momentum

The Volkswagen Group magazine

NEW BEGINNING

A journey into the mobile future

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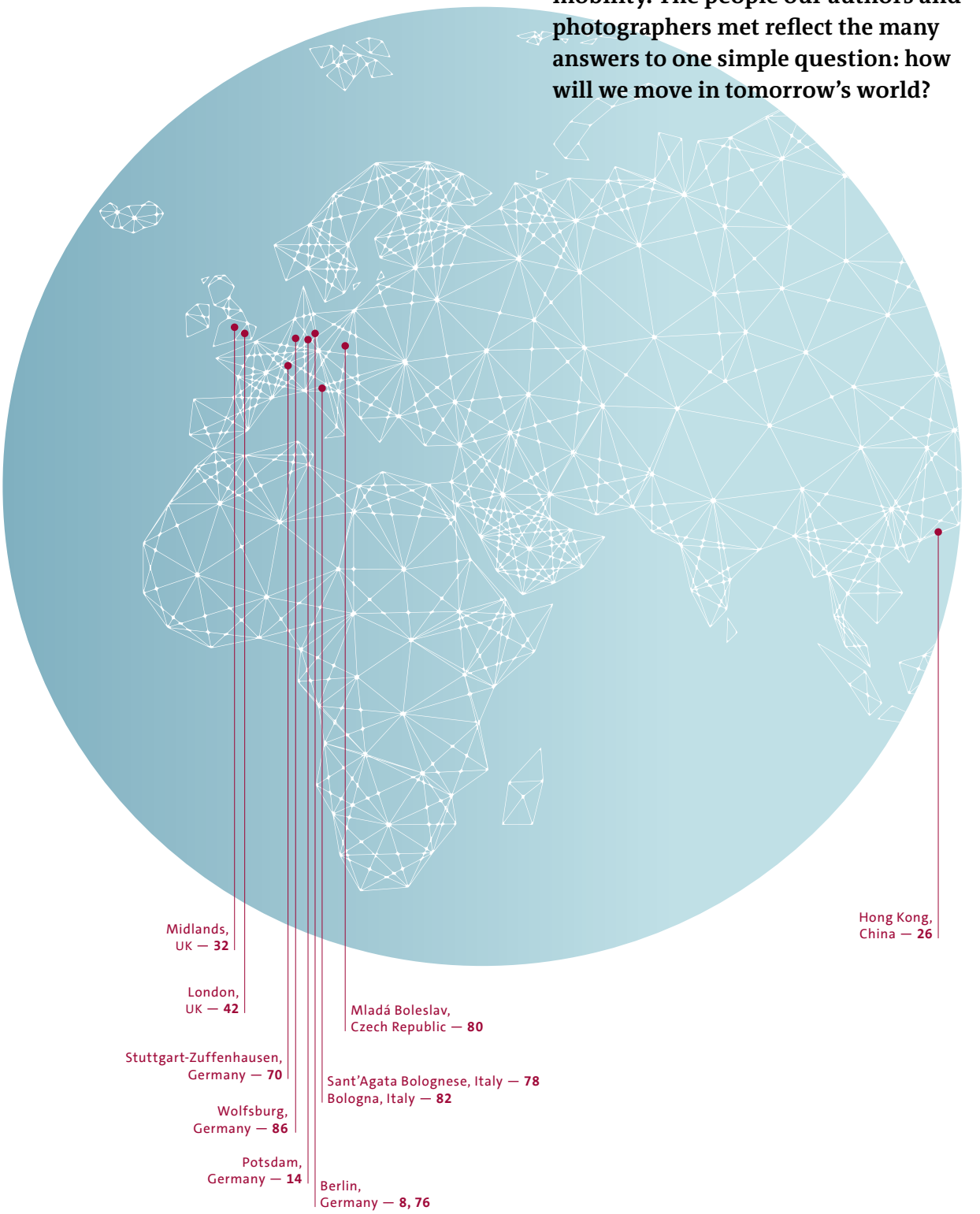
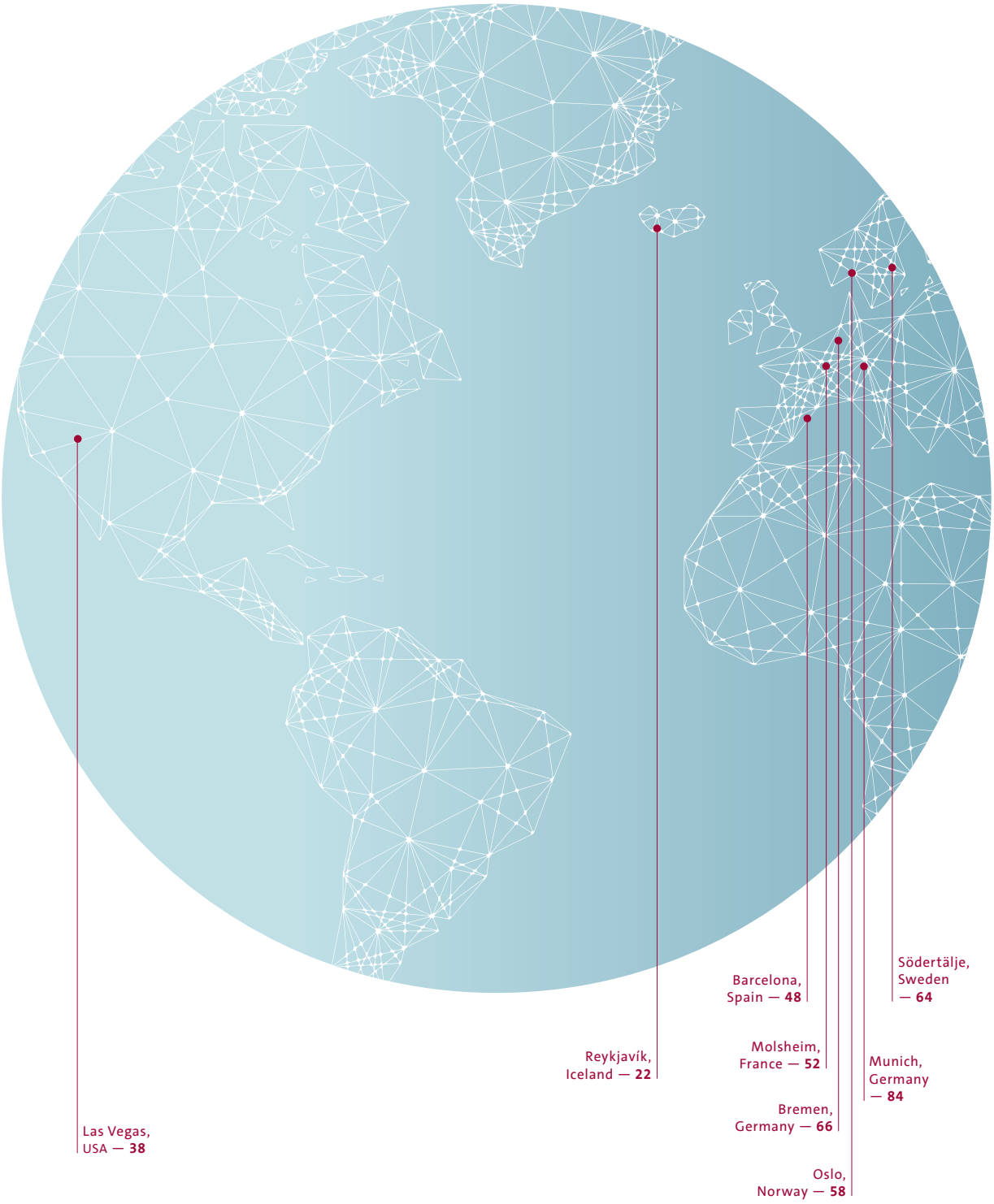
The Volkswagen Group is transforming itself from one of the largest car manufacturers into a globally leading provider of sustainable mobility.

This metamorphosis is already visible in many areas today: new powertrains, strong partnerships for new forms of mobility, and new digital products and services.

This issue of momentum brings you stories about people who have set out to drive this change. The journey into the mobile future has begun.

This issue of momentum takes you to places where the Volkswagen Group is working on the future of mobility. The people our authors and photographers met reflect the many answers to one simple question: how will we move in tomorrow's world?

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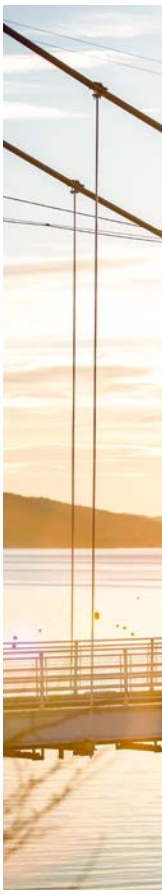
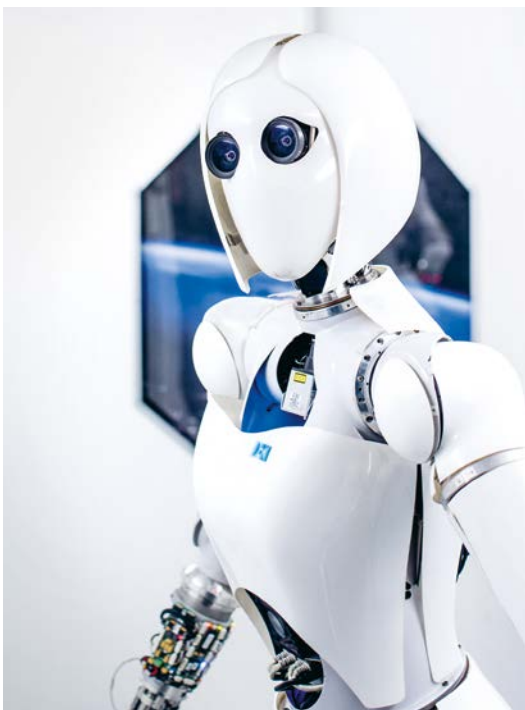




A QUESTION OF VALUES

What do people really want from everyday mobility? How important are electric vehicles, automated driving and car-sharing to them? momentum put these questions to families in Berlin.

Text Laurin Paschek
Photography Urban Zintel, Volker Kreidler

“We associate mobility with spontaneity and lifestyle. That’s why car-sharing schemes today have to improve.”

_____ Lars Hodeige (40), right

When Lars Hodeige, who runs his own creative agency, and ghostwriter Paul Nielsen need to get around in Berlin, they almost always use car-sharing. Having a car of their own isn’t important to them. But they would very much like to see greater choice in this segment: “There just aren’t enough model options in car-sharing”, Paul Nielsen says. “That limits our flexibility, for instance when we’re traveling with friends or when we have to transport something.” They would also like to use the vehicles on longer journeys: “Making a snap decision to spend the weekend on the Baltic coast doesn’t work with car-sharing at the moment.”

Lars Hodeige (right) and Paul Nielsen (29): car-sharing schemes should offer a greater choice of models.

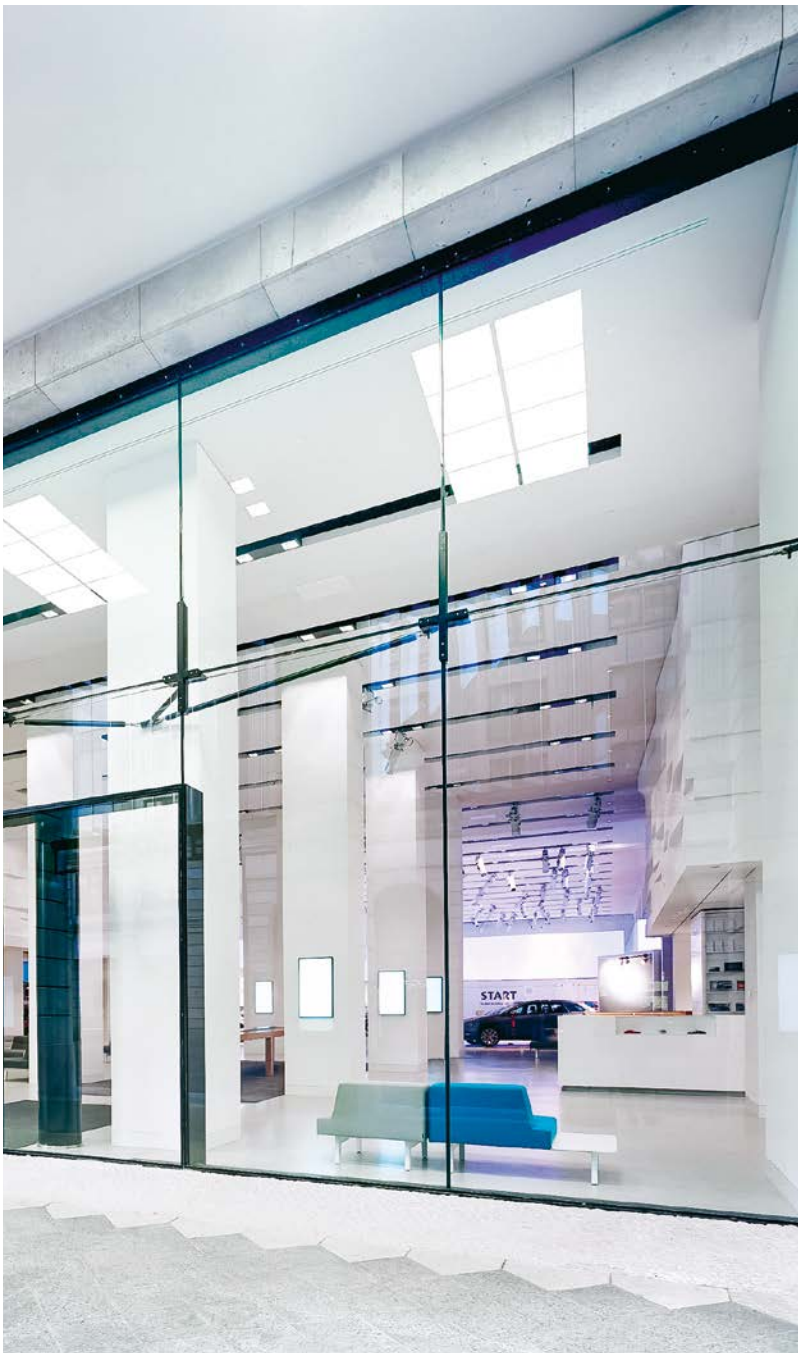
“For me, everyday utility is the top priority. But the car is also a place where I can find peace and quiet.”

_____ Selma Aras (38), far right

Children play the main role in the life of Selma Aras, who is married to a computer scientist. Having her own car is a time-saving boon in the hectic everyday life of the mother of three and part-time preschool teacher. “I often drive short distances, to kindergarten, school or work”, she says. “But for me, the car doesn’t just take us from A to B, it’s also a place where I can find peace and quiet, like a second home.” So for her, cars should be designed to turn travel time into quality time – for instance, with no-hassle infotainment systems.

From right: Selma with her daughters Ela (7) and Defne (16), husband Servet Celik (41), her mother Ayda (55) and toddler Levin (3): having an own car saves lots of time in everyday life.

From right: Elias with his uncle Marlo Szüts (31), cousin Aris Lioe (6 months) and aunt Denise Lioe (37): off to soccer training in a spacious family station wagon.



Elias Lioe would like to take his driving test in an eco-friendly electric car that travels quietly through the streets of Berlin – possibly even in self-driving mode. “But it must still have a steering wheel so that I can take control if things get tricky”, Elias says. Today, he’s on his way to soccer training in a spacious family station wagon with his Aunt Denise, Uncle Marlo and young cousin Aris. “We haven’t always had a car and in the past we used public transport most of the time”, his aunt says. “But with a baby, having your own car does make life much easier.”

“I care about the environment. Electric cars are much quieter and cleaner.”

Elias Lioe (11), far right


DIGITAL

DESIGN

What will it be like to ride through the city in a self-driving electric car? What sets different brands apart in the digital age? These questions are being explored by the Volkswagen Group's Head of Design, Michael Mauer, and the Group's Chief Digital Officer, Johann Jungwirth. We talked to them at the Volkswagen Group Future Center in Potsdam.

Text Johannes Winterhagen
Photography Urban Zintel

Will we still travel in the digital era?

Michael Mauer The way we approach mobility will change, just like the way we communicate has changed as a result of the Internet and smartphones. What's more, trends always trigger counter-trends. The more we move in a virtual reality, the more we value our personal experiences. In future, we might preview our travel destination with the help of a virtual reality headset, but that doesn't mean anyone would be willing to miss the 'live' experience, the personal encounter. Physical mobility will still have high priority.

Johann Jungwirth Self-driving cars can actually make individual mobility possible for many people. Take the elderly, who are no longer able or willing to drive. Mobility on demand, affordable for everyone, will lead to entirely new vehicle concepts. I'm convinced this is how Volkswagen can help improve the lives of many people.

How can you make reliable predictions about the way mobility will develop in future?

