

eMove[®]

Mobility 4.0 – electric • connected • autonomous



Electrified drive architectures | the Audi e-tron GT Concept | Steam ahead
Going with the autonomous flow | Interview about the future of mobility

eMove360° Asia 2019

International Conference and Exhibition for Mobility 4.0
electric - connected - autonomous

 Korea Electric Vehicle Association

Nov. 13 - 15, 2019, Seoul Coex, Korea

IN PARALLEL
TO

JEC ASIA
2019 International
Composites Event
November 13-14-15, 2019
SEOUL COEX
REP. OF KOREA



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LADIES AND GENTLEMEN,

Cities have important economic importance as central places of value creation. They are a creative space for social, economic, environmental and political innovation and provide both living space and jobs. Almost three quarters of Germans live in urban areas. Ascending trend. Citizens want reliable transport systems, affordable housing and a functioning public supply of electricity, gas, broadband and water for their city of the future.

The congestion of the road network and the inadequate maintenance of the transport infrastructure, criticized by the business community, repeatedly lead to bottlenecks and high congestion in inner cities and access routes. The increase in commuting and trucking increased the traffic load in urban areas and thus also noise and exhaust emissions. Every smart city therefore needs a good deal of smart logistics. Modern city concepts can not do without intelligent solutions for the movement of goods. At a time when the agglomeration is growing, traffic is increasing and the mobile internet is connecting all areas of life, urban delivery processes also need new, creative approaches.

The challenges can not be met by an efficient infrastructure alone - this is just the necessary prerequisite. Rather, city-compatible, resource and infrastructure-friendly logistics concepts are required to ensure mobility and economic dynamism. One of the future fields for delivery traffic lies in the field of autonomous logistics systems. Autonomous delivery vehicles, also in the form of drones, should in the future relieve the inner-city delivery traffic. Another area is the delivery traffic of the so-called „last mile“ in the quarter. This can be redefined via inner-city micro-logistics centers or decentralized distribution warehouses. This requires corresponding micro-areas at suitable locations in the neighborhoods.

In order to achieve a more far-reaching effect, which also has climate-relevant consequences, the use of small electric vehicles and cargo bicycles for end customer delivery makes sense, for example. Further positive effects are expected from the merger of traders in the district or in industrial areas. Collective orders, the sharing of mobility offers or distribution logistics in the immediate vicinity offer opportunities to reduce traffic and thus achieve related positive effects.

Best wishes

Marco Ebner
Editor in Chief eMove360°



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eMove360° Asia 2019: MunichExpo expands into the Asian market

MunichExpo expands to Asia with its eMove360°, the leading international trade fair for Mobility 4.0 – electric – connected – autonomous. Held in parallel to the leading fibre composite fair JEC Asia 2019, which will take place from 13 to 15 November at the COEX exhibition centre in the South Korean capital Seoul, MunichExpo will be organising eMove360° ASIA for the first time in addition to the fourth edition of eMove360° Europe.

The eMove360° Asia is organized in close cooperation with the KEVA - Korean Electric Vehicles Association and thus offers a strong internationality as well as a strong Korean community of attendees. The basis of the eMove360° ASIA is the International eMove360° ASIA Conference, which will be dedicated to the key topics of electric mobility, Charging & Energy, Battery & Powertrain, as well as Vehicles and Mobility Concepts. The parallel trade fair offers an ideal platform to approx. 50 exhibitors to reach especially engineering experts from the automotive, energy and infrastructure sector. Companies from the New Mobility sector will have the opportunity to present their solutions for tomorrow's mobility to an international audience of experts in one of the key markets in this area. Asian manufacturers – from Korea, Japan, but

also from China – dominate the international vehicle market, the market-leading battery manufacturers are also located in the region with a few exceptions. And Asia also plays an enormously important role as a huge sales market for the worldwide spread of e-Mobility. "Recently, there have been growingly positive perceptions on EVs not only in advanced countries but also in South Korea. Moreover, it is so meaningful that this trend is spreading more widely, and thus promoting the growing necessity for EVs. Therefore, we are delighted to work together with eMove360°, the world's leading trade fair electric mobility and autonomous driving. The Asian markets are an important stronghold for our organization – and through the collaboration with eMove360° we want to pursue our internationalization and to connect more closely with the European e-mobility community", says Kim Pil-su, Chairman of the Korea Electric Vehicle Association (KEVA).

„The two focus area Composites and Materials as well as Electric Mobility and Autonomous Driving complement each other perfectly: The core topic in e-Mobility is to reduce the weight of the vehicles, so there is a great demand for innovative materials and new lightweight construction concepts. JEC ASIA offers an ideal environment, as last year alone around 7000 engineers – mainly from Asia – visited the trade fair. In this respect, a new and above all very affine target group for the exhibitors of the first eMove360° ASIA is virtually guaranteed. And we are very pleased that the cooperation with the KEVA gives us the opportunity to provide our exhibitors from electric mobility and autonomous driving sector in Seoul a successful entry into the Asian market and to create an international New Mobility communication platform in Korea and throughout Asia. I see great potential here to grow together and develop the Asian market“, says Robert Metzger, CEO & Publisher of MunichExpo and organiser of the two international eMove360° trade fairs. The JEC Group, leading company for the promotion of the materials industry, will be present, as a further element of this cooperation, at eMove360° Europe 2019 International Trade Fair for Mobility 4.0 – electric – connected – autonomous with a pavilion for „Composite Solutions for E-Mobility“. At the stand, companies from this sector will be showing the latest technologies that are driving the development of battery electric, hybrid and hydrogen vehicles. As part of eMove360° Europe 2019, the world's largest trade fair for electric mobility and autonomous driving, the JEC Group will hold an international round table at the Munich Exhibition Centre in addition to the pavilion,

highlighting the advantages of composite materials in the development of battery-powered and hybrid cars, as well as connected and autonomous vehicles.

Eric Pierrejean, JEC Group CEO, says: „The automotive industry is accelerating the transition to electric mobility, but also to alternative energy sources such as hydrogen. At the same time, connected vehicles are increasingly developing into entirely autonomous systems. In both cases, composite materials play a crucial role because of their numerous advantages. They enable not only lightweight construction and ultimate freedom of design, but also the integration of new functions such as connectivity, battery housings and insulation for electric cars or fuel tanks for hydrogen and CNG vehicles.



ABOUT KEVA

The Korea Electric Vehicle Association, an affiliated organization of The Ministry of Environment, is composed of more than 50 member companies who are largely involved in the manufacturing of electric vehicles, batteries, chargers, charging services, electric vehicles parts, etc. KEVA carries out mediation and communication among the related governmental organizations. And also it performs the roles as cooperator and helper among the related industries. Thus, KEVA contributes to leading the development of South Korea's EVs industry into the highest level in the global EVs markets.



ABOUT JEC GROUP

JEC Group is the world's leading company dedicated entirely to the development of information and business connections channels and platforms supporting the growth and promotion of the composite materials industry. Publisher of the JEC Composites Magazine - the industry's reference magazine, JEC Group drives global innovation programs and organizes several events in the world, including JEC World (the foremost and world-leading international exhibition dedicated to composite materials and their applications), which takes place every March in Paris.

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Progress = Challenge



According to a study conducted by the Roland Berger consulting company, the growing number of mobility services calls for innovative vehicle designs.

New automobile eras will require new mobility solutions. In the years ahead, providers of mobility services will gain ever greater shares of the market, and car ownership will be thrown into question by competing concepts. As a result, the automotive industry will also have to change. It will need to develop vehicles that are adapted to these trends. In a recent study, the Roland Berger consulting company asserts that these vehicles will face automakers with entirely new demands. Instead of focusing primarily on the driver, as they have in the past, automakers will have to take all the passengers of these new vehicles into account. An interview with Dr. Wolfgang Bernhart, the author of the study and a Senior Partner at the Automotive Competence Center of Roland Berger. At the Center, Dr. Bernhart is responsible for all themes related to electric vehicles, connectivity, and autonomous driving.

Mr. Bernhart, in your study you conclude that mobility on-demand requires the development of completely new kinds of vehicles. What are conventional car models missing in terms of the mobile future?

Dr. Wolfgang Bernhart: The architecture of these new vehicles will be much more flexible than that of current car models. In the future, far more variants can be produced on a rolling chassis with electric drive for precisely defined applications — and they can also be produced in small batches. For example, these variants

could include conventional taxis, shared taxis, shuttles, and so on. Especially in the Asia region, there's a demand for vehicles that are inexpensive but also offer the passengers a high level of comfort. This is exactly the point where the new variants differ from conventional models, which generally focus on the driver. With the new variants, the buyers don't drive the vehicles themselves. Instead, the company offers transportation services to their customers. The requirements for the vehicles are entirely different.

What specific tasks must these new models perform?

Bernhart: The operators primarily expect affordable costs for the vehicles' acquisition and operation. The other requirements depend on how the vehicles will be used. For example, a vehicle that drives for short distances within a city and has an ever-changing stream of individual passengers mainly needs to ensure that the passengers can enter and exit the vehicle quickly and easily. By contrast, the passengers of a shuttle that travels over longer distances, for example from an airport into the city center, expect a more comfortable vehicle interior. Shared taxis have to be designed differently from vehicles that transport only individual passengers. In every one of these situations, connectivity is essential. It must be available to all passengers. The variants range from a mobile workplace or conference room to vehicles that



„We have to separate the development of a car and its hardware on the one hand and the development of electronics and software on the other.“

mainly emphasize comfortable travel. In order to create a large range of very specific models, the ideal solution is to use electric/electronic platforms that can easily be varied.

Does mobility on-demand involve only electric and autonomously driving vehicles?

Bernhart: No, of course not. At the moment, mobility on-demand still requires human drivers and still functions mainly with combustion engines. However, in response to the discussion of clean air in city centers, we have to significantly increase the proportion of electric vehicles. This is also an interesting topic in relation to operating costs, which can be considerably cheaper for electric vehicles, especially those operating in urban traffic. The next step would be an autonomously driving mobility service without human drivers. At some point, mobility on-demand will be exclusively electric and autonomous. At the moment we still can't predict exactly when that will happen.

In your study you assume that these vehicles will have a relatively short life span. They will have to be replaced every three or five years. Isn't that a waste of resources?

Bernhart: These vehicles will of course be used much more intensively than a private car, so they will be subjected to a completely different level of wear and tear. We've therefore defined replacement after three to five years

as a basic guideline. But of course we can also imagine concepts in which only certain parts of the vehicle are replaced rather than the entire vehicle. For example, that would include changing the battery or redesigning the interior, which would be especially subject to wear and tear. On the other hand, we can also imagine scenarios like those for airplanes, in which the interiors and the technology are adapted every few years to the customers' new requirements, but the fuselage remains unchanged for decades. This is a completely realistic scenario because an electric motor has a long service life, after all.

Mobility on-demand will become a mainly urban theme. Will we have two types of mobility in the future — one for cities and another one for long-distance travel?

Bernhart: That depends on where people will use these services. Our surveys show that the main reason for switching to mobility services is not the desire to stop driving a car. In Asia, where the demand is greatest at the moment, many people can't afford to own a car, for a variety of reasons. As a result, they depend on alternative mobility services. Such services are also successful in big cities where parking is simply too expensive. So there might be two types of mobility in the future, mainly because of financial reasons.

How will the market develop in the years ahead?

Bernhart: It will certainly grow significantly in the future, especially in China. At the same time, we're seeing a shift in relative weight as providers of mobility services launch their own vehicles on the market. As a result, the fleet business will play an increasingly important role, and the buying power of these service providers will increase considerably.

How will the new mobility affect the business operations of traditional automakers?

Bernhart: On the one hand, they will have an opportunity to thrive if they can rely on the right platform concepts and build up fleets of customized vehicles. On the other, their business operations with private customers may decrease. Since the business with private customers is much more profitable than the fleet business with its high discounts, there might be pressure on their profit margins. Besides, fleet operators often don't depend on a single brand. As a result, the significance of brands may well decrease. However, that doesn't apply to all automakers because some providers of mobility services purposely want to offer only premium brands as a unique selling point.

At last year, Daimler presented the smart vision EQ fortwo. Is this model compatible with the new mobility scenario?

Bernhart: Definitely. But there are additional opportunities for Daimler's larger vehicles, depending on factors such as a model's equipment. The smart already fits ideally into a carsharing concept, and as an autonomous electric model it's also part of the new future of mobility. The smart vision EQ fortwo as a driverless electric model could primarily become interesting for people who value their privacy and are willing to pay a bit more for this luxury. In this scenario, the product spectrum could range from the smart vision EQ fortwo to an autonomously driving Vito with electric drive.

What factors must car designers and automakers adapt to in the future when these new vehicles become a reality?

Bernhart: The auto industry must abandon the idea that a vehicle standing in a dealer's showroom has been developed as far as it can

go. We have to separate the development of a car and its hardware on the one hand and the development of electronics and software on the other. The vehicle acts as a carrier, and in the course of time it must be able to provide additional functions. This paradigm change is very different from what is going on today. But we no longer have a lot of time at our disposal. In the next two or three years, companies will have to change the way they operate.

Does the trend favoring mobility services providers, which Daimler is participating in, promise success in the future?

Bernhart: There are several conceivable models for future developments, so it's not possible to identify the best concept. One option is to define yourself as a traditional automaker and develop and produce vehicle models according to the standards set by the mobility services provider. Another one is to develop your own range of mobility services — that is, to become a service provider yourself and to offer your services in as many big cities as possible. However, the traditional brand strength of the various automakers tends to play a secondary role here. By contrast, the offer of mobility services can certainly strengthen a company's core business, especially that of the premium automakers.

Thank you for the interview. ■

Author: Robert Metzger



Dr. Wolfgang Bernhart, Senior Partner at the Automotive Competence Center of Roland Berger, responsible for all themes related to electric vehicles, connectivity, and autonomous driving.

BMW CUSTOMER RACING.



**“We made BMW
Motorsport
history this year”**

There is no longer any such thing as a winter break in modern motor racing – not if you have such an exciting portfolio of activity as BMW Motorsport. In the ABB FIA Formula E Championship, BMW i Andretti Motorsport celebrated a thrilling debut with victory in Ad Diriyah (KSA) in mid-December. In this interview, BMW Motorsport Director Jens Marquardt reviews 2018 and looks forward to the new season to explain why BMW i Motorsport and BMW M Motorsport are a perfect match.

Mr. Marquardt, an eventful year of motorsport with many highlights for BMW is coming to an end. Which were the most memorable moments for you?

Jens Marquardt: There are plenty to choose from, as it was an intensive 2018 season for BMW Motorsport, with a comprehensive programme from the very first race. Of course, I particularly like to look back at the big wins – such as the one-two result for the BMW M6 GT3 at the Spa-Francorchamps 24-hour race, the first triumph for the BMW M8 GTE in the US, winning the FIA GT World Cup in Macau or Timo Glock's DTM victory at Hockenheim after his epic duel with Gary Paffett. António Félix da Costa's win in our very first Formula E race stands out in particular. BMW is just starting to race with fully-electric cars, and we won at the first attempt. Thus, we made BMW Motorsport history this year. Of course, the DTM guest appearance by Alex Zanardi and our return to the 24 Hours of Le Mans were very special too. In short, we experienced a host of great moments in 2018, for BMW i Motorsport and also for BMW M Motorsport.

Your memories of the Formula E season-opener will be especially vivid. What was your experience of this weekend?

Marquardt: The first competitive appearance with a new race car like the BMW iFE.18 is always particularly exciting, even more so when you consider that our Formula E debut was a historic event. This is our first season in electric motor racing. It also marks our return to single-seater racing after an absence of nearly ten years. We already had a good feeling after the tests. We hoped that our BMW i drivetrain would be competitive right from the start and the season-opener in Ad Diriyah showed just that. António Félix da Costa clinched pole position and then victory in the very first Formula E race for BMW i Andretti Motorsport. That was the perfect way to round off our 2018 season and the perfect start to our Formula E project.

What does this success mean to you?

Marquardt: I am particularly proud of this – and of the

whole team behind it. I know just how much passion and dedication everyone involved has put into this project. Compared to other manufacturers, the Formula E involvement is organised differently at BMW. The Formula E project saw the closest collaboration ever between BMW developers from motor racing and from production. The ideas just keep flowing in our 'TechLab'. What makes it even more special is that the same people who developed the e-components for the Racing eDrive01 drivetrain are also working on the electric drives of the future for the BMW Group. The result is an extremely efficient, high-performance BMW i drivetrain, which – as we saw in the first race – is good enough to win from the word go. On the track, we have also shown that BMW is one of the world's leading manufacturers in terms of electromobility. This success gives a great boost to our series and motor racing developers. Now we want to continue in this vein.

In your opinion, how do BMW i Motorsport and BMW M Motorsport fit together?

Marquardt: It is of fundamental importance that the two motorsport areas do not operate solely for their own benefit. The focus must be on the value for the company as a whole. Technology is the decisive driver in both areas. The BMW M8 GTE is the pioneer for its production counterpart, Formula E is our 'TechLab' for iNEXT and future generations of cars from BMW i. Our focus is always on the close alliance between production and motor racing, so that every race kilometre and all the experience we gain also benefit BMW customers. In strategic terms, we are very well set up overall. BMW i Motorsport and BMW M Motorsport are also a great visual match. The shared design features for all our cars ensure that this will remain so, regardless of whether they use combustion or electric engines. These include the matt black cockpit elements that can be found on the BMW iFE.18 and on our BMW M race cars from the BMW M4 DTM to the BMW M4 GT4. I think that these visual design elements are fantastic. They are symbolic of how the components of the two worlds fit together.

Author: Edyta Szwec





DAIMLER AND NEWMOTION OFFER INTELLIGENT CHARGING SOLUTIONS FOR FLEET CUSTOMERS

The provision of intelligently networked charging facilities, and convenient access to them, plays a key role in the e-mobility initiative of Mercedes-Benz Cars and is an elementary component of the corporate strategy for the mobility of the future, which Daimler has formulated under the acronym „CASE“. The four letters stand for the strategic future pillars of networking (Connected), autonomous driving (Autonomous), flexible use (Shared & Services) and electric drive systems (Electric), which are being systematically further developed and intelligently combined by the company. For private customers, Mercedes-Benz offers charging solutions for the home and in public places. However where the electrification of fleets is concerned, an integrated charging infrastructure is also of enormous importance for companies with their wide-ranging mobility requirements. In order to offer commercial customers the most convenient and least complicated all-in charging infrastructure possible – on a brand-neutral basis, which is particularly relevant to mixed fleet - Daimler AG is cooperating with NewMotion B.V., one of Europe’s leading providers of charging solutions. This Dutch company has been developing intelligent solutions for the expansion of the charging infrastructure since 2009. Using the NewMotion charging card, employees are able to carry out and pay for charging operations at public charging points in the European network of NewMotion and 200 roaming partners. The charging card is also used for access to charging stations at the workplace and at home. The NewMotion app also enables employees to find charging stations and view their billing details. A specialised online tool gives fleet managers full transparency about the charging infrastructure and all charging pro-

JAGUAR I-PACE IS EUROPEAN CAR OF THE YEAR

The European Car of the Year jury comprises 60 motoring journalists from 23 countries, and the award recognises technical innovation, design, performance, efficiency and value for money. „For our first electric vehicle to also be the first Jaguar to win European Car of the Year gives us a huge sense of pride. I-PACE was designed and engineered in the UK from a clean sheet of paper. It is the most technologically advanced battery electric vehicle. It’s a true game-changer. Winning European Car of the Year is an honour and real recognition of what our world-class team has delivered,“ said Prof. Dr. Ralf Speth, Chief Executive Officer of Jaguar. Designed and developed in the UK, the Jaguar I-PACE has had profound sales success globally, with more than 8,000 customer deliveries to date – 75 per cent of them in Europe. Nothing else on the road looks or drives like the I-PACE. It is engineered to take full advantage of its electric powertrain and bespoke aluminium architecture, offering sports car performance and SUV practicality. Charging is made easy for customers using the Jaguar public charging service, accessed via a dedicated app or using an RFID key. With tailor-made charging packages and tariffs compiled into a simple monthly bill, it gives I-PACE customers access to more than 85,000 charging points throughout Europe. ■



cedures. They also have the option of enabling further services such as load management, access authorisation (e.g. guest users) and billing functions. ■



eMove360° ASIA

1st International Conference & Exhibition for Mobility 4.0: electric - connected - autonomous
November 13 - 15, 2019, Seoul Coex, Korea



EXHIBITORS' INFORMATION



MOBILITY 4.0

electric - connected – autonomous

Ladies and Gentlemen,

the future of mobility is electric, connected and autonomous – the era of the Mobility 4.0. Experts predict that the human being behind the steering wheel will be replaced by a computer within the next 10 years. Especially the market potential related to Mobility 4.0 won't stop to grow: being estimated at around 32 Billion Euro today it is expected to multiply to 115 Billion Euro in the year 2020.



With eMove360° we have created a core brand for the Mobility 4.0: B2B trade fairs, conferences, awards, magazine or news portal - eMove360° is a comprehensive information platform for Mobility 4.0. Empower your market communications with our exclusive access to your premium target audience: face-to-face, via print or through digital channels.

So please let me recommend you to participate – as an exhibitor or as a conference participants in Korea.

