

tomorrow

EXPERIENCING TECHNOLOGY WITH SCHAEFFLER



Visions

What it takes to grow
by embracing challenges

Chal | lenge ['tʃælɪndʒ]

1. a call to compete in a contest or in a fight
2. something that by its nature is a test or a difficult thing to accomplish
3. a demand, request, or question to explain or justify something

Source: Challenge, 2019, in WordReference.com
Retrieved April 2, 2019 from <https://www.wordreference.com>



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DEAR READER,

Our first words, our first steps, our first bicycle ride, our first kiss, our first test at school – we're continually confronted with challenges we need to master from the day we were born. Running a longer distance than ever before, climbing higher mountains, impeccably playing Paganini's "24 Caprices" – challenges incite us to push our limits, to become better. Challenges are our mental fuel. In our personal and our professional lives. Challenges are omnipresent. Just like in the current issue of our technology magazine "tomorrow" to which I'd like to welcome you on this page.

The diversity of possible challenges is matched by the wealth of helpful hints for how to master them. Self-help books fill entire rows of shelves in public libraries. But no matter how well our personal preparation and the gear we're planning to use may be – the moment of truth will come sooner or later: go on or stop now. 60 years ago, American pilot Joseph Kittinger ascended into the stratosphere in a balloon only to jump out of it in hopes that on his way down the parachute on his back would do its job 16 kilometers later. I think anyone who's ever stood on the edge of a 16-ft. diving platform of a swimming pool may have an inkling of what Kittinger felt while he was standing at the edge of the gondola of his balloon and had to take that one crucial step toward the Earth. A total challenge. Go on or stop now. "Stepping into the unknown" is the name of a video about this scene – a fitting title. Read more about courageous explorers and how they used technology to their advantage starting on page 52.

Equally captivating – and motivating – are the portraits of 13 strong women from more than 2,000 years of history (starting on page 34). These physicians, scientists, inventors and adventurers not only courageously took on their unique personal challenges but also defied male resentment. The latter frequently proved to be an even bigger hurdle to overcome.

And even today equal rights for men and women continue to be one of the major global challenges. Just like overpopulation, energy transition, social justice, climate protection, mobility or the transformation of the working world. "tomorrow" talked to renowned experts about all these topics (starting on page 18). Some of their answers may not be convenient and others even controversial – but all of them are worth reading.



Challenges need to be tackled. Starting on page 12 read how Schaeffler's experts tackle the challenge of installing or servicing heavy bearings around the globe at dizzying heights or at arctic temperatures. This, for sure, is no mean feat, but then again, what challenge is? You know as well as I do that no success story writes itself, and rarely if ever is written from one day to the next. How at Schaeffler inspiration, expertise, unwavering perseverance, and sometimes even a shoe box serve to turn a good idea into success is illustrated by four examples described in "tomorrow" starting on page 44.

One of the really big challenges Schaeffler faces is helping to actively shape mobility for tomorrow. This also requires us to leave some of our own beaten tracks and to dare something new: Our startup, Bio-Hybrid GmbH, is one example of how we do this. There an all-new vehicle category – eco-friendly and tailored to the needs of urban areas – is in the making. Read more about our adventure on the way to new mobility horizons starting on page 94.

Enjoy the read. I would be happy if "tomorrow" inspired you to tackle any challenges you may have postponed and wish you the best of luck in mastering them.

A handwritten signature in black ink that reads "Klaus Rosenfeld". The signature is fluid and cursive, with a large, stylized 'K' and 'R'.

Klaus Rosenfeld
Chief Executive Officer

global

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Better not. Race drivers call them **courage corners**. This is where victories and titles are decided

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GREAT IDEA! AND THEN?

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TERRA INCOGNITA

We owe the greatest **discoveries** to bold adventurers. And to intelligent innovations



here and now

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IT security is becoming increasingly important. Open – albeit carefully controlled – data networks are the key

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A generation of tech-adept young people is set to change a lot of things **south of the Sahara**

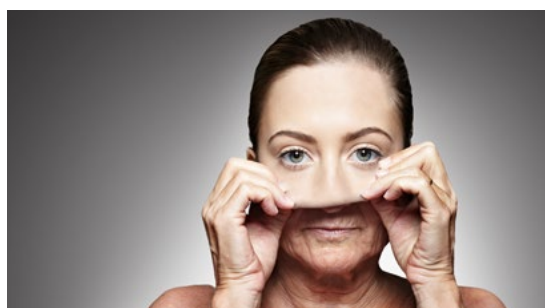
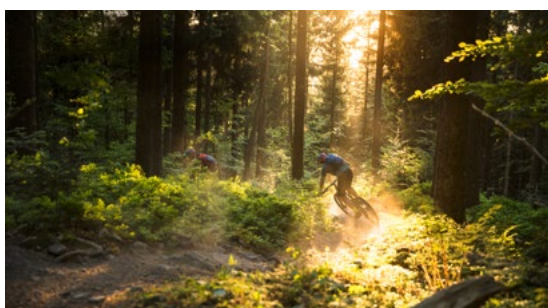
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WATCH WHOM YOU TRUST!

— A green anaconda is able to grow to a length of up to nine meters (30 feet) and may weigh up to 200 kilograms (441 pounds) by some accounts. Accordingly, these huge reptiles are somewhat sluggish on land but fatally fast in water. They're also able to dive for up to ten minutes without breathing. The most awesome snake in the world feeds on tapirs, amphibians, fish and caimans – in other words anything that gets in front of the sit-and-wait predator's mouth. And why bite a chunk off your prey if you're able to open your jaws at a 180-degree angle and devour a 50-kilogram (110-pound) pig in one piece? So all in all, a green anaconda is not the kind of creature you'd normally like to meet while taking a swim.

Unless you're Franco Banfi. For the world-famous underwater photographer, such encounters are like hitting a jackpot. Fear? That's not part of the vocabulary of the Swiss, who also gets close to sharks, crocodiles and walrus: "I don't feel that these animals are generally dangerous. For me, the real challenge is to be able to quickly read their behavior because you don't get many chances to shoot an exciting picture; in fact you normally just get one. Baiting them with food is not a good idea, though, because you never know how they'll react." In spite of his fearless nature, there's one animal that even Banfi stays clear of: the hippopotamus. For good reason, as the infographic below shows.

» The utopian thinker sees the paradise,
the realist sees the paradise plus the snake

Friedrich Hebbel (1813–1863),
German poet and dramatist

DANGEROUS CREATURES AREN'T NECESSARILY PREDATORS

ø annual number of human deaths



5–15

Even when adding up the victims of all **shark species** the number is rather small.



25

Seemingly harmless **cows** are responsible for the deaths of about 25 humans. The other way around the number is 300 million.



100

A look at their teeth reveals that it's best to stay clear of **hippopotamuses**. Even more dangerous by the way are **elephants**: 500 deaths.

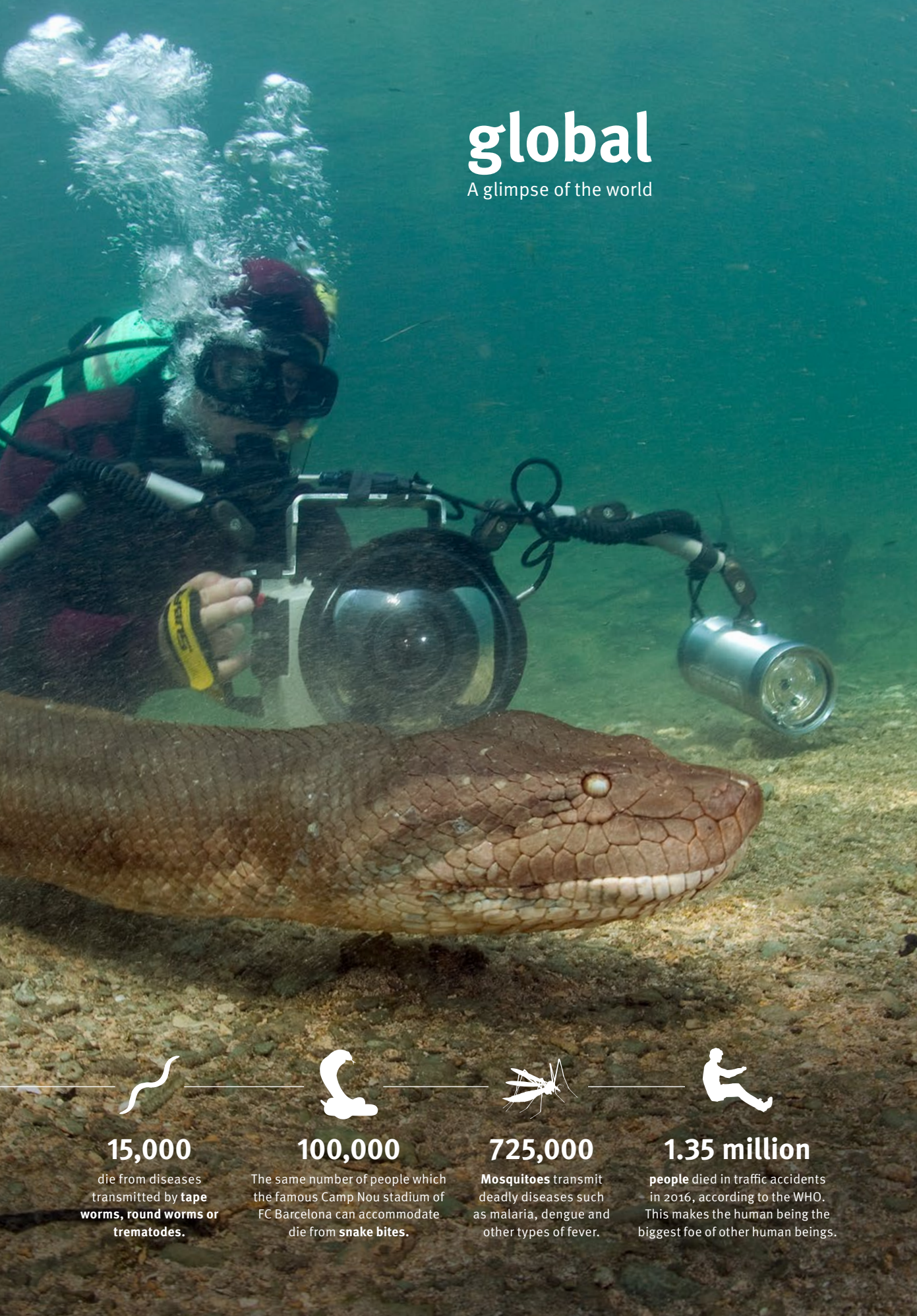


10,000

people are killed by sleeping sickness, transmitted by the **tsetse fly**.

global

A glimpse of the world



15,000

die from diseases transmitted by **tape worms, round worms or trematodes.**



100,000

The same number of people which the famous Camp Nou stadium of FC Barcelona can accommodate die from **snake bites.**



725,000

Mosquitoes transmit deadly diseases such as malaria, dengue and other types of fever.



1.35 million

people died in traffic accidents in 2016, according to the WHO. This makes the human being the biggest foe of other human beings.

360° CHALLENGE

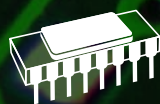
Facts, figures, oddities – a panoramic view of the focus topic of this issue of “tomorrow.”

MICROCHIPS – BEYOND THE PHYSICAL LIMITS?

According to **Moore's law**, every two years the number of transistors on a chip doubles, which nearly equates to double computing power. For decades, this prediction made in the early days of the computer age by Intel's founder, Gordon E. Moore, proved to be right. Up until now. The circuits that have meanwhile shrunk to sizes in the nanometer range cannot become even small-

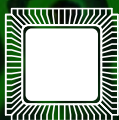
er because they produce too much heat that's no longer able to escape. The solution: instead of electrical charges scientists use magnetic waves, so-called spin waves, to transport information, which hardly generates any heat. The challenge: developing the so-called “sound chips” to market readiness. The prediction: it will still take a few more years.

Number of transistors per computer chip over the course of four decades



INTEL 4004

- Introduced in 1971
- Size in mm² 12
- Transistors **2,300**



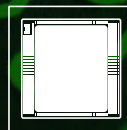
INTEL 80186

- Introduced in 1982
- Size in mm² 60
- Transistors **55,000**



PENTIUM PRO

- Introduced in 1995
- Size in mm² 307
- Transistors **5,500,000**



GC2 IPU

- Introduced in 2018
- Size in mm² 825
- Transistors **23,600,000,000**

1970

1980

1990

2000

2010

2020

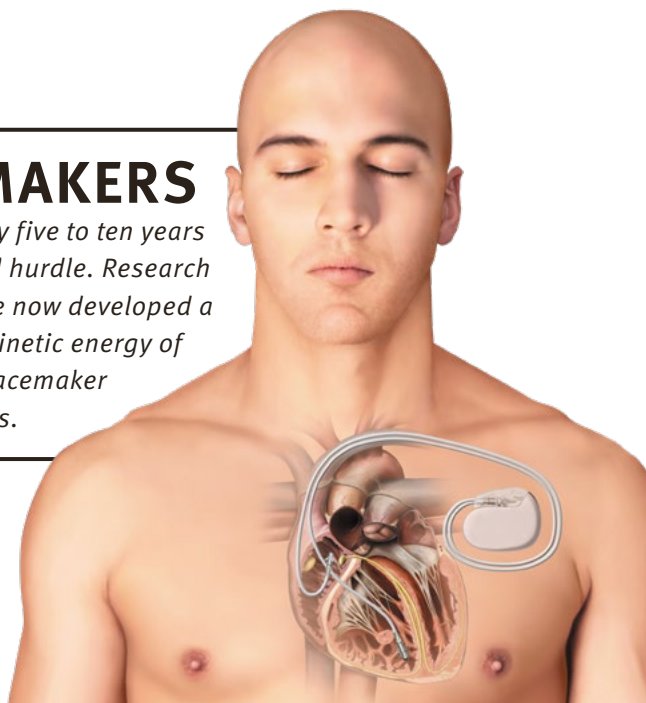


ROBOTS WITH FEELINGS

*For robots and humans to be able to interact, the machines have to master a whole host of challenges. One of them is to **read and analyze gestures**. Fraunhofer Institute for Machine Tools and Forming Technology has managed to teach them how to do this. The scientists developed a novel technology that enables robots to recognize a human's face and body posture and, as a result, makes critical handovers of hazardous objects possible, for example.*

PERPETUAL PACEMAKERS

Wearers of pacemakers have to have surgery every five to ten years to change the battery – a medical and mental hurdle. Research scientists at the Thayer School of Engineering have now developed a pacemaker that's supplied with electricity by the kinetic energy of the heart. The scientists estimate that the piezo pacemaker will be ready for production in about five years.





Streetlight 2.0 – let there be more than light!

Smart cities pose a huge technological challenge. A traditional element of urban infrastructure – street lights – might be able to assist in mastering it. Energy utility Innogy has already launched some pilot tests in Bochum. This is what streetlight 2.0 is supposed to be able to do in the future:

- ▶ Serve as a charging station for electric cars
- ▶ Measure pollutants in the air
- ▶ Function as a WLAN base station
- ▶ Provide an SOS phone
- ▶ Indicate vacant parking spaces
- ▶ Mobility via 5G technology

SCHAEFFLER BUSINESS SOLUTIONS

Digital transformation is one of the greatest challenges at the moment. Schaeffler contributes its know-how to **global strategic alliances** for precise solutions. Two examples: The e-F@ctory Alliance Network with Mitsubishi Electric creates custom-tailored Industry 4.0 (smart factory) solutions that reduce machine downtimes and increase productivity. "SupplyOn" that Schaeffler established together with other automotive suppliers in 2000 combines diverse industries: Automotive, Aerospace, Railway and Engineering. "SupplyOn" covers all processes in the digital supply chain, from production materials to services to consumables. Among its 4,600 customers: **Airbus, BMW Group, BorgWarner, Deutz, Liebherr, Safran, Schindler, Siemens, and Thales.**

WORDS TO REMEMBER

» *Everyone said it couldn't be done until someone came along who didn't know it couldn't be done and just did it*

Unknown source

» *Obstacles and difficulties are steps upon which we rise*

Friedrich Nietzsche (1844–1900), German philosopher

» *I choose a lazy person to do a hard job. Because a lazy person will find an easy way to do it*

Bill Gates (born in 1955), Founder of Microsoft

» *With the stones others put in our way we can also build a house*

Johann Wolfgang von Goethe (1749–1832), German poet and naturalist

» *Prudence keeps life safe but does not often make it happy*

Samuel Johnson (1709–1784), English poet

» *A pessimist sees a threat in every chance, an optimist a chance in every threat*

Chinese proverb

TV FREQUENCIES TAKE THE INTERNET TO REMOTE AREAS



Providing internet access to sparsely populated areas poses a challenge to network operators because it's complex and expensive. The solution: old, analog TV frequencies. These "white spaces" can make digital, mobile services – such as wireless internet – possible where neither cable nor DSL connections are available. U.S. authorities have now initially released some of these unused frequencies. However, so far neither providers nor suitable end user devices exist.



750,000

pieces of **astro-garbage** are orbiting the Earth. The projectiles fly through space with up to 28,000 km/h (17,400 mph) – posing a risk to spaceships and satellites. The challenge: how can space trash be brought back into the Earth's atmosphere where it will burn up? Ideas: collecting debris by means of nets and harpoons or using laser guns to shoot at it to force its trajectory to change in the direction of the atmosphere.

