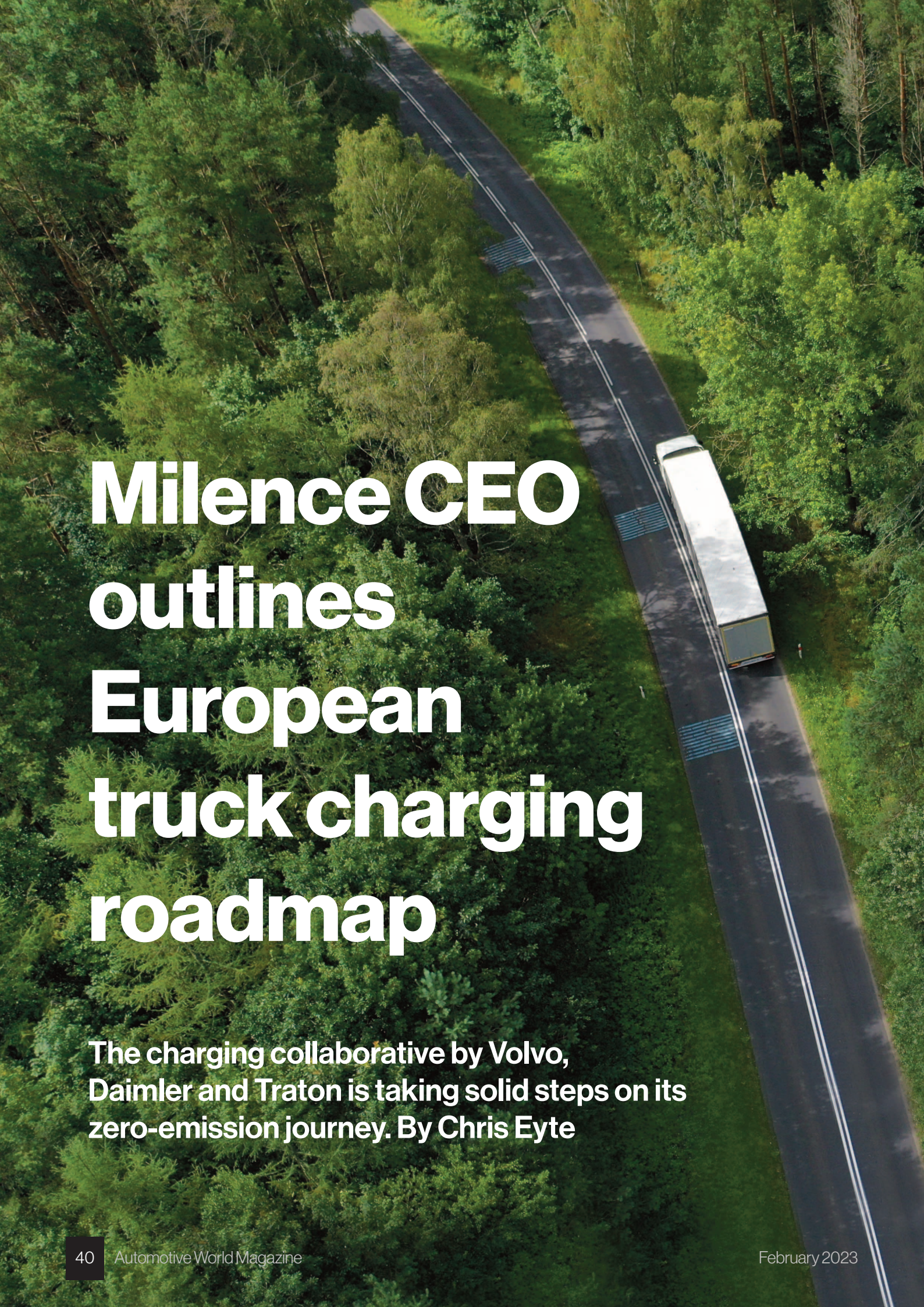
A modern car's connected devices can generate around 25,000MB of data per hour—how that data is equitably monetised will be core automotive industry concern

focus on improving the end-to-end brand experience to convince consumers there is value in outright vehicle ownership or remaining locked into their brand from a subscription perspective. ”

In the music industry, the affordability and variety of streaming platforms has challenged physical media. Similarly, car ownership could be replaced by flexible subscription models that “allow someone to drive a Mercedes one week and a McLaren the next,” says McVicar. Data on customers' driving habits and preferences could be analysed to provide suggestions on the ideal vehicle for each journey type, thus optimising energy expenditure and spatial requirements.

However, until such a shared mobility platform becomes feasible, OEMs must concentrate on the fundamentals of data monetisation. McKinsey suggests five imperatives: match short-term profitability with long-term development; always improve the customer experience; respond to regulatory pressures concerning security; monitor competitor tech; and focus on new business models.

McVicar adds that automakers should not be surprised if data monetisation strategies are received with scepticism at first: “People generally don't want their data to be monetised, but they're also reluctant to pay for connected car services.” Data monetisation could have many positives, such as reducing the upfront sticker price of a car, but communicating the ongoing value of data sharing will be crucial, both in an ownership and shared mobility context. Whether through subscription-based services or supported by advertising, OEMs must make consumers feel empowered and valued by their brand selection.



Milence CEO outlines European truck charging roadmap

The charging collaborative by Volvo, Daimler and Traton is taking solid steps on its zero-emission journey. By Chris Eyte

The European Automobile Manufacturers' Association (ACEA) estimates there will be 270,000 battery electric medium-duty and heavy-duty vehicles operating in Europe by 2030. These zero-emission trucks will need 40,000 to 50,000 heavy-duty vehicle charging points by then, each with an output between 350kW to 500kW. Despite these operating needs, the charging infrastructure for battery-electric trucks is currently "almost completely lacking."