Best regards,

Robert Metzger
CEO & Publisher





EXHIBITION AREAS

- Vehicles (electric, connected, autonomous)
- Infotainment & Connectivity
- Automated Driving & Electronics
- Battery & Powertrain
- Mobility Concepts & Services
- Urban & Mobile Design
- Materials & Engineering
- Charging & Infrastructure



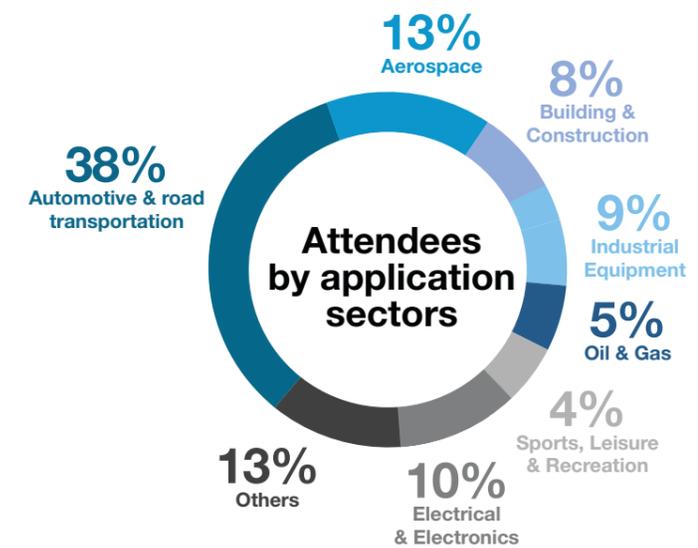


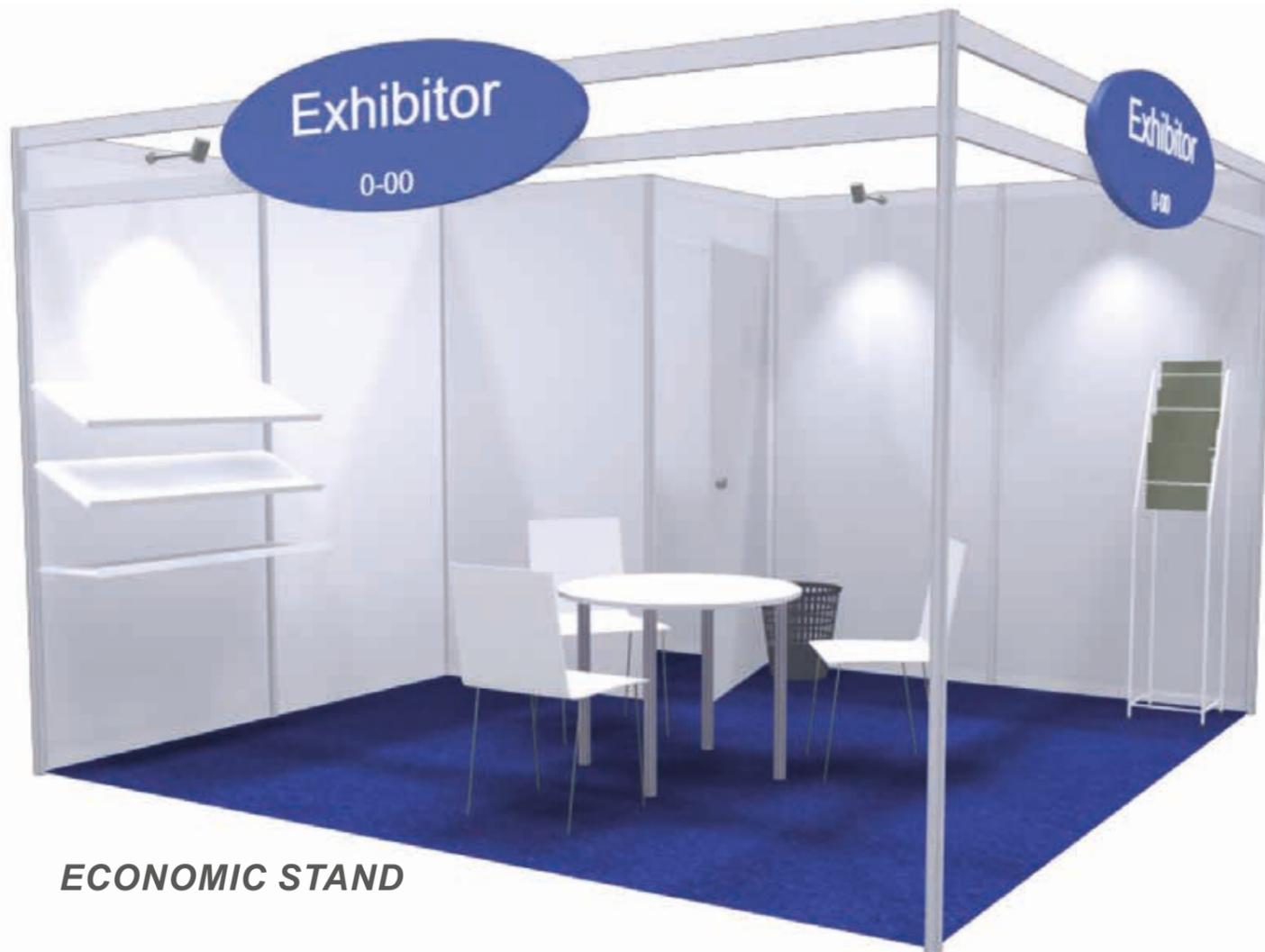
TARGET AUDIENCES

- Engineers
- Designers
- IT Experts
- Procurement Managers
- Fleet Managers, Taxi and Car Sharing
- Cities, Communities and Politics
- Dealers, Repair Shops
- Hotels, Tourism, Real Estate and other Users
- Consumers

50% ENGINEERS

50% USERS





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* plus 19% VAT



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VW IS BRINGING BACK THE BEACH BUGGY

Nearly 60 years ago, Bruce Meyers created the Meyers Manx - an indecently cute VW Beetle-based dune buggy that came to define the beach culture that conceived it. If you're under the age of 30, it's the BF Injection from Grand Theft Auto. Now, VW is bringing the dune basher back. And it's electric. Currently unnamed but more-than-likely called the I.D. Buggy, or something, it's an all-electric concept that'll utilise the firm's modular electric (MEB) construction. Just like the MQB platform that now forms the underpinnings of anything from a hatchback to a premium sedan, MEB is just as flexible. The chassis is a kind-of skateboard that contains the motors and batteries, freeing up passenger space and theoretically enabling VW to stick basically anybody they like on top of it, everything from a hatchback to a crossover and, as they're keen to show at the Geneva, a beach buggy. Annoyingly, VW forgot to turn the lights on in the pictures provided, but it's obvious that its new buggy wants to stay true to the original. There's no fixed roof or doors, so occupants have to climb in it like a pedalo. And with chunky wheels and tyres, a squat stance and low centre of gravity, it very much looks like a modern-day Manx - just with the trendy 2019 trinkets; a backlit Volkswagen logo, and trendy spotlights that re-vamp the originals. ■

ELECTRIC VEHICLE CHARGING & AUTOMATED PARKING CONCEPT

Hyundai Motor Company and Kia Motors Corporation unveiled a video featuring the concept of electric vehicle wireless charging system with the Automated Valet Parking System (AVPS). The system will offer a convenience to drivers who are faced with an overcrowding of both parking and charging locations as electric vehicle numbers grow steadily. It relocates fully charged vehicles from charging stations and allow other awaiting electric vehicles to charge. Upon commanding the vehicle to charge using a smartphone, the vehicle will automatically cruise to a vacant wireless

charging station. When the vehicle is fully charged, it will relocate to another vacant parking space using the Automated Valet Parking System (AVPS), allowing other vehicles to charge at the spot. When the driver calls for the vehicle, it will then autonomously return to the location of the driver. The overall process is performed by continuous communication between electric vehicle, parking facility, charging system and driver. The parking facility sends location of empty parking spaces and charging stations, while the charging system updates the charging status of the vehicle in real-time. Hyundai and Kia are considering on commercializing the technology upon the launch of level 4 autonomous vehicle around year 2025. Hyundai and Kia also plan to commercialize autonomous vehicles in various smart cities from 2021 with a goal of launching fully autonomous vehicles by 2030. ■

DAIMLER AND GEELY HOLDING FORM GLOBAL JOINT VENTURE TO DEVELOP SMART

Daimler AG and Zhejiang Geely Holding Group announced the formation of a 50-50 globally focused joint venture to own, operate and further develop smart, the pioneer of small urban vehicles, as a leader in premium-electrified vehicles. Under the joint venture agreement, a new generation of smart electric models will be assembled at a new purpose-built electric car factory in China with global sales due to begin in 2022. Dieter Zetsche, Chairman of the Board of Management of Daimler AG and Head of Mercedes-Benz Cars, said: "For more than 2.2 million customers, smart represents a pioneer in urban mobility. Based on this success story, we look forward to further enhancing the brand with Geely Holding, a strong partner in the electric vehicle segment. We will jointly design and develop the next generation of smart electric cars that combine high-quality production and known safety standards for sale both in China and globally. In the future, we are looking forward to working with all partners to sustain our success in China and worldwide. Separately, Mercedes-Benz will produce a compact electric vehicle at the Hambach plant, sustaining employment with further investment in the facility." The joint venture is expected to be finalised by the end of 2019. ■

An aerial, high-angle photograph of a multi-lane highway at dusk. The sky is a deep, dark blue with some light clouds. The highway is filled with cars, their headlights and taillights creating a stream of light. On the left side of the highway, there is a modern building with a grid of windows, some of which are lit up. In the background, several tall office buildings are visible, some with lights on. A large blue highway sign is positioned on the right side of the road, with white text and arrows. The overall scene conveys a sense of urban mobility and modern infrastructure.

Interview: Future of mobility

↑ Essen-
Holsterhausen
40

↑ E-Zentrum
224 400 m



Electric, connected, autonomous, shared — Bram Schot, acting Chairman of the Board of Management of AUDI AG talks with mobility researcher Carlo van de Weijer about the future of mobility.



A thought leader on mobility, van de Weijer not only conducts research as Director of the Strategic Area Smart Mobility at Eindhoven University of Technology but also heads up R&D at a leading global provider of navigation solutions in addition to advising governments, industry associations and businesses around the world on the future of technology and mobility. He has driven an electric car for the past five years.

According to a United Nations forecast, two thirds of the planet's total population will live in cities in 30 years' time. That means the threat of ever worsening space constraints, pollution and overtaxed infrastructure. Do urban mobility concepts need to be completely overhauled?

Dr. Carlo van de Weijer: Mobility as an abstract concept will always exist. Since time immemorial, people have had a tendency to be on the move for about an hour a day, and that will remain constant. The only thing that has changed over the millennia is the fact that mankind has evolved and technology has taken us further. So while we now get around faster, we don't spend any more or less time on the go. I believe we will have safe, clean ways to get around in the future. The only major problem with traffic that requires a solution is the space it takes up.

Many studies say that car traffic in urban areas occupies up to ten percent of the available space.

Van de Weijer: If by "traffic" you mean all mobility systems including streets, tracks, parking spaces,

etc., it's actually 40 percent of a city's total area. In other words, cities are extremely badly organized. People don't go to the city to look at mobility. They go to the city to meet other people, to experience things, to shop and eat. So something took a fundamentally wrong turn somewhere. That has to change in the future. We will see fewer cars in downtown areas because cars are not an efficient use of space. Most things that fall into the category of mobility will still be provided adequately through cars. But in terms of square footage, the way we use them is inefficient.

Mr. Schot, how does a carmaker like Audi respond to this accusation?

Schot: Cars will always be part of our mobility. But at the same time, traffic jams and parking scarcity are delineating the limits of mobility. Now the question is: How can we organize mobility intelligently such that it creates value for our customers according to their personal needs? We see the car as part of the solution, not part of the problem. Audi is testing swarm technologies, self-parking cars and connected

traffic lights, for example, as ways to optimize traffic flow and simplify the search for parking. But you have to understand how people behave in cities. Everyone needs to take part in this: Urban planners, architects, politicians, researchers and carmakers have to work together to create smart concepts for using the available space in cities more efficiently. No one is efficient enough in their own sphere of action, but by working together, they can achieve a lot.

Mark Simon of the New York City Department of Transportation says, "We don't want more cars in the city; we want more bike paths, more green areas, more space for pedestrians." Will city dwellers need to part with their private cars?

Van de Weijer: If you live in the center of a city, you may need to accept the idea that this fact doesn't automatically require you to own a car. But that doesn't mean you can't use one. So many different services are springing up that enable car use without car ownership. Yet the trend is clear: Cities are re-zoning space that used to be reserved for mobility so people feel good about being there. The High Line in New

York, which used to be train tracks and has now been turned into a park, is just one example. Today's cities are moving away from allotting 40 percent of their space to traffic.

What will that mean for Audi if tomorrow's mobility not only gets less space but also results in less ownership?

Schot: I am sure that mobility will become more and more of an individuality factor. The premium experience is still key for Audi customers. But autonomous driving will fundamentally change society, the role of cars and our mobility behavior going forward. A new kind of individual traffic using robot taxis might be an option, for example. That can potentially make traffic more efficient by maximizing vehicle capacity utilization. At the same time, it would require less space for parking and reduce the time each car spends idle. Why should cars only be used for 30 percent of their service life? They could also be used for 70 percent of that time. That will spawn new business models in the future. Maybe down the road Audi will also sell kilometers driven per hour.

The native of the Netherlands is a father of two sons — "one of them a gearhead, the other not especially enthusiastic about cars" — and Chairman of the Board of Management of AUDI AG responsible for Sales and Marketing. He sees far too little of his home town, Amsterdam, where he likes to live in the city center. With all the traveling he has to do for work, he's already really looking forward to tomorrow's premium self-driving cars.

„I sincerely believe that by as early as 2025, electric cars will account for 30 to 40 percent of cars on roads around the world.“

Bram Schot, acting Chairman of the Board of Management, AUDI AG

Van de Weijer: Whenever new concepts like this are emerging, people tend to use cars more, not less. The services now being created do not pose a threat to car manufacturers' business; in fact, they will mean even more business.

Is automated traffic the golden path to tomorrow's urban development?

Schot: There will be more transportation options. For instance, when I want to go from the center of Amsterdam to Schiphol Airport on a Monday morning, I will be able to choose between a taxi, an Uber or a robot taxi. But using a shared car does not entirely satisfy my individual needs if, for instance, what I really want is to own an Audi RS 6 Avant or a convertible. The new usage models make mobility more efficient with more passengers per car, so overall there will be fewer vehicles driving around on the streets. Increased effectiveness also spells freer traffic flows. And that in turn can mean more fun for me behind the wheel of my Audi RS 6 Avant.

Mr. van de Weijer, you predicted in a recent lecture: "This development will also increase traffic, because autonomous cars are convenient and safe."

Van de Weijer: Yes, I'm afraid tomorrow's driverless vehicles will not really solve the problem in cities. Many say driverless cars

will transport more people per vehicle. I don't really see it that way, because cars will also be driving around without passengers. So the average number of people transported per car will actually even drop. Even if four people used one car, that would not reduce the number of vehicles enough for our urban centers. Tomorrow's cities don't need driverless cars; they need carless drivers.

In Amsterdam, 31 percent of commutes are undertaken by bicycle. The network of cycle lanes is 600 kilometers long and 80 percent of residents own at least one bike. In fact, there are apparently more bicycles than people in the city. Is this a direction we should pursue with future traffic concepts?

Van de Weijer: It all comes down to what is known as corridor capacity: In other words, how many people can pass through a 3.5-meter-wide corridor into a city within an hour? The figure 3.5 meters is the average width required for a street or train track. Today, the corridor capacity for cars is about 1,000 people. If you put four people in each car, it rises to 4,000. In autonomous cars that run like trains, that number could even go up to 5,000. But that's not enough. A public transport system, such as buses, achieves roughly 10,000 people per hour, while subways push 25,000. The surprising thing is that a cycle lane has a corridor capacity of up to 15,000,

The new Audi Q4 e-tron concept is a compact four-door SUV with an exterior length of 4.59 meters whose relation to the Audi e-tron is apparent at first glance.





„Autonomous cars are not going to put an end to congestion over the next decade.“

Carlo van de Weijer, Mobility Researcher

which is why bicycles are enjoying a boom as a mode of transport in urban areas. After all, cities need to put some thought into optimizing corridor capacity. How much space do they need to be able to transport a specific number of people into a city? The answer determines what is the most suitable mode of mass transport. That's why I keep driving home the point that instead of driverless cars, I want to see drivers without cars.

Schot: Even so, autonomous driving will have a huge impact on how cars are perceived. At present, the car is just a mode of transport. You get behind the wheel and, while you're there, the only thing you can do is converse with a passenger, drive wherever you're going and park the car. From that moment, the car becomes an inefficient object, because it's just sitting there unused. Instead, it could autonomously drive off to the school to fetch the kids. Or I could use it to hold a video conference with colleagues or have a twelve-minute power nap. That would make it far more efficient. The car would become part of my life and make it more streamlined and pleasant. When, in the future, I can finally do all the things in a car that I couldn't do before, then travel ceases to be an obstacle. And there's nothing to stop you using a car. On the contrary, tomorrow's cars will become the new living space. People will spend more time and have more control over what they do in cars.

Van de Weijer: Autonomous cars are not going to put an end to congestion over the next decade. But people won't care that they create bottlenecks because they can work during a journey in a self-driving car. By the same token, this would, however, alleviate the enormous economic impact of gridlock without actually preventing the jams themselves. If bottlenecks no longer bother people much, it becomes possible to resolve the traffic jam problem without eliminating it. An upshot may be the ability to schedule congestion, which, for logistical reasons, would be a win.

Does that mean you agree with Bram Schot that swarm intelligence and autonomous driving will make tomorrow's cars more attractive?

Van de Weijer: Yes, these are the forms of intelligence that spur a surge in quality. If gridlock is no longer a headache, then car journeys are much more pleasant. As a rule, people don't want to waste their time in traffic, get into accidents, search for parking or have to park the car themselves. These are all inconveniences that new technologies can banish from our lives. And when the unpleasant aspects of driving disappear, then driving becomes all the better for it. I like to compare it to skiing. The sport became popular when lifts took the bother out of getting back up to the top of the slope. Which is exactly

what's now happening with automation in mobility. It's not about driverless cars or robot taxis. It's about getting rid of what's tiresome about driving and replacing it with a higher quality experience.

Do you see electric drives contributing to this increase in quality?

Van de Weijer: Absolutely. Electric mobility will be clean and affordable — it's the next logical step toward the future. Electric cars last longer and require less maintenance than vehicles with combustion engines — they're the more economical choice. I was very skeptical before I bought my own electric car. Now, I know that a range of 400 kilometers is sufficient. I start my day with a fully charged battery and very rarely need a speed charger. When that occasionally happens — less than once a month — it's not a problem because I've already taken the half hour of charging into account when planning for a longer journey. And rather than sitting around waiting during that time, I work in the car or eat lunch. If you prepare for it, this charging time is surprisingly enjoyable and just takes one neat click. Filling up the tank in a car with a combustion engine, you have to stick a nozzle to direct the flow of fuel into the car for three minutes. Just thinking of those three minutes annoys me.

Schot: Once charging is possible whenever and wherever, that will be a huge draw for electric cars. We talk to a lot of customers and many are still unnecessarily concerned about having to make compromises with an electric drive. It's a very interesting debate, because average drivers in Europe tend to cover 28 to 30 kilometers per day. So this isn't about whether a car has a range of 400 or 500 kilometers. The key questions are where can the car be charged, and how fast. I sincerely believe that by

as early as 2025, electric cars will account for 30 to 40 percent of cars on roads around the world. At Audi, we have also committed to ensuring that one in every three cars sold is electric. My experience is that people who own an electric car are very happy with it.

Don't the anticipated leaps forward in battery technology also put customers off buying an electric car today?

Van de Weijer: It's the same problem as holding out for an even better computer. You end up never buying one at all. At some point, you just have to get on board with the technology. I've been driving an electric car for almost five years now. And the battery capacity is still at over 90 percent. The capacity loss is nowhere near what most predicted. Off the showroom floor it had a range of 400 kilometers, while today that's 378 kilometers. So that really isn't a problem.

Thank you for the interview. ■

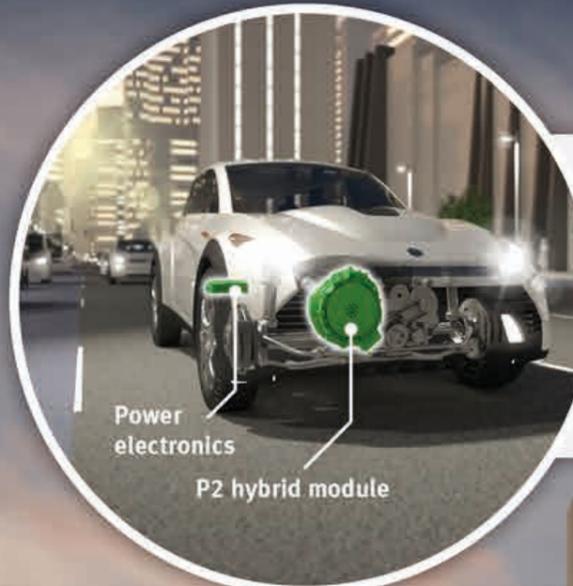
Author: Edyta Szwec



Electrified drive architectures

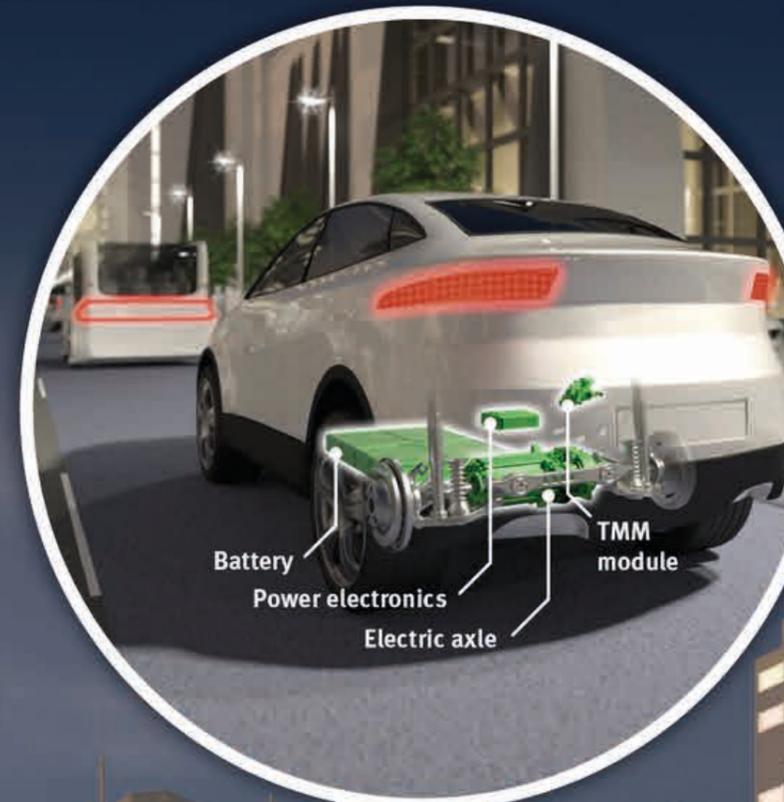
SCHAEFFLER

The entire field of electric mobility – which includes electric and hybrid vehicles – will determine tomorrow's mobility. From high-voltage hybrid modules through to electric axles and visionary wheel hub drives – Schaeffler offers a wide range of products for the age of electrified drive architectures.



HYBRID MODULE

Plug-in hybrids can also operate using electric power only and therefore make local emission-free driving possible. Schaeffler offers technologies for this, such as the high-performance **hybrid module for 48-volt and high-voltage applications** – systems that ensure efficient future mobility thanks to the perfect interplay of electric motor, power electronics, battery, and additional internal combustion engine.



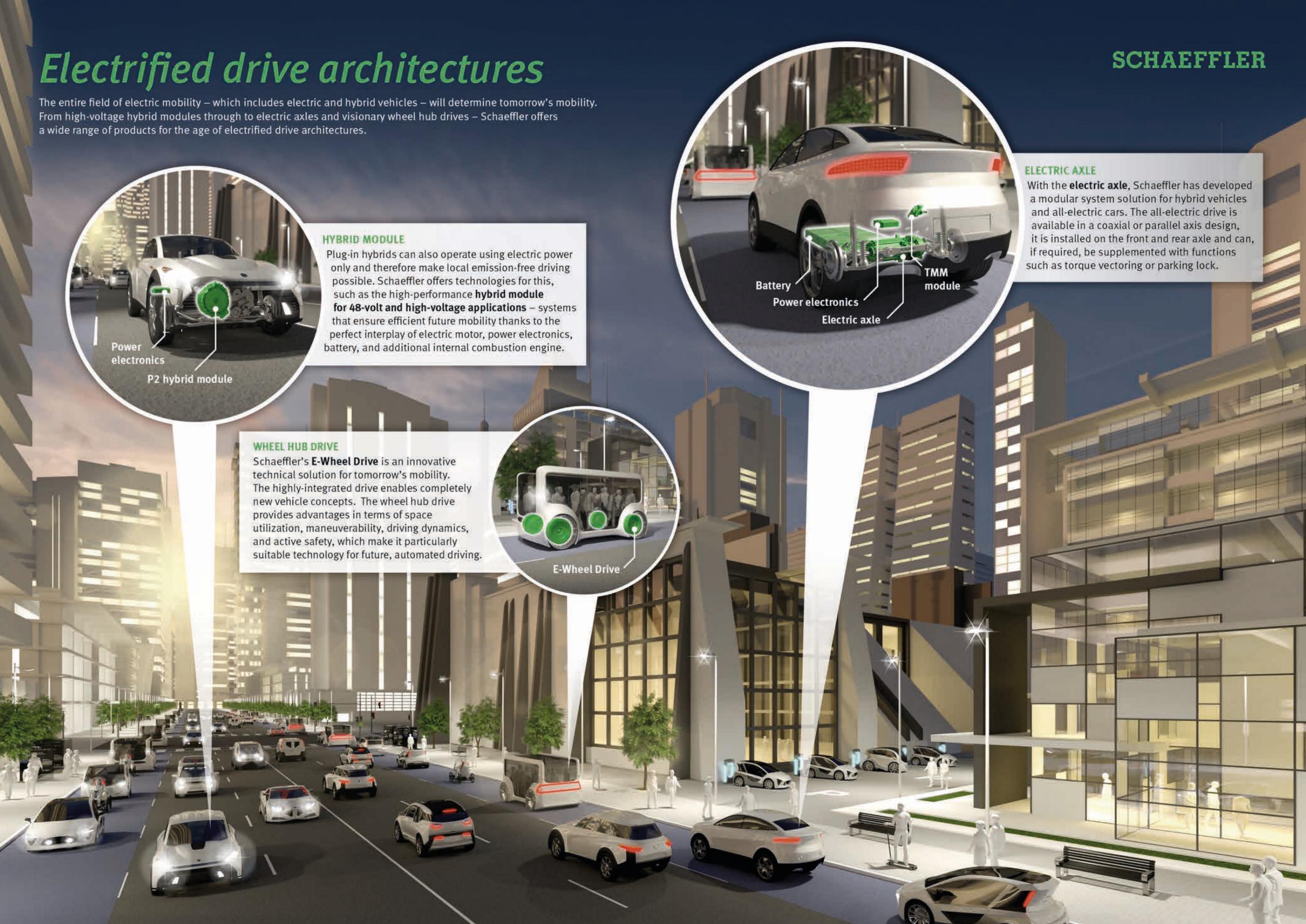
ELECTRIC AXLE

With the **electric axle**, Schaeffler has developed a modular system solution for hybrid vehicles and all-electric cars. The all-electric drive is available in a coaxial or parallel axis design, it is installed on the front and rear axle and can, if required, be supplemented with functions such as torque vectoring or parking lock.