AROUND THE WORLD WITH WIND, SUN, AND HYDROGEN

THE CHALLENGE: WHY NOT PROPEL SHIPS BY MEANS OF A FUEL CELL – AFTER ALL, THERE'S PLENTY OF WATER UNDERNEATH THE HULL. ON BOARD OF THE "ENERGY OBSERVER," AN ENERGY-SELF-SUFFICIENT VESSEL, A SYSTEM BY MEANS OF PHOTOVOLTAICS AND TWO WIND TURBINES PRODUCES PURE HYDROGEN TO OPERATE A FUEL CELL. IN GOOD WIND CONDITIONS, THE CREW ALSO USES A KITE TO PULL THE VESSEL. SINCE ITS DEPARTURE FROM SAINT-MALO, FRANCE, IN 2017 THE "ENERGY OBSERVER" HAS ALREADY TRAVELED 10,326 NAUTICAL MILES (MORE THAN 19,000 KILOMETERS/11,800 MILES). ITS DESTINATION IN 2020 IS TOKYO – THE VENUE OF THE OLYMPICS.





Christian Schuster is one of seven specialist mechanics of Schaeffler's field service that performs worldwide maintenance and repair work

THIS MAN LOVES **CHALLENGES**

London, Paris, Madrid – what sounds like the stops on a tour of a TV commercial for hairspray in the late 1980s may also at times be hairy routine for Christian Schuster – this story, though, is not about the hairstyle of Schaeffler's field mechanic but about tricky maintenance jobs around the globe.

— by Carsten Paulun

Be sure not to turn around, don't look up, and definitely don't take off your goggles: The bright sunshine feigns warm temperatures that Christian Schuster can only dream of at the moment. At 20 degrees centigrade below zero (-4 degrees Fahrenheit) and a biting coastal wind, the 33-year-old mechanic is perched on a scaffold at a height of a one-family house in the Finnish port city of Pori, about a three hours' drive northwest of Helsinki. His mission: replacing the main bearings of the two reels of a pipe-laying vessel. Exposed to exceptional forces, each bearing has an outer diameter of 1.75 meters (5.74 feet) and weighs six metric tons (6.6 short tons) because several kilometers of pipe previously welded onshore is wound on the reels. Replacing the bearings is no mean feat and requires Schuster and his crew to insert the spherical roller bearings with millimeter precision into the housing that also weighs several tons.

A great team that Schaeffler is proud of

Christian Schuster is one of seven members of Schaeffler's field service crew. They're the men for special challenges. Be it maintenance, repair or replacement,



**» I turned
my dream
into my job**

Christian Schuster,
industrial mechanic

be it in a steel mill, on trains or in a mine, out in the middle of the North Sea or in the "ice house" at Pori – whenever precision work needs to be done on huge high-tech components, Schuster and his colleagues are called. "A great team that Schaeffler is proud of," says Andreas Krieg, who is in charge of the field service crew.

Besides the work itself, the conditions at the site pose a challenge because in spite of all advance coordination, the local situation often differs. There's just one constant: the required completion date. Schaeffler's mechanics must adhere to the defined time window under all circumstances. "In spite of tight schedules, we have to work with millimeter precision," Schuster explains.



PORI (FIN)

Each of the two reels of the "Deep Energy" pipelayer has a diameter of 25 meters (82 feet) and is able to take up 2,800 tons (3,086 short tons) of welded, ready-to-lay pipe for pipelines. With a 200-millimeter (7.9-inch) pipe this is enough for a total of more than 90 kilometers (56 miles) of pipeline.

MAINTENANCE & SUPPORT **WORLDWIDE**

Specialty bearings from Schaeffler are used around the globe. Mechanics from Schaeffler's customer support team handle all the necessary maintenance and repair work. Here are a few examples.

OPEN-CAST MINING GARZWEILER (D)

The bucket wheel of the **coal excavator** has a diameter of 21.60 meters (71 feet). The massive bearings have to be inspected regularly.



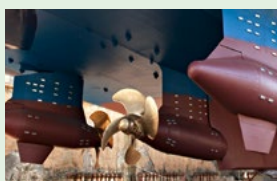
MOJAVE DESERT (USA)

To repair a **wind turbine** in the Mojave Desert, the mechanics have to work at a height of 80 meters (262 feet). Constant wind force 4 puts axial and radial loads on the specialty bearings.



LONDON (GB)

Work at dizzying heights: The **wheel** of the 135 meter (443 feet) high "London Eye" weighs 2,100 metric tons (2,315 short tons) and is supported by two Schaeffler spherical roller bearings.



SINGAPORE (SGP)

Due to their Azipod propulsion systems that can rotate by 360 degrees, **cruise ships** and other huge vessels are extremely agile. The bearings are replaced when a ship like this is in a dock.



NORTH SEA (GB)

During the extension of an **offshore gas platform** in the middle of the North Sea, new joints for the pile foundations had to be installed.



“You can’t cut corners with our precision components. The next failure would be pre-programmed.”

Completing one of these specialized on-site jobs takes an average of one week, plus all the preparatory work such as selecting the required external staff, specifying the component, arranging for equipment and tools. Naturally, working in foreign countries with their unique cultures and the diversity of people holds a special attraction as well. “Yes, it’s exciting every time, even though in many of our projects we work to

a schedule that hardly leaves any time for the country and its people,” says Schuster. But at least working with local colleagues at the site provides some small insights. “And sometimes the job involves a weekend on which we may not be working quite as long as usual,” says the family man and father of two, who “by all means wanted to work with the final product of rolling bearings” even when he was still an apprentice at Schaeffler being trained as an industrial mechanic.

Specialty bearings with a diameter of 2.62 meters

Christian Schuster has been a field service mechanic for special missions since 2007. The lead picture and the one at the bottom of this article show him after just having replaced the spherical roller bearings of the lock and dam complex in Hagestein, the Netherlands. They sit on the cable winches that pull up the two lock gates, each weighing 270 metric tons (298 short tons). Since 1958, the lock and dam complex has been controlling the water level of the Lek river to keep the waterways navigable at all times.

The two spherical roller bearings in London’s rotating landmark, the “London Eye,” have to bear even greater weight. The Ferris wheel that with a height of 135 meters (443 feet) is Europe’s biggest weighs 2,100 metric tons (2,315 short tons). Its hub sits in specialty bearings with an outer diameter of 2.62 meters



Installation of a large housing with assembled spherical plain bearing for an offshore platform



(8.59 feet). Both bearings have a design life of more than 50 years. An inspection is necessary every year. Large bearings expert Christian Schuster has just performed the most recent one.

Having no fear of heights is one of the prerequisites that Schuster has to meet in addition to his qualification as an industrial mechanic. “Plus, we’re trained in fitness for heights, rope rescue, and helicopter underwater escape for missions at offshore wind farms or oil and gas platforms,” the Schaeffler employee explains.

How do you get a job like this?

Sounds tough, so it’s not really a dream job? “Yes it is! Fortunately, my family accepts that I’m away all the time,” says Christian Schuster, who initially came into

contact with the technical field service during his apprenticeship at Schaeffler and was ultimately approached by one of his colleagues back then: “You love challenges, so that’s right up your alley.”



THE AUTHOR

Carsten Paulun was already fascinated with technology as a young child. He’d dismantle and examine anything he could get his hands on – and still does today. In the members of Schaeffler’s field service crew, especially Christian Schuster, he instantly found the right people to talk shop with.

At the lock and dam complex in Hagestein, the Netherlands, Christian Schuster just finished replacing the bearings on the cable winch drive of the gates each of which weighs 270 metric tons (298 short tons)



GLOBAL CHALLENGES

From overpopulation to the future of work to energy transition – there are plenty of issues to be tackled on our planet. Nine experts tell us what needs to be done now.

— by Alexander von Wegner and Volker Paulun



OVERPOPULATION

Space on our mother ship, Earth, is limited. How many humans Earth can sustain has been the subject of speculation ever since the 17th century. The current population count is 7.67 billion. More recent research shows our planet's life-sustaining capacity to range between 500 million to as many as 65 billion people. In most calculation models, the range is between 8 and 16 billion.

Why are there such vast differences between these figures? The reason is that the calculations they're based on are highly varied and have been performed using diverse methods. Another question is whether or not they take only a single limiting factor such as food into account. The Stockholm Resilience Centre for instance names nine processes that indicate our planetary limits: climate change, acidification of the oceans, loss of ozone, nitrogen and phosphorus cycles, fresh water consumption, land use, loss of biodiversity, aerosol concentration in the air, and chemical pollution.

This is what the expert proposes: The approach pursued by economist Graeme Maxton, Secretary General of the Club of Rome until 2018, is the concept of a "sustainable equilibrium economy." It's based on the notion that economic growth has to stop driving social development because economic growth itself is driven by a growing population and increased efficiency. Both, Maxton warns, accelerate environmental destruction and global warming.

The current state: At the moment, Maxton sees the economy of mother ship Earth as being off-balance: "Given the ecological footprint (Global Footprint Network, N.D.) of 7.6 billion people today, it seems likely that the maximum population would need to be much lower than this ..., " he writes. However, accepting the number of people on the planet as

a given means that equilibrium can only be achieved by a reduction of the material standard of living.

In the light of this, is humanity condemned to stagnation? By no means, says Maxton: "Humanity can still develop. Rather than boosting material consumption, it can grow artistically, culturally, intellectually, and technologically." Human development, according to Maxton, will have to be overhauled: "Societies will need something like a new Enlightenment, to redefine just humanity's role and purpose."

Can technologies have a positive impact on creating equilibrium? With respect to global warming, which Maxton is seriously concerned about as well, they might be able to help. In fact, the power of the sun, wind, and water is sufficient to cover humanity's present and future energy demand multiple times – if we had the technologies that are necessary to generate, store, and transport energy. Feeding all the people on our planet is another great challenge. Even at this juncture, intensive and high-tech farming confronts environ-

80 million

The current size of Germany's population equates to the number by which the world population is growing per year.

Source: Deutsche Stiftung Weltbevölkerung

800 million

people are starving while 2.1 billion are overweight.

Source: United Nations

mental protection with serious problems. Research and technology can assist in making better use of water and fertilizers. We personally have to do our part as well, for instance with respect to what we eat. The consumption of meat, which is far too high and rising especially in threshold countries, has an extremely negative effect on the environment.

Maxton's urgent plea: "We are standing at the turning point of the 21st century. No Hollywood hero will come to our rescue. We must act now!"



» Given our ecological footprint today, it seems likely that the maximum population would need to be much lower

Graeme Maxton,
Club of Rome



One of Africa's great challenges: of all the planet's continents, the poorest one has the fastest population growth

The perspective is misleading: the financial gap between the rich and the poor is enormous especially in threshold countries

4.4 billion

people are living below the poverty line. 700 million of them not even have **1.60 euros per day** at their disposal.

Source: World Bank, 2019

€ 2.5 billion

The wealth of the world's nearly **2,200 billionaires** increased by this much in 2018 – per day.

Source: Oxfam, 2019

SOCIAL JUSTICE

Social justice – what is meant by this term? Economist, development expert, and long-standing Secretary General of Deutscher Caritasverband, Professor Georg Cremer, PhD, explains: “Social justice is on everyone’s lips, but the kind of justice concept that’s being addressed in the respective context is seldom precisely defined: equal civil rights, trade justice, contributive justice, equality of opportunity, and distributive justice. And there’s one dimension I often find to be absent completely: capabilities-based justice.”

Capabilities-based justice is a human-centric concept. Every individual by nature has physical and cognitive abilities with which he or she is able to perceive options for action. “But in order to do so, people need certain prerequisites which they’re unable to secure on their own,” says Cremer.

What are these prerequisites? Cremer includes in them a nurturing family, a stimulating social environment, a healthy environment, a political system that assures the individual’s rights, adequate healthcare, and an open educational system. Equally

important is access to resources and incomes. Cremer criticizes: “The welfare state is often its own worst enemy. Fragmented responsibilities and budget conflicts prevent effective help being provided from a single source to people living in precarious circumstances.”

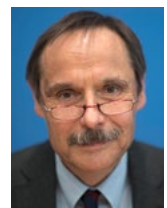
Do economic and social interests get in each other’s way? Cremer says: “Those who want to effectively defend the social market economy mustn’t limit their rationale to the – totally justified – argument that this type of economic order secures our wealth. We also have to look at the fringes. At the people who fail in an educational system that’s unable to loosen the link between social background and educational success, as well as at those who in a

growing, non-unionized service sector can’t make ends meet. The social market economy also has to prove its viability on the fringes.”

An example of effectively implemented capabilities-based justice: In Germany, 80 percent of the roughly half a million people with autism are unemployed – because they’re almost always reduced to their impairments rather than focusing on their outstanding capabilities such as logical thinking, excellent recognition of patterns and flaws, high concentration, and accuracy in details. Exactly this is what IT consultancy Auticon does. The people with autism who work there, for instance, develop software or detect disconnects in the logic of complex processes.

» Fairness is indispensable to the social market economy

Prof. Georg Cremer, PhD,
University of Freiburg



CLIMATE CHANGE

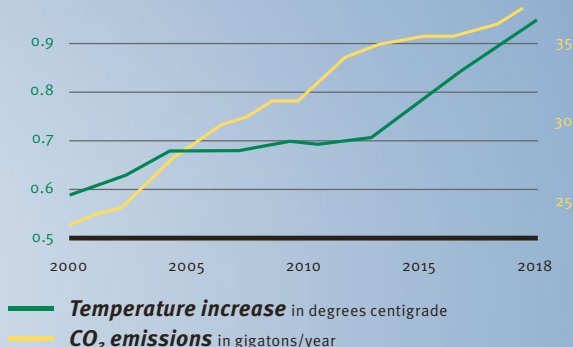
Is the climate changing – and if, so who's responsible? Scientists interpret the increasingly large number of extreme weather events as clear signs of progressive climate change. Mojib Latif, an internationally acknowledged climate expert at GEOMAR Helmholtz Center for Ocean Research in Kiel, Germany, takes an unmistakable stand on the issue: "Climate change in the form of a warming of the Earth is taking place, and humans are the main cause. This has been scientifically proven. For instance, the five-year period from 2014 to 2018 was the warmest around the globe ever since the first large-scale temperature measurements were made in 1880."

By how many degrees has the Earth warmed compared to the pre-industrial age? Latif explains: "So far, global warming has amounted to one degree centigrade. The effects are already obvious. The ice of the Earth is melting, the sea levels are rising, and extreme weather events are increasing worldwide." Other experts and organizations such as the Intergovernmental Panel on Climate Change (IPCC) have made similar estimates – 0.8 to 1.2 °C – of human-caused global warming.

Shocking statistics illustrate the need for action. According to a UN report, 6,457 weather disasters between 1998 and 2017 killed more than 600,000 people and injured 4.1 billion. The financial damage during that period amounts to 1.9 quadrillion euros.

Is the Paris Agreement with the internationally binding target of limiting global warming to clearly below two degrees centigrade versus the pre-industrial level an all-clear signal? Latif analyzes the agreement critically: "The Paris Agreement did not produce the expected impetus. In 2018, worldwide greenhouse gas emissions reached another all-time high. Ever since the topic of climate protection has been on the agenda emissions of the most important greenhouse gas, carbon dioxide, have virtually skyrocketed. Since the early 1990s they increased by about 60 percent."

ALONG WITH CO₂ EMISSIONS TEMPERATURES RISE



Sources: Temperature: NASA; CO₂: Carbon Dioxide Information Analysis Center (CDIAC)

Who's causing the greenhouse gas emissions? According to the most recent IPCC survey, worldwide it's the energy sector (35 %), forestry and farming (24 % including climate-harmful methane and nitrous oxides), industrial operations (21 %), transportation (14 %), and buildings (6 %).

This is how compliance with the two-degree limit can be achieved: According to projections, the global emissions of greenhouse gases by 2050 would have to be reduced by 40 to 70 percent versus 2010. By 2100, emissions would have to be at near-zero or below.

What does the expert propose? Latif explains: "The future belongs to renewable energies and alternative drive systems. The future belongs to digitalization and decentralized energy supply. Countries that fail to pursue these developments run a risk of no longer playing in the premier league. The climate problem can only be resolved by all countries together. So as far as this goes, all countries are also required to take part in climate protection. Blaming each other does not help the climate."



» Humans are the main cause of global warming

Prof. Mojib Latif,
GEOMAR Helmholtz Center
for Ocean Research, Kiel



EQUALITY OF OPPORTUNITY

Equality of opportunity – this is the current state: Absolute equality of opportunity does not exist in any country on Earth (see info box). Women still have to fight for health, education, work, equal pay, and in some countries even for survival. “We have quite a way to go,” says Saadia Zahidi. The Harvard graduate who was born in Pakistan 38 years ago is a board member of the World Economic Forum.

How long will be the way we still have to go? The annual Global Gender Gap Report that has been published by the World Economic Forum since 2006 analyzes the four thematic dimensions in 149 countries: Economic Participation and Opportunity, Educational Attainment, Health and Survival, and Political Empowerment. The shocking results in 2018: If we continue to pursue equality of opportunity at the current pace, it’ll take another 108 years to close the gap between men and women worldwide.

What does the expert propose? “Industries must proactively hardwire gender parity in the future of work

through effective training, reskilling and upskilling interventions, and tangible job transition pathways,” says Zahidi. It’s in their long-term interest because diverse businesses



» Diverse businesses perform better

Saadia Zahidi,
World Economic Forum

perform better.” Governments can promote this development, for instance by expanding the opportunities for childcare and care for the elderly to ease the burden on women, who usually take care of these needs in the family.

Where else is equality of opportunity a key issue? In the areas of health, education, and politics. Particularly in the context of political empowerment, the participation of women has been seeing a worldwide decline. In 2018, only ten countries were governed by women, five of them in Europe.

Do women benefit from technological progress? Unfortunately, not, says Zahidi: “There have been big shifts in the labor market with greater use of technology and automation, and women have borne the greater brunt associated with those changes.” Another challenge is the fact that although more and more women have academic degrees, they still have deficits in technology, science, and math, in other words in fields that are important in a modern digital world.