In an ACEA report from 2021–*Heavy-duty vehicles: charging and refuelling infrastructure requirements*–the association opined that higher energy demand for trucks means they cannot use the same charging points as passenger cars: "Widespread market deployment of new powertrain vehicles will not be possible if a sufficiently dense network of charging stations specifically suitable for heavy-duty vehicles is not available."

ACEA added that the issue must be addressed urgently and called on stakeholders and policymakers to take immediate action and "ensure a rapid infrastructure roll-out."

Prepping the big rollout

This urgent need to install battery electric truck charging stations is being addressed by Milence. Formerly known as Commercial Vehicle Charging Europe, the collective group was formed in July 2022 by the Volvo Group, Daimler Truck and Traton Group to set up charging points specifically for heavy-duty trucks. The group intends to install 1,700 charging points in Europe within the next five years, planting them across Germany, France, the Netherlands, Sweden, Norway, Italy, Spain and Belgium.

Anja Van Niersen, Chief Executive Officer of Milence, tells *Automotive World* that the first charging points will be established in 2023, with the initial rollout seeing between 150 and 180 battery charging points going live in 30 to 35 locations across five European countries: "We are now heavily prepping the big rollout and we are discussing the details."

> "We need to take action now

Van Niersen says that the Milence trucking companies hold a joint ambition by recognising that zero emission "is the way to go forward in mobility." They also understand that heavy-duty trucks, with ranges of more than 400km, are unable to operate without a proper charging structure. Volvo, Daimler and Traton, therefore, decided to set up the required network: "The Milence venture will at least make sure the basic networks in Europe are set up within the next five years. This will allow battery-electric trucks to drive safely from Bordeaux to Warsaw, London to Lisbon, and then eventually across all of Europe."

A zero-emission journey

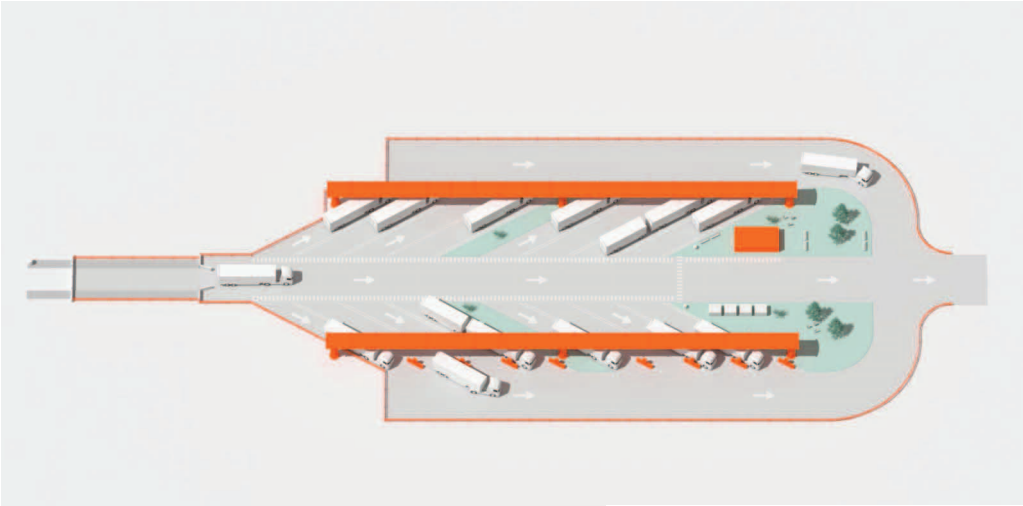
According to the European Federation for Transport and Environment, a campaign group for cleaner transport in Europe, trucks currently emit 22% of CO2 emissions on the EU road transport network and yet represent only 2% of vehicles on European roads. It is clear that there is a compelling case for the decarbonisation of road freight, and Van Niersen is mindful of that aim; she says that Milence is on a "zero-emission journey."

As an illustration, Milence aims to use stored green energy to help reduce electrical grid congestion. Van Niersen says the reason for the current energy crisis is not just about access to natural gas but "net congestion, grid congestion, and so we need to make sure that whatever we do in the industry is part of the solution for the energy system and not part of the problem."

The group is therefore working with electric grid companies to find solutions to utilise renewable energy rather than adding to grid congestion. "What we will try to do is connect heavily to renewable energy," adds Van Niersen.

Respecting the truck driver

The Megawatt Charging System (MCS) utilised by Milence will allow a 40-tonne truck to be charged within 30 to 45 minutes. This timescale



© Milence

An initial layout of a medium-sized Milence charging point site

complements a truck driver's legal timescale for a rest break. Van Niersen says that Europe is underproviding appropriate rest break services for these drivers. Milence wants to change that culture and provide clean toilet facilities, food and beverage services and reliable security.

Partnerships are being negotiated and formed with service providers. However, Van Niersen says there is no intention to make a business case out of additional services: "We are mostly looking at the base level of services that any person in his working environment would need. We want to create a welcoming, safe and secure area for these truck drivers."

Charging stations with amenities are thus geographically laid out using "an elaborate network planning tool based on where trucks drive, where trucks stop, where the energy system is, and where renewable energy is being generated." This data is collated to show the locations preferable to drivers for charging trucks and rest breaks.

We need to do something

Van Niersen says getting permission from each European member for the charging stations with service facilities is labour intensive. Even so, electric propulsion helps to deter harmful emissions, and this point is clearly understood by political authorities. "If we want to reduce CO2 emissions by 55% for 2030/2035, we need to take action now," she says. "Setting up these charging stations is a very good way for municipalities and local authorities to work towards that goal."

While Milence is actively setting up charging stations for heavy-duty trucks, Van Niersen hopes other trucking industry companies will also help build the European charging network. The development will need to include the installation of charging points on national roads as well as highways. "There is so much work and investment required that we will never be able to do it alone," she concludes.