WHEEL HUB DRIVE

Schaeffler's **E-Wheel Drive** is an innovative technical solution for tomorrow's mobility. The highly-integrated drive enables completely new vehicle concepts. The wheel hub drive provides advantages in terms of space utilization, maneuverability, driving dynamics, and active safety, which make it particularly suitable technology for future, automated driving.



Interview:
**„We do not see any
supply risks for
battery cells“**



„The BMW Group is already developing its fifth generation of electric drive systems.“

Stefan Juraschek, Vice President Development Electric-Powertrain, BMW Group.

Mr. Juraschek, was BMW slow off the mark with electric mobility?

Stefan Juraschek: No, absolutely not. The BMW Group actually played a pioneering role with BMW i. Today we are the premium manufacturer offering the widest range of battery electric vehicles and plug-in hybrids. We currently produce the following electrified models: the BMW i3 (third model evolution with 120 Ah) , BMW i3s, BMW i8 Coupe, BMW i8 Roadster, BMW 740e, BMW 740Le, BMW 530e, BMW 225xe Active Tourer, MINI Cooper S E Countryman ALL4 and, in China, the BMW X1 xDrive25Le. Plus, we have also announced new plug-in hybrid variants of the 3 Series Sedan and BMW X5 for 2019 following the arrival of new model generations. This number is set to grow to at least 13 plug-in hybrid models by 2025. Adding these to the wide selection of all-electric cars – whose range is due to increase substantially next year incidentally – will bring the portfolio of electrified vehicles to at least 25. Sales topped the 100,000 mark last year and will have grown by around 50% this year.

Is the BMW Group prepared if electric mobility starts to gather momentum at an even greater pace in future?

Juraschek: The BMW Group is already developing its fifth generation of electric drive systems, meaning that it has created an excellent foundation for the future. This latest generation will go into service as soon as 2020 in the BMW iX3. A crucial advantage of this fifth-generation system is that the electric motor, transmission and power electronics now form a single, highly integrated electric drive component. This extremely compact unit takes up far less space than the three separate components used in preceding generations. Its modular construction means that it is scalable,

too, allowing it to be modified to suit all sorts of different installation spaces and power requirements. The BMW Group will start to fit the next generation of battery cells in the new, scalable and even more powerful vehicle batteries alongside the introduction of the new electric drive components. The modular “building block” concept will allow the new batteries to be incorporated flexibly into every vehicle architecture. Another highly integrated component will be added to the portfolio in the form of a DC/DC charger unit.

So how will it all work?

Juraschek: On the one hand, we will have flexible vehicle architectures and, on the other, the scalable and modular building blocks for the electric drive systems. This will bring about a lasting increase in flexibility. In future, we will be able to swiftly decide which models we are going to equip with what mix of all-electric drive, plug-in hybrid drive or exceptionally efficient combustion engines. This will let us partially or fully electrify each model in accordance with market demand, creating the basis for the mass-market introduction of pure battery electric vehicles in the future.

Don't you think there is a risk of not being able to obtain the necessary quantities of raw materials once battery electric vehicles start to be produced in big numbers?

Juraschek: We do not see any supply risks, even in the event of growing demand for battery cells. My colleagues in Purchasing have secured a reliable supply with long-term contracts. We have also built up in-house battery cell expertise over the course of joint projects with international partners throughout the value chain. This is used to ensure access to





the technology and to safeguard supplies. At the same time, we are also endeavouring to gradually lower the proportion of critical raw materials that are used. For example, one of the key objectives of our research and development activities is to bring about a substantial reduction in the proportion of cobalt in battery cells. The electric motor in our fifth-generation electric powertrain is another illustration of this, as it is completely free of rare earths.

Staying on the subject of battery cells: Some well-known competitors of yours are employing round cells or pouch cells. Why are you using prismatic cells?

Juraschek: The prismatic hard case arrangement makes the battery modules more suitable for industrialisation by increasing the level of automation during module assembly. Besides this, safety systems such as a safety valve for shutting down the cell in the event of a short circuit can be integrated more easily. It also

allows us to achieve a higher packing density, meaning that optimum use can be made of the installation space in the vehicle.

Battery cell manufacturers in China, Japan and Korea have been investing enormous sums of money in cell development and future battery technologies for years now. Is it still possible to catch up with them, both technologically and economically?

Juraschek: We don't consider any of our competitors to hold an advantage over us when it comes to the battery technology. When all the characteristics are viewed together, our battery technology is on a par with or superior to the competition's, depending on how you look at it. We have been dealing with the issue of battery cells since 2008 and are in a strong position today thanks, among other things, to an international network of collaborations. For us, it is important to continue to expand our in-house expertise and keep advancing battery

cell technology. What's more, building battery cell prototypes and producing small batches enables us to fully analyse the production processes and acquire build-to-print capabilities. In this way, we can provide system suppliers with exact instructions based on BMW Group specifications, from material selection through to cell production.

So why don't you produce the battery cells yourselves?

Juraschek: In the BMW Group's view, producing the cells would not give us a competitive advantage, either now or in years to come. We make electrical components ourselves, using our in-house manufacturing facilities, whenever we think there is an advantage to be gained from it, as is the case with the electric powertrain. That's why we use supplied battery cells to produce the modules ourselves, before turning them into complete high-voltage batteries.

Is it really worth doing that? Surely you could buy the electric motor from a supplier instead?

Juraschek: When the development plans for the BMW i3 became tangible, there wasn't a single electric motor on the market that would have met all our criteria. And today we are still just as unwilling to make any compromises when it comes to key performance characteristics, such as space requirements, output and weight. Drive systems have always been an area that has set the BMW Group apart from the competition. And exactly the same applies to electric drive systems.

All electric motors are basically the same, though. Can customers really notice a difference?

Juraschek: The customer may not be able to identify every characteristic of an electric motor, but a significant difference does become apparent in head-to-head comparisons. Probably the most obvious thing that the customer will notice is the speed up to which the motor can sustain its performance. A more indirect effect is that the vehicle's range will drop faster if the electric motor operates less efficiently.

The BMW Group is working together with Northvolt and Umicore. Why is that exactly?

Juraschek: The objective is to establish a closed lifecycle loop for sustainable battery cells in Europe. This starts with a recyclable cell design and continues with a production process that mainly uses renewable energies. The battery cells should first fulfil their primary purpose

in cars for as long as possible. Once their lifecycle there comes to an end, they could potentially be used in stationary energy storage devices. Finally, the battery cell is recycled and the raw materials reused, completing the loop.

And what are the tasks fulfilled by each of the three partners?

Juraschek: The BMW Group is focusing on cell development, Northvolt is building a cell production facility in Sweden and Umicore is the materials cycle and recycling expert.

BMW had already come up with some developments for materials recycling. What do you now expect to achieve by joining forces with Umicore?

Juraschek: Yes, both partners are embarking on this project with their own fundamental developments. We are working together with Umicore on the development of recyclable cell/battery technology that is then followed by a sustainable production process. At a later stage, large quantities of material will, of course, be fed back into the loop for recycling. Before this happens, however, I foresee a long phase of primary use in vehicles followed by second-life use in stationary storage devices.

How does this secondary use work exactly?

Juraschek: As far as the BMW Group is concerned, employing used batteries as stationary energy storage devices is a logical step towards holistic sustainability. The use of stationary energy storage devices is set to gain greatly in importance with the ongoing energy revolution. At times when surplus electrical power is generated from renewable sources, it can be stored in these stationary devices. And during periods of low electricity generation, the storage device can then release the accumulated power. We have already successfully implemented this type of power grid stabilisation with used batteries from BMW i3 and MINI E prototypes as part of joint development projects with partners such as Vattenfall, Bosch and NextEra. The energy storage farm at BMW Group Plant Leipzig, which holds a total of 700 BMW i3 batteries, is one example of how profitable use can be made of batteries at the end of their service life in vehicles by giving them a second life as part of a sustainable energy model. This demonstrates once again how the sustainability concept at BMW i extends far beyond the vehicle.

Thank you for the interview. ■

Author: Robert Metzger



**Bosch presents
tomorrow's mobility
today**

A light, airy, minimalistic design, a futuristic outer shell made of display screens and glass, and a spacious interior – that is how architects might describe a novel structure, but in actuality the description also fits a completely new class of vehicle and a new kind of mobility: driverless electric shuttles that glide almost silently through city centers and are seamlessly connected with their environment. These will soon be a common sight on our city streets – whether they are transporting goods or people. Bosch provides components and systems for automating, connecting, and electrifying the shuttles, but shuttle mobility won't be possible without mobility services. In the future, the company will offer these services too, bundling them into a smart, seamlessly connected ecosystem. That will include booking, sharing, and networking platforms, parking and charging services, and software solutions for managing and maintaining the vehicles, as well as infotainment during the journey. "Bosch is developing a unique package of hardware, software, and mobility services for shuttle mobility of the future," says Dr. Markus Heyn, member of the board of management of Robert Bosch GmbH.

SERVICES FOR USERS AND SHUTTLE OPERATORS

The emergence of the shuttle segment is a result of rising demand for ridesharing services: in Europe, the U.S., and China alone, about one million such on-demand shuttle buses will be on the roads as early as the year 2020, growing to 2.5 million by 2025 (source: Roland Berger). Many of these vehicles, available 24/7, will be fully electric, and they will also be completely autonomous by the middle of the next decade at the latest. That's why Bosch has packed every square centimeter of its concept shuttle with the appropriate technology – from electric powertrains and 360-degree surround sensors to connectivity management and vehicle computers. Yet these components and systems go only part of the way towards shuttle mobility. To make on-demand vehicles suitable for flexible everyday use, they must be connected to mobility services. "In the future, every vehicle on the road will make use of Bosch digital services," Heyn says. These services allow users to book the vehicles, share rides with other passengers, and pay for the journey. Charging, repairing, and maintaining the vehicles, plus route planning and administrative activities, also call for services that Bosch will offer shuttle fleet operators in a seamlessly connected ecosystem.

Users can easily book a shuttle via smartphone, regardless of whether they're relaxing on the sofa or sitting at their desk at work. Working behind the scenes, an algorithm

identifies the vehicle closest to the requested location and finds other users who wish to travel a similar route. The more passengers a single shuttle can transport, the cheaper the journey for everyone. This approach also reduces the amount of traffic in cities and mitigates the impact on the environment. Bosch is developing the necessary software platforms to make this a reality. When the shuttle pulls up to the requested pick-up point, users again use their smartphones to identify themselves – thanks to Bosch's Perfectly Keyless digital access service. It recognizes the owner's smartphone as unmistakably as a digital fingerprint and opens the vehicle only for them. Every passenger always gets the seat that they reserved.

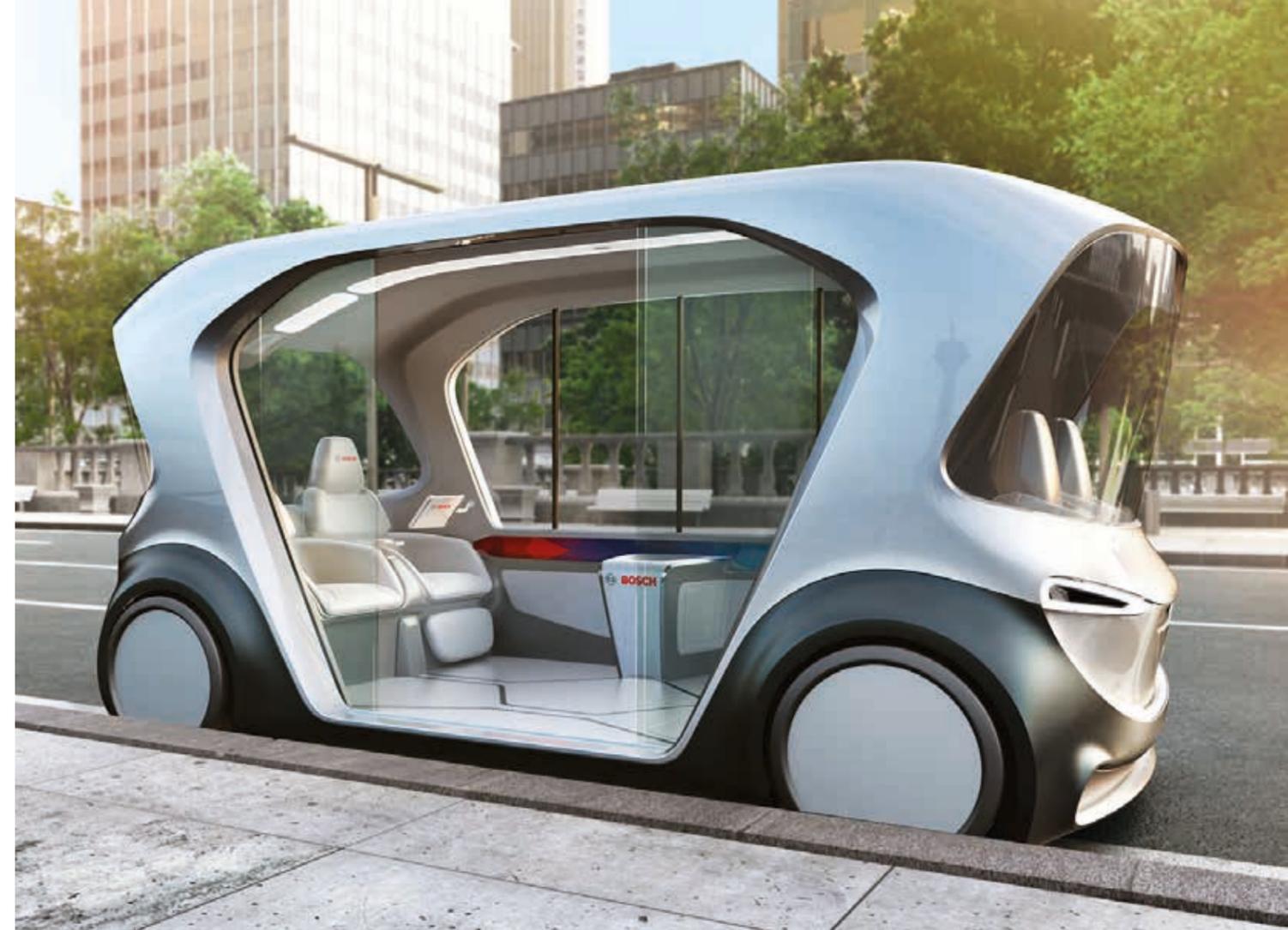
MOVING FORWARD: ELECTRIFIED AND AUTOMATED

Bosch's electric axle drive makes the shuttles especially efficient yet affordable as they wend their way through the city. And the company's Convenience Charging service knows just how long the battery charge will last and where to recharge the vehicle. This service means that even today, drivers no longer need to worry about being stranded with a dead battery. It also links vehicle information, such as the current state of battery charge or how much energy the heating and air-conditioning systems are consuming, with environmental data such as congestion and weather forecasts, so as to predict vehicle range with particular accuracy. Furthermore, Convenience Charging finds the ideal charging station and can reserve it in advance. And thanks to a standardized access and payment system, charging is easier than ever.

Driverless e-shuttles provide users with transportation that is not only nearly emissions-free, but also very safe. For automation, Bosch develops and makes its own radar, video, and ultrasonic sensors, braking control systems, and power steering, to name a few examples. Smart digital services are indispensable here, too: Bosch predictive road-condition services let automated vehicles know in advance what environmental conditions to expect. They can thus adapt their driving style as needed so as to ensure maximum safety throughout the journey. The Bosch road signature is a map-based localization service with which automated vehicles can accurately determine their position in the lane down to a few centimeters – another crucial prerequisite for the safety of automated shuttles.

COMFORTABLE INTERIOR

Bosch has designed the interior of its concept vehicle to provide space for four passengers, seating them across



from one another to maximize legroom and comfort. Infotainment is provided on screens that can be used either by each passenger individually or in groups; for example, a family can watch a movie together as they travel somewhere for the weekend, or colleagues can work on a presentation on their way to the office. Smartphones use the on-board Wi-Fi and can integrate seamlessly with the infotainment system, thanks to Bosch connectivity technology. Its concierge service turns the shuttle into a personal assistant. With all kinds of information at its disposal, the shuttle can provide passengers with recommendations, advance bookings, weather reports, and travel tips at any time. Once the shuttle has arrived at its destination, the passengers can pay for their journey with Bosch's e-payment service.

But Bosch services do not end when a rideshare journey is over: the company's camera-based system for the vehicle interior checks whether anyone has forgotten their phone or handbag. If a passenger does forget something, the shuttle informs them directly via smartphone. The cameras can also detect gum on the seat or an overturned coffee cup – in other words, whether the shuttle needs

cleaning – and can make the necessary arrangements immediately. This is so every passenger can start their journey in a clean shuttle. Bosch's service for over-the-air updates can determine whether the driverless shuttles have the latest software version. The service detects software updates as soon as they are available and executes them in the vehicle securely and reliably. Thanks to sensors installed in the vehicle, predictive diagnostics can monitor the condition of key components and notify the shuttle before a fault actually occurs, so it has enough time to drive itself to a repair shop. This prevents the car from suddenly breaking down, which is a boon to operators. In the future, Bosch will pool updates from the data cloud and predictive diagnostics into a comprehensive connectivity platform. This will give vehicle manufacturers and shuttle service operators a constant overview of the condition of their fleets, so they can ensure that their shuttles are always ready for action. And finally, the Bosch subsidiary ESCRYPT's security solutions handle vehicle security – whether for keyless access systems, data connectivity with the outside world, or software updates. ■

Author: Edyta Szwec



Autonomous transport solution for open cast mining

Volvo Trucks has just signed a landmark agreement with Brønnøy Kalk AS in Norway to provide its first commercial autonomous solution transporting limestone from an open pit mine to a nearby port.

The solution for Brønnøy Kalk AS consists of limestone being transported by six autonomous Volvo FH trucks on a five kilometer stretch through tunnels between the mine itself and the crusher. Tests of this solution have been carried out successfully and will continue throughout 2018 to become fully operational by the end of 2019.

The agreement follows recent successful automation projects involving mining, sugar cane harvesting and refuse collection. Yet this commercial solution represents an exciting first for Volvo Trucks. Rather than purchasing autonomous trucks, Brønnøy Kalk is buying a transport solution – specifically the transport of the limestone between the two hubs.

“This is an important step for us,” says Raymond Langfjord, Managing Director of the mine. “The competition in the industry is tough. We are continuously looking to increase our efficiency and productivity long-term, and we have a clear vision of taking advantage of new opportunities in technology and digital solutions. We were searching for a reliable and innovative partner that shares our focus on sustainability and safety. Going autonomous will greatly increase our competitiveness in a tough global market.”

Raymond Langfjord, Managing Director of the Brønnøy Kalk mine, sees new opportunities in technology. “Going autonomous will greatly increase our competitiveness in a tough global market.”

“We are proud to be able to present an autonomous solution which will meet the challenges of our customers both in terms of safety, reliability and profitability,” says Claes Nilsson, President of Volvo Trucks. The global transport needs are continuously changing at a very high pace and the industry is demanding new and advanced solutions to stay ahead. Our aim is to be the leader of the development of products and services to respond to these demands”, continues Claes Nilsson.

Six autonomous Volvo FH trucks will transport limestone over a five-kilometre stretch through tunnels between the Brønnøy Kalk mine and the crusher.

