tomorrow

EXPERIENCING TECHNOLOGY WITH SCHAEFFLER

Motorsports, the powerhouse for ideas

Schaeffler accelerates electric mobility in Formula E

On the road toward Industry 4.0

Car production transitioning from the 19th to the 21st century

Issue 3 · 2015

SCHAEFFLER

» *I am primarily interested in the future because that is the time I will live in* Albert Schweitzer

DEAR **READER,**

The world is on the move. We all are, in fact. And the pace seems to be picking up. This is also evident in our technology magazine 'tomorrow.' The first issue was published in the spring of 2015, and now you are holding the third edition in your hands. In this issue, we once again shine the spotlight on 'mobility for tomorrow.' For good reason.

We are convinced that efficient 'mobility for tomorrow' is a critical component in satisfying the growing needs of an expanding world population in moving towards more growth and prosperity. As one of the world's leading automotive and industry suppliers, we feel it is our task to help fulfil the growing need for mobility without compromising the environment. Our employees around the world all work towards achieving this by coming up with ideas, solutions and products towards 'mobility for tomorrow.' You can read about the work they are doing, for instance, in texts on the concept car 'efficient future mobility China,' or in our venture into the field of 'micro mobility.' These are just two examples of many.

Nevertheless, the challenges we face are far from solved. You can also read about this in this issue. How can we optimize the flow of the ever-increasing stream of goods? How can we generate energy to make mobility environmentally sustainable? How can systems help make traffic more efficient? All of these questions make one thing clear: these challenges can only be overcome through joint efforts and shared beliefs.

The second reason we put mobility in the limelight of our technology magazine is the Frankfurt Motor Show (IAA), and it is no fluke that the opening date coincides with the publication date of this issue. The industry exhibition at Frankfurt has long been regarded as one of the most important automobile trade shows in the world. It has become a showcase for state-of-the-art mobility – because in recent years the car has developed more and more into a medium in which different future aspects complement, network and connect. It is not without reason that the slogan of this year's IAA is 'mobility connects.'

Unfortunately mobility not only connects, but also causes rifts, particularly in congested urban areas. Rifts between car and train commuters, between cyclists and pedestrians. Instead of the desired harmony, reality seems to be confrontation. The article 'Urban mobility' highlights how to get these fronts moving towards each other. A paragon for free-flowing city traffic – certainly a surprise for many – is the densely built-up, bustling city of Hong Kong. We, too, wanted to know what other cities might learn from the Chinese metropolis. More on this story on page 8.

Another reason to put mobility in the limelight is the fascination that is associated with travel. Holidays provide the most wonderful occasions to move. Some of you have certainly caught trains, others took planes, cars or ships in the past weeks – or perhaps even a combination of these. A few of you may also have jumped on your bikes and rode, like the author in the story on traversing the Alps by mountain bike. One popular destination is Route 66, arguably one of the most famous roads in the world. For many of us, this route is legendary, but unfortunately over the years it has crumbled. This, too, is a topic we cover in 'tomorrow.'

It would give us great pleasure if you could find some time – despite or even because of the 'moving times' we are living in – to dive into our 'tomorrow' magazine.

Klaus Rosenfeld
Chief Executive Officer

global

Different countries –
different traffic conditions

in motion

Mobility in the course of time

here and now

A tour of our mobile life

mobility tomorrow

How we move around in the future

» Innumerable people enjoy reading stories. Only a few, however, are brave enough to write them Wadim Korsch

global

Different countries –
different traffic conditions

REV-**AIR**-RENCE

Mobility is becoming increasingly efficient and safer thanks to state-of-the-art technologies. However, there are places on the planet that remind us that traveling can still be adventurous. Like the Nepalese airport Lukla, which is one of the world's most dangerous. The sole runway – which by the way was only paved in 2001 – ends at a 600-meter deep abyss, on the other side of which rises a Himalayan cliff face. The first take-off or landing attempt must be spot on, since overshooting or pulling-up is impossible due to the short runway. And as if this adrenalin rush wasn't enough, unpredictable winds and frequently hazy visibility complicate the pilot's task when approaching the Kamikaze airport officially called Tenzing-Hillary Airport. The most serious accident to date occurred in 2008: 18 people died when a Yeti Airlines propeller machine crashed on landing. Eleven years before, Lukla moved into the public eye as the setting for the opening scene of the James Bond movie 'Tomorrow Never Dies.' More about the mobility of the world's most famous secret agent starts on page 56.

MODEL OF **MOBILITY**

More than seven million people scurry around the densely-packed precincts of Hong Kong. And yet, according to one study, the city is leading the way in urban mobility. We investigate the reasons.

by Torben Schröder

The number of people who live in cities is on the rise. In 2007, more than 50 percent of the world's population lived in cities. According to forecasts, this figure is expected to climb to 70 percent by 2050. 'Explosion warning': gridlocked traffic, shortage of parking spaces, noise. But, above all, air pollution is a major cause for concern. For a long time now, the problem not only has implications for known cases like Beijing, but also for cities in Europe such as Stuttgart and Paris. In order to find a solution to the particulate matter in the French capital, the government imposed a ban on vehicles. On one day, all cars with plates ending in odd numbers were allowed to drive, the next day cars with even numbers were permitted on the roads.

Air pollution is just one of many aspects that the American management consultancy Arthur D. Little has constantly monitored in a scientific study on urban mobility since 2011. Where is the public transport system most

TOP TEN OF THE SURVEY

1st place 58.2 points
HONG KONG

+ Very high use of public transport
+ Low number of cars/1,000 inhabitants
+ Smart card widely used as public transport payment method
– Cycle unfriendly

2nd place 57.4 points
STOCKHOLM

+ Third largest cycle path network in the world
+ Very low air pollution
+ Low death toll on roads
– Very expensive public transport

3rd place 57.2 points
AMSTERDAM

+ 33 % bicycle share in traffic
+ Second highest frequency of car sharing worldwide
+ Low air pollution
– Low use of public transport

attractive financially, where is the best road network infrastructure, where do the least number of road deaths occur – using 84 cities from all over the world as a basis, these and many other questions are answered. The surprising winner: the Chinese Special Administration Zone Hong Kong.

Urban planners and builders must give thought to a wide variety of prerequisites, such as geographical obstacles like mountains, valleys and bodies of water, as well as extreme climatic fluctuations and cash-strapped residents. The challenge in Hong Kong lies in the relatively high population density. 7.1 million inhabitants live in an area covering just 1,100 square kilometers. That's 6,400 people per square kilometer. The population density alone of Hong Kong Island – the historical, political and financial hub – is just over 16,000 people per square kilometer. By comparison, the ratio in Hamburg is around 2,300.

And it is not just the people living in Hong Kong who have to get around, but millions of visitors, too. In 2014, Hong Kong welcomed 47 million tourists, that's almost seven times the population. Thanks to tax advantages, the Chinese neighbours, in particular, use the former British colony as a shopping paradise day after day. The solution to the traffic chaos threat is an almost perfectly designed, developed and well-functioning system of local public transport (LPT). The study conducted by Arthur D. Little found that public transport made up 64 percent of the choice of transport, or 92 percent including pedestrians. Only eight percent of the population used bikes or

Masses of people, taxis and buses – a typical sight in the streets of Hong Kong

4th place 56.4 points
COPENHAGEN

+ World's safest public transport network
+ Lowest number of cars/ 1,000 inhabitants in Western Europe
+ Many cyclists
– Expensive public transport

5th place 56.0 points
VIENNA

+ High use of public transport
+ Buses with LPG
+ 'Bike City' a future project
– Smart card not available as public transport payment method

6th place 55.6 points
SINGAPORE

+ Very high use of public transport
+ Low number of cars/1,000 inhabitants
+ Smart card widely used as public transport payment method
– High death toll on roads

The majority of Hong Kong's population uses the subway (left). Payment is made using the electronic Octopus card

Two widely-used modes of transport in Hong Kong: the minivan (left) and the city bus

private cars. In most large European cities, the proportion of cars amounts to 40 to 70 percent, and in some American cities that percentage can even reach 90.

The number of cars per capita in Hong Kong is one of the lowest of the study: 73 per 1,000 inhabitants. In Western Europe and the USA the ratio is around 500 vehicles. One reason for minor role of the private car can be attributed to the lack of do-it-yourself mentality. The average Hong Kong Chinese lets someone else do it for them. She gets her new purchases delivered, his new floor laid, and their housekeepers organize the essentials. The car as a mode of transport is simply not necessary. Moreover, the car is by far not the fastest means of getting around a megacity like Hong Kong. It simply makes no sense to drive to work, as is customary in Europe. Those who do own a car mainly use it for excursions into the countryside. In the inner-city areas, people can get around faster and more easily on foot and by using the well-developed public transport system.

Minibus express

The closely-meshed network of the public bus system is reinforced by a range of private providers – so-called minibuses. The vans carry significantly less passengers and do not run to a fixed timetable. They usually cover greater distances from one corner of the city to the other. A shout lets the minibus driver know when

7th place 55.4 points
PARIS

+ Very good subway network
+ Third highest frequency of bike sharing worldwide
+ 2,000 electric cars for car sharing
– High air pollution

8th place 54.7 points
ZURICH

+ Very good subway network
+ Extensive cycle path network
+ Third highest frequency of car sharing worldwide
– High number of cars/1,000 inhabitants

9th place 53.2 points
LONDON

+ High use of public transport
+ Smart card widely used as public transport payment method
+ High frequency of bike sharing
– Very long commuting time

ORDERED CHAOS

Why worry about regulations when everything works itself out anyway. For example, in Meskel Square in the Ethiopian capital of Addis Ababa.

passengers want to hop on or off. Above ground, this is the fastest and most convenient form of transport. More of a tourist attraction than an efficient mode of transport is the tram. The double-decker 'Ding Ding' operates exclusively in the north. Ferries are used to cross Victoria Harbour. Like in most major cities, a taxi waits at every Hong Kong corner. The 'secret' of a well-functioning passenger transport system in large cities is diversification. A study by Schaeffler on urban mobility also comes to this conclusion. "Intermodal transport, which means switching between different modes of transport, will be a matter of course in the future," says Heinrich Schäperkötter, Head of Innovations Management at Schaeffler and initiator of the mobility study.

However, the star of local public transport in Hong Kong is the subway. It is fast, reliable and excellently networked. In Hong Kong's congested areas, the next station is no more than five minutes away on foot. At peak hour, the trains on the ten lines run every 90 seconds. Still, it is not uncommon for passengers to let several trains pass before managing to find room inside. For these well-filled wagons, the railway employs so-called pushers to pack people into the trains. Despite the mass processing, everyone shows consideration for each other. The scarce seats – a subway compartment features predominantly handrails – are reserved for the elderly and mothers. Chaos or even panic just doesn't happen.

Public transport tickets as currency

Guaranteeing the smooth running of the subway is its payment method. There are no monthly or annual tickets and, since 1997, cash transactions are no longer accepted for single tickets either. The only way to pay is by Octopus card. The subway operator Mass Transit Railway (MTR) is regarded as the inventor of this technology. It works like a prepaid ticket. Users can obtain it almost anywhere, pay a deposit, and top it up with extra credit as needed. In the subway stations there are devices that read the card's chip and a barrier opens. The system calculates the exact amount depending on the station. There is no need for inspectors, and there are no free rides. The success of the Octopus cards was so huge that the method of payment has spread. Now, they are also accepted on buses as well as in many convenience stores, supermarkets, fast food restaurants and cafés. More than 24 million Octopus cards are in circulation. Of the twelve million daily transactions, passenger transport accounts for 75 percent.

But even an exemplary example of urban mobility like Hong Kong also has its weak points. When it came to 'car sharing,' 'bike sharing' and 'expanding the cycle path network,' the creators of the study awarded each category zero points. The fact that the push bike is almost non-existent as a means of transport is again due to the high population density. The sidewalks are packed with people, the streets are crammed with taxis and buses. Bikes paths simply don't exist. Many Hong Kong Chinese don't even know how to ride a bike because it was never part of their upbringing at home or at school.

A more commonplace sight is people pushing handcarts. These are neither homeless people nor junk dealers, but couriers. On foot or even by train, they deliver their goods on time. That's Hong Kong.

9th place 53.2 points

HELSINKI

+ Most extensive cycle path network in the world
+ Smart card widely used as public transport payment method
+ Low air pollution
– Virtually no bike sharing service

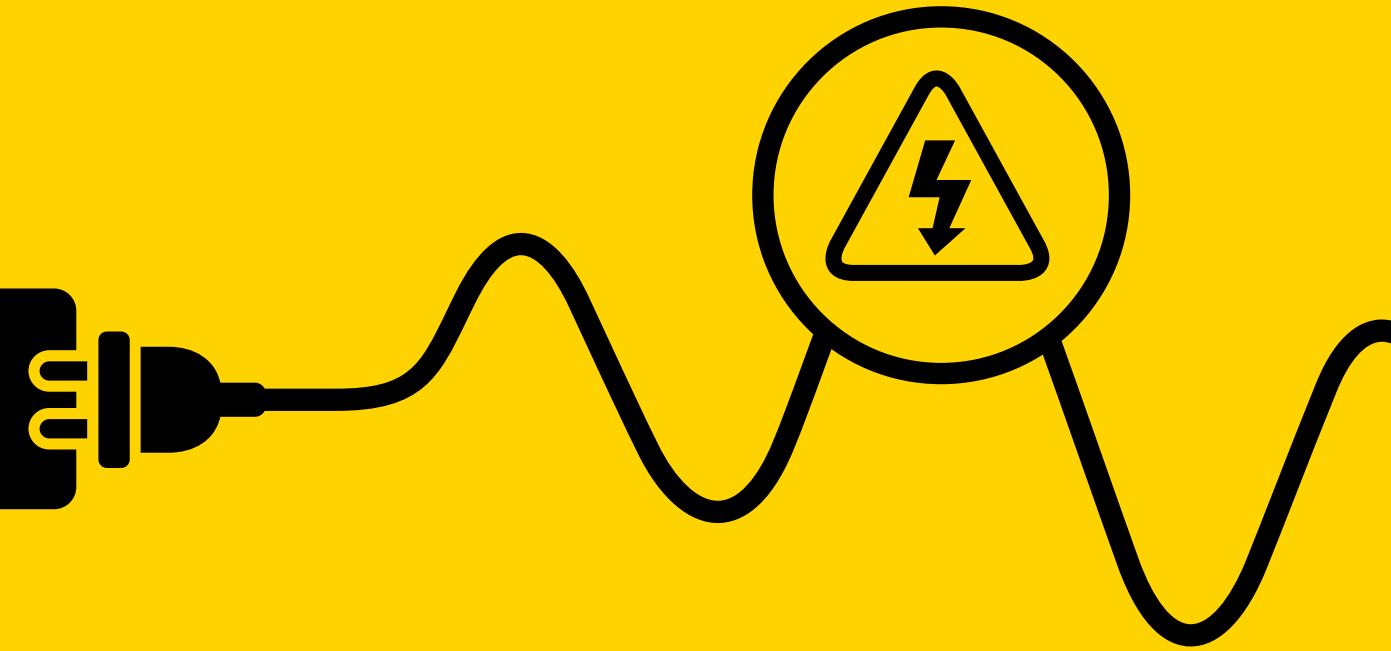
THE AUTHOR

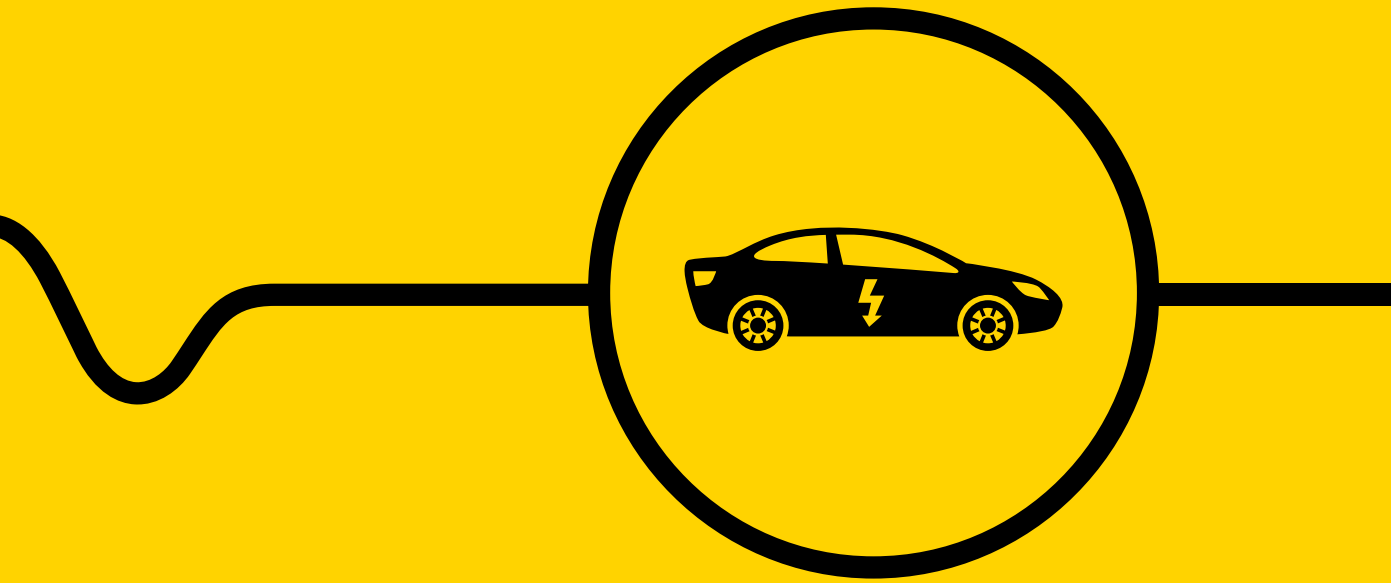
Torben Schröder *has tackled many different types of transport possibilities on his trips to cities around the world. He is also a diligent public transport user in his hometown Hamburg. The editor for the Speedpool Agency got an even deeper insight into Hong Kong life after talking with local Hong Kong Chinese Tsen-Yang Kwong.*

ELECTRO IS COOL! BUT ...

Electric cars are in fashion. But hardly anyone is buying them. Falling prices, increasing cruising ranges and additional incentives could spark demand amongst the E-generation, say experts. Until then, plug-in hybrids are the stopgap measure to electromobility.

by Michael Specht





Only a low swoosh can be heard, but the acceleration is as punchy as that of a Porsche. Anyone who has stepped on the gas, sorry, accelerator pedal, is not only completely amazed but wildly enthusiastic about the dynamics. Electric cars are simply great fun. If this were the only buying criterion, the roads would be crammed with them. And knowing that they are good for the environment just adds to the driving pleasure. No burned fuel, no oil changes necessary, no exhaust fumes fouling up the air – at least not when the electricity for the green cars is generated from renewable sources such as solar, water or wind power.

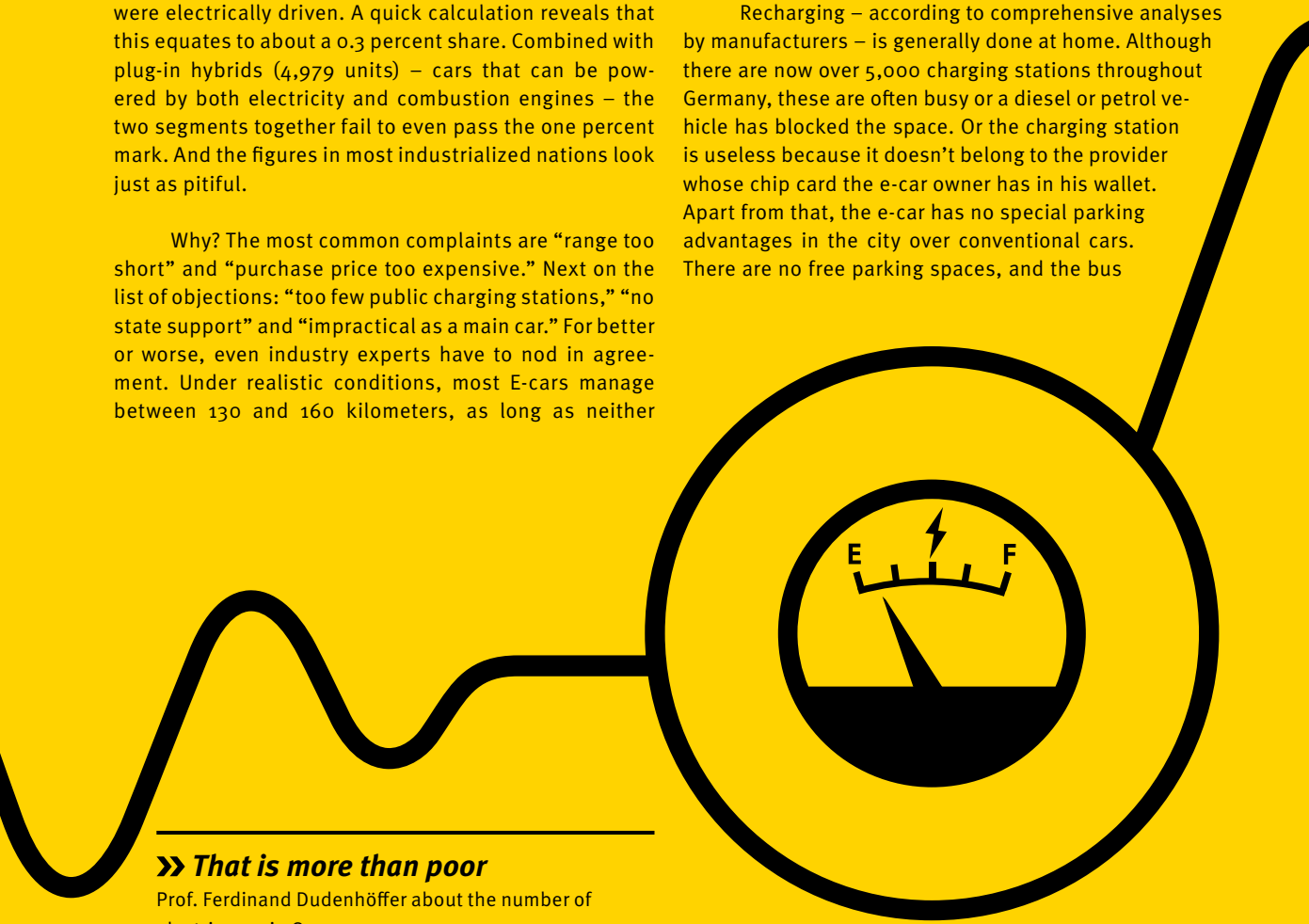
But in reality things look quite different. In Germany, for instance, the home of automotive global players like Audi, BMW, Mercedes-Benz, Opel, Porsche and VW, electro-vehicles populate the roads in homeopathic doses. One is more likely to see a Ferrari than a BMW i3. Last year, 25,300 electric cars were registered. "That's more than poor," says acclaimed automobile expert Prof. Ferdinand Dudenhöffer. For the first half of 2015, the Federal Motor Transport Authority (KBA) Flensburg reported over 1.6 million new car registrations, but only 4,633 of those were electrically driven. A quick calculation reveals that this equates to about a 0.3 percent share. Combined with plug-in hybrids (4,979 units) – cars that can be powered by both electricity and combustion engines – the two segments together fail to even pass the one percent mark. And the figures in most industrialized nations look just as pitiful.

Why? The most common complaints are "range too short" and "purchase price too expensive." Next on the list of objections: "too few public charging stations," "no state support" and "impractical as a main car." For better or worse, even industry experts have to nod in agreement. Under realistic conditions, most E-cars manage between 130 and 160 kilometers, as long as neither air-conditioning nor heating are running. In winter, the range can sometimes fall under 100 kilometers. This is simply not enough for many motorists, even if, as statistics underline, 80 percent of their daily commute is less than 50 kilometers. And one should not underestimate the psychological effect, the so-called 'range anxiety,' the fear of being left stranded on the side of a lonely country road with a dead battery.