MM Classic customer surveys will not get us very far, especially given that the world is changing so fast. People live in the here and now and compare the new with the familiar. That is why we take a different approach in the Future Centers. We look far ahead, we time-warp ourselves to the world of 2030, or even 2040, and develop a vision. Starting from this vision we then work our way back to the present. We come up with some very unusual approaches, such as a car where children sit in the front seats because that is where they have the best view. Many people find that difficult to imagine today because of the safety risks – but surely it's only logical in an era where accidents will have become a thing of the past?

JJ We look very carefully at how life is changing for city dwellers, because that's where the future has already arrived, it's just unevenly distributed from a geographic standpoint. If you look in the right places, such as Silicon Valley, Shanghai or Berlin, you can already see key changes, such as a strong willingness to treat mobility as a service. Another phenomenon is the big regional differences we are seeing in city clusters as regards the mobility of tomorrow. Our thoughts, actions and decisions always center on people and the user experience.

For many people, the car is something very emotional. Will that still be true in the digital future?

MM I definitely think so. But the difference will be what triggers those emotions. In an electric car, for instance, the way the engine sounds isn't as important. If you're riding through dense city traffic in a highly-automated car, you are less concerned about the driving dynamics – and more interested in the way the interior is designed.

JJ The critical factor will be the perfect symbiosis between the physical and the digital world. There mustn't be any interruption in our digital lives when we transition from one location to another – from the home to the office or the car. On the contrary, we must intensify the digital experience, for instance by using the windows – even the side windows – as augmented reality displays to add virtual information to the view of the world outside.

MM We often talk about the optimal user experience. That will depend on the priorities set by the individual brands. Imagine a sports car fitted with a virtual trainer. That would help many customers experience the full potential of their car for the first time – naturally only on the race circuit. In a Bentley, on the other hand, you could imagine a holographic chauffeur.

How do you find the optimal user experience?

JJ We rely on agile development methods where ideas are turned into software very quickly – within one to three weeks. The teams always include a user experience designer and what we call a user tester, who tests the operating logic of each new software release with users as soon as it is ready, for example. The final product is perhaps totally different to what we had envisaged to begin with – but it is optimally aligned with what people want.

MM We involve customers in the design and development process at a very early stage. We recently designed a concept for a self-driving urban car by asking people on the streets in Berlin for their ideas – how they would like the seats to be arranged, for instance. That was very enlightening.

Digitization and design

How automation, digitization and electrification bring new freedom to vehicle design:

INTERIOR

The interior of fully-autonomous electric vehicles can be entirely designed around people. Seats can be positioned at will.

BODY

Until now, external design has largely been determined by the fact that the vehicle body must be able to absorb the energy generated by a collision. If highly-automated road traffic means there are no more accidents, the variety of body shapes will increase.

INTERACTION

Knobs and buttons are things of the past: every vehicle has a virtual assistant that understands human speech and can anticipate wishes thanks to artificial intelligence methods.

DISPLAYS

Large displays with augmented reality functions create a premium character – they replace the windows.

DRIVETRAIN

If a vehicle is based on Volkswagen's Modular Electric Drive Kit (MEB), all the drive and chassis components, including the traction battery, are integrated in the floor.

DIGITAL ECO SYSTEM

With their user ID, every Volkswagen Group customer can take all their settings along with them from one vehicle to the next – rather like swapping a SIM card from one smartphone to another.

JJ And we invited the same people to join us in the Future Center Europe to design and optimize the user experience for this self-driving urban vehicle; that's how we came up with new solutions. Another thing we did was to get blind people in London involved in the design process so that we could optimize the concept car to suit their needs as well. Our vision is mobility for everyone, at the touch of a button.

Does a car powered solely by electricity look different from today's vehicles with internal combustion engines?

MM It's the designer's job to visualize this new freedom. I think the Volkswagen brand's designer team did an excellent job in achieving that with the I.D. and I.D. Buzz concepts. They demonstrate how electrification opens up entirely new possibilities for designing the interior.

"We must intensify the digital experience."

Johann Jungwirth

Until now, technology imposed restrictions on design and we had to make people as comfortable as possible in the remaining space. That situation is being reversed now: we can design the interior based on people and their needs, and can quite literally design it around them.

JJ There will be greater diversity, just like the rooms in a building can be decorated in totally different ways: there will be very puristic, function-oriented interiors as well as very stylish ones. Thanks to our brand diversity, self-driving cars with no steering wheel, pedals or cockpit give us the chance to become even more versatile.

Surely the way the brand character is perceived will be strongly influenced by the content of the displays?

JJ We are building up our own digital platform and our own digital eco system so that customers remain within the Volkswagen Group world. The user ID means customers can take their profile along with them from one vehicle to another, even to rental cars or mobility-on-demand vehicles.

MM However, user interfaces as well as functions will differ from brand to brand, similar to the way we create a brand-specific driving experience today even though we have the Group's modular engineering and electronics tool kits.

JJ We will define the interaction between people and vehicles as well as designing the user interfaces even if content comes from third parties. This will all be based on a standardized digital platform for all passenger car brands that can meet all customer needs. In parallel, Volkswagen Truck & Bus is setting up 'RIO', a digital B2B platform for the transportation industry.

How will the interaction between driver and vehicle work in the future?

JJ We have just begun a partnership with the chip manufacturer Nvidia to develop a cockpit based on artificial intelligence. That will give the driver an on-board assistant to minimize the number of operating steps. Ideally, there would be no need for any manual interaction whatsoever, because the system predicts the next steps in a given situation at a given location and determines the information

“Electrification opens up entirely new possibilities for designing the interior based on people and their needs.”

Michael Mauer

required as a function of the context, the situation and the location.

What is the difference between a digital product from the Volkswagen Group and other digital offerings?

JJ For us, this is about values, and above all about digital fairness. By that we mean data protection, data security and transparency in handling customer data. We want to leave it to users to decide for themselves what data they are willing to share. Today, people already entrust us with their most precious asset: their own lives. And they will place their trust in us in a digital world, too. For us it is extremely important to handle their data with respect and fairness.

MM Some of the values from the traditional world of cars are definitely transferable. Quality, for example, because software that functions perfectly is just as important as perfect engineering.

JJ Or performance: we are aiming for top-level processor speed across all brands and the same applies to over-the-air update capability and durability.

You both work for the Volkswagen Group. What tasks are centralized and what tasks do the brands themselves perform?

MM The brands work very independently. My role is to act as an initiator. To do that, there has to be a certain distance between my work and series production projects. The brands also have progressive ideas, but they have to keep on asking themselves whether these ideas are feasible. We have the freedom to question everything. But we don’t do that in isolation, we are in constant dialog with the brand chief designers.

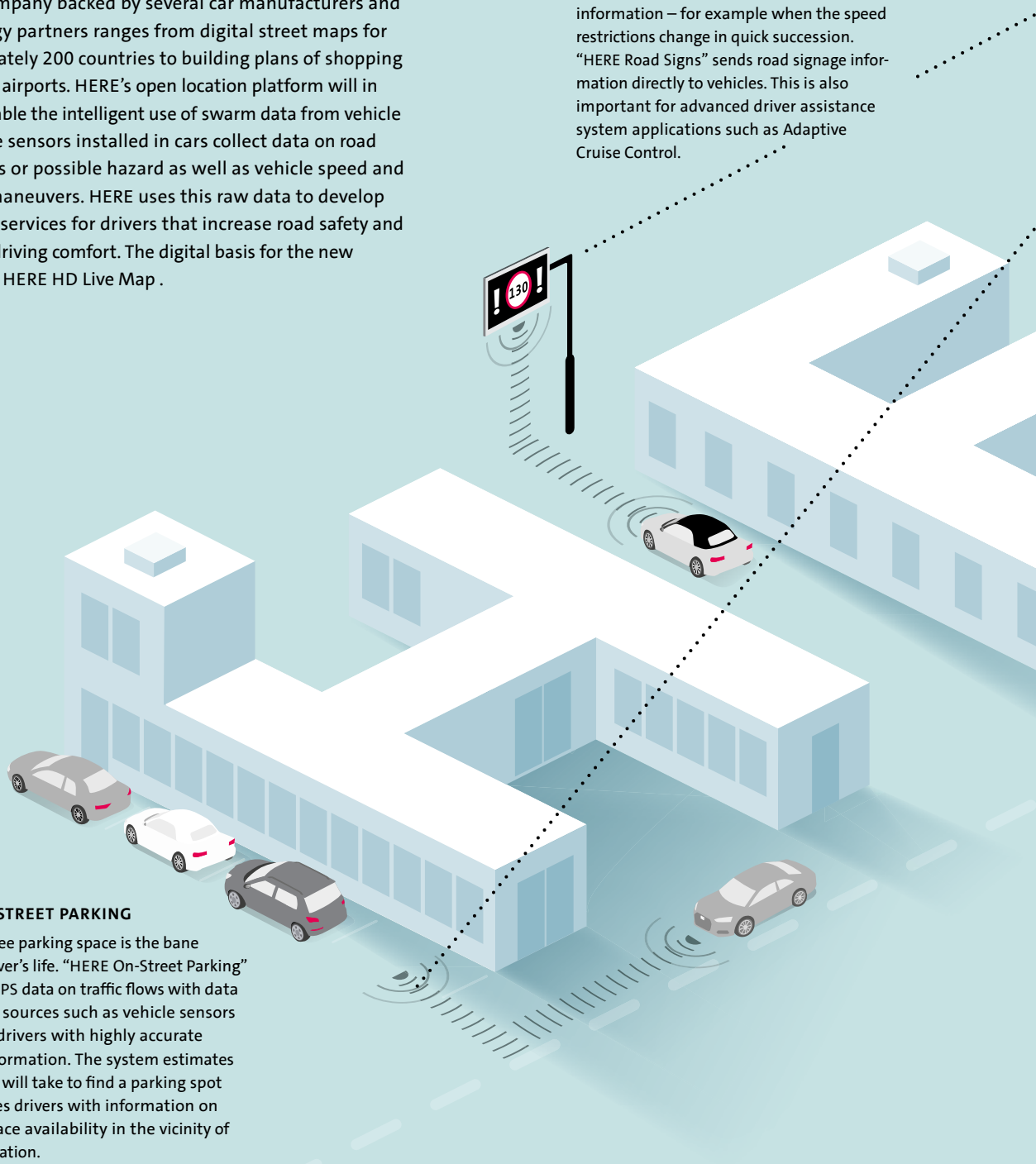
JJ It makes sense to harness the synergies within the Group. Neither the Group nor the brands want to do everything themselves. We collaborate closely with strategic partners because the impetus for digital life often comes from outside, from the consumer electronics world, for instance. The Volkswagen Group is a very interesting partner for the IT industry that drives such developments; after all, our brands put some ten million vehicles on the streets each year and we have around 100 million active customers and users. Bringing the full strength of all brands to negotiations with potential partners is an advantage.

RIGHT HERE?

All navigation systems and telematics services are based on high-precision, up-to-date mapping data. This is why Audi AG holds a stake in HERE, a developer and provider of cloud-based mapping services. The wealth of data owned by the company backed by several car manufacturers and technology partners ranges from digital street maps for approximately 200 countries to building plans of shopping malls and airports. HERE's open location platform will in future enable the intelligent use of swarm data from vehicle fleets: the sensors installed in cars collect data on road conditions or possible hazard as well as vehicle speed and braking maneuvers. HERE uses this raw data to develop real-time services for drivers that increase road safety and enhance driving comfort. The digital basis for the new services is HERE HD Live Map .

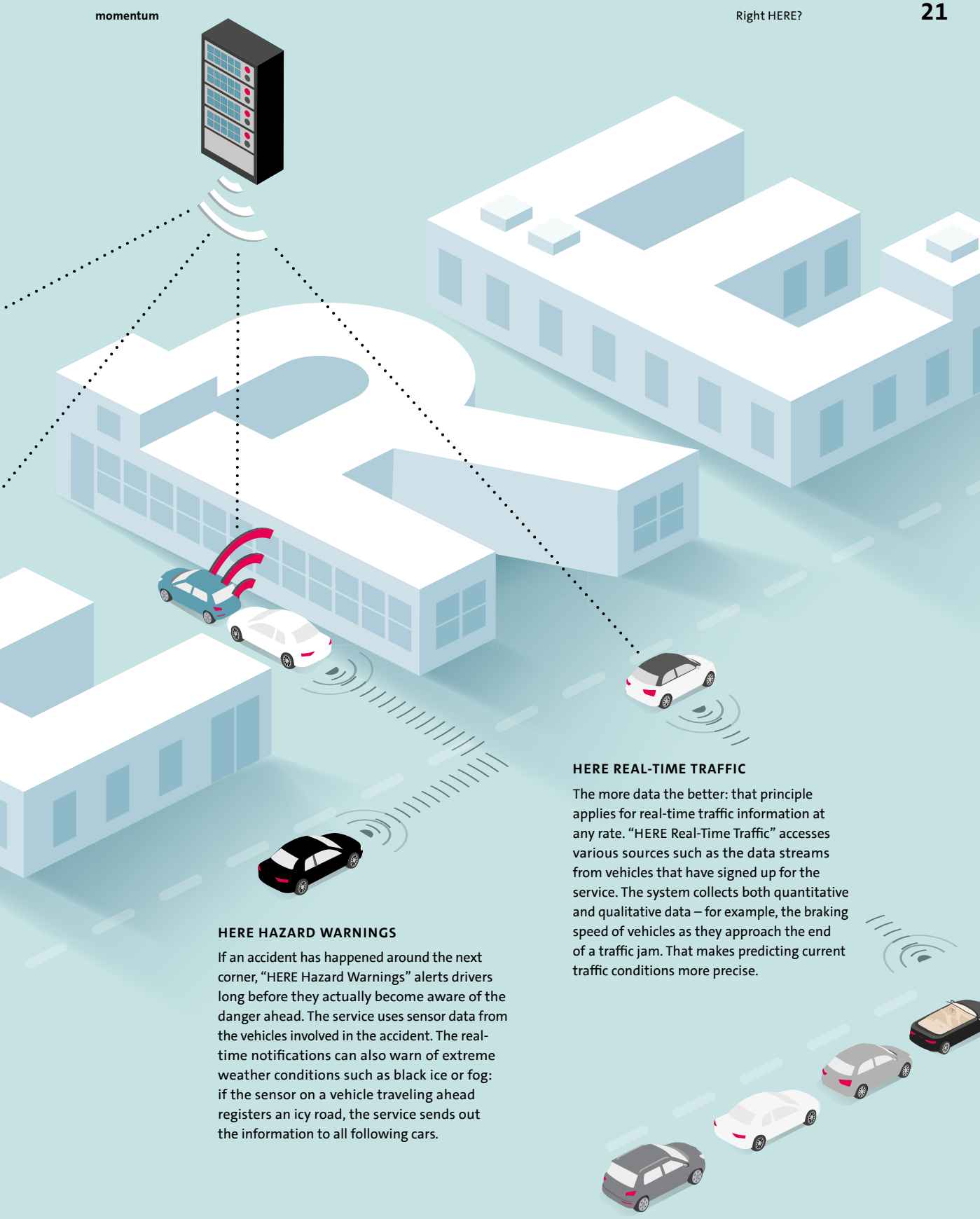
HERE ROAD SIGNS

Digital displays like the ones often found on gantries help improve traffic flows and enhance safety. However, drivers sometimes find it difficult to keep up with the signage information – for example when the speed restrictions change in quick succession. "HERE Road Signs" sends road signage information directly to vehicles. This is also important for advanced driver assistance system applications such as Adaptive Cruise Control.



HERE ON-STREET PARKING

Finding a free parking space is the bane of every driver's life. "HERE On-Street Parking" combines GPS data on traffic flows with data from other sources such as vehicle sensors to provide drivers with highly accurate parking information. The system estimates how long it will take to find a parking spot and provides drivers with information on parking space availability in the vicinity of their destination.



HERE HAZARD WARNINGS

If an accident has happened around the next corner, “HERE Hazard Warnings” alerts drivers long before they actually become aware of the danger ahead. The service uses sensor data from the vehicles involved in the accident. The real-time notifications can also warn of extreme weather conditions such as black ice or fog: if the sensor on a vehicle traveling ahead registers an icy road, the service sends out the information to all following cars.

HERE REAL-TIME TRAFFIC

The more data the better: that principle applies for real-time traffic information at any rate. “HERE Real-Time Traffic” accesses various sources such as the data streams from vehicles that have signed up for the service. The system collects both quantitative and qualitative data – for example, the braking speed of vehicles as they approach the end of a traffic jam. That makes predicting current traffic conditions more precise.

ON TOUR WITH THE CRAFTER

Volkswagen Commercial Vehicles has set out to conquer new markets with the new Crafter. This is why the specific requirements of people from very diverse trades played a key role in development work. Whatever their craft, these experts had one wish in common: quality. That is why craftspeople across Europe were given the opportunity to check out the Crafter. One of them was Anna María Karlsdóttir, an artisan and designer living in Iceland.

Text Laurin Paschek
Photography Matthias Haslauer

The Crafter makes its way swiftly down the rough gravel track. Every now and then, the tires kick up one of the innumerable small pieces of lava scattered all over the ground. A thin layer of snow covers the volcanic landscape that surrounds us. We are right on top of the Mid-Atlantic Ridge which splits Iceland from north to south. Geologically speaking, we have America on one side of the track and Europe on the other. Iceland owes its volcanoes – and thus its existence – to the fact that two tectonic plates are drifting apart here.