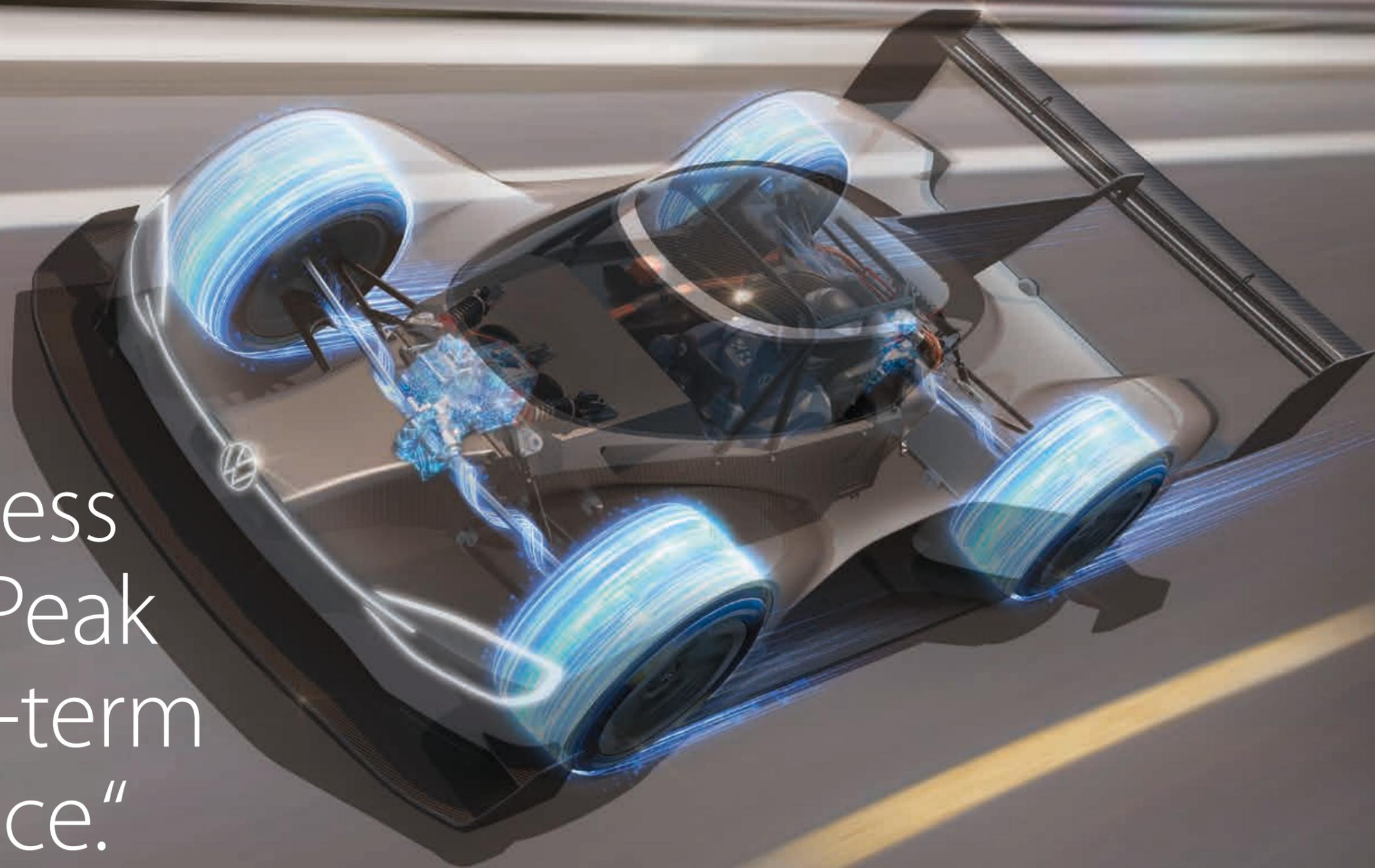
“It is exciting to reach this point where we introduce autonomous solutions, says Sasko Cuklev, Director Autonomous Solutions at Volvo Trucks. By working in a confined area on a predetermined route, we can find out how to get the best out of the solution and tailor it according to specific customer needs. This is all about collaborating to develop new solutions, providing greater flexibility and efficiency as well as increased productivity.” ■

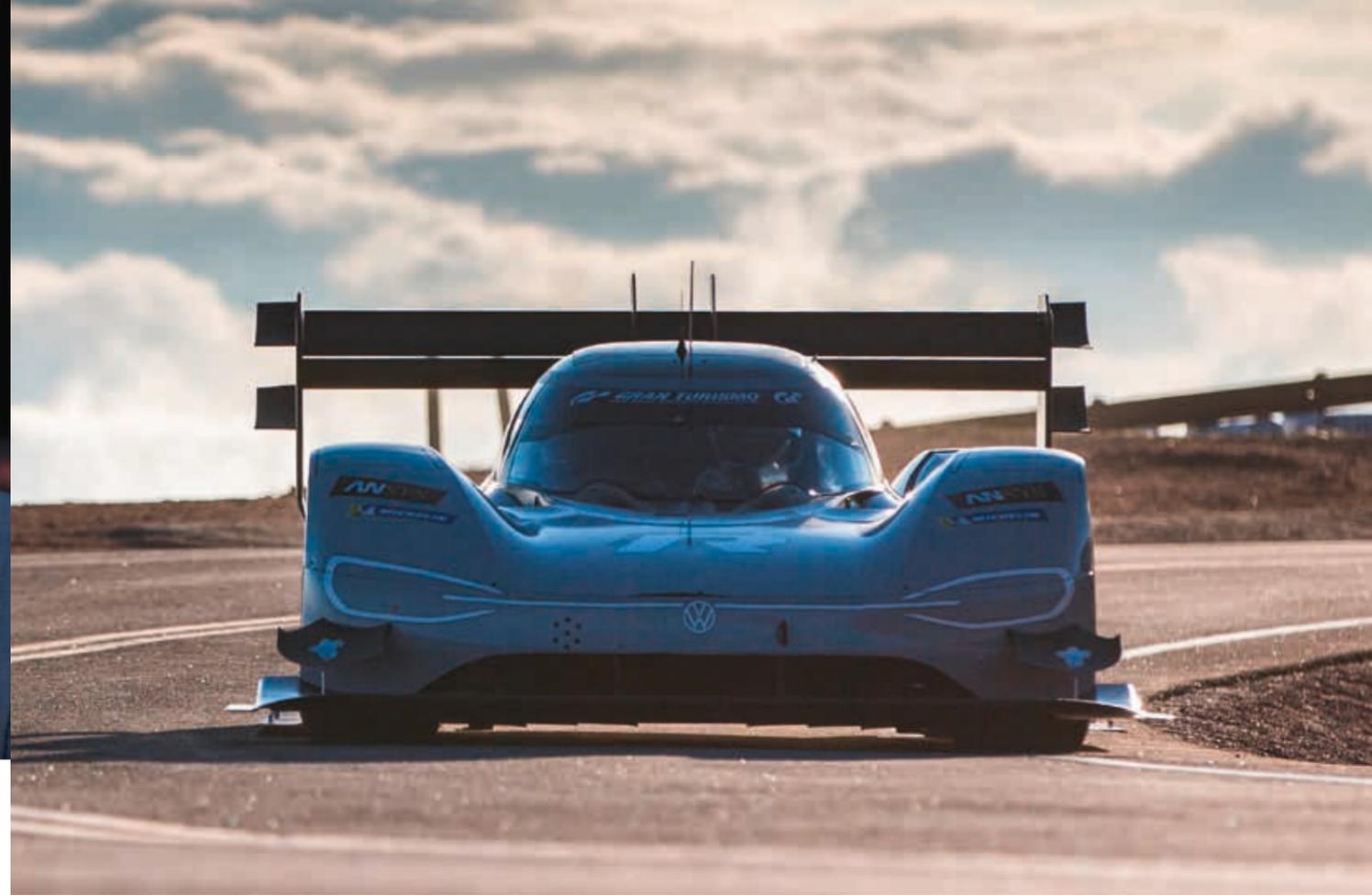
Author: Robert Metzger



Interview:

„The success on Pikes Peak is of long-term importance.“





The Volkswagen ID. R Pikes Peak made history with its record-breaking run at the Pikes Peak International Hill Climb on 24 June: the first fully-electric racing car from Wolfsburg conquered the 19.99-kilometre route in 7:57.148 minutes. However, the 500-kW (680-PS) ID. R Pikes Peak is far more than just a record holder – it is the sporty ambassador for the ID. family, Volkswagen's range of fully-electric production vehicles, which will hit the market from 2020 onwards. In an interview, Dr. Frank Welsch, Member of the Board of Management of Volkswagen Passenger Cars brand with responsibility for Technical Development, speaks about what this means for the future, the challenges faced when developing the ID. R Pikes Peak, and the strategy behind competing at the Pikes Peak International Hill Climb.

Dr. Welsch, this weekend the I.D. R Pikes Peak will be one of the stars at the famous Concours d'Elegance in Pebble Beach, USA. A few weeks down the line, how do you assess the record-breaking run on Pikes Peak?

Dr. Frank Welsch: I am still very proud of the fantastic efforts of the entire Volkswagen Motorsport team. And you're right, only now that the dust has settled a little is it possible to take in the enormity of this success. The project had a very tight timeframe, the entire development was completed within a matter of months, and the race itself lasted less than eight minutes – however, the success is of long-term importance. I believe that the first victory for an electric race car against conventional drivetrains is of ground-breaking proportions – similar to four-wheel drive in rallying.

The success on Pikes Peak was more than just a motorsport victory and record. How would you assess what was achieved in terms of its overall importance for Volkswagen?

Welsch: Volkswagen is following a clear E-strategy and will launch an entire range of fully-electric vehicles with the name I.D.1 in 2020. The I.D. R Pikes Peak is the sporty ambassador to this new generation of vehicles and not only underlines our clear commitment to electromobility, but also the huge potential performance that E-drive can offer in the future.

Was the decision to field the newly-developed I.D. R Pikes Peak at the Pikes Peak International Hill Climb taken for strategic reasons?

Welsch: Yes! It is the most famous hill climb in the world. The name is mentioned in the same breath as many other

iconic motorsport venues – such as Le Mans, Monte Carlo and Daytona. We were obviously excited about the opportunity to take on a race of this kind with a fully-electric racing car for the first time. And the fact that we only had one attempt there. There is no second run, no pit-stop strategy to adjust anything. No, everything has to be spot on – a great challenge for developers.

Speaking of developers, how much leeway did the regulations give them?

Welsch: That was what made it so exciting and spectacular: Pikes Peak offers great possibilities, because the regulations impose hardly any restrictions. Particularly in the Prototype class. We were left to our own devices and our engineers were given a blank sheet of paper. In terms of the race itself, that meant establishing what is important? Is it of central importance to have as little weight as possible? And, given that, how large and heavy can the batteries afford to be? In the case of the latter, it was important to find an ideal compromise between range and optimal performance. On top of that you had the aerodynamic set-up and the altitude, at which the race took place – all of these factors interacted and had to be taken into account. It was a big testing ground and development laboratory.

E-mobility is often accused of being relatively emotionless. Can a success like the one on Pikes Peak change that?

Welsch: Motorsport has always served as a test laboratory for future technology and stirs emotion and excitement among fans and protagonists alike. The I.D. R Pikes Peak is the best example of this: its extraordinary design, pioneering technology and enormous performance set the pulses of many fans racing. I followed the race on livestream in Autostadt, together with more than 500 motorsport fans; that was pure excitement and emotion – two elements that are obviously also radiated by our future I.D. family.

What does the project mean for the I.D. family, with regard to the transfer of technology?

Welsch: There is always a close exchange of knowledge between production development and the colleagues in motorsport. A few specific examples of the development of the I.D. R Pikes Peak acquiring important knowledge for production are the strategies for and effects of the rapid charging process for the batteries, the optimal management of the energy recuperation, and the 3D printing of ultra-light materials, some of which had to withstand extreme loads.

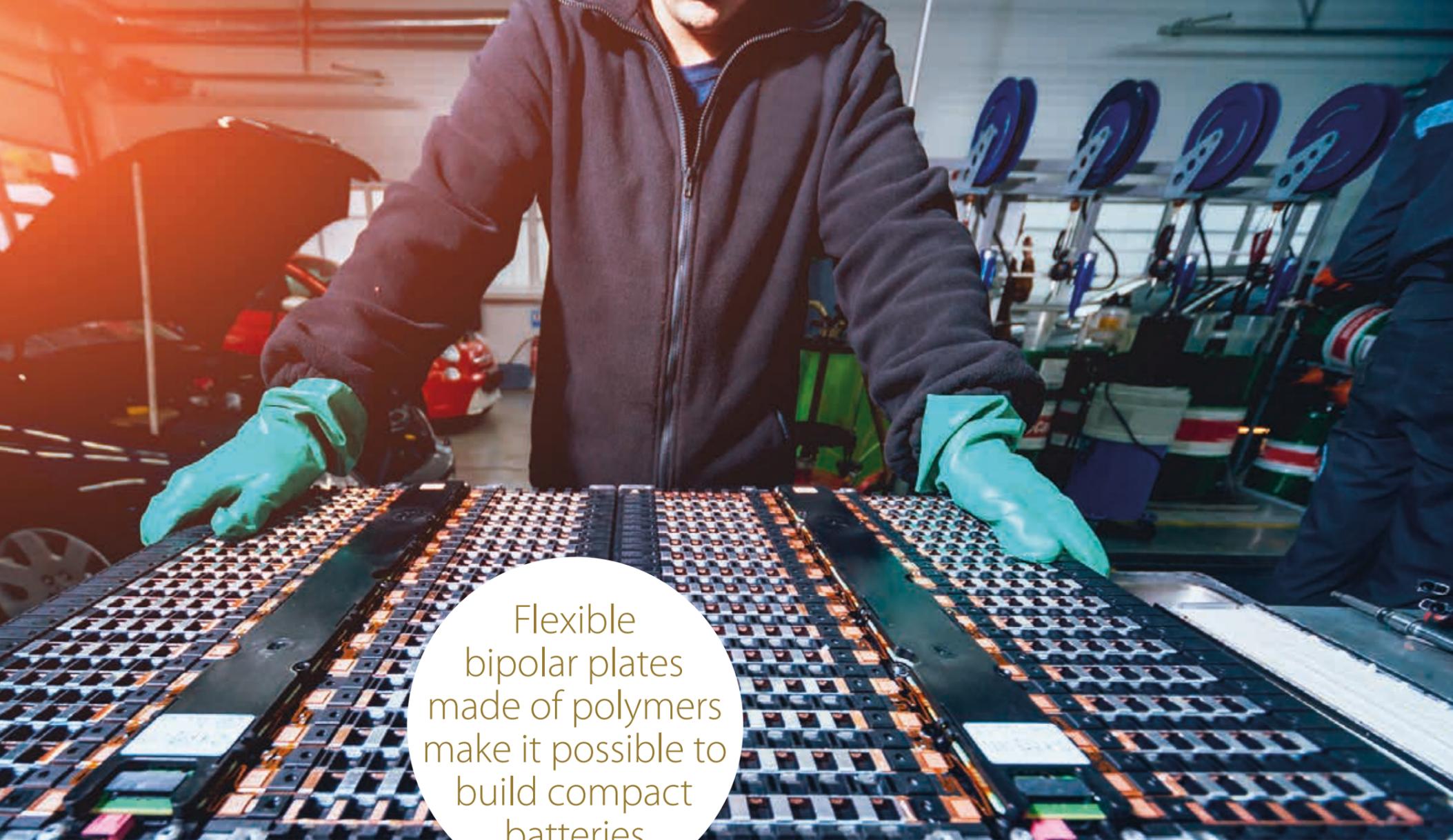
How did the knowledge transfer take place?

Welsch: In the field of high-voltage technology, the motorsport colleagues benefitted from the knowledge of the specialist departments for E-mobility in Wolfsburg and in Braunschweig – for example, when designing the battery modules or shielding highly-sensitive signal cables in the high-voltage environment of the I.D. R Pikes Peak, which reaches several hundred volts in strength. On the other side, the colleagues in Wolfsburg were very interested in the use and durability of the racing car's ultra-light carbon fibre/Kevlar chassis.

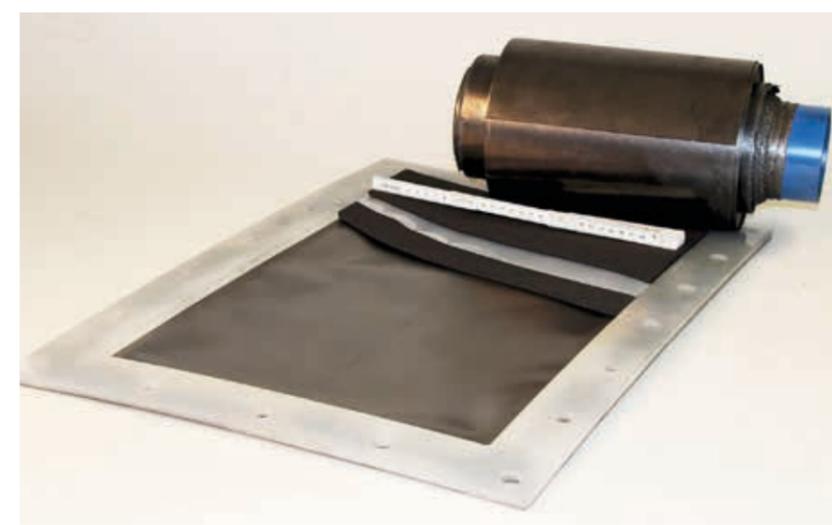
In your opinion, how is the future looking for motorsport with electric drive?

Welsch: The race on Pikes Peak was a very successful introduction to motorsport with E-drive for Volkswagen, and we have many more ideas for further outings with the I.D. R Pikes Peak. Furthermore, we have for some time now been looking into possibilities for electric racing cars, such as the FIA World Rallycross Championship, in which electric racing cars will line up in the future. The question of what challenges Volkswagen will take on next remains a very exciting one.

Thank you for the interview. ■
Author: Edyta Szwec



Flexible bipolar plates made of polymers make it possible to build compact batteries



COST-EFFECTIVE MANUFACTURE THROUGH ROLL-TO-ROLL TECHNIQUE

Whether used for power supply or in electric cars, current battery systems are based on a series of interconnected individual cells, which has certain disadvantages in terms of efficiency and manufacturing. Bipolar battery setups, in contrast, comprise compact stacks of individual cells. A new type of flexible and extremely thin bipolar plate allows batteries to be manufactured cost effectively.

Conventional battery systems are extremely complex. They usually consist of several individual cells that are connected with each other via wires. Not only is this costly and time-consuming, it also entails the danger of hot spots – areas in which the wires get too hot. In addition, every single one of these cells has to be packaged, meaning that a large portion of the battery consists of inactive material that does not contribute to battery performance. Bipolar batteries are designed to solve this problem by connecting the individual cells

with each other using flat bipolar plates. However, this gives rise to other challenges: either the bipolar plates are made of metal and are thus prone to corrosion, or they are made of a carbon-polymer composite, in which case they have to be at least several millimeters thick as a result of the manufacturing process.

MATERIAL SAVINGS OF MORE THAN 80 PERCENT

Researchers at the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen have now developed an alternative. “We manufacture bipolar plates from polymers that have been made electrically conductive,” says Dr.-Ing. Anna Grevé, department head at Fraunhofer UMSICHT. “In this way, we can produce very thin plates and – compared with conventional cells connected by wires – save over 80 percent of the material used.” In addition, the material

offers numerous other advantages, such as the fact that it does not corrode. Another major advantage is that the material can be subsequently reshaped. This makes it possible, for example, to emboss structures, which are important for fuel cells. Moreover, the innovative new bipolar plates can be welded together, so the resulting battery system is absolutely tight.

Conventional bipolar plates, in contrast, are unsuitable for welding due to the thermal and mechanical stressing of the material during manufacture. Joining them in such a way that neither gases nor liquids can pass through the joints requires seals. However, seals become quickly porous, and they also take up space. A further advantage of the new material is that the researchers are able to adapt the properties of the bipolar plates to specific requirements. “We can make plates that are so flexible that you can wrap them around your finger, as well as ones that are completely stiff,” specifies Grevé.

The primary challenge consisted in developing the material and the manufacturing process. “We use commercially available polymers and graphites, but the secret is in the recipe,” says Grevé. As the material is made up of about 80 percent graphites and only about 20 percent polymer, the processing methods have little in common with ordinary polymer processing. The team of researchers at Fraunhofer UMSICHT opted for the roll-to-roll technique, which allows cost-effective manufacturing, and adapted it using a lot of know-how. After all, the ingredients that go into the manufactured plates must be distributed homogeneously, and the plates also have to be mechanically stable and completely tight. Because of the initial structure of the materials, this was no easy feat. However, the experts also mastered this challenge. “We were able to fulfill all requirements in one process. Consequently, the plates can be used just as they are when they come out of the machine,” explains Grevé. Another advantage of the technique is that the plates can be manufactured in any size. ■ Author: Edyta Szewc

The Networker

Sandra Phillips thinks ahead: she designs future mobility services. Furthermore, the shared-mobility expert was the winner of the TED Next Visionaries. The competition is hosted by BMW i in collaboration with TED. She explains how her ultimate goal is to make greater mobility available to everyone and why ecological sustainability and shared mobility play key roles.

When you're at a party, how do you explain to people exactly what you do for a living?

Sandra Phillips: I tell them that I'm a kind of architect, except that it's not buildings I design, but mobility networks. And we have a huge need for these right now. On the one hand, we already have public transportation networks and good mobility services, but except for in megacities such as New York or London, they have huge gaps in their coverage. On the other hand, we have privately owned vehicles, but a lot of people can't afford or don't want to buy a vehicle of their own – or simply don't want to use their car on occasion. Children obviously can't drive yet, and many older people can't use their cars any more either. Shared mobility can bridge these gaps. This makes sense not only economically, but also environmentally. It's mainly about sustainability.

And how exactly does it work?

Phillips: My agency provided consultancy services to BMW for the launch of ReachNow in North America, for example. We were directly involved in the implementation of the ride sharing service and we trained the management team. ReachNow not only has a premium car fleet for car sharing but also an app-based ride-hailing service. But the shared mobility network can be taken much further, for instance with bicycle or scooter rental services. And of course there's ride

sharing services, where passengers make use of the same minivan and driver, to name only one possibility. The next step could be an autonomous minivan.

So you're looking forward to the opportunities that autonomous driving will bring along?

Phillips: Absolutely. Sion in Switzerland has had an autonomous bus running on a dedicated route through the city since 2016. The whole idea of autonomous driving is in fact hugely important for shared mobility. It's part and parcel of car sharing that vehicles are often not left in places where they will be needed again, so it would be good if they could drive themselves to the next user or a charging station.

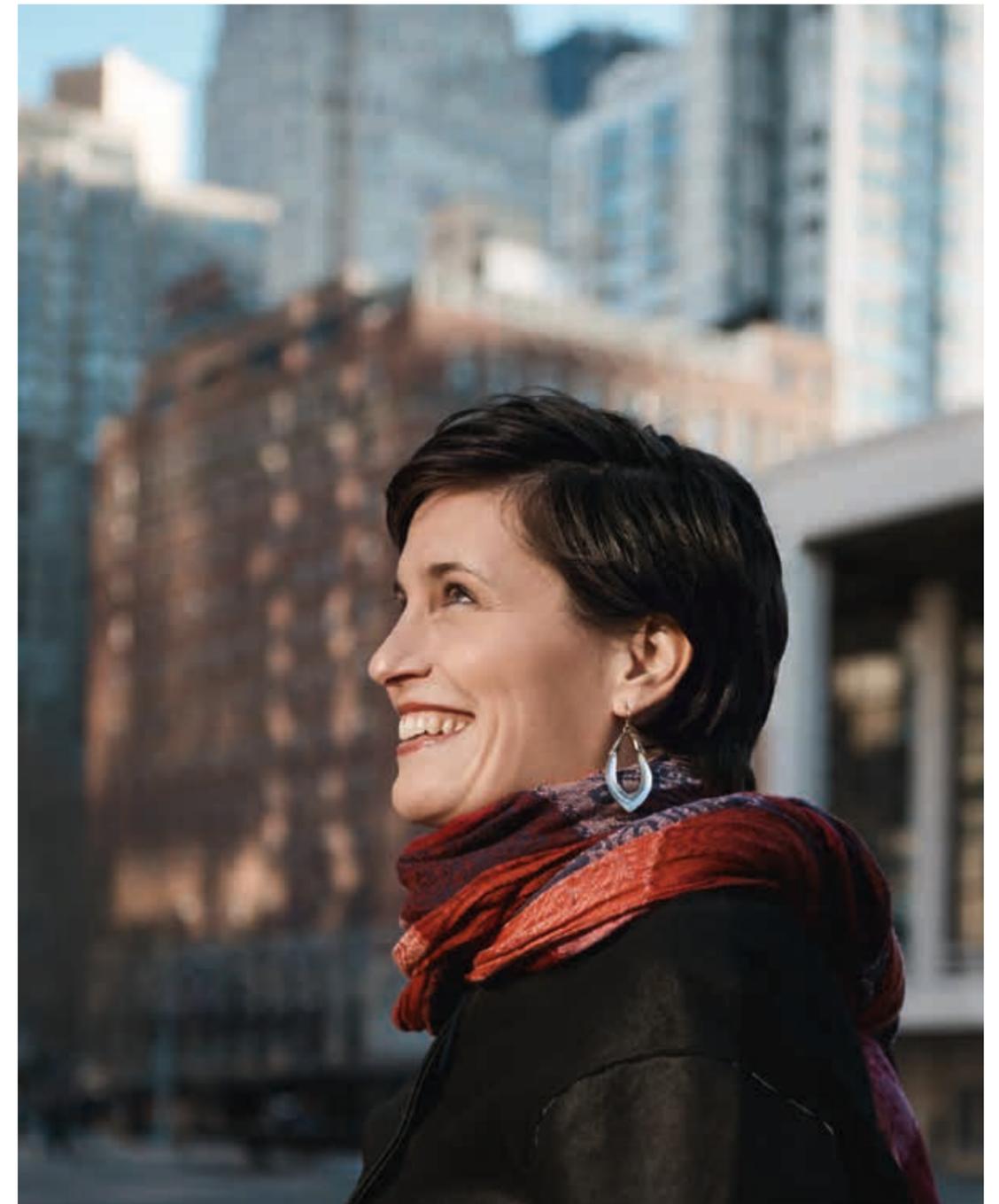
Where do you see the greatest need for improvement at the moment?

Phillips: Right now, shared mobility is primarily focusing on large cities, simply because this is where a large number of people live in a relatively small area, meaning there are lots of potential customers. It's smaller cities with fewer than 500,000 inhabitants that usually have gaps in the coverage of mobility services. And then, of course, we should be thinking more of markets such as Africa, South America or Asia, where the potential is huge.

Who would you describe as shared mobility's main target group?

Phillips: Up to now, it's primarily been fairly well-educated, highly-paid men that the idea has appealed to. It's my vision to provide better mobility options for everyone – and by doing so to improve their access to healthcare services, education, and a richer cultural and social life.