E-cars as eco-status symbol

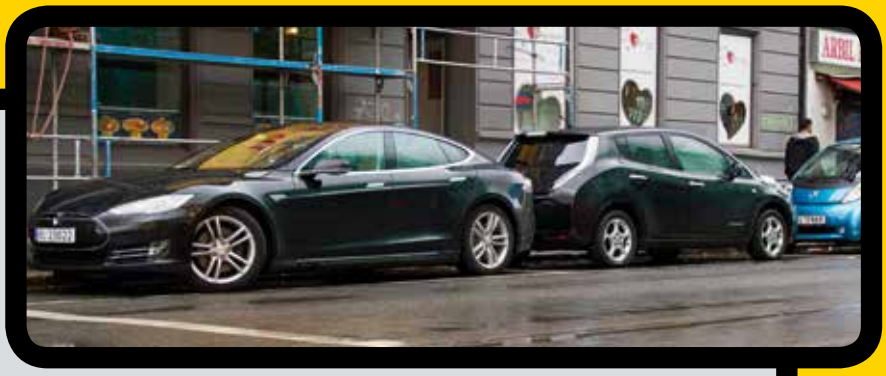
Another obstacle is the purchase price. Through their expensive lithium-ion batteries, electric cars cost around 10,000 to 15,000 euros more than their performance-comparable pendants with combustion engines. It is impossible to reduce this additional cost through lower running costs (under five euros per 100 kilometers). The fact is: those who buy an electric car don't do the math. They simply want to demonstrate to their fellow man: look, I'm a sustainable, progressive, green sort of person. And that is worth the high additional cost to me.

Recharging – according to comprehensive analyses by manufacturers – is generally done at home. Although there are now over 5,000 charging stations throughout Germany, these are often busy or a diesel or petrol vehicle has blocked the space. Or the charging station is useless because it doesn't belong to the provider whose chip card the e-car owner has in his wallet. Apart from that, the e-car has no special parking advantages in the city over conventional cars. There are no free parking spaces, and the bus



» *That is more than poor*

Prof. Ferdinand Dudenhöffer about the number of electric cars in Germany



ELECTROMOBILITY **NORWAY**

Norway is a pioneer when it comes to electromobility. *Based on the number of inhabitants, there is nowhere else in the world with more electric cars. And nowhere else are e-cars more subsidized. Vehicles bearing the 'EL' number plate can park in the city for free, are not liable to pay transport costs on ferries, can recharge at public charging stations for free, use the bus lanes and don't have to pay a congestion charge in cities (up to five euros a day). Models like the Tesla S luxury sedan from America have almost the same registration numbers as a traditional VW Golf. No wonder: electric cars are exempt from taxes and duties. The 'surcharge' compared to a conventional car is reduced to almost nothing. Plug-in hybrids are also subsidized, albeit to a lesser extent. The reason for this is the weight of the battery. Bus lanes are also taboo for plug-in hybrids. By 2020, at least 200,000 electric vehicles and twice that number of plug-in hybrids are expected to roll along Norwegian roads. Because charging stations are often occupied, Oslo is planning various parking facilities in the inner city area that are reserved exclusively for electric cars. As far as energy is concerned, Norway is in an enviable position. 98 percent of their electricity is generated from hydropower. E-cars are virtually CO_2 neutral.*

and taxi lanes are still out of bounds. The only government concession in Germany at the moment is the ten-year exemption from paying motor vehicle tax. An item worth around 100 euros per year.

Goodies from the state help

All in all, these are not the best prerequisites in achieving the oft-quoted number of one million electric cars on German roads by 2020 – a figure that the federal government announced in 2009. Germany aims to become the leading market for electromobility, declared Berlin. From a political stance, nothing has happened yet. In the German Federal Republic there is still only a tiny niche for electric cars and plug-in hybrids – despite an extensive choice. By the end of the year, almost 40 models will be on the market. Lacking are direct incentives for buying. Overseas markets are doing better in this regard, with some e-car buyers receiving hefty support: either through purchase discounts, tax bonuses, special depreciation allowances, free parking in cities, free recharging, access to bus lanes, and more.

E-role Norway

In no other European country are more electric and plug-in cars sold than in Norway. The market share is 13.7 percent. Incentives ensured that the Tesla S ranked second on the new registration list after the VW Golf last year. Purchasers of a Tesla model save a whopping 60,000 euros in luxury taxes. Moreover, VAT charges of 25% are dropped. The Scandinavian country has set the year 2020 as the goal to achieve a fleet consumption of newly-registered passenger cars of only 85 grams of CO_2

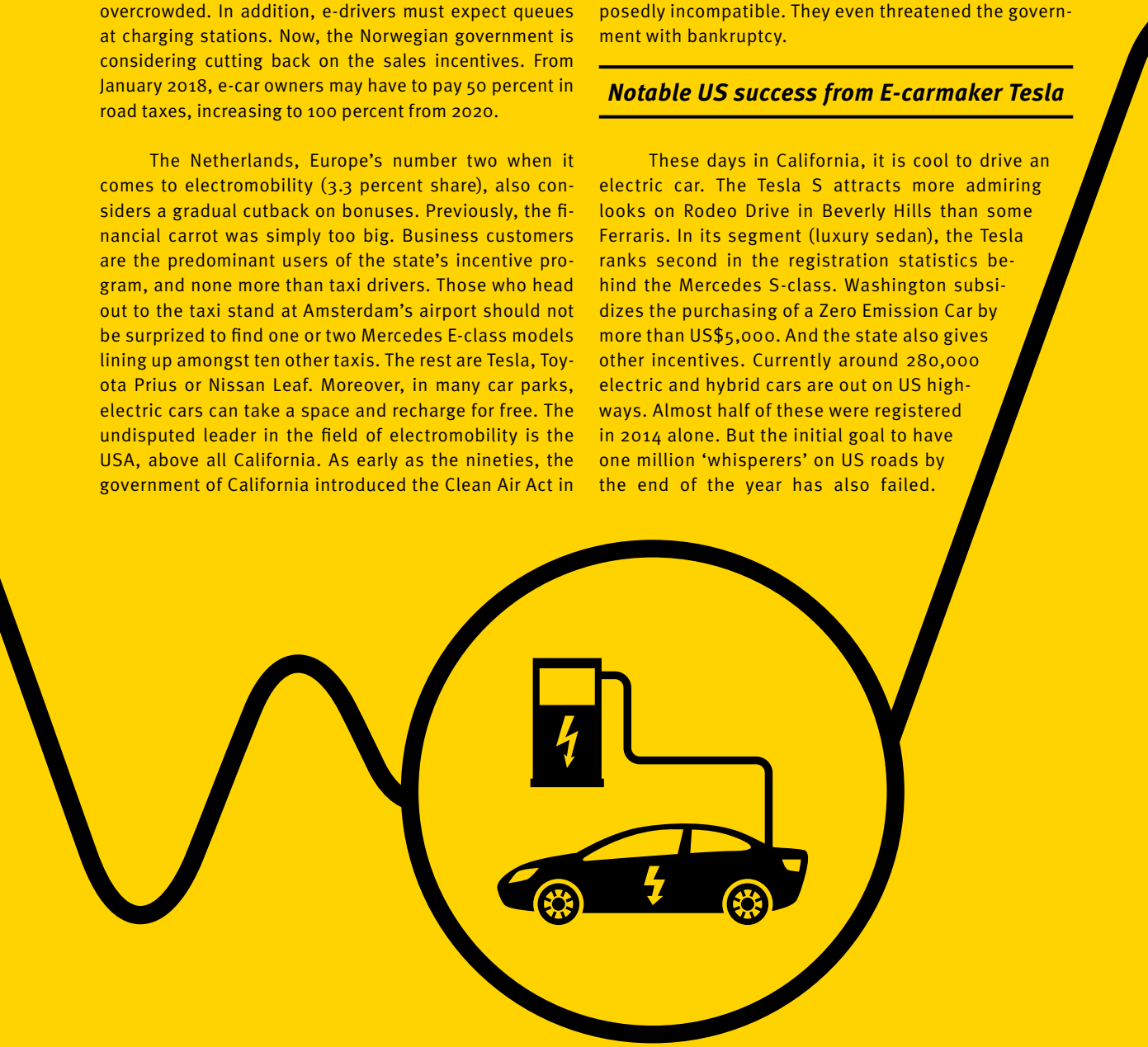
per kilometer. Recently, they reached the threshold of 100 grams. No other country has matched this.

The flipside of the coin, however, is that the bus lanes that electric cars are permitted to share are now overcrowded. In addition, e-drivers must expect queues at charging stations. Now, the Norwegian government is considering cutting back on the sales incentives. From January 2018, e-car owners may have to pay 50 percent in road taxes, increasing to 100 percent from 2020.

The Netherlands, Europe's number two when it comes to electromobility (3.3 percent share), also considers a gradual cutback on bonuses. Previously, the financial carrot was simply too big. Business customers are the predominant users of the state's incentive program, and none more than taxi drivers. Those who head out to the taxi stand at Amsterdam's airport should not be surprized to find one or two Mercedes E-class models lining up amongst ten other taxis. The rest are Tesla, Toyota Prius or Nissan Leaf. Moreover, in many car parks, electric cars can take a space and recharge for free. The undisputed leader in the field of electromobility is the USA, above all California. As early as the nineties, the government of California introduced the Clean Air Act in an attempt to force carmakers to offer a certain percentage of their new vehicles as Zero Emission Cars. The project failed due to lobbying by the 'Big Three' from Detroit: General Motors, Ford and Chrysler. As far as they were concerned, the ratio of investments to return was supposedly incompatible. They even threatened the government with bankruptcy.

Notable US success from E-carmaker Tesla

These days in California, it is cool to drive an electric car. The Tesla S attracts more admiring looks on Rodeo Drive in Beverly Hills than some Ferraris. In its segment (luxury sedan), the Tesla ranks second in the registration statistics behind the Mercedes S-class. Washington subsidizes the purchasing of a Zero Emission Car by more than US$5,000. And the state also gives other incentives. Currently around 280,000 electric and hybrid cars are out on US highways. Almost half of these were registered in 2014 alone. But the initial goal to have one million 'whisperers' on US roads by the end of the year has also failed.



In California, the Tesla S ranks second in the luxury segment behind the Mercedes S-class.

NEW YORK **ELECTRO-TAXIS**

In the largest metropolitan region of the USA, a third of all taxis are expected to be electrically powered by 2020. *Four years ago, Nissan won a prestigious contract. The Japanese manufacturer was commissioned to supply the world famous New York taxi fleet with small NV200 vans. The contract runs until 2023. Nissan will deliver 13,000 vehicles. Moreover, plans are in the pipeline for an electric version of the NV200. The city aims to find out just how durable electric cars are. Tests are currently underway with six Nissan Leaf models. The driving force behind this electric taxi initiative was the former mayor of New, York Michael Bloomberg. He had the vision that by 2020 one in every three New York taxis would run on electricity. Rapid-charging stations should fully recharge the e-taxis within just 30 minutes.*

Specialists cite low fuel prices as the main reason for the weak performance.

Fuel prices subsidize electromobility in China

China, now the largest automobile market in the world, wants to plug in. For very good reasons. Number one: there's something in the air. Millions of cars pollute large cities such as Beijing, Shanghai, Shenzhen and Guangzhou. So-called NEVs, or New Electric Vehicles, are expected to bring long-term relief. For this reason, NEVs receive massive support from the state (see box below). Thanks to these measures, China has become the largest sales market for electric cars and plug-in hybrids. Last year, 75,000 NEV models were registered for the first time. And it's trending upwards. Infrastructure has also received a major financial injection. Now, on a 600-kilometer stretch of highway between Beijing and Shanghai, a rapid-charging station is positioned every 50 kilometers. With enough power to fully recharge an E-car within half an hour. Other stations along important routes are under construction. China's investment in electromobility is predominantly financed through increased fuel prices. The drivers of conventional cars end up paying for the advancement of alternative drive systems. A model like that would very likely come up against resistance in some countries.

HOW CHINA ADVANCES **ELECTROMOBILITY**

Tax benefits, subsidies, registration easements, and other privileges – in China, electromobility enjoys considerable support. Some examples: *acording to the price list, the BYD Denza electric car, developed and produced in conjunction with Mercedes-Benz, costs 369,000 CNY (around 50,000 euros), but the actual purchase price in Beijing is 261,000 CNY. The reason: the subsidy there currently amounts to 108,000 CNY, with national and regional authorities splitting the shortfall fifty-fifty. In Shenzhen, that figure is 114,000, in Shanghai 94,000 CNY. Normally, buyers are liable for a ten percent so-called 'Purchase Tax,' NEVs (New Energy Vehicles), however, are exempt from this. Likewise the 'Vehicle and Vessel Tax.' In Beijing, a license plate lottery is held every month. This makes the approval of passenger cars fitted with combustion engines very difficult, usually even impossible. NEVs have their own lottery with very good 'winning chances.' Moreover, conventional cars must be left at home one day a week, NEVs don't. In Shanghai, number plates are auctioned – costing up to 10,000 euros. For NEVs, these license plates are free. This support only applies to locally-produced vehicles. Reason enough for Mercedes to launch a joint venture with BYD (Build Your Dream) in the development and production of the Denza.*

CONCEPT FOR CHINA
SCHAEFFLER EFFICIENT FUTURE MOBILITY CHINA

"In the next 15 years the automobile combustion engine will still dominate, but electricity will come increasingly more to the fore," says Peter Gutzmer, Board Member for Development at Schaeffler AG. Schaeffler underlined how this is feasible for one of the world's largest automotive suppliers at the 'Auto Shanghai 2015' trade show in China last April. A popular mid-size sedan with downsized three-liter petrol engine (92 kW/125 hp) and six-speed dual-clutch transmission serves as a technology flagship in China. Conti supplies the power electronics. The complete hybrid module, developed by Schaeffler, including vibration damping, start-stop system and energy recovery, produces 42 kW/57 hp. The Schaeffler sedan runs solely on electrical power up to 120 km/h. Drivers have three modes to choose from: hybrid, sport and EV. Compared to a conventional petrol-powered sedan, the concept car uses up to 57 percent less fuel. "We want to demonstrate that we're capable of developing all plug-in hybrid technology components locally and to produce it regionally, as well," says Gutzmer. Schaeffler is already manufacturing the so-called P2 hybrid module in Anting near Shanghai. This module is suitable for universal use in many types of transmission.

For Schaeffler, China could become the largest market ever. By 2020, the populous republic aims to reduce its average fuel consumption by a third compared to 2013, from 7.3 to 5.0 liters per 100 kilometers. Experts believe that without electrification of the drivetrain this step will be difficult to achieve. Development head Gutzmer sees potential, especially in low cost hybrid technology, or in other words: recuperation via 48 volts in combination with a range of 25 kilometers on electric power.

THE AUTHOR

What are the strengths and, more importantly, the weaknesses of an electric car? Writer Michael Specht wanted to find out himself: in an experiment over 20,000 kilometers at the wheel of a BMW i3.

Loud is out. Never again a car with a combustion engine, concluded Specht over a year ago. And the perfect e-machine for him: the BMW i3 – a high-tech ride with carbon body, lavish styling and an ultra-modern concept. No pollution, no smell, no noise. The price tag, however, starts at 35,900 euros. Add a few extras and it quickly reaches 45,000 euros. It is no surprise that so few i3 cars are on the road.

On the other hand, one can savor the exclusivity – and the almost soundless and brawny acceleration. After just a few weeks, the Hamburg journalist could no longer imagine ever wanting to drive a conventional car again. Even one putting out 500 hp.

The final cost of the i3 adventure could be determined after 18 months. Specht's average fuel consumption: 11.9 kWh/100 km. Energy including charge loss: around 15 kWh/100 km. Driving distance: 20,000 kilometers. With the current energy costs at 27 cents/kWh, this adds up to about 800 euros. It would be difficult to find a worthy equal in individual mobility in his German homeland, certainly not with a 170 hp car. Workshop/service costs to date: zero. The i3 electric engine runs virtually without any wear. Oil changes are unnecessary. Specht is a convert: "I'll stick with electricity. Because I believe that, despite the disadvantages of the battery, this is the future of automotive transport."

FASTER, LONGER, DEEPER

As fast as an airplane, as big as shopping malls or as expensive as palaces – a review of seafaring records.

by Marco Kraft and Volker Paulun

HIGHEST PAYLOAD

The heavy-lift freighter 'Dockwise Vanguard' can even lift an entire drilling platform. *It can accept loads of up to 117,000 tonnes – the equivalent of more than the entire population of Munich. The parts of the deck that actually disappear below the surface is no problem for the so-called semi-submersible ship. The novel design featuring structural columns on all four corners of the hull also make it possible to transport extremely long or wide freight, which extend beyond the deck dimensions of 275 x 70 meters. A diesel electric drive producing 35,486 hp (26,100 kW) permits a maximum speed of 14 knots (26 km/h).*

SUPER SUPERTANKER

'Jahre Viking,' the world's largest oil tanker to date, first set sail across the oceans in 1975. *After being extended in 1980, the ship reached today's unrivalled dimensions of 458.5 meters in length, 68.8 meters in width and a draught of 24 meters. The ship's hold consumes as much as 564,000 tonnes of oil. The problem: the 'Viking' was too bulky for the important waterways such as the Panama or Suez canals. In addition, a stopping distance of six kilometers limits the operational areas even further. When environmental protection regulations also got in the single-hull tanker's way, it cast anchor and served as floating tank storage between 2004 and 2009 before scrapping began in 2010.*

CONTAINER GIANT

The 'CSCL Globe' shoulders a near unbelievable 19,100 containers on its back. *At 399.67 meters in length and 58.60 meters wide, the gigantic freighter is currently the world's biggest and longest container ship in operation. On its transport route between Europe and the Far East, the 'CSCL Globe' is propelled by a powerful 77,227-hp two-stroke MAN diesel engine. In this aspect must the 'Globe' sadly concede: the 'Emma Mærsk' and its sister ships plough the world's seas with 109,000 hp two-stroke diesels.*

FIRST SOLAR CIRCUMNAVIGATOR

Around the globe at sea – only with solar energy. *Built in Kiel, the catamaran 'Tûranor PlanetSolar' achieved this previously unmatched feat in 2012. The futuristic looking ship completed the 60,000 kilometers in 584 days, 23 hours and 31 minutes. On their circumnavigation, the five-person crew was reliant on the energy supplied by 38,000 solar cells. When the sun shone, the 31-meter long catamaran ploughed through the waves at six knots. In bad weather and darkness, the reserve batteries propelled the ship for another three days. By the way, the name Tûranor originates from the Lord of the Rings novels and means 'Power of the Sun.'*

DEEPEST DIVE

On January 23, 1960, the submarine 'Trieste' reached Challenger Deep in the Mariana Trench. *The measurement instrument showed the two-man crew of Jacques Piccard and Don Walsh a depth of 10,916 meters. To this day, no submarine – manned or unmanned – has dived deeper. Filmmaker James Cameron ('Titanic') also failed in his attempt to surpass the probably all-time record. With his 'Deepsea Challenger' (photo left), he reached 10,908 meters. However, the three hours he spent on the ocean floor was considerable longer than his two predecessors did in the 1960s. While humans would simply be crushed at this depth with a pressure exceeding one tonne per square centimeter, there are animals in the deep sea that withstand these extreme conditions.*

IMPOSING WARSHIP

The 'USS Enterprise,' launched in 1961 and decommissioned in 2012, was the first nuclear powered aircraft carrier (range: 800,000 nautical miles or 13 years), *and even today is the longest warship in naval history. At 342.3 meters in length, the Enterprise is almost as long as the Empire State Building is high. 5,230 crew members and as many as 110 aircraft were stationed onboard. Only the displacement of the Enterprise was bettered by another floating airport: the 'USS Nimitz' weighs in at 97,000 GRT, 'Big E' at 93,234 GRT (Gross Registered Tons). Nevertheless, hardly any other ship in the US Navy is so well known. The Enterprise also lends its name to the TV spaceship of the same name and was the setting for the film 'Top Gun.'*

LONGEST CRUISE LINER

At a length of 362 meters, a width of 47 meters and a draught of 9.1 meters, the 'Allure of the Seas' is the world's biggest cruise liner *and, due to construction tolerances, a hand's width bigger than the identical sister ship 'Oasis of the Seas.' Up to 5,400 guests bustle on 16 passenger decks. In addition to a 'Central Park' with 12,000 real trees, the floating small town provides the usual cruise ship luxury and also a 25-meter high rope slide and an artificial wave machine for surfers. All of this would make the good old 'Titanic' sink alone through envy – without an iceberg. The two jumbos ply their trade in the Caribbean and Mediterranean Sea.*

FASTEST BOATS

The speed record set by Ken Warby and his 'Spirit of Australia' in 1978 has existed for almost 40 years now. *Propelled by a jet turbine, the homemade wooden boat skips across the water at 275.98 knots (511.11 km/h). The fastest sailing ship was not quite as fast. However, 'Sailrocket 2,' which glides over the water like a hydrofoil boat, still reached 65.45 knots (121.21 km/h) in 2012.*

BIGGEST MEGA YACHT

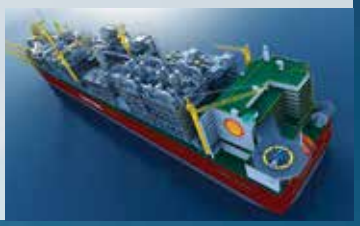
Superlatives bring great prestige specifically in the area of private mega yachts. *The Russian oligarch Roman Abramovich had good reason to be annoyed after completion of the 'Azzam.' The 180-meter construction launched in 2013 by the Bremen based Lürssen shipyard for Sheik Khalifa bin Zayed Al Nahyan from the United Arab Emirates topped his 'Eclipse' by 18 meters. It remains to be seen whether Abramovich can still brag about owning the world's most expensive yacht, because reliable information is shrouded in secrecy. Purchase prices of around 800 million euro circulate for both ships. However, for both boats this lofty sum includes a submarine and a missile defense system onboard.*

THE STRONGEST ICEBREAKER

The Russian icebreaker '50 Let Pobedy' (50th anniversary of the victory) rams its bow with the power of 71,788 nuclear generated horsepower into frozen ice and even breaks through five meter thick ice blocks. *As part of the torch relay on the way to the 2014 Winter Olympic Games in Sotschi, the audacious power pack brought the Olympic flame from its homeport Murmansk to the North Pole in a record time of 91 hours and 12 minutes. The ship is equipped with a sports center, sauna, swimming baths, library and a restaurant. Not just the 138 crew members enjoy these facilities. During the ice-free season, the icebreaker sets sail on tourist expeditions along the route Murmansk–North Pole–Franz Josef Land.*

BIGGEST FLOATING OBJECT

488 meters long, 105 meters high and a water displacement similar to the six biggest aircraft carriers all together *– the 'Prelude' is the largest floating object capable of maneuvering itself. Equally monumental: the construction costs of over 10 billion euro. The mix of drilling rig and tanker should start operation off the West Australian city Perth in 2015. It should retrieve, process and store natural gas. To liquefy the natural gas, the 'Prelude' needs 50 million liters of water every hour.*



OLDEST SHIP

The frigate 'USS Constitution' commissioned in 1798 is the world's oldest seaworthy ship. *Because cannonballs allegedly rebounded from the thick Virginian oak sides of the ship in combat with the British frigate 'Guerriere' in 1812, the three-master bears the nickname 'Old Ironsides.' During its days as an active warship, the 'Constitution' armed with 55 cannons sank or scuttled 35 enemy ships, the majority of them English. At that time, 450 men crewed the US Marines' flagship, today it is 55. To serve on the museum ship today is regarded as a special distinction.*

SCHAEFFLER AT SEA

Schaeffler bearing technology is also an integral part of the shipping industry. *For example, in the giant cruise liner 'Celebrity Solstice' that made its maiden voyage in 2008. Two axial and one radial spherical roller bearing from FAG per power unit ensure that the largest ship built in Germany at that time accelerates to a speed of 24 knots (45 km/h), steers safely and can be stopped with pinpoint accuracy. Minimal wear and low friction running make an important contribution to the efficient, low maintenance propulsion. However, Schaeffler expertise is not only in demand in the drive field. Bearings are also used during loading and unloading – the majority under the toughest conditions. Like on the world's largest working vessel 'Pioneering Spirit' (photo). Schaeffler supplies over 240 bearings with an external diameter of between 400 and 1,060 mm for the 'Topsides Lift System,' the lever mechanism for oil drilling platform superstructures. The 382 meter long and 123.75 meter wide 'Pioneering Spirit,' which was launched as 'Pieter Schelte' in 2013, is furthermore the biggest ship ever built according to gross tonnage (403,342 GRT) and width. The total cost of the ship used for pipeline and drilling platform construction was estimated at three billion US dollars.*

In cooperation with ABB, Schaeffler adapted its fully variable valve control system UniAir found in car engines to suit the large 500 kW plus engines used in shipping. Combined with an ABB high-pressure supercharger, the UniAir system considerably improves the efficiency of the power plant.