EQUALITY OF OPPORTUNITY: ICELAND IS IN THE TOP SPOT

On the global average, the gender gap has been closed at a rate of 68%. Yemen, at the bottom of the ranking in 149th place, has not even come halfway (49.9%).

1. Iceland	85.8 %
2. Norway	83.5 %
3. Sweden	82.2 %
4. Finland	82.1 %
5. Nicaragua	80.9 %
6. Rwanda	80.4 %
...	
12. France	77.9 %
13. Denmark	77.8 %
14. Germany	77.6 %
15. Great Britain	77.4 %
...	
51. USA	72.0 %
...	
103. China	67.3 %
...	
141. Saudi Arabia	59.0 %

Source: Global Gender Gap Report 2018



MOBILITY

Why is mobility so important? For innovation expert Prof. Dr.-Ing. Tim Hosenfeldt from automotive and industrial supplier Schaeffler, “Mobility is an important foundation and prerequisite for a free and self-determined life: from the stage of a toddler to the exploration of one’s surroundings to the development and sustainment of a social network for earning one’s living through to the mobility that’s needed to sustain an autonomous and healthy life in old age.”

That’s why mobility has to change as well: population growth, global warming, urbanization, and the transformation of work require mobility to be continually, and to some extent even radically, adapted to changing needs. “The focus in this context has to be on the entire chain,” says Hosenfeldt.

There are many ways to achieve this. Hosenfeldt says: “A single solution for mobility of the future doesn’t exist. In the area of urban mobility alone, the solutions range from expanding micromobility by concepts such as the Schaeffler Bio-Hybrid (see article starting on page 94) to autonomous vehicles (see article starting on page 90) – where Schaeffler is gaining initial experiences with the Schaeffler Mover – to vertical mobility with drones in the airspace (see article starting on page 80). In the inter-urban context, mobility will see some radical changes as well: from intensified utilization of high-speed trains to alternative propulsion systems in aviation and in heavy cargo transportation by ships, trains, and trucks, where the hydrogen chain will also be gaining increasing importance, to all-new concepts like the Hyperloop train.”

These are the propulsion technologies of the future: “A wide range of possible solutions: small vehicles that are battery-powered with zero local emissions, for short hauls of passengers and cargo deliveries; hybrid powertrains from mild hybrids to plug-in-hybrids, for larger vehicles and longer distances. Fuel cell propulsion system generating the required traction power from hydrogen in CO₂ neutral ways are a good approach as well,” Hosenfeldt explains.



» There will be no single solution for mobility of the future

Prof. Dr.-Ing. Tim Hosenfeldt, Schaeffler



Microvehicles such as the Schaeffler Bio-Hybrid (right) traveling in dedicated lanes could help decongest traffic

5.61 million

cars with plug-in-hybrid and all-electric powertrains were registered worldwide on December 31, 2018 – **65 percent more than at the end of 2017**. However, they only account for 0.4 percent of all passenger cars.

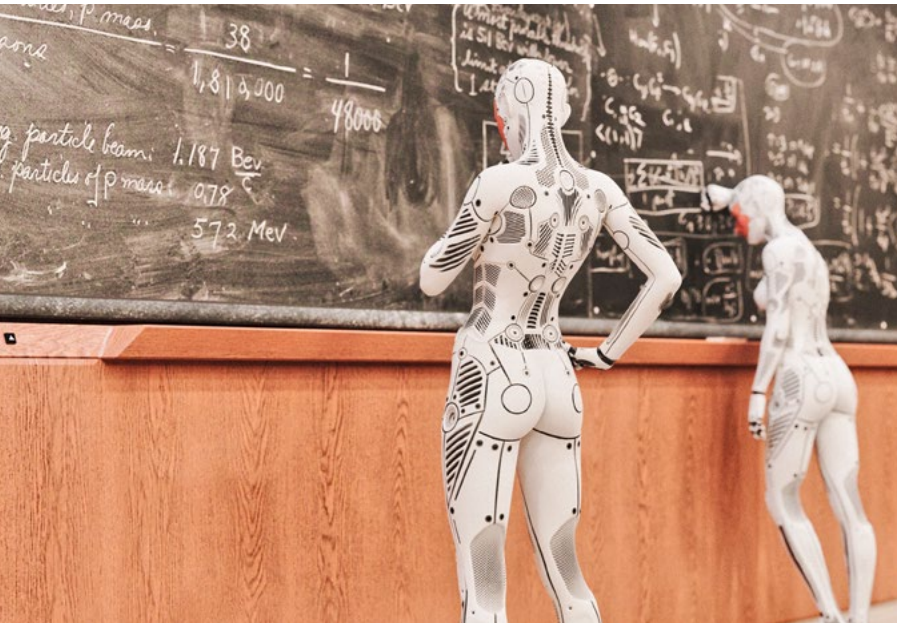
Source: Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

30/40/30

In 2030, 30 percent of all vehicles sold worldwide will be propelled exclusively either by electric power or by IC engines, according to **Schaeffler forecasts**. At 40 percent, hybrids account for the largest market share.

This is what we need to bear in mind: More than ever before, the future of mobility will be linked to the energy chain. Hosenfeldt: “We have to intensify our use of renewable energy sources for mobility. Instead of using fossil fuels we need to increasingly tap into the hydrogen chain including CO₂-neutral fuels such as synthetically produced e-fuel. Plus, we have to create additional means of storing electrical energy in affordable ways and ensure that the political parameters support these efforts. For manufacturers, it will not be enough to establish new vehicles. However, the potential for new business models centered on mobility is huge.” In Hosenfeldt’s opinion, this systematic view leads to these crucial questions: “Who will orchestrate/finance the system change? What will be the roles of classic manufacturers and their suppliers in the context of this transformation? And to what extent will new mobility providers such as IT companies become active in the field of mobility?”

WORKING WORLD



33 %

of all jobs in Slovakia are highly automatable, in Norway only 6 percent are.

Source: OECD, 2018

145.8 mn

people in the United States had a job in 2017 – 205 percent more than in 1970 when computers were still in their infancy. The population grew only by 58.8 percent during the same period.

Source: OECD, 2018

The working worlds of the future are a hot topic. Scientists at Karlsruhe Institute of Technology (KIT) – an alliance partner of Schaeffler – perform relevant research in this field as well, with diverse views on the subject.

IT professor and Industry 4.0 expert Michael Beigl says: “The working worlds of tomorrow will remain the same – and, even so, be different. What will remain the same is our work in general. The things that will be different in particular are the artificial intelligence assisted tools we’ll be working with.” Beigl provides some examples: “Production engineers, for instance, will not only analyze the results of measurements but their smart software will provide them with rules of why something works or not. Office workers will not only see their transactions but also be provided with suggestions of how to accomplish the same job with less effort. However, employees of the future will still have to use such proposals creatively to achieve results and make decisions themselves.”

Technology philosopher Professor Armin Grunwald is concerned about the social consequences. “People who will be affected by automation are not necessarily qualified for the new jobs. We’re facing major social issues in this respect,” says Grunwald. His demand: “We have to pay taxes, robots don’t. This is a clear competitive disadvantage for humans. As a result, robotics will make its ways into the working world at a highly accelerated pace. The time has come to think about this in the political context, a tax for robotic work will have to be levied at some point in time.”

Ergonomics scientist Prof. Barbara Deml sees a polarization of the working world on the horizon: “I expect monotonous, repetitive jobs to become even more systematically automated. In this context, I’m not only thinking about the shop floor but also about jobs in office environments or sales. On the other hand, though, there’s the economic call for very fast development of highly complex digital products. This dynamic, research-intensive knowledge work will make

maximum demands on some employees.” To appropriately respond to the changes, the expert feels that it’s not enough to just appeal to the flexibility and willingness of employees to learn. Equally important, she says, is that companies actively help shape the transformation process and define guard rails themselves, for instance with working hour models.



» **We have to pay taxes, robots don’t. That’s a clear competitive disadvantage**

Prof. Armin Grunwald,
Karlsruhe Institute of Technology

ENERGY TRANSITION

A large population requires a large amount of energy. From 1970 to 2015 the world population doubled and the consumption of primary energy increased by 168 percent. So far, 80 percent of this consumption has been covered by fossil energies, resulting in a rise in both CO₂ emissions and global warming and the need to switch to renewable energy sources.

This is what the development looks like: The World Energy Council has predicted that the primary energy demand growth will drop to one third by 2060. This means that due to technological innovations, digitalization, as well as social transformation, we will save energy. At the same time, the proportion of fossil energies in primary energy demand will decrease – to between 50 and 70 percent, depending on the scenario. The proportion of nuclear energy will remain roughly the same, whereas the proportion of renewable energies will increase from today's 14 percent to a range between 21 and 37 percent, according to the World Energy Council.

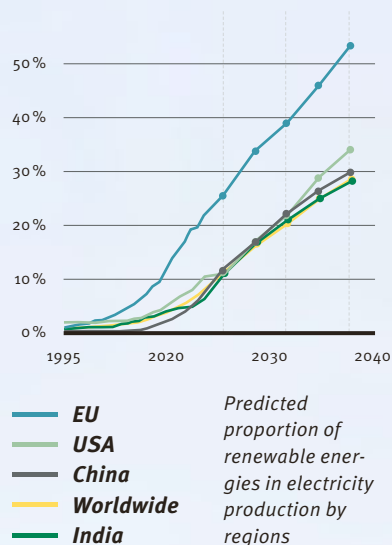
The impact of renewables is particularly strong in electric power generation. Although the global demand for electricity will double by 2060 – between 55 and 98 percent of it, depending on the scenario – will then be produced without CO₂ emissions.

Is the energy transition technically feasible? Yes, says Prof. Wolfgang Irrek, PhD, an energy management expert at Ruhr West University of Applied Sciences. Assured supply, though, is the big challenge. Related to his native Germany, Irrek says: "Solar and wind power might only be able to cover five percent of the electricity load on some days, but 198 percent of it on others." During most hours of the year solar and wind power in Germany would continue to be insufficient. Natural gas or hydropower stations or storage systems would have to fill the gap. The expert expects that in Germany alone, following the country's exit from coal power in 2038, up to 50 gigawatts of excess electricity would have to be stored, depending on weather conditions, and during prolonged periods of insufficient sunlight electricity gaps of up to 70 GW would have to be filled. For comparison: an average power station provides 1 GW.

Is the energy transition economically feasible, too? Irrek explains: "The exit from coal and the entire energy transition will only be feasible if the economic incentives are sufficient to motivate the required capital expenditures." These, he says, are not only necessary for the massive extension of renewable energies but also to ensure the flexibility and system stabilization op-

tions in the electricity market. This is where Irrek also sees a need for action on the part of policymakers in terms of more effectively establishing suitable price or quantity control parameters and other regulatory actions for a consistent framework within which a socially fair energy transition process can develop in line with efficiency considerations of a market economy and compatibility with the natural environment.

RENEWABLE ENERGIES ARE SEEING A GLOBAL UPSWING



Source: BP Energy Outlook 2018



» The energy transition is technically feasible

Prof. Wolfgang Irrek, PhD,
Ruhr West University of
Applied Sciences



HEAVEN AND HELL

They give auto races that extra kick, are both loved and feared: courage corners. Challenges in which adrenaline is pumped through the body and centrifugal forces tug at the limbs.

— by Leopold Wieland



Eau Rouge: the uphill S-section can be driven at near 300 km/h (186 mph) in the Porsche 919 Hybrid Evo sports prototype

— Just a blink of the eye and there it is. Like a rogue wave at the end of the high-speed downhill section. Nearly 25 meters (82 feet) high. So wide, so steep. A tarmac skyward ramp. Up it in a heartbeat, across it in a heartbeat. Blind flight with goose bumps and bated breath – with a 17-percent gradient and a heart rate close to 200. Because you can't see what's beyond.

From one second to the next the valley swallows you and spits you out again on the hill some 120 meters (394 feet) later, with the centrifugal hammer hitting you hard in the process: left, right, and from above. To top it off, it tries to pull you out of your seat. And ultimately puts the car's suspension through its paces like there was no tomorrow.

That, in a nutshell, is auto racing's most famous courage corner.

It's called Raidillon de l'Eau Rouge – or Eau Rouge in short – named after the small babbling stream underneath the race track at Spa-Francorchamps. Above it the world's fastest cars have been flying through the forest since 1921, with Formula One cars, sports prototypes and GTs leading the way. Now it's flat-out or close to it. In the 2018 Belgian Grand Prix, Vettel, Hamilton and company shot through Eau Rouge in eighth, the highest, gear without lifting – at near 300 km/h (186 mph). Although Formula One in 2019 might be a little bit slower with the front wings of its cars having been widened again, courage, just like concentration and precision, is

still an absolute must in high-speed-weaving through this S-curve monster with millimeter perfection.

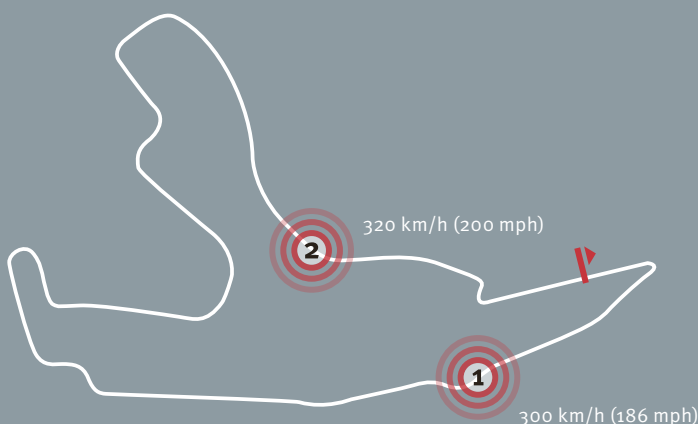
"If there's a corner in which higher speed and the related risk of an off-track excursion gives an advantage, then we have no choice as racers. That, for me, is a courage corner," says Lucas di Grassi. The seasoned Brazilian racer is the reigning Formula E teams' champion and factory driver of the Audi Sport ABT Schaeffler team.

Get it right or get off-track

Allan McNish, his team principal and as a former race driver intimately familiar with the fastest race cars in Formula One and the World



300 km/h (186 mph) and more: the Eau Rouge (1) and Blanchimont (2) courage corners



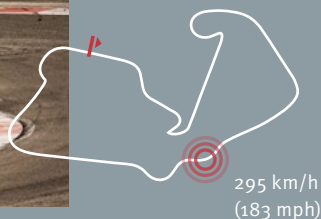
EAU ROUGE & BLANCHIMONT SPA (B)

"Which corner?" – "Lift?" For Michael Schumacher, Eau Rouge (1) was more of a courage straight than a courage corner. His fellow racer Gerhard Berger once described the near 300 km/h (186 mph) ride through the famous left-right combination of the Ardennes roller coaster in these words: "You see a mountain in front of you, like an impenetrable wall. Then the sky, gray or blue." Blanchimont (2) is the second famous courage corner of the tradition-steeped Belgian circuit. The left-hand bend shortly before the end of the Spa lap leads toward the finish chicane. Speed: up to 320 km/h (200 mph).



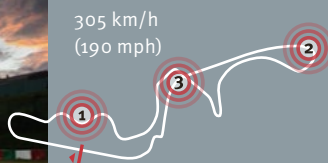
PORSCHE CURVES LE MANS (F)

"An awesome combination," enthuses Schaeffler's brand ambassador Lucas di Grassi. "In sports car racing, we'd run through it at 260 km/h (162 mph) – for 24 hours and partly in total darkness, and would even overtake the cars of the slower classes on the outside. That's crazy but also cool."



MAGGOTS/BECKETTS SILVERSTONE (GB)

295 km/h (183 mph) is the speed at which the first right-hander of the combination is driven. The driver's neck muscles have to withstand centrifugal forces of up to 5 g. F1 champion Lewis Hamilton: "Your wildest imagination cannot describe what we're feeling out there."



ESSES, SPOON, 130R SUZUKA (J)

Courage times three: First, through Esses (1), then through Spoon (2) and shortly before the start/finish straight through the ultra-fast 130R double left-hander (3, photo). Ex-F1 champion Jenson Button: "It's a mega challenge – no other circuit has the same combination of corners."

Sportscar Championship as well, says it more directly: "A courage corner is always high speed. A courage corner is one you have to get right. If you get it right, then you are fast. If you get it wrong, you are either slow or having the chance of a big accident." A number of drivers have had off-track excursions in Eau Rouge and badly crumpled their cars.

Same speed, more protection, less risk

Race tracks – not only the one at Spa-Francorchamps – have become a lot safer over the years. Ample run-off areas, padded guard rails, smoothed-out tarmac surfaces and chicanes that slow the cars down: all of these are "mitigating circumstances," just in case. At the same time, cockpit protection has become better and better in the cars of all racing categories. As a result, some of the courage corners have lost a bit of their awesome bite, but not their challenging characteristics.

A perfect case in point is Signes at Le Castellet, a high-speed corner of some 330 km/h (205 mph) and currently the fastest turn in Formula One. However, instead of the previous grass and safety fences lurking at the end of the wide right-hand bend, paved areas now serve as speed limiters. Drivers who end up in them, because courage turned into



Absolute courage corner connoisseurs: Allan McNish (left) and Lucas di Grassi

120 km/h (75 mph)

1
2

175 km/h
(109 mph)

CORKSCREW & RAINEY LAGUNA SECA (USA)

“Laguna Seca is not just any race track, Laguna Seca is the left ventricle in the rib cage of real racers,” says DTM record champion Bernd Schneider. The highlight of a lap is the downward-winding Corkscrew combination (1). Across a hilltop, briefly bending toward the right, the drivers approach the up to 18-percent drop of the left-right combination blind. 30 meters (98 feet) below the ultra-fast Rainey left-hander follows (2). “Incredible g-forces are pulling on you there, it’s like a roller coaster ride,” says ex ChampCar champion and former F1 driver Cristiano da Matta.