Thank you for the interview. ■



„It's my vision to provide better mobility options for everyone – and by doing so to improve their access to healthcare services, education opportunities, and a richer cultural and social life.“

LION ELECTRIC SELECTS DANA AS PREFERRED SUPPLIER FOR ITS ALL-ELECTRIC CLASS 8 VEHICLE

Dana Incorporated (NYSE: DAN) today announced that it has been chosen as a preferred supplier to the Lion Electric Company for traditional and electrified componentry on its all-electric urban Class 8 vehicle, the Lion8. The truck features Dana's TM4® direct drive system and traditional Spicer® driveline components and is immediately available for ordering. Founded in 2008, Lion Electric develops and manufactures all-electric architectures for Class 5-8 trucks; full-size school



buses; and midi- and mini-buses for paratransit, school, public transit, and public transportation. The company launched its first electric bus in 2016 and has since deployed more than 200 zero-emission school buses in North America, with more than two million road-proven miles. „Dana's collaboration with Lion Electric further solidifies our strategic initiatives as the leader in e-Propulsion. The Lion8 moves beyond simply testing these advanced technologies with the ability to order clean, electric-powered vehicles today," said Mark Wallace, president of Dana Commercial Vehicle Driveline Technologies. „Lion Electric has a talented and dynamic team and we look forward to expanding our efforts in providing fully integrated, high-efficiency solutions." The Lion8 will include the TM4 SUMO™ HD direct-drive motor, BCI20 charger and inverter, and the Neuro vehicle controller. Also supplied by Dana will be Spicer® DS404 drive axles, and SPL® 250 driveshafts. „We are pleased to be partnering with Dana to bring innovative zero-emission solutions to the commercial-vehicle market," said Yannick Poulin, COO for

Lion Electric. „Dana's unmatched proficiency in proven e-propulsion systems will be a strong addition to the development of our all-electric truck platform." ■

AIR FRANCE SWITCHES TO ELECTRIC POWER FOR ITS RAMP VEHICLES WITH CARWATT

As a major economic player in its area of activity, Air France is aware of its responsibility and integrates sustainable development into its activities and operations. The company's objective is to continuously improve the customer experience while reducing its environmental footprint and improving its procedures, particularly through innovation. As part of its commitment and in line with the Government's announcement of its support for the electric battery sector, Air France is gradually starting to replace the diesel engines in the conveyor belt vehicles used for loading and unloading baggage on aircraft by replacing them with an electric drive made from recycled products. To develop this collaborative project, Air France has chosen to team up with CarWatt, a French start-up that retrieves used lithium-ion batteries from individual electric vehicles and recycles them to give them a new life. The first operational prototype has just gone into service at Paris-Charles de Gaulle airport and the conversion of 10 additional belt vehicles is under consideration. ■

VOLVO CE GOES ELECTRIC ON SMALLER MACHINES

In a pioneering commitment to future technology, Volvo CE has announced that by mid-2020 it will begin to launch a range of electric compact excavators (EC15 to EC27) and wheel loaders (L20 to L28), stopping new diesel engine-based development of these models. With this move, Volvo CE is the first construction equipment manufacturer to commit to an electric future for its compact machine range. This follows an over-

whelmingly favorable reaction from the market after the successful unveiling of a number of concept machines in recent years, and by working closely with customers. This move is aligned with the Volvo Group's strategic focus on electromobility in all business areas. The first machines will be unveiled at the Bauma exhibition in April 2019, followed by a staged market-by-market introduction and ramp up in 2020. While the company stresses that diesel combustion currently remains the most appropriate power source for its larger machines, electric propulsion and battery technology is proving particularly suited to Volvo's smaller equipment. With research and development investment now focused on the rapid development of its electric compact wheel loaders and excavators, Volvo CE is taking a step towards diesel-free compact equipment in the future. "Volvo CE is delivering on its commitment of 'Building Tomorrow' by driving leadership in electromobility and delivering sustainable solutions that support customer success," comments the company's President, Melker Jernberg. "The technology we have been developing is now sufficiently robust and this, together with changes in customer behavior and a heightened regulatory environment, means that now is the right time to commit to electromobility in our compact equipment ranges in the future." ■

PETERBILT UNVEILS ELECTRIC MEDIUM-DUTY TRUCK

Confirming back in May last year that their future would be, at least in part initially, electric, Peterbilt Motors Company, a PACCAR-owned brand, has taken the covers off one their first electric models. The Peterbilt Model 220EV was unveiled at the Consumer Electronics Show (CES) in Las Vegas this year. The all-electric medium-duty truck will go to market in the middle of 2019, initially with one single operator (who is not yet confirmed). The 220EV joins the previously announced Model 520EV and the Model 579EV in the Peterbilt electric vehicle line-up. It is powered by two battery packs that deliver a drive range of around 100 miles (160km). An optional DC fast charging system will also be available to operators – though at this stage charging times are yet to be confirmed. Peterbilt and DAF Trucks are the first brands under the PACCAR banner to announce future electric models, while Kenworth is tied up in a venture with Toyota that is studying the use of hydrogen-powe-



red heavy-duty trucks. Landon Sproull, PACCAR vice president, tells us the manufacturer won't be left behind on electrification. ■

BOEING AUTONOMOUS PASSENGER AIR VEHICLE COMPLETES FIRST FLIGHT

The first test flight of Airbus autonomous passenger air vehicle (PAV) prototype in Manassas, Virginia, is done. Boeing NeXt, which leads the company's urban air mobility efforts, utilized Boeing subsidiary Aurora Flight Sciences to design and develop the electric vertical takeoff and landing (eVTOL) aircraft and will continue testing to advance the safety and reliability of on-demand autonomous air transportation. The PAV prototype completed a controlled takeoff, hover and landing during the flight, which tested the vehicle's autonomous functions and ground control systems. Future flights will test forward, wing-borne flight, as well as the transition phase between vertical and forward-flight modes. This transition phase is typically the most significant engineering challenge for any high-speed VTOL aircraft. „In one year, we have progressed from a conceptual design to a flying prototype," said Boeing Chief Technology Officer Greg Hyslop. „Boeing's expertise and innovation have been critical in developing aviation as the world's safest and most efficient form of transportation, and we will continue to lead with a safe, innovative and responsible approach to new mobility solutions." Powered by an electric propulsion system, the PAV prototype is designed for fully autonomous flight from takeoff to landing, with a range of up to 50 miles (80.47 kilometers). Measuring 30 feet (9.14 meters) long and 28 feet (8.53 meters) wide, its advanced airframe integrates the propulsion and wing systems to achieve efficient hover and forward flight. „This is what revolution looks like, and it's because of autonomy," said John Langford, president and chief executive officer of Aurora Flight Sciences. ■

„It all depends on
the **chemistry**“



Drive & Charge



Batteries for electric vehicles are becoming bigger, with higher energy density — and thus expanding the vehicles' range. At the same time, quick-charging technology is shortening the charging times of the energy storage units.

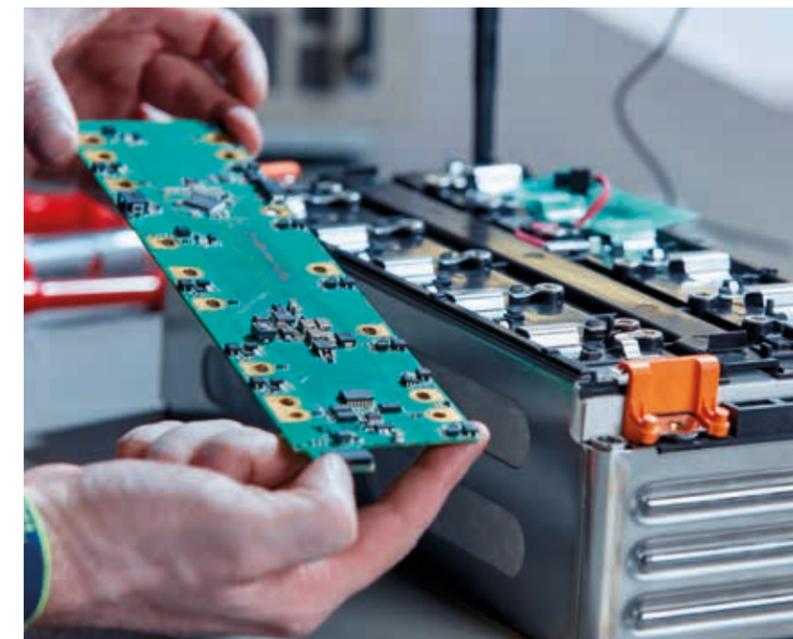
The battery is at the heart of electric mobility. In recent years, battery technology has made significant progress. In particular, batteries' energy density, which is the crucial determinant of a vehicle's range, has been further optimized. The auto industry is currently relying on lithium-ion technology. In the years ahead this technology will continue to set the pace, according to Martin Winter, a professor of materials science, energy, and electrochemistry at the University of Münster and the spokesman of German battery research. A discussion about the future of the battery.

If we are to believe the automakers' announcements, the ranges of electric vehicles will increase significantly in the years ahead, to at least 500 kilometers. How will the automakers make this leap?

Prof. Martin Winter: New types of cell chemistry and bigger batteries will be largely responsible for this development. Through the use of lithium-ion technology we've managed to triple the energy per kilogram and per liter since 1991. Besides, we now have a large portfolio of cell components. As a result, we can develop a road map in order to further optimize the ranges of electric vehicles. However, I think it will be difficult to once again triple the ranges we have now. We might eventually be able to increase them by a factor of two or two and a half. That's because we're gaining an ever better understanding of the cell chemistry of the lithium-ion battery, while at the same time the batteries are getting bigger.

Will the center of the battery industry shift toward Asia in the future?

Mobility is a vitally important factor of our quality of life and our economy. The mobility of the future must focus increasingly on sustainable



technologies. Batteries will play a significant role in this regard. Companies in Asia became aware of this future-oriented issue early on, and since then they have been securing market share for themselves. They've done that by using the manufacturing and cell chemistry expertise they have gained through the production of battery cells for mobile phones, laptops, and tablets. At the moment, many cell manufacturers are selling their products below their production costs. In other words, they are betting on the future and securing a future-oriented market position. European manufacturers are reluctant to make these investments. Meanwhile, Asian manufacturers are going one step further and no longer limiting themselves to the role of cell manufacturers. Instead, some of them are already producing their own chemistry. The cell manufacturers are also getting in on the production of battery systems and electric drive systems. The various roles in the value chain are being redistributed and reorganized.

How does the improved range affect the batteries' service life?

Winter: FElectric vehicles with batteries that are guaranteed to last for eight years or more are now standard. Meanwhile, batteries are becoming more powerful, thanks to increasingly refined battery management systems. However, higher energy density often decreases the battery's service life. In the future we will see a much greater differentiation between very high energy densities in areas such as consumer electronics, moderate energy densities for durable products, and low energy densities combined with very high outputs for applications for which quick charging is becoming important. We have to find the right balance between installed power — in other words, range — and quick-charging capacity, because there's a tendency for batteries with very high energy density to be relatively slow-charging and vice versa. So we want to continue optimizing quick-charging capacity at

high energy density. Ultimately we'll have to make decisions that combine strategic and commercial perspectives.

What does the future of battery technology look like? Or, to put it another way, what will come after lithium-ion technology?

Winter: Lithium-ion chemistry is a very powerful chemistry with great potential. It's going to be hard to beat. That also goes for the materials that could be used in lithium-ion batteries in the future, as far as we can tell today. Most importantly, it also applies to the issue of energy content per unit volume. For a tablet, it's less important whether it weighs 20 or 30 grams more, but if it should suddenly double its volume because of the size of its battery, the situation becomes critical. It's the same for vehicles: If the battery is so big that it suddenly requires giving up passenger space, you lose comfort. In these applications, volumetric energy content plays an im-

portant role, and lithium-ion technology is very strong in this regard. Resource-efficient technologies and manufacturing processes can lead to further increases in energy density, so that more energy can be stored in the same battery volume. In addition, the batteries will become significantly lighter. That will have a positive effect on vehicle handling and fuel consumption. Finally, the material composition of the lithium-ion battery cells will change. The combination of nickel, manganese, and cobalt that is normally used today on the cathode side may soon be a thing of the past, because the cobalt is to be largely replaced by nickel. Starting in 2025, alternatives to lithium-ion technology will also be used. Today it's not yet clear whether these successor technologies will be cells with solid electrolytes, lithium-metal anodes or lithium/sulfur systems. But we do expect great progress to result from the introduction of alternative technologies, especially in terms of costs and energy density, even though these advantages still have to be proved.



Professor Martin Winter is Scientific Director of the Münster Electrochemical Energy Technology (MEET) battery research center at the University of Münster.

What about the raw materials involved, which are becoming ever scarcer? What kinds of alternatives are researchers working on?

Winter: The availability of materials such as lithium, cobalt, nickel, and copper plays an important role. For present-day lithium-ion batteries we need cobalt, a rare element that is also used for other applications besides batteries. We're working to decrease the proportions of cobalt that are used. In lithium-ion batteries, we're decreasing this proportion massively. In the search for alternatives to rare raw materials, researchers are now investigating materials that are rich in manganese and low in cobalt, among other things. In addition, researchers are using iron, which is readily available, with varying success. However, in the years ahead cobalt will remain essential, though in smaller and smaller amounts. Sodium-ion batteries and magnesium batteries are being promoted as alternatives, but so far no one has succeeded in raising their energy content to the level of lithium-ion batteries. Other alternative materials worth considering are titanium and vanadium, and aluminum could replace copper thanks to its comparative conductivity. But at the moment no one can say when these alternative materials will be used on a large scale. The automakers are convinced that lithium-ion batteries will continue to contain cobalt until 2025, even though the proportion will be reduced.

What role could be played in the future by the supercaps that are already being used in motor sports?

Winter: Supercaps are power storage units that work better than batteries in situations when

you need very high power values for short periods of time. For example, they could theoretically also be used in garbage trucks, where the energy can repeatedly be recuperated between their stops, and a battery is not the best choice. But if you take their energy content into account, supercaps are very expensive to produce. Besides, they have a very high level of self-discharge: When they're not used, their voltage and energy are quickly lost. Batteries are a better way to meet medium to long-term energy needs. But supercaps will continue to play an important role in the future as high-performing short-term power storage units.

Many manufacturers are promoting the solid-state battery as the solution for all range problems. Is this the beginning of a new era of electric mobility?

Winter: In a solid-state battery, the conventional liquid electrolyte is replaced with a solid one. The electrodes are solid too. A lithium-ion battery can be transformed into a solid-state battery if you replace its liquid electrolyte with a solid-state electrolyte. The solid-state battery can probably also create cellular chemistries that are not possible for liquid electrolytes. The key word here is the lithium-metal electrode, which makes it possible to have higher energy content combined with optimized safety due to the solid-state electrolyte. This is a very exciting field of research, especially now that scientists have discovered that certain solids can conduct lithium ions just as fast as liquid electrolytes. This means that we'll have no problems with quick charging or with acceleration.

When will this type of battery actually be able to power vehicles?

Winter: A lot of work still needs to be done. Cars powered by batteries based on polymer solid-state electrolytes are already on the road in some cities in carsharing systems or as taxis. In general, we researchers still don't know enough about how the performance and service life of solid-state batteries will develop over time. This area of research is still too new. I don't think that solid-state batteries will be in use as early as 2022.

Author: Robert Metzger



BYD looks ahead with long, pure electric bus

China's leading carmaker BYD launched the world's longest pure electric bus in Shenzhen on Monday, as a precursor to providing comprehensive e-bus production lines in overseas markets.

BYD's new K12A is 27 meters long, triple that of a regular bus, has a passenger capacity of 250 and a maximum speed of 70 kilometers per hour. It is also compatible with the global Bus Rapid Transit (BRT) system. The company states the bus can run almost 300 kilometers with one charge - enough for the demands of a full day's operation. According to industry analysts, companies are looking at the global markets as new growth frontiers as the domestic e-bus market has become extremely saturated. With the new production line, we can cater to most of the e-bus demand in the world, from 6 to 27 meters, said Stella Li, senior vice-president of BYD. According to company officials, the new bus is an ideal fit for South American countries. Citing the example of Bogota, the capital of Colombia, officials said the city is looking to replace current extra long buses with electric ones for its large transportation needs. Daily passenger flows on Bogota's BRT system has exceeded 2.8 million and is growing steadily. In addition, governments across the world are pushing for the use of new energy vehicles.

Li said the company is working toward meeting the world's demand to replace petrol and diesel buses, especially in the overseas market. Besides commercial promotion, she said BYD is also working with authorities in many countries to push zero-emission regulations. „As the results converge, we will see a surge in sales of e-buses in the overseas markets.“

Till date, BYD has delivered more than 50,000 pure electric buses globally. In particular, its pure electric buses (longer than 10 meters) are the global leaders in terms of total sales. However, few of them are in the BRT system. Li explained the tenures of the BRT contracts are usually as long as 10 to 20 years, so it is difficult to gain such orders, but the situation is about to change very soon.

Demand for such buses is huge in the foreign markets and important for Chinese e-bus makers, as there are few international suppliers in the industry, said Wang Lius-heng, chief analyst for the automobile industry at China Merchants Securities.

Domestic sales of such buses has fizzled out after a strong start as most of the major cities have completed the replacement of traditional buses. However, he warned it will be a difficult and long process, considering the highly uncertain economic environment in the global market.

Wu Yongqiang, editor-in-chief of chinabuses.com, a professional consultancy and information platform on Chinese buses, said many foreign governments, especially those in Europe and South America, have launched deadlines for zero-emissions, opening new channels for Chinese carmakers. Wu believes that profits in the overseas market is promising as the price is high, though subsidy is far less than in the domestic market. China started to offer hefty subsidies in 2009 on new energy vehicles to stimulate the sector's development, but now is gradually scaling them down and plans to eliminate it completely by 2020. ■



**Going with the
autonomous flow**



What will we do in our cars if we no longer have to do the driving ourselves? An international study conducted by the Fraunhofer IAO provides some answers.

5 p.m. Once again, it's the evening rush hour in a big city. But we're not part of it. Sheltered from the turmoil, we're sitting in comfortable seats and dozing or maybe watching a film. In the midst of time-consuming stop-and-go traffic, we're making a switch — and gaining time.

Is this the ideal scenario for traveling in an autonomously driving vehicle? Visions of a chill-out lounge on wheels or a traveling office are actually very similar to the wishes of many car users. That's the conclusion of the international study "Enabling the Value of Time" that was conducted by the Fraunhofer-Institute for Industrial Engineering (IAO) in cooperation with the consulting company Horváth & Partners. The authors of the study gave 2,500 car users in China, Japan, the USA, Germany, and France a look at the future of autonomously driving cars and asked them to answer some questions. Are drivers already prepared to give up their steering wheels? Should driverless taxis transport us

through road traffic according to a specific motto? And what would be the ideal equipment for an autonomously driving vehicle?

LOOKING FORWARD TO AUTONOMOUS DRIVING

The study shows that almost half of the respondents are looking forward to a completely new travel experience. The most enthusiastic subgroup was the Chinese: Almost three quarters of them could imagine traveling in an autonomously driving vehicle. And most of the Japanese respondents — 58 percent — also said they were fans of self-driving cars. The respondents in Germany, where the safety risks are still viewed critically, were more cautious. Dr. Florian Herrmann, the lead investigator of the Fraunhofer IAO survey, is nonetheless convinced that "step by step, automated driving will become part of our lives." He points out that for private cars in particular, a clear development can be seen, proceeding from the assistance

functions that are already available to highly automated driving and eventually to fully automated driving.

It's also clear that the more densely populated a region is, the more its inhabitants look forward to self-driving vehicles. From Paris to Beijing, the residents of big cities in particular would love to have higher-quality transportation systems. The way mobility is organized today is obviously absorbing increasing amounts of time and energy. A key advantage of autonomously driving cars could be the fact that they reverse this loss of time. The study shows that this factor is appreciated most of all by city dwellers and by families. In all the countries where the survey was conducted, these groups showed above-average interest in the interior setup of autonomously driving cars. They are also ready and able to pay more for the technology. Young people and users of local public transportation are also among the target groups that are more open to the idea of autonomously driving vehicles and better prepared to pay for them.

According to the Fraunhofer study, people want to have a relaxing and comfortable environment in an

autonomously driving vehicle. In all the countries surveyed, sleeping and relaxing were the passengers' favorite activities. That was especially the case for people traveling alone or making longer trips during their vacations and their leisure time. They want to sit in comfortable seats with a fully reclined position and travel in peace and quiet, sheltered from the world outside. But many respondents could also imagine themselves doing the opposite — working and being productive. That's no surprise, because this is an ideal option for business trips and the daily commute. In this case, the respondents' wishes ranged from comfortable seating to computer workstations and virtual assistants for managing documents. They too wanted a quiet and sheltered atmosphere.

The favored interior design also depended on the number of passengers that was envisioned. For trips with two or more people in the vehicle, entertainment was at the top of the wish list. For most people, it's obviously more fun to watch films, listen to music, or play games with others than to do these things alone. And in order to offer these activities, the vehicle should be seamlessly connected

and set up for multimedia applications. For many respondents, eating and drinking is another pleasant pastime. They could imagine having a kitchenette for storing a supply of snacks and drinks or even complete meals that can be kept cool or warmed up.

But there were also things that few respondents wanted to do in a moving vehicle. Only a few wanted to use this time for fitness exercises, body care or applying makeup — activities for which other locations would probably be more suitable.

CHINA LEADS THE TREND TOWARD AUTONOMOUS DRIVING

The Chinese respondents were most likely to have already made the imaginative leap into the era of autonomous driving. “Chinese people are generally interested because they have a strong affinity for technology and fewer reservations regarding data security and data use,” explains Florian Herrmann. He suspects that the Chinese are more likely to see the potential of new technologies and their sometimes complex development

processes, rather than the disadvantages. This feeling is backed up by a statistic from the “RoboCab Acceptance Study” conducted by the Fraunhofer IAO on behalf of the German Federal Ministry of Transport and Digital Infrastructure. According to the study, 70 percent of the Chinese respondents would entrust their children to a robot taxi. Only about 30 percent of the respondents in Germany and the USA would do the same. In addition, the Chinese respondents’ preferred activities were not related to the number of other passengers in the car. This is because many Chinese live in three-generation households, and they find it normal to share a car. For them it’s also not a problem to relax or sleep in the presence of other passengers.

WHO WILL PAY FOR IT?

For most participants of the study, driving on autopilot is a positive concept because it enables them to have more living space and more time for themselves. But are they also prepared to pay more for these advantages? Once again, the Chinese respondents lead the way, with the greatest readiness to pay more. The Japanese are also

looking forward to automated driving functions, but they are not willing to pay very much more for them. One reason for this is that the Japanese spend less-than-average amounts of time in their cars: The average amount of time the Japanese spend in their cars is 44 minutes per day — significantly less than the overall average of 70 minutes. That also explains their comparatively low interest in the option of working in an autonomously driving vehicle. German and US respondents are less enthusiastic about autonomous driving than people in China, Japan, and France. However, if they are impressed by the technology or the equipment, they are willing to spend comparatively large amounts of money for it.

MOVIE THEATERS ON WHEELS, MOBILE RESTAURANTS

Carsharing is a major lever for reducing traffic volume and the scarcity of parking spaces in densely settled areas. But whether people want to share a car largely depends on their living conditions, according to the study. For four out of five people living in rural regions, having their own car is very important. And 60 percent of the US respondents also insist on driving their own cars. By contrast, many French people are willing to make use of carsharing concepts. Short-term rentals and carpooling offers are already common practice in France.

“Fully automated driving and car or ride sharing complement each other beautifully and could lead to a complete change of our mobility systems,” says Herrmann. In addition, more and more new mobility solutions and innovative vehicles, such as electric scooters, autonomous minibuses, and air taxis can be seen on the move, especially in urban areas. Another future vision involves vehicles that search for parking spaces outside the city on their own, instead of taking up valuable urban space. This would be one way to improve the quality of life in densely populated cities.