ELECTRIFYING FUTURE

Nowhere is electromobility more sexy and emotional than in the Formula E race series. Technology partner Schaeffler joins the action.

by Mark Schneider


SCHAEFFLER
ABT
QUALCOMM
MICHELIN

At the heart: with the ABT squad, Schaeffler developed a drivetrain for the single-seater

361,000 spectators at the tracks, 187.5 million TV viewers and almost 6,700 hours of high-voltage racing broadcast on channels worldwide: in its first season, the Formula E series has had a powerful impact. Initially regarded with scepticism by some observers, the first racing series to campaign electrically-run single-seaters has firmly established itself in the world of motor racing. As the exclusive technology partner, Schaeffler was there right from the start and, in collaboration with the German team, has developed its own powertrain for the second season. The squad, ABT Schaeffler Audi Sport, takes on the international competition.

Contesting Formula E as a showpiece

"The entire field of electromobility, including hybrid solutions and electrical drive, will greatly influence future mobility," states Prof. Peter Gutzmer, CTO at Schaeffler, describing the company's commitment. "To be at the forefront here, our involvement in the Formula E is ideal and stands us in good stead as a role model: our engineers should push the limits and seek out competition – both in production and motorsports." And the techies have taken this to heart. Gutzmer says: "We have addressed all areas that allow us leeway within the regulations and, alongside our partners, we've developed our own, optimized solutions."

Fast ambassadors: Daniel Abt (left) and Lucas di Grassi compete for the ABT Schaeffler Audi Sport team

While all teams contested the inaugural Formula E season with identical cars, for the 2015/2016 season the design of the entire drivetrain is now left to them. At the heart lies the electric engine, dubbed the 'ABT Schaeffler MGU 01.' The focus was on development and achieving the best possible efficiency, high reliability and optimal

temperatures, thanks to modified cooling. “Our engine has improved torque and better efficiency than its predecessor,” says Prof. Peter Gutzmer. Just six months after initial discussions, the first parts were produced and sent off for testing. This was followed by countless hours on the computer, on test benches and on the race track. “The timing was tight, as it always is in motorsports, but we did it,” says Gutzmer. After final tests in late August, the material and the four race cars were loaded up and transported by rail from Great Britain to China.

After the first race in Beijing, the circus then sets off on a world tour to Malaysia, Uruguay, Argentina and the USA and back to Europe, where appearances are scheduled in Paris, Moscow, Berlin and London.

WORLD PREMIERE AT DONINGTON

In late August at Donington *(Great Britain), journalists from all over the world got their first glimpse of the new design and gained an exclusive insight into the technology of the ABT Schaeffler FE01. During the last official tests before the start of the new season, the ABT Schaeffler Audi Sport squad unveiled its electric racer. And, of course, Schaeffler board member Prof. Peter Gutzmer, the two pilots Daniel Abt and Lucas di Grassi, as well as team boss Hans-Jürgen Abt were there as well.*

Schaeffler also developed a new transmission specifically for the engine, which was manufactured by the renowned partner Hewland following specific requirements. It is now stiffer and more compact. In order to achieve the goal of less gear shifts per lap, the engineers opted for a variant with three gears. The suspension also underwent fine-tuning, resulting in increased rigidity and improved kinematics.

Swift ambassadors in the cockpit

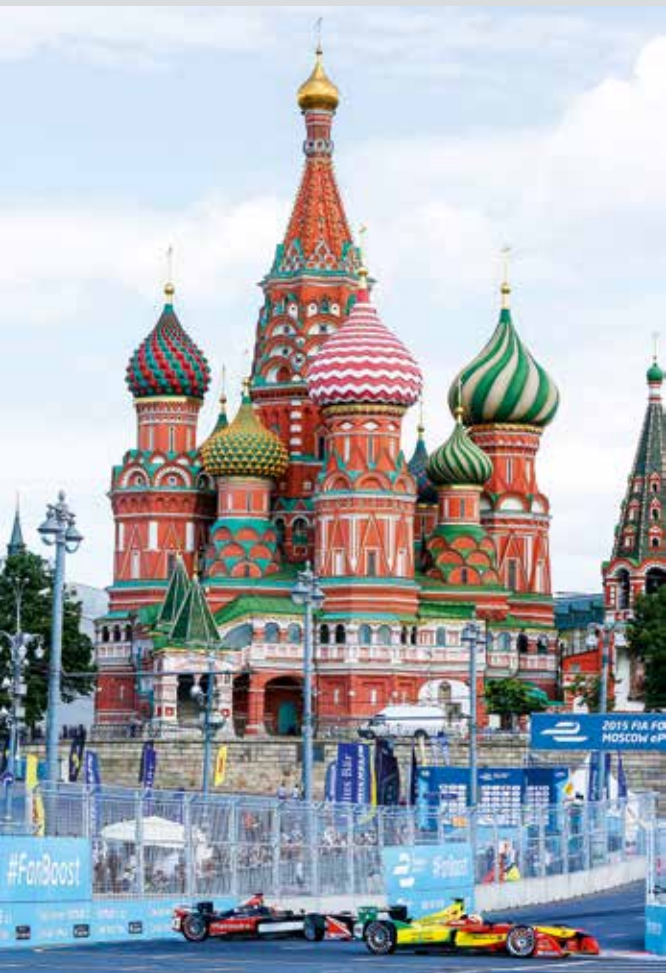
Linking all the elements is the redeveloped software, which is responsible for the interaction of all components. Perfecting the functionality took priority in the test drives.

Shaping mobility for tomorrow – Schaeffler pursues this mission statement with a commitment to 'E-racing' in order to advance developments for daily life. The fast ambassadors for pioneering technologies are Daniel Abt and Lucas di Grassi, who man the cockpits of the ABT Schaeffler FE 01. During their first season, the German-Brazilian duo clinched third overall in the teams' classification.

Teamwork pays: technical director Franco Chiocchetti with sports director Thomas Biermaier, board member Prof. Peter Gutzmer and team boss Hans-Jürgen Abt (above, from left). Popular man: Daniel Abt signs autographs in the pit lane (bottom left). Hard work: testing at Donington, the team gives the car its final tweaks before the season kicks off

FORMULA E **2015/2016 CALENDAR**

October 17	*Beijing (CN)*
November 7	*Kuala Lumpur (MAL)*
December 19	*Punta del Este (ROU)*
February 6	*Buenos Aires (RA)*
March 19	*Mexico City (MEX, TBC)*
April 2	*Long Beach (USA)*
April 23	*Paris (F)*
May 21	*Berlin (D)*
June 4	*Moscow (RUS)*
TBD	*London (GB)*



New look: even more distinctive Schaeffler livery emblazoned on the sides of the ABT Schaeffler FE01

Lucas di Grassi even battled for the drivers' title to the very last of eleven rounds. No other pilot climbed the podium as often as the South American flying the Schaeffler colors. "Next season we want to fight for the title again. That was and still is our goal," says Lucas di Grassi, who in the past has competed in both Formula 1 and at the 24 Hours of Le Mans. "With Paris we have a fantastic new venue on the calendar. And by developing our own drivetrain, the competition between teams is lifted to a whole new level."

Electricity instead of gasoline, kilowatts instead of horsepower, and high-frequency whirring instead of roaring engine sounds – that's Formula E. And aside from technology, the FIA-approved series strikes out in a new direction as well: the races will not be contested on sterile race tracks out in the country, but in the heart of cities. Long commutes are avoided; spectators can arrive by bike or subway. And they can bring their families with them to witness the action without having to wear ear plugs. This is how future mobility in an urban setting could look.

» Change and transformation are loved by those who live Richard Wagner

in motion

Mobility in the course of time

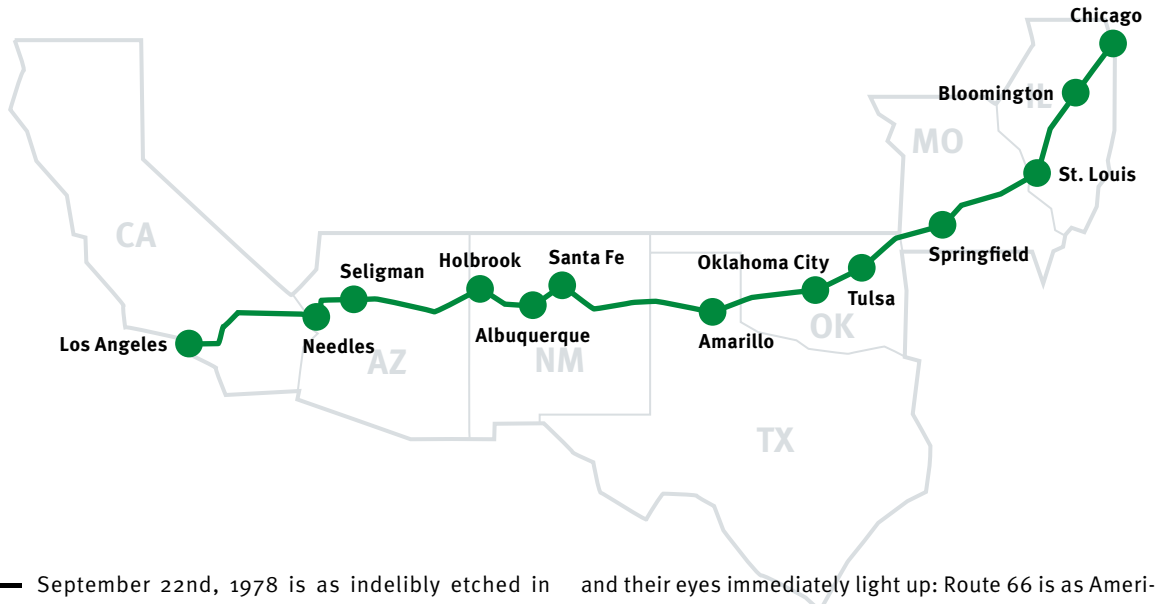
CHANGING SIDES

You've probably wondered at least once what would happen if a country changed from driving on the right to the left or vice versa. The Swedes did exactly this: on September 3, 1967, a Sunday, their traffic world changed. Instead of driving on the left, they now drove on the right like the rest of mainland Europe. Thanks to low traffic density, good preparation and a generous amount of police, the changeover ran more smoothly than the photo would otherwise suggest. The Japanese island Okinawa made the last big 'lane change.' In 1978, six years after the US occupation ended, the island returned to driving on the left like the mother country. Currently, 59 countries on earth drive on the left. A direction of travel that probably arose in medieval times: because in an unpleasant encounter, a fighter riding on this side could thrust their sword quickly with the right hand towards the opponent. When Napoleon later conquered the majority of Europe, he introduced his favored right-hand traffic, which established itself in this and many other regions over time. The minority of countries with left-hand traffic include former colonies like Hong Kong (see also page 8) and Macau – in contrast to its new mother country China. The traffic flow is reversed here using lane-changing bridges at the transition points.

MOTOR WEST
ON THE HIGHWAY THAT'S BEST

Route 66 – the blacktop of America's original highway may be dilapidated, but the legend lives on. The once indispensable 'mother road' is no longer used simply as a means of transporting goods from A to B, instead travelers who take Route 66 today are looking for one thing: freedom, endless freedom.

by Lukas Stelmaszyk



September 22nd, 1978 is as indelibly etched in the memory of Angel Delgadillo as Route 66 is in the North American landscape. On this day, the Interstate 40 replaced the legendary stretch in Delgadillo's home state of Arizona. At first he felt sad and then angry, says the hairdresser. Now 88 years old, he has lived his whole life on Route 66. Delgadillo was born in a roadside house in the little town of Seligman five months after the 'Main Street of America' was opened on November 11th, 1926 – and there he stayed.

» Those looking for the old America will find it on the historic Route 66

Angel Delgadillo

Ever since the former U.S. Highway 66 was downgraded to a secondary road, the sprightly pensioner has battled to prevent the glory from fading by founding the 'Historic Route 66 Association.' In the meantime, Delgadillo has become a living Route 66 legend and the number of fellow campaigners has grown rapidly. Many 'Historic Route 66 Association' outposts have cropped up along the entire route.

Despite these efforts, the image of the pulsating artery between Chicago and the Midwest to Santa Monica in sunny California has changed. Today empty gas stations, derelict hotels and cracked road surfaces are what's left along very possibly the most famous road in the world. Today, only 85 percent of the route is fit for traffic. But its unmistakable charm keeps shining through. Talk to bikers and vacationers who have driven Route 66 themselves, and their eyes immediately light up: Route 66 is as American as fast food, American football and the star-spangled banner. Still today, the interstate strip of road traversing the continent represents the daring and pioneering spirit of Americans. With the industrial development of the United States spreading to the west in the early 20th century, combined with the as yet unquenched thirst for mobility, the 3,945 kilometer long Route 66 played a major role.

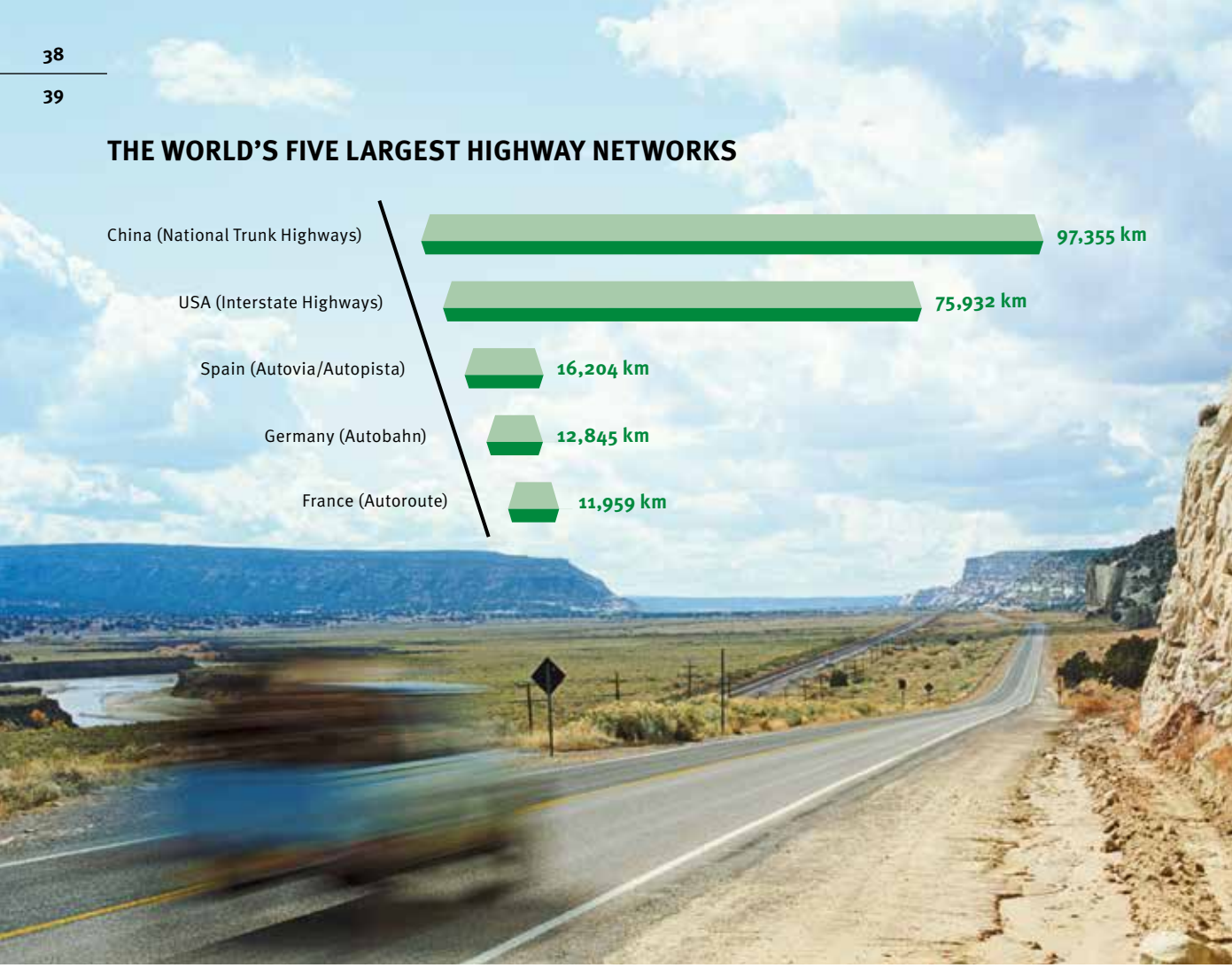
Around 1900, a paved East-West connection was still an American dream. When the USA had to absorb the final great wave of European immigrants at the end of the 19th century, the east coast was already densely populated and the space and resources in the neighboring Midwest had markedly dwindled. Droughts and unemployment spread – and hordes of fortune-seekers set out for the promises of the west. The reasons were anything but romantic. Unlike the tourists today, for many back then it was a matter of survival, or at least a better life. The rich soils of California lured many rural workers and farmers. Other professions followed.

The dusty National Old Trails Road, which Route 66 would essentially follow, served as the main trunk line in the early 20th century. But it was anything but modern. In 1916 at the wheel of a Cadillac 8, legendary race driver Erwin G. 'Cannonball' Baker took seven days to traverse the country from Los Angeles to New York.

INTERESTING FACTS ABOUT ROUTE 66

- *Opened on November 11th, 1926*
- *The name 'U.S. Highway 66' is repealed on June 27th, 1985*
- *The original route covered over 3,945 km (8 states, 3 time zones)*
- *Starting point Chicago (Illinois), ending in Santa Monica (California)*
- *85 % of the route is fit for traffic*
- *Author John Steinbeck gave it the nickname 'Mother Road' in his novel 'The Grapes of Wrath'*
- *The song 'Get Your Kicks On Route 66' by Nat King Cole climbed to third on the American R&B charts in 1946*
- *116 episodes of the series 'Route 66' were broadcast on American television from October 1960 to March 1964*
- *The venue of the 10-day American Solar Challenge cross country race for solar-powered cars in 2001 and 2003*

THE WORLD'S FIVE LARGEST HIGHWAY NETWORKS



With the advent of motorized vehicles, the demand for paved roads increased significantly. While there was one car for every 18,000 inhabitants in the U.S. at the end of the 19th century, this ratio now exploded. Henry Ford was partly responsible for this: in 1914 mass production of his 1908 'Model T' began in earnest. Millions of Model T Fords, affectionately dubbed 'Tin Lizzy,' roared onto the streets of America.

To make long distance trips easier, the call for more interstate roads intensified. And the government heard it: U.S. President Woodrow Wilson approved the construction of a national highway network in the Federal Aid Road Act of 1916, with a total budget of 75 million U.S. dollars (today's value about 1.7 billion USD) earmarked for the project over the following five years. The First World War, however, delayed the construction process considerably.

Only in the early 1920s did the project get the green light again and a building boom followed. In 1922 General John Joseph Pershing presented his concept of a nationwide highway network to the Federal Congress. Named in his honor, the 'Pershing Map' outlined roads with a total length of 130,000 kilometers – the basis for the expansion of a road network throughout the USA.

Route 66 was fully paved for the first time in 1938

This included Route 66. When the new road was opened officially in November 1926, only 800 kilometers of the entire distance was paved. Nevertheless, Route 66 became the most widely-used passage to the west. 'Cannonball' Baker again decided to take a look for himself: in 1933 the race driver crossed the country, this time from east to west. At the wheel of his Graham-Paige Blue Streak he followed a large part of Route 66 and it took him just 53 hours – a record time that stood for almost 40 years.

In 1938 all the dirt passages of Route 66 had disappeared and the entire route was paved – the East-West connection experienced its first heyday. Motels with blinking neon lights grew like mushrooms at the side of the road and lured travelers in droves. Eating too sped

Typical image on Route 66: the ravages of time have eaten away what was once the most important interstate route in America

up. In 1934 in the town of Normal, Illinois, the first convenience restaurants opened their doors with set menus and small portions. Route 66 had become the birthplace of fast food chains. Unsurprisingly, McDonald's staked its first claim here. In May 1940 in the town of San Bernardino, California, the future fast-food giant opened the first of around 34,500 franchises today. Drive, eat, drive, shop, drive, sleep: Route 66 became the perfect microcosm of a mobile life.

World War Two and the associated rationing of gas and tires led to a depression into the late 1940s. Straight after the war another boom saw more than 200,000 jobs created on the west coast through the burgeoning defense and aerospace industries, and at the same time faster, multi-laned roads were being built over the entire country based on idea of the German autobahn. Under President Eisenhower, the US Government set aside 30 billion dollars in 1956 from their Federal Aid Highway Act for the construction of 66,830 kilometers of highways.

The construction of the interstate network marked the beginning of the end for Route 66: the legendary narrow and winding stretch became increasingly unattractive for long haul distances, the infrastructure went into decline. But the yearning for remote landscapes, idyllic bridges and quirky people that are reflected in the legend of adventure and freedom is still being quenched – Angel Delgadillo and his comrades-in-arms fight for this every day.