© EasyMile

Autonomous shuttles—from tech showcase to commercial service

EasyMile believes its latest win marks a tipping point for the viability of self-driving shuttles. Megan Lampinen hears more

Autonomous driving comes in many forms, from robotaxis navigating city streets to heavy trucks plying the world's highways. Some of these use cases involve numerous challenges in the form of other road users, high speed driving, and government regulations. As a result, mass commercialisation could take many years. But what if the operational design domain was limited to a set route and the speed was capped at a low level?

Autonomous shuttles represent a potentially lucrative low-hanging fruit for self-driving developers, as EasyMile has discovered. The French company's autonomous shuttles are already at work in a handful of commercial deployments, including one at the IUCT Oncopole medical campus in Toulouse, France. Here an SAE Level 4 shuttle has been taking visitors and staff to and from the parking lot and main entrance, a short 600m run. A remote operator supervises and can intervene if necessary. At its launch, this marked the first SAE Level 4 autonomous shuttle service on public roads in Europe.

EasyMile shuttles are also at work at the ArianeGroup industrial site west of Paris, transporting staff and visitors around the large industrial complex, which manufactures rockets. This represents a more complex operating environment, covering 92 hectares and including road and pedestrian traffic, roundabouts, intersections and parking areas.

The company scored another coup with Belgian Centerparcs site Terhills Resort for a project worth €4m (US$3.8m) and potentially running for ten years. Notably, EasyMile itself is only eight years old. The vehicles are replacing a fleet of existing manned 12m buses that operate on the site. According to EasyMile there is nothing quite like this deployment on the market so far.

© EasyMile

Driverless applications mean service need not slow down during quieter times

A commercial business case

"This is not a technology demonstration; it's an actual service meeting a commercial business case," emphasises Benoit Perrin, General Manager at EasyMile. "The client's objective is not to showcase some technology; it's to deliver a service to the community."

In early November 2022, the shuttle started operating along a 2.5km route that connects the attractions of the Terhills Hotel to the Terhills Resort. The user-interface inside shows riders the route and the next station, along with a message informing them they are in a driverless vehicle. The initial fleet consists of just two vehicles, initially running for eight hours a day. Passengers won't need to wait more than ten minutes at any time for the next vehicle. With the previous manned bus service, the wait time could be up to 20 minutes. When it's only a ten-minute walk, few people will wait 20 minutes for a bus.

> "Following private sites, developments on public roads should pick up speed in the next three to five years

The shuttle fleet may be expanded to five or six shuttles, cutting down the wait time to just four minutes per shuttle at the busiest times. A decision on a full rollout will be taken by the site by mid-2023. "When you have a shuttle with a driver and it's running at close to empty, you always wonder if you need to decrease your service," Perrin tells *Automotive World*. "With a driverless shuttle you are consuming some electricity, but it is negligible in terms of cost, so you can maintain a good level of service even outside of peak hours. For this kind of operation, that's important."

As in the other deployments, a remote operator monitors the vehicles. "The operator is really there to monitor that nothing out of the ordinary is happening," says Perrin. "If the shuttle stopped, why did it stop? Is there an obstacle that needs to be removed or something else at work?"

These operators are employed by Belgium company Ush, which is tasked with running the service on the ground in Terhills. Notably, the Belgian resort is on a relatively flat site with roads well suited to AVs. It's also a closed site, as opposed to the public roads on which many tech demos run. That also makes it a bit easier on the regulation side. "The regulation on a private site works differently to a public road. It's the site's decision what they want to do," says Perrin. EasyMile is currently in the midst of the approval process and undergoing a safety assessment with the site.

"The sites themselves represent industry best practice," he adds. "We went through a robust tender process for this; they really put us through our paces. We had to describe our safety architecture in great detail. Throughout the whole process and even now they still have an independent safety assessor in the loop."

Room for growth

The contract value of €4m covers the sale of the shuttles as well as some services and a maintenance license

© EasyMile

A remote operator can intervene if needed

on the software over ten years. On top of that, EasyMile will gather valuable data from the vehicles' operation that it can use to improve and refine its products. "We are looking at the number of kilometres the vehicles drive and what kind of difficulties are encountered, if any," says Perrin. "With each unexpected event we look at everything that happened to see if there's something that needs to be improved in future with the software."

For example, the company is paying close attention to the GPS and localisation systems. "We know that the GPS doesn't work as well under certain tree coverage or with clouds. In response, we have implemented alternatives to GPS—including LiDARs—to know exactly where we are," he explains. "We are monitoring the performance of all these means of localisation."

If the performance of these starts to degrade, the vehicle will stop and then restart. It's a similar case in severe weather, like heavy rain or blizzards. The data that these vehicles send back during their operation at Terhills will help engineers figure out exactly what happened and come up with ways to improve their systems.

Moving forward, Perrin's aim for the next two years is to expand on the Terhills example to show other private sites the value proposition available: "This is not just a dream. It's really something that delivers a service in certain private sites where you have these kinds of mobility requirements: big factories, resorts, even in airports."

Following private sites, developments on public roads should pick up speed in the next three to five years. "We always wanted to do first- and last-mile services on public roads, especially to connect to more traditional ways of public transportation like a Metro or tramways," he adds. "This is where there is a huge demand today, made more challenging by a shortage of drivers."

AI to unpick liability in autonomous vehicle incidents

Artificial intelligence can help determine who—or what—is responsible in an incident involving self-driving vehicles. By Neil Alliston

Autonomous vehicles are already here, with trucking and fleets leading the way. Autonomous trucks, operating at least at SAE Level 4 are plying the roads in Texas, California and elsewhere, and driverless buses are on the way. While self-driving passenger vehicles are slightly behind, they will be here–en masse–very soon, experts say.

Who or what is at fault?