Breath-taking downhill run: first right, then left through the Corkscrew-S, then down the drop and left through the Rainey high-speed corner

cockiness, will only wind up destroying their lap time, but not their cars.

To protect the drivers, the moment of shock cast in concrete at Suzuka called 130R has long been defused as well. Up until Allan McNish’s crash in qualifying for the 2002 Formula One finale, this flat-out left-hander on Japan’s racing roller coaster was a huge gamble. Keep your foot on the gas pedal or briefly lift at 305 km/h (190 mph)? McNish at the time kept his right foot down, went into a skid, and crashed through all barriers in his Toyota.

The Scot got away with some bruises and memory gaps. “On the first lap afterwards, not even 24 hours after the crash, I was careful. On the second lap, I forced myself to attack this corner again. And from the third lap onwards, I had control of it again,” McNish recalls.

Also a record of courage

“A corner or combination of turns gives you a real thrill only if it’s not just super-fast but also doesn’t forgive any mistakes.” This is Timo

Bernhard’s take on courage corners, such as the Porsche Corners at Le Mans or the Nordschleife of the Nürburgring in the Schwedenkreuz, Fuchsröhre, Klostertal and Stefan-Bellof-S track sections. Bernhard is one of the most successful endurance racing drivers and became world champion with Porsche and Schaeffler in 2017. Since June 29, 2018, the Nürburgring-Nordschleife has essentially been nothing but a single courage corner.

On this brilliant summer day, Bernhard wrote a very special chapter of motorsport history in the “Green Hell” and redefined race car driving on the more than 90-year-old mother of all motorsport arenas on setting his record in the Porsche 919 Hybrid Evo with 1,160 horsepower: In an incredible 5m 19.55s, Timo Bernhard completed a lap on the 20.8-kilometer (12.9-mile) Nordschleife of the Nürburgring – nearly 52 seconds faster than Stefan Bellof in the Porsche 956 C (620 hp) had 35 years earlier. Bernhard’s average speed of 233.8 km/h (145.3 mph) was about 31 km/h (19 mph) higher than Bellof’s in 1983.

Crossing hilltops “like on rails”

Even though Porsche had prepared its marketing activity in every single detail, Timo Bernhard had previously reeled off umpteen test laps in the German sports car manufacturer’s race simulator, and specifically practiced the riskiest sections, it still took a huge amount of courage at the wheel of the LMP1 prototype trimmed for setting a record to approach that last bit of remaining grip. Nine times per lap the Porsche factory driver broke the near 300 km/h (186 mph) mark, drove through each of the 73 corners 40 to 50 km/h (25 to 31 mph) faster than in the production-based GT3 911 with 460 horsepower. And suddenly some of the Nürburgring’s courage corners



New record for Porsche and Schaeffler:
Nordschleife in an incredible 5m 19.55s

have stopped being courage corners in the white, ground-hugging 1,160-horsepower car – such as the high-speed downhill run through the Fuchsröhre, where the Porsche 919 Hybrid Evo thanks to its aerodynamics tailored for XXL-size downforce in spite of all hilltops even at 330 km/h (205 mph) was still running “like on rails” (Bernhard).

By contrast, in the Klostertal section, one Nürburgring challenge



All-new dimensions of a Nürburgring driving experience: record breaker Timo Bernhard



FOUR NÜRBURGRING COURAGE CORNERS

Schwedenkreuz (1), Fuchsröhre (2), Klostertal (3), Stefan-Bellof-S (4): These are the four most challenging corners around the Nürburgring. All of them are located on the nearly 21 kilometer (13 mile) long Nordschleife – in other words in the so-called “Green Hell.” The entire track is regarded by many as one big courage corner. Not without reason no races have been held there for a very long time in Formula One (since 1976), for sports prototypes (since 1983) and the DTM (since 1993).



Schwedenkreuz: wide left-hander across a hilltop, no view of the exit when turning into the corner



Fuchsröhre: downhill run meandering into a valley then uphill again – and all flat-out



Klostertal: double left-hander with bumps on the approach, guard rails close to the right-hand edge of the track



Stefan-Bellof-S: right-left section, can be driven at nearly 310 km/h (193 mph) in the Porsche 919 Hybrid Evo



suddenly turned into two in the mega sports car. Timo Bernhard explains it this way: "That's where you have to grit your teeth even on the approach because you arrive at more than 330 km/h (205 mph), brake on surface bumps, the car gets off the line, and even before that you have to turn the wheel toward the left."

The following double left-hander, called "Courage Corner" in Nürburgring-speak, loses some of its bite in the prototype – but: "The next right-hander with its blind turn-in and the guard rails on

the left close to the track deserves being labeled 'Courage Corner 2.0' in an LMP1 car." Bernhard admits: "That's where I had to concentrate extremely and really bring myself to do it. Just like in the Stefan-Bellof-S at the Pflanzgarten exit, where I was at the limit with my speed processing."

Allan McNish fittingly concludes this courage corner discussion: "You have to show respect to courage corners! If you don't they will bite you and show you that that they are the boss and not you!" —

COURAGE CORNERS IN RALLIES: ARMIN SCHWARZ EXPLAINS



Armin Schwarz:
World Rally
Championship
racer from 1988–
2005 and now an
off-road endurance
racing driver, driver
coach, and long-
standing Schaeffler
brand ambassador

As rally drivers always follow the pace notes read to them by their co-drivers is the term "courage corners" even relevant in rally racing?

Because we're only allowed to drive the routes before the event at a maximum of 80 km/h (50 mph) we have a description of every corner, but you never know exactly how fast you can handle such a turn when you approach it at 100 km/h (62 mph) more or even faster. That's why in rallies and off-road endurance races the fastest corners are always courage corners.

How risky are they compared to those in circuit racing?

The risk in rally racing is generally to be rated higher, even in comparison to a challenging circuit like the Nürburgring Nordschleife. The reason is that there you can approach a courage corner lap by lap to see if you'll be able to handle it flat-out or not. In rallies, you only get one shot at it.

Your favorite courage corners?

Colin's Crest on the WRC course in Sweden, for example. You jump across a hilltop, fly a 40-meter (131-foot) distance, and continue offset on the right-hand side. You have to make a pinpoint landing in the ice lane or else you'll end up in the snow with far too little traction. Another great place is the sequence of countless courage corners in the Monte Carlo Rally at Col de Turini when the conditions become increasingly icy going uphill. If you're too fast there only once, your rally is over.

»» *The art of driving is to be the fastest as slowly as possible*

Emerson Fittipaldi, two-time Formula One Champion from Brazil about efficiency in motorsport



2019 DTM EVENTS

May 4/5		Hockenheim
May 18/19		Zolder
June 8/9		Misano
July 6/7		Norisring
July 20/21		Assen
August 10/11		Brands Hatch
August 24/25		Lausitzring
September 14/15		Nürburgring
October 5/6		Hockenheim
November 23/24		Fuji (Combined race with Japanese Super GT Series)

in motion

Innovations in the course of time

GREEN MACHINE

— DTM – the three letters have stood for top-caliber touring car racing since the nineteen-eighties. An arena for building motorsport expertise that manufacturers also use for their production models. Legendary battles by renowned brands and drivers have strengthened the DTM's reputation as the most spectacular touring car series. In 2019, the DTM is taking major steps, going forward. Two-liter turbo engines now delivering 600 hp (about 100 hp more than the previous V8) are ringing in the era of advanced, efficient IC engines. Newcomer Aston Martin challenges Audi and BMW. The DTM forges links with the Japanese Super GT Series with Honda, Nissan and Lexus. And Schaeffler presents a new partnership with BMW. At the wheel of the green-white M4 DTM: Franconian Marco Wittmann, the 2014 and 2016 DTM Champion. See you soon on track, green machine! —



CHALLENGERS OF PATRIARCHY

Resourcefulness, sharp intellect, and enormous willpower: for centuries, bold women have been stunning the world with pioneering acts and causing patriarchal walls to crumble.

— by Wiebke Brauer and Volker Paulun



AGNODICE
(~300 BC)

THE PHYSICIAN

*If we can believe Gaius Julius Hyginus, Agnodice was the first female physician in antiquity. According to his accounts, she lived in ancient Athens around 300 BC and studied medicine and midwifery under Herophilos. Since women are not allowed to study or practice medicine, Agnodice cuts her hair short and wears men's clothes – which of course raises the question of how her teacher could have missed the fact that his student was a woman. **Following her training, Agnodice goes on to practice***

gynecology so successfully that envious colleagues accuse her of seducing her patients. To exonerate herself, she reveals her true gender – and faces another trial. Only when courageous Athenian women of influence intervene – purportedly, they even threatened to leave their husbands – Agnodice is acquitted. And not only that: the law is changed, henceforth allowing women to study midwifery and medicine, and to treat female patients.

About women who pretended to be men

Agnodice was neither the first nor the last woman to pretend she was a man. Two further examples: At the beginning of the 19th century, the French mathematician Sophie Germain sends her work on number theory to Carl Friedrich Gauss under a male pseudonym. At the beginning of the 20th century, the German chemist Ida Noddack disguises herself as a man in order to attend lectures to which only men are admitted.

THE POLYMATH



HILDEGARD VON BINGEN
(1098–1179)

*It would be unfair to reduce Hildegard von Bingen's achievements to those of an esoteric healer. Although the abbess also has a wealth of knowledge about herbs she is, first and foremost, a scientist and composer, and one of the most amazing persons of the High Middle Ages. Born in 1098 as the last of ten children, she is put into the care of a convent due to her frail health. Even as a child the subsequent polymath has "religious visions." Today it is assumed that she was suffering from migraine headaches. Hildegard von Bingen not only masters the challenge of founding two convents but **goes on to become an adviser to influential personages of her time, monarchs such as Frederick Barbarossa or high-ranking members of the clergy up to and including the pope: amazing mojo** for a woman who lived at a time when contemporary writings would describe women as "inferior" and therefore "having to subordinate themselves to men."*

About women in the Middle Ages

The story was a worldwide success as a book and a movie – but did Pope Joan really live? Several medieval sources mention a woman who purports herself to be a man and rises to the highest ecclesiastical office. However, fiction and truth are often not far apart from each other in papers written in those days. It's also possible that "Pope Joan" was Marozia. From 914 on, the Roman senatrix bends several popes to her will and in doing so establishes a rule of mistresses ("pornocracy"). Pope Joan is said to have lived at about the same time.

About female IT pioneers

Grace Hopper (1906–1992) in the late 1940s comes up with the idea of writing computer programs in an understandable language instead of just in ones and zeros. In pursuing her idea, Hopper performs important preliminary work leading to the development of the COBOL programming language. Hopper (her motto: "If in doubt – do it") receives more than 90 awards in recognition of her achievements. Curiously enough, in 1969, the Data Processing Management Association presents her with its "Man of the Year" award. Which goes to show how rare women like "Amazing Grace" – as many of her admirers call her – are in the IT sector in her day.

THE COMPUTER SCIENTIST

In 1843, she writes the first computer program – and, essentially, it's her dissolute father's fault. Ada Lovelace is the daughter of the poet Lord Byron. Her parents separate one month after her birth. To prevent Ada from following in her father's footsteps, her mother bans any kind of poetic note from Ada's education and instead has her taught in natural sciences – by the famous mathematician

*Augustus De Morgan, among others. De Morgan recognizes her talent but doesn't promote it because he basically deems women to be unsuitable for science. The young girl only feels all the more challenged by his attitude: **At the age of twelve, Ada designs a flying machine modeled on a dead crow, with a steam engine to power the wings.** Unfortunately, the machine won't fly. At the age of 17, Ada meets Cambridge professor and mathematician Charles Babbage. His project: the Analytical Engine, a mechanical computer that is decades ahead of its time, albeit will never be built. Ada Lovelace recognizes its potential, more than its inventor does. She writes a numerical list of commands with operations and variables – which today is acknowledged as the first computer program. One sentence in her papers is currently being hotly debated in the wake of the advance of artificial intelligence: **"The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform."***



ADA LOVELACE
(1815–1852)

THE AVIATOR

*"The Aéro-Club de France, Paris, certifies that Madame de Laroche has been licensed as an airplane pilot. March 8, 1910. The President." The history of motorized aviation is still young in those days. Only seven years earlier, Orville and Wilbur Wright succeeded in performing the first seconds-long flights. Madame de Laroche is born Élise Deroche around 1885 to a family living in modest circumstances. She later tries her luck as an actress, calls herself Baroness Raymonde de Laroche, and meets aircraft constructor Charles Voisin, who suggests that she learn to fly. The courageous young woman welcomes the challenge. **At the first opportunity that presents itself, she takes off in his single-seater without permission.** The year is 1909.*



ÉLISE DEROCHE
(1886–1919)

About female aviators

In 1935, the American Amelia Earhart is the first person to fly solo across the Pacific Ocean between Hawaii and California. Two years later, she embarks on the first equatorial flight around the globe. Earhart has completed three quarters of the distance when she disappears somewhere in the South Sea. In a comment preceding this flight, she reportedly said: "Women, like men, should try to do the impossible. And when they fail, their failure should be a challenge to others."

*Her flight instructor is less than enthusiastic, but be that as it may, her flight marks the first ever solo of a woman in the history of aviation. Deroche feels that flying is the best possible thing for women: "Flying does not rely so much on strength, as on physical and mental coordination." Right after receiving her pilot's license, Mme Deroche crashes in Reims and is rescued with severe injuries, but just two years later, the Frenchwoman is flying again. **"Perhaps I'll tempt fate once too often. But I have dedicated my life to aviation and always fly without a trace of fear,"** she says. On July 18, 1919, she dies in a crash landing after a test flight with an experimental plane.*

THE SCIENTIST

*One should assume that a remarkable female scientist inspires nothing but admiration – yet even during Marie Curie's lifetime the press writes that she is a "strange woman." But let's start from the beginning: Marie Curie is born Maria Salomea Skłodowska in Warsaw in 1867. Women are not admitted to universities there, so in 1891 she moves to Paris to study at the Sorbonne. Even there the gender ratio shows the great challenge that a university education poses to women in those days: only 23 of more than 1,800 students are women. The educational migrant – besides finding her future husband, the physicist Pierre Curie – discovers polonium and radium. Later, she'll be the first woman to teach at the university, albeit only **after her husband has died in a road accident and the chair in the physics department he previously held is bestowed on her.** Three years earlier, she had been the first woman to be awarded the Nobel Prize in physics together with her husband Pierre Curie and her doctoral thesis supervisor, Henri Becquerel. In 1911, she receives the most distinguished scientific recognition once more, this time in chemistry and without having to share it. Curie's daughter Irène, by the way, will subsequently follow in her footsteps and*



MARIE CURIE
(1867–1934)

in 1935 receive the Nobel Prize in Chemistry as well.

Her mother is no longer alive at that time: on July 4, 1934, Marie Curie, aged 67, dies of the consequences of decades-long handling of radioactive materials. Albert

*Einstein says about her: **"Marie Curie is, of all celebrated beings, the only one whom fame has not corrupted."***

About recognition

That Marie Curie in 1903 is awarded the Nobel Prize on an equal footing with her husband and her fellow scientist Becquerel was not to be taken for granted. Even decades later women, who were instrumental in achieving breakthroughs in scientific research projects, are ignored, like Jocelyn Burnell. In 1967, aged only 24, she discovers the first radio pulsar, but the Nobel Prize goes to her thesis supervisor Anthony Hewish. Rosalind Franklin is another example. The English scientist in the 1950s is decisively involved in the discovery of the double helix structure of DNA. The Nobel Prize for this discovery, though, is awarded to Francis Crick, James Watson and Maurice Wilkins, who had availed themselves of the results of her research without her knowledge.

THE MOTORISTS

The first-ever cross-country motorized drive in human history was undertaken by a woman (see box below). Even so, women at the wheel of motor vehicles were a rare sight for many years, particularly if the trips were adventurous. **Effie Hotchkiss, merely 20 years old, and her mother, Avis, take on such a challenge in early 1915.** In a Harley-Davidson motorcycle-side car combination, they rumble across the United States from New York to San Francisco, covering a 9,000-mile (14,000-kilometer) distance, mostly on dusty or even muddy unpaved roads that were typical in those days. Not least due to these hardships, the “Orange County Times-Press” on April 23, 1915, wrote about the two adventuresses that they were an interesting example of how far women could go with determination. **A year later, the Van Buren sisters, Augusta and Adeline, tackle the challenge of crossing the United States.** The reason for their journey: “Gussie” and “Addie” want to serve in the military – as dispatch riders. Their applications, however, are rejected. Not acceptable, the sisters find, and intend to prove how well-suited they are for the job. “Woman can, if she will,” is Augusta’s motto. On July 4, 1916, Independence Day, they embark on their journey on two heavy Indian Powerplus (998 cc, 18 hp) motorcycles. In spite of being arrested on numerous occasions for wearing men’s clothes, they master their awesome ride – albeit they won’t get the coveted job as military dispatch riders after all. **In the 1920s, Clärenore Stinnes dares an even greater adventure of surrounding the whole world in an automobile.** As on previous occasions, her family raises eyebrows about the avid race driver’s boyish zest for action: around the world in a car, are you serious?! You bet she is! Not least thanks to benevolent support by the automotive industry. Frankfurt-based Adler-Werke provide their latest “Standard 6” production sedan: 6 cylinders, 45 hp, 80 km/h (50 mph) top speed. On May 25, 1927, the 26-year-old departs from Frankfurt, accompanied by two mechanics, Swedish cameraman Carl Axel Söderström (whom she will later marry), plus a travel budget of 100,000 reichsmark. The eastbound trip becomes increasingly strenuous. Söderström: “I pushed the car more than I shot footage.” Heat in the Syrian desert, ice at Lake Baikal, mud in Siberia, rough terrain in the Andes – none of this stops Clärenore Stinnes. After having driven a distance of nearly 47,000 kilometers (30,000 miles), she and her team arrive in Berlin on June 24, 1929, greeted by a cheering crowd.