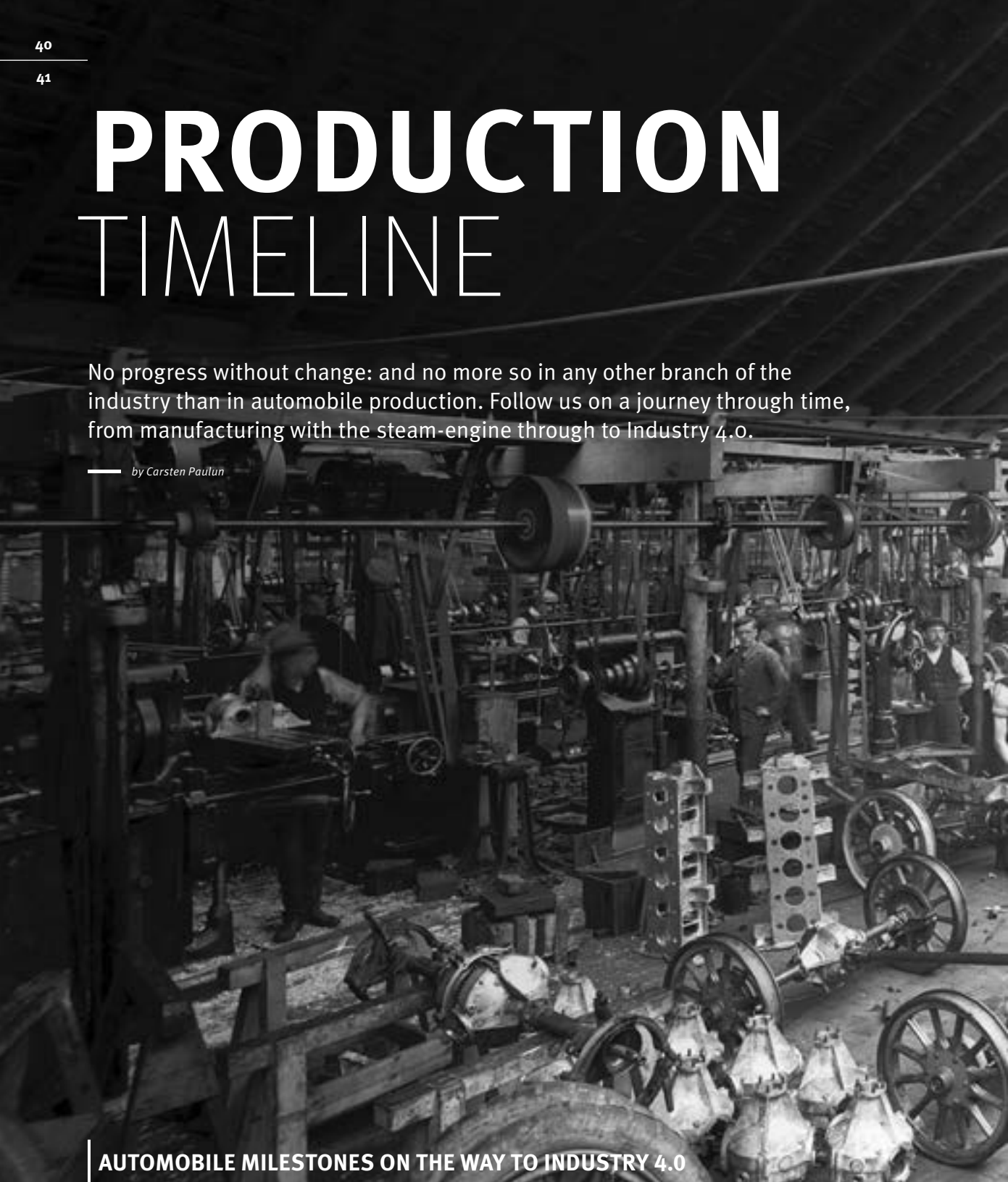
THE AUTHOR

Lukas Stelmaszyk *has been working as an editor in the field of sport for twelve years, with his current focus being in motorsport. With Route 66 he is brought into contact with his own wanderlust. His personal 'Route 66' is the stretch between his hometown of Cologne and his adopted home of Hamburg.*

PRODUCTION TIMELINE

No progress without change: and no more so in any other branch of the industry than in automobile production. Follow us on a journey through time, from manufacturing with the steam-engine through to Industry 4.0.

by Carsten Paulun



AUTOMOBILE MILESTONES ON THE WAY TO INDUSTRY 4.0

1886

Carl Benz receives the patent DRP Nr. 37435 for his Benz Patent Motor Car No. 1 on November 2, 1886.

1887

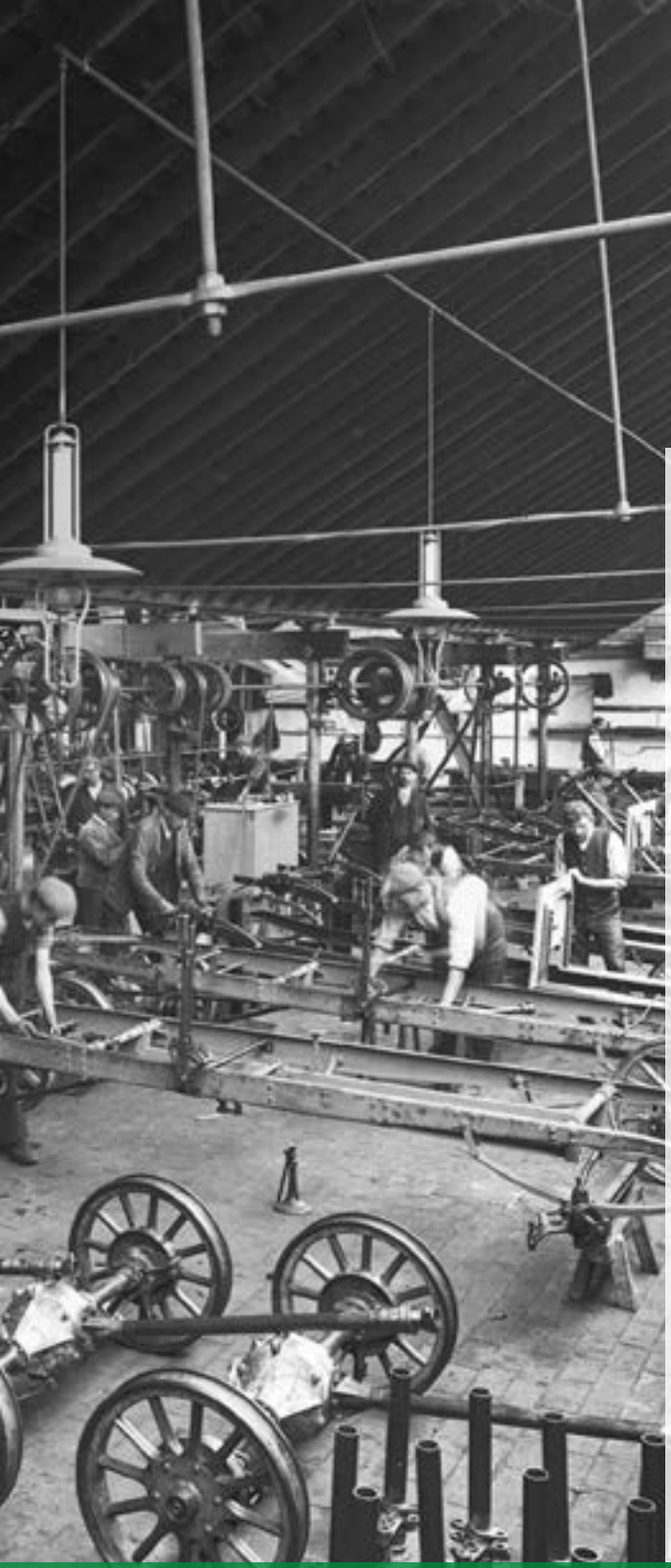
Rudolf Diesel designs an engine which is named after him. The first motors were built in conjunction with MAN.

1891

Frenchman Édouard Michelin invents the pneumatic tire with inner tube. Both ensure greater driving comfort and safety.

1894

Alfred Vacheron replaces the steering crank with a steering wheel in his Panhard 4hp. Four years later, Panhard & Levassor fits the steering wheel to its cars as a standard feature.



MANUAL LABOR INDUSTRY 1.0

Two decades before the first automobiles rolled off the assembly line, vehicles were already being produced in series. In spite of the assistance from steam engines, which had triggered the industrial revolution in the late 19th century, a great deal of manual labor was needed. The photo here shows a factory in the British Midlands in the year 1907. But as early as 1891, Panhard & Levassor, as the first company in the world, produced and sold a small series of vehicles powered by combustion engines. In the Paris assembly plant of the former woodworking-machine factory, the reek of soot, hot oil and the sweat of laborers lingered. The machinery for manufacturing components was driven via belts from steam engines and later from self-fabricated gas engines. Initially, tamped clay was underfoot, but was later replaced by bricks. Despite various furnaces, the halls were very cold in winter. Nevertheless, the production plant at Panhard & Levassor was regarded as modern for the conditions of that time. Still, the amounts to leave the factory were homeopathic (in six years only 180 vehicles were built), and the selling price was correspondingly exorbitant.

The engine of the first production vehicle, the P2D, was manufactured under the license of the German Gottlieb Daimler. The first five vehicles were delivered to customers in 1891. Already back then, Panhard & Levassor commissioned subcontractors to manufacture parts for the P2D and used coaches to deliver them to the production facility. The growing number of motorized transport vehicles allowed the entire fledgling automobile industry to flourish.

1900

The Lohner-Porsche designed by Ferdinand Porsche features an electric motor on each of the four wheels. This is hailed as the first all-wheel drive.

1902

Frederick Lanchester from Great Britain is awarded the patent for the disc brake. It is used for the first time in 1948 in the Tucker Torpedo.

1903

Gustave-Désiré Leveau invents the safety belt. This, too, is debuted in the Tucker Torpedo.

1911

The Marmon Wasp, the winner of the maiden Indy-500 race, is the first car to feature a rear-view mirror.

1912

Cadillac is the first manufacturer to put an electric starter motor in its vehicles.

ASSEMBLY LINE PRODUCTION INDUSTRY 2.0

"The car has no future. I'm putting my money on the horse," said Kaiser Wilhelm II in 1903. Ten years later, an American proved just how wrong the German Emperor was, and wrote history – industrial history. Henry Ford introduced the 'moving assembly line' in 1913, the first in automobile production. The photo shows Ford's Highland Park factory in Detroit around 1914.

With this, Ford increased production eightfold, with the price of the Ford Model T simultaneously dropping to the point that the general public could afford a car. And Ford paid his workers a minimum wage of US$5 a day, while most others were earning US$2.34. Henry Ford also realized that components for industrial mass production had to demonstrate consistently reliable production tolerances and high quality. In addition, he relied on simple technology. The Ford T had neither a conventional transmission with clutch and gear stick, nor a cooling water pump, oil filter and dipstick nor fuel pump. Repairs were easy and spare parts could be ordered at every hardware store.

The fact that the 'Tin Lizzy' only came in black had two production reasons: black was the color that dried the quickest, and a second or third color would have thrown a spanner in the production works. Up until the end of production of the Ford T 1927, more than 15 million vehicles had rolled off the assembly line. This record was only broken in 1972 – by the VW Beetle.

And by the way: the first German vehicle to be built on the production line from 1924 was the Opel PS4, nicknamed the 'tree frog.'

1914

Malcolm Loughead invents the hydraulic brake. However, it would take another 50 years before vehicles are equipped with mechanical cable-operated brakes.

1923

The latest trend in the USA is cars featuring electric windshield wipers.

1932

The first car radio is unveiled at the International Radio Exhibition in Berlin.

1938

Headrests in the Buick provide added driving comfort.

1938

The ‘Volkswagen’ people’s car, developed by Ferdinand Porsche, is now ready for series production, but mass production only begins after the war.

1939

The American carmaker Packard fits the first air-conditioners to its vehicles.

1939

General Motors launches the first automatic car transmission.

MAN, GET STUCK IN INDUSTRY 2.1

It runs and runs and runs – until production finally halted in 2003. No other product symbolizes the German economic miracle of the post-war era better than the VW Beetle.

In December 1945, directly after the Second World War, production of the Volkswagen began with massive British support. After a slow start due to high levels of ill health, quick staff turnover, shortages of raw materials, as well as massive wartime damages, the assembly lines began to pick up speed. In 1954, 246,000 Volkswagen cars were built. Volkswagen adapted the manufacturing methods of the American automobile industry, which, following on from the first assembly line, became increasingly automated under the name 'Detroit Automation.' However, the virtually complete removal of the human factor proved to be a dead end. As a result of increasingly shorter model cycles and more complex specifications, the mechanical machine monoculture of that time proved significantly less lucrative than expected. The service lives of the inflexible and expensive equipment were too short, and a new arrangement too time-consuming. The decision-makers at VW recognized this weakness early on and addressed it by putting their trust in the symbiosis of American methods, in the diversified production that was popular in Germany, and in the historically-grown cooperation between management and workforce. Still today, workers enjoy a high level of control within the VW Group.

After churning out 11,916,519 Beetles, VW finally halted production at the Wolfsburg facility on July 1, 1974. At Karmann in Osnabrück, the last 'European' VW Beetle rolled off the assembly line on January 10, 1980. It was a convertible. And on July 30, 2003, the very last Beetle in the world, with the production number 21.529.464, was built in Mexico.

1948

Michelin develops the first radial tires for Citroën. They last longer and offer more comfort and safety than the previous bias tires.

1949

The development of the needle-bearing cage by Dr. Georg Schaeffler is an important contribution to the development of efficient and cost-effective automobiles.

1951

Chrysler is the first manufacturer to offer power steering as an option in its sedans for effortless driving.

1951

The Munich inventor Walter Linderer applies for a patent for the airbag. The first vehicles with airbags are available in the USA from 1974.

1952

Daimler-Benz designer Béla Barényi invents the deformation zone. Safety is afforded increasingly more importance in automobile construction.

1958

The Chrysler 300 is the first production car to feature an electronic injection system. In Germany, FAG Kugelfischer pioneers the Kugelfischer fuel injection in the 1960s.

1963

In Germany, the previously-used extendable indicator must be replaced with the electric blinker.

1978

Once again, Mercedes-Benz sets a milestone in vehicle safety with the first anti-lock-braking system in the S class.

1983

With the Electronic Pilot for Motorists (EVA) from Blaupunkt, car drivers can now navigate for the first time without printed road maps.

1985

With the C-Netz – a first generation analogue cellular device used primarily in Germany – the first telephone without a switchboard and with significantly fewer disconnections is built into cars.

ROBOTIC CO-WORKERS INDUSTRY 3.0

1961 could well be called the bleakest year for the labor movement. Or the most fortunate. In 1961, General Motors introduced the first industrial robot to one of its production lines. The 'Unimate' took parts from a material cart and lifted them onto the production line. Later, it was also able to perform welding work in inaccessible places. Initially, these robots were driven hydraulically. Since the mid-seventies, however, the automatons have been replaced by electric actuators with a microprocessor controller.

Initially, they could only complete simple tasks, whereas today's robot can assemble, glue, weld, package, stack, lacquer, split, measure, fold and much more. The robot population has increased year to year, peaking in the late 1980s in the Fiat Cassino plant. Here, 40 percent of the work was to be done by machines. Production actually began at the factory, but it never reached the expected level of automation. In fact, this was also the case at other factories with high levels of automation, for example at Hall 54 at VW. Man and machine were equally to blame. The robots proved incapable of dealing with unexpected situations in the production process. And the assembly line workers were assigned the monotonous, undemanding jobs. Discontent and the number of work days lost due to illness increased dramatically. Later, work islands were introduced, albeit still on the assembly lines, but employees shared more of the process stages. This paved the way to Industry 4.0.

1993

Ford becomes the first manufacturer to introduce a parking aid with ultrasonic sensors.

1994

The first vehicles from BMW, Ford and Volvo mounted with natural gas engines are delivered to German dealerships.

1995

Mercedes-Benz launches the Electronic Stability Program ESP for the S class – after the seat belt, ABS and airbag, this marks the next major safety milestone.

1997

With the Prius, Toyota launches the first mass production car featuring hybrid drive: a combination of electric and combustion engines on an axle.

2000

Citroën and Peugeot develop the diesel particle filter for cars and plant it in the C5, 406 and 607 models.

2001

As the first high-volume model, the Nissan Cima luxury sedan receives Lane Keeping Assist support, which warns drivers when veering off the lane.

2005

'Stanley,' the VW Touareg developed by Sebastian Thrun, wins a competition for driverless vehicles – the beginning of autonomous cars.

2008

On March 17, the new electric car marque Tesla unveils its first model, a roadster based on a Lotus.

WITH BITS AND BYTES INDUSTRY 4.0

New technologies, new materials, and increasingly rapid model changes require new production methods. This is achieved by networking and digitalisation. Information and communication technologies will merge with automation and production. Welcome to Industry 4.0. The assembly line, the likes of what Henry Ford once created, has long since become obsolete in many factory buildings. To satisfy the needs of car buyers, manufacturers must react faster and more flexibly. Development comes under enormous time pressure, production is put under massive cost pressure. The depth of production will continue to shrink, already today suppliers are given the responsibility for the development and manufacturing of entire modules. These components are then delivered to the carmakers' factories and assembled in the vehicle. And production itself becomes more digitalized. Today, every wrench, robot and tool in an assembly facility are networked. Every tightening torque for each screw is controlled and logged. Welding seams are already checked during the process, any errors are immediately identified and automatically corrected. Cars roll autonomously on special carriages in ultra-clean halls from one assembly stage to the next.

Instead of welding metal, carbon and aluminium are glued, like on the BMW i3. Modern car factories generate their own electricity via solar panels and wind turbines. It still takes manpower, but the requirements are becoming higher and this is generating a growing demand for specialists who can deal with highly complex systems.

THE AUTHOR

Carsten Paulun *worked for many years as the department head of 'Auto & Technik' at the BILD newspaper. After switching to freelancing, he has remained true to his specialist area. Backed by an excellent network, he takes an in-depth look behind the scenes of the industry.*

2010

The Chevrolet Volt is launched in the USA as the first large-scale production car featuring a range extender. The sibling model Opel Ampera follows on January 14, 2012.

2012

Volvo again positions itself as a safety-conscious marque with the first pedestrian airbag in the V40. The airbag deploys between the engine hood and the windshield.

2013

Hyundai offers the first automobile with a fuel cell. This generates emission-free energy from hydrogen and oxygen. The ix35 Fuel Cell costs 65,450 euro.

2014

The BMW i8 is the first production car with laser light on board. At 600 meters, it illuminates two-times the distance of an LED beam.

MILESTONES
50 YEARS LUK

Efficient, comfortable and innovative drivetrains – these attributes distinguish LuK. Quality, technology and innovation shape the image. The success story began with the entrepreneurial decision taken by brothers Dr. Georg and Dr. Wilhelm Schaeffler to contribute substantially to the company 'Lamellen und Kupplungsbau August Häussermann' and subsequently to establish the company LuK. LuK has produced diaphragm spring clutches since 1965. Today, every third car worldwide rolls off the production line with an LuK clutch. A summary of the six most important technical milestones from the last half century.

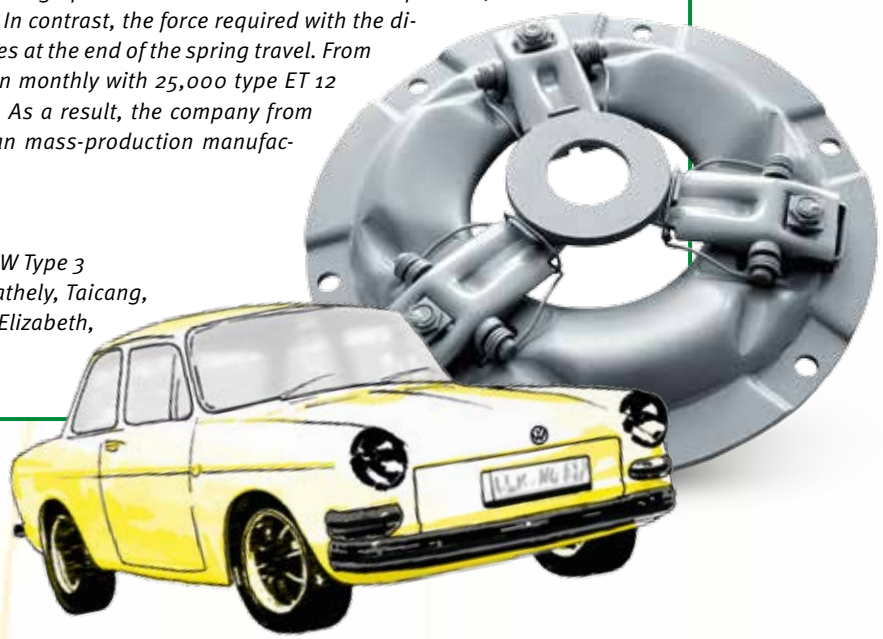
by Alexander von Wegner

MORE EFFICIENCY FOR MORE POWER

DIAPHRAGM SPRING CLUTCH

It was the development in the automotive industry that also increased demands on supplier products. The VW Beetle originally produced 25 hp and 67 Newton meters torque, these values climbed in the Type 3, the VW 1500, to 54 hp and 106 Newton meters. Engines producing increasing amounts of power required greater contact pressures in the clutch. The coil spring clutch in the Beetle was no longer up-do-date due to the high pedal loads. The more it was compressed, the greater the effort required. In contrast, the force required with the diaphragm spring actually reduces at the end of the spring travel. From 1965, LuK supplied Volkswagen monthly with 25,000 type ET 12 lever-arm diaphragm clutches. As a result, the company from Bühl became the first European mass-production manufacturer of this type of clutch.

Development year: *1965*
First production installation: *VW Type 3*
Production sites: *Bühl, Szombathely, Taicang, Hosur, Sorocaba, Puebla, Port Elizabeth, Ulyanovsk, Rayong*
Quantities produced: *500 m.*



CALMING INFLUENCE

DUAL MASS FLYWHEEL

The two oil crises in the 1970s drove prices at the filling stations up by 70 per cent. The automobile manufacturers reacted with economical drivetrains like the diesel engine, and thanks to turbocharging and direct injection, the power figures increased dramatically. With combustion engines – especially with such powerful diesel engines – irregular rotations occur. Without vibration damping the oscillations are transmitted into the transmission where humming and rattling noises occur. Because conventional torsion springs are overstressed by the powerful engines, LuK developed the dual mass flywheel. One mass is connected to the engine crankshaft, the other with the transmission input shaft. Elbow springs connect both masses and ensure smooth running. In 1985, the innovation broke into mass-production at BMW in the 324d. In addition, LuK has integrated a centrifugal pendulum into its flywheel since 2008. Thanks to the combination of the dual mass flywheel's spring mass system and the centrifugal pendulum, more than 90 per cent of the oscillations are isolated.

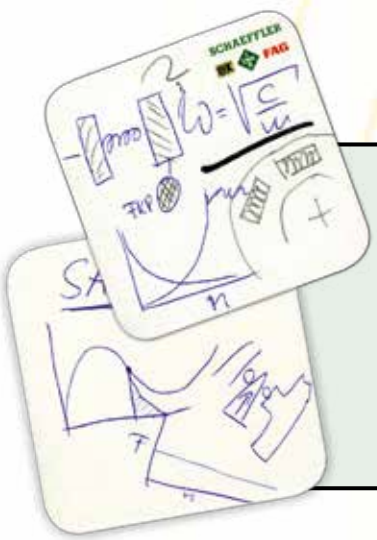
Development year: *1985*
First production installation: *BMW 324d*
Production sites: *Bühl, Szombathely, Taicang*
Quantities produced: *100 m.*

NO MAINTENANCE

SELF-ADJUSTING CLUTCH (SAC/TAC)

Significantly improved rust prevention extended the car's lifespan by an average of seven years in the 1980s, and today by around 18 years. A consequence: the mileages increase, and the components must also last longer. In the mid-1990s, LuK developed the Self-adjusting Clutch (SAC). As the friction lining wore, the clutch adjusted itself and compensated for the wear. Consistent pedal feel, the increased life-span and greater comfort, all ease everyday motoring and are kind to the wallet. The product has been used in mass-production since 1994. The Ford Ranger was the first model equipped with it as standard. In 2013, development of the travel adjusting, self-adjusting clutch (TAC) followed.

Development year: *1993*
First production installation: *Ford Ranger*
Production sites: *Bühl, Wooster, Szombathely, Sorocaba, Puebla, Taicang, Unna*
Quantities produced: *70 m.*



BIG IDEAS START SMALL

A small group of engineers sit together after work in 1990. They treat themselves to a beer and discuss the idea of a self-adjusting clutch together with Head of Development Dr. Wolfgang Reik.