And while many believe autonomous vehicles will result in greater road safety, no technology is perfect. Even with their currently limited numbers on the road, self-driving vehicles have been involved in collisions and can, just like any other vehicles, sustain physical damage, even from minor incidents. As more autonomous vehicles take to the road, the number of incidents in which they are involved will grow. Questions will arise about the viability of the vehicles themselves, as well as about the quality of their software or the control systems that guide them.

And those questions will be exacerbated by the fact that autonomous vehicles will be sharing the road with driver-controlled vehicles, pedestrians, bikes, motorcycles, electric scooters perhaps even futuristic hoverboards. At that point, the lawyers will go to work; attorneys, courts, and owners will have to grapple with issues of responsibility. But to determine responsibility for an accident–ie, who pays–they will have to delve deeply into the different "responsible parties" that may have caused it.

Was there a problem with the vehicle's on-board software or with the transmission of instructions from the central server? Did the vehicle owner fail to apply a mandatory software update? Was the problem with the vehicle itself, with a flaw developing because

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> “The ideal inspection for autonomous vehicles combines the deep analysis capabilities of AI systems with human supervision

of a manufacturing issue? Was the incident due to a problem in the 5G communication network on which autonomous vehicles will rely? Was it due to nothing more than a flat tyre, and if so, did the owner fail to inflate the tyre properly?

Analysis

The only way to reveal the answers to these questions is with a deep-dive analysis of all aspects of the vehicle—both physical and software-related—using advanced technologies like artificial intelligence and machine learning, as part of a general inspection and condition report. While inspections are standard for driver-controlled vehicles, they will play a far greater role for autonomous vehicles, because the responsibility for vehicle and road safety goes beyond just the driver. And AI systems are the most efficient way of conducting these inspections.

These legal issues are already manifesting; adding to Elon Musk's recent problems is a criminal investigation of Tesla over crashes of vehicles using its semi-autonomous driving software. The Department of Justice is investigating whether the company misled owners into believing that vehicles were

Industry players are debating how to determine liability in the case of a road incident with autonomous vehicles

"more autonomous"–that they could function properly with less driver supervision–than they really are, leading to more than a dozen crashes. This is just one example of a wide array of complicated cases–concerning dozens of issues, from manufacturing flaws to software problems to owner negligence–in which autonomous vehicles are likely to be involved over the coming years.

There are several steps that can be taken to meet the emerging legal challenges, both in advance of an accident and after one. In order to be licensed as fit for the road, many states require vehicles to be inspected–and inspections of autonomous vehicles need to be more advanced than inspections for standard vehicles. Those advanced inspections need to analyse not only the physical integrity of vehicles, but also the integrity of the software running them, both on-board and external.

The inspection needs to analyse how the vehicle will act under specific traffic conditions, and compare those situations to a database of previous accidents to determine if a vehicle is in danger of becoming entangled in an accident. In order to accomplish this, inspectors need to adopt AI and machine learning-based analysis systems, which can determine relationships between vehicle condition, software, and road conditions far more accurately than any human inspector could, because of the huge number of variables that need to be checked.

If a vehicle is involved in an incident, AI and computer vision systems can also be used to determine the level of responsibility for each element. By examining the scene of the incident and the circumstances surrounding it–level of traffic, weather, time of day–the system can determine if the software took into account all the factors it was supposed to in order to ensure safe driving. If the software was operating properly, the system can check the integrity of the vehicle–whether all the parts were operating properly or if the vehicle was properly maintained–as well as any possible role played by the human driver, passengers or

controllers, or any other external factor. Again, no human inspector could be expected to reach this level of detail in their inspection.

With that, AI inspection systems, just like the autonomous driving system, need to be supervised. While AI systems have significantly reduced the problem of false positives and significantly streamlines the process of decision-making for many organisations, it's not perfect. And when AI does fail, it tends to fail in a big way. Human supervisors need to monitor AI decision-making to ensure that those decisions make sense—that they conform with the law, that they do not entail undue financial risks, that they do not violate the sensibilities of the public.

Those bad decisions could be the result of numerous factors, from bad programming to bad data. AI problems are difficult to troubleshoot, and with lives at stake, managers of autonomous vehicle grids need to ensure that the system works properly at all times. Until AI systems are advanced enough to diagnose themselves for errors on the fly, human supervision is the best method to ensure autonomous vehicle road safety.

And while AI systems will likely do a thorough inspection job when it comes to the major systems in a vehicle—ignition, motor, braking, and others—it may miss some of the smaller issues that could be just as crucial to road safety. For example, current machine vision systems could "pass" a headlight on inspection, but if the casing of the light is dirty or dusty, it could lose lumen power, making it less bright to oncoming vehicles at night and thus more prone to accidents. The same goes for issues like scratches on a tyre, which don't affect the tyre's performance right now, but could quickly cause a deterioration of quality. Human eyes are much more likely to pick up on issues like these, again demonstrating that the ideal inspection for autonomous vehicles combines the deep analysis capabilities of AI systems with human supervision.

Autonomous vehicles and driver-controlled vehicles serve the same purpose, but unlike with the latter, where much of the responsibility for road behaviour lies with the driver, autonomous vehicles are controlled by a variety of factors: software, data networks, OEMs, control centres, the physical condition of a vehicle, and more. So who, or what, is responsible for an accident? Who pays? AI is going to be an important factor in determining the answer to that question.

About the author: Neil Alliston is Executive Vice President of Product & Strategy at Ravin.ai

Stellantis looks to Level 3 and beyond

Autonomous driving is a key part of the automaker's efforts to become a sustainable mobility company. By Michael Nash

For many people, the idea of the AI-operated autonomous car may conjure images of the popular 1980s TV show Knight Rider, with a bemused David Hasselhoff meeting KITT for the first time—a one-of-a-kind AI-infused car that thinks for itself. And while this vision was certainly futuristic in the '80s, the idea that an AI-based car could soon be driving around on public roads might still be a little far-fetched, or even scary. But for Neda Cvijetic, Head of AI & Autonomous Driving at Stellantis, the promise that this technology brings is extremely exciting. She describes her vision for mobility, and explains that the deployment of AI-based vehicles is already taking place.