EFFIE HOTCHKISS (1894–1966)



ADELINE VAN BUREN (1894–1949)

AUGUSTA VAN BUREN (1892–1959)



CLÄRENORE STINNES (1901–1990)



About female motorists

In August 1888, Berta Benz – without her husband’s knowledge (“Carl would have never allowed it”) – drove the Benz Patent Motor Car Number 3 from Mannheim to Pforzheim (106 km/66 mi) in Germany. The trip not only made her the first woman to operate an automobile but also the first person to go on a cross-country automobile journey.

THE TELE-COMMUNICATOR

The story sounds like fiction: An actress, regarded as the most beautiful woman in the world, meets an avant-garde composer during the Second World War. Together they invent a radio technology for the U.S. military, which today is said to have laid the foundation for modern telecommunications. Now when was this? It was in the 1940s, in Hollywood, where Hedwig Kiesler, born in Vienna in 1913 as the daughter of a banker, had ended up. Under the name of Hedy Lamarr she co-stars in movies with Clark Gable, Spencer Tracy, and James Stewart – her face even serves as the model for Walt Disney's "Snow White." – "Any girl can be glamorous," she once says, "all you have to do is stand still and look stupid." Obviously, beauty was not enough for the screen goddess, who already had

HEDY LAMARR
(1914–2000)

About Hollywood

1970, 1980, 1990 ... guess what year a woman won the Academy Award for Best Director for the first time? It's hard to believe but it's not until 2010 that Kathryn Bigelow is the first and so far only woman to win this distinction for her work on "The Hurt Locker" in the 91-year history of the Academy Awards.

an interest in technology as a child. Lamarr purportedly even had a car on the set that was dedicated to her inventions – which were intended to help fight National Socialism. Together with a friend, composer George Antheil, she experiments with a "secret communication system" to guide torpedoes by means of radio communication – unaffected by enemy jamming. In 1942, she has the invention of frequency hopping patented, albeit the U.S. Navy initially ignores the technology and advises her that she'd make a

*greater contribution by selling kisses to push war bonds. Years later, internet developers pick up the idea: **frequency hopping becomes the foundation for wireless communication such as WLAN and Bluetooth.** It is not until 1997, three years before Lamarr's death, that the American Electronic Frontier Foundation (EFF) recognizes her invention with the Pioneer Award. Her comment: "It's about time."*

THE CHEMIST

*That she had a special interest in fashion is somewhat surprising. But this is exactly what the chemist Stephanie Kwolek, who developed Kevlar in 1965 and as a child was incessantly sewing clothes for her dolls, said. The American of Polish descent would have liked to have become a physician. To raise money for medical school, she takes a temporary job at chemical corporation DuPont. The work there suits her so well that she decides not to pursue a medical career. **In 1964, she discovers liquid, crystalline polymers that can be processed into synthetic fibers. The material, subsequently better known as Kevlar, is five times harder than steel yet amazingly lightweight.** The synthetic fiber is still used in bullet-proof vests, helmets and aircraft today. The scientist herself will later refer to her discovery as a “lucky coincidence” in the “Washington Post.” This can be assumed to be an understatement, especially since she has to persuade her colleagues to spin the material like a fiber. She does not, by the way, directly benefit from the profits DuPont generates with Kevlar. In 2014, she dies at the age of 90. A few years earlier Kwolek says in an interview: “At least I hope I’m saving lives. There are very few people in their careers that have the opportunity to do something to benefit mankind.”*



STEPHANIE KWOLEK
(1923–2014)

About female inventors

Born in 1867, married at 14, a mother at 18, widowed at 20 – Sarah Breedlove has to “woman up” early in life. When she suffers hair loss at age 33, she experiments with an antidote and later goes on to develop a gel to straighten curly hair with a “hot comb” – a huge success with African-American women that lays the foundation for a cosmetic empire. Its name is Madam C. J. Walker, a name Sarah adopts after marrying her second husband. She becomes the first female self-made millionaire. Walker not only uses her wealth to have a mansion built in New York next to the Rockefellers, but gives generously to charity and supports the fight for equal rights of African-Americans. It is a short life as an entrepreneur, activist and philanthropist: Walker dies, aged only 51.



LAURA DEKKER
(*1995)

THE SAILOR

She doesn’t want to go to school and definitely not live in a house. Laura Dekker, born in New Zealand in 1995 to Dutch-German parents, is strong-willed and determined to tackle a very special challenge: sailing around the world in her two-masted ketch “Guppy” at age 14. In 2010, she sets sail after a court has previously ruled against her journey. Child welfare authorities had intervened, plus her plan is hotly debated in pubs, sailing clubs and the media. Is it okay to let a child sail around the world? Laura prevails – with support from her family. The 50,000-kilometer (31,000-mile) trip starts in Gibraltar and, on January 21, 2012, ends on the coast of the Dutch Caribbean

*island of St. Maarten. **At age 16, she secures the “behind-the-scenes” title of “youngest solo circumnavigator.”** The accolade will never become any more official than that due to fears that others might want to follow her example. Today, Laura Dekker is 23 years old and planning to build a boat: “Guppy XL,” an ocean-going two-masted ketch, 24 meters (79 feet) long. She intends to start sailing it in 2022, albeit not alone. “I’d like to show children and teenagers how to cut their own path and make their dreams come true,” she says.*

About female circumnavigators

A woman who played an important part in paving the way for Laura Dekker is the British sailor Tracy Edwards. 30 years before Laura’s journey, Edwards contested the tough Whitbread Round the World Race with her yacht “Maiden” and an all-female crew – an affront against the ocean regatta world that was dominated by men up until that time. The female skipper receives threatening letters, her front yard is polluted by oil, and the sailing press accuses her in advance of being at fault in the event of an accident. But the “Maiden” finishes as the second-fastest boat in class – and changes female sailing for good.

BACK TO THE TRACK

Rail transportation had its heyday in many parts of the world up until the middle of the 20th century but was subsequently neglected in favor of burgeoning road transportation. Today we realize that this was a mistake, for instance in Brazil. The return to the railroad confronts the country with major challenges.

— by Denis Dilba

— For the 10th of July 1875, the Brazilian town of Sorocaba had made a special effort of spiffing itself up: palm trees were lining the streets, flags posted, and the houses had fresh coats of paint. Hundreds of people were celebrating to the sound of live music in tents set up in the heart of the city. They were waiting for the train to arrive that would officially open the Sorocabana Railroad – and that was supposed to boost the economic development of the region.

And it proved to do so. Now, on the first connection of the new line, it was possible to haul large volumes of cotton from Sorocaba to São Paulo and from there to the nearby port of Santos. The construction of the railroad tracks, bridges, and train stations alone

mobilized some 1,500 workers – more than ten percent of the town's population of 13,000 at the time. Only a year later, the route was extended to the Ipanema Iron Factory, Brazil's first steel mill.

The end of the line: a ghost station

In the following decades, the network of the Sorocabana Railroad was gradually extended all the way to the states of Paraná and Mato Grosso do Sul. This was the Sorocabana Railroad's golden age. It created jobs, simplified trade, and so accelerated the economic growth of the region. In 1971, exactly 96 years after it was officially opened, the government in São Paulo integrated



1.62 million km (1.01 million miles)

is the length of the **maintenance interval** a Schaeffler customer has specified for the FAG tapered roller bearing units in its high-speed trains. This distance equates to circling the Earth 40 times.

the Sorocabana Railroad with FEPASA – a merger of various railroad operators. Investments in the railroad infrastructure severely subsided and between 1996 and 1999, the lines in Brazil were privatized. The train station in Sorocaba was closed back then, too, and today only freight trains pass through it. However, they're no longer traveling as frequently anymore either as Brazil's economy would actually need them to.

At least, some 37,000 kilometers (23,000 miles) of railroad tracks have been built since the 1950s, albeit a third of them have since been shut down again – a mere third is still being used to capacity. As a result, the world's fifth-largest country with an area of 8.5 million square kilometers (3.3 million square miles) is heavily dependent

on trucks that haul 63 percent of Brazil's entire freight. The consequences: a lot of traffic on the roads and growing logistics costs which, in the end, might adversely affect the supply of goods to the population.

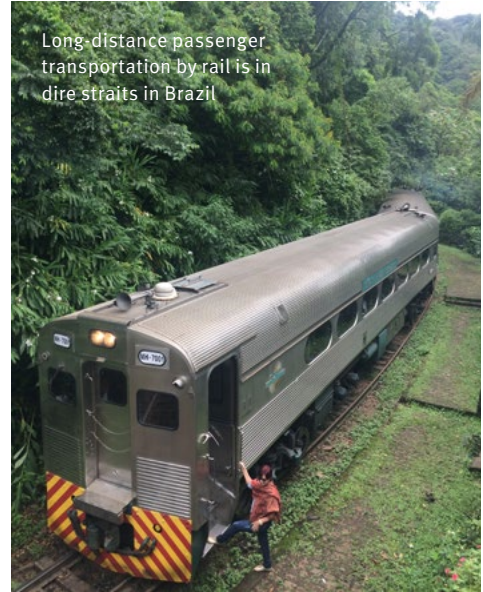
The course of transportation planning slows down Brazil's growth and makes it more difficult for the country to develop its economic potential. Obviously, the government in the capital, Brasília, has long recognized this issue and taken on the challenge. However, large-scale projects such as the Transnordestina – 1,728 kilometers (1,074 miles) of new broad gauge tracks from the ports of Suape (near Recife) and Pecém (near Fortaleza) to Eliseu Martins in the state of Piauí – and the 4,500-kilometer (2,800-mile) north-south line that's intended to

OLD LOCO, NEW LUSTER

To keep Brazil's railroad history alive, "MPF-Sorocabana," the association for the preservation of the railroad, restores old locomotives and railroad cars. **Most recently, volunteer engineers and mechanics, with financial support by Schaeffler Brazil, restored the old Whitcomb 3036 traction unit.** The last remaining mechanical diesel locomotive of the Sorocabana Railroad was built by the American Whitcomb Locomotive Works in Illinois in 1942 and came to Brazil only in 1956. During its entire lifespan, it was used for switching trains and railroad cars in Brazil, first by the Iperó track welding operation and later by the railroad association FEPASA in Sorocaba. The association aims to open a "Memory Center" in the old train station of Sorocaba and to operate a tourist train, says Eric Mantuan, operations manager of MPF-Sorocabana. "For this purpose, we plan to restore a total of five locomotives and eight passenger railroad cars." With the Whitcomb 3036, two locomotives are now in good repair again.



Schaeffler Brazil helped put the old switcher back on track



Long-distance passenger transportation by rail is in dire straits in Brazil

connect the mines and farms in Brazil's interior with the ports on the Amazon River and the São Paulo metropolitan area are still awaiting completion.

A second chance – in freight transportation

The fact that it's mainly geared to exports of raw materials, and thus freight transportation, is one of the past and present challenges posed to Brazil's railroad system. For passenger transportation by rail there are hardly any viable prospects: too many stations, lines, and tracks have been shut down and not enough people would use newly built routes in sparsely populated regions. Most people in Brazil live in big cities. There, however, passenger transportation by rail is indispensable: the São Paulo Metro alone hauls 4.7 million people on average per day.



THE AUTHOR

As a child **Denis Dilba** wanted to become a naturalist and explore the Amazon River. But then he decided to study mechatronics. During his research the thought crossed his mind that a job as a railroad engineer in Brazil could have actually combined both interests. Too late, now he's a journalist specializing in science and technology.

RAIL INTERNATIONAL



JAPAN

Japan has one of the world's most closely knit networks (covering 27,311 km/16,970 miles). **However, trains by now only play a subordinate role in long-distance freight transportation.** From 1965 until today, the proportion of tons hauled per kilometer dropped from 31 to 5 % (coastal shipping currently accounts for 44 %, trucks for 50 %). By contrast, in passenger transportation – which is privately organized like freight transportation – the railroad is the backbone of both urban and interurban service. In 1964, the first route exclusively used by high-speed trains was officially opened between Tokyo and Osaka. **Experts regard the Japanese railroad system as the best in the world.** The tolerance in the departure time of the Shinkansen high-speed train is exactly five seconds (!), the stopping position at the track in the station is supposed to be reached with an accuracy of one centimeter (0.4 inches).



CHINA

Along with the country's economic reform and modernization starting **at the end of the 1970s rail transportation in China began to experience an upswing as well.** Initially, transportation on the existing tracks increased, and from the turn of the millennium on, the network was massively expanded as well – from 50,000 to 150,000 km (31,000 to 93,000 miles) today. For freight transportation, this is still not enough. Many routes are so heavily utilized that in recent years more and more cargo migrated from rail to road. Between 1963 and today, the proportion of rail transportation in long-distance cargo shipping shrunk from 75 to 20 %. **That China attaches great importance to rail transportation of freight is also evident in the "New Silk Road" mega infrastructure project with rail connections all the way to Europe. The expansion of the high-speed train network is another large-scale project.** Covering a distance of more than 11,000 km (6,800 miles), it's already longer than that of the entire rest of the world. By 2025, it's planned to grow to 38,000 km (23,600 miles). Schaeffler benefits from the growth of the railroad sector in China as well: The technology group deployed initial axlebox bearings there as early as in the 1980s. Today, Schaeffler is an important development partner for high-speed, local, and freight rail applications with local development, manufacturing, and service know-how.



INDIA

In India, the railroad has traditionally been one of the most important means of transportation.

In 1832, the first train was operated there. In 1950, the railroad network had grown to an amazing 54,000 km (21,300 miles). Today, it covers some 67,000 km (41,600 miles) – in fourth place in the world ranking behind the United States, China, and Russia. While the railroad network in the past six decades has grown by only 23 % the number of passenger kilometers (due to higher incomes and growing urbanization) has seen a massive increase by 1,624 %. The freight tons have increased tenfold due to growing industrialization. **That's why rail transportation often surpasses the capacity limits, especially in the densely populated north.** The government and the state-owned Indian Railway – with 1.3 million workers the country's biggest employer and eighth-biggest in the world – have recognized the problem and are counteracting it by reshaping this sector and a capital expenditure program of several billion dollars.



USA

In 1930, an incredible 690,000 km (429,000 miles) of train tracks traversed the United States. Today, it's 200,000 km (125,280 miles), which still **keeps the U.S. at the top of the world's ranking.** More than in other countries, the railroad lost market share to the road and commercial aviation after the Second World War – especially in the passenger transportation sector. In 1910, the railroad accounted for 95 % of the market share in passenger transportation, compared to 1 % today. **However, in freight transportation, the railroad has been making up ground again in recent years,** now accounting for a remarkable 40 % of the market share, which is twice as much as in the EU. The advantage in the United States is that freight trains can be almost infinitely long due to the low utilization of the tracks by passenger trains. A U.S. train on average hauls 3,000 metric tons (3,300 short tons), ten times more than in the EU. Accordingly, the costs of one ton-kilometer on a U.S. freight train are low, compared with 20 cents on a truck (EU 11/14 cents).



HOW IDEAS TURN

Even the most brilliant ideas are not guaranteed to turn into success. Ideas need people who believe in them and make them reality with unwavering determination. The four examples described on these pages illustrate how Schaeffler manages to transfer innovative stimuli into successful projects.

— by Björn Carstens



THINKING OUTSIDE THE BOX

Mini soccer tables, guitars or small sailboats: an ordinary shoe box can be converted into all kinds of exciting things. Now the OmniSteer project proves that such a simple object as a cardboard box may even lay the foundation for successful

innovations in a high-tech company. Together with several partners Schaeffler has developed a chassis system that paves the way for a new approach to urban mobility: parallel parking without stopping in the process – enabled by individually controllable wheels that are steerable up to a 90-degree angle. And the whole project started with a simple cardboard box.

The story of the OmniSteer project sounds like a modern fairytale, produced on the “stage of science” in a way that almost appears to have been choreographed in every detail – along the lines of “Once upon a time there was a shoe box ...” In this case, though, reality surpassed the boldest research fantasies. “Starting with a cardboard box to which four servo motors were attached, we ultimately developed Schaeffler’s

INTO SUCCESS



OMNISTEER

first self-driving vehicle,” says Prof. Dr.-Ing. Tim Hosenfeldt, Senior Vice President Technology Strategy and Innovation at Schaeffler. Now how did this come about?

The idea was inspired by the search for use cases for the wheel hub drive that Schaeffler had recently developed: Now wouldn't it be a smart thing if vehicles were able to parallel park in one go in a fully automated process and without obstructing traffic? After all, every driver is familiar with the unnecessarily long lines of cars forming within seconds because someone in front is trying to squeeze their vehicle into a tight parking space.

Directed by Dr. Marcel Mayer, the first leader of OmniSteer, the project consortium received a 1.9-million euro grant from the German Federal Ministry of Education and Research. Mayer found powerful partners: Paravan GmbH, a specialist in acces-

sible vehicle conversions with high expertise in steer-by-wire systems, HELLA Aglaia Mobile Vision GmbH (smart imaging software), and research teams from Karlsruhe Institute of Technology (KIT).

Based on the famous cardboard box mentioned above, the team initially designed “Oscar Junior,” a 1:5-scale prototype with environmental sensors and four corner modules. Subsequently, the “large” full-scale Oscar was created, a test vehicle that, thanks to its special kinematics with height-offset, steerable wishbones, boasts extreme agility – the kind of maneuverability that Schaeffler intends to incorporate in future Cargo

and People Mover concepts, among other things.

A positive side effect of the project: Schaeffler has since entered into a joint venture with Paravan GmbH, plus former student employees involved in the OmniSteer project have since been hired by Schaeffler under permanent contracts. Dr. Ralf Stopp, Head of the SHARE (Schaeffler Hub for Automotive Research in E-Mobility) cooperation office at KIT, Philipp Kautzmann, Team Coordinator of the Automated Mobility Working Group, and Project Leader Dr. Paul Haiduk had joy about the successful project written all over their faces during the final presentation at the end of March.