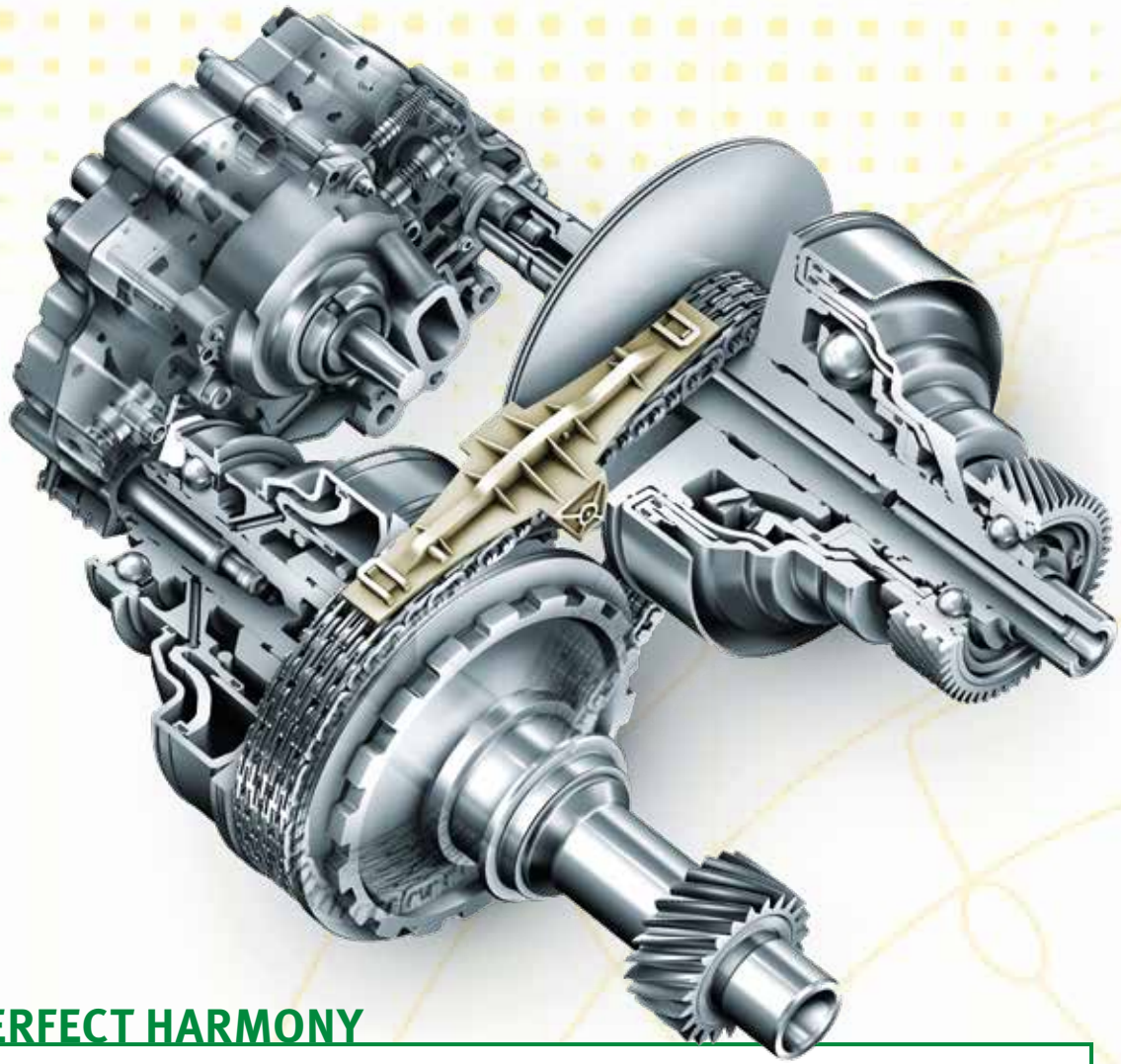
Ultimately, it is LuK stalwart Edmund Maucher who sparks the assembled engineers into action. Dr. Reik sketches his flash of genius on a beer mat – the birth of SAC, one of the greatest innovations to emerge from LuK. A team of young engineers turns the proposal into a fully functioning component.

EFFICIENCY BOOSTER

TORQUE CONVERTER

Conventional automatic transmissions are reliant on a torque converter instead of a mechanical clutch module. The company has developed converters at Wooster in the USA since 1996. Among the first models to be equipped is an Allison fire engine. The latest innovation is the integrated Torque Converter (iTC) from LuK, which integrates the lockup clutch in the converter turbine. This saves weight and creates installation space for the centrifugal pendulum, which also reduces the oscillations in the event of bridged power transmission. Fuel consumption and CO_2 emissions sink thanks to this innovation.

Start of mass production: *1997*
First production installation: *Allison 4000 transmission, fire engine*
Production sites: *Wooster, Bühl, Taicang, Puebla*
Quantities produced: *18 m.*



PERFECT HARMONY

CVT VARIATOR AND PLATE LINK CHAIN

Infinitely variable power transmission – this sounds like perfect harmony for power delivery. The Continuously Variable Transmission (CVT) is made possible by a plate link chain and a Variator, whose cone-shaped discs continuously change the diameter of their contact surface and thus infinitely change the transmission ratio. The LuK solution transmits up to 400 Newton meters of torque. This form of power transmission provides the greatest comfort in dense or slow-moving traffic in particular. The car accelerates without gearshift jolts, and the engine speed remains constant. European motorists in particular miss the sensuous perception of changing gear. Nevertheless, cars are sold in great quantities worldwide every year. Audi trusted Schaeffler's CT technology for the first time in its Multitronic transmission. The Ingolstadt based company's advert remains unforgotten: a 'Waggle Elvis' on the dashboard stoically refuses to swing his hips thanks to the gentle power delivery.

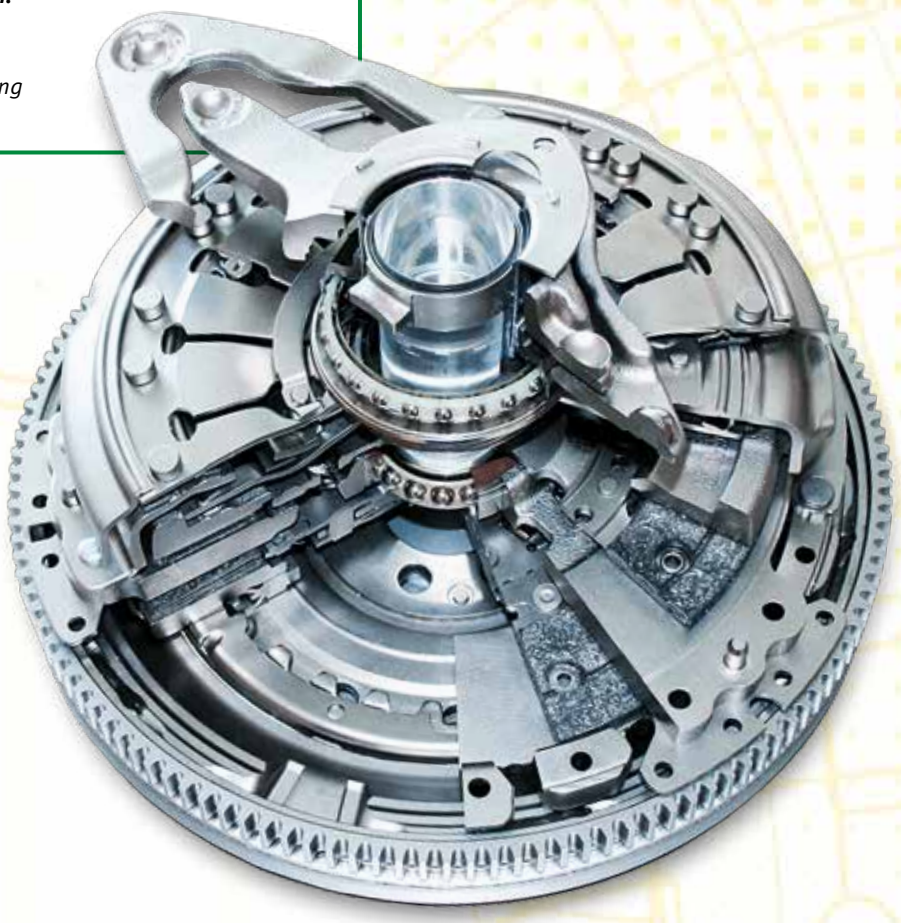
Start of mass production: *1999*
First production installation: *Audi A6*
Production sites: *Bühl*
Quantities produced: *3.5 m. CVT, 7 m. chains*

NON-STOP

TWIN-CLUTCH

Driving without torque interruption: the dry or wet LuK clutches make this possible. Instead of a clutch and input shaft, this transmission is distinguished by two of these assemblies. The gears are fitted alternatingly on the two shafts – for example gears 1, 3, 5 and 7 on one shaft and gears 2, 4 and 6 on the second. When changing gear, a clutch opens and the other closes within a hundredth of a second. As a result, the engine torque is transmitted without interruption. A dry LuK twin-clutch ran in a VW Golf for the first time in 2008. The solution ensures excellent comfort thanks to a dual mass flywheel. In addition to the dry twin-clutch, the Schaeffler brand also provides wet systems that are more resilient to higher temperatures.

Start of mass production: *2008*
First production installation:
VW Golf
Production sites: *Bühl, Szombathely, Puebla, Taicang*
Quantities produced: *12 m.*



HER MAJESTY'S **SECRETS**

James Bond has been keeping a huge fan community spellbound for generations. There's the mythos of the invincible secret agent who, in the course of his career, fights evil around the world, saves the British Empire and, to reward himself for his efforts, seduces the most beautiful women. Plus, there's the secret technology that Agent 007 officially uses in serving Her Majesty. Every time the Royal Secret Service entrusts its top spy with a new technical secret, moviegoers watch with wide-eyed amazement. And many of these inventions provide the agent with perfect mobility in any situation he encounters.

by Volker Paulun

No doubt one of the most spectacular Bond vehicles: the Lotus submarine from 'The Spy Who Loved Me' (1977, photo above). The heavily armed diving car carried the idea of amphibious vehicles to extremes. The question remains: who, except for a secret agent on the run, has any use for a vehicle like that? The creative auto think tank Rinspeed failed to answer this question as well, but seized the idea in its 'sQuba' (small photo) nonetheless

The most popular of all Bond cars: the Aston Martin DB5, equipped with machine guns, tire slitters and, of course, the famous ejection seat, as well as other gadgets. The car also had a navigation system with a circular monitor assisting in the pursuit of adversaries. With it, Bond was 20 years ahead of his time. The first onboard car navigation system hit the market in 1983. In 'The Living Daylights' from 1987, Bond's Aston Martin was again equipped with an onboard cockpit feature that would appear in production cars two decades later: a head-up display

Obviously, the countless dream cars on the screen have also had a part in creating the mythos of the Bond series of films: first and foremost, the silver-colored Aston Martin DB5, equipped with revolving license plates, machine guns, tire slitters and the famous ejection seat. But now and then, the plots also involve zany vehicles or tools on water and in the air that save Bond's life in hairy situations.

A notable aspect of the Bond films from yesterday to today is the fact that Albert Broccoli, who produced them for many years, was right in saying that these movies tended to show 'science fact' rather than 'science fiction.' So, the gimmicks, gizmos and gadgets available to Bond aren't flights of fancy, but ideas that might become reality within the foreseeable future and therefore suggest taking a look back on six decades of cinematic history and to check out what has by now become reality in the realm of mobility.

James Bond's cars

When young people watch the movie 'Goldfinger' today, there's a good chance that they wouldn't recognize at least two futuristic gizmos as such. Laser beams, for instance, have been reading CDs or creating spectacular shows at discos for decades and laser technology is now even making its way into the light technology of automobiles. But when in 1964 the producers of the movie departed from the original script to show a laser beam, this was deemed to be a bold move. The technology itself had been invented only four years earlier. In author Ian Fleming's book, a disk-saw was threatening the agent, but now the laser beam represented the mortal danger he was exposed to. The navigation system in the Aston Martin was the second stroke of genius in 'Goldfinger.' In combination with trackers installed on the cars of his pursuers, James Bond was able to see the locations of his adversaries as well as his own on a map that was displayed on a screen in the center console. Revolutionary! A few more decades were to pass before the first onboard navigation systems became available for cars. That today, in the age of big data, every smartphone can tell its owner where he or she is located, and forecasts of traffic jams will soon be created on this basis, pales the invention of old in comparison.

The same goes for the hands-free devices that we take for granted today. As far back as in 1973, James Bond and his CIA colleague Felix Leiter, in the movie

'Live and Let Die,' communicated via an onboard microphone disguised as a car cigarette lighter. In 1981, in 'For Your Eyes Only,' Bond used a two-way radio/transmitter in his wristwatch. Now this may have little to do with mobility at first glance. But it pays to take a closer look: today, Bluetooth enables hands-free communication while we're driving a car.

The head-up display is another information and convenience feature that is now spreading in automobiles. While the technology has been known in aircraft since as far back as the forties, European automobile manufacturers have been using it only since 2003. In 'The Living Daylights,' Timothy Dalton looks at a head-up display in his Aston Martin V8 Vantage back in 1987 – even though a rocket booster has a higher priority in an agent's life than trip data and traffic conditions.

Unforgotten, as well, are 007's remote-controlled cars. In 'Tomorrow Never Dies,' the protagonist operates a BMW 7 with his cell phone in 1997. Two years later, in 'The World Is Not Enough,' he only needs his ignition key to drive his Z8. Today, the system can be ordered by 'normal' customers as well. The new BMW 7 is the first remote-controlled production car made by the Bavarian automobile manufacturer. Its owners can make these luxury sedans maneuver into or out of a parking space or garage using their key as a remote control device. That spares them from having to get into or out of their vehicles in tight spaces – and, as a side effect, lets them feel a little bit like James Bond.

Another feature a Bond car was provided with by 'Q,' the unforgettable inventor of gadgets, was the invisibility function in the movie 'The World Is Not Enough' from 1999. While the usefulness of this feature in normal road traffic may – admittedly – be limited, it did become reality. In 2012, the producers of a commercial video made a Mercedes B-Class 'disappear' by placing an LED projection area on the bodywork. The idea of an invisible vehicle

In 'Tomorrow Never Dies' (1997), a stuntman still had to squat in the car's rear to simulate a remote-controlled drive in a BMW 7. The most recently launched generation of the luxury sedan can pull into or out of parking spaces via remote control provided by the ignition key

makes clearly more sense in military applications where – as in Bond's case – camouflage, cover and concealment have always been among the tricks of the trade. British tank engineers are experimenting in this direction and LED areas are used here as well.

Aerial pleasures

From time to time, James Bond and his adversaries would go airborne with more or less pioneering gadgets, such as flying cars or jetpacks, as well as mini jets or helicopters deployed from a suitcase.

In 1974, 'The Man With The Golden Gun' escaped seizure by Bond when his Ford Pinto transformed into an airplane. Actually, it was only a model that lifted off the ground at the time – the original specifically purchased for the movie had previously crashed! Today, companies such as Pal-V, Terrafugia or Aeromobil are experimenting with flying cars for doctors, the military or rescue teams deployed in natural disasters. But this market is very small and therefore mass production hardly makes any sense.

As early as in 1965, James Bond, in 'Thunderball,' used a jetpack to escape with. 19 years later, a stuntman opened the Olympic Games in Los Angeles with a jetpack featuring a similar design. While this form of locomotion, which had previously been developed for real-world military missions, is very dangerous (burns by the jets) and permits short flights at best, a variant for water sports is more user-friendly. The Jetlev Flyer, that has become popular in the past two summers, lifts its wearer several meters above the water surface by the blow-back of a 6-bar (87-psi) water jet. When buying such a fun gadget, the unlimited credit card of a double O agent comes in handy: it costs around 100,000 euros.

Two other aircraft have been made famous by Bond movies, but are not inventions by the Bond makers: the gyrocopter 'Little Nellie' in which Sean Connery lifted off above Japan in 'You Only Live Twice' in 1967 and the 'Acrostar' mini jet from 'Octopussy' (1983). Gyrocopters have been in existence since the 1920s. Unlike helicopters, their rotor blades are not actively powered but use air flowing through the rotor disc to generate rotation and lift. An engine-powered rear propeller provides forward thrust. The advantages of this design: compact dimensions (in the movie, 'Little Nellie' was delivered in suitcases) and ease of operation. Furthermore, if the engine fails, a gyrocopter will only lose altitude slowly due to the gyro effect. Today, gyrocopters made by the German market leader Autogyro are being used by the police, for surveying flights or for coast guard missions. Unlike the cute gyrocopter named 'Little Nellie,' the 'Acrostar' mini jet proved to be a vicious craft. That was one of the reasons why the aircraft introduced in the 1970s was deprived of a successful market career. In contrast to movie agents, real-world pilots only live once …

The first laser was completed in 1960. The Bond makers recognized the potential of the new development and integrated it into the movie 'Goldfinger' (1964) – as a weapon against 007. Today, there is a wide range of applications for laser light, including the first production vehicles that have been illuminating roads with it since 2014

It's one of the most popular James Bond stunts of all: the flight with the jetpack in 'Thunderball' (1965). The rocket-propelled rucksack actually exists, but its use is very dangerous, if for no other reason than the heat it develops. Hardly less spectacular, but clearly less hazardous: the 'Jetlev Flyer' (large photo) propelled by water pressure that can be seen at many beaches today

In 1978, the first wetbike hit the market – but Bond actor Roger Moore had already driven it in 1977 in the movie 'The Spy Who Loved Me.' The wetbike is a predecessor of today's jet skis

Space shuttles, airlocks for space stations – much that would become space reality in subsequent years was flying across the screen in 'Moonraker' as early as in 1979

Even space travel has been inspired by James Bond. Back in 1967, moviegoers, in 'You Only Live Twice,' saw a reusable spaceship. While in those days all spacecraft were purely built for one-way trips, NASA, in 1981, managed to successfully launch a reusable object for the first time – the Space Shuttle. Visually, the US space shuttle – like a twin – resembled the 'Moonraker' in which Bond, back in 1979, had lifted off for his space adventure as an agent in the same-named movie. Also in 'Moonraker,' the actors entered a space station through airlocks – back then, this was only possible in the movie. But seven years later, the Soviet Union turned this idea into reality for the first time for the cosmonauts manning the 'Mir' space station.

Today, nearly half a century after the thriller was released, the space station from 'You Only Live Twice' in the interior of a volcano is one of the most impressive sets in cinematic history. The features created by set designer Ken Adams included a magnetic levitation train moving around the station – another precursor to a future reality.

You can't win if you don't dive

On water, the British agent moved around with all kinds of tricks and innovations as well. In 1977, Roger Moore, in 'The Spy Who Loved Me,' hunted down the villain Karl Stromberg (played by Curd Jürgens) on a wetbike that was unheard of at the time. A year after the prototype of the novel vehicle debuted in the movie, the wetbike went into mass production. Today, further developments of the wetbike idea are zipping across the water at many beaches. They're called jet skis.

In the same movie, Bond stunned the world with his floating Lotus Esprit. When he takes it on a dive in front

of the Bahamas and drives it back on shore as he sees fit, dreams come true – driving, floating and diving, all in a single vehicle. The wheels fold inwards, and in their stead all kinds of flippers, fins and propellers appear to maneuver the white sports car. Like in the case of the flying car, the question remains: for what? Furthermore, amphibious vehicles are by no means new. Yet the Esprit served as an inspiring model. 30 years later, the Swiss automobile specialist Rinspeed presented the 'sQuba.' The Lotus-based electric sports car reaches a speed of 120 km/h on the road, more than 6 km/h on water and 3 km/h under water. The jet-powered sports car can dive down to a depth of 10 meters.

But even those who move through waters without any type of motorization need mechanical help. In the movie 'Thunderball,' Sean Connery uses a minimalistic breathing apparatus which he puts into his mouth – no comparison with an unwieldy oxygen bottle. Today, these mini oxygen bottles with a mouthpiece are used by sea rescue squads and as safety equipment in life boats. A company from South Korea has picked up the idea of the mini breathing apparatus and developed it further. The recently presented result: the 'Triton' device. It works like gills, separates oxygen from water and is battery-powered. This diving aid is still far from being ready for mass production, but when taking the idea even further, completely new possibilities arise, up to and including 'breathing' underwater cities. Utopia? Perhaps. Or this idea will end up like so many other gimmicks invented by the Bond screenwriters – one day they'll become reality and part of our everyday life.

Even Bond was stunned when his technology outfitter 'Q' in the movie 'You Only Live Twice' (1967) worked the miracle of extracting a mini helicopter from a couple of suitcases. Too far out? Not at all. 'Little Nellie' wasn't a model from the trick studio, but a real-world Wallis WA-116 Agile gyrocopter of the type the Royal Air Force would sporadically use as well. But the gyrocopter's technology only became world-famous through Bond

THE AUTOR

Volker Paulun *has a collection of 30 James Bond vehicles sitting on his shelves at home, as well as various books and magazines about the world's most famous secret agent. The 23 movies of the series to date (plus the first movie version of 'Casino Royale' with David Niven starring as 007) are within reach as DVDs as well. His favorite one: 'Casino Royale' with the current Bond actor Daniel Craig.*

In 'The World Is Not Enough' (1999), Bond has his first opportunity to drive a car that can make itself invisible – a technology which, thanks to LED projection, is actually possible today

Link to commercial video featuring the invisible Mercedes B-Class

» I like to think that this is what brains are for: they are for producing the future. We extract information from our environment, from the past and from the present, and use it to produce the future Paul Valéry

here and now

A tour of our mobile life

TRAIN TRAVEL
INTO THE FUTURE

The Estação do Oriente train station in Lisbon arches over its eight tracks like a cathedral of mobility: an impressive building, no doubt – and a much-used one as well. With some 75 million travelers per year, the 'eastern train station' is almost as heavily frequented as the famous Grand Central Station in New York – the most famous and largest of all train stations. Be it the American classic or the Portuguese youngster: practically all of the current stops would have to be fundamentally upgraded if passenger trains should develop in the direction some experts predict. Not only are they expected to travel at speeds of 400, 500 or even 600 km/h, but also to carry up to 1,600 passengers at the same time. For comparison: the current Deutsche Bahn ICE 3 train can accommodate only 460 people – and even this number hopelessly stretches the limits of some of today's platforms. A good example that shows that means of transportation and the associated infrastructure have to develop in sync – or else progress will literally only be made in slow motion.

WORKSHOP IN A HIGH-SPEED LAB

It's Thursday evening in June at the 24 Hours of Le Mans – the qualifying session on the famous race track. Spellbound, the seven Schaeffler engineers watch the precision work in the Porsche pits, practised a hundredfold. The engineers from the Corporate Innovation and Vehicle Testing departments have traveled to the greatest and most important endurance race in the world to exchange ideas with their motorsport colleagues from Porsche.

by Oliver Runschke

The close contact to the moving machine is not just part of earning the daily bread for the Porsche pit crew. Schaeffler technicians also appreciate getting up close to the real deal in their work

EXPERTISE IS AT HOME AT SCHAEFFLER

As a future-oriented company, Schaeffler puts considerable resources into research and development. *Around the world, more than 6,000 staff work in 16 research and development centers in close consultation with customers on new, technologically and economically viable solutions – for example in the fields of materials, tribology and coatings. In 2014 alone, this commitment resulted in 2,518 new patent applications. This puts Schaeffler at the forefront of the most inventive companies in Germany.*

Almost silently, the Porsche 919 Hybrid sports car glides into the pits at the legendary Le Mans 24 hour race. As soon as the white prototype brakes to a halt, the fastest choreography in motorsport begins. Air guns clatter, wheels are swapped, petrol glugs through the hose into the tank, Nick Tandy unbuckles himself from the cockpit and makes room for Nico Hülkenberg, who slides into the tight carbon-fibre tub. After just a few seconds, the Formula 1 pilot puts the fastest race vehicle ever built by Porsche into gear and heads out to turn his qualifying lap on the 13.6 kilometer circuit of Le Mans.

First-hand knowledge

The Schaeffler engineers hear, see and smell the race cars' hunt for top times – an intense experience for people who are crazy about technology, and one that kindles a craving for knowledge. Their colleagues from the sports car factory, however, are on hand to quench their thirst. In roundtable talks, race engineers, drivers and project leader Fritz Enzinger share the background information on the Porsche Le Mans project. Last year, the Swabians reopened the campaign for overall victory after a 16-year break – with Schaeffler as the Porsche team's official partner. "In the past I've always watched the race on television. But to experience the incredible technical effort and the atmosphere firsthand is impressive," marvels Sebastian Wielgos, Project Manager Corporate Innovations, during his first visit to Le Mans.