From hype to reality

"For me, the most exciting aspect of working in the field of autonomous vehicles (AVs) is that the technology is exiting the hype phase and becoming real," Cvijetic tells *Automotive World*. "This is already happening in the form of mass-market Level 2 deployments, and will also happen with Level 3 deployments that have a concrete and positive impact on both customer experience and safety."

Level 2 refers to vehicles that have partially automated driving functionality over the steering, accelerator and brake pedals. Tesla's Autopilot is a prime example, whereby the driver must

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In December 2022, Stellantis announced that it finalised the acquisition of aiMotive, a developer of advanced AI and autonomous driving software

still be present and alert, ready to take control at any time. Many new cars today have this capability, while Level 3 vehicles are only just starting to hit the market. These vehicles must be able to scan and analyse the surrounding environment to make informed decisions, such as overtaking a slow moving vehicle. A human driver must still be present and ready to take control when prompted.

To make these informed decisions, Level 3 requires AI and a powerful computer that can process complex information. Few carmakers are yet to bring these systems to market, but Cvijetic suggests that the technology is moving fast. "The rise of AI-based capabilities for AV in recent years has been a major breakthrough," she emphasises. "The AV domain has, in several ways, been a pioneer of real-world AI-based computer vision software, and we are now also seeing AI leveraged in other parts of the AV software stack–both onboard the vehicle and in offboard AV toolchains."

AI-based computer vision software has been at the heart of Level 3 autonomous driving and beyond. Car and tech companies have been using the software to process information from a host of sensors and cameras attached to the vehicle, feeding it into powerful on-board computers that then leverage AI to make driving decisions in real-time. By feeding software more data and putting it through increasingly complex scenarios, Cvijetic thinks that AI-based computer vision tools are becoming more robust and sophisticated. The auto industry has served as a test-bed for the technology.

The next step

The next logical step in AV development, according to Cvijetic, is to make Level 3 systems commonplace on the road. She believes that this will first take place within the confines of specific driving scenarios before spreading out to general vehicle use. "The next step is Level 3 systems that provide full automation within a very specific and clearly defined operational design domain–for example, in low-speed traffic jam scenarios with clear lane markings and good weather conditions," she muses. "Based on real-world, data-driven learnings from these scenarios, this operational design domain can then be gradually extended over time. Having highly robust and effective autonomy hand-off mechanisms between the human driver and the machine is also a key aspect in design and deploying such Level 3 systems."

Ensuring the human driver can easily take manual control of the vehicle and safely override an autonomous driving feature is an important aspect of Level 3 and beyond, as is the handover of control from the human driver to the autonomous system.

> “Reducing driver fatigue, giving customers time back during a stop-and-go commute, and complementing the iconic stature of our brands with AV technology are key influencing factors

This was one of the integral points of examination during the Stellantis L3Pilot project, a four-year collaborative effort that saw 70 cars equipped with Level 3 autonomous driving functionality cover a distance of 400,000km on motorways and 24,000 in urban environments. The project was completed back in October 2021, and the company said that it had been able to analyse “the performance of autonomous systems from the user’s point of view” and had gained an understanding of the impact that the technology would have when deployed on roads in “a mixed traffic context.” But the testing hasn’t stopped there.

Stellantis is also part of the Hi-Drive project, another collaborative scheme that aims to push the development of AV technologies, this time co-funded by the European Union. One of the specific goals of Hi-Drive is to “considerably extend the operational design domain (ODD) from the present situation, which frequently demands interventions from the human driver.” Essentially, the idea is to further develop the technology so that it is capable beyond specific scenarios like low-speed traffic jams. The OEM has also worked with the 5G Automotive Association network to test real-time in-vehicle and pedestrian safety notifications using 5G cellular and multi-access edge computing (MEC) technology in live trials conducted in Turin, Italy, in late 2021 and Virginia, US, in early 2022.

Mastering complexity

As for higher levels of autonomous driving capability, Cvijetic thinks that it is certainly achievable, providing there is a focus on the data and information that has already been gleaned from past use cases. “Before Level 4 and Level 5 AVs are commonplace on the roads we need to master the long tail of corner cases and rare events that make driving so complex in the real world. In that sense, I think that real-world, data-driven learnings from mass market scale Level 2 and Level 3 deployments will be highly beneficial,” she notes.

These rare events are difficult to recreate, she continues, and the technology may not be familiar with the scenarios that unfold as a result of the event. More data and testing is needed so that AI-based systems in vehicles can learn how to act

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Ensuring the human driver can easily take manual control of the vehicle and safely override an autonomous driving feature is an important aspect of Level 3 and beyond

accordingly when a rare event takes place. Tests on Level 4 AVs are already taking place today, but Cvijetic clarifies that these are robotaxis and shuttles that are operating in "very constrained environments," so the likelihood of a rare event occurring is extremely low.

She admits that it is difficult to predict when Level 4 technology might be readily available and present in consumer cars, but expects to see deployments before the end of the decade in well-defined operational environments. "For example, shuttles for people or hub-to-hub goods transportation, as well as Level 4 consumer deployments in the form of low-speed parking manoeuvres," she predicts. "I think we will see milestones come in the form of increased capabilities at a given level of autonomy–for example, going from Level 3 low-speed highway-only driving to Level 3 high-speed and urban driving. By 2050, we will also have a large percentage of heavy duty trucks operating on interstate routes autonomously."

But what is all this for? Why are carmakers throwing millions at making AVs? Is it to boast the best tech, or because AVs could be a big cash cow? There are many reports projecting enormous growth in the value of the AV market, but among the most conservative is one by Strategic Market Research that predicts a CAGR of 25.7% between 2021 and 2030, with the market reaching an eye-watering value of US$196.97bn.