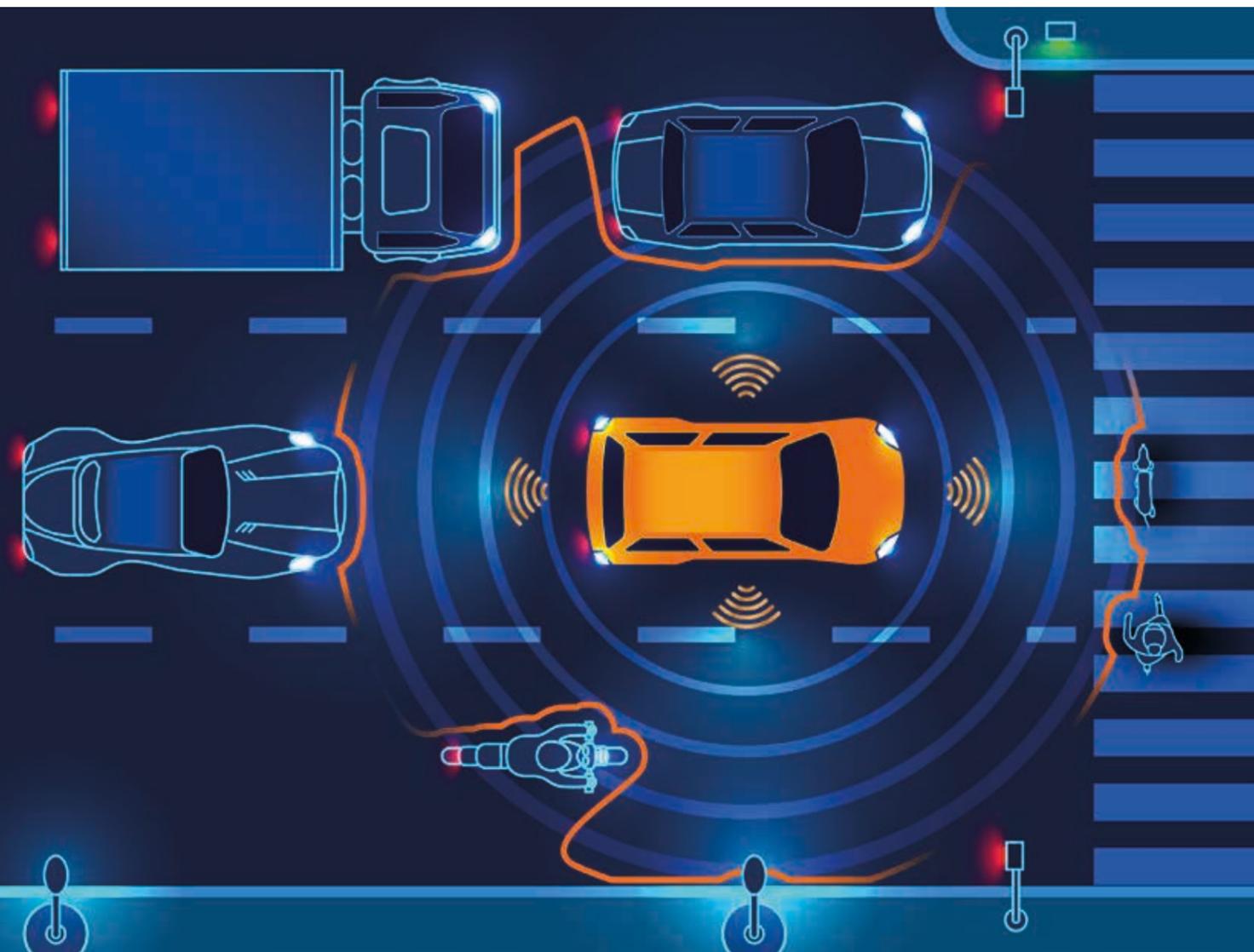
“On demand” driving services are already powerful engines of the transformation of mobility. One special option is self-driving “motto taxis” that pick up their passengers and give them a ride that is designed in line with a specific theme. Which of these themes are popular with the survey respondents? As with private cars, the “quiet car” with relaxation functions was preferred by almost two-thirds of the respondents. Almost equally popular was the “sightseeing car,” which provides the passengers with information about their surroundings during the drive. About a third of the respondents voted for the “restaurant car” and the “movie car” — except for the hard-working Germans and Chinese, who granted

second place behind the quiet car to the “productivity car,” which enables them to do concentrated work during the drive. It’s also interesting to note that whereas the “wellness car” impressed 32 percent, or almost a third of the participants, “beauty taxis” and “fitness taxis” convinced only nine percent. The “gaming car” and the “party car” were among the least popular motto taxis, receiving only 12 and 15 percent of the votes, respectively.

For future users of autonomously driving cars, doing pleasant and useful activities during a drive enhances the value of the time they spend in the car. Manufacturers can make such activities possible by, for example, creating modular interior concepts that can provide peace and quiet, relaxation, work facilities, food and beverages, and entertainment — depending on what the passengers want. All the major automakers have already developed autonomously driving concept cars, but they could further increase people’s acceptance of these future technologies through more dialogue and by involving the public in this development early on, says Herrmann.

He is convinced that autonomously driving vehicles offer tremendous potential for everyone involved in the transportation system — ranging from local authorities to automakers and their suppliers, local public transport companies, and the people who use mobility services. If autonomous vehicles are correctly integrated, they would help to optimize the transportation system. Herrmann also believes that two further aspects are important. “Autonomous vehicles make older people who need assistance, as well as people without a driver’s license, more mobile. And according to all the forecasts, the number of traffic deaths will be significantly reduced.”

Herrmann himself agrees with the majority of the respondents: He would like to have a car with a setup that enables him to work and also to relax while he’s on the road. “In addition, I’d like to have a traffic system that is more flexible and includes a variety of options so that we can use the available mobility resources in line with our needs. That’s the only way we can increase utilization while at the same time reducing our demand for resources. From my perspective, that makes autonomously driving cars valuable components for meeting our wide spectrum of mobility needs.” In the future, people will probably be even more mobile than they are now. Nonetheless, they can still have more time for themselves — for example, because they will no longer have to organize their own mobility. They will have products that incorporate the management of their passengers’ valuable time into autonomous driving. ■



Future transport solution
**with autonomous
electric vehicles**





„Our autonomous vehicles do not produce exhaust fumes or noise, they can drive day and night.“

Mikael Karlsson, Vice President Autonomous Solutions

Volvo Trucks



Volvo Trucks is now presenting a new transport solution consisting of autonomous electric commercial vehicles that can contribute to more efficient, safer and cleaner transportation. The long-term goal is to offer companies that need continuous transport services between fixed hubs a complement to today's offerings.

Growing world population and increasing urbanization are leading to significant challenges to solve environmental issues such as congestion, pollution and noise. Rising consumption, the fast growth of e-commerce and the wide-spread shortage of drivers put higher demands on efficient transport solutions.

„The full potential of the transport industry is yet to be seen. Everything suggests that the global need for transportation will continue to significantly increase in the coming decade. If we are to meet this demand in a sustainable and efficient way, we must find new solutions. In order to secure a smoothly functioning goods flow system we also need to exploit existing infrastructure better than currently. The transport system we are developing can be an important complement to today's solutions and can help meet many of the challenges faced by society, transport companies and transport buyers,“ says Claes Nilsson, President Volvo Trucks. Volvo Trucks' future transport solution is intended

to be used for regular and repetitive tasks characterised by relatively short distances, large volumes of goods and high delivery precision. Transports between logistic hubs are typical examples, but additional use cases can also be applicable.

„Our system can be seen as an extension of the advanced logistics solutions that many industries already apply today. Since we use autonomous vehicles with no exhaust emissions and low noise, their operation can take place at any time of day or night. The solution utilises existing road infrastructure and load carriers, making it easier to recoup costs and allowing for integration with existing operations,“ explains Mikael Karlsson, Vice President Autonomous Solutions.

The operation is handled by autonomous electric vehicles linked to a cloud service

and a transport control centre. The vehicles are equipped with sophisticated systems for autonomous driving. They are designed to locate their current position to within centimetres, monitor in detail and analyse what is happening with other road users, and then respond with high accuracy.

The transport control centre continuously monitors the progress of the transport and keeps an accurate watch of each vehicle's position, the batteries' charge, load content, service requirements and a number of other parameters. As with an industrial production process, speed and progress are tailored to avoid unnecessary waiting and to increase delivery precision. In this way it will be possible to minimise waste in the form of buffer stocks, and increase availability. Vehicles that operate on the same route cooperate to create optimal flow. Author: Edyta Szewc



Rigel Smioldo is a senior principal machine learning engineer in the data and artificial intelligence department of Mercedes-Benz Research & Development North America.

Timo Rehfeld is a principal engineer in the sensor fusion team of Mercedes-Benz Research & Development North America.

Rigel Smioldo und Timo Rehfeld, Daimler's AI and machine learning experts explain how autonomous cars learn to see and behave well in traffic.

Artificial intelligence is a hot topic, but what exactly can AI and machine learning contribute to make autonomous driving a reality?

Rigel Smioldo: At its very core, an autonomous vehicle has to make decisions. That involves understanding two questions. First, what is the environment I'm in right now? That is complicated enough. The second question is about taking action, such as turning or increasing the throttle. And how will that action influence my perception of the environment? Both of those aspects intersect with the realm of AI and machine learning.

Timo Rehfeld: AI refers to artificial intelligence as a whole. In the past, if you had a set of rules, you would call it AI. The first chess computer was no more than a set of rules that were hard-coded. It made decisions, but those were pre-programmed. Machine learning is an improvement that gives a computer the tools to learn decisions and complex patterns based on examples we provide — for instance how to detect a pedestrian in a camera image. We use all the different sensors you can think of: radar, cameras, and LIDAR, which is a key sensor because it has very precise distance measurement.

You recently attended an AI conference in Southern California and left most of the highway driving to a Mercedes-Benz E-class. How hard was that feat for the car to accomplish?

Smioldo: When you use DISTRONIC Plus with distance keeping and lane keeping, you can be relatively lazy on that long, long stretch of freeway going from the Bay Area to Los Angeles. Which goes to show that certain aspects of autonomy are not 10 or 15 years out but are already part of your car today. When you look at the advanced driver assistance and safety systems (ADAS) of a Mercedes-Benz today, they give you some level of autonomy. But what we're working on is the whole picture of autonomous driving.

And how do we get from driver assistance to autonomy?

Smioldo: A lot of people think that someday there will be this magic switch when they wake up and suddenly the whole world has changed. In reality, it's more of a gradual shift.

Rehfeld: You also have to distinguish between different use cases. Unlike me driving on a highway, urban mobility services are an entirely different scenario. They don't drive that fast, so you can increase the computer's processing times. You have more hardware, more sensors because those vehicles are part of a fleet. The algorithms change, too, if you're driving in the city. I think those technologies will co-exist for a quite a long time. Eventually, they might converge.

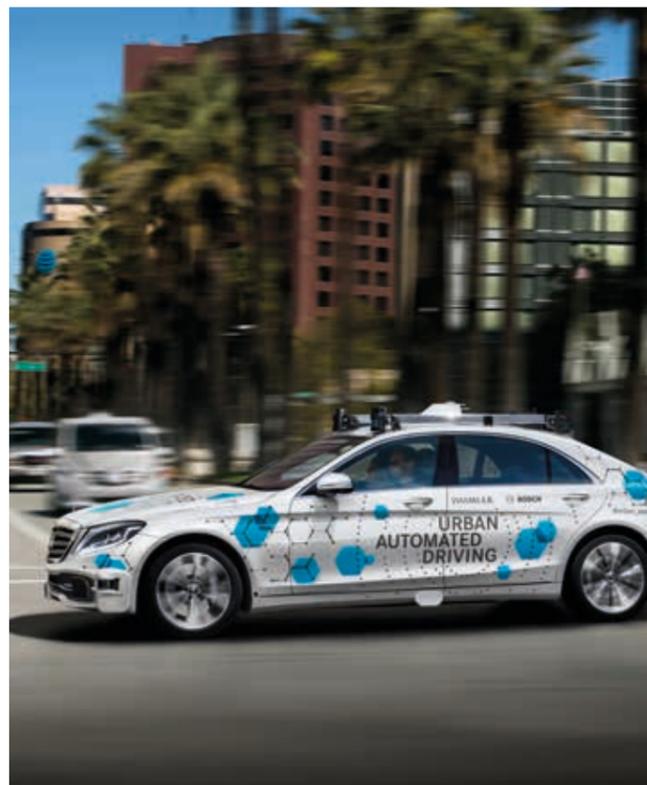
What are the things that cars can do today, and what are the things that still stump them?

Smioldo: It's mostly about reasoning about a complex environment — the psychological factors. As a vehicle, you want to anticipate if the pedestrian is crossing the street or not, so you need to make sure that he sees you. If the person looks at the vehicle, I know he or she will probably stop. If he's looking at his phone, you'd rather brake. There are subtle things, too, like the pedestrian waving you through, although the traffic light is red. Those are all corner cases that are really hard for a self-driving car to handle properly because it's not a physics modeling but a human behavior modeling problem.

What about cars interacting with other autonomous vehicles?

Rehfeld: The mixed environment is a challenge. If you have car-to-car communication and every single vehicle can communicate with every other vehicle, the problem is basically solved. But that's not the case in real life, and it will probably never be the case for the next decades. So you have to enable your car to drive in a mixed environment, and that involves teaching the car.

Smioldo: Think about what it takes for a person to gather that cultural data. You have 18 years until you're an adult. Imagine how many data it takes for a car to get there. With one key



„A vehicle doesn't have an ego“

„A lot of people think that someday there will be this magic switch when they wake up and suddenly the whole world has changed. In reality, it's more of a gradual shift.“

Rigel Smioldo, Senior Principal Machine Learning Engineer, Mercedes-Benz

difference compared to humans: Once you have the data, you can roll it out to all the other cars.

OK, so you gather a lot of training data instead of hard-coding rules. How exactly does machine learning work?

Rehfeld: Let's say we want to see two pedestrians in an image, the first thing we need to do is have the data annotated by a human to give the computer the desired outcome. A human marks all the pedestrians in one image so that the computer knows what it needs to detect. Machine learning in the end is an optimization problem. Eventually we will arrive at unsupervised learning, where the computer doesn't need human annotation anymore, but right now we are heavily dependent on good annotations.

Will humans have to change their behavior as more and more autonomous vehicles hit the road?

Smioldo: Like with any other emerging technology whenever new things become possible, the culture shifts around it. There will be an evolution in the way pedestrians behave once they get used to autonomous vehicles. They'll make their movements more, let's say,

obvious — just like we talk differently to voice assistants. That makes it easier for the car. That being said, cars can also become more obvious about their intentions. We can build external user interfaces with visual cues, acoustic cues, lights. One of the nice things is that a vehicle doesn't have an ego. It doesn't have that angry New Yorker attitude, insisting that it's "my turn."

What about the experience for people inside the vehicle? What do you show them to build trust?

Rehfeld: We need to think about building a holistic system where the AI that interacts with the customer is connected to the AI driving the car. You don't want the customer asking: "Do you see that pedestrian in front of us?" And the system responds: "Well, I don't know, because I'm not connected to the autonomous driving (AD) system." We need to expose the answers from the core of the AD system to build trust, then humans feel comfortable letting go and letting the car drive. People who'll grow up around and inside autonomous vehicles will have faith in this technology by the time they are adults.

Thank you for the interview. ■

Author: Edyta Szwec

TESLA STARTS UNLOCKING MORE POWER IN EXISTING SUPERCHARGERS

Following the announcement of its Supercharger V3, Tesla is now also starting to unlock more power in its existing Supercharger stations. When Tesla launched Supercharger V3 earlier this month, it introduced an improved top charge rate of 250 kW at the new charging stations. At the same time, the company also announced that it would unlock more power in its existing Supercharger V2 stations. Tesla said that they are going to update the current V2 infrastructure to a new peak charge rate of 145kW for single-vehicle charging. We already knew that the stations were able to deliver that charge rate, but the vehicles were believed to be the bottleneck. Now that we know Model 3 vehicles can charge at up to 250 kW (even 256 kW in some instances), it's clear that they could take more power out of the existing V2 Supercharger stations. This week, Tesla started pushing a new software update (2019.7.11) to enable Model 3 vehicles to take advantage of that new charge rate. ■

BATTERY RECYCLING RATE TO OVER 80%

Electrification will rapidly increase the need for batteries. A new solution by Nordic clean energy company Fortum makes over 80% of the electric vehicle (EV) battery recyclable, returns the scarce metals back into circulation and resolves the sustainability gap by reducing the need to mine cobalt, nickel, and other scarce metals. „There are very few working, economically viable technologies for recycling the majority of materials in lithium-ion batteries. We saw a challenge that was not yet solved and developed a scalable recycling solution for all industries using batteries," says Kalle Saarimaa, Vice President, Fortum Recycling and Waste. Fortum achieves the recycling rate of over 80% with a low-CO2 hydrometallurgical recycling process. The current recycling rate for batteries is approximately 50%. The batteries are first made safe for mechanical treatment, with plastics, aluminium and copper separated and directed to

their own recycling processes. The hydrometallurgical recovery process allows cobalt, manganese and nickel and lithium to be recovered from the battery and delivered to battery manufacturers to be reused in producing new batteries. This technology was developed by Finnish growth company Crisolteq. Crisolteq has a hydrometallurgical recycling facility in Harjavalta, Finland, that is already able to operate on an industrial scale. „Circular economy in its strictest sense means recycling an element to its original function or purpose. When we discuss the recycling of lithium-ion batteries, the ultimate aim is for the majority of the battery's components to be recycled to new batteries," Saarimaa concludes. Fortum is also piloting so-called „second-life" applications for batteries where the EV batteries are used in stationary energy storages after they are no longer fit for their original purpose. According to a forecast by the International Energy Agency, the number of electric vehicles on the world's roads will increase from 3 million to 125 million by 2030. In 2015 the global lithium-ion battery recycling market was worth about EUR 1.7 million, but it is expected to boom in the coming years to more than EUR 20 billion. ■

NISSAN AND DOCOMO TEST I2V TECHNOLOGY

Nissan and NTT Docomo are putting Nissan's Invisible-to-Visible technology through its field test in a moving vehicle, using Docomo's fifth-generation mobile communications connectivity. The technology, first revealed at the CES trade show in Las Vegas in January, is being tested at Grandrive, Nissan's proving ground in Yokosuka, Japan. Invisible-to-Visible, or I2V, is a future Nissan Intelligent Mobility technology that merges the real and virtual worlds. By combining information from sensors outside and inside the vehicle with data from the cloud, it helps drivers "see the invisible" – such as what's farther down the road, behind a building or around the corner. I2V also connects drivers and passengers to the Metaverse, a virtual world where people can interact through avatars. Family, friends or others in a remote location can appear inside the car as three-dimensional, augmented-reality avatars to provide company or assistance. For the field test, the companies are using Docomo's high-speed, large-capacity, low-latency mobile 5G connectivity to transmit avatar data wirelessly into the test vehicle, and in-car camera views from the vehicle, in real time. The test vehicle is based on Nissan's NV350 Caravan. ■



A man with glasses and a dark blue shirt is gesturing with both hands raised, palms facing forward, as if explaining something. He is standing in front of a large screen displaying a car's front end. The background is a light blue wall.

**Interview with
Volkswagen Chief Designer
Klaus Bischoff:**

“The cards are
being reshuffled”

How does the electric-era change the work of car designers? What characterizes the DNA of the ID. family? And what role does augmented reality play in daily work? Volkswagen Chief Designer Klaus Bischoff gives the answers.

Mr. Bischoff, electric mobility is also fundamentally changing the work of car designers. What is particularly new for you?

Klaus Bischoff: Actually, almost everything is changing. The cards are being reshuffled – from the tools of the trade to the product itself. It starts with an element that has dominated the laws of car design from the beginning – the combustion engine – being taken out of the equation. This creates a new territory, a new freedom that must now be used. For a car designer like me, there is nothing more exciting.

An electric car no longer has a bulky engine, but a bulky battery at a central point in the vehicle floor. What does this mean for the design?

Bischoff: So far, around a third of the vehicle's body has been occupied by the engine - hence the classic hood with radiator grille. Behind it came the occupants and the trunk: a layout that we have further developed over decades. Now a vacuum is created in one third of the vehicle that has to be filled. In addition, the vehicle now has a different foundation, which also changes a lot, for example you sit higher in the electric car. All of this, however, increases our degree of freedom considerably. On the base plate, into which the battery is embedded, we can arrange the occupants relatively freely and tailor the rest around them. This enables completely new product characters.

The heavy battery in the underbody also affects the driving characteristics of the car. Electric cars have a particularly low center of gravity?

Bischoff: Exactly. This also gives more freedom in the interior. Until now, the drivetrain and wheels had to be coupled, and there was always the center tunnel for the drive shaft. This has now

changed and creates unimaginable possibilities in interior design. Through digitalization and connectivity, we can create new user experiences, new operating philosophies and a completely different driving experience.

In the past decades, car design was strongly framed by the requirements of aerodynamics and wind tunnels. Is this influence dwindling in the e-era? Or to put it another way: Will electric cars possibly look more striking and different?

Bischoff: In any case, I believe that we will see a development leap in e-design that corresponds to the new technologies. This era offers us car designers the opportunity to act more disruptively, question routines and explore new territories.

Can one say that in the e-era the interior of a vehicle is becoming increasingly important? Also because the car is evolving as a living space and digital assets offer new potentials?

Bischoff: Yes, the car is changing from a driver's workplace, i.e. an ergonomically optimized machine control system, to a fully networked living room. Voluminous fixtures are becoming lighter, slimmer and smaller in the course of digitalization. The air conditioning system no longer takes up as much space as before because most of it moves into the former engine compartment. All this results in more spacious, more valuable interiors. E-cars still need restraint and safety systems however. In the future, this will be achieved by autonomous driving – and thus create even more design freedom.

Is the real revolution yet to come with autonomous driving?

Bischoff: With driverless mobility, the steering wheel and driver's compartment will also be eliminated. Yes, but there are still many steps to go. For now, we are doing everything we can, to make electric cars attractive for many people. The democratization of mobility has made Volkswagen great. Now we can offer everyone a journey that is more relaxed, quieter, more enjoyable and safer than ever. We have exciting times ahead of us.

The new Volkswagen ID. will be launched at the beginning of 2020 – the first model of the MEB-

based ID. family. What makes the difference of the "ID. DNA" for you?

Bischoff: With the ID. we are trying to create a new e-family identity. Everyone on the street should immediately see: wow, that can only be an e-car! And the second thought: wow, that can only be a VW! The ID. aura is likeable, unobtrusive and purist-clear. So drawn with a few, but very sensitive design elements. The form is very innovative, focusing on disruption rather than continuity. We want to present genuine e-personalities, also in order to reduce inhibitions about the new drive technology. And we always have democratization in mind. E-mobility for all. That is the claim.

Do you have a personal favorite?

Bischoff: Perhaps the ID. BUZZ* – because this vehicle uniquely combines the advantages of electric mobility with a unique brand-related design: the origin of Volkswagen, the myth of the Bulli, completely reinvented.

Sound design also plays a new role in the e-era – surely an attractive task to equip a silent car

with a sound that then becomes part of the brand identity?

Bischoff: This is a new field of activity for seasoned car designers. Of course, we've already worked on sounds – but now an electric vehicle is virtually noiseless. With increasing speed, driving noises that today are masked by engine noise also become more present. Insulation is therefore important – and how things sound. We perceive every click, every touch, every actuation of switching elements more clearly. This offers undreamt possibilities. At the same time, customers will feel and recognize a brand more strongly than ever through the sound. Sound imitation is required by law. But I would like people to recognize from the sound alone: an ID. just passed by!

How should a Volkswagen sound in your mind?