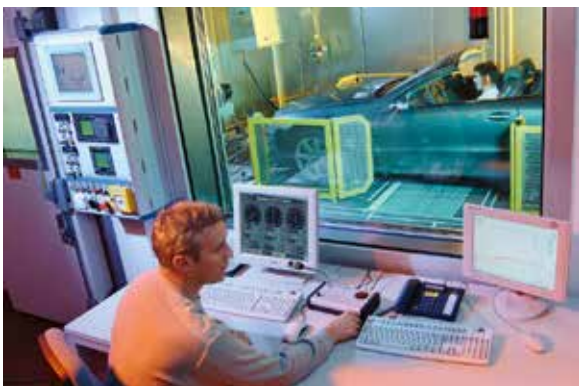
Nowhere else in motor racing do engineers come under such intense pressure as at Le Mans. The innovative technical regulations at this classic are unparalleled, with the amount of energy that a vehicle is

permitted to use per lap as the only restriction. The type of drive configuration is open, hybrid systems are mandatory for factory teams. The result is a mixed bag of technical concepts: Porsche combines a turbocharged petrol engine with two hybrid systems and stores the energy in batteries. Audi's turbo-diesel and the normally-aspirated engine from Toyota are supported by the recovery of kinetic energy, which is stored in a flywheel in the Ingolstadt contender, with the Japanese using super capacitors. Christian Marek, Systems Developer Corporate Innovations, also finds these different concepts fascinating. "Motorsport shows great parallels with series development. Once you decide on a concept after an analysis phase, you have to stick with this decision and systematically develop it, all the while checking that you're still on the right track."

More high-tech than Formula 1

The race on the 13.6-kilometer circuit in western France, of which about two thirds is contested on cordoned-off public roads, is legendary and attracted more than 260,000 fans this year. Le Mans is an epic with worldwide appeal: the renowned magazine 'National Geographic' recently declared this race to be the best sporting event in the world. This year, Porsche, Toyota and Audi battled for overall victory with the fastest cars ever witnessed in the race's 90-year history. Technologically, the sports cars with the distinctive glass cockpit have long overtaken Formula 1 cars. The powertrains in both series are similar, but at Le Mans the prototypes must maintain the pace over 24 hours with a system performance of around 1,000 hp – at an average speed of more than 220 km/h.

Le Mans is a high-tech laboratory with a 340 km/h top speed. The hybrid technology in the Porsche 919 generates enough energy over 24 hours of racing to supply a family home with electricity for three months. "The exciting thing about Le Mans is how the new drivetrain



Regardless whether it's Porsche at the race track or Schaeffler at the test bench – computer analyses are part of everyday life for an engineer

PORSCHE WINS LE MANS

Impeccable precision work: *Porsche won the 83rd running of the Le Mans 24 Hours on June 14, 2015 – exactly 45 years to the day after the first of 17 overall victories of the marque at the Sarthe, by now. With this, Porsche holds an unparalleled record. No other automobile manufacturer in the world has won arguably the toughest long distance race on Earth more often. Schaeffler is proud to be a partner in this success – back then and now. When Porsche celebrated its maiden victory in 1970 with the 917, the twelve-cylinder racing sports car featured valve train tappets produced by the Schaeffler brand INA. Today, the Porsche 919 Hybrid, as one of the most sophisticated racing sports cars of modern times, flies the Schaeffler logo. On the way to a one-two victory, the LMP1 race car demonstrated maximum efficiency. Earl Bamber, Nico Hülkenberg and Nick Tandy completed 395 laps. Over one day and one night, they clocked up 5,382.82 kilometers and achieved an average speed of 224.2 km/h. Finishing second, their team mates Timo Bernhard, Brendon Hartley and Mark Webber rounded off the success. With this, all Porsche pilots benefitted from the elaborate and powerful hybrid system that can recover both kinetic and thermal energy. Using this system, the race car generated and used 2.22 kilowatt hours of electrical energy per lap. If this was a power station, it could have supplied a family home with electricity for a quarter of a year with the power generated during the 24-hour race.*

technologies are evident here. The vehicles demonstrate how these new technologies can be turned into lap times," notes Raphael Fischer, who supervises innovation projects at Schaeffler.

"We're working with identical tools"

There is a close link between the sophisticated technology in Porsche's Le Mans racers and the development of future cars. Whereas lap times, stability and cost have priority at Le Mans, Schaeffler researches future mobility solutions under the aspects of function, stability and cost: "Porsche thinks about lap times the same way we think about fuel consumption cycles in our daily work," said Fischer.

The tools of the trade are identical: "At Le Mans we witness confirmation of our daily work," acknowledges Benedikt Bechmann, Team Coordinator for Vehicle Testing, Complete Vehicle Department. "We're working with

Man and formidable machines: Porsche Motorsport experts with a ca. 1,000 hp 919 hybrid sports car, and Schaeffler engineers at the test bench for 3,200 mm bearings for wind turbines

the same tools that are used in motorsport. The measurement techniques and the concepts are similar. We can learn a lot here."

Equally as fascinating as the function of the Le Mans prototype is the structure of the 120-strong Porsche team at the race track. Daniel Pfeiffer, Project Manager for Transmission Elements: "There is a clear and concrete division of tasks within the team. Everyone is extremely focussed. You notice exactly what constitutes a strong team. In the pits the outfit gives the impression of an anthill – everyone focuses totally on their job." At the same time, the hierarchies are strict yet flat. "The team spirit is unique. In the hospitality area, board members sit with mechanics, engineers and drivers. They form a team."

At Porsche, more than 200 engineers work 365 days a year towards Le Mans, but decisions are still made at lightning speed. Pfeiffer: "Decisions need to be made quickly because they won't postpone the start of the race just because you haven't made up your mind." The fact that the decisions of the Porsche engineers were not only fast, but correct, was validated at the finish line on Sunday afternoon. Clinching a one-two, Porsche notched up its 17th overall victory at Le Mans: Schaeffler's engineers have learned from the best.

THE AUTHOR

Oliver Runschke *spends – much to the dismay of his family – more weekends at the race tracks of this world than at home. His focus is firmly on the drivers, the cars and the race action in the sports car sector. Exploring the subject from both engineers' standpoints has given him new insights.*

MOUNTAIN **HIGH**

Traversing the Alps – it's a term that arouses euphoria in mountain bikers all over the world. Crossing the Alps has become synonymous with a new kind of freedom. Anyone can explore their personal limits while exploring culture and nature. Our author Tom Bierl shares his trans-Alpine adventures.

by Tom Bierl

The Alps – no other mountain range in the world enjoys such a vast network of trails; created over centuries from the diverse needs of the local people. Old trade routes like the Roman-built Via Claudia Augusta, smugglers' tracks through lonely valleys and over almost insurmountable peaks, hiking paths to enchanting huts, or deteriorated military roads constructed for a senseless Alpine war.

The finely-spun web of trails of every extreme treats mountain bikers today to a very special kind of holiday experience. The classic Alpine crossing typically starts in Germany on the northern flanks of the Alps and finishes in the south, usually at a lake in northern Italy. Between these two points, however, lie unimaginable personal challenges and stunning scenery. Twenty years ago, such an experience was regarded as the exclusive territory for a select group of robust adventurers. Today, thanks to detailed trip descriptions and modern GPS technology, traversing the Alps can now be tackled by almost any intrepid mountain biker. The experience is no less thrilling and the level of exhilaration is the same for all.

Body runs like clockwork

Exhilaration? Right now, just below the 2,200 meter Pfitscherjoch – the critical point when traversing the Alps main ridge – I'm having my doubts. Sweat drips in small rivulets onto the frame of my mountain bike. Thirty gears for this ascent are still not enough and I'm longing for an even smaller front cog. Ahead of me, the last ramp of the day rises like a wall. I'm only vaguely aware of my surroundings. Behind me lies the eternal ice of the Hintertux Glacier, in front of me the 'three-thousanders' of the Ziller Valley mountain landscape soar high into the bright blue sky. Under my wheels, the 1,000 year old

MORE THAN 30 OPERATORS

offer the ‘Transalpine’ experience as a bookable adventure. The advantage: luggage is transported, all accommodation is reserved.

900

different routes over the Alps are listed. More than half of these tours end at Lake Garda.

stone slabs prove treacherous and energy sapping. Before vehicles took over as a means of transportation, inhabitants hauled their wares over the mountain passes on foot for many centuries. My body runs like clockwork. Breathe in, breathe out, don’t push the heart rate too high. This is the only way I can survive this self-imposed week-long ordeal.

1,200 participants from 40 countries tackle Transalp Challenge

We headed off this morning from Mayrhofen in Austria. We, a bunch of ten mountain bikers, have booked this ‘Transalp Adventure’ through a specialist tour operator called go-alps. Included in the package are a guide, luggage transport and accommodation. This is a fail-safe way for us all to enjoy the week. But enjoyment is something we have to work hard at, because, after all, a mountain is a mountain. Our final destination is the Italian city of Bassano del Grappa in Veneto – five daily stages, 350 kilometers and around 8,000 meters of altitude difference from here.

But I’m not thinking about that today. First comes the challenge of the Pfitscherjoch. Meter by meter it loses its terror grip on me. By 3 pm we’ve done it. We find a spot in the sun in front of the refuge. Apple strudel has never tasted better. We’re not the only ones enjoying the achievement of having conquered the divide. Twenty or so other trail bikers share the distinction of crossing the border into Italy. Crossing the Alps on a mountain bike has become synonymous with a new kind of freedom.

Annually, around 160,000 bikers from all over the world – according to a study from the University of Innsbruck – set out to navigate the Alps. Whilst the majority of riders come from mountain-biking-mad Germany, the number of international cyclists is increasing every year. The yardstick for this is the so-called 'Transalp Challenge.' In two-person teams, almost 1,200 participants from more than 40 countries tackle the 'toughest mountain bike race in the world' each year.

Frost, even in August

While professional riders knock off the day's stages of this race in less than four hours – with over 3,000 meters altitude difference and often in excess of 100 kilometers – for us it's more about enjoying nature and actually reaching our destination. Our toughest day would see us tackle just on 80 kilometers with a 1,660-meter altitude difference. This gives us time to take a welcome rest at a mountain hut, or – like now – for our first Cappuccino at the Italian border.

The special appeal of an Alpine crossing on a mountain bike lies in the interplay of personal experiences. After the first few meters, the combination of the natural environment, the exertion, riding pleasure and team spirit makes the stresses of everyday life a thing of the distant past. Even for me, the first day is almost like a drug. Irritations are forgotten. The incredible relaxation that one reaps from the exertion is the secret of success in every Alpine crossing. Our guide Olaf agrees. He has dedicated his whole life to the service of the mountain bike. In winter he runs his own bike facility on the Canary Island of La Palma, in the summer he traverses the Alps six, seven, or even eight times. The window of opportunity for an Alpine crossing is small. If the route leads above 2,000 meters, the passages are normally only reliably snow-free from July. In early September, however, the first low pressure systems sweep in from the north and can possibly bring the first snow.

Now, late in July, we don't have to worry about snowfall. The weather forecast looks good with a stable high over the region. Still, we come prepared. Thunderstorms in the mountains are often accompanied by icy hail. Even in August, temperatures can quickly plummet to zero. "Don't be afraid of bad weather," says Olaf. Storms and snow in particular initiate real bonding experiences for groups and can intensify the personal stories of their Alpine crossing.

"It's all downhill from here," announces our guide Olaf gleefully, giving us the green light for a very special treat. Thanks to our full-suspension mountain bikes and wide tires, even rocky mountain paths are 'rideable.' The combination of skill, technique, body control and speed make these tricky trails purely exhilarating. All thoughts vanish. Exhausted but happy, we reach our destination and fall into bed.

Climb, conquer the summit, apple strudel, descend followed by a hearty dinner: this has become our daily ritual. Already on day two we listen more intensively to our bodies. Treat it right, pay attention to any signs, sense the exhaustion – and the strength. The distances in the Alps

BIKES OF THE **FUTURE**

Three years ago it was considered almost inconceivable, but now an entire industry is riding the wave. The electric mountain bike lends bicycle manufacturers wings. Everyone is proclaiming this to be the next big trend. Even tough challenges like an Alpine crossing will be possible with the help of an E-MTB, even for novices.

The fight for future markets is already in full force in the Alps. All major ski resorts have discovered the electric mountain bike as their saviour. After virtually snowless winters, the anguished looks on the faces of ski strategists can hopefully disappear in summer thanks to the electro bike. Virtually all renowned ski resorts now feature an electric mountain bike facility. 'Thighs from the power socket' can now take on the mountains. Initial reviews of Alpine crossings with an E-bike are now appearing on the Internet, and the feedback is resoundingly positive. In fact, the electric mountain bike has the potential to launch a whole new biking movement. Unlike with a motorbike, the E-bike is not powered by the twist of a handle. Instead, the E-motor is charged when the rider pedals. This creates the impression of ascending the mountain under one's own steam. A new piece of sporting equipment is born. The limiting factor at the moment is the cruising range of a standard battery. Although electric bikers can easily cover over 100 kilometers on flat terrain, in the mountains the performance decreases dramatically. Still, 60 kilometers with an altitude difference of up to 1,500 meters are now achievable without any great effort – and this is more than most moderately fit mountain bikers can manage without 'electric thighs.' In fact, many diehard specialists are swapping their trail bikes for electric ones. With electro-support, they not only scale the steepest inclines that had so far evaded them, but even master technically more difficult passages. The industry sees enormous potential in this target group, as well. After all, it's all about the thrill. For the transalpine pioneer and 'BIKE' publisher Uli Stanciu, this is very definitely the new trend. Tackling the Alps on an E-bike will be the next big boom in recreational activities. "E-bikes simply give you more freedom," is how Stanciu describes the new feeling. And he should know. He has produced more travel books about traversing the Alps with the bicycle than any other author, he has crossed the Alps countless times powered by his own strength and also initiated the most gruelling mountain bike race in the world – the Transalp Challenge. Now he uses the new E-bike to push his limits even further. "Where you would have hopped off and pushed a conventional bike in the past, you now just select the next support level with the E-bike and you manage it." This intensifies the natural experience on the bike, and there is one other spin-off that is welcomed by every biking group. Weak riders no longer exist on the mountains. Thanks to electro-support, all bikers arrive at the summit together and can share the moment of triumph.

Torque sensors from Schaeffler provide important information on powering modern electric bikes

seem tailor-made for man and mountain bike. While hikers rarely cover more than 30 kilometers a day, we manage 80 kilometers or more, even including tortuous climbs over mountain passes. One week is enough to conquer the Alps – perfect for a holiday.

On the war path

The landscape and the challenges change daily. On our trip, the Alpine divide is just the beginning. The next few days are filled with the peaks of the Dolomites. In 2009, the unique landscape was declared a UNESCO World Heritage Site. The gigantic remains of a giant primeval coral reef now tower more than 3,000 meters into the sky. Mountains don't get more spectacular than this and the procession of highlights don't stop there. The Alps of Belluno are part of a forgotten Italy. Away from the tourist masses, this region in the middle of Europe is as deserted and wild as Canada. Like a fortress, the Monte Grappa as the last mountain of the Alps, stands between us and the Italian lowlands.

"You'll need at least two liters of water in your backpack today," our guide Olaf warns, in deference to the last leg of our trip. With some sections at a 25 percent incline, the former military road snakes up the mountain in tight bends. The Monte Grappe massif is an Italian national shrine. In World War I, the front ran along here. In the 1930s, the fascists erected a monumental mausoleum. More than 20,000 soldiers lost their lives on this fateful mountain. As mountain bikers, we benefit from the adventurously-carved former supply routes over the mountain. Partially dilapidated, they now constitute a physical challenge. At around noon we've scaled it. From the summit we can see all the way to Venice, with flatlands stretched out below us. We have conquered the Alps using our own stamina. Exhausted but on a high, we congratulate each other. Never has a holiday experience been more intense.

THE AUTHOR

Tom Bierl, editor-in-chief of the magazine 'TREKKINGBIKE,' *has turned his hobby into a career. No matter if he's on a mountain or touring bike, cycling has become his life. In the saddle, he explores the world's most remote mountainous regions. He spends his summers in the Alps, winters in Asia, preferably in Laos and northern Thailand. To date, he has traversed the Alps more than 30 times.*

TRANSALP ROUTES

The easiest: Salzburg–Grado
410 kilometers, 2,400 meter altitude difference. A dedicated, signposted cycle path away from traffic through the Hohe Tauern. Also possible with a trekking bike.
www.alpe-adria-radweg.com

The favorite: Augsburg–Venice
740 kilometers, 4,500 meter altitude difference. Following the traces of the ancient Roman road, Via Claudia Augusta, on sealed bike paths.
www.viaclaudia.org

The classic: Garmisch–Limone
516 kilometers, 18,300 meter altitude difference. Over tricky mountain bike trails to Lake Garda – a challenging tour.
www.bike-gps.com

The original route: Oberstdorf–Lake Garda
312 kilometers, 13,500 meter altitude difference. The 'Heckmair Route' is regarded as the first Alpine crossing, with difficult passages where the bike must be carried at times.
www.wikipedia.org

TO SEE AND **BE SEEN**

In the Formula Student motorsport engineering and design competition, engineers of tomorrow are pitted against each other. Schaeffler has been supporting teams for many years and is the principal sponsor of the German event at the Hockenheimring.

by Torben Schröder

The hands are trembling, the pulse is racing, the right foot is nervously twitching toward the gas pedal – the race is about to start. Christian Marek knows exactly how the drivers and their team mates in Formula Student feel at this moment. A few years ago, he was one of them. Today, the 33-year-old is working on the mobility concepts of tomorrow as an engineer in the Innovation Projects Department at Schaeffler in Herzogenaurach. Marek is a perfect example that shows how taking on an additional commitment in one's student days can pay off.

So, what is Formula Student? Within the period of one year, student teams from around the world conceptualize and design a prototype of a single-seat race car. The key question concerns the choice of the powertrain concept: a combustion engine or an electric motor? A few years ago, the majority of the teams would still opt for a standard powertrain. Today, half of the participants choose an electric motor. In the other areas of automotive engineering, the teams, barring a few safety-relevant requirements stipulated by the regulations, can give free rein to their knowledge and their creativity. Subsequently, the events in which the teams compete against each other, and which are held around the globe mainly in summer, are the highlights of the year. In addition to the on-track comparison in various disciplines,

the contest is about optimum budgeting and suitable marketing activities.

Schaeffler and Formula Student – a perfect match

For Schaeffler, Formula Student, alongside the WEC, DTM and Formula E, is not just another platform to present the company in motorsports, but also an opportunity to scout out young talent with potential as future employees. For this reason, Schaeffler has been supporting many teams around the world with know-how and products since 2006. Additionally, since 2014, Schaeffler has been the principal sponsor of the German event, 'Formula Student Germany' (FSG), held at the Hockenheimring. "Success in motorsports is closely linked to the abilities of every individual, but even more so to teamwork," says Prof. Peter Gutzmer, Chief Technology Officer at Schaeffler. "Our Formula Student commitment puts us in close touch with the talent we seek to recruit as future employees: students who enjoy technology and bring project experience to the job that can't be gathered in the day-to-day academic environment."

Christian Marek has managed the leap to Schaeffler. "In Formula Student, I learned to keep track of things and to effectively coordinate a team. That prepared me for a professional career." Aside from all the practical aspects, the successful learning curve and the bonus points on his resume, the unique experiences that Formula Student provided him with are the things that count most for Christian Marek. "Obviously, the competitions were the bee's knees

At the end of Formula Student Germany, the best teams were honored. Here, a Schaeffler partner, Stuttgart University, celebrated second place overall in the category of vehicles with combustion engines

Two Schaeffler teams in various Formula Student disciplines: RWTH Aachen with an electric car on the handling course (left), FHWS Schweinfurt in an acceleration test with a combustion-engine vehicle

for us: the many wonderful people from around the world, the exciting atmosphere, the team spirit."

Marek's successors had the opportunity to gather experiences of this kind as well in the summer of 2015. The field of Formula Student Germany at the Hockenheimring was filled to the brim and included twelve teams supported by Schaeffler, all competing with the formula race cars they had designed themselves. However, before hitting the track, the young engineers had to prove their ingenuity, in terms of ergonomics, for example. How much discomfort can I expect the driver to put up with in order to save weight? "While my compromise tends to put a greater load on the driver, it's also clear that my team mates should be sitting as comfortably as possible," says Georg Angst, member of 'Rennteam Uni Stuttgart' which is supported by Schaeffler. "The same applies to us as a team: the compromise has to fit. Success is important to us, our motto is: 'Compete – Finish – Win.' Still, in spite of all our ambitions, it's important not to sacrifice the element of fun." Georg Angst, with his roughly 35 team members,

» You have an opportunity to learn outside the normal college environment and wind up with a finished product

Schaeffler employee Christian Marek says about Formula Student

A CHANCE TO ZONE OUT

Get some rest, recharge their batteries and network – *this is what visitors were able to do in the area dedicated to FSG's principal sponsor Schaeffler. The complex, billed as 'Recharge Zone,' was divided into four sections. In the 'Tech Zone,' Schaeffler engineers displayed a Formula E show car and the eWheelDrive concept car. Information on entry-level and other career opportunities was provided to interested visitors in the 'Career Zone.' In the 'Energy Zone,' the young racers were able to refresh themselves with beverages, snacks and fruit salad. Absolutely deep relaxation was provided by three massage chairs awaiting exhausted young racers in the 'Relax Zone.'*

FORMULA STUDENT FACTS AND FIGURES

20–40
participants typically form a university team that competes in Formula Student.

1,300
students are **employed by Schaeffler** every year.

6,000
visitors attended FSG 2015, including **2,500 industry representatives**.

RWTH Aachen designed a model sporting Schaeffler colors in the Bobby-Car contest

successfully put two thirds of this motto into action at Hockenheim. The 'Win' element, however, didn't work out. Following the eight disciplines, which included a sprint, a long run and various presentations in front of a jury, Stuttgart took second place in the combustion-engine category, and third with their electric vehicle. This made them the best German university in both groups and the most successful Schaeffler team.

As a special highlight on the occasion of the FSG's tenth anniversary, the organizers fueled a bit of competitive spirit among the sponsors as well. Every one of them received a Bobby-Car along with the task to creatively pep it up and to ultimately contest a small race with it. With hands-on support by the Ecurie Aix Formula Student team of RWTH Aachen, the red toy was transformed into a motorized racer sporting Schaeffler colors and named 'Schaeffolution – Solution for Evolution.'

Traditionally, all Formula Student Germany teams gather for an impressive group shot prior to the competitions

3,600

participants were involved in Formula Student Germany 2015.

1,000

points is the maximum that can be scored at a **Formula Student** event.

10

times Formula Student Germany. In 2015, the event celebrated an **anniversary**.

» Yes, my friends, I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light Jules Verne

mobility tomorrow

How we move around in the future

MARINE **ENERGY**

71 percent of the Earth's surface is covered with water. And even the famous author and visionary Jules Verne – as he said in the quote on left – predicted that incredible energy reserves lie dormant there which can be harnessed for zero-emission mobility. And not only in the form of hydrogen, as Verne believed, but also as kinetic energy. But the sea is a store of further sources of energy. Scientists from Oregon State University, for instance, have managed to generate electricity from decomposing plankton: tremendous prospects, as plankton exists in abundance. These microorganisms account for about 98 percent of the biomass in the world's oceans and provide the basis for life under water. While the individual organisms are so small that the human eye cannot detect them, large aggregations of them are even able to color huge surfaces such as the one of the Black Sea, as impressively shown in this picture. The Oregon scientists have the vision that in the future ships will strain out plankton from the ocean in their paths like whales do and transform it into energy via fuel cells.

THEY **DELIVER**

Without the logistics industry, the global economy would all but come to a standstill. Not a single assembly line would move, not a single wheel would turn. We would have no PC monitor, no smartphone in front of our nose, and little to eat on our table. Yet the freight forwarding industry's reputation has been suffering. Innovative ideas are to make this key sector more efficient and eco-friendly.

by Thomas Wöhrle

The public image of the logistics industry isn't the best. Traffic jams on our roads, clogged cities, noise pollution, people protesting against new warehouse construction projects – there are a lot of negatives associated with logistics.

But many of those who complain about these conditions ignore the fact that logistics is a supporting pillar of the global economy – not only because of its connecting function in the movement of goods. Some of the key figures are impressive as well. The industry's sales exceed 1,000 billion euros, with three-percent annual growth rates, according to forecasts.