We are heading for the community of craftspeople called "Íshús Hafnarfjarðar" in the fishing village of Hafnarfjörður to the south of Iceland's capital city Reykjavík. In summer 2014, Anna María Karlsdóttir and her husband Ólafur Gunnar Sverrisson, a professional wooden boat builder, rented an old fish factory in the harbor, refurbished the building, divided it into several zones and set up workplaces for initially twelve designers and craftspeople.

"Our idea was to give freelance designers their own space for working on their craft – as well as providing them with access to the communal areas, along with our ceramic and porcelain kilns and our tools, plus the small fleet of vehicles."

The success of the Icelandic start-up was overwhelming. Anna and Óli have since expanded and now have 32 workplaces for a total of 45 artisans, including wood carvers, potters, graphic and fashion designers. Most of their tenants are women, although there is also a cutler from Greece. "We primarily use old materials for our work", Anna says. An old buoy is transformed into a lamp, a piece of driftwood becomes a work of art and an everyday wooden pallet is converted into an elegant table. Most of the raw materials are found on the island: old furniture, wooden boards, stones, scrap metal. The items created in Íshús Hafnarfjarðar are then sold, some of them to tourists in Reykjavík.

“Our idea was to give freelance designers their own space for working on their craft – and the chance to share a small fleet of vehicles.”

ANNA MARÍA KARLSDÓTTIR, ARTISAN AND DESIGNER

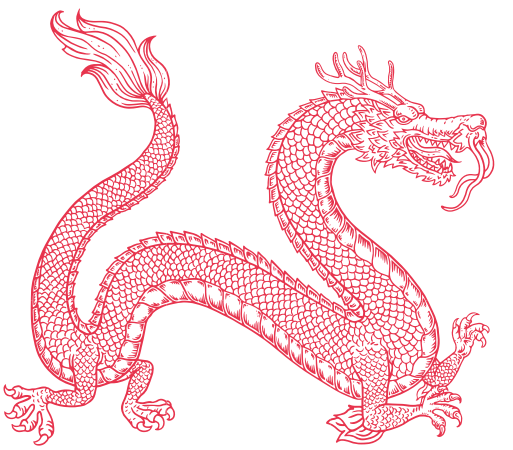
“My husband and I spend a lot of time driving round the island in the transporter collecting raw materials”, Anna says as she inspects the Crafter’s loading space. “Our top priority is having plenty of space. I don’t think that’s a problem with this van”, she adds with a grin. All-wheel drive is also important because otherwise it would not be possible to negotiate the roads on the island, many of them only rough tracks, during the cold season which lasts from September to May. “Another thing I really like about the Crafter is that you can order it with several rows of seats”, says the anthropology graduate. “That means we could use it to take our four kids to the swimming pool, or visit friends with the whole family.”

The Crafter as an all-rounder for collecting materials, delivering finished works of art, as well as a family van: versatility is what’s needed in Anna’s colorful community of craftspeople on the ridge that separates America from Europe.

CRAFTER2CRAFTSMEN

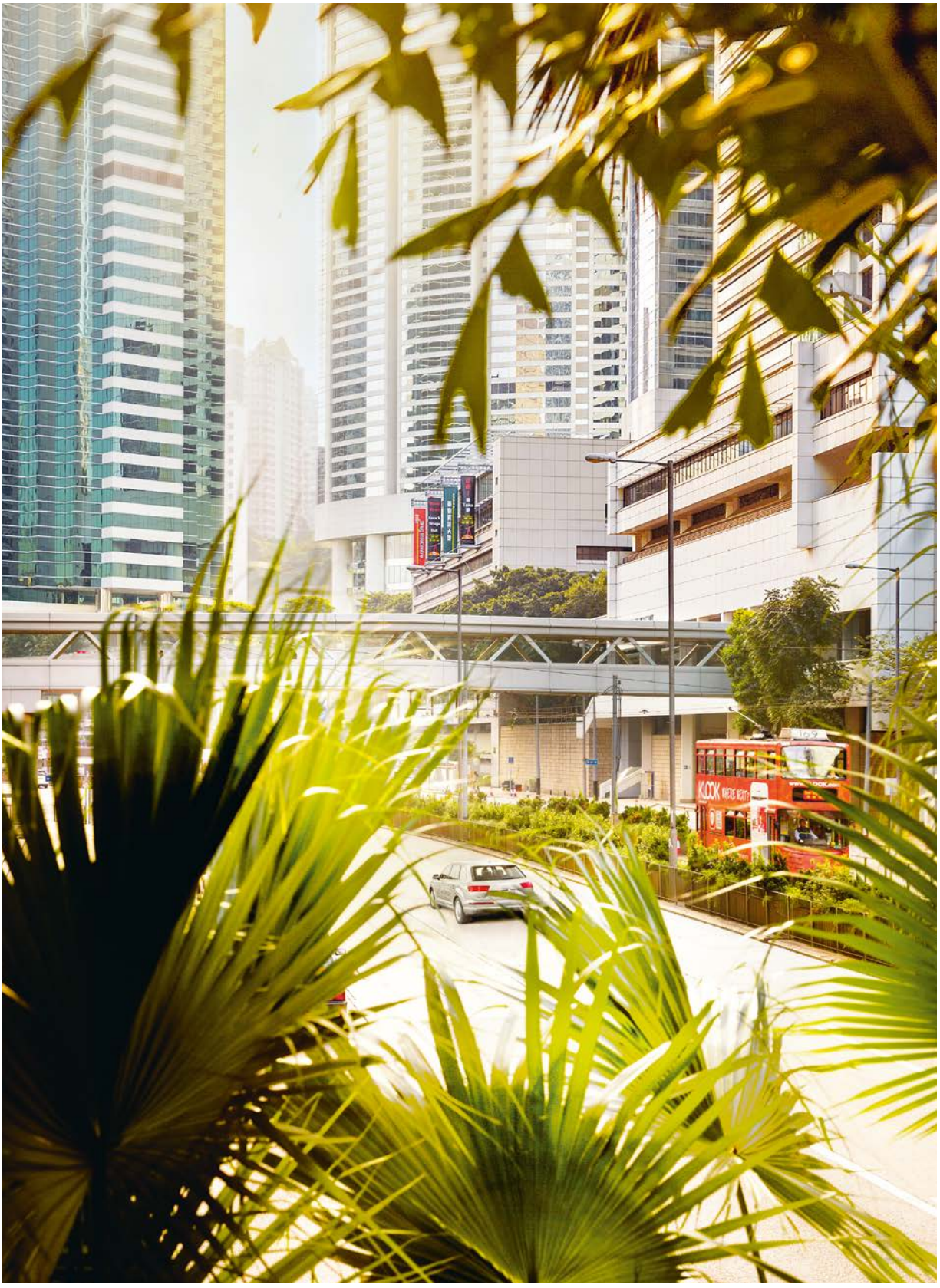
30 countries, 42,000 kilometers, four months: prior to the market launch, Volkswagen Commercial Vehicles sent the new Crafter on a final quality check – from the North Cape to Morocco, from Iceland to the Black Sea – in search of out-of-the-ordinary craftspeople. The test users included a bagpipe maker, a windmill restorer, a royal florist and a blacksmith who makes axes. They all put the new Crafter through its paces and gave their impressions on just how practical, innovative and cost-efficient the new van is – and how it would suit their business.

AT HOME WITH THE DRAGONS



Hong Kong is one of the most densely populated megacities in the world, and parking spaces there are in short supply. That is why Audi has launched a mobility service in the Dragons Range residential complex. “Audi at home” offers individual mobility without the need for a private parking space.

Text Christiane Kühl
Photography Andreas Mader


KOOK

“What impressed me most was that I could book my car with the app.”

Ken Wong, Dragons Range resident

The road from the apartment towers of Dragons Range winds its way along narrow serpentines, down the hillside planted with evergreens and into the valley. The next subway station is a long way away, the next shopping mall even more distant. A few high-rise apartment blocks in one of the neighboring satellite towns are just visible through the haze. The residents of Dragons Range appreciate the peace and quiet. But they also want to get around flexibly and independently, which makes the new residential complex the ideal choice as the first location for “Audi at home” in Asia. Via the “Audi at home” app, residents can choose from an Audi A3 Sportback e-tron[1], an Audi TT Roadster[2] or an Audi Q7[3], which they can book for a few hours, a day or a whole week.

It takes around 45 minutes to travel from Dragons Range to downtown Hong Kong. “There is a shuttle service to the subway station, but it isn’t very flexible”, says Alex Yeung, who regularly uses “Audi at home”. The 39-year-old

investment banker frequently uses the A3 e-tron to collect her parents and take them home again. Or she takes her husband to the station when he is traveling on business. The couple faces a problem that is typical for Hong Kong. "We own an Audi Q7, but we don't have anywhere to park the car here", Yeung says. "That's why we left it with my parents-in-law."

For years now, there has been a shortage of parking facilities for the millions who live and work in the densely populated city of Hong Kong. For 670,000 registered vehicles, there are only around 590,000 public and private parking spaces. Residential developers are only allowed to build parking facilities for a proportion of the new apartments in their projects. That is one of the ways the government is seeking to limit the number of cars in Hong Kong. In Dragons Range, for example, 970 apartments have been sold – but there are only 500 parking spaces.

"Hong Kong urgently needs new mobility concepts", says René Koneberg, Managing Director of Audi Hong Kong. "At the same time, the city is a trendsetter for the whole of China. That makes it an ideal place to test new services." 150 residents of Dragons Range have already registered with "Audi at home". The vehicles are booked via app. A QR code is sent to the customer's smartphone 15 minutes before departure. The customer can then collect the key from the property's concierge. Ken Wong, another Dragons Range resident, recently tested the service for the first time, picking up the Q7 from the Audi fleet to collect a friend and his family plus luggage from the station. They then drove downtown for a shopping trip. "It was all really easy", the 55-year-old says. "What impressed me most was that I could book my car with the app."

The "Audi at home" rental charge includes fuel, battery power and insurance. And the service also has the occasional surprise in store: every now and then, Audi temporarily adds a "mystery car" to the fleet. At Dragons Range, the new Audi Q2[4] was the latest surprise, but users have also been treated to an Audi RS6[5]. Sports cars are very popular in Hong Kong, and so are electric vehicles. "We've included the Audi A3 e-tron plug-in hybrid in the portfolio because people here are becoming more eco-conscious and welcome such models", Koneberg says. Hong Kong is not very large in terms of area, so the battery's range is easily sufficient to travel from one end of the city to the other. And the gasoline engine takes over on a longer journey. That is why the A3 e-tron is popular with "Audi at home" service users in Hong Kong.

15

minutes before departure, a QR code is sent to the customer's smartphone. Then they can collect the key from the property's concierge.

Audi has been working on new mobility concepts for megacities for quite some time. At Audi Business Innovation GmbH, the company develops ideas for the urban mobility of the future. "We have a look at urban areas and then think about the kind of intelligent mobility concept that would be a good fit", Bettina Bernhardt, Managing Director of Audi Business Innovation GmbH, explains. Such concepts include "Audi on demand": in Munich and San Francisco, customers can make a spontaneous vehicle booking online and collect their vehicle just a few minutes later. Other established concepts in Germany are "Audi shared fleet", an innovative car-sharing system for companies, and "Audi select", a rental service where customers can use up to three different models in one year.

“Hong Kong is like a trendsetter for the whole of China. That makes the city an ideal place to test new services.”

René Koneberg, Managing Director Audi Hong Kong

Hong Kong is already the second location for “Audi at home”, following on from San Francisco. “The target group for our new mobility service is people who live in large apartment complexes and are therefore accustomed to sharing services”, Bernhardt says. “We wanted to find out whether they are also willing to share cars.” The service was first trialed in San Francisco and was very well received by the buzzing start-up scene there. “People who work on digital services adapt more quickly to using such services themselves”, Bernhardt points out. “And digitization opens the door to connected cars and bookings via app.” A lot of the experience gained in the USA can be transferred to Hong Kong. “For instance, we noticed there are clearly defined profiles within the user group.” Some users always book the same car, others test the entire range. Some make high-frequency bookings for short trips, others only book infrequently, but when they do, they book a car for a whole week. Bernhardt analyzes these behavior patterns to tailor the service to meet these needs.

Dragons Range resident Yan Kuan has already tried out several “Audi at home” models – including the RS6 “mystery car”. “That was amazing”, the 26-year-old says with a broad grin. Kuan moved from Hangzhou in eastern China to Hong Kong to study for his master’s degree, and he also works part-time at a trading company. He and his girlfriend rented an apartment in Dragons Range because he finds downtown Hong Kong too crowded and too hectic. They both use the new Audi service. “It’s more convenient and more flexible than taking the bus or subway”, Kuan explains. “You can usually get a car pretty quickly. Once I even needed one at two in the morning, but that wasn’t a problem, either.”

Looking to the future, there are plans to introduce this Audi service at other residential complexes in Hong Kong. “We see a big demand”, Bernhardt says. The Dragons Range project is just the beginning.

1 Audi A3 Sportback e-tron fuel consumption in l/100 km combined from 1.8 to 1.6; energy consumption in kWh/100 km combined from 12.0 to 11.4; CO_2 emissions in g/km combined from 40 to 36. Efficiency class A+.
2 Audi TT Roadster fuel consumption in l/100 km combined from 8.5 to 4.7; CO_2 emissions in g/km combined from 194 to 118. Efficiency class from E to A.
3 Audi Q7 fuel consumption in l/100 km combined from 7.6 to 1.8; energy consumption in kWh/100 km combined from 19.0 to 18.1; CO_2 emissions in g/km combined from 199 to 48. Efficiency class from C to A+.
4 Audi Q2 fuel consumption in l/100 km combined from 5.8 to 4.1; CO_2 emissions in g/km combined from 134 to 109. Efficiency class A.
5 Audi RS6 fuel consumption in l/100 km combined 9.6; CO_2 emissions in g/km combined 223. Efficiency class E.

A population of over seven million, 670,000 registered vehicles, but only 590,000 parking spaces: Hong Kong needs new mobility solutions.

TIMELESS

A Bentley Mulsanne Speed[1], exquisite watches and the art of finding the perfect combination of tradition, modernity and luxury: on a drive with entrepreneur George Bamford through the Midlands of England.

Text Peter Gaide
Photography Matthias Haslauer

George Bamford in the Midlands: what better way to travel in style through this region known as the heart of England?


XII BWD

Customers of the Bamford Watch Department can take a closer look at their personalized luxury watch in the Bentley Mulsanne Speed.

A winding country lane in the Cotswolds in Central England, a captivating, undulating landscape not far from Oxford. A sonorous purr marks the passage of a deep black Bentley Mulsanne Speed as it glides past head-high hedges and walls. Gnarled trees and stone farmhouses salute from the wayside. A pub appears at the side of the road, next to it a red phone box – this is picture book England. What better way to travel in style through this region known as the heart of England. George Bamford smiles softly, but cannot be drawn into responding. Maybe the way he drives is answer enough. Cool, calm and collected, he is in complete control despite – or maybe even because of – the Bentley's huge reserves of power.

George Bamford is a car enthusiast and entrepreneur. The 36-year-old founded the "Bamford Watch Department" headquartered in London 13 years ago. The business customizes luxury watches to meet the wishes of their wealthy owners. Bamford's father, Lord Anthony Bamford, is the chairman of a leading construction equipment manufacturer founded by Bamford's grandfather.

Bamford brings the Bentley to a halt in the courtyard of an expansive country house. The beige gravel crunches quietly under the tires. This is where Bamford spends weekends with his wife and three children. His collection of exclusive cars is housed in several garages, tended daily by a member of his staff, and shrouded in delicate covers resplendent with the "B" emblem.

Bentley and Bamford: that has become a tradition. "Our family owns a few Bentleys", Bamford says as the kettle boils for tea. It would be no exaggeration to talk of an almost timeless love affair which began with his grandfather. "Bentley is a brand with a unique blend of style, perfection and engineering prowess", he adds. Bamford's black Mulsanne Speed is a one-off model, designed in close collaboration with Mulliner, Bentley's in-house bespoke personalization division.

"For me, my Bentley Mulsanne Speed is the embodiment of what true luxury products must deliver in the 21st century to keep their clientele satisfied and turn them into loyal customers." Bamford believes the critical factor is to create a unique, almost symbiotic relationship between the product and the owner through personalization. And that is exactly what Bamford Watch Department does. Some 50 designers, technicians, watchmakers and marketing experts in and around London craft and market luxury watches. These sophisticated timepieces are one of a kind: a watch face was designed for a horse owner in a shade of brown to match the pants worn by her jockey when he won a prestigious race. Another customer commissioned an intricate mechanism that conjured up a tiny heart on the watch face to celebrate her wedding anniversary each year. The exquisite chronometers are available from 48 branches all over the world.

The Bentley Mulsanne Speed has a special place in Bamford's world. "The car is a particularly noble 'workhorse' in our company." It collects customers from the airport and chauffeurs them through London. The comfort, the black-in-black interior and other color highlights help to build a relationship with the Bamford Watch Department brand. During the journey, customers can take a closer look at the watches displayed in a futuristic carbon box located in the back of the car.