"For us, the primary factors are safety and customer-centricity," Cvijetic states. "On the safety side, the number of traffic fatalities in the US exceeded 20,000 in the first half of 2021–the highest first-half total since 2006. Reducing this number to zero is the most powerful motivator for our work. On the customer-centricity side, reducing driver fatigue, giving customers time back during a stop-and-go commute, and complementing the iconic stature of our brands with AV technology are key influencing factors."

Highway autonomy hinges on truck transfer hubs

Embark's CEO believes autonomous trucking will kick off in 2024. Megan Lampinen hears more

The prospect of vehicles that can drive themselves has attracted billions of dollars in funding and eaten up countless hours of R&D over the last few years. Whether it's providing mobility independence for individuals with disabilities or facilitating non-stop movement of goods, the impact of a driverless society will be significant. California-based software specialist Embark has honed in on the logistics sector and spent the past seven years working to commercialise self-driving software for trucking.

"We think trucking represents the use case with the highest impact for this technology, as well as the one that's best suited to its technical maturity today," says Embark Chief Executive Alex Rodrigues.

The benefits promised by autonomous driving are

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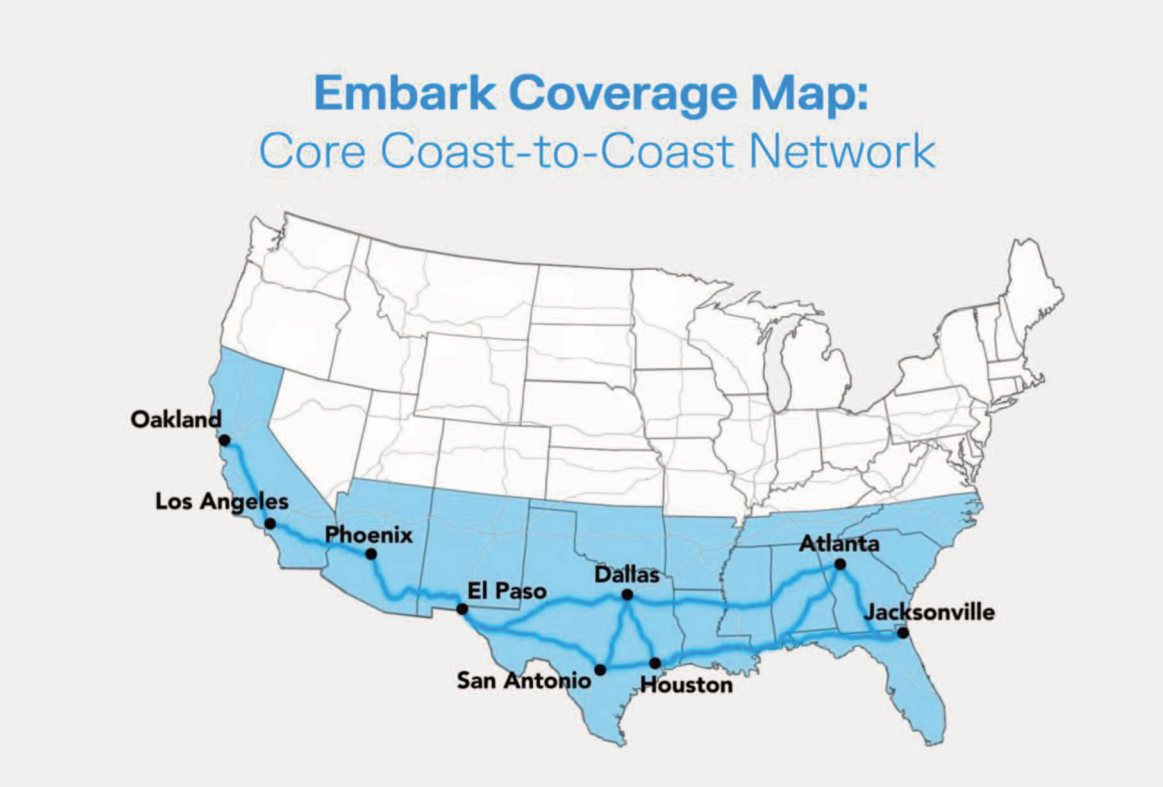


particularly relevant to the challenges currently faced by transport providers. "The driver shortage is really driven by lifestyle and demographics," Rodrigues notes. Older drivers may have historically accepted that they would need to be on the road for weeks at a time, but it's not so easy to convince the younger generation that this makes a good career. American Trucking Associations estimates that in the US, Embark's home market, the industry will need to recruit nearly 1.2 million drivers over the next ten years to replace those leaving the sector and avoid the shortage swelling to more than 160,000 by 2031.

The other two big challenges for the sector revolve around sustainability and safety. By replacing a human with a machine and theoretically eliminating driver error, the safety record should dramatically improve. Automation also optimises fuel-efficient driving behaviour, ticking another important box for fleets. With these tailwinds, it's little wonder that Embark's been growing rapidly.

Highway driving and transfer hubs

One of the things that makes driverless trucks different from robotaxis or city buses is their ability to focus on highway driving. Embark software is not designed to drive in city centres but rather between the outskirts of major cities. Once a truck running on this software reaches the edge of the city, it will pull off into a transfer hub. This is essentially a parking lot, where the truck can drop off its trailer. A local driver, based in the nearby city, then picks up the trailer and takes it to the final destination. "In that framework you end up with the first and last mile being done by a local driver, with driverless trucks doing the long-haul segment," clarifies Rodrigues.

Transfer points are where local drivers bring freight from a nearby facility and transfer it to an Embark-enabled truck

That vision, however, requires the establishment of physical infrastructure in the form of transfer hubs. "There's not a ton going on at these hubs," Rodrigues tells *Automotive World*. "It's like a gated, secured parking lot near the highway. But it is important all the same to have this physical real estate for trucks to be able to pick up and drop off."