Project initiators
Prof. Peter Gutzmer
and Lucas di Grassi



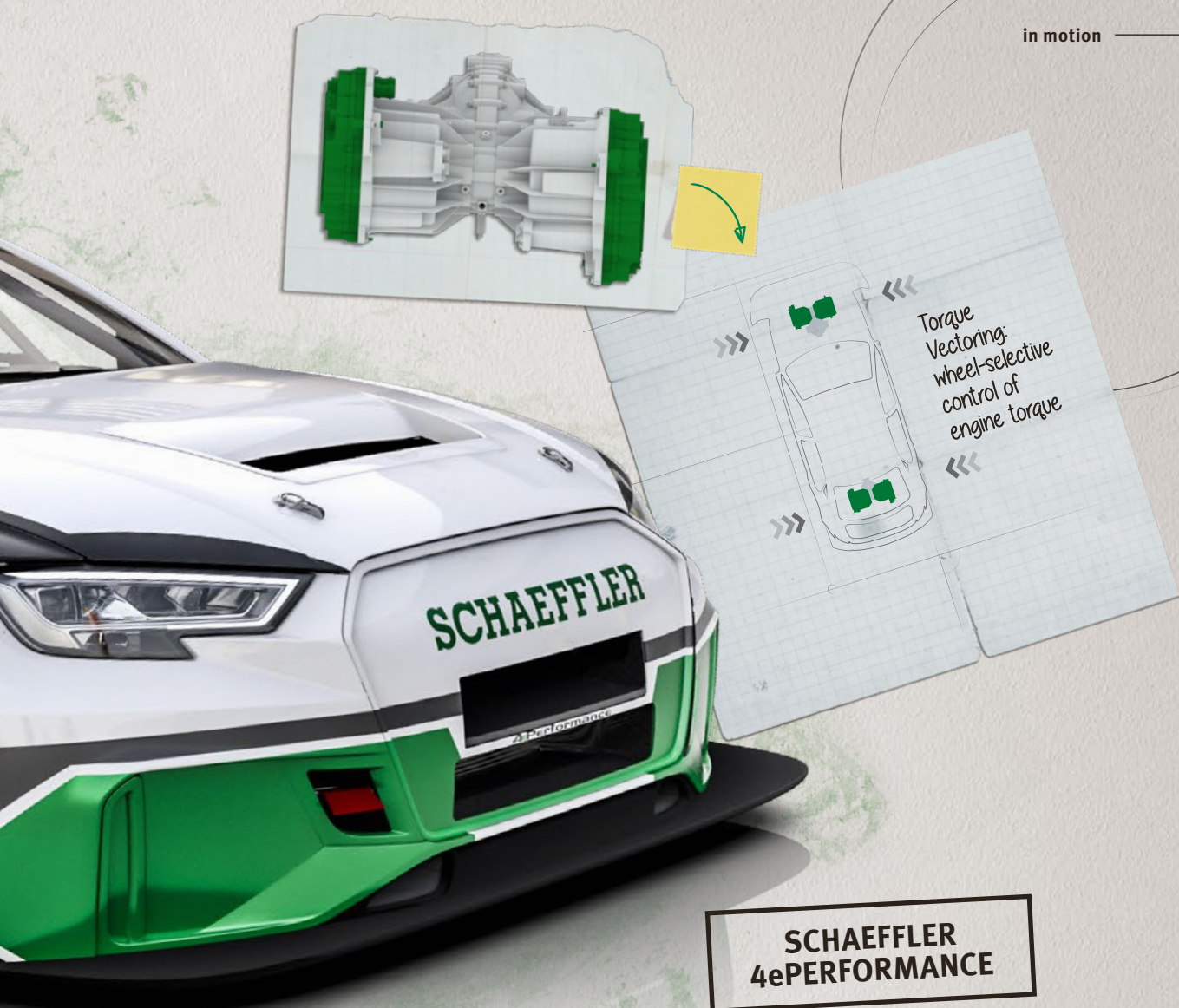
“WE’RE GOING TO MAKE SOMETHING THAT NOBODY HAS”

The humming of the electric race cars had gone silent, and the hustle and bustle of the Formula E circus in Hong Kong made way for the more relaxing part of the day. The late afternoon of October 8, 2016, is regarded as the time when the Schaeffler 4ePerformance was born – or at least the idea that was to turn into a technological adventure. In the pit lane, Audi driver Lucas di Grassi and Schaeffler’s Chief Technology Officer Prof. Peter Gutzmer talked about everything under the sun, including electric mobility, robocars, and their future. How could the subject be emotionally energized? How could people’s enthusiasm be inspired for it?

After a while, a somewhat far-out plan was formulated: “We’re going to make something that nobody has. We’re going to build the prototype of a super sports car to show that Schaeffler is able to deliver the total package for an

electric four-wheel drive system.” The objective: learning the maximum from Formula E for a potential production application. Gutzmer: “Projects like the Schaeffler 4ePerformance accelerate the development of new technologies and particularly the buildup of expertise from the perspective of a whole vehicle, from packaging requirements to mechanical systems, from mechatronics and software applications to specific functions such as driving functions or cooling concepts.”

Seen in this light, it’s easy to understand why Schaeffler pushed such a challenging project so vigorously. Why else would anyone come up with the idea of installing four Formula E motors with real oomph (880 kW/1,200 hp in total) from the Audi Sport ABT Schaeffler race car into a vehicle that had never before existed in this form? Along the lines of something like: look how fast the magic of



SCHAEFFLER 4ePERFORMANCE

putting motorsport technology on the road can be performed. A car from the test lab – not a hermetically sealed laboratory – one that everyone is able to admire and that evokes emotions. An awe-inspiring laboratory.

So much for the idea, now let's look at how it became reality: In an exchange with Dr. Simon Opel, who was in charge of Special Motorsport Projects at the time, a plan was forged and a team put together: 18 men and women in total. A young crew that was willing to walk the extra mile for the project. "Compliments to the team. Not once during the whole time did I hear them say, 'We're at our wits end.' They always came up with solutions," says Gutzmer. On board as partners were Schaeffler's subsidiary Compact Dynamics (electric motors), Schaeffler Engineering (control units and software), ABT Sportsline (total vehicle bodywork) and Simon Opel's motorsport

team. The ambitious timeline from the initial idea to its implementation: one year.

An extremely short period of time, considering that the team was initially faced with a completely stripped-down Audi RS 3 LMS TCR race car, but the team worked hand in hand. Gutzmer: "The colleagues involved from the various technology units of the Schaeffler world gelled superbly. We generated a lot of knowledge and additional expertise during the project." Torque vectoring, the wheel-selective control of engine torque, is just one of many examples. The project resulted in a vehicle that utterly impresses, as Daniel Abt proved on setting his memorable world record of driving in reverse (210 km/h/130 mph). Lucas di Grassi's text message sent to Peter Gutzmer after the first test drive was equally impressive testimony: "We made it, it's outstanding!"



DUAL SYSTEM **AN EXPORT HIT**

Squealing drills are eating their way through steel as thick as a thumb. Keeping an eagle eye on them, a lineup of trainers is watching the manual dexterity of their apprentices. Schaeffler continuously trains some 600 of them in China – in the same way apprentices have been trained in Germany for decades: one third of their time is spent in the classroom of a vocational school, two thirds at the company, the usual split. At the beginning of the 2000s, the situation in the Far East still looked different.

Hiring skilled workers proved a real challenge. A needle in a haystack would have been easier to find. This prompted Schaeffler to export the proven German vocational education system.

At Schaeffler, mastering this massive challenge is closely linked to the name of a man who has since retired: former training manager Bernhard Schwab. Schwab recalls: “Actually, there was a lack of everything.” Hopelessly overcrowded vocational schools and ancient ma-

chines: rusty, defective, and hardly usable. Poorly trained trainers and a system in which apprentices were filled up to their ears with theoretical knowledge but hardly gathered any practical experience. Schwab: “The quality of the vocational training did not meet our requirements.”

However, in 2003, Schaeffler was in dire need of skilled workers in order to expand the plant in Taicang. Manufacturing operations were to be ramped up and a quick decision had to be made. Schwab and



Bernhard Schwab



DUAL VOCATIONAL EDUCATION

the then Chief Human Resources Officer Kurt Mirlach were in agreement that the situation called for a pragmatic approach, so they rented an old warehouse filled to the brim with all kinds of stuff and had modern CNC turning, milling and grinding machines – some of them from Germany – sent to the site. Schwab started meeting with government authorities and vocational schools, summoned two handfuls of trainers from Herzogenaurach to Taicang, and had courses in Chinese as well as acknowledged examinations of

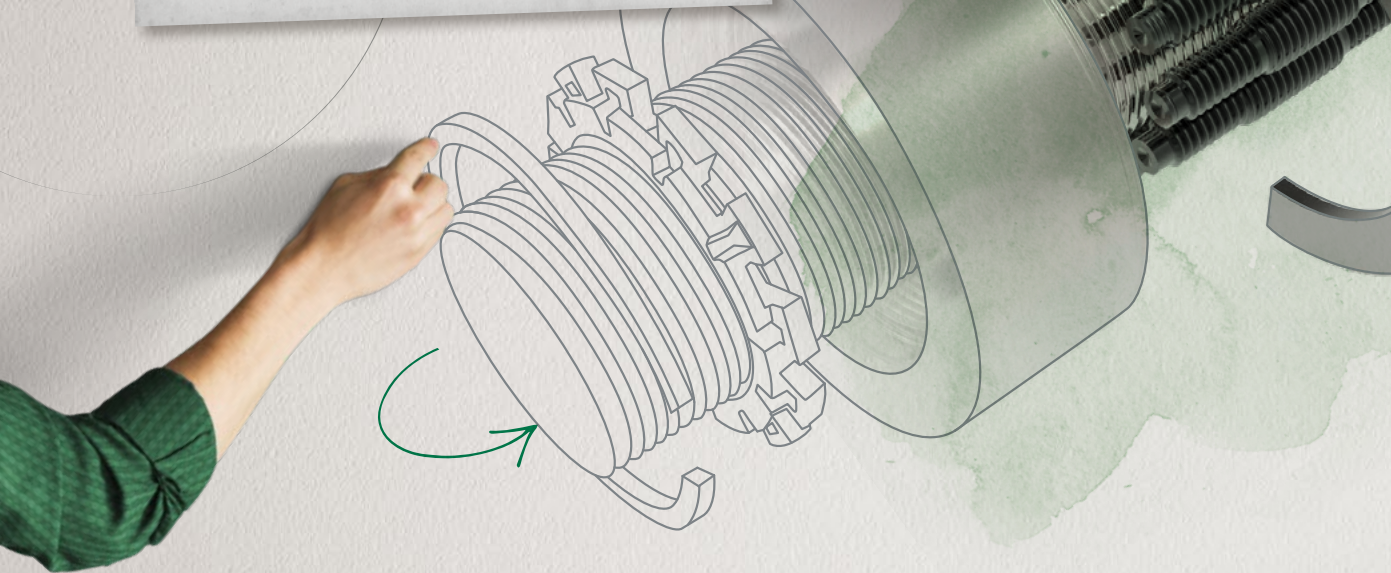
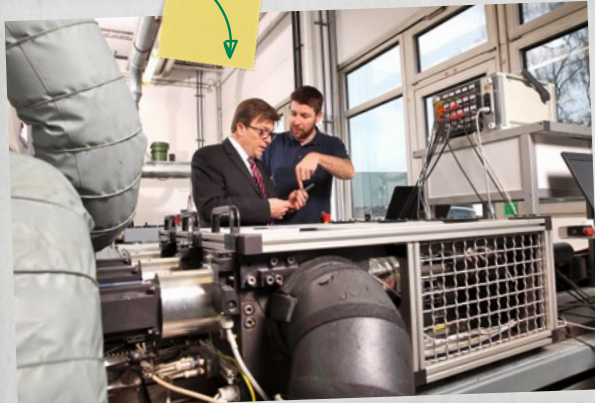
skilled workers developed in collaboration with the German Chamber of Commerce.

The whole project at times had a somewhat improvised character but that didn't diminish its success. "Although we had interpreters a lot of the communication was done by using our hands and feet, plus translation computers," says Schwab, looking back on those days with a smile. Practically from scratch, Schaeffler hired some 100 apprentices in 2003 – the beginning of a

success story that Schaeffler has since continued in Mexico, Romania, and other places in the world. Especially in China, it also helped pave the way for other companies to train their own skilled staff. The vocational education program has seen its logical continuation in Schaeffler's integrated degree program billed as "Two-in-One," which has won several awards in China, including "Best Community Promoter" of the China Association of Enterprises with Foreign Investment (CAEFI).

PLANETARY SCREW DRIVE

Dietmar Rudy



PRECISE MOTION

Planetary screw drive (PWG) – the name of this technical component doesn't necessarily exude linguistic elegance nor suggests that it might be the basis of an exciting story about hospital beds, robots, and a Space Shuttle mission. But continue reading and find out how the PWG became part of the Schaeffler world.

A customer inquiry got the ball rolling: this is our problem, do you have an idea how to solve it? Business as usual at Schaeffler. Developing solutions on an equal footing with the customer. Customers have great confidence in the supplier's development and manufacturing expertise. This particular case was about screw drives. Their performance limit had been reached in the customer's application, so something new was needed: a powerful linear actuator, in other words a device that electromechanically moves

a load on a straight line. The system was to be compact, powerful and – equally important – affordable.

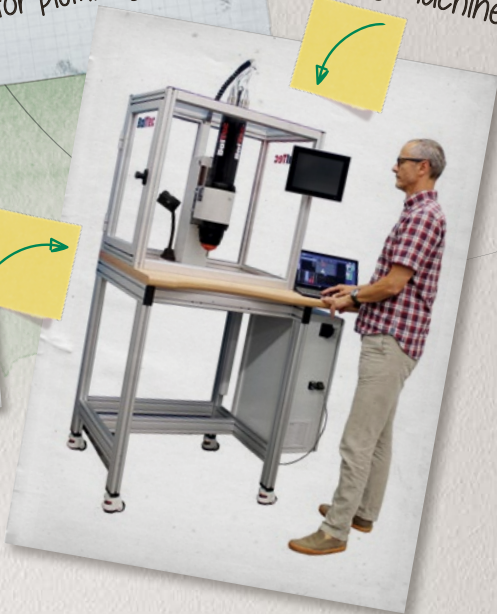
This was by no means a challenge to be mastered in a snap. The road to the perfect solution was long. The project billed as "High-Performance-Smart-Actuator" began with market research because it was clear that an economically and technically feasible solution would not be achievable without the required production volumes. The results of the survey were extremely positive. More than 80 potential applications were identified for the new product: from riveting machines, plier welding heads, and clamping cylinders to hospital beds and dental chairs.

"We found that aesthetically appealing design plays an increasingly important role also for all kinds of technical

Applications

- Radial riveting tools
- Clamping systems
- Clamping cylinders
- Plier welding heads/tongues
- Agricultural machines
- Press tools for plumbing etc.

Riveting machine



devices,” explains Dietmar Rudy, Head of Product Development Linear Technology at Schaeffler. Clever solutions instead of clumsy technology monsters are in demand. This, however, means: “The drives must be so small that they invisibly blend with the structure. This only works with a small screw drive that, with low drive torques, is able to generate more axial force per available design space than previous systems,” says Rudy.

The development process began, initially with an industry comparison that included sectors such as aerospace. Now hadn't there been a robot on board of a Space Shuttle in 1993 that performed complex assembly work with an extremely powerful electrical spindle system? Right! Rotex was the name of the robot that was able to do heavy-duty jobs using the previously mentioned planetary screw drive. Rudy: “Rotex’ motor system promised to meet all the key requirements.” The only disadvantage: “The space technology was far too costly for utilization on Earth.” The technical requirements were too high and the production volume too low in spite of the many fields of application. Fortunately, the know-how of diverse business divisions mesh like cogwheels at Schaeffler. In 2011, the Automotive Division was in search of a solution for a compact electromechanical clutch actuator and the In-

dustrial Division shouted: Hello there, we've got something for you! The PWG. The integrative interaction produced the breakthrough. Due to the high-volume automotive production, the PWG for industrial applications can be offered at market price level. “The enormously large production volumes of these actuators made it possible for us to make the necessary investments in a reliable, non-cutting manufacturing process,” says Dietmar Rudy. Previously, costs had always been the impediment that kept the PWG from making its way into technical applications.



THE AUTHOR

To research the information for this article, journalist **Björn Carstens** immersed himself in the Schaeffler universe to understand how spontaneous ideas turned into true success stories. The author with a degree in business has not launched any technical innovations yet, but at least recently managed to fill out his income tax return forms by himself.



PLEASE UNFOLD ►

NEW WORLDS

In the depths of the ocean, the vast expanse of the sky, or the boundlessness of the desert – over the course of millennia, daring explorers would embark on journeys time and time again in their quest for discoveries. Many of these challenges were only mastered with the help of technical instruments and tools.

— by Carsten Paulun

— Ship, sextant, and compass – what islands, peoples, and continents might have gone undiscovered until today without technical equipment? Presumably quite a few. Even though the settlement of our planet began on foot from Africa about 125,000 years ago, the pieces of the Earth's puzzle were put together only thousands of years later – with the help of ships. Ships made it possible to explore the world. Thanks to their longships the Vikings traveled far eastward via the Volga River all the way to the Caspian Sea as early as in the 9th century. From Iceland via Greenland, Leif Eriksson explored the coastal regions of today's Canada and has come to be regarded as the true discoverer of North America – some 500 years before Christopher Columbus. To navigate the high seas, all seafarers would use the stars and the position of the Sun for orientation. Thanks to a technical tool the Vikings, including Leif Eriksson, were able to reliably navigate even at dusk and dawn, and in fog. They used a crystal they called a sunstone.