Having a motorcar that he can use for business because his discerning guests feel completely at ease in its luxury – so much so that some even might lose track of time. That is definitely beneficial for Bamford's business. The design of the Mulsanne Speed may be timeless – but a chronometer is still extremely useful for everything else.

1 Bentley Mulsanne Speed fuel consumption in l/100 km combined 15.0; CO_2 emissions in g/km combined 342. Efficiency class G.

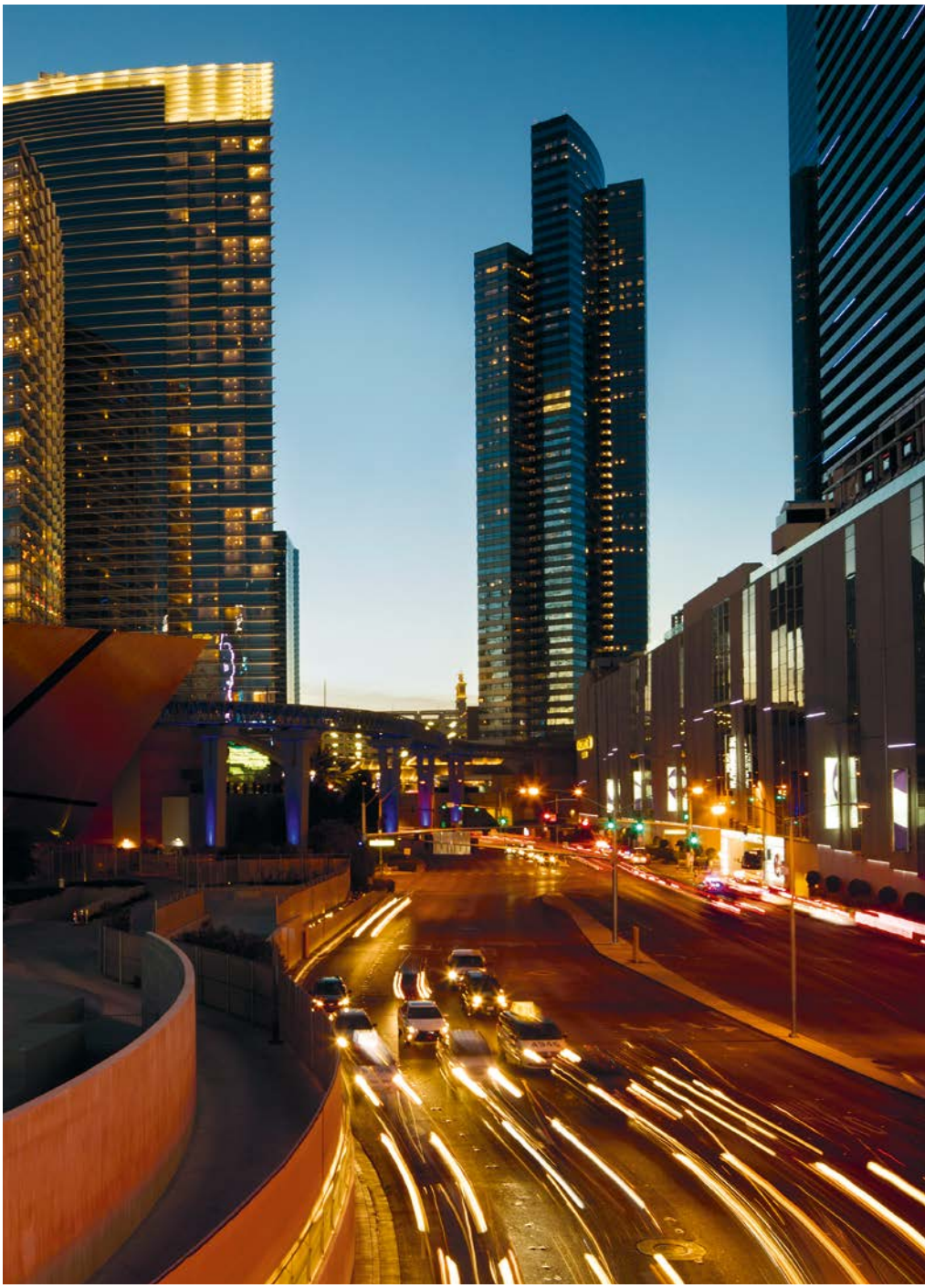
LUXURY PRODUCTS MUST CREATE A UNIQUE, ALMOST SYMBIOTIC RELATIONSHIP WITH THEIR OWNER.

LET'S TALK NERDY

Every year, 200,000 nerds – the top technology specialists from the automotive and IT worlds – meet up in Las Vegas for the Consumer Electronics Show (CES). The star at the Volkswagen booth this year was a car that recognizes the digital identity of its users: the Volkswagen I.D. Three visitors to the 2017 tradeshow share their impressions.

Text Johannes Winterhagen
Photography Roderick Aichinger

Once registration for a Volkswagen user ID has been completed owners have access to all of the brand's mobility worlds. That means they can take their personal settings and accounts from third-party services along with them, regardless of the vehicle they are using. So a rental car feels much more familiar with their own personalized seat and climate control settings or their favorite music ready and waiting. All users need for identification is their smartphone. Volkswagen demonstrated the advantages of the user ID at CES 2017: all visitors could download a user ID to their smartphone and then try out their personal configuration live at the Volkswagen booth.

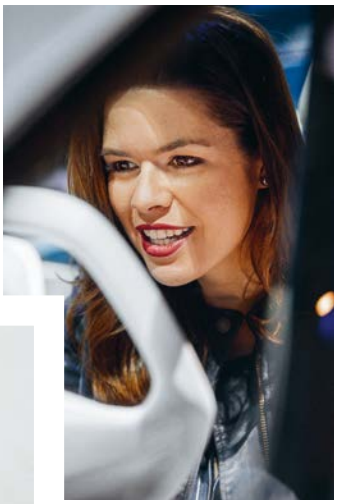


Manuela Midl (32), electrical engineer from San Francisco

"Originally I come from Austria, but I'm currently spending three years working for my employer, an Austrian engineering firm, in Silicon Valley. I'm developing a cloud solution for industrial automation. I was very keen to try out the virtual reality cockpit, even though that meant queuing for quite a while. It's fascinating to see how quickly new technologies are becoming part of our lives. I think Volkswagen's idea of networking people and cars via a user ID is pretty convincing. I don't want to waste time sorting out settings. It's much better to have a car that already knows what I want before I actually get in."

Guoliang Shen (37), marketing specialist from Shanghai

"This is my first time at CES. It's awesome to see so much high-tech in one place, from domestic robots to self-driving cars. Lots of stuff here fits in really well with the digital lifestyle we Chinese love. We want to be mobile, but we also want to stay connected. And we want things to be as comfortable as possible. For instance, we find using cash annoying. So the fact that you can use Volkswagen's user ID to reserve and pay for a parking space is just perfect. You know, finding a space to leave your car is often the most difficult thing about driving in my home town."



Abby Bollenbacher (28), actress from Los Angeles

"I grew up on a remote farm in Ohio, now I'm working on my acting career in Hollywood and I also anchor events. I think cars are great fun – and I admit I like driving fast. What does it for me is the feeling of power when you accelerate. That's where electric vehicles like the I.D. have a big advantage. Unfortunately, driving in Los Angeles often means spending a lot of time sitting in traffic jams. So I'm really looking forward to autonomous driving. Then I can use the time I spend in the car much more effectively, for instance, to coordinate my schedule. We're so lucky to be living in an age when this kind of technology can make a breakthrough."

Ole Harms is convinced that urban mobility solutions can only succeed in close cooperation with municipalities.

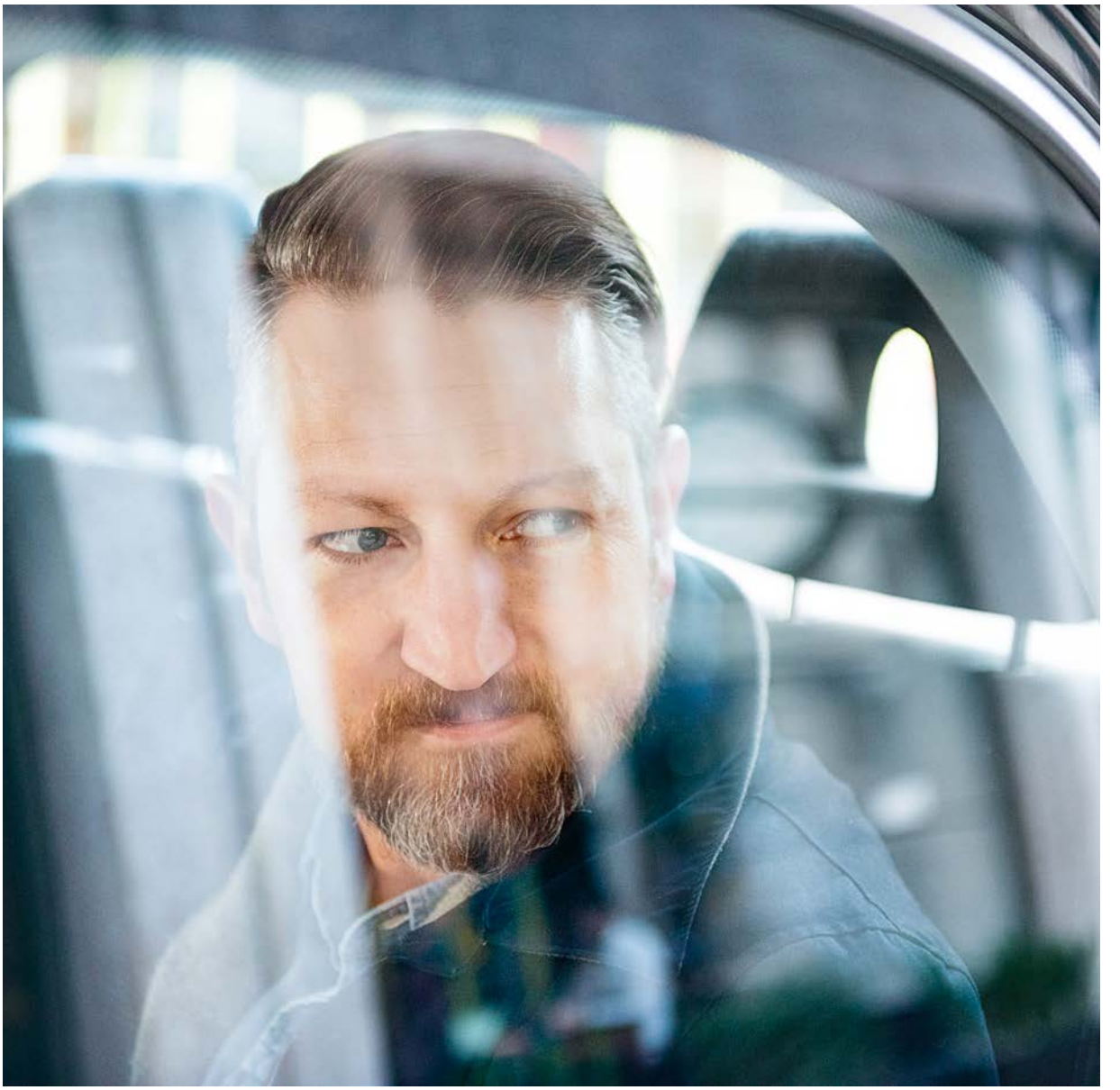
AMBITIOUS GOALS

Mobility services that enchant users – that is the mission of Ole Harms, CEO of MOIA, the newest company in the Volkswagen Group. On a ride through London he explains what will set MOIA apart from other mobility solutions. And he talks about the role that vehicles specially designed will play in making this difference.

Text Johannes Winterhagen
Photography Urban Zintel

Ole Harms checks his smartphone. "Our taxi's almost here", he says with a broad smile. Seconds later, a typical black London cab draws up. The logo emblazoned on its door reads "Gett"; Volkswagen made a 300-million-dollar investment in the ride-hailing service in 2016. Gett is currently active in more than 100 cities, including megacities like Moscow or New York, and of course in London. Every third cab in the British capital already uses the service to pick up fares.

"For us, the Gett deal was just the first step to gaining a foothold in the fast-growing market for mobility services", Harms explains as we climb in. "We want to be one of the world-leading players in this segment in ten years' time." The Volkswagen Group founded MOIA with this aim in mind. The word is derived from the Sanskrit term for "magic". "We love that analogy. We want our services to make urban life much better for our customers", says Harms. This has been the Volkswagen



Building vehicles tailor-made for new mobility services: the Volkswagen Group's brand diversity offers the perfect foundation for that.

66.4 %

of the world's population will live in cities in 2050.

manager's ambition since 2014. Back then, on a business trip to Jakarta, he was met at the airport by a chauffeur and spent hours stuck in a traffic jam on a journey of just a few kilometers. He came to the conclusion that "we need new mobility solutions for the world's megacities."

How do you make life better? And how do you accomplish that in a market which already has many players? Pooling is one of the concepts at the top of MOIA's agenda at the moment. With ride pooling, an app bundles several mobility requests and matches them with available rides. Initially, MOIA is planning a service where drivers collect passengers at various points along a route in specially designed ride-pooling taxis and take them to their destinations. At a later stage, self-driving electric vehicles are expected to take over this task. For Harms, one key to success lies in the fact that the Volkswagen Group brands have the ability to build cars tailor-made to meet the demands of these new mobility services. He knows the hallmarks of these vehicles: they are electric, they will soon also be self-driving, the interior is specifically designed for the needs of the urban target group, and the vehicles are spacious and fully connected. The aim is to fill the gap between public transport and existing taxi services. Buses and trains are confined to fixed routes and schedules and cannot fulfill all mobility needs. On the other hand, many people find taxis too expensive. "Rides must be available at a comparable price to public transport", Harms says. "That will allow us to reach new target groups."

MOIA could also offer further mobility services, but Harms rules out a global one-size-fits-all solution. "Urban mobility solutions can only be created in close cooperation with municipalities. Each city has its own ideas and needs." Negotiations with potential partner cities are already underway, and Hamburg will be the first metropolis to test the new solutions with the Volkswagen Group. MOIA will complement, not replace, existing mobility services offered by other brands in the Volkswagen Group. "There are many possible approaches for collaboration within the Group", Harms explains, citing the dealer network as one example. The time will come when the vehicles built specially for MOIA will need to be serviced – or simply parked and charged overnight.

Harms' smartphone blinks constantly as new messages arrive. "We attracted a great deal of international interest when we launched MOIA and we're now getting a lot of enquiries about possible cooperation projects", Harms says. He decided on London as the venue for the launch, even though MOIA is headquartered in Berlin. With its population of over eight and a half million, London has always been a pioneer when it comes to new mobility

Destination Copper Box: the app automatically takes care of payment. “Often it’s the little things that make life simpler.”

solutions. In the 19th century, when the population expanded from one million to five million, the city aldermen built the world’s first underground railway: the Tube began operating back in 1863. And in 2003, London was the first megacity to introduce a toll on motor vehicles traveling in high-volume innercity areas. This model has since been copied in many cities worldwide. He may be brimming with enthusiasm, but Ole Harms is definitely not a dreamer. The former strategic consultant knows that new mobility services will only succeed in the long term if they are profitable. “At the moment we’re focusing on getting the business going, but we will have to build up the volume in the coming ten years.” MOIA will initially be rolling out its services in the home market of Europe, but Harms is nevertheless already looking to China, where the booming and extremely fast-paced environment for new business models and mobility services is a very attractive proposition. MOIA needs local partners in China. “We’re already in talks there”, Harms confirms. He is not only counting on the strength of the Volkswagen Group to shoulder the capital-intensive start-up phase. “Looking ahead, we are open to investors from outside the Group as well.”

Our destination is the “Copper Box Arena” in London’s up-and-coming borough of Stratford, once a center of the railway industry. No cash is needed to pay for the ride because the Gett app automatically takes care of that. “Often it’s the little things that make life simpler”, Harms points out.