Bischoff: Every Volkswagen needs a sympathetic, friendly and reserved presence. In other words, the opposite of aggressive, intrusive, annoying. This requires a sound design that won't get on your nerves even the

Klaus Bischoff has been shaping Volkswagen design for three decades now. Born in Hamburg, he started his career as an interior and exterior designer in Wolfsburg in 1989. Since then he has developed four model series, including the Golf and Passat, the SUV models Touareg, Tiguan and T-Roc, the small up! and the premium Arteon. But nothing was as challenging for the 57-year-old as working on the vehicles of the upcoming ID. family. Here, Bischoff, who has been responsible for the worldwide design of the Volkswagen brand with more than 400 employees since 2007, explains what new opportunities and freedom the E-era offers for car design.





THE WORLD'S FIRST WIRELESS FAST-CHARGING INFRASTRUCTURE FOR TAXIS

Clean-energy company Fortum is in cooperation with the City of Oslo and the American company Momentum Dynamics to build a wireless fast-charging infrastructure for taxis in the Norwegian capital. The project aims to install wireless charging using induction technology. Charging plates are installed in the ground where the taxi is parked and a receiver is installed in the taxi. This allows for charging up to 75 kilowatts. The project will be the first wireless fast-charging infrastructure for electric taxis anywhere in the world, and will also help the further development of wireless charging technology for all EV drivers. „We will install the wireless chargers at taxi stands, such as the one at the Oslo Central Station. Taxis will be able to drive up to the charger and a wireless charging session will automatically start. This allows the taxis to charge in a place where they would anyway be waiting for new customers. The difference is that they won't be emitting exhaust while waiting, instead they will be receiving renewable energy to charge the taxi's battery," says Annika Hoffner, Head of Fortum Charge & Drive. „The future is electric, and it is already here, right now. Wireless charging is a potential game changer. From 2023 onward, all taxis in Oslo will be zero emission. Together with the taxi industry we will make sure that the shift is as user friendly and efficient as possible. Oslo will always be at the front of innovation and we are delighted to join forces with two of the industry's most progressive players in this game-changing move to launch the world's most ambitious plan for wireless charging of a taxi fleet," says Sture Portvik, the City of Oslo's Electro Mobility Manager. „We believe this project will provide the world with the model it needs for keeping electric taxis in continuous 24/7 operation. It will build on the success we have demonstrated with electric buses, which also need to be automatically charged throughout the day in order to stay in operation. Momentum is very excited to be working with the people of Oslo and with our partner Fortum," says CEO Andrew Daga of Momentum Dynamics. ■

THAILAND TO BE LOCATION FOR LARGEST TEST CENTRE FOR LITHIUM-ION BATTERIES IN THE ASIAN REGION

TÜV SÜD has signed a cooperation agreement with Thailand's Ministry of Industry and the Thailand Automotive Institute (TAI) governing the establishment of a battery test centre near Bangkok. The agreement paves the way for building the largest and most modern test centre for Li-ion batteries in the ASEAN region, involving total investments of 13.5 million euros. By establishing this cooperation in Thailand, TÜV SÜD bridges the gap between its battery laboratories in Korea and Japan and the test laboratories it is currently building in China. „The test centre will enable us to offer genuine first-class services to our customers in this region at reasonable costs and without excessive bureaucracy," says Volker Blandow, Head of Electromobility at TÜV SÜD. Activities at the test centre will focus on electric drive batteries for electric vehicles, but will also include intensive testing of stationary storage systems and batteries for electric two-wheelers for their use in tropical conditions. With a total of 650 Million inhabitants and increasing levels of prosperity, the countries in the ASEAN region represent a huge vehicle market. The leading country for automotive production is Thailand. German manufacturers had been building plug-in vehicles in the country for some time before also embarking on manufacturing their battery systems there in 2019. „Many suppliers have been operating research and development centres in Thailand, so that local content will rise steadily in this area too. TÜV SÜD has been contributing technical benchmarks and the experience we have gathered in the eight battery laboratories that we have been operating to date," says Blandow. The increasing activities in vehicle electrification present many of the newly industrialised countries with the challenge of keeping pace with technological change and avoiding being left behind, which would jeopardise the success built up by their automotive industry over the last 20 years. On the other hand, electromobility offers new economic operators a host of opportunities in a dynamic market environment. Along with electromobility, the governments of ASEAN countries are addressing two of their most pressing issues: air pollution in big cities, and boosting the competitiveness of their still fledgling industry. ■

tenth time and makes the day more pleasant.

Digital vehicle tools are becoming increasingly important in the e-era. Does this result in closer cooperation with software developers and UX designers for your work?

Bischoff: We car designers today need a holistic approach. It is about much more than pure vehicle design. We ensure across all touchpoints that people find a coherent brand philosophy. For example, I need to know – and design – how a Volkswagen feels on a smartphone. How I can operate a feature so "seamlessly" via a tablet that it feels exactly like it does in the car, with the same sound, the same graphics, design and navigation. Our field of work has expanded considerably.

Must tomorrow's car designer be a UX designer more than ever?

Bischoff: UX is rather another facet of the generalist claim this profession has today. You can't get very far with pure design. You need a deep understanding of brand values, product identities and digital fingerprints.

What role does Augmented Reality play in your everyday life today?

Bischoff: The working methodology has also changed. Of course, everything starts with a visualized 2D idea, whether on tablet or paper. But the leap into the third dimension is much faster and more direct. I put VR glasses on, make a three-dimensional sketch, and the team and board members can sit down together in the virtual vehicle body. And if I like it, I can send the draft directly to the wind tunnel and have the Cd value checked. In the past, such steps took weeks and months. The digital workflow makes us more agile and efficient. Which is all the more important because my teams are based in Wolfsburg and Shanghai, São Paulo and Mexico City.

So when Mr. Diess asks „What about the ID. CROZZ, Mr. Bischoff?“, you hand him some glasses and say: „Just sit down and have a look, boss!“?

Bischoff: Yes, he has already done that. And to be honest, he thought it was pretty great.

Thank you for the interview. ■

Fully charged

Bosch is putting electric vans on the road

Ordered with two clicks and conveniently delivered to your door the same day: the boom in online shopping is stretching delivery traffic in major cities to its limits. Vans and heavy trucks squeeze their way through city centers, where a lack of loading zones often leads them to double park. The result: blocked roads, noise, and emissions. In cities around the world, this is also causing traffic jams and fueling discussions about driving bans. And it's not just delivery services that are affected, but also tradespeople

and other small companies that make customer visits in vans. "To keep pace with goods supply in cities, there's no avoiding a rethink of delivery traffic," says Dr. Markus Heyn, member of the board of management of Robert Bosch GmbH. This is one objective Bosch is looking to fulfill with its new electric powertrain for light commercial vehicles. The first vehicles to have this under the hood will launch in 2019.

Deutsche Post has already initiated change in urban

deliveries with its StreetScooter, which uses a Bosch drive system. Now Bosch is going a step further by launching an electrical powertrain suitable for the vast majority of delivery vehicles. The idea behind this electromobility campaign is for electric vans to handle last-mile deliveries from distribution centers to recipients. The kind of stop-and-go traffic this entails is one area in which electric vehicles are particularly efficient, because they can recuperate the energy from constant braking, which increases their range. Most delivery routes amount to less than 80 kilometers a day – a distance easily covered on a single battery charge. Fleets can then be recharged overnight at the depot. Any driving bans in city centers would not affect electric fleets, since their powertrains cause zero local emissions. And it's not just cities that are keen to see package and courier services make resource-

Why goods distribution and delivery needs rethinking

10,000,000 packages daily
Global online retail is booming, and the number of deliveries is growing. More than 10 million packages are sent every day in Germany alone.¹

500g of CO₂ per package
According to calculations by Deutsche Post, delivering a single package leads to the emission of around 500g of carbon dioxide.²

500 times around the world
For 10 million packages, that roughly equates to the emission produced by a car driving around the earth 500 times – every single day!³

¹Statistik der Bundesagentur für Arbeit (IAB), ²ADP-Statistik 2017, ³Umweltbundesamt (UBA), ⁴Umweltbundesamt (UBA), ⁵Umweltbundesamt (UBA)

sparing deliveries. For 61 percent of Germans, whether an online retailer makes deliveries with electric vehicles is a key criterion in their choice (source PwC). One further advantage is that electric vehicles make less noise, which should also increase people's willingness to accept deliveries later into the evening. This could relieve traffic at peak times and provide for more flexible delivery windows. "Bosch is bringing e-mobility to where it really makes sense – urban deliveries," Heyn says.

READY FOR THE MASS MARKET

There are two versions of Bosch's eCityTruck powertrain: one with a transmission and one without. The goal is to create solutions that are quick to integrate and accommodate automakers' differing requirements. These powertrain solutions can be scaled for light commercial vehicles weighing two to 7.5 metric tons, making

them suitable for a large section of the commercial vehicle market. How? Small vans are very common; approximately three-fourths of all commercial vehicles registered in Germany belong to this class, and that number is on the rise (source: Shell). "Bosch's electrical powertrain for commercial vehicles has the potential to change the face of urban delivery traffic. We're getting electric vans ready for the mass market," Heyn says. With its new eCityTruck powertrain concept, Bosch has taken multiple components such as an electric motor and power electronics and combined them into one unit. This economizes on parts, making the powertrain not only far more efficient, but more affordable as well. Thanks to the easily integrated solution, customers no longer have the time-consuming task of developing new components. One further advantage for automakers, both established names and new players, is that the Bosch solution lets them bring vehicles to market quickly.

Mit der eAchse für Pkw bietet Bosch bereits eiBosch already offers an all-in-one solution for passenger cars – the e-axle – which significantly shortens vehicle development times. By expanding its product portfolio to include light commercial vehicles, Bosch is taking another decisive step in supporting automakers with their electrification strategies. Bosch's plans for the electrification of commercial vehicles go beyond vans. Together with the Nikola Motor Company, a U.S. start-up, Bosch is developing a powertrain that raises the bar for electric range. For Bosch, these powertrain technologies for delivery traffic are another milestone on the path toward achieving a leading global position in the electromobility mass market set to emerge after 2020, and toward making its vision of emissions-free, accident-free, and stress-free mobility a reality. Bosch sees the future of mobility as automated, connected, and electrified. ■

Author: Robert Metzger

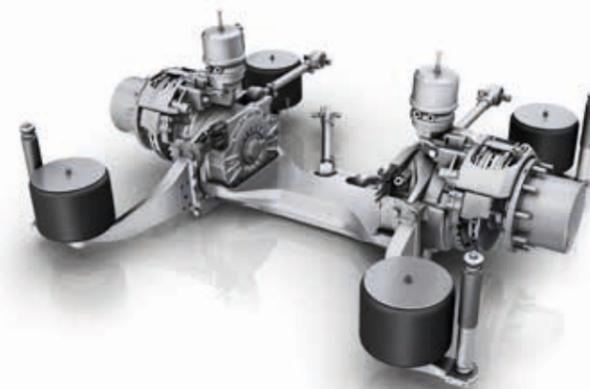




Steam ahead

The British bus manufacturer Alexander Dennis Ltd. (ADL) is expanding its product line, adding a double-decker model powered by a fuel cell drive. This new model is also equipped with ZF's AxTrax AVE electric drive axle to prevent local emissions. ZF also provided additional hardware and software solutions for optimum performance. An initial prototype was impressive, operating at high efficiency during field testing.

Powerful and environmentally friendly, ZF's AxTrax AVE electric drive axle drives low-floor buses up to a maximum axle load of 13,000 kilograms. The electric motors integrated into the wheel heads have a total output of 250 kilowatts.



The successful AxTrax AVE electric portal axle product line goes from strength to strength. "We are delighted that the British manufacturer Alexander Dennis has placed its trust in the AxTrax AVE electric drive solution from ZF," says Fredrik Staedtler, head of ZF's Commercial Vehicle Technology Division. "ZF has simplified the process of electrifying vehicle platforms for the manufacturer while making an important contribution toward keeping city center mobility solutions free from emissions."

The AxTrax AVE will be installed in a bus with a fuel cell drive. The bus, designed by ADL, is based on its Enviro400 product line. This configuration comprises a secure system that uses hydrogen to generate electricity, which, in turn, drives two electric wheel-hub motors in the electric portal axle. As fuel cells do not utilize fossil fuels, they produce no hazardous emissions, only steam."

ADL spent two years developing this hydrogen-driven double-decker bus with ZF selected as a partner right from the start. During field testing, the prototype operated along real bus routes in several cities throughout the United Kingdom. The Enviro400 design impressed everyone with its outstanding efficiency.

In addition to the AxTrax AVE, ZF also provided the inverter, the EST 54 electronic control unit and the appropriate control software. In this complete system, the company optimally aligned performance, efficiency and the service life of the drive. Moreover, this system solution helped reduce the test and homologation costs for ADL.

The British manufacturer has already presented the prototype of the new fuel cell double-decker to the public as well as several fleet operators.

The AxTrax AVE was introduced for the first time in 2012 and has been successfully deployed around the world ever since. The electric drive axle can be used in a wide array of possible applications as it can not only be operated in the mentioned fuel cell configuration, but also as a hybrid or purely electrically with lithium-ion batteries. In addition to the striking drive performance – totaling 250 kW up to a maximum axle load of 13,000 kilograms – the compact design is also appealing. Since neither a conventional unit nor a universally jointed shaft is necessary for transmitting power, manufacturers now have more freedom to design the passenger area the way they want. They can add seating and standing room, for example, or provide for step-less entry and exit or a completely flat passageway. ■

Author: Edyta Szwec



The Audi e-tron GT concept

Audi e-tron, the third: Last fall, the brand with the four rings presented one of the stars of the motor show in the film capital of Los Angeles. With the electric-powered Audi e-tron GT concept, a four-door coupé made its debut as a show car. The volume-production counterpart is set to follow in around two years.

The next electric Audi is being launched, following in the footsteps of the Audi e-tron* SUV and the Audi e-tron Sportback slated for 2019. This time with a flat-floor architecture that provides for exciting proportions and a low center of gravity. 434 kW (590 metric horsepower) ensures performance fit for a sports car. The torque is transferred to the wheels via the quattro permanent all-wheel drive with torque vectoring, as you would expect for such a dynamic Audi. The performance subsidiary Audi Sport GmbH is responsible for subsequently transforming the car into a volume-production model.

INSPIRATION DRAWN FROM THE WIND TUNNEL: DESIGN AND BODY

Flat, wide and with a long wheelbase – those are the proportions of a classic Gran Turismo. And the Audi e-tron GT concept reflects these with its 4.96-meter length, 1.96-meter width and 1.38-meter height. The lightweight body of the four-door coupé is manufactured using a multi-material construction. Here you have a roof section made from carbon along with numerous aluminum components and supporting elements made from high-strength steel. The technology for this automobile was developed in close collaboration with Porsche.

The gently sloping roofline of the e-tron GT concept that extends well into the rear echoes the Sportback layout that is the hallmark of the brand. This is, however, clearly taken forward into the future, pointing the way to the next evolutionary stage of the Audi design language. The cabin that tapers strongly toward the rear stands out compared with current Audi models. Wheel arches and shoulders are sculpted emphatically and, together with the flat floor that is unusual for an electric vehicle, visually underlines the low center of gravity and the dynamic potential of the Audi e-tron GT concept.

PERFORMANCE AND RANGE: THE DRIVE

434 kilowatts (590 metric horsepower) of system power – that is an impressive figure for the potential of the all-

electric drive. Separate electric motors are fitted to the front and rear axles. In both cases these are permanently excited synchronous motors. They put down the torque onto the road via all four driven wheels – naturally the new Audi e-tron GT concept is also a genuine quattro. An electric quattro to be precise, since there is no mechanical link between the front and rear axle. The electronic control system coordinates the drive between the axles as well as between left and right wheels. That means optimum traction and just the desired amount of slip.

In the future, the vehicle should accelerate from 0 to 100 km/h in around 3.5 seconds before going on to 200 km/h in just over 12 seconds. The top speed is regulated at 240 km/h to maximize the range. The range of the concept car will be over 400 kilometers, determined according to the new WLTP standard. The required drive energy comes from a lithium-ion battery with an energy content of more than 90 kWh, which takes up the entire underfloor area between the front and rear axle with its flat design. The decisive advantage of this design is the car's extremely low center of gravity – comparable with that of the Audi R8 – which in turn decisively benefits dynamic handling. All-wheel steering translates this into a perfect synthesis of sports car-like agility and precision, augmented by superb directional stability. The recuperation system increases the range by up to 30 percent on Audi electric vehicles – this is essential even with such a sporty car as the Audi e-tron GT concept. The recuperation involves both the two electric motors and the electrohydraulically integrated brake control system. Different recuperation modes are combined: manual coasting recuperation using the shift paddles, automatic coasting recuperation via the predictive efficiency assist, and brake recuperation with smooth transition between electric and hydraulic



deceleration. Up to 0.3 g, the Audi e-tron GT concept recuperates energy solely via the electric motors, without using the conventional brake – that covers over 90% of all decelerations.

REDUCING CHARGE TIMES: 800-VOLT CHARGING SYSTEM

The battery in the Audi e-tron GT concept can be charged in several ways: using a cable which is connected behind the flap in the left front wing, or by means of contactless induction with Audi Wireless Charging. Here a charging pad with integral coil is installed permanently on the floor where the car is to be parked, and connected to the power supply. The alternating magnetic field induces

an alternating voltage in the secondary coil fitted in the floor of the car, across the air gap. With a charging output of 11 kW the Audi e-tron GT concept can be fully charged conveniently overnight.

Wired charging is much faster as the four-door coupé is fitted with an 800-volt system. This substantially reduces charging times compared with conventional systems that are currently in use. Thus it takes around 20 minutes to recharge the battery to 80 percent of its capacity, once again providing a range of more than 320 kilometers (WLTP). The e-tron GT concept can, however, also be recharged at charging points with lower voltages, providing the driver with access to the entire charging network. ■

Author: Edyta Szwec

LIGHTNING LAUNCHES ALL-NEW \$13,000 STRIKE ELECTRIC MOTORCYCLE

DanaLightning Motorcycle, based in San Jose, California, rolled out their newest electric motorcycle today. The Lightning Strike employs a number of innovations from the company's previous model,



the LS-218. That bike holds the world record for fastest electric motorcycle at 218 mph (351 km/h). The Lightning Strike isn't quite as fast as its big brother, but still ties Energica for the second fastest commercially available production electric motorcycle at 241 km/h (150 mph). The Strike is available in three different options: Strike Standard, Strike Mid Range and Strike Carbon Edition. All three use the same liquid-cooled motor, but offer different levels of power, speed and battery capacity. ■

FORD TO DEPLOY ITS FIRST C-V2X-EQUIPPED VEHICLE IN CHINA IN 2021

Ford Motor Company announced plans to begin deploying cellular vehicle-to-everything, or C-V2X, technology in Ford vehicles in China in 2021. C-V2X technology can help make streets safer with vehicles that will be able to "talk" and "listen" to each other, pedestrians, cyclists and traffic lights, and supports the development of autonomous driving. This commitment demonstrates Ford's drive to accelerate the commercial deployment of C-V2X wireless communication technology and follows the company's plan to deploy C-V2X

technology in all new Ford models in the United States beginning in 2022. This month, Ford began testing its C-V2X-based driver-assist technology combined with Multi-access Edge Computing (MEC) technology in Shanghai. MEC technology moves to cloud computing to the roadside infrastructure to enhance latency and reliability. During the tests, Ford vehicles equipped with C-V2X will be able to interact with a variety of road users – including pedestrians and vehicles without C-V2X capability – via cameras from roadside infrastructure. This will provide Ford vehicles equipped with C-V2X with more comprehensive safety measures even before C-V2X is widely utilized. ■

SONY AND DOCOMO TO TEST DRIVERLESS CONCEPT VEHICLE VIA 5G TRIAL NETWORK IN GUAM

Sony Corporation and NTT DOCOMO announced that they will jointly trial Sony's conceptual driverless vehicle, the New Concept Cart SC-1, which leverages 5G mobile technologies for various remotely controlled functions. The test will be conduc-



ted using the trial network in DOCOMO 5G Open Lab GUAM, which will provide test facilities and an outdoor verification environment constructed by DOCOMO and operated by DOCOMO PACIFIC. The test will verify data transmission and operational performance required to remotely control the cart from a long distance via the extra-high speed, large capacity, low latency and massive-device connectivity. This will be the firms' second joint trial of 5G technologies, following a trial conducted in Japan in 2017 to test the real-time transmission of high-definition video via a 5G system to a 4K digital-signage system fitted to the outside of the cart. ■

eMove360° Europe

4th International Trade Fair for Mobility 4.0
electric - connected - autonomous
October 15 - 17, 2019, Messe München





MOBILITY 4.0

electric - connected – autonomous

22.000 sqm

300 exhibitors

11,000 visitors

Ladies and Gentlemen,

the future of mobility is electric, connected and autonomous – the era of the Mobility 4.0. Experts predict that the human being behind the steering wheel will be replaced by a computer within the next 10 years. Especially the market potential related to Mobility 4.0 won't stop to grow: being estimated at around 32 Billion Euro today it is expected to multiply to 115 Billion Euro in the year 2020.



With eMove360° we have created a core brand for the Mobility 4.0: B2B trade fairs, conferences, awards, magazine or news portal - eMove360° is a comprehensive information platform for Mobility 4.0. Empower your market communications with our exclusive access to your premium target audience: face-to-face, via print or through digital channels.

So please let me recommend you to participate – as an exhibitor or as a visitor – in the world's unique trade fair for Mobility 4.0 eMove360° that will take place in Munich from October 15 - 17, 2019.