As of November 2022, Embark's network covers nine coast-to-coast transport hubs, mostly along Interstate 10. The transfer hub network has initially focussed on the Sunbelt region, due to both its favourable weather and regulatory environment. US policy governing self-driving vehicles is largely determined at state level but many players, including Embark, are pushing for a more homogenised approach. Around 26 states currently allow for the deployment of driverless trucks.

Some large fleets may also have their own hub locations through which they operate, and Embark is working to include these private locations within its hub network. "This network is the backbone on top of which customers can build," he adds. "We need to make sure that there's access to the major cities on a universal basis to enable the scaling and deployment of the technology."

Transformative

Only with these hubs in place can autonomous highway trucking become feasible, and the benefits start to be realised. Rodrigues is confident that self-driving technology will have a "transformative" impact on numerous industries, including manufacturing, retail and resource extraction. It touches "pretty much all the different major industries that ultimately rely on transportation," he says.

Speed is one of the particularly notable areas of impact. A driverless truck doesn't need to follow the mandated hours of service and could theoretically run 24 hours a day, seven days a week. Instead of taking seven days to travel across the US, a self-driving truck could possibly complete the journey in just two. "That can be transformational for spoilage and just-in-time manufacturing," he enthuses. Then there is the cost aspect, potentially providing huge savings in driver wages and simultaneously avoiding the struggles linked to a lack of drivers.

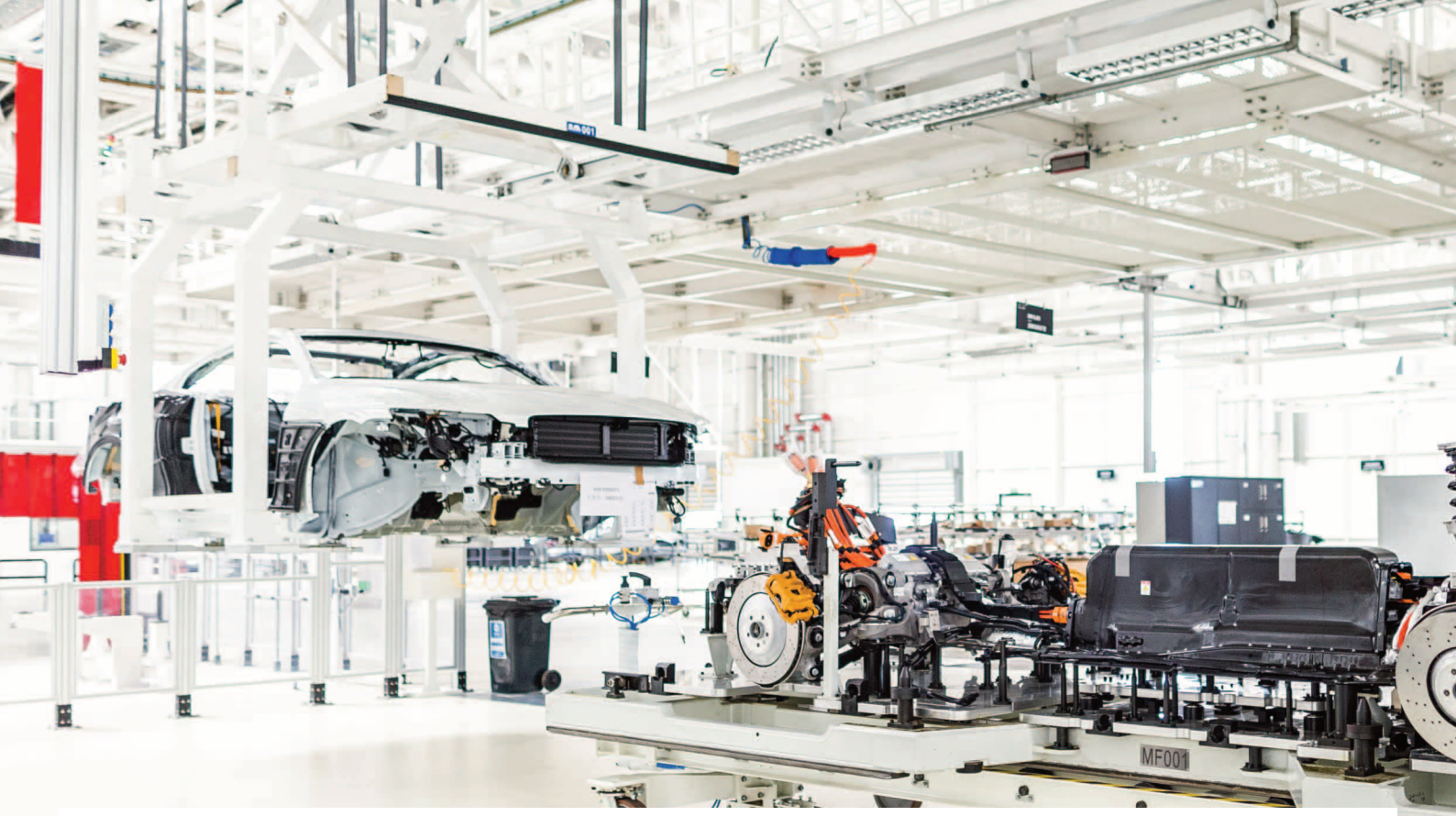
Embark is developing self-driving software that can power any fleet

"It will be absolutely tremendous," emphasises Rodrigues. "That said, the impact will scale up over time. As Embark looks at near-term deployments, we're focusing on where we think we can be the most effective in the short-term." He emphasises that this will be a gradual process: "We don't expect the whole US$700bn trucking industry deploy self-driving vehicles on every lane on the highway immediately." Rather, he anticipates specific focus lanes deploying self-driving in the near future.