First seafarers 62,000 years ago

Even much earlier – around 60,000 BC – the first humans ventured out onto the high seas. To settle Australia, they must have crossed an ocean with a width of about 100 kilometers (62 miles) near today's Makassar Strait. That the settlement of Polynesia took place from South America, as Thor Heyerdahl in 1947 aimed to demonstrate on his expedition with the legendary "Kon-Tiki," today is deemed to have been refuted. At least, though, the Polynesians are regarded as the discoverers of astronavigation. It was the ship, the

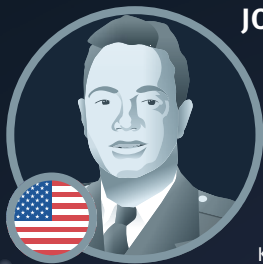
sextant, and the compass that made the discoveries of the world possible.

11,000 meters deep, 384,400 kilometers high

With their help, James Cook, the great explorer and cartographer of the 18th century, on his three voyages around the globe, filled nearly all uncharted areas on the world's map. In 1960, Jacques Piccard in the deep-diving submersible "Trieste" dove nearly 11,000 meters (36,000 feet) deep into the ocean and Neil Armstrong, in 1969, was the first human to set foot on the Moon. By the way, the vehicle that took him there – and fortunately back again – was a ship as well, a spaceship.

95 percent of the oceans still unexplored

Terra incognita, unexplored territory, still exists. Humanity's great urge to explore and discover notwithstanding, we hardly know anything about our own planet – in spite of the most advanced technology. Only five percent of the oceans is deemed to have been explored. Experts estimate that despite our state-of-the-art tools and equipment we haven't discovered even ten percent of all living organisms yet. Large parts of Africa, the cradle of humanity, the Arctic and the Antarctic have so far only been photographed from satellites. Even today, researchers are still discovering previously unknown areas in South America's jungles and peoples that have never had any contact with the outside world before. —



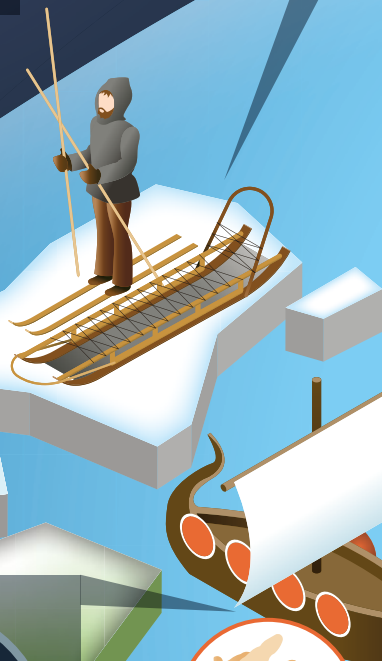
JOSEPH KITTINGER AUG 16, 1960

Goal Testing of a new rescue system at high altitudes.

Challenge Entering the stratosphere, minus 60 °C (-76 °F), hardly any oxygen, the low pressure transforms body fluids into gases.

Innovations A pressure suit, Kittingers balloons introduce the pressure chamber into space travel.

Special aspect With his third stratosphere jump Kittinger sets four world records: highest balloon flight (31,333 meters/102,799 feet), longest-free fall jump (16 kilometers/10 miles), highest speed of a human without a protective shell (988 km/h/614 mph), and longest parachute jump (9:09 minutes). Three of these records are only broken by Felix Baumgartner's stratosphere jump in 2012. Baumgartner's adviser: Joseph Kittinger.



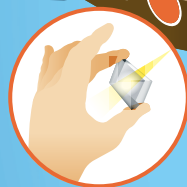
LEIF ERIKSSON TURN OF THE YEAR 999/1000

Goal Exploring new islands west of Greenland.

Challenge Advancing into unknown territories, navigating without sunlight.

Innovations Special calcite crystal for navigating in conditions of poor visibility; due to their shallow draft, the ocean-going longboats with a length of up to 30 meters (98 feet) are perfectly suited for rivers as well.

Special aspect The regions and islands Leif Eriksson discovers and explores include Helluland, today's Canadian Baffin Island. Consequently, the Viking Eriksson is regarded as the true discoverer of North America.



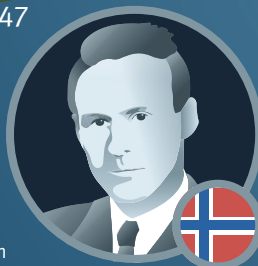
THOR HEYERDAHL APR 28 – AUG 07, 1947

Goal The Norwegian Thor Heyerdahl intends to demonstrate that the settlement of Polynesia took place from South America and not from Asia.

Challenge Will a raft built by using Incan methods survive a 6,980-kilometer (4,337-mile) voyage across the Pacific?

Innovations Archaic today, but innovative more than 3,000 years ago: ocean-going Incan rafts with sails, daggerboards (guaras) for stabilization, and cabins. Dimensions of the "Kon-Tiki" replica: 13.7 m (50 ft) long, 5.5 m (18 ft) wide. Thanks to its 25-m² (270 square foot) sail, the Humboldt Current and trade winds, the "Kon-Tiki" achieves an average speed of 2.8 km/h (1.78 mph).

Special aspect Classic beats modern approach: Heyerdahl connects the balsa wood logs with hemp rope because the steel cables recommended by experts would have cut through the soft wood.





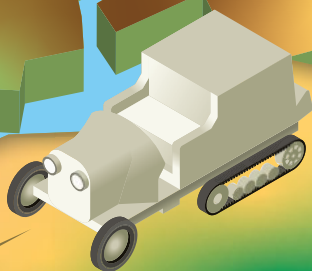
FRIDTJOF NANSEN AUG 15 – OCT 03, 1888

Goal Traversing Greenland.

Challenge Temperatures down to minus 46 °C (–54 °F), unexplored territory with climbs of more than 2,700 meters (8,860 feet).

Innovations Nansen invents layered functional clothing and the Nansen sled that's easy to pull even with 100 kilos (220 lb) of cargo.

Special aspect Nansen studies zoology and writes his doctoral thesis about the central nervous system of marine invertebrates, which provides foundations for modern neurology. He takes a stand for Norway's independence and becomes a League of Nations commissioner.



GEORGES-MARIE HAARDT DEC 17, 1922 – JAN 07, 1923

Goal Creating a car connection between Algeria and the countries south of the Sahara.

Challenge Technology vs. nature: In the early 1920s, André Citroën wants to demonstrate that his automobiles are able to reach the remotest corners of the world.

Innovations Citroën's chief executive Georges-Marie Haardt converts wheeled vehicles into half-tracks by fitting the rear axles with continuous tracks. With 30 horsepower and a top speed of 45 km/h (28 mph), he masters the unexplored desert. On paved roads, though, the tracks soon wear out.

Special aspect Only a year later, in 1924, competitor Renault masters the Sahara challenge without chains – using three-axle trucks.

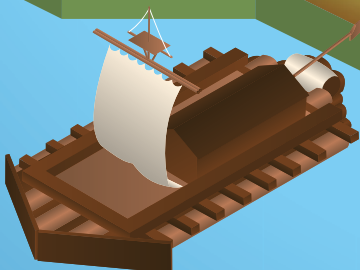
ROALD AMUNDSEN DEC 14, 1911

Goal Becoming the first human to reach the South Pole.

Challenge Overcoming 1,400 kilometers (870 miles) of a frozen desert, with Robert Scott on his heels.

Innovations The race proves that technology is only of help if it's sophisticated: Scott's motorized sleds break down in the cold (minus 34 °C/–29 °F) even before the assault on the Pole starts. Amundsen relies on dog sleds, is better prepared, and has the better route.

Special aspect Amundsen's ship "Fram" is designed so that the pack ice pushes it up instead of crushing it. Amundsen accurately navigates using a sextant. It subsequently turns out that he missed the actual South Pole by only 200 meters (650 feet).



JAMES COOK 1768–1771



Goal Taking scientists and their valuable instruments for astronomical observations to Tahiti, exploring the ocean south of the 40th parallel, and finding “Terra Australis” (Australia).

Challenge Reaching uncharted territories with a relatively small vessel and mapping them.

Innovations Cook identifies foodstuffs with vitamin C as the best antidote against deadly scurvy. From 1795 on, citrus fruits are mandatory on all ships.

Special aspect Cook’s “Endeavour” is a spacious bark (39.7 m (130 ft) long, 70-member crew). Its flat-bottom design makes it possible to beach the ship, allowing it to be repaired at low tide.



ZHENG HE 1404–1407

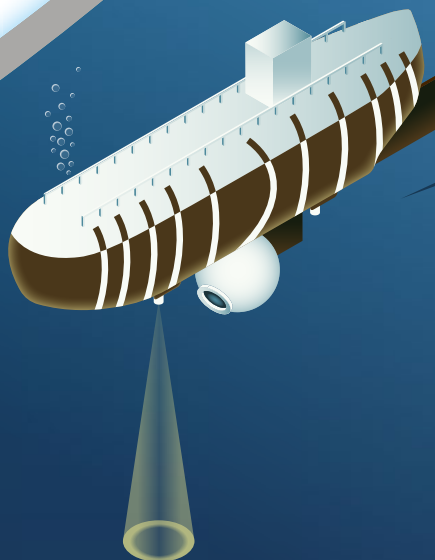
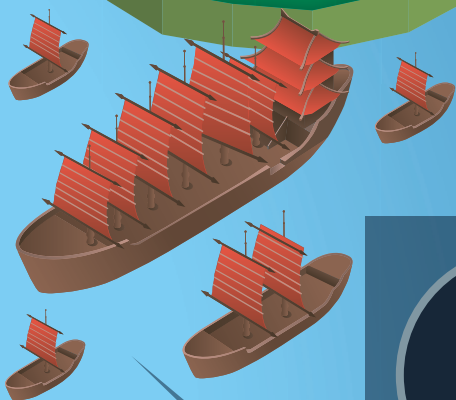


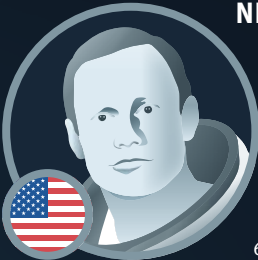
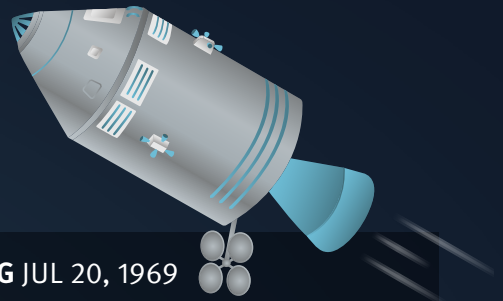
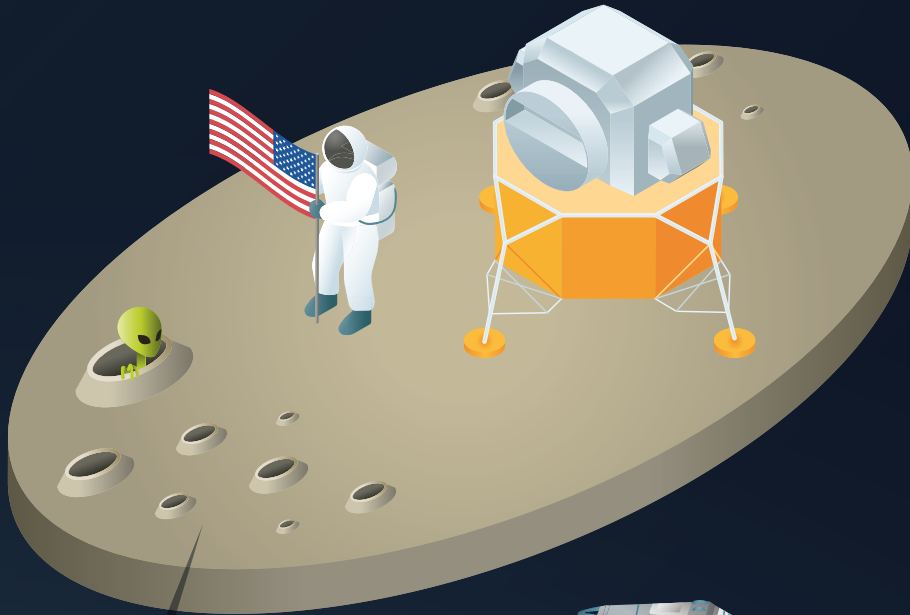
Goal Voyages to Indian, Persian, and Arabian trade ports.

Challenge Expanding China’s sphere of influence.

Innovations Construction of the world’s largest fleet at the time. From 1404 to 1407 the eunuch admiral Zheng He has more than 500 ships built in seven dry docks – 500 years before the Europeans invent the dry dock. The largest ships have up to nine masts and are 84 meters (276 ft) long.

Special aspect To stay the course on his total of seven voyages, Zheng He uses a magnetic compass. His ships have watertight bulkheads that keep them afloat in case the hull is damaged.





NEIL ARMSTRONG JUL 20, 1969

Goal First human on the Moon.

Challenge Complex space maneuvers that are not possible to simulate on Earth.

Innovations A three-pack of high tech takes astronauts to the Moon: Saturn-V Rocket (38,800 km/h/24,110 mph), Columbia Command Module (heat-resistant up to 2,726 °C/4,939 °F) and the LM-5 Lunar Module (lightweight design in order to accelerate to 6,480 km/h (4,026 mph) on its ascent from the Moon). The "Apollo Guidance Computer" (AGC) automatically guides the spacecraft. AGC is regarded as the forerunner of the fly-by-wire systems of modern aircraft.

Special aspect From today's perspective, AGC is a slowpoke: smartphone have 10,000 times more processing power.

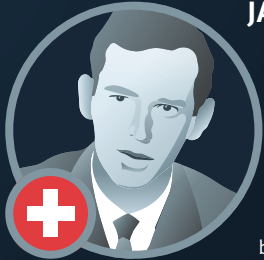
JACQUES PICCARD JAN 23, 1960

Goal Setting a deep-diving record (11,000 meters/36,000 feet).

Challenge The pressure at this depth amounts to 1,100 kg/cm² (15,970 psi) – like a small car on a thumbnail.

Innovations Originally, Piccard's "Trieste" bathyscaphe is able to dive down to only some 6,000 meters (19,700 feet). A new cast high-pressure sphere (bathysphere) with 13 cm (5.1 inches) thick walls enables a depth of 11,000 meters (36,000 feet). For comparison: in 1934, the first bathysphere achieved only 923 meters (3,028 feet).

Special aspect Piccard's father, Auguste, in 1931 was the first human to rise into the stratosphere in a balloon. Piccard's son, Bertrand, flew around the Earth in a balloon and in a solar aircraft, respectively. Rumor has it among trekkies that Jean-Luc Picard, captain of the starship "USS Enterprise" received his name in honor of the Piccards.




PUSHING THE LIMITS

— Steep drops, sweat-inducing climbs, long jumps, and narrow banked turns – mountain biking poses an awesome diversity of challenges. Due to disc brakes, modern protective gear, and suspension forks like those of motocross bikes, humans and hardware are pushed to the limits. However, not only the bikes have seen huge changes ever since the early days: While the first mountain bikers would ride on public hiking trails in the San Francisco Bay Area, today's outdoor athletes prefer triggering their adrenaline

rushes in bike parks with human-made obstacles and jumps. One of the most spectacular parks of its kind is the Schaeffler MTB Arena Sasbachwalden in Germany's Southern Black Forest. "The challenge here is to precisely adjust your pace at the right moment in order to take maximum speed out of the turns and berms," says Merlin Bürkle. The 49-year-old holds the downhill track record of 7m 59s for the fastest downhill run on the Alpirsbacher Schwarzwaldtrail, one of the trails in the MTB Arena.

TRAILS IN THE SCHAEFFLER MTB ARENA

 bikesport-sasbachwalden.de



Alpirsbacher Schwarzwaldtrail

Length 4,000 meters (13,123 feet)
Drop 330 vertical meters (1,083 feet)
Banked turns 43 berms
Obstacles 49 jumps



Starting point
 905 vertical meters (2,969 feet)

Pfad Zwo

Length 1,300 meters (4,265 feet)
Drop 80 vertical meters (262 feet)
Banked turns 12 berms
Obstacles 16 jumps

Starting point
 832 vertical meters (2,730 feet)

here and now

Living with progress

» *It is by riding a bicycle that you learn the contours of a country best, since you have to sweat up the hills and coast down them* Ernest Hemingway



A high-angle, wide shot of a train traveling through a dry, hilly landscape. The train consists of many flatcars, each carrying a large, white, cylindrical wind turbine blade. The blades are secured with metal brackets. The train is moving along a gravel track that curves through the terrain. The landscape is arid, with sparse, dry vegetation and rolling hills in the background under a clear blue sky.

THE JOURNEY OF THE GIANTS

Huge bladed wind turbines rotate on their towers near-weightlessly – but before these behemoths are able to generate electricity at dizzying heights they have to complete an arduous journey. The transportation of wind power systems is packed with challenges – and is never routine business.

— by Kay Dohnke



The huge rotor blades travel long distances – like here in the United States – also by rail

— The way to heaven leads through the eye of a needle: Before the components of a wind turbine system – tower segments, the nacelle, and the rotor blades – can be installed on-site under maximum technical demands and rise up to a height of 140 meters (460 feet) they have to arrive first. And that entails a logistical effort of mammoth proportions due to their size and their weight.