London is not only a pioneer when it comes to urban mobility, it is also a key center for the international start-up scene. Its members meet up regularly at the “TechCrunch” held in the Copper Box Arena used for the 2012 Olympic Games to share ideas and collect fresh capital. In his cardigan, jeans and sneakers, Harms blends with the participants. The exhibition is reminiscent of a university event: the booths are tiny, new technologies are presented on simple tables, and a striking number of these new concepts have something to do with artificial intelligence. It’s the ideas that count, not the presentation format. That is exactly why a new chapter in the history of Volkswagen began here in December 2016 with the launch of MOIA.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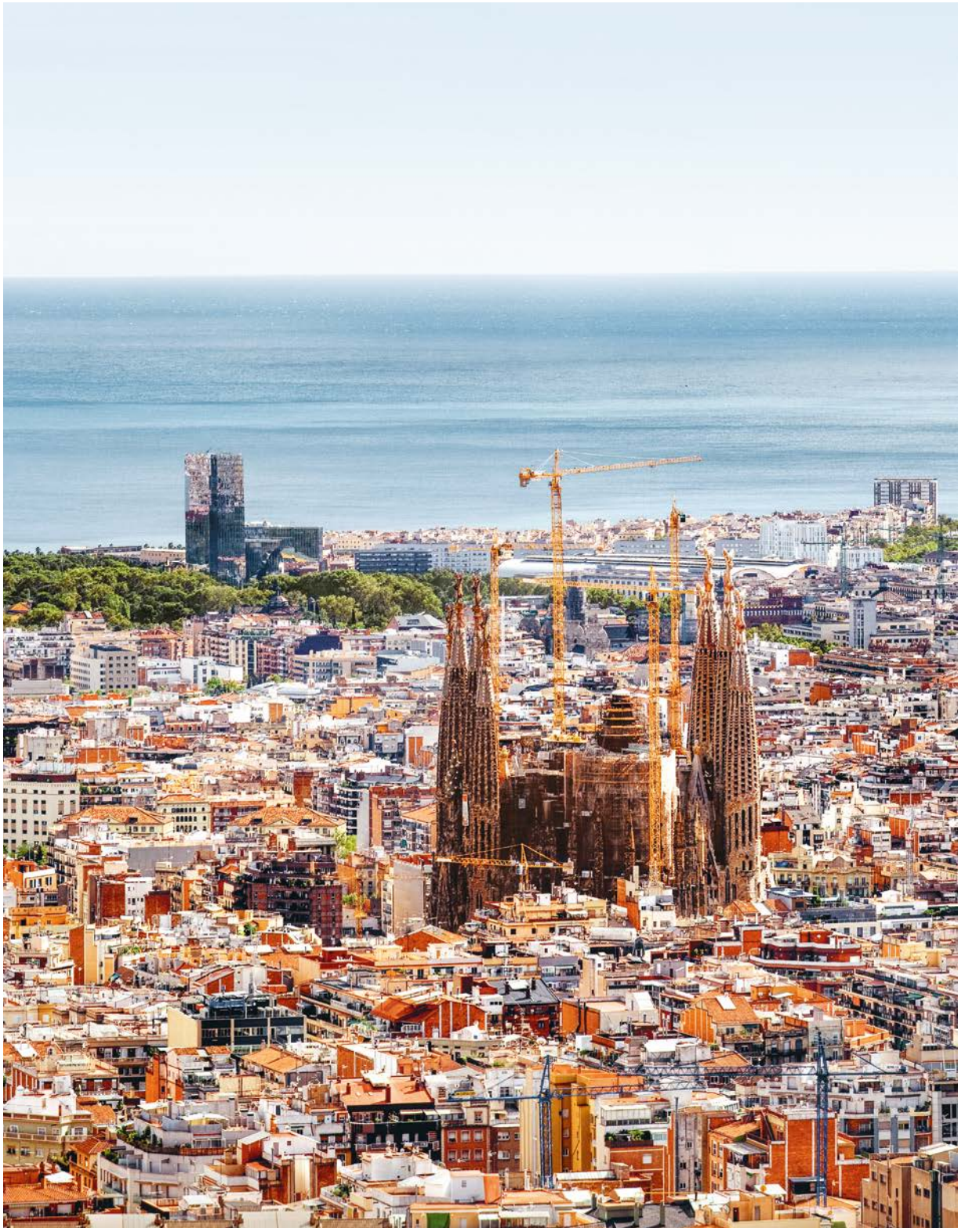


MOBILE CITY

In Barcelona, the pioneering smart city, SEAT is working on the future of connected mobility in partnership with universities such as the Universitat Politècnica de Catalunya (UPC) and with Volkswagen Group Research. The network's first projects focus on new car-sharing concepts and the intelligent use of scarce parking space.

Text Laurin Paschek
Illustration Anje Jager

The flight path takes us over the deep-blue ocean and follows the coastline, past the port, the sandy beaches and the city blocks arranged like a chess board. On the approach to Barcelona airport, the capital city of Catalonia looks dressed in its best. But its coastal location also presents a challenge for the metropolitan area: Europe's second most densely populated city of over a million inhabitants has hardly any space to grow. Nevertheless, its population has swollen by more than 100,000 to over 1.6 million since the turn of the millennium. Over the same period, the number of tourists has doubled to roughly nine million per year.

More and more people also means ever-denser traffic. That is why the city's administration has launched the "Barcelona iCity platform" which, among other things,

"The CARNET research network is developing technologies that respond to the challenges of metropolitan areas – and improve mobility for city dwellers at the same time."

Fabian Simmer, Digital Officer, SEAT

Say goodbye to searching for a parking space: sensors under the road surface and in cars driving by collect data on **vacant parking spaces,** and the navigation system then takes the driver there.

Everyone benefits: **car-sharing** and **ride-sharing** use cars more efficiently – and bring financial benefits for the owner.

collates traffic flow data, and thus lays the foundation for research into future-oriented traffic solutions. "Barcelona offers us the ideal environment to develop digital mobility concepts", says SEAT Digital Officer Fabian Simmer. He leads research on the digital transformation and the mobility of the future in Barcelona. SEAT has teamed up for this work with Volkswagen Group Research and several universities, such as the UPC, to form the "Cooperative Automotive Research Network", or "CARNET" for short.

The primary goal of the network partners is to create digital solutions that improve the quality of urban life and the mobility of city dwellers. The first project of this kind is an app that enables registered users to share their vehicles with others. For what is known as "peer-to-peer sharing", SEAT has collaborated with CARNET to develop a version of the Ateca[1] model series with smart technology, and fitted a display on the exterior of the B pillar. Whenever a potential car-sharing user walks past the car, an app on their smartphone lets them know the car-sharing rates and allows them to send an enquiry about vehicle availability. If the owner gives the go-ahead, the user is issued with a digital key. The display on the side of the car takes the user through the hiring process step-by-step. Car owners can also offer ride sharing via the app: they can let other members of the app community know when they will be traveling along a certain route and invite them to share the ride. A pilot project for SEAT employees will be launched this year.

Direct communication between the vehicle and the smartphone is crucial in this context. "For this kind of digital

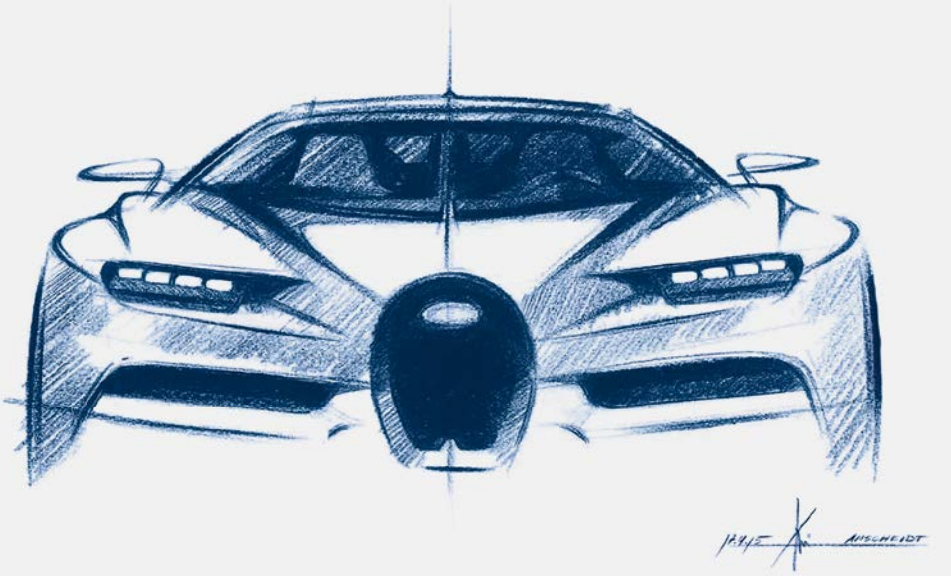
Planned city: hemmed in by its city walls, Barcelona was full to overflowing when in 1850 urban planner Ildefons Cerdà expanded it with a characteristic grid-like design.

technology to be accepted, we must offer users and drivers the easiest solutions imaginable", Simmer explains. However, developing shared transportation concepts for city dwellers that optimize the use of vehicles also means providing sufficient parking space as near as possible to residential areas. That is why CARNET is working on the "Smart City Parking" project in the "Les Corts" district in the western part of Barcelona's old city. Sensors installed under the road surface collect data on free parking spaces. At the same time, SEAT cars are equipped with technology to locate vacant parking spaces as they drive by. The data are transmitted in real time to Barcelona's iCity platform and the vacant parking spaces are displayed and updated on a map shown on the screen in the car. The navigation system then guides the driver directly to the vacant space.

"Our projects are designed to demonstrate what's technologically possible", says Simmer. The CARNET alliance is currently working on more than 20 research projects. "Things will get really exciting when cars start delivering data to a smart city platform like the one we are planning with our iCity platform for Barcelona." That will create entirely new collaboration models for cities and car manufacturers.

1 SEAT Ateca fuel consumption in l/100 km combined from 6.1 to 4.3; CO_2 emissions in g/km combined from 141 to 113. Efficiency class from C to A.

SYMBIOSIS



A mighty 16-cylinder, eight-liter power plant in a mid-engine configuration with a power output of 1,500 hp and maximum torque of 1,600 newton meters: designing a super sports car combining such an exceptional power plant with classical aesthetics calls for a focused approach. For the designers of the Bugatti Chiron[1], the principle was "form follows performance".

Text Laurin Paschek
Photography Hartmut Nägele

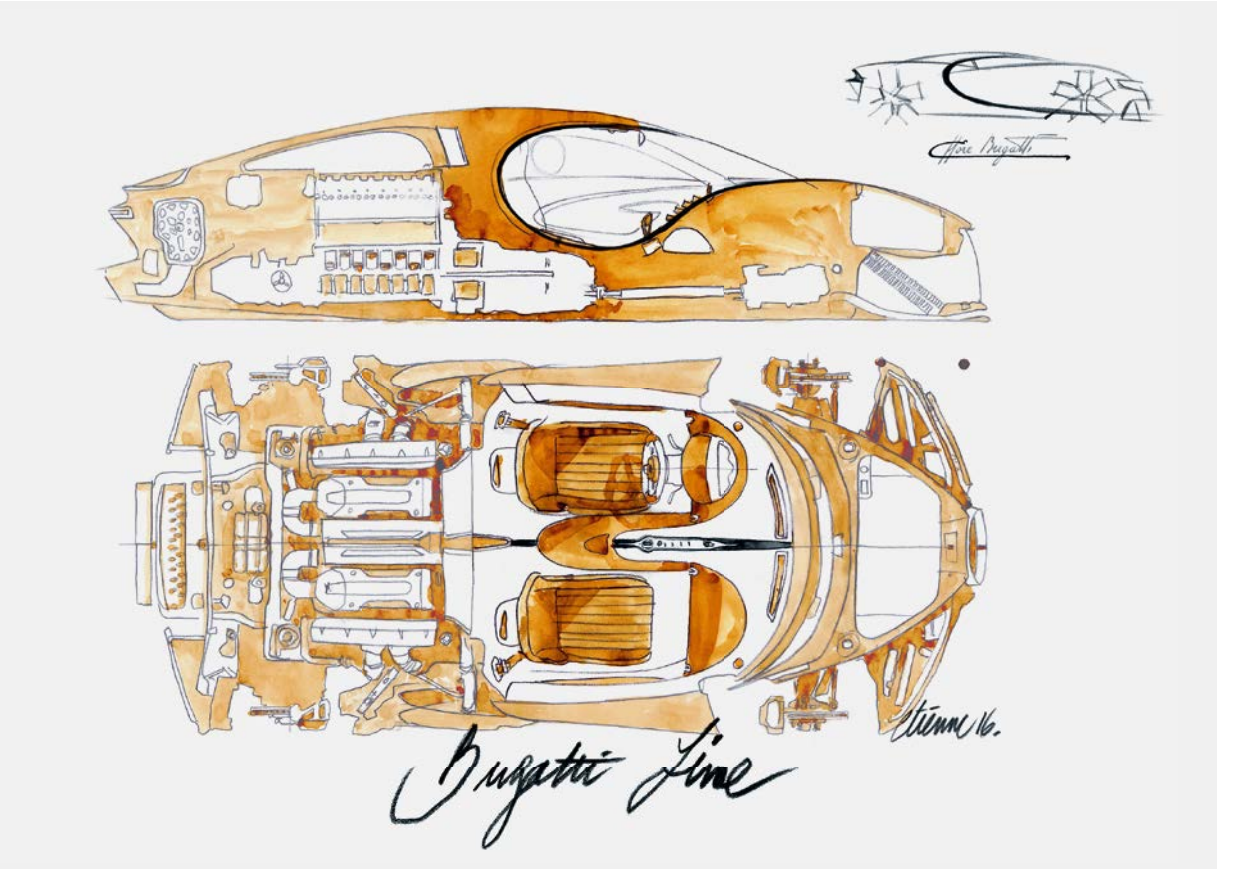
"'Form follows performance' is our response to the extreme technical challenges and is imperative for the design of the new Bugatti Chiron", says Achim Anscheidt, Director of Design at Bugatti.

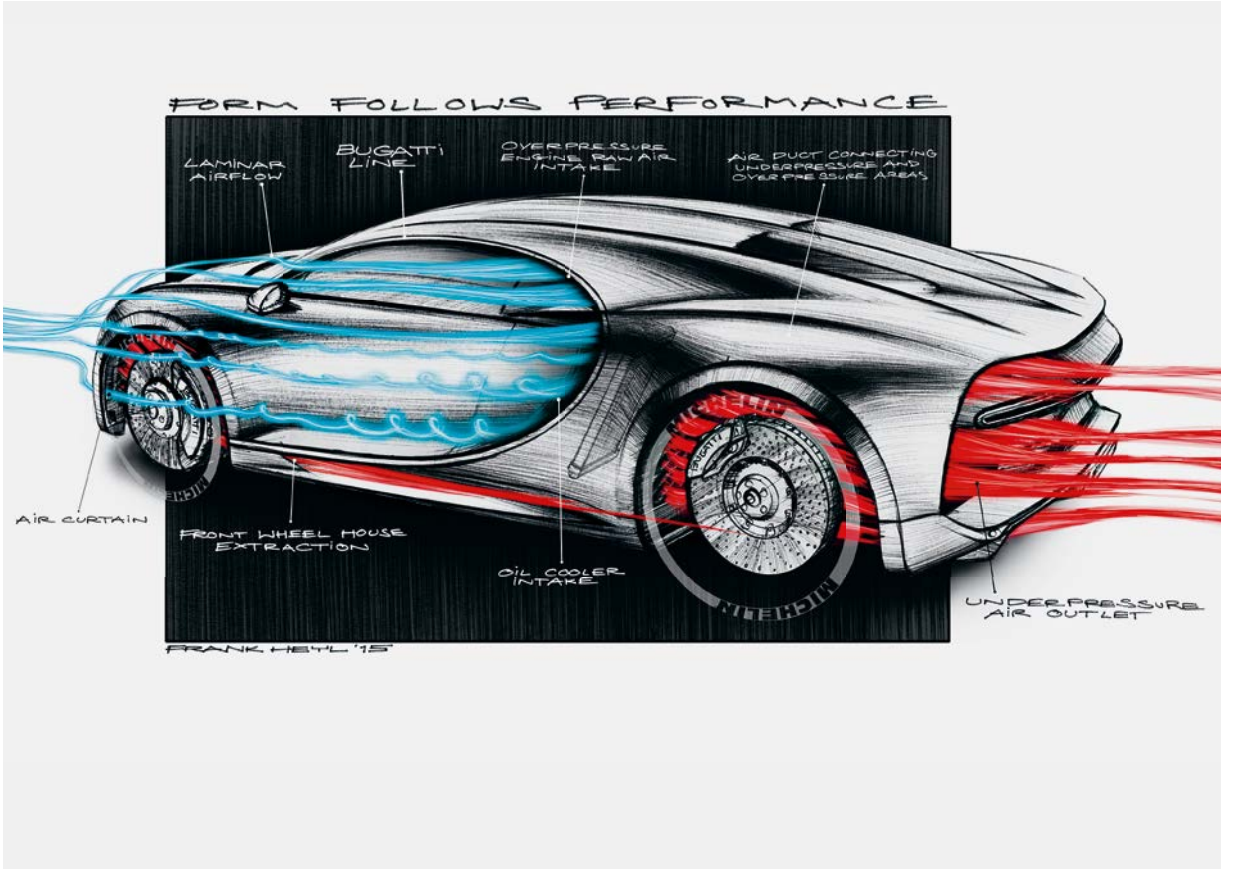
The key requirements for fulfilling this mission, transforming the sheer power of the engine into an effortless driving experience while redefining the unmistakable design in the legendary Bugatti tradition: these were the main requirements in the design brief based on the principle of "form follows performance". The best example is the Bugatti C-line with a broad, sweeping curve described along the side of the car. The line features wide air intakes, capturing the air that flows along the bodywork behind the A-pillar at the level of the windows. This provides the Chiron's 16-cylinder engine with the cooling performance it needs, representing an improvement of 25 percent over its predecessor, the Veyron 16.4 Super Sport[2].