In Germany, for instance, logistics is the third-largest industry, trailing the automotive sector and the wholesale and retail trade. It even ranks above the electronics and the mechanical engineering sectors – and, with about 2.9 million people, has three times more employees than the latter. Controlling the flow of goods and information, as well forwarding and warehousing goods, are important economic functions that create high value. Approximately 235 billion euros in cross-industry sales were generated in 2014, according to the Federal Logistics Association (BVL). Plus, Germany is the reigning 'logistics world champion.' The World Bank selected the Federal Republic of Germany as the leading nation in terms of logistics capabilities among 160 countries. Deutsche Post DHL is the world's biggest logistics corporation, followed by UPS, China Railway, FedEx and Maersk. 480,000 employees in 220 countries and territories work for the 'yellow' mega corporation that generates sales of more than 55 billion euros.

Interface par excellence

Around the world, logistics has long become more than a matter of forwarding freight from A to B. The BVL defines logistics as 'a system which, initially within a company, as well as across companies with suppliers and customers, means optimum supply of materials, components and modules to production sites and markets.' However, logistics is an interface discipline par excellence not only across companies but also across industries. A high level of innovation prowess and the ability to profitably integrate the latest technology into process improvements are essential to succeed in this

discipline and a provider's capacity to offer powerful transportation or logistics solutions.

Automated driving on roads and in warehouses

Automated driving no doubt is one of the major trends these days – for road and rail vehicles, as well as in the warehouse. Daimler recently announced that test operations for (partially) self-driving trucks will be launched on German autobahns before the year is out. The first tests, the company says, are planned in Baden-Württemberg. The state's department of transportation has given the green light for them. Subsequently, Daimler is planning to run these tests throughout Germany. According to the Stuttgart automaker, the vehicle has the potential of becoming a game-changer in the transportation industry and of dramatically reducing the number of serious accidents. In addition, automated or partially automated trucks are expected to reduce fuel consumption and CO_2 emissions by up to five percent. Partially self-driving trucks are expected to be ready for production in two or three years from now – maybe this would be a lot sooner than the possible market launch of corresponding passenger cars. Other major commercial vehicle manufacturers such as Volvo or Scania are pursuing these aims on an international scale as well.

But the further development of automated driving is not only being pursued on the road. Tests of driverless operation in rail freight transportation are underway as well. At the test center for rail vehicles in Wegberg-Wildenrath (Germany), scientists from RWTH Aachen tested a trial locomotive with fully autonomous switching capability using the Galileo satellite navigation system.

Rolls-Royce is planning to develop remote-controlled ships. In about ten years from now, the onboard technology will have reached a level where the captain can steer the ship from an onshore office, the engineers of Rolls-Royce's marine department predict. The intent is to reduce HR costs, make the ships faster and, possibly, safer. More than 30,000 ships are being operated on the world's oceans with Rolls-Royce equipment.

More and more logistics companies and warehouse operators are relying on autonomous internal transportation systems as well. Self-driving robots that move racks and goods across the warehouse, seemingly guided by an invisible hand, have versatile uses. Grenzebach Automation has launched 'G-Com' on the market – a system made up of mobile shelves. Small robots called 'Carrys' move underneath the shelves, lift them and automatically take them to the pick station. Eisenmann, a company based in Böblingen (Germany) describes its twin-tine 'Logimover' system as a 'fork without a truck.' It consists of two autonomous

Trucks are changing – inside, outside and in the engine compartment. As with passenger cars, automated driving, lightweight design and electrification are key topics

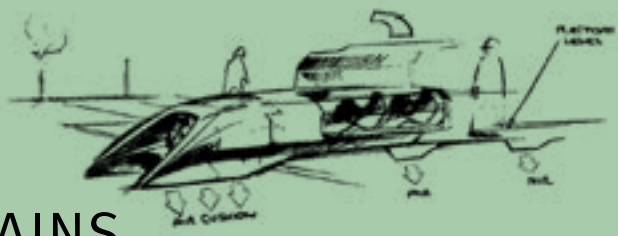
parallel tines that, for example, can automatically locate and tunnel under pallets, lift them and take them to a different warehouse location. These systems still require clarification of certain insurance and legal issues.

Electric mobility and 3D printing can reduce emissions

Electric mobility is another trendy topic. Automobile manufacturer BMW, for instance, is starting to field

INTELLIGENT TRUCK TRAFFIC LIGHT SYSTEM

The Hamburg Port Authority (HPA), together with NXP Semiconductors, recently presented the first intelligent traffic light for the Hamburg port. It is able to optimize the flow of truck traffic and guide people through the increasingly frequented port area in less time. The so-called 'Smart Port Traffic Light' is designed to avoid traffic jams and reduce emissions via a special Wi-Fi communications facility.



HIGH-SPEED CAPSULES
INSTEAD OF FREIGHT TRAINS

American billionaire Elon Musk has put forward a high-speed transportation system proposal called 'Hyperloop.' The system is designed to quickly move people and freight from A to B in capsules riding on air cushions through a tube system. The founder of the Paypal online payment system and electric vehicle pioneer Tesla has proposed a notional route for the system between San Francisco and Los Angeles where travel time on the roughly 600-kilometer track could be reduced to merely 35 minutes. However, today, nobody can predict when – or even if at all – this will become reality.

a fully electric 40-ton truck in the city this summer. The Munich-based BMW Group is Germany's first automaker to use an electric truck of this size to move material on public roads, according to information released by the company. The electric truck will be making eight runs per day between the logistics company Scherm and the BMW plant, covering a distance of nearly two kilometers on each run. However, the idea of 'e-logistics' isn't quite as new as the Bavarians would like to make us believe. VW has connected its 'Transparent Factory' in Dresden, where the Phaeton luxury sedan and other models are produced, to Dresden's streetcar system. Since then, supply trains with automotive components have been moving from a logistics center on the outskirts to the plant in the city.

But e-trucks or e-vans can play a major role not only in supplying materials to industrial plants but also in urban freight distribution, which is referred to as city logistics. Parcel delivery services such as UPS or Deutsche Post DHL are already using such vehicles. Retail companies are testing them as well. Walmart, for example, presented a truck concept vehicle last year with an e-motor powered by an onboard gas turbine. In addition, the use of carbon as a light-weight material increases the vehicle's loading capacity. In Germany, Tedi, Rewe and Lidl are testing the e-trucks.

The continuous progress achieved in the field of 3D printing offers a wide range of opportunities to the logistics industry as well. Local Motors, for instance, prints cars on a 3D printer in Phoenix and Las Vegas. It takes the printer, which has the size of an intermodal container, 44 hours to print a car. After two and a half days, the battery, motor and electronics have been installed and the buggy-like vehicle is finished. The logistics sector would like to tap into this new technology too. It just takes a little imagination. Logistics companies, for instance, could turn into printing shops and subsequently deliver the product to the customer or, if necessary, print it on the fly. In the case of difficult transports, such as ocean freight, a technician could simply print the appropriate spare part that is needed for a repair job. In exotic countries, companies would no longer have to set up production operations for simpler products or have the goods shipped to far-away sales markets in a complex

The computer as captain: remote-controlled cargo ship concept by Rolls-Royce

and costly haul – just push the button on the printer and the desired part would be ready for delivery shortly afterwards. Warehouse spaces could shrink in many places as well if inventories were reduced to files and a bit of material.

Drones – between a pioneering spirit and legal concerns

The use of drones is currently a subject of controversial debate. While supporters are seeing major opportunities for special deliveries – Deutsche Post DHL recently launched a project to supply the island of Juist with medicines using its 'parcelcopter' – opponents primarily keep raising legal concerns. Particularly issues of privacy protection and data security when unmanned aerial vehicles are equipped with cameras are repeatedly mentioned in this context.

A quick solution to these problems is not very likely. Nevertheless, companies such as Amazon, UPS or Hermes are currently testing possible uses for drones in their business. They primarily expect to achieve cost savings through manpower reductions.

This is generally a mega trend that dramatically changes the entire field of logistics. Increasing automation in recent years will continue – in the warehouse, in the movement of goods and, in an overall context, by increasingly smart interlinking of IT and logistics. In the future, the main mission of logistics will be to provide all of the relevant information along the value chains. Digitalization, Big Data or Industry 4.0 are key words in this context. However, optimum interlinking and automation not only help cut manpower requirements, but can also reduce unnecessary empty runs. This, too, will assist in improving the industry's image in the future.

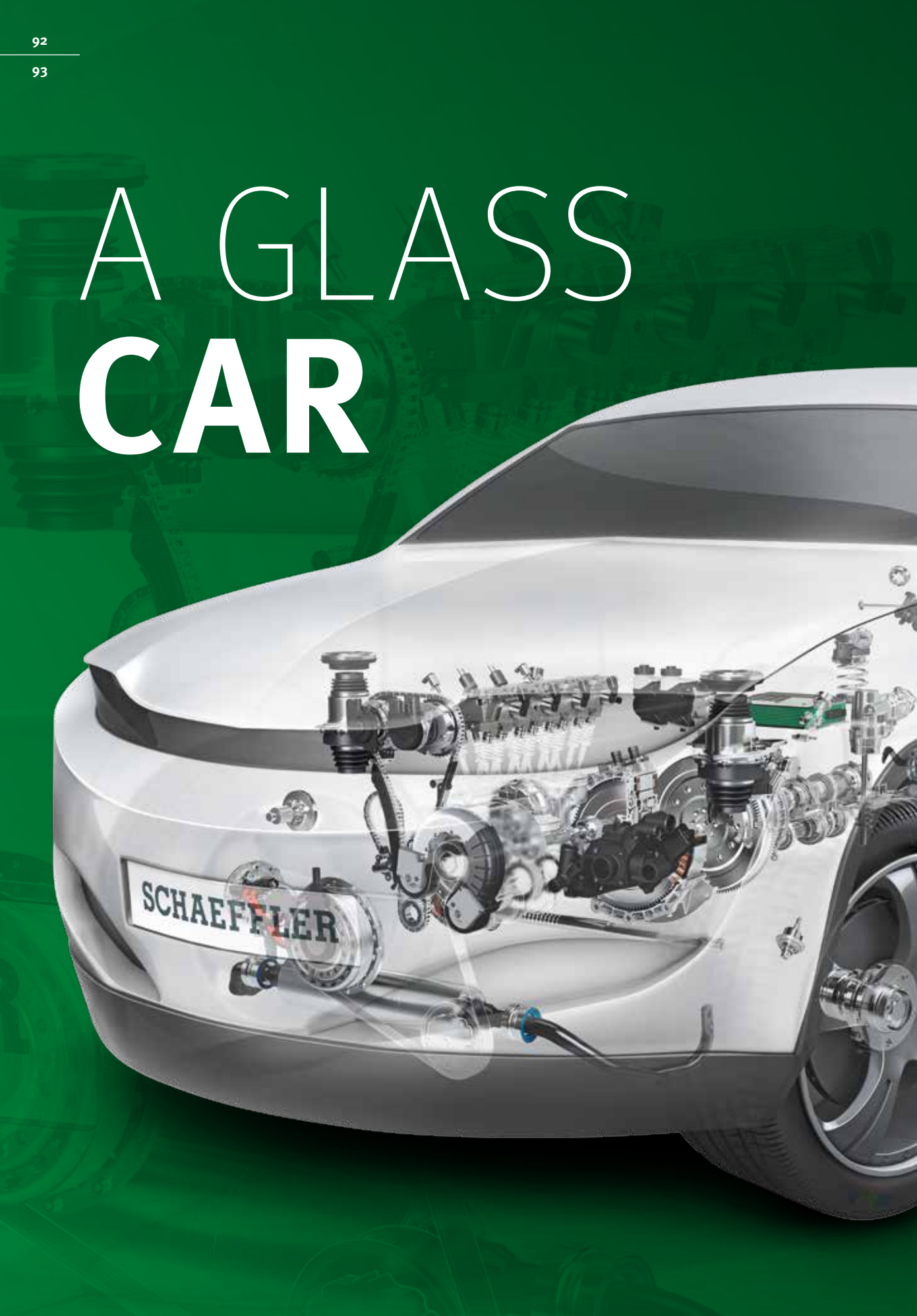
THE AUTHOR

*After earning his master's in economics, **Thomas Wöhrle** switched to journalism. Stations in the early years of the hobby musician's career included Canada and 'Manager Magazin' in Hamburg. Ever since his internship, the 44-year-old has been focusing on logistics, transportation and IT system topics. In this issue of 'tomorrow,' he also presents current developments in the field of mobility apps (see p. 96).*

URBAN LOGISTICS WITH **BIOHYBRID**

Major courier and parcel services are currently testing the deployment of couriers on cargo bikes in big cities across Europe. Obviously, cargo bikes are not really new, but increasingly better and less costly electric motors assisting the operator's muscle power have been lending wings to this sector. The agile pedal-transporters beat their four-wheeled competitors to their destinations with greater eco-friendliness and flexibility, and usually, in less time. Schaeffler is involved in the development of new ideas for urban micro mobility as well – not only for the movement of goods but also for transporting people.

A GLASS **CAR**



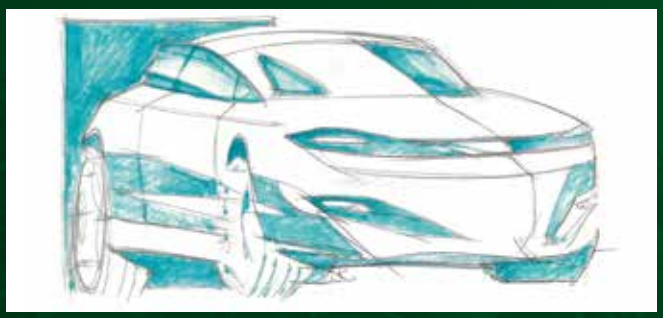
Most technologies from Schaeffler make their important contributions to increased efficiency and performance undercover. With a virtual ‘Glass Car,’ the supplier now brings its solutions to light in a particularly transparent way.

by Laurin Paschek

The Glass Car displays technologies specifically in their place of operation and allows an interactive configuration of system solutions. The digital software platform is complemented by a real Glass Car that is showcased at international automobile motor shows.

Global demands concerning the automobile are growing. In many cases, Schaeffler technologies ensure that vehicles consume less, yet generate more power and performance. With the large-scale Glass Car project, Schaeffler now makes these complex technologies strikingly visible. The Glass Car project follows a two-pronged approach: firstly, it includes a digital product catalogue which allows direct access to solutions from Schaeffler thanks to a comprehensive, three-dimensional model library and the latest data. This makes it possible to mix and match individual technologies and thus develop system solutions in the fields of engine, transmission and chassis. Secondly, the project includes a real glass model, which will be unveiled at this year’s IAA Frankfurt Motor Show.

The virtual Glass Car offers an overall view of the vehicle, with users able to navigate within the three-dimensional space and move into specific areas – the engine, for instance, and from there to the valve train and on to the switchable variable valve train elements. Each component is accompanied by an explanatory text and a product film in which the design and the function are animated and explained. In a detailed description, the user can then rotate the components and ‘explode’ them to isolate the individual parts for a more in-depth look.



The Glass Car concept of the Faculty of Design at Pforzheim University (top left) was adapted into an initial virtual model by the company Seven M (top right). In its advanced stage, Schaeffler components were added to the model and it could then be incorporated into artificial landscapes (left)

A special feature is the intelligent configurability of the components. This allows the user to exchange parts, for example, when the cylinder shut-off in the valve train should be actuated via a supporting member rather than a rocker arm. In this way, the Schaeffler engineers and their customers can put together individual all-in-one solutions directly on the monitor and, using the virtual model display, exchange ideas about different technologies and how they interact.

The Glass Car is brought to life

Complementing the virtual Glass Car is a real model, which was created in collaboration with the 'Transportation Design' study program at the Faculty of Design at Pforzheim University. Under the direction of Professor James Kelly, the underlying design for the virtual vehicle was developed first. In order to demonstrate the diversity of technologies and solutions, a mid-size SUV coupé was used as the basis – a vehicle category that is widespread in global markets. Next, the sketches were transferred into a computer model using a sophisticated process from the special service provider Seven M. Finally, the technologies were selected that would then be incorporated into the unusual body. "With the Glass Car, we outline our very broad range of products including the components and systems in the areas of engine, transmission, chassis and electric mobility," explains Jörg Walz, Head of Communications and

Marketing at Schaeffler. "Thus, the products that one sees in our Glass Car are not specimen parts, but real components. In this way we can present our technologies in a very authentic way to motor show visitors at Frankfurt, Tokyo or Detroit.

With so much exciting technology at hand, some visitors may be tempted to actually climb into the Glass Car. But this is not possible, at least not directly. Instead, two large, sliding touch screens are arranged around the exhibition piece, giving visitors the chance to 'climb aboard' the digital twin of the real model and explore it. Users can access individual technologies either thematically via categories and strategic topics like efficiency, performance and electrification or from a detailed product list. Thanks to the computerized-based implementation, suppliers can bring solutions to life, because through an intuitive interface, visitors can pull up brief profiles and detailed functional animations of various components.

As an example, take the coaxial 48-volt hybrid module in which the additional electric motor is mounted between the engine and transmission. With the hybrid module, the combustion engine can be uncoupled in suitable driving situations, which saves up to 20 percent in fuel consumption and CO_2 emissions. Or the two-speed, electric final drive, which is suitable for both hybrid and all-electric vehicles, and can also contribute significantly to a reduction in fuel consumption and emissions. Systems can be selected such as the electro-mechanical roll stabilizer, in which the previously-used conventional hydraulic stabilizers are replaced with electrically-operated swivel motors. This not only lowers fuel consumption, but also provides improved system dynamics and a more precise steering response.

THE AUTHOR

Laurin Paschek *is the co-owner of the editorial office delta eta in Frankfurt am Main. As a technology journalist, he is a passionate explorer into all things high-tech under the hood of beautiful cars. He was particularly impressed with the digital 'Glass Car' from Schaeffler. For many years, Paschek also managed the editorial office of the online portal all4engineers.*

A draft version of a scenario depicting how the Glass Car could be made accessible to the public at the IAA

APP & AWAY

How smartphone apps have changed the way we move.

by Thomas Wöhrle

What would we do without the little helpers in our tablets and smartphones? They make our lives easier, especially when it comes to mobility. With the appropriate app, you know when the next train is due and how much the same journey would cost with an intercity bus. But there are also examples that fall under the caption 'just for fun.' For instance, the app with which drivers can pay for parking and then place their mobile devices under the windshield instead of a parking disc.

The great thing about an app is that it is easy to use. Information is usually needed quickly: where is the nearest gas station, which trams run from here, what's the name of the town that we've just hurtled through on the train? Many apps work along the same lines: they transmit information from the internet to the smartphone's operating system – or vice versa.

It is a well known fact that apps feed on electricity. And many are very hungry. The trick when using an application is to make sure that it doesn't completely drain the battery. To prevent this, it helps to carry an additional power bank – a spare battery that charges mobile devices multiple times before it, too, goes flat – or to use one of the many battery monitoring apps to locate energy guzzlers and change the settings.

The all-inclusive app that organizes the entire mobile life has yet to be invented. But why should there not be a combined app soon that takes into account all aspects of using a big data approach? One that includes the route, traffic jams, service station network, snowfall, scenic beauty, check-in time, long weekends and school holidays ... and then determines the best way of getting around. And if this 'super app' is monitoring your health and wellbeing, it might just recommend walking to the train station. But until that time comes, you can enjoy the mobility apps that are already on track to popularity – or for that matter, on the road, depending on which app you use.

MOBILITY APPS AT A GLANCE

Bike rental *In Hamburg 'StadtRAD,' in Munich 'nextbike,' in London 'Santander Cycles,' in Paris 'Vélib.' 'Call A Bike' from the German Railway Deutsche Bahn is available nationwide. Those who want to hire a bicycle can do this now via app, hotline call, station terminal or on-board computer. An interesting tip: some providers, for example 'Movelo,' also offer electric bikes.*

Intercity bus *Long distance travel by bus has changed the meaning of mobility for many, particularly young people. A good tip for international bus tours is the 'intercity bus app' from Busradar.com. 'Bustripping' is a top start-up company in the USA which compares companies to find the best deal.*

Taxi *There are many players in this transport segment, including 'Taxi.de' in Germany or 'MyTaxi' worldwide. Even the Chinese have developed a taste and can hail a cab from 'Kuaidi Dache-Didi Dache' or 'Uber.' The apps offer advice on waiting time, price comparisons and electronic payments.*

Car sharing *Decisive when sharing car rides is not the app but the actual number of vehicles. Currently scoring top points here are 'Car2Go' and 'Drive Now.' These two providers have a large number of vehicles and they are everywhere, which makes pick-up and drop-off easy. Car2Go joined forces with 'Moovel,' allowing Car2Go customers to use the service in many European countries and even in the USA. Major car rental companies and even manufacturers offer car sharing.*

Public transport *Many transport associations offer their own apps which give access to timetables, route networks, departure monitors in real time and traffic reports. Some feature a mobile ticketing function. Those wanting to find out when the next tram departs throughout Europe, Australia and the USA can download the free app 'Öffi.'*

Ridesharing *Apps have simplified the concept of catching a ride. The differences between the biggest providers such as 'BlaBlaCar,' 'flinc.org' or 'Fahrgemeinschaft' are the amount of the fees and what they offer. 'BlaBlaCar' provides details such as a driver rating, type of vehicle and comfort, as well as the number of Facebook friends and even if the driver enjoys a chat. 'Karzoo' covers Europe, 'Uber,' 'Sidecar' and 'Lyft' are international.*

All-rounders *Throw all modes of transport together and quickly calculate the best way to get from A to B: this is what 'Moovel' promises with a very simple app. Although the information is not as comprehensive as that of the individual providers, it is still helpful if you have no idea which is the smartest, fastest and cheapest way. The app 'Ally' covers 86 cities on three continents. 'Qixxit,' an initiative of the national railway operator Deutsche Bahn, includes 15 modes of transport in Germany and offers an added benefit: it follows the trip in real time, even when changing trains and in the event of delays.*

Finding parking *In crowded inner cities it makes sense to let an app direct you to the next available car park. Popular providers for this service are 'Parkpocket' or 'Parkda,' and they often guide drivers to available spaces in multi-storey car parks. Avid sharing economists can find or offer private parking spots and storage space via 'Ampido.' 'JustPark' is popular in Great Britain. Around half a million British drivers can choose from over 100,000 parking spaces, mostly located close to airports, train stations and hospitals. Parking spaces are also offered by companies or individuals who make their driveways available for parking.*

QUO VADIS
URBAN MOBILITY?

While we're caught in traffic jams, honking our horns, urban planners and futurologists are dreaming of a post-fossil mobility culture – with urban spaces without rules, in which everything that has wheels will be shared, and change has become routine.

by Wiebke Brauer

People are gliding above the asphalt on hoverboards, light is shimmering on the solar panels of rickshaws, and a group of cyclists is zipping by like a swarm of butterflies. An electric train stops. Throngs of commuters are pouring off it, heading for their homes in greened skyscrapers that look as though a bunch of garden plots including arbors had been stacked on top of each other, reaching all the way up into the blue sky. Great prospects for a new world, with clean air and happy people. In Berlin and London, in Beijing and Moscow, in Copenhagen and Istanbul. People who do not despair in stop-and-go traffic, who do not suffocate in smog, who are not run over by cars because the law of the road is like the law of the jungle and the combustion engine enjoys built-in right-of-way. The future could look so bright. The only question is: when will it begin?

At the moment, we're still struggling with a rising flood of motorized vehicles, with the increasing density of the world's metropolises and, essentially, with ourselves – creatures of habit with an unbending will to move forward and an innate aversion to standing still. How did the French philosopher Blaise Pascal put it? "Our nature lies in movement; complete calm is death."