Best regards,

Robert Metzger
CEO & Publisher



EXHIBITION AREAS

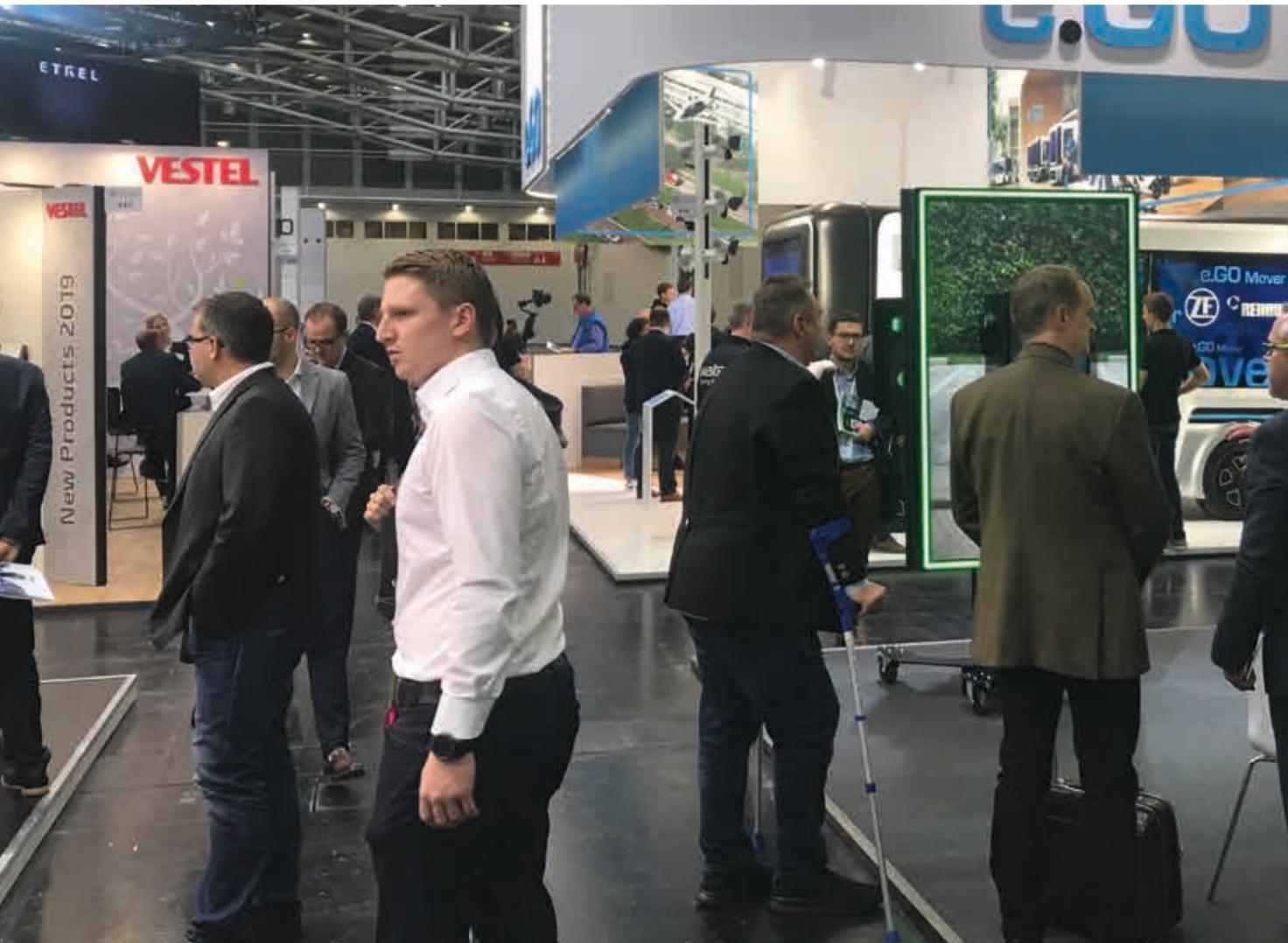
- Vehicles (electric, connected, autonomous)
- Infotainment & Connectivity
- Automated Driving & Electronics
- Battery & Powertrain
- Mobility Concepts & Services
- Urban & Mobile Design
- Materials & Engineering
- Charging & Infrastructure

TARGET AUDIENCES

- Engineers
- Designers
- IT Experts
- Procurement Managers
- Fleet Managers, Taxi and Car Sharing
- Cities, Communities and Politics
- Dealers, Repair Shops
- Hotels, Tourism, Real Estate and other Users
- Consumers

50% ENGINEERS

50% USERS

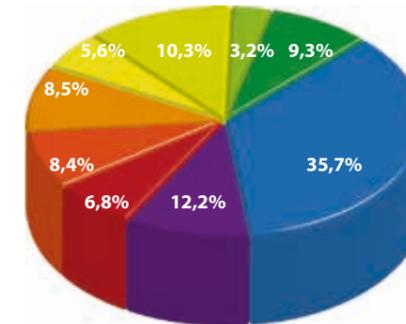


Facts & Figures

Visitors: 10.000 from 69 countries
(plus 30% compared to 2017)

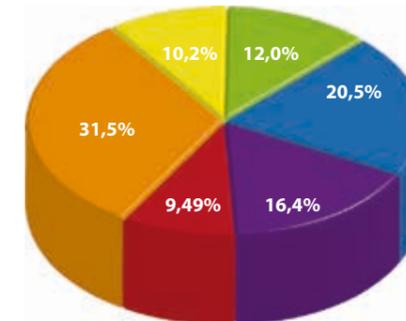
Exhibitors: 272 from 25 countries
(44% International)

VISITORS-INDUSTRIES



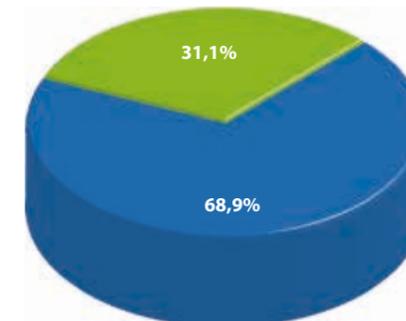
35,7% AUTOMOTIVE
12,2% TAXI, CARSHARING, SUPPLIERS
10,3% ENERGY
9,3% CITIES & COMMUNES
8,4% ARCHITECTURE & CONSTRUCTION
6,8% BATTERY
5,6% TOURISM
3,2% OTHER INDUSTRIES
8,5% PRIVATE

VISITORS-POSITIONS



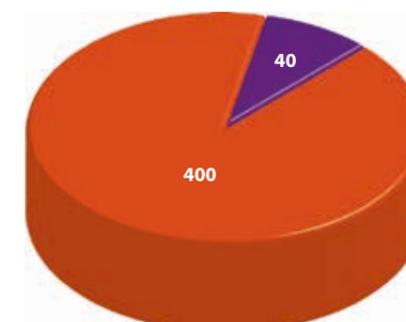
31,5% DEVELOPMENT
20,5% MANAGING DIRECTORS
16,4% PURCHASE & FLEETS
10,2% COLLEGES & STUDENTS
9,49% ARCHITECTURE & DESIGN
12,0% OTHER

COUNTRY DISTRIBUTION



68,9% GERMANY
31,1% INTERNATIONAL FROM 69 COUNTRIES

PRESS



400 JOURNALISTS
40 MEDIA PARTNERSHIPS



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PARTICIPATION - BOOK YOUR SUCCESS

Island stand (4 sides open), from 100 m ²	€ 250,00* / m ²
End stand (3 sides open), from 60 m ²	€ 270,00* / m ²
Corner stand (2 sides open), from 25 m ²	€ 290,00* / m ²
Row stand (1 side open), from 20 m ²	€ 310,00* / m ²
Open air site, from 20 m ²	€ 219,00* / m ²

Registration / exhibitor fee
incl. online database basic entry

€ 550,00*

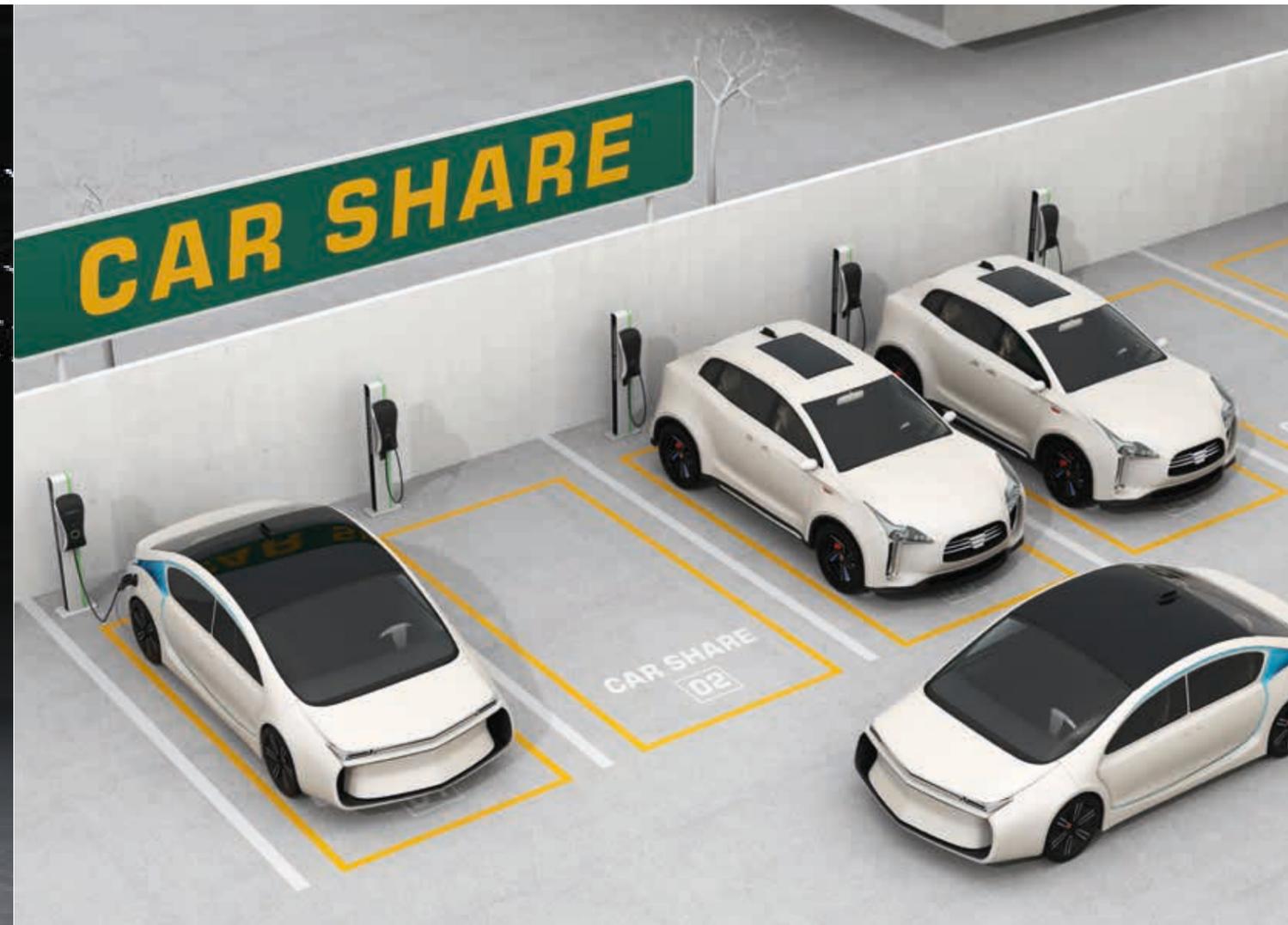
* plus 19% VAT



Full-Service-Booth 12 m²

ALL INCLUSIVE - FULL-SERVICE-OFFER TYPE A

- Stand area: 4 x 3 m, stand walls 2,5 high
- Lockable cabin (1 m²) with checkroom and shelf
- 3 kW bus bar and triple socket assembly
- Carpet
- Lighting
- 1 Magazine stand
- 1 Standing table with 2 bar stools
- 1 Display cabinet
- Marketing Package Business (forum, news, magazine)
- Application fee
- € 7.990,00 plus 19% VAT



Full-Service-Booth 20 m²

ALL INCLUSIVE - FULL-SERVICE-OFFER TYPE B

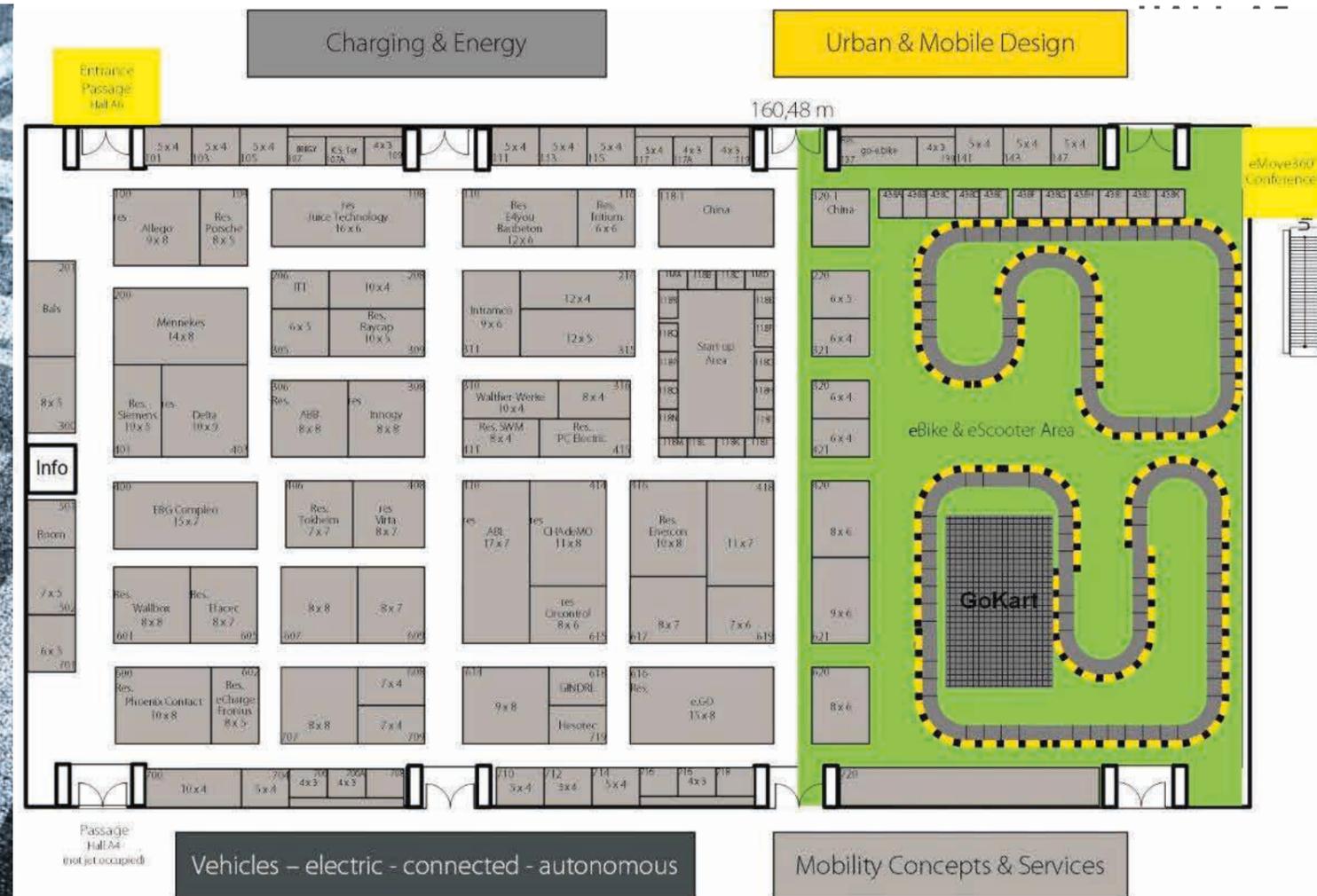
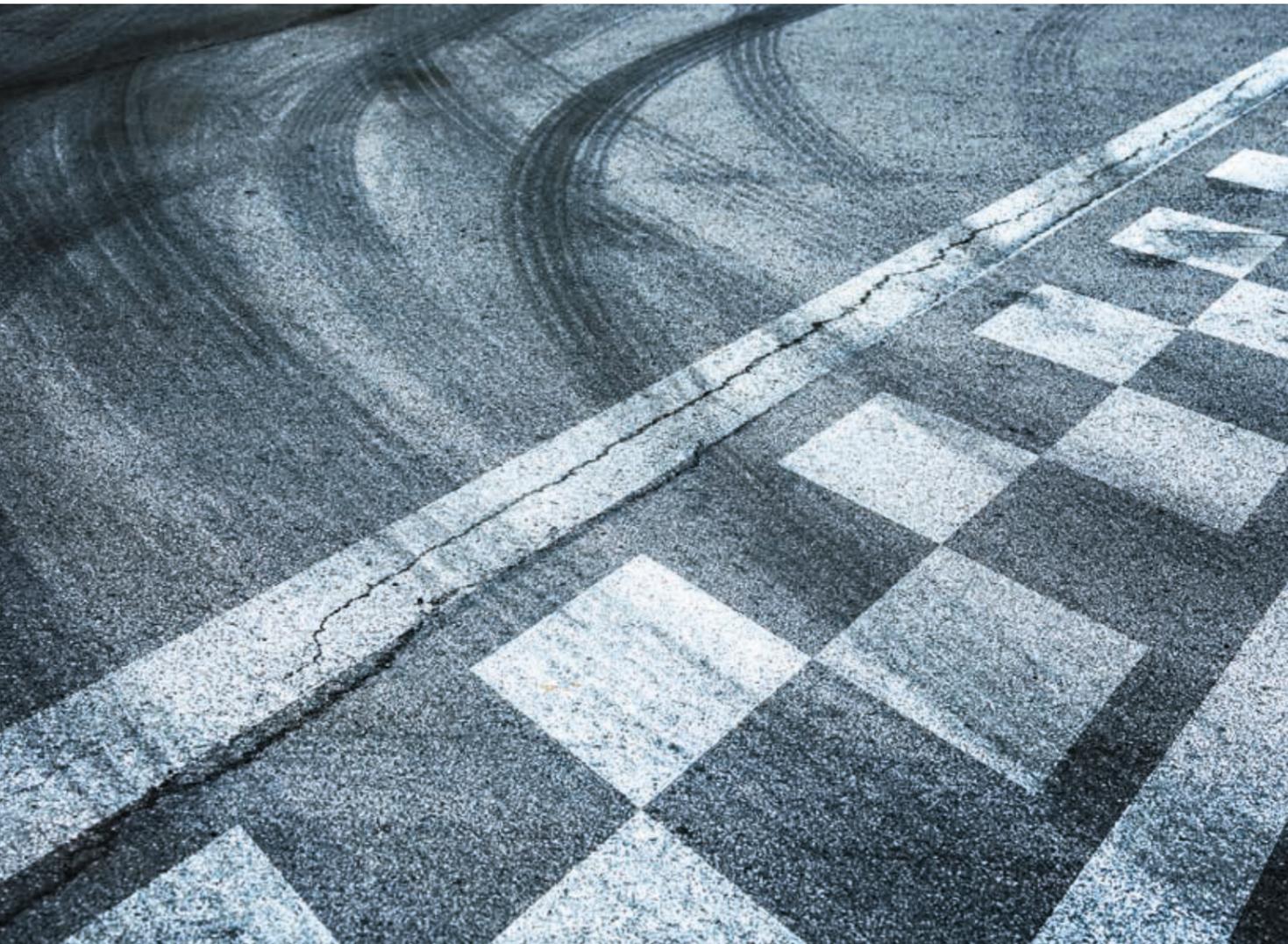
- Stand area: 5 x 4 m, stand walls 2,5 m high
- Lockable cabin (2 m²) with checkroom and shelf
- 3 kW bus bar and triple socket assembly
- Carpet
- Lighting
- 1 Magazine stand
- 1 Meeting table with 2 chairs
- 1 Display cabinet
- 1 Standing table and 2 bar stools
- Marketing Package Business (forum, news, magazine)
- Application fee
- € 11.700,00 plus 19% VAT



Demopoint, 6 m² Start-up group stand

ALL INCLUSIVE - DEMOPOINT

- Stand area: 3 x 2 m, stand wall: 3m wide, stand height: 3 m
- 3 kW bus car incl. consumption with triple socket assembly
- Carpet anthracite
- Lighting, 2 Spotlights
- 2 Bar stools
- 1 workplace with lockable cupboard
- Illuminated graphic tablet in workplace
- 1 Brochure holder and 1 waste paper basket
- Application fee
- € 4.400,00 plus 19% VAT

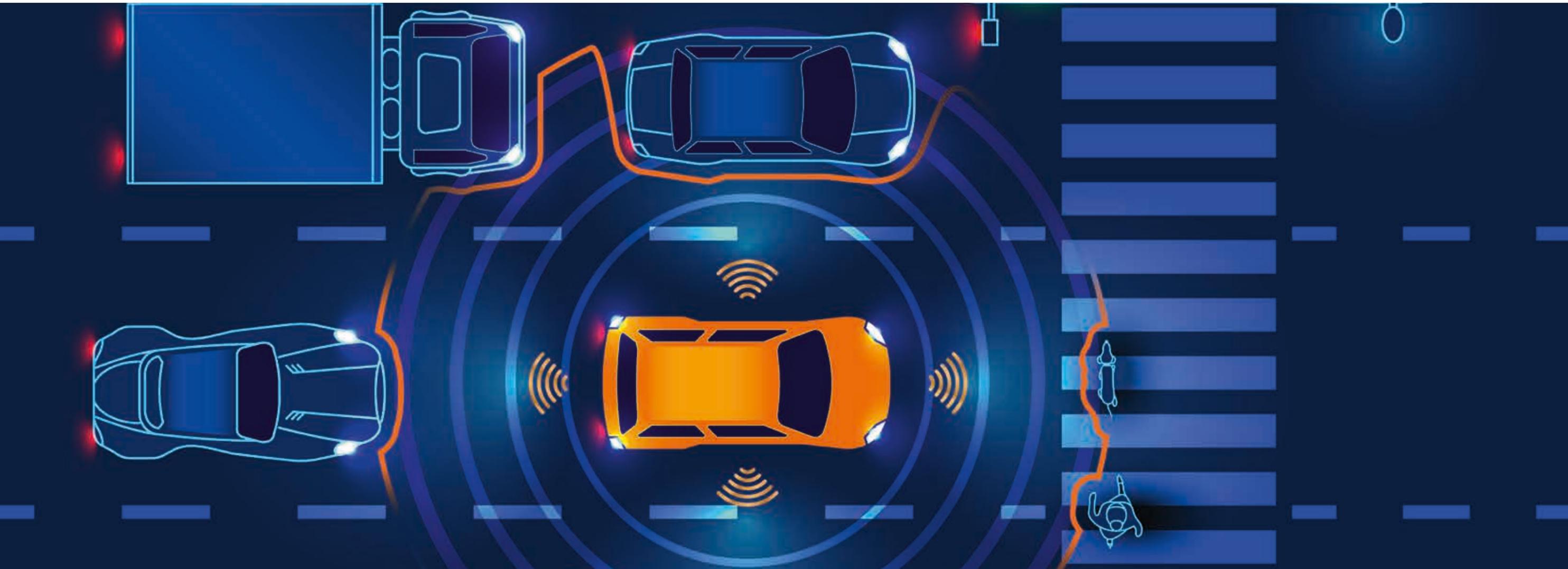


Test Track

Exhibitors of eMove360° Europe have the opportunity to make available their vehicles during the exhibition period for the visitors test drives. The outdoor area is designed, so that all trials and demonstrations can be performed.

PRESENTATION POSSIBILITIES

Pit Lane Box incl. tent construction	€ 3.980,00*
Parking Lot Pro Car incl. 2 banners	€ 1.990,00*
Parking Lot Basic Car	€ 490,00*
eBike Parking Lot	€ 90,00*
Individual space (from 20 m ²)	€ 219,00* / m ²
Gate archway (exclusive) incl. banner production	€ 7.490,00*
Banner on the test track (2,5 x 0,7 m), without production	€ 300,00*
Sponsorship	on request



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BOOK YOUR PRESENTATION AT THE FORUM

Do you offer new, innovative products? Are you a company with exciting future visions? Use our forum on the eMove360° and present your company, products or services in 15-20 minute presentations and reach a broad, international specialist audience. Following your presentation, we encourage a questionnaire and active networking.

1 Slot € 950,00

2 Slots € 1.550,00

3 Slots € 2.000,00

(Free guest tickets for your colleagues & business partners, stage, speakers desk, headset, technical equipment and support at the forum are included)



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Search for new, qualified employees on the eMove360° through a posting on the job board.

Job Ad (Display on the spot, online, in the exhibition edition eMove360°) € 290,00

Each additional ad € 90,00

1 Speakers Slot on the Forum & Job Ad in eMove360° Magazine € 950,00

Job Counter & Job Board 6 sqm € 3.950,00



Awards

To reward the diversity in Mobility 4.0 properly, participants can choose between two awards.

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Call for papers in 5 categories

- Material
- Surface & Technology
- Product
- CO₂ Efficiency
- Special Award: Student

Deadline: July 27, 2019

eMOVE360° **AWARD**

International Award for Electric Mobility and Autonomous Driving

Call for papers in 7 categories

- Electric Vehicles
- Energy & Infrastructure
- Autonomous Vehicles
- Software & Apps
- Automated Driving & Electronics
- Battery & Powertrain
- Mobility Concepts & Services

Deadline: July 27, 2019



Network-Club & Publishing House for the Mobility 4.0

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e-Monday is Germany's leading network for the mobility 4.0 and specifically addresses experts in economy, technology, science and politics. It is a club of friends and enthusiasts of electric mobility as well as connected and autonomous driving. The e-Monday organizes monthly networking events with expert speeches in Munich and other locations. Furthermore, e-Monday is a networking platform for the mutual exchange between providers, buyers and experts regarding future projects, cooperations and incentive opportunities.



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Redaktion eMove360°-Reisetipp:
Sabine Metzger

Layout

Dagmar Rogge / Marco Ebner

Place of Jurisdiction

München
Registergericht München, HRB 191293

VAT-ID

DE276580540

Bank Details

Deutsche Bank
Account Number: 24008770, BLZ: 700 700 24
SWIFT / BIG: DEUTDEBMUC
IBAN: DE 65 700 700 240 240 0877 00

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4th International Trade Fair for Mobility 4.0
electric - connected - autonomous

October 15 - 17, 2019, Messe München

IN PARALLEL
4
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