“Performance is not just about figures – it also means that the driver intuitively finds all the controls at the right time.”

ETIENNE SALOMÉ, HEAD OF INTERIOR DESIGN, BUGATTI

The Chiron’s interior reflects the dynamics of its exterior, including the Bugatti line. The C-bar sweeps through the center of the symmetrically configured passenger compartment in a way that is reminiscent of the exterior. Here, “form follows performance” means that all the controls consistently focus on the driver. From the driver’s seat in the cockpit, all systems can be operated intuitively, for example using the multi-function buttons on the newly designed steering wheel. The central eyecatcher is an analog speedometer with a scale reaching to the magic figure of 500 km/h – even though the Chiron is limited to 420 km/h in road use.


Bugatti Line


FORM FOLLOWS PERFORMANCE
LAMINAR AIRFLOW
BUGATTI LINE
OVERPRESSURE ENGINE& RAM AIR INTAKE
AIR DUCT CONNECTING UNDERPRESSURE AND OVERPRESSURE AREAS
AIR CURTAIN
FRONT WHEEL HOUSE EXTRACTION
OIL COOLER INTAKE
UNDER-PRESSURE AIR OUTLET
FRANK HEYL '15

The sheer size of the 16-cylinder engine calls for a certain vehicle configuration to ensure balanced weight distribution. Its extremely high top speed poses ultimate challenges for the aerodynamic design of the Chiron. Starting from these two premises, the design of the vehicle evolved in a series of steps with designers and engineers repeatedly weighing up technical and aesthetic requirements in order to arrive at solutions. You could say that the Chiron looks just as it does precisely because it has this 16-cylinder engine. The design has been shaped by a unique symbiosis of engineering and aesthetics.

1 Bugatti Chiron fuel consumption in l/100 km combined 22.5; CO_2 emissions in g/km combined 516. Efficiency class G.

2 Bugatti Veyron 16.4 Super Sport fuel consumption in l/100 km combined 23.1; CO_2 emissions in g/km combined 539. Efficiency class G.

“To make a vehicle like the Chiron possible, designers and engineers need to work hand in hand in every respect.”

FRANK HEYL, HEAD OF EXTERIOR DESIGN PRODUCTION DEVELOPMENT, BUGATTI

ELECTRIC HEART

Norway is the country with the highest number of electric cars per capita in the world. The capital city of Oslo is the ideal starting point for a trip with the new e-Golf [1], which has over 50 percent more range than its predecessor.

Text Johannes Winterhagen
Photography Matthias Haslauer

The temperature outside is zero degrees. It is still rather dark; in early December, the sun does not rise in Oslo until just before 9 o'clock. Nevertheless, Dr. Florian Hofemeier is wide awake and in good spirits early in the morning. The young engineer, who is responsible for the energy management systems of Volkswagen electric vehicles, takes his place behind the wheel of a new e-Golf. The car welcomes driver and passenger into its warm and cozy interior. "I've already heated up the cabin", Hofemeier explains. He programmed the electric auxiliary heater the night before using an app. "By the way, this is one of the most important features of our e-Golf for my wife", Hofemeier says. But it is not only for her sake that he makes sure the car is comfortable. It is his job to see that Volkswagen electric cars use precious battery power extremely frugally. Heat management plays a key role. Normally, the range of an electric vehicle is significantly reduced in winter because power is also needed for

Charging time

60 mins

The battery can be charged to 80 percent capacity within an hour at a CCS charging station.

heating the interior. The e-Golf, on the other hand, uses an efficient heat pump – a miniature version of the technology that already heats many homes. The sophisticated unit even harnesses the waste heat generated by the electric drive system when the vehicle is in motion. "Depending on the outdoor temperature, we can produce up to three kilowatt-hours of heat from one kilowatt-hour of electricity", Hofemeier is proud to report.

300 kilometers is the nominal range of the new e-Golf, based on the official New European Driving Cycle (NEDC). This is an improvement of more than 100 kilometers, or 50 percent, over its predecessor introduced in 2014. "However, what is much more important is the fact that in terms of annual average, customers can now travel 200 kilometers under real-world conditions despite using the heater or air conditioning system", Hofemeier explains, moving the shifter of the automatic transmission from P to B. This option means that when the driver takes his foot off the gas, the electric engine brakes sharply, recharging the battery with the energy that is recovered.

However, the first-generation e-Golf was already equipped with regenerative braking and a heat pump. So how has the range been boosted by more than 50 percent? The most important factor is that although the number of cells has remained unchanged, battery capacity has been increased from 24.2 to 35.8 kilowatt-hours. "We've managed to pack much more active material into the same space", Hofemeier explains. "Battery technology is currently making great inroads and we are consistently taking advantage of these improvements." However, more active material also means a heavier vehicle and therefore, potentially, higher energy consumption. Thanks to other changes in the vehicle, Hofemeier's team was able to more than compensate for this drawback. For example, the transmission of the new e-Golf features a

Max. torque

290 Nm

The torque has been boosted to offset the slightly heavier battery for a dynamic driving experience.

Battery capacity

35.8 kWh

Much more active material has been packed into the same space.

new, more efficient bearing design and a higher final drive ratio. Normally, this would reduce the starting torque, which gives the e-Golf its powerful acceleration from low speeds. However, as the torque developed by the electric motor has also been boosted – again without changing the motor's external dimensions – a balance has been retained between driving pleasure and energy consumption. "This is a very important factor for me", says Hofemeier. "I want to play my part in making sure that individual mobility and climate protection are compatible."

That is why the engineer is pleased to see so many cars on the roads of Oslo with an "E" license plate indicating that they have an electric drive. The market share of electric cars in Norway is about 15 percent, higher than in any other country. It is even higher for Volkswagen vehicles. The e-Golf accounts for one-third of all new Golf models registered in the country, and the Golf GTE[2] with plug-in hybrid drive system for another third. One of the main reasons is that e-mobility has been subsidized by the state in Norway for 15 years. Anyone buying an electric vehicle not only saves value-added tax, which is 25 percent in Norway, but also the car purchase tax, which is based on a vehicle's power output and emissions. And on top of that, electric vehicles can use toll roads and ferries free of charge. The use of ferries is a convincing argument, especially in the west of the country with its coastline dissected by fjords. In the rush hour in Oslo, electric cars can even use the bus lane if they have at least two occupants.

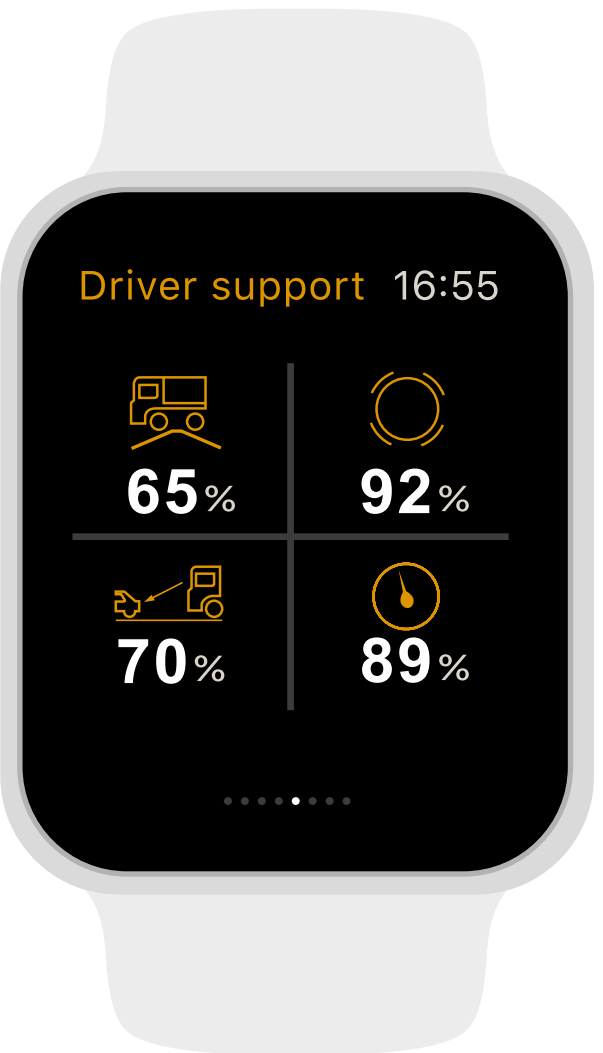
For more than 100,000 of five million inhabitants of Norway, driving an electric car has become part of everyday life. Take Magne Bjella, for example, manager for new media at Oslo Opera house and an enthusiastic driver of a first-generation e-Golf. He meets us in the foyer of the opera house; shaped like an iceberg, it dominates the harbor district skyline – a symbol of a country where a tangible sense of optimism has prevailed for several years. Bjella admits: "I actually wanted to buy a conventional Golf. The car really suits me." But then the dealer persuaded him to take a test drive in an e-Golf. As Bjella puts it: "It drove just like a Golf should, but better." Hofemeier listens, smiles, then says: "That's exactly what an electric car must offer – everyday mobility and driving pleasure." We continue towards the nearby coast with its picturesque towns and small islands, where many inhabitants of the capital city have weekend homes. As long as there is a road or ferry to the islands, they are within the range of the e-Golf.

1 Volkswagen e-Golf energy consumption in kWh/100 km combined 12.7; CO_2 emissions in g/km combined 0. Efficiency class A+.
2 Volkswagen Golf GTE fuel consumption in l/100 km combined from 1.8 to 1.6; energy consumption in kWh/100 km combined from 12.0 to 11.4; CO_2 emissions in g/km combined from 40 to 36. Efficiency class A+.

Energy manager Florian Hofemeier (left) tests a second-generation e-Golf, opera manager Magne Bjella (right) owns a first-generation e-Golf.

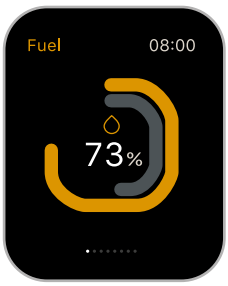
WATCHING OUT FOR DRIVERS

A Scania S 500 is on its way from Copenhagen to Södertälje in Sweden: the Scania Apple Watch on the driver's wrist displays important information during the journey. The mini-computer calculates key performance ratios along the way to make the trip even safer and driving performance even more efficient.



Record after record

Drivers can beat their own record with the help of the four key parameters that are part of the Scania Driver Support system. Does the driver take his foot off the accelerator in good time at the crest of a hill, and apply the brakes correctly? Does the driver anticipate situations well, and shift gears at the right time? The better the performance, the higher the score displayed on the watch. One quick glance at the watch tells the driver exactly where there is still room for improvement.



2. Coffee break: Ljungby
227km —— 2hrs55mins

15-minute break

Rain on its way

The driver activates the watch to make sure his break lasts the legally prescribed 15 minutes. During the coffee break, the watch says that rain is expected in the next 20 minutes. Wet roads ahead! The driver heeds the warning and exercises special caution as the truck sets off again.

4. Destination: Södertälje
624km —— 8hrs55mins

Unloading the cargo

The final score

Before the cargo is unloaded at the end of the journey, the Apple Watch-Scania Edition displays the average fuel consumption, giving the driver a good indication of whether today's driving performance was fuel efficient. The latest parameters from the Scania Driver Support system give the driver immediate feedback on whether there has been an improvement in any of the driving metrics.

3. Lunch break: Jönköping
336km —— 4hrs30mins

Food and fitness

Active recovery

The driver makes optimal use of the lunch break by taking a short walk after the meal. Just 15 minutes should be fine. The watch not only monitors the time; sensors constantly measure the driver's pulse to optimize his walking speed as well. Refreshed and rested, he continues on his journey.

1. Start: Copenhagen
0km —— 0hours

Ready to roll

Everything under control

The 40-tonne truck sends the current fuel and AdBlue levels to the Apple Watch-Scania Edition via the fleet management system. If the levels are OK, the truck is ready to roll. The driver can also use the app to check up on sleep metrics during his rest periods: seven hours and 48 minutes of sleep last night. A good night's rest in Copenhagen.

AILA and me

When it comes to putting driverless cars on the road, research into intelligent autonomous systems such as female robot AILA plays an important role. That is why Volkswagen has acquired a stake in the German Research Center for Artificial Intelligence (DFKI). Prof. Dr. Frank Kirchner from the DFKI's Robotics Innovation Center is working on teaching machines how to learn.

Text Johannes Winterhagen
Photography Evelyn Dragan

When will machines have reached the stage where their abilities rival human intelligence?

The English computer scientist Alan Turing, probably the most gifted mathematician of the 20th century, devised a test, which no machine has so far passed: a machine is only considered intelligent if a human interrogator interacting with the machine and another human through language alone, without visual contact, cannot tell the difference between the two. We still have a very long way to go before machines have reached that stage, given that the human brain is still far superior because it has made massive advances as it has evolved. At a rough estimate, the brain has 100 billion neurons that can network with one another. In fact, the number of possible connections in a single human brain is probably larger than the number of celestial bodies in the entire universe. And on top of that, humans are much more than just computing power and storage capacity – they also have the ability to learn and to perform very complex movements.

Research into artificial intelligence began in the 1950s. How would you describe the present status of this work?

What we are witnessing at the moment is the "second summer" of artificial intelligence. The "first summer" began in the 1980s with what are known as expert systems. The idea behind these systems is to feed machines with vast amounts of knowledge in order to generate new knowledge. That works well, but it would be wrong to assume this process creates intelligence. Two things have come together in recent years to lend new impetus to our work: first, we now have computing methods that solve complex problems by observing nature because they use soft

computing techniques based on fuzzy logic: it is perfectly possible for the result of a calculation to be "between one and two" instead of "1.65". And second, we have powerful computers that enable these computing techniques to be used decentrally.

How important is the robot lady AILA for you?

If robots are to operate in an environment created for people, such as a factory or a space station, it makes sense to give them a human-like appearance. That is why we developed AILA five years ago. AILA's arms, for example, can lift objects that weigh more than the lady herself; for robots, the reverse is usually the case. To do that, we explored new approaches; for instance, we integrated many of the sensors directly into the robot structure in the same way as sensory cells are part of the human body. That is how we are gradually increasing the complexity of robots. Above all, we have to learn how to build systems based on existing technical and mathematical capabilities that can behave autonomously over a long period of time.

That includes the ability for robots to find their way around in completely unknown terrain?

Yes. And that is why we must teach machines how to learn. Imagine a "robotic car", for example, a driverless car that operates in inner cities: it would be totally impossible to program the car to handle every single situation that could potentially occur. That would take an incredibly long time. Not only that: all physical systems show signs of wear-and-tear over time, so that has to be factored in as well. The general solution, then, must be a robotic car that has predictive capabilities similar to those of an experienced driver, in other words, it must be able to anticipate what could potentially happen next. In complex situations, the robotic car has to take an endless number of possibilities into account. To do that and still take decisions quickly, it must be able to deal with residual uncertainties.

Will the day come when we will see fully autonomous cars on our roads?

Yes, most definitely. Driverless cars will become a familiar sight on our roads. But that will only happen if we develop an intelligent infrastructure alongside the vehicle technology – for example, traffic lights that monitor a crossroads and transmit information to all vehicles in the vicinity. As fascinating as the human brain may be, networked machines have one crucial advantage: they can process enormous amounts of information in milliseconds and exchange data in real time.

Computer scientist Prof. Dr. Frank Kirchner, born in 1963, heads the DFKI's Robotics Innovation Center in Bremen. Kirchner discovered his passion for programming when, as a young guitarist, he found himself without a band after moving home. He solved the problem by connecting his synthesizer to a Commodore 64 computer.

MY ENGINE

At the new Porsche engine plant in Stuttgart-Zuffenhausen, more than 100 innovations ensure that people and machines work together in perfect harmony. Volkan Atas, a skilled engine assembly worker who has been with Porsche for 15 years, takes us on a tour of the new eight-cylinder engine assembly line.

Text Johannes Winterhagen
Photography Evelyn Dragan


PORSCHE

It all starts with ergonomics

The starting point in the life of an engine is an intelligent workpiece carrier that conveys the engine along the assembly line over the next six hours. The carrier not only allows height adjustment but can also turn the engine through a full 360°, which means that Volkan Atas can always work in an ergonomically optimized position.