Defined mobility zones determine the current state

But how are we moving toward the future? When looking at the urban space, it becomes apparent that city planning has been developing in the same direction all over the world. Cities have been dissected to accommodate automobiles, pedestrian zones created, and shopping malls built. The demarcation lines between the spheres of driving, working, living and shopping have been drawn with excessive emphasis and marked with an

abundance of signs. The result: total dreariness, albeit well-regulated. At night, we can ramble through lifeless pedestrian zones that don't give us the slightest clue whether we're in Essen or Budapest. Urbanization means only one thing: uniformity. No wonder we're dreaming of a turnaround – and the perhaps most radical one is called 'shared space.' This term refers to streets without rules and laws. There are no flashing traffic lights, no signs commanding people to stop, no one to issue warnings or orders. In many countries, they are currently being built or intensively discussed: in Germany and the Netherlands, in the United Kingdom and Denmark, in Switzerland, as well as in the United States or Australia.

Everyone has priority

The term 'shared space' was coined by the British traffic planner Ben Hamilton-Baillie. The concept had been developed in the mid-nineties by the Keuning Instituut, headed by the Dutch traffic planner Hans Monderman at the time. In the shared space of the cities, nothing is supposed to be predetermined. No one has priority in traffic anymore or, more precisely: everyone has priority. Hans Monderman, who died in 2006, explained his shared space idea as follows: "The space has to tell the people how to behave." According to Monderman's vision life should return to the cities. He was dreaming of urban life in which social manners have become more important again than traffic regulations. Only the rule that right has right-of-way would apply. Everything else would have to sort itself out.

Sounds great? Not for everyone. Some planners oppose the new philosophy as it means that all their previous regulations and designs may have been developed in vain and all their decisions may have been wrong. It would mean having to plan the unplanned! Accordingly, Siegfried Brockmann, Head of the Accident Research Unit (UDV) of the German Insurance Industry, expressed criticism in an article published in 'Süddeutsche Zeitung.' "Shared space is a politically trendy term," he said, adding that Germany does not even have standard criteria. That sounds dangerous. The truth, though, is that accident rates drop in places where signs and traffic lights are being dismantled. Plus, although drivers have to reduce speed due to the jumble, travel times decrease because traffic continually flows. Traffic lights may be nice and colorful, and make for reassuring routines – but above all, they cause stop-and-go traffic.

In the United Kingdom, many cities have opted for a 'road revolution,' as shared space is called as well. This

means that every town or city has to determine the way in which it implements Monderman's ideas. There are no limits to freedom of choice in this case either: sometimes all traffic lights – or just a few – are removed, sometimes a few signs – or none – are left in place.

Bikes as the saving grace

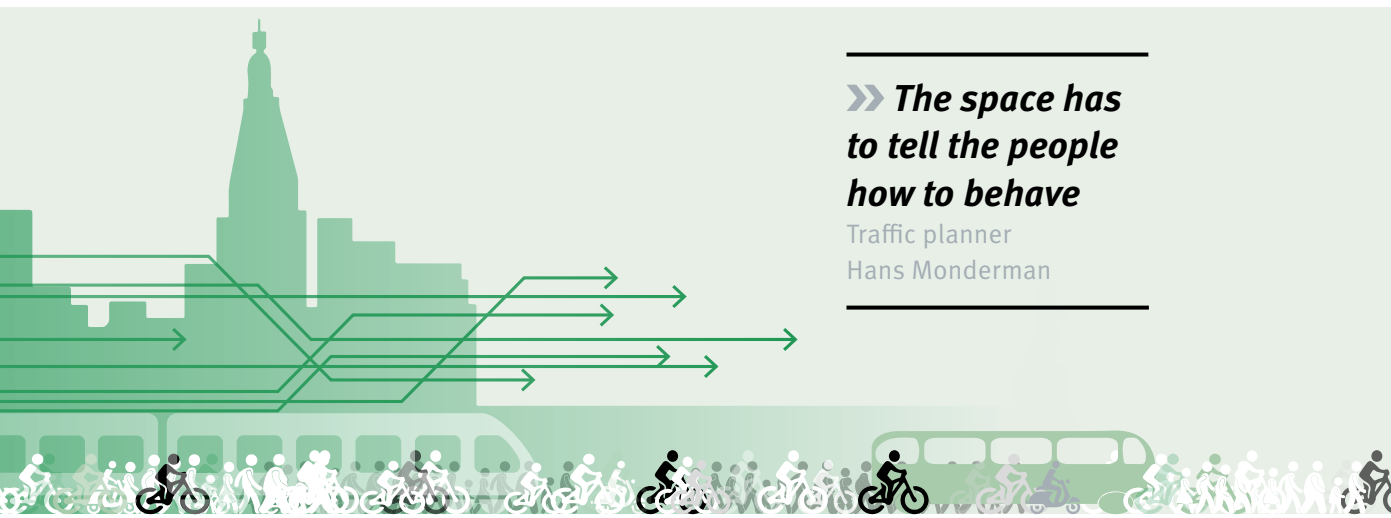
The United Kingdom is a pioneer – or at least aims to be – in another respect as well: the infrastructure for bicycle traffic. In London, four cycle superhighways have been opened in recent years, plus star architect Norman Foster last year presented a network of separate cycle highways traversing the city over a distance of 219 kilometers. The 'SkyCycle' is not only supposed to be routed on the ground but also above the train tracks. Shielded from the other traffic, up to 12,000 cyclists per hour could use these routes. A minor drawback: taxis and delivery vans are illegally parked on the superhighways and cycling between buses and trucks can be life-threatening.

Furthermore, the 'SkyCycle' – presumably for cost reasons – has been put on the back burner for the time being. But while Londoners continue to do their math and argue, the Danes have once again passed them on the right-hand side. In June, a miniature version of the 'SkyCycle,' the 220-meter long 'Cykelslangen,' was opened in Copenhagen's harbor district. The 'cycle snake' is a 190-meter long bridge across Copenhagen's inner harbor. No wonder that the word 'copenhagenize' has already made its way into the English language when it comes to redesigning cities with special preference given to bicycle traffic.

Healthier, more eco-friendly, more cost efficient in economic terms, and simply faster than cars or public transportation – bikes have come to be regarded as the saving grace among urban means of transportation. Still, the issue of how to solve the parking problem when even larger numbers of cyclists start chasing across the tarmac remains. In Amsterdam, a bikers' mecca, it is planned to build a new underwater parking facility for 7,000 bicycles in front of the central train station. Two additional, floating islands are to provide a total of 4,000 parking places for bikes. In Berlin, on the other hand, it is planned to make better use of space with a so-called 'double-deck bicycle parking system.'

And there are the cars and the space

The search for parking places by now accounts for more than a third of the global urban automobile traffic. In a single business district of Los Angeles, drivers cover a distance of roughly 1.5 million kilometers a year while looking for parking spaces, the American economist and city planner Donald Shoup has found out. Growing e-mobility adds another factor: the parking space not only has to be vacant but be equipped with a power connection as well. Even though digital interlinking of parking spaces, cars and drivers by apps



» ***The space has to tell the people how to behave***

Traffic planner
Hans Monderman

increases the probability of hitting a jackpot in the daily parking place lottery – it's unlikely that the digital assistants will completely eliminate the problem from the urban world.

Switching made easy

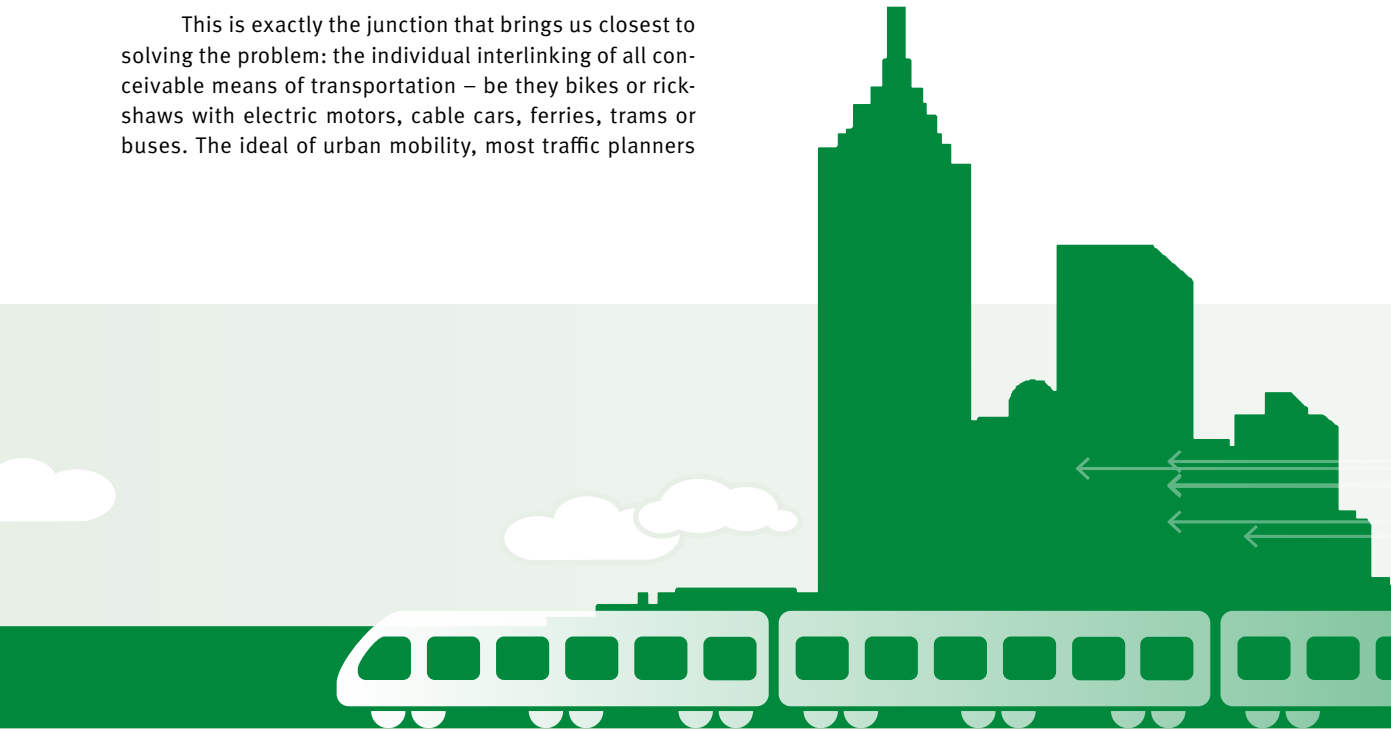
So, there's just one thing left – freely adapted from the 'Monopoly' chance card: "Back to GO and don't get into your car." At the same time, nothing appears to be trickier than motivating the multitude of commuters to leave their cars at home and to use public transportation instead. A new idea of how to accomplish this is called 'Ultra,' an acronym for 'Urban Light Transit,' that is already being used at London's Heathrow Airport. The eco-friendly system consists of driverless 'pods' on rails that can accommodate up to four people and their baggage. Even baby buggies, bicycles and wheelchairs fit in the spacious 'bubbles.' In Dubai, the world's largest fully automatic metro has been running on a 50-kilometer route between the port of Jebel Ali and the district of Al Rashidiya. The computer-controlled trains are said to not only be more punctual and safer, but also less costly. Still: in the course of growing individualization, everyone would like to travel according to the beat of their own drum and in their own space, not showing the least interest in the capacities of metro lines and the flexibility and extensive branching of bus systems.

Combination is the key

This is exactly the junction that brings us closest to solving the problem: the individual interlinking of all conceivable means of transportation – be they bikes or rickshaws with electric motors, cable cars, ferries, trams or buses. The ideal of urban mobility, most traffic planners and thought leaders agree, might have us get into an electric vehicle first thing in the morning, then board a tram or train with a rented bike in order to cycle the frequently discussed 'last mile.'

'Curated mobility' is the keyword – and it is best explained by Prof. Stephan Rammler. He is the founding director of the Institute for Transportation Design (ITD), professor for transportation design & social sciences at the Braunschweig University, and author of the book 'Schubumkehr – Die Zukunft der Mobilität' ('Reverse Thrust – The Future of Mobility') that anyone with an interest in tomorrow should read. Rammler is not a great fan of investing engineering expertise in personal mobility which, in his opinion, has reached the end of its development cycle. Instead, he advocates 'using the digital technologies to interlink transport systems.' In concrete terms, this means using mobility consultants such as 'Qixxit,' 'Moovel' or the Austrian mobility platform 'Smile,' which aim to get people to use and combine a wide range of means of transportation in order to be mobile in a more eco-friendly way.

Car makers and other mobility providers, as well, have long known that mass motorization is facing dramatic changes. They're gradually exploring new business models. Be it BMW's 'DriveNow' and 'car2go' by Mercedes, 'quicar' by Volkswagen, the 'Multicity' electric fleet by Citroën or 'Share-Your-Fleet' by Peugeot and Citroën – just twenty years ago, it would have been unthinkable for automobile manufacturers to act as



service providers and for total strangers to be sharing cars with each other. ‘Sharing economy’ is the name of the cure-all that can be used to make money and to make the world a slightly better place, because sharing conserves resources. But companies not only share their own products. Opel recently launched a sharing community called ‘CarUnity’ that makes it possible to rent vehicles from any manufacturer. Thus, Opel not only competes with private providers such as ‘Cambio’ or ‘Flinkster’ but proves that an entire industry is in the process of changing its way of thinking and heading for the future – not least because large IT companies like Apple, Google & company have begun to stir and reach for all-new business segments. Two years ago, Google acquired an interest in the app-based taxi service Uber in order to be able to offer robot taxis in the future. Who knows, maybe we’ll all soon be breezing through the megacities as transparent citizens in little, self-driving Google Bubbles while the Smarts and Minis of this world are being scrapped. Rammler: “The direction in which the large IT industry is headed and whether the automotive industry will turn into suppliers is being decided now.”

But how can someone who likes getting their breakfast rolls in their SUV be enticed to switch to a bicycle or even walk? Prof. Rammler is convinced that it no longer suffices to invest in the expansion of alternatives and to rely on voluntary choices, but that restrictive actions are called for. Rammler: “Especially for the generation that has been socialized in the spirit of the

HOW THE TRAFFIC LIGHT WAS BORN

Even before the automotive age, *various road users would collide with each other in big cities. In London, the police recorded 102 traffic fatalities in 1866. The metropolis, which had a population of three million at the time, was bustling with countless horse-drawn carts, horse-buses, carriages and pedestrians. The city fathers took action to get the situation under control: on December 10, 1868, on Parliament Square, the world’s first traffic light was switched on. It was operated by gas. The first electric traffic light followed in Cleveland (USA) in August 1914. 1920 saw the first three-colored traffic lights, also in the USA, in New York and Detroit (photo). Europe’s first traffic lights illuminated in Hamburg and Paris in 1922.*

THE AUTHOR

Wiebke Brauer *lives and works as a journalist in Hamburg. She loves her black Mercedes 380SL and her old BMW R 60/7 more than anything, but zips through town on her bicycle every day.*

85 %

of German motorists are in favor of reducing traffic signs, according to a Dekra survey. Every third driver can even imagine completely doing away with traffic signs. Accordingly, only signs warning motorists of icy patches or falling rock or at pedestrian crossings would be desirable.

OVER 20 MILL.

traffic signs are installed alongside or above Germany's streets and roads, one every 28 meters on average. We have to be familiar with 39 different warning signs, 74 regulatory signs, 93 directional and informational signs, 26 icons and 133 supplementary signs. Germany has 365 different traffic signs.

Source: 'Die Zeit'

automotive culture, nudges are needed, in other words stimuli with a restrictive effect resulting from reduced usability and higher prices." This statement immediately conjures up an image of critics reflexively raising their fingers and vehemently talking about the downfall of western civilization and the end of modern democracy. Rammler: "Talking about an eco-dictatorship is total nonsense. The introduction of inner city tolls and parking facility management concepts is nothing but a way of moderating scarcities, using the tools of a market economy. Acting this way is a genuine task of political leaders. This is not totalitarian dictatorship."

It seems absurd that mobility in the urban space is primarily about democratization, about dividing the space without hierarchies, and about the sharing principle that provides for collective usage of a wide variety of means of transportation, each of which enjoys equal rights – and that's supposed to be made possible only by using undemocratic means? Who knows? Perhaps our minds will be moving forward on their own and we will opt for a joint path toward the future based on our own free will – so that, at some point in ten or a hundred years from now, a human being can hover above the asphalt on a hoverboard, through a megacity, on a sunny morning in May.

“ELECTRIC MOBILITY CAN BE FUN”

Prof. Peter Gutzmer

An interview with Prof. Peter Gutzmer, member of the executive board of Schaeffler AG and responsible for research & development, about the challenges of urban mobility.

Let’s take a look at the crystal ball: in your opinion, what will urban transportation look like in the future?
I’m convinced that we’re going to see a totally different form of multimedia transportation – and that the big cities like London, Paris, Singapore or the Chinese megacities are going to play a pioneering role in this context. Passenger cars and commercial vehicles will continue to have their part in this, albeit electrified, automated and interlinked. The same applies to the bus and rail systems. In addition, there will be fully automatic taxis, traveling in dedicated lanes to some extent. In addition, micro mobility will be a topic. We can already tell today that the bicycle, particularly when it’s electrified, is also gaining emotional importance. Another thing I’m expecting is that the big cities such as London or Singapore are going to make access to core urban areas more difficult, by road pricing or space reductions. However, the megacities will have to provide alternatives because people need and love individual mobility.

And that’s where biohybrids come in. What exactly is a biohybrid?
Essentially, biohybrids are further developments of e-bikes with weather protection and luggage compartments. They’re modeled on the tricycles with weather protection and a transport facility in which tourists are chauffeured around today. However, today’s electric bikes still operate by requiring the rider to pedal, assisted by an electric motor. But in the future, the rider will have a free choice: would I rather pedal for physical fitness and would I enjoy that – or would I prefer to ride in fully electric mode?

Will cars be disappearing from the scene then some day?
No, the car will remain an important mobility system, especially in sub-urban areas, and a central one in rural areas. And because there will always be people living in non-urban areas, after all they account for more than a third of the world’s population, I’m not worried about the automotive industry.

And what will change as a result of automated driving?
We’ll soon be seeing automated driving, particularly on freeway-like roads and in the longer run, in an extended form, in cities as well: for instance, as previously mentioned, in the form of self-driving taxis. Providers like Uber are already working on making taxi services with self-driving cars a reality. Another current example: in Singapore, plans are in preparation at the moment to enable fully automated flexible commercial vehicle traffic from the harbor to the cargo airport or logistic centers on special, subterranean roads. In such separate lanes, automated operation is definitely possible even with oncoming traffic.

And what about the thing that, today, we’re still referring to as driving pleasure?
I hope that individual lifestyles will not be impaired by the restrictions that may occur. People seek enjoyment in life, particularly in conjunction with technology. This, too, will keep the desire for individuality in mobility and for new opportunities in this area alive. The things that people feel as mountain bike enthusiasts, as drivers of sports cars or even classic cars, are part of life and will continue to exist. The love for and emotional attachment to vehicles will remain.

So, electric vehicles can evoke emotions?
Yes, I’m convinced that electric mobility can be fun. Just look at motorsports and the many people that follow the races in Formula E with enthusiasm, to name just one example. And perhaps our children and grandchildren will be driving the first hybrids we built as classic cars – with a smile on their face.

MASTHEAD

Published by
Schaeffler AG
Industriestraße 1–3
D-91074 Herzogenaurach
www.schaeffler.com

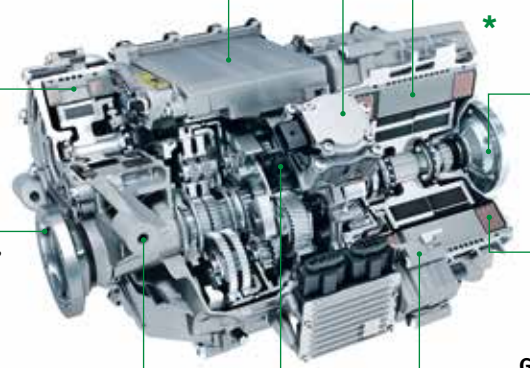
Communications, Marketing and Investor Relations
Christoph Beumelburg
(Senior Vice President)
Jörg Walz (Automotive)
Martin Adelhardt (Industry)
Jasmin Löffler (Corporate)

Concept
Jörg Walz (Schaeffler)
Thomas Voigt (Speedpool)

Editor-in-Chief
Jörg Walz

Editorial Team · Production
Speedpool GmbH
www.speedpool.com

Executive Editor
Volker Paulun



*

Coordination
Carina Chowanek,
Benjamin Hoffmann

Copy Editors
David Feist,
Christoph Kirchner

Pre-press Stage
Julien Gradtke, Anke von Lübken,
Mathias Mayer

English Translation
Kaye Müller, Helga Oberländer

Printing
Blattwerk Hannover GmbH

Graphik Design
Manuela Mrohs (AD), Gökhan Agkurt,
Oliver Breilmann, Jana Herbst,
Mariessa Rose, Thomas Wildelau

Authors
Tom Bierl, Wiebke Brauer, Marco Kraft, Laurin Paschek,
Carsten Paulun, Oliver Runschke, Mark Schneider,
Torben Schröder, Michael Specht, Lukas Stelmaszyk,
Tom Tessmer, Alexander von Wegner, Thomas Wöhrle

Photo Credits
Front page: Westend61/Getty; pp. 4/5: Jon Elk, Keystone, Cahir Davitt, Stocktreck/all Getty; pp. 6/7: Jon Elk/Getty; p. 8: Wolfgang Kähler/Getty; p. 9: Mike Clarke/Getty; p. 10: Antony Dickson, Mike Clarke, Tse Hon Ning, Lucas Schiffres/all Getty; pp. 12/13: colourbox.de; p. 15: mariordo/Wikipedia; p. 17: Nissan; p. 18: colourbox.de; p. 19: Schaeffler, private; p. 20: Dockwise; p. 21: Jahre Shipping, Keith Skipper/Wikipedia, Loic Thebaud/PlanetSolar; p. 22: Daniel Meshel/US Navy, Don Walsh, Rolex; p. 23: Royal Caribbean, Ken Warby, Jonathan Torgovnik/Getty; p. 24: elitefon.ru, Lürssen, Shell, Victoria Kinney/US Navy, Schaeffler; pp. 26–31: Michael Kunkel/Hoch Zwei; pp. 32/33: Keystone/Getty; p. 34/35: Alan Copson/Getty; p. 36: Frank Smits; p. 37: Bill Dickinson/Getty; p. 38: Andy Caulfield/Getty; p. 39: Richard Jordan/Getty; p. 40/41: SSPL/Getty; pp. 42/43: Oxford Science Archive/Getty; pp. 44/45: Pictorial Parade/Getty; pp. 46/47: Glowimages/Getty; pp. 48/49: Christoph Busse/BMW; pp. 50–55: LuK; pp. 56–63: Imago, Rinspeed, NASA, BMW, Audi, Jetlev Flyer; pp. 64/65: Cahir Davitt/Getty; pp. 66–71: Porsche, Schaeffler; pp. 72–77: Tom Bierl; pp. 78/79: Christian Kreutzmann; pp. 80: Pierre Buck/FSG; p. 81: Stephanie Bergan, Pierre Buck/both FSG, Schaeffler; p. 82: Schaeffler; p. 83: Stephanie Bergan/FSG; pp. 84/85: Stocktreck/Getty; pp. 86–91: Shutterstock (Graphics), Manufacturers (Photos); pp. 92–95: Seven M; pp. 96/97: Anbieter; pp. 98–105: Shutterstock (6), clipartp.co, 123RF (2), Purodha Blissenbach/Wikipedia, dreamstime, Fotolia

**This illustration shows an electric axle. With this component Schaeffler offers another very interesting family of products for advanced and high-performance hybrid vehicles. The drive element also has a modular design and can thus be adapted to suit the customer's specific requirements.*

DON'T MISS
THE NEXT ISSUE OF
tomorrow

We'll be pleased to include
you in our mailing list
tomorrow@schaeffler.com

All issues are also available in
digital form in our media library
www.schaeffler.de/en/tomorrow

01/2015

02/2015

03/2015

WEB WORLDS
Discover mobility for tomorrow on the internet
schaeffler-mobility.de