Spotlight on 2024

2024 is when Rodrigues anticipates the first commercial and scalable operations starting to kick off. Its modular system is designed to work with any sort of vehicle platform or powertrain from any manufacturer, providing it meets certain minimum standards. "We're in conversations to understand how each of those manufacturers is progressing towards the ability to roll a vehicle off the factory line that meets those standards," he adds. In the intermediate period, vehicles will likely have the necessary components installed post-factory but before they arrive at the fleet.

By the end of the decade, Rodrigues believes Embark's software will be "very broadly deployed", though still with room for improvement. "This is the sort of technology that could really impact and improve the lives of everyday consumers," he adds.



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Is 'industrial origami' the future of chassis manufacturing?

Polestar's project to create a climate neutral car by 2030 could broaden the scope for revolutionary new manufacturing techniques. By Will Girling

In a 2010 article from *The Guardian*, it was estimated that manufacturing a new internal combustion engine passenger vehicle produced six to 35 tonnes of CO2 depending on the size and spec. The European automotive industry alone collectively emitted 12.4 million tonnes of CO2 that same year. Encouragingly, the European Automobile Manufacturers Association's (ACEA) review 12 years later found that a 44.5% overall reduction in carbon intensity had been achieved.

As the push for electrification continues to gain momentum, for which one of the motivators is its environmental benefit, automakers are logically exploring ways to make supply chains and manufacturing processes greener. Fisker, for example, announced that its all-electric SUV–the Ocean–was part of a mission to create "the world's most sustainable car." Integral to that goal was the resolve to publish a pre-production report on its vehicle's environmental impact, with the company challenging other OEMs to follow suit.

Polestar's ongoing concept car project–Polestar 0–fits into this new direction for the automotive industry. Aiming to create the world's first 'climate neutral' car by 2030, the innovative automaker has been collaborating with stakeholders across the industry in order to realise its vision. "The next five years will be critical, and we need partners that will engage with the Polestar 0 project to ensure its success," stated Hans Pehrson, Project Leader and Head of R&D at Polestar.

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Tue Beijer (left) and Jonas Nyvang (right), Founders of Stilride, with the SUS1 and a Polestar 2

Industrial origami

One company in particular, Stilride, is helping to optimise frame manufacturing with a unique process that Co-Founder Tue Beijer calls "industrial origami". Based in Sweden, Stilride's distinctive approach serves to reduce costs and carbon emissions by folding single sheets of steel into strong and functional component shapes using a robotic arm. The company claims that doing so can lower overall frame weight by 40%, use 70% fewer components, and reduce both material and labour costs–20% and 25%, respectively.

Despite focusing primarily on the electric motorcycle sector–its pre-series SUS1 model will go on sale for European customers later in 2023–Stilride joined the Polestar 0 project in September 2022 as its first

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electromobility partner. However, Beijer tells *Automotive World* that his company's work remains speculative in its application to car manufacturing. "There are three technology levels involved: ready, developing, and research. We are the latter, hence why Stilride joined so early in the process," he explains.

Despite this, Beijer is confident that the principles established during e-bike production are both transferable and beneficial to cars. The environmental benefits are particularly appealing when combined with other green manufacturing practices. For instance, *Carbon Brief* found that conventional steel plants are responsible for 9% of global CO2 emissions. However, Swedish steel producer SSAB—also a partner in the Polestar 0 project—is substituting coal and coke for hydrogen in the creation of its product. The resulting 'green steel' reportedly removes 90% of associated emissions and could cut Sweden's total CO2 emissions by 10%. By combining green steel, sustainably generated electricity, and the removal of welding in favour of origami-style folding, Stilride believes emissions can be avoided or otherwise eliminated from chassis manufacturing.

This is not to say that there won't be challenges—Beijer highlights the requirement for crash testing as a clear difference between car and bike manufacturing. Another hurdle is that, as a relatively novel approach, industrial origami must still demonstrate its worth in the automotive space. The Polestar 0 could prove to be a defining use case. "There will always be sceptical voices when a new process emerges, but we think the cost and carbon reduction

potential speak for themselves," he says. While Stilride has yet to design a specific chassis for Polestar, Beijer hints that the combination of tensile and compressive forces observable in ship rigging could provide an answer.

The future of manufacturing?

While the Polestar 0 will represent the culmination of the automaker's and its partners' efforts, Pehrson made it clear that the journey would be just as valuable as the destination: "We will also see spin-off effects across various industries when we address the challenges in the automotive sector with innovation and the development of climate-neutral supply chains throughout a wide array of base industries." Stilride's approach to manufacturing could prove to have the lasting impact to which he alludes, and not just with regards to carbon neutrality.

Perhaps the greatest advantage of industrial origami, suggests Beijer, is that it can be implemented in existing workshops—no new technology or equipment is required, only a different design philosophy. Subsequently, component production could become more local to end customers, such as automakers, if implemented more broadly. With research from the Centre for Climate and Energy Solutions finding that 15% of supply chain emissions come from transport logistics, this demonstrates the multi-faceted approach with which Stilride can contribute to Polestar's climate neutral mission.

"The future for industrial origami is very exciting," Beijer continues. "I can envision combining it with 3D printing to produce steel sheets with threads, guidelines, etc., pressed onto the surface. These could then be used to create very complex components." This act of producing 3D parts from a 2D surface—he calls it "steel couture"—would mitigate the need for jigs and therefore make design, engineering and manufacturing all easier simultaneously.

> "There will always be sceptical voices when a new process emerges, but we think the cost and carbon reduction potential speak for themselves

As such, Stilride views its processes as bridging the gap between styling and engineering disciplines in the automotive market. "By experimenting with something as simple as a piece of paper, we can gain insights into the best way to design a car chassis, both structurally and aesthetically," concludes Beijer. As the industry awaits the realisation of Polestar's climate neutral vision in 2030, it's possible that Stilride's contribution could eventually make manufacturing cleaner, cheaper, and easier than ever before.