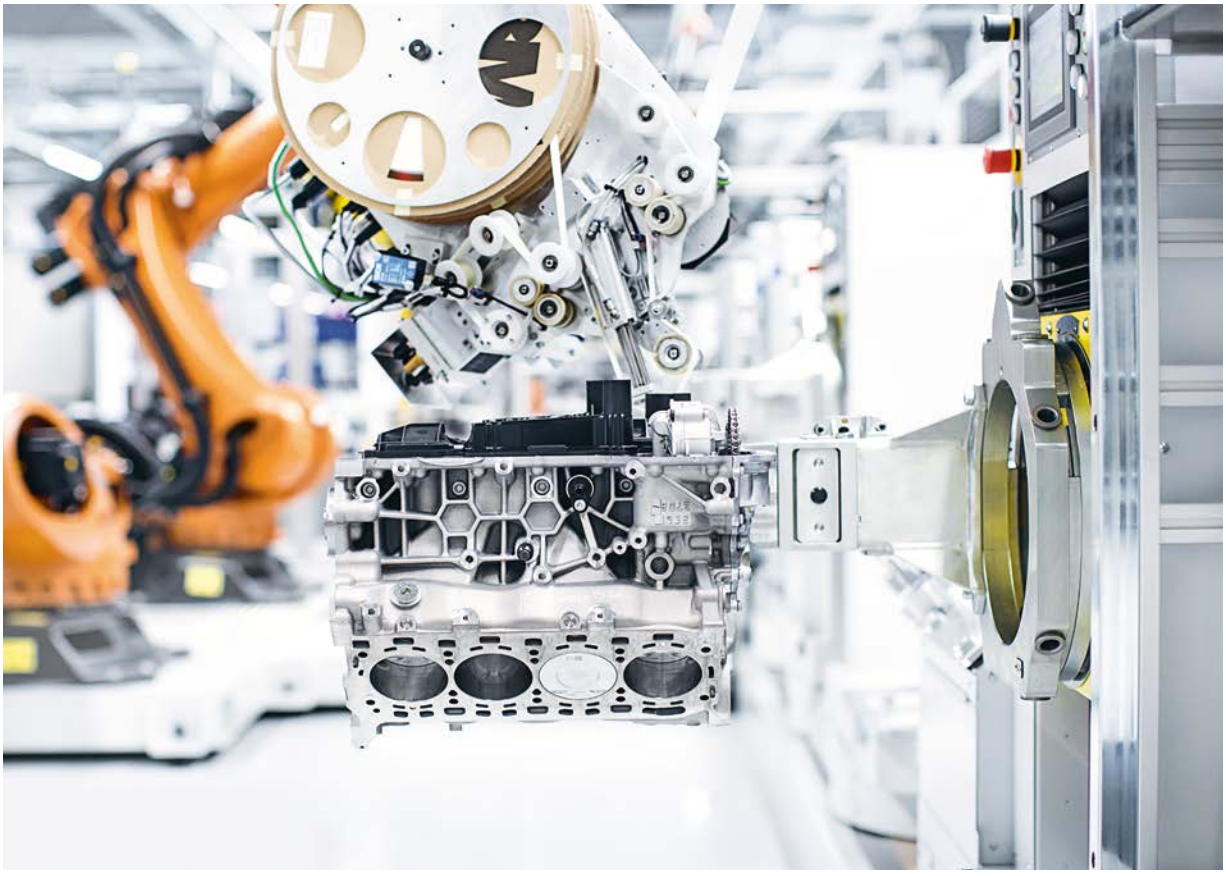
ABOUT

200

EIGHT-CYLINDER ENGINES CAN BE PRODUCED DAILY AT THE NEW ENGINE PLANT WHEN IT IS OPERATING TO FULL CAPACITY.

Human beings and machines

The assembly of the piston unit is one of the most sensitive steps – it has a decisive impact on the functioning and durability of the crankshaft drive. This is why Porsche decided to assemble the connecting rod, big end bearing, piston and wrist pin using a fully automated process in a dirt-protected area. However, inserting this unit into the cylinder block still calls for the experienced hands of a skilled worker. One after the other, Atas assembles a total of eight pistons. A small trolley with the required parts is temporarily attached to the workpiece carrier during this stage, keeping Atas' hands free.



Clean seals

High precision in repetitive tasks is one of the key strengths of industrial robots. This feature is put to good use in sealing the oil sump, for example. An effective seal guarantees that oil stays in the engine, allowing it to perform optimally. During this step, it is essential to ensure that the seal surfaces are free from grease and dirt. This is why a robot initially cleans the surfaces with a cleaning strip – a microfiber cloth moistened with primer which picks up particles. A second robot then applies the liquid sealant. The other sections of the new engine plant are also extremely clean. The entire assembly unit is located on its own floor, which is separate from the logistics areas.

ALMOST

80

MILLION EUROS WERE INVESTED BY PORSCHE IN THE FIRST STAGE OF THE NEW ENGINE PLANT.

Smarter bolting

The cylinder heads – two for each engine – are preassembled in a separate area outside the assembly line. When they are installed in the engine, the bolts must be tightened following a precisely defined torque curve. The tools used at Porsche's engine plant have exact information on the torque curve and document compliance with the specified limits, even if they are transferred to another work station. As a general principle, bucking bars are always used when applying high torque to minimize the physical stress on assembly line workers. In addition, the overhead guide system on which the tools are installed is designed to allow rotation in two directions, another feature that facilitates precise, ergonomic working.

A digital twin

Every engine has an embossed number and all major parts are marked with a data matrix code, which Volkan Atas scans as he is assembling an engine. A component is only released for assembly if it is precisely the right part for the engine variant being assembled. As the data of all components is stored on the system, this process creates a digital twin of the physical engine. The system also stores all test data. The evaluation of this data allows for continuous process and quality optimization.

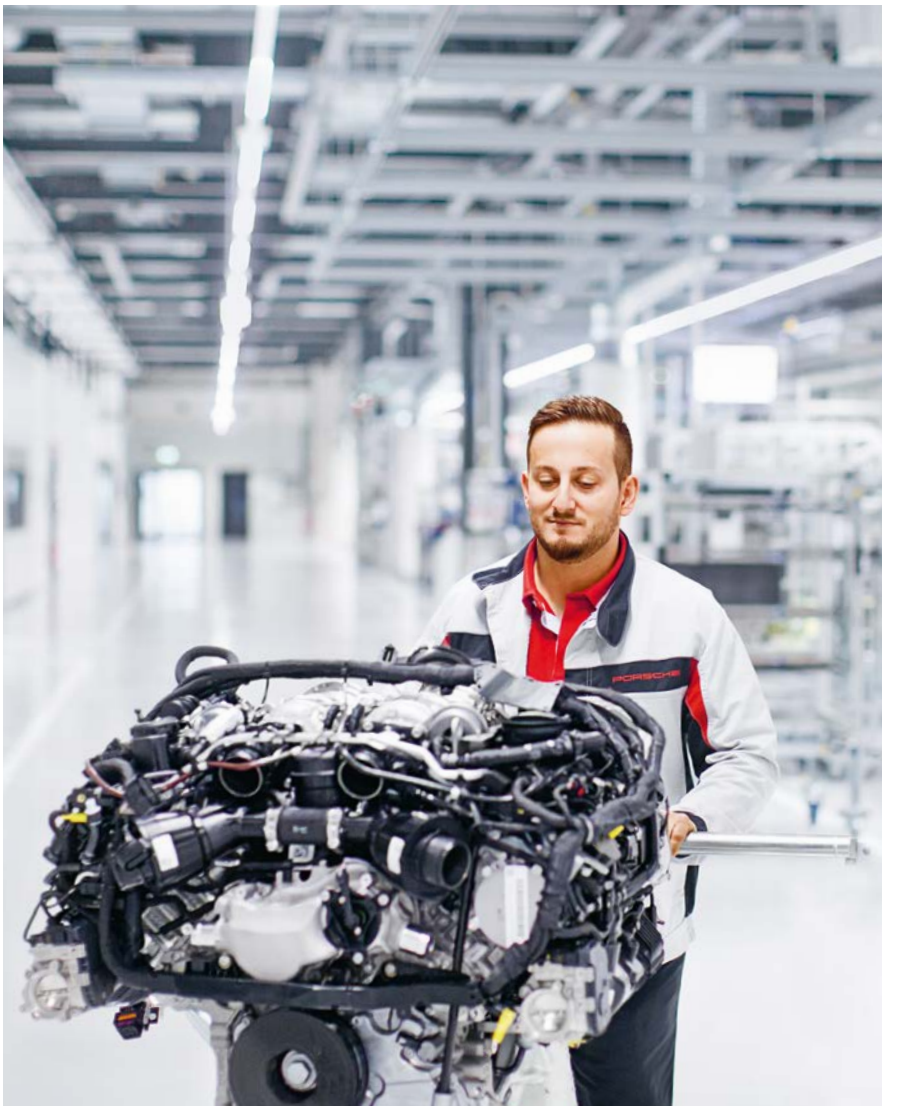
ABOUT

6

HOURS IS THE LENGTH OF TIME IT TAKES TO ASSEMBLE A COMPLETE EIGHT-CYLINDER ENGINE.

“When I look at a finished engine, I always feel proud. And I’m really happy that we will be building engines for other Group brands here soon, too.”

VOLKAN ATAS, SKILLED WORKER, PORSCHE

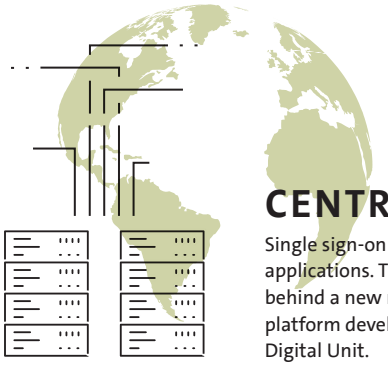


Hot and cold

Following each manual or automated work station, checks are made to ensure that every part has been installed properly. The workpiece carrier only continues its journey when Atas has pressed a green button. All the same, a cold test covering all electrical and mechanical functions is carried out on each engine when it reaches the end of the assembly line. Some engines selected on a random basis are also subjected to a hot test: for this purpose, the engine is transferred to a separate test bed where it is operated using fuel.

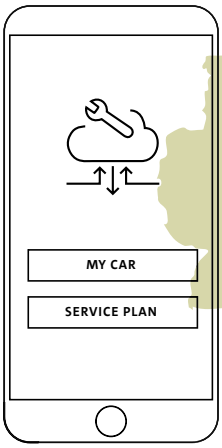
ANY TIME, ANY PLACE

Volkswagen Financial Services has set up a "Digital Unit" comprising a team of international experts based in the start-up mecca of Berlin. The team is working on new digital services. Looking ahead, Volkswagen Group customers will be able to order and manage finance, insurance and maintenance for their vehicles by computer or smartphone in one integrated process via a central service platform. Here are three examples.



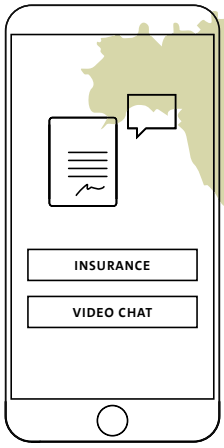
CENTRAL PAYMENT SERVICES

Single sign-on – multiple applications. That is the idea behind a new multi-brand platform developed by the Digital Unit.



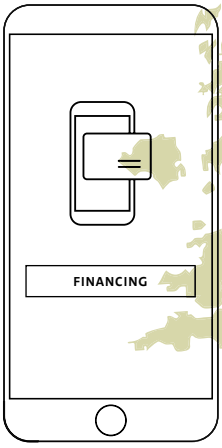
GOOD PLANNING

If you love your car, you need to look after your service manual. Or your car's online profile. The Volkswagen brand launched an entirely new, flat-rate service in August 2016: for a fixed monthly sum, car owners can opt to sign up for servicing and maintenance according to the service schedule. All it takes are a few details and a couple of clicks. There are plans to expand this service to other Group brands, too.



FACILISSIMO

Typically, car liability insurance in Italy is only valid for twelve months from the date of registration. Italian customers used to have to renew their insurance by letter or phone. Now, though, there is a new online platform for customers of all Group brands; they can use this digital service to take out new insurance contracts as well as renewing existing ones. The platform also features a video chat function for customers who prefer personalized advice.



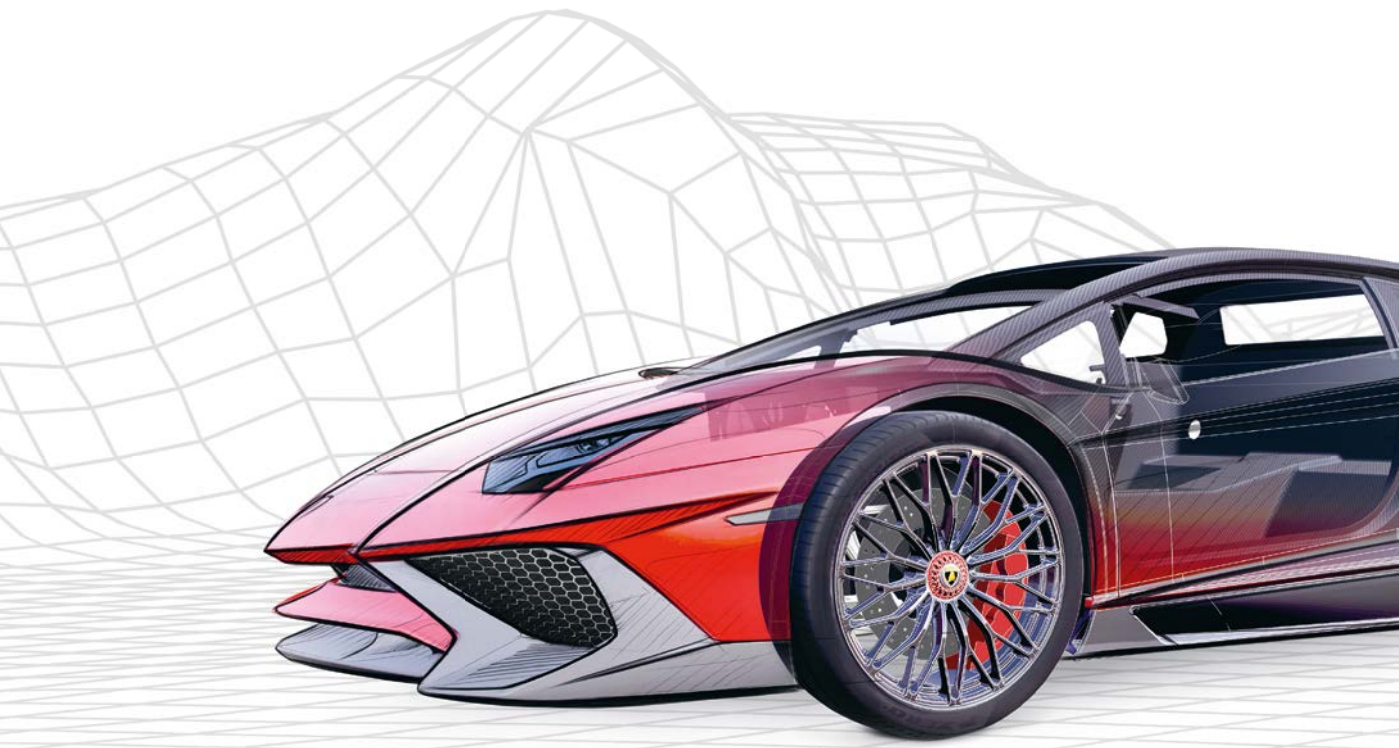
CAR SHOPPING

The trendy "intu Lakeside Shopping Center" on the fringe of Greater London attracts 26 million customers every year. SEAT decided on this location for its very first retail store offering buyers selected SEAT models at fixed monthly instalments. Customers who choose one of these models can make all the financing arrangements either via the specially-designed instore tablets or from their computer back home. They only need to return to the store to sign the finance agreement. What began as a pilot project at SEAT has already proven its worth, and is to be made available to Audi customers in the UK soon, too, under a scheme which will apply to finance agreements concluded with any Audi dealer.

VIRTUAL REALITIES

Vehicle design in the Volkswagen Group begins with virtual reality: developers use computers to calculate and simulate material properties, compare design alternatives and define driving characteristics. These results are then tested on real components and prototypes at later stages in the development process.

Text Laurin Paschek
Photography Hartmut Nägele



LAMBORGHINI AVENTADOR SUPERVELOCE COUPÉ

Carbon is not only extremely light, it also provides excellent protection for occupants – if this innovative material is used correctly. Specialists at Lamborghini are constantly refining their digital tools with that in mind.

Perfect driving performance on the one hand, uncompromising safety on the other – developing a super sportscar like the Lamborghini Aventador Superveloce Coupé[1] is a balancing act. The bodywork must be light, but at the same time extremely strong and stable. It should be able to absorb as much energy as possible in the event of a crash. Carbon is the material best suited to meet these requirements. The complete chassis structure of the Aventador Superveloce Coupé is made of carbon fiber.

Carbon fiber can be used flexibly in a range of thicknesses and forms. However, the specific properties depend on the type of composite. That makes carbon simulation very difficult. Engineers at Lamborghini have developed a multi-stage method for verifying the calculations and simulations in a series of tests on real components; this method also constantly optimizes the calculation process. That is how they gradually built up a carbon fiber chassis made of a single unit – a monocoque – which weighs as little as possible while at the same time providing the necessary stability.

2.03 kg per hp

is the power-to-weight ratio of the Aventador Superveloce Coupé. The 12-cylinder engine delivers 750 hp, the vehicle only weighs 1,525 kg.

A 3D panorama lets developers view the geometries of virtually-designed components. Radoslav Horák, coordinator from Technical Development, uses the so-called 3D cave to optimize the cockpit.

18 cm

Seven people can travel in the Kodiaq, ŠKODA's new SUV. To achieve that, the middle row of seats can be slid forwards or backwards by 18 centimeters.

ŠKODA KODIAQ

Compact on the outside, plenty of room wherever you sit inside – that is what is expected of a modern SUV. The developers of the new ŠKODA Kodiaq[2] mastered that challenge by seating virtual test persons in a simulated interior.

The new Kodiaq marks ŠKODA's entry into the large SUV segment. The development brief for the cabin was to provide the very best in terms of ease of use and seating comfort for all occupants, short or tall. The Kodiaq's third row of seats offers something special as regards comfort: it has no difficulty accommodating tall passengers, while still giving smaller occupants easy access to all key controls in the cabin.

Using three-dimensional design software, ŠKODA engineers calculated various model variants for the cabin and simulated access to the controls as well as to the third row of seats with the help of virtual occupants. Projections in a so-called 3D cave were used to optimize the position of the infotainment display, for example, and to test for any distracting reflections during virtual rides. The simulation results were then verified on real prototypes later in the development process.

DUCATI SUPERSPORT

“Fare una bella figura” is an Italian expression that can be translated as “look good” or “achieve a great performance”. Ducati’s mission is to deliver on both.

Creating motorcycles with an inimitable design and sporting character – the new SuperSport carries on this Ducati tradition. But this bike goes even further as a light, compact road-going sports bike with perfectly-balanced comfort. The most important task for the SuperSport’s designers was combining all the components to achieve this goal. What’s more, the designers also had to bear in mind that most motorcycle components are not hidden under a bodyshell, but are clearly visible.

So the developers used innovative virtual methods to calculate all chassis components and mounted parts. Their aim was to simulate the performance of individual variants and to find the optimal solutions: for example, making the muffler as compact as possible or pairing frame functional requirements with aesthetics, while also incorporating the comfort features from the design brief. Weight reduction is a key factor to ensure the best handling and performance. That is how the new SuperSport achieves superior dynamics in many different situations.

1 Lamborghini Aventador Superveloce Coupé fuel consumption in l/100 km combined 16.0; CO_2 emissions in g/km combined 370. Efficiency class G.
2 ŠKODA Kodiaq fuel consumption in l/100 km combined from 9.1 to 4.7; CO_2 emissions in g/km combined from 170 to 139. Efficiency class from C to A.

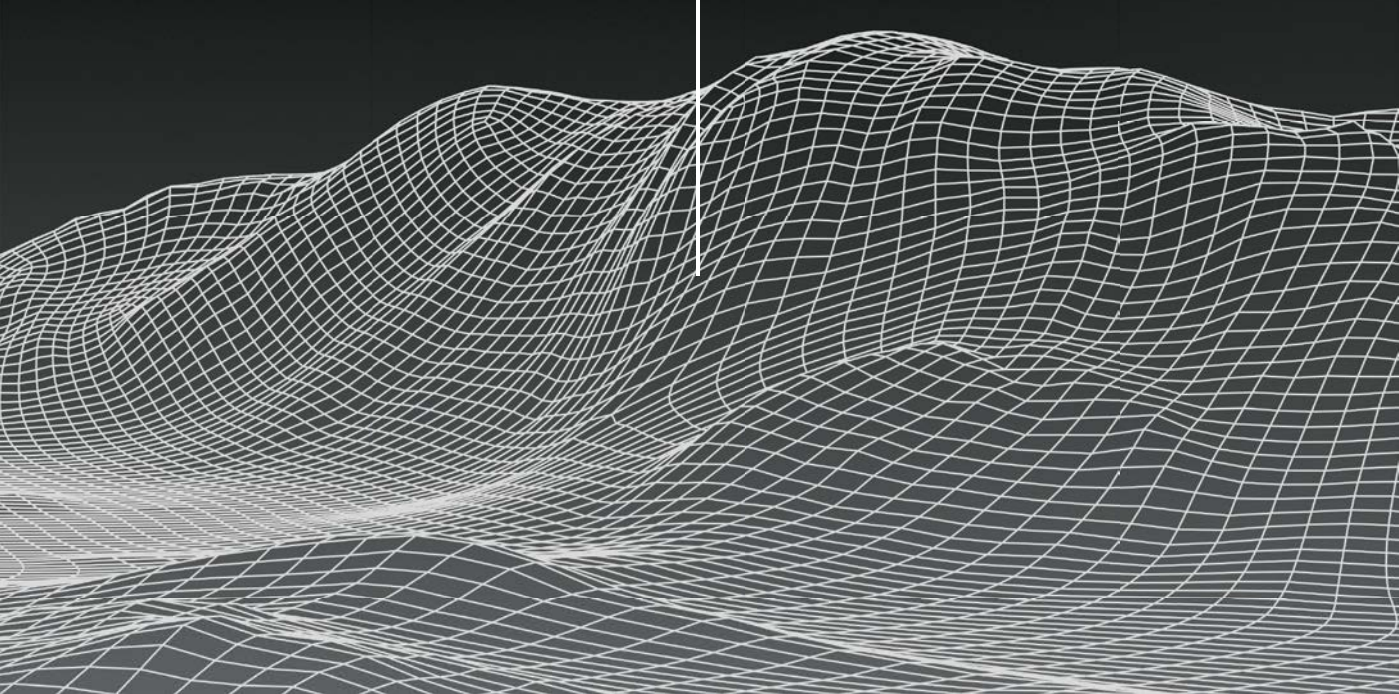
80 kg

is the average weight of a motorcycle rider. The SuperSport weighs in

at about

200 kg

which is only 2.5 times more than the rider's average weight.



ALL-IN-ONE

FORWARDER — TRANSPORTER

LOADFOX

Today, 35 percent of cargo space in freight transportation is unused. The "LoadFox" partner network aims to change that: based on demand from other shippers, this service for smart order management can assign additional cargo along the route of only partially loaded trucks. The software combines partial loads along a route to suggest options for profitable tours. Vice versa, the network partners can assign part of their own loads to other transportation companies if they do not currently have any free capacity.

SUPPLY CHAIN

A fully connected digital supply chain – that is the aim of RIO, the new, open digital platform for the entire transportation industry launched by Volkswagen Truck & Bus, the Group's commercial vehicles arm. The cloud-based logistics solution stems from an MAN initiative and delivers solutions for mixed fleet operators as well as forwarders or workshops from the Munich location. By combining information from tractors, trailers, bodies, drivers and orders, and pooling this information with traffic, weather or navigation data, for example, RIO provides its users with concrete recommendations that significantly enhance transportation and logistics processes, such as enabling predictive maintenance for trucks, improving cargo space utilization and calculating the optimal route for navigating drivers to drop-off locations.

RIO is based on the principle that anyone willing to share data can participate in the connected supply chain – and, of course, enjoy the benefits themselves. Thanks to intelligent algorithms, RIO combines different sources of data, carries out big data analyses and transmits the findings, for instance to shippers, workshops, drivers and orderers.

As of 2017, all new MAN trucks will be equipped with RIO as standard; in addition, all Scania customers can connect with RIO. Using a refit box, any truck – no matter what brand – can be integrated into the network via a fleet management system gateway.

SHIPPER — DISPATCHER — DRIVER → **RECIPIENT**

RIO GEO

Getting the full picture: to assist fleet operators with their logistics planning, "RIO Geo" provides up-to-date road maps showing the exact position of their vehicles. The trucks send information on their location to the system at one-minute intervals. Fleet managers can also define geographic areas within specific boundaries – known as geofences – for specific trucks. The system also provides assistance in calculating charges for road toll systems in Europe and offers fleet planning support in the form of smart asset tracking.

RIO CONNECT

Putting drivers first: "RIO Connect" offers maximum support every day. Drivers first use the chat function to coordinate with the dispatchers and then receive tour and order details directly from the service. Before they set off, drivers use the app to check that everything, such as lights, tires and brakes, is in good working order. One click activates the navigation, and the app guides the driver directly to the customer's drop-off location. While they are on the road, RIO Connect reminds drivers of the compulsory rests and displays the maximum permissible remaining driving time.

HOW DO WE TURN CHANGE INTO SUCCESS?

Matthias Müller, CEO of Volkswagen Aktiengesellschaft, about transition and change in the company.

"I was at a friend's farewell party not so long ago. He was about to go abroad for a few years and wanted to spend some time with good friends before he left. That evening brought home to me just how much we need a sense of belonging when we are about to embark on something new. Change always brings uncertainty and risk. But people are creatures of habit and like to surround themselves with the familiar. That creates stability and security in a world that is changing at a breathtaking pace.

As a company that has notched up one delivery record after the next, for a long time we lacked the impetus to wholeheartedly embrace new horizons. Success seemed to prove us right. We continued to grow, kept on working to make our vehicles ever safer, more efficient and comfortable. In the end, though, it was the diesel crisis that compelled us to stop talking about change and actually get down to implementing it. Volkswagen must change. Not because everything so far has been wrong, but because the needs of our customers and thus our industry itself will change more fundamentally in the next ten years than in the last hundred. The advancement of traditional competences will not be sufficient to master this epochal transition.

That said – how do we make a success of such a profound transformation from a car maker to a global mobility provider? That takes different structures, a sound strategy, the necessary financial buffer for investing in the future. On its own, though, that is not enough: above all, we have to refresh the way we think and operate. We need to take decisions faster and become more agile. We need an even greater entrepreneurial spirit at Volkswagen. We must open up to partnerships and participations. And we need to take our courage in both hands and go ahead and try things out instead of just looking at the risks.

That sounds easy, but it is in fact a difficult undertaking. A transformation process on this scale needs time and patience. This magazine is proof that we are not just talking the talk – we are really getting down to business when it comes to addressing the issues of the future. However, we must also bear in mind that change is a painful process. We must overcome fears, break down resistance, win over customers and employees to the new Volkswagen.

We can draw strength from what has always been the very heart of our company: the passion we bring to developing, building and marketing cars for our customers. I firmly believe that if we succeed in building the bridge between the "old" and the "new" mobility world, we will be able to understand change for what it is: an enormous achievement that ultimately brings benefits for everyone.

My friend recently sent me an email. He described how difficult the first few weeks in his new homeland had been. That it would still take some time for him to adjust to his new environment. But he also wrote he was glad he had taken this decision in favor of change. I fully understand what he means."

“Volkswagen must change. Not because everything so far has been wrong, but because the needs of our customers and thus our industry itself will change more fundamentally in the next ten years than they have in the last hundred.”

MATTHIAS MÜLLER

Key Figures

FISCAL YEAR 2016

VOLKSWAGEN GROUP

Volume data[1]	2016	2015	%
Vehicle sales (units)	10,391,113	10,009,605	+3.8
Production (units)	10,405,092	10,017,191	+3.9
Employees at Dec. 31	626,715	610,076	+2.7

Financial data (IFRSs), € million	2016	2015	%
Sales revenue	217,267	213,292	+1.9
Operating result before special items	14,623	12,824	+14.0
as a percentage of sales revenue	6.7	6.0	
Special items	– 7,520	– 16,893	–55.5
Operating result	7,103	–4,069	X
as a percentage of sales revenue	3.3	–1.9	
Earnings before tax	7,292	–1,301	X
Earnings after tax	5,379	–1,361	X
Earnings attributable to Volkswagen AG shareholders	5,144	–1,582	X
Cash flows from operating activities	9,430	13,679	–31.1
Cash flows from investing activities attributable to operating activities	16,797	15,523	+8.2
Automotive Division[2]			
EBITDA[3]	18,999	7,212	X
Cash flows from operating activities	20,271	23,796	–14.8
Cash flows from investing activities attributable to operating activities[4]	15,941	14,909	+6.9
of which: capex	12,795	12,738	+0.4
as a percentage of sales revenue	6.9	6.9	
capitalized development costs	5,750	5,021	+14.5
as a percentage of sales revenue	3.1	2.7	
Net cash flow	4,330	8,887	–51.3
Net liquidity at Dec. 31	27,180	24,522	+10.8

Return ratios in %	2016	2015	
Return on sales before tax	3.4	–0.6	
Return on investment (ROI) in the Automotive Division	8.2	–0.2	
Return on equity before tax (Financial Services Division)[5]	10.8	12.2	

1 Volume data including the unconsolidated Chinese joint ventures.
2 Including allocation of consolidation adjustments between the Automotive and Financial Services divisions.
3 Operating result plus net depreciation/amortization and impairment losses/reversals of impairment losses on property, plant and equipment, capitalized development costs, lease assets, goodwill and financial assets as reported in the cash flow statement.
4 Excluding acquisition and disposal of equity investments: €18,224 (€17,270) million.
5 Earnings before tax as a percentage of average equity.

VOLKSWAGEN AG

Volume data	2016	2015	%
Vehicle sales (units)	2,632,144	2,676,629	–1.7
Production (units)	1,241,217	1,255,771	–1.2
Employees at Dec. 31	113,928	114,066	–0.1

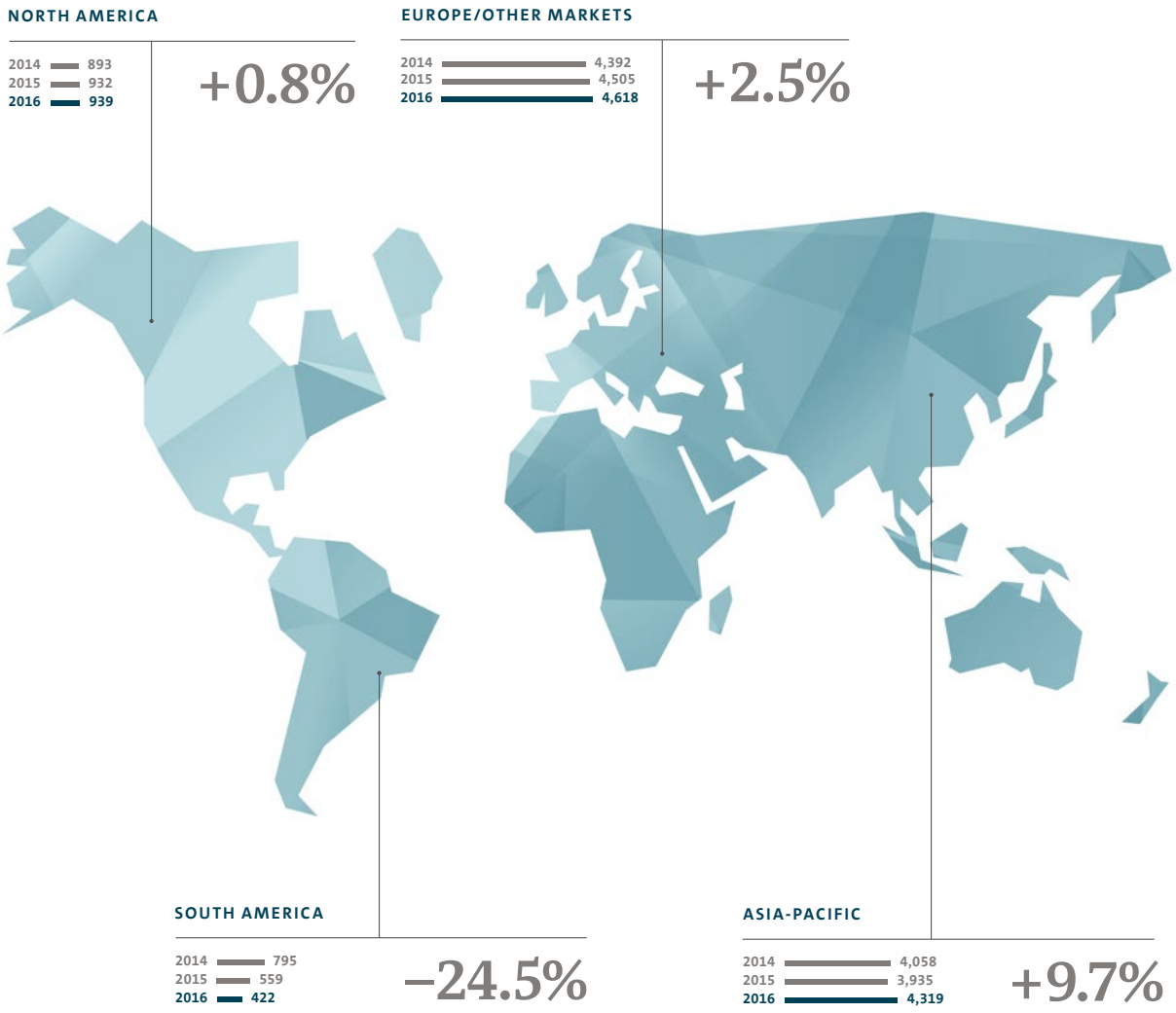
Financial data (HGB), € million	2016	2015	%
Sales	75,310	73,510	+2.4
Net income/net loss for the year	2,799	–5,515	X
Dividends (€)			
per ordinary share	2.00	0.11	
per preferred share	2.06	0.17	

This version of the annual report is a translation of the German original. The German takes precedence. All figures shown in the report are rounded, so minor discrepancies may arise from addition of these amounts. The figures from the previous fiscal year are shown in parentheses directly after the figures for the current reporting period.

Moving Globally

FISCAL YEAR 2016

VOLKSWAGEN GROUP DELIVERIES – IN THOUSAND UNITS



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