We've all seen the long-load trailers carrying the rotor blades in parking facilities along the freeway – up to 60 meters (200 feet) long, they're parked there until traffic subsides around 10 p.m. and they can continue their journey. By that time, they've already overcome a number of obstacles. Traveling on highways or freeways is no special feat – at least that's what one might think. However, the comparatively small radii of freeway entrance ramps now and then make it necessary to lift the load across the guardrails. Plus, the special heavy-duty trucks have to leave the freeway at some point in time to reach their destinations on backroads. Unsurprisingly, wind turbine manufacturers make maximum use of trains and riverboats to transport the huge components across long distances, but even so, the moment of truth when the heavy cargo has to hit the road will inevitably arrive. And that has been the case increasingly often since wind power has begun to burgeon.

A job with no routines

"We know when a transfer starts," explains Florian Dufresne, "but we can never be sure when it will



Tight corners, unpaved roads, and larger slope angles pose challenges to transporting the heavy components

arrive." As amazing as that may sound: these jobs are never routine business. Every route, every transport is unique. Even though the title of his job with wind turbine manufacturer Senvion is that of a "local transport manager" Dufresne no doubt ranks among Europe's most experienced logisticians for special transports of wind power systems. He handles a thousand of them per year.

A job that keeps him on the road? No, says Dufresne, who manages almost every part of it from his desk at the office. Asked if in the digital age he had access to a database with cornering radii, overhead clearances, the widths of underpasses, and the load ratings



In bottlenecks like this one in the French village of Lussac-les-Églises, the blade lifter raises the rotor blade by up to 50 degrees. The length of the vehicle on the ground then shrinks to the dimensions of a normal truck and the truck moves forward in creep mode



here and now

Mass production: here finished rotor blades in Lianyungang (China) are waiting to be shipped

12,500

wind power systems were newly built in 2018 – **most of them in China**, followed by the United States and Germany.

Sources: BloombergNEF, GWEC

50 GW

is the rated capacity of all new wind power systems established in 2018. It suffices to supply **30 million households** with electricity.

Source: BloombergNEF

4–5 cents

This is how much one **kilowatt hour of electricity** produced by wind power costs in Germany. In the United States it's only 3 cents due to better wind conditions.

Source: Överböhmle C&M

of bridges, he matter-of-factly comments that there's no such thing. Reconnoitering the respective route is the responsibility of the freight hauler. "We can safely transport our wind power systems to the intended sites only by working as a team with their drivers and route planners. And they do exactly what should actually be a contradiction in terms – hauling heavy cargo and improvising. In fact, unforeseeable challenges that have to be spontaneously resolved on the ground keep cropping up," Dufresne says with obvious respect for the work of the haulers.

Solving the problem by means of the special lifting vehicles subsequently led to totally different challenges. Because they have to provide a stable counterweight to the huge rotor blades, they're extremely heavy – a blade lifter including the rotor blade tips the scales at 120 metric tons (132 short tons). Consequently, old bridges in particular pose a problem as their load carrying capacity is insufficient. In this case, the team will lay a heavy-duty auxiliary bridge above the actual bridge.

Blade lifter raises rotor

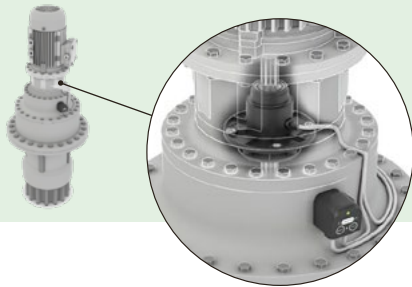
Like during a rotor transport to Lussac-les-Églises on the High Plateau in Central France. Initially, no-one saw any possibility to maneuver the more than 60 meter (200 foot) long special trucks through the narrow streets of the centuries-old country town. But, thanks to technology, it proved to be possible after all. "We simply raised the rotor blades on one side using the blade lifter and edged them through the streets that way."

60 meters, 120 metric tons, 10 centimeters

Centimeters or inches may pose even greater problems than the 60 meters (200 feet) or 120 metric tons (132 short tons). As wind turbine towers keep getting taller, the towers, which have to be transported to the site in several segments, grow in terms of diameters as well. What doesn't grow, though, are the overhead clearances of road or railroad underpasses. So far, Dufresne emphasizes, solutions have always been found. In the case of the tower segments, the technology of the trucks helps – the special low-bed trailers are able to

SCHAEFFLER ENHANCES WIND EFFICIENCY

Transmission, rotor shaft, generator, yaw control, blade adjustment – Schaeffler has been producing bearing solutions, analysis and monitoring tools for wind turbines for more than 30 years. Predictive monitoring is a recent addition to the portfolio. Together with Bonfiglioli, the market leader in transmissions for yaw control and blade adjustment, Schaeffler has developed a compact Industry 4.0 package. It combines the measuring systems SmartCheck (on the housing) and TorqueSense (on the shaft) into a new condition and torque monitoring system. It not only detects and limits peak loads and their frequency but also recognizes impending failures at an early stage due to the SmartCheck vibration diagnostics. The resulting major advantage: repairs can be planned and performed on days with little or no wind.



hydraulically lower their cargo beds down to 10 centimeters (4 inches) of ground clearance and will then edge their way forward underneath the bridge. However, the trailers must not bottom out on any bumps in the road surface under any circumstances, plus the overhead clearance is only about the breadth of a hand, too.

Logistics with diplomacy

The haulers' route scouts are resourceful no matter what and discuss the routes they've reconnoitered with transport manager Dufresne. "There's not a lot I need to tell my hauling colleagues – they're absolute pros: I can rely on their planning 100 percent." Instead the part of the Senvion logistician is to discuss the project with all the other stakeholders, approving authorities, private highway operators and, above all, the people on the ground. At that time, he's a diplomat first and foremost, having to alleviate the concerns of mayors and county officials that the special transports won't cause any damage. Plus, he has to explain why the journey of the giants has to be routed through their region in particular even

though the wind farm will be established at a remote location. "We can never take the shortest possible route. To cover a distance of one kilometer, the convoys often travel ten, 15 or more kilometers on the road. A bridge with a sufficient load rating may be located five kilometers farther to the east, but then an underpass that's too low may have to be given a wide berth. So one kilometer is added to another and approvals must be obtained again and again," explains Dufresne.

In spite of extensive preparations and ample experience, there's always a chance of unforeseen things to happen. Once, Dufresne relates, there was an unannounced construction site – the trucks concerned were stuck for three weeks. Even driving forward is extremely challenging, but backing up is practically impossible with a 60-meter (200 foot) trailer.

Systems are becoming larger and larger

The further the development of ever more powerful wind turbines progresses the more difficult the

1.148 million

people are employed in the wind energy sector worldwide, compared to 500,000 in 2009. In total, the sector generates annual sales of 94 billion euros. However, due to falling prices and growing competitive pressures, especially from Asia, many manufacturers are fighting for survival. With sales of ten billion euros (2018), Vestas Wind Systems A/S from Denmark is the world market leader, followed in second place by Siemens Gamesa and the Chinese manufacturer Goldwind in third.

Sources: IRENA, REN21, GWEC



To install the giant offshore wind farms, the wind power industry uses special vessels that lift themselves out of the water by means of hydraulic jacking systems



transports become – because higher rated capacity also means taller towers, heavier nacelles, and longer rotor blades. Rather than calling them more difficult, Dufresne would call them more demanding – or more challenging. Explaining the implications, he says: “As a result of the fast dimensional growth in technology, our experiences with specific routes soon lose their value.” Things that are still possible with 120 tons may fail with 140. “We now even have to see familiar routes we’ve used many times before in a new light.”

Local challenges

In view of the many challenges that ground transportation entails one would expect the hauling of components for offshore wind farms to their sites at sea to be child’s play. Yet even maritime transport encounters bottlenecks. Here’s an example to illustrate the point: The components for wind farms produced at the Labrador harbor in Bremerhaven have by now become so large that they can no longer be shipped through the narrow lock at the fishing harbor to the

seaside loading quay. Instead of using the simple route across the water the components now traverse the town – as a heavy transport – before being loaded onto a special vessel and heading for the open sea. There – far away from the shore – the ship lifts itself out of the water on huge steel struts and mutates into a mounting platform for the towers, nacelles, and rotors. Now only the wind as an adversary can delay their installation – the wind, though, is the reason why the components are here.



THE AUTHOR

Ever since **Kay Dohnke** saw the “Large Wind Farm” Gro-wian in the German state of Schleswig-Holstein he’s been fascinated by wind power and enjoys writing about it and other sustainability topics. The only experience he’s still lacking is a visit to the nacelle of a turbine on top of the tower.

FED UP!

The massive plastic pollution of the oceans is one of the greatest challenges of our time. However, there are encouraging, ambitious projects and ideas.

— by Christel Trimborn

— A dolphin with its mouth filled to the brim with carelessly discarded plastic bottles and bags, disposable tableware and plastic wrap. A line above the picture says: “We are fed up!” The current state of the seas and their inhabitants could hardly be described more fittingly than by this daunting image with which the World Wildlife Fund (WWF) is currently attracting public attention to the growing worldwide trash pollution of the oceans.

Actually, the problem for animals that live in the marine environment such as dolphins, sea turtles and seabirds – and ultimately for us humans – is a much more dangerous one: It’s estimated that about 70 percent of the huge amounts of plastic in the oceans does not even consist of large, floating plastic pieces but of microplastics. Even tiniest particles in the form of additives in cosmetic peels, shower gels, and toothpaste are flushed into the oceans. Others are created by abrasion, UV radiation, and the constant sea current that decomposes and grinds large plastic parts into microplastics. Some of these microparticles drop to the bottom of the deep sea from where in all likelihood it will never be possible to raise them again. Another part is eaten by marine animals and thus will end up in our stomachs at some point in time. Plastic wrap used to be around the fish we consume, today it’s part of our diet whenever we eat fish.

It has been established that currently some 150 million metric tons (165 million short tons) are polluting the oceans, and up to 13 million (14 million) more end up there per year. Plus, 80 percent of the waste gets into the oceans due to being discarded by people living in coastal regions – the countries of South East Asia being one of the main areas. Scientists are working on projects exploring the paths of plastic migration into the oceans, how this can be avoided, and whether the waste can at least be partially eliminated from the oceans again and recycled. In this context, the German

Federal Ministry of Education and Research (BMBF) in 2017 initiated a research program billed as “Plastics in the Environment – Sources, Sinks, Solutions.” Until 2022 a total of 20 joint projects plus a scientific supporting project will be funded with some 37 million euros. The objective is to explore the extent of the problem in greater detail and to develop solutions to reduce the amount of plastic waste being generated.

Avoiding & educating

Every one of us can and should help prevent the generation of even more amounts of plastic waste. The international traveling exhibition “Ocean Plastics Lab” aims to heighten public awareness of the plastic waste issue. Project Coordinator Dr. Julia Schnetzer lists some of the seemingly small, yet efficient behaviors consumers can adopt in order to control and reduce the amount of plastic waste: “First, avoid plastic packaging when shopping and generally consume less. Second, dispose of household garbage in ways that make more effective recycling possible. And third, wear less clothing made of synthetic materials such as fleece because every laundry cycle flushes microfibers into the sewer systems

32 %

of the annual amount of 78 million metric tons (86 million short tons) of plastic packaging used around the world end up in **our environment** such as our oceans **uncontrolled**.



which many wastewater treatment plants are unable to filter out or which end up on farm fields as sludge.”

From an overall perspective, environmental experts expect a change in consumer attitudes and behaviors to have the greatest impact on controlling and reducing the flood of plastics. As well as generally choosing not to buy products packaged and wrapped in plastics, this includes the use of returnable packaging and reusable tableware at events, according to Greenpeace. However, a lot of education and information is necessary to bring about this change in thinking. Especially in countries such as Indonesia, Vietnam or China, from where particularly large amounts of waste get into the oceans, knowledge and the requisite technology are often lacking.

The German marine biologist Dr. Mareike Huhn, for example, has dedicated herself to changing this situation. For five years, she has been personally active in educating the population on the Indonesian Banda

have to change their ways. For centuries, says the German activist, they've been used to disposing of their – previously biodegradable garbage – in the ocean. Obviously, such practices are problematic in the age of plastic packaging.

Cleaning & collecting

To keep plastic waste from suffocating the oceans, smaller and larger initiatives and organizations around the world are providing First Aid. While some of them are looking for ways to skim plastic parts off the ocean surface in large-scale cleanup projects using innovative technology, others are ridding the beaches of discarded plastic bottles and plastic sandals washed ashore by tedious, albeit efficient manual work.

The most commonly known and ambitious ocean cleanup projects include “The Ocean Cleanup” and



Islands about disposing of garbage. With her “Banda Sea” organization she has not only established a type of garbage collection system but also provides environmental education to the local population because the inhabitants of these scenic spice-islands urgently

“Pacific Garbage Screening (PGS).” Initiator of “The Ocean Cleanup” is the 24-year-old Dutchman Boyan Slat, who as early as in his high school days was shocked by the huge amounts of garbage he encountered while snorkeling in coastal waters of Greece. His idea: Garbage

floating in the upper five meters (16 feet) of the water surface is to be trapped by means of V-shaped floating “arms,” aspirated by a platform anchored on the bottom of the sea, and subsequently recycled. The maritime garbage collector is intended to use the current of oceanic whirlpools to drive the garbage into the system’s “tentacles.” First field tests

600 years

is the time it takes for a fishing line **to fully dissolve in water**, 450 years for a PET bottle, 50 years for a styrofoam cup, and 20 years for a plastic bag.

4.5 times

as large as Germany is the “Great Pacific Garbage Patch” northeast of Hawaii: 80,000 metric tons (88,000 short tons) of plastic are concentrated there in an area of 1.6 million km² (618,000 square miles).

in the Pacific last fall were foiled by technical issues. The system is currently being revised.

Still in the development and funding phase is the 400 by 400 meter (1,300 by 1,300 foot) large “Pacific Garbage Screening” project devised by Marcella Hansch, a student from Aachen, Germany. “PGS is designed to be a floating platform directly anchored in the garbage whirlpool. The best part about it: it works without nets and filters, so fish and other marine animals can swim through it without risk,” she says, explaining her idea. The operating principle of PGS: the platform is intended to calm the wild currents within the garbage whirlpool so that the lightweight micro-particles can rise to the surface from where they’re skimmed off. She and her team have also thought about future uses of the collected plastic waste. “We don’t want to just incinerate the plastic materials but, for instance, use them as a resource to generate energy and biodegradable plastics,” says Hansch.

Afroz Shah, a young Indian lawyer, began to collect plastic waste that was littering Mumbai’s Versova beach. Subsequently joined by thousands of volunteers, he has completely cleaned up the beach by now. Even the sand that at the beginning of the campaign had been completely covered by mountains of plastic garbage washed ashore is now visible again.

Recycling & processing

Obviously, not all plastic waste from the ocean can be recycled into stylish bracelets, nor into innovative sneakers, functional shirts or chlorine-resistant swim suits like those produced by German sportswear manufacturer Adidas. However, projects like these do serve to heighten public awareness of the acute threat to the oceans. Plus, per pair of the “green shoe” that uses 85 percent recycled marine waste an average of eleven plastic bottles are recycled, according to Adidas.



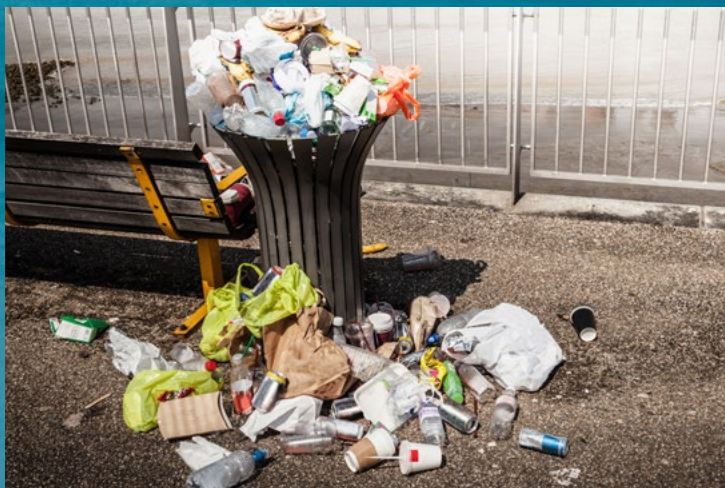
By contrast, the “4Ocean” initiative founded by Andrew Cooper and Alex Schulze performs manual work in every respect. Like many others, the two surfers from Florida turned into environmental activists due to personal experiences with garbage floating in the ocean. With their organization that was founded only two years ago they have by now managed to motivate some 150 volunteers around the world to join cleanup crews collecting plastic waste on coasts and beaches by hand. The project is financed by the sale of stylish bracelets produced from recycled plastic waste. So far, more than two million kilos (4.4 million pounds) of plastic waste have been collected, according to the organization.

Arguably the most spectacular trash collection campaign, though, was launched in India in October 2015. It shows what enormous effects the initiative of a single individual can have. Initially acting on his own,

Some 10 %

of the plastic waste in the oceans **emanates from fishing**, due to illegal trash disposal on the high seas and lost fishing nets, among other things.





Up to 120 billion

dollars **worth of resources** are lost per year because packaging is used only once and then discarded.

Source: Heinrich Böll Foundation

Some 33 %

of global waste **is produced in highly developed countries** although only about 16 % of the world population lives there.

Source: World Bank Report "What a Waste 2.0"

So what can be done with the remaining floods of plastic waste? A marketable technology for recycling large quantities of plastics is not available yet, not least because each of the six economically most important polymers is made up of diverse basic components that are not chemically compatible. Consequently, waste collection by material type would be imperative to achieve effective and economically feasible recycling. What's more, many types of plastics cannot simply be melted down and reused. Due to chemical reactions, some of them become unusable and others react with tiny residual contaminations that are hard to eliminate.

The bacterium that was accidentally discovered on a Japanese sanitary landfill, and investigated and developed further by U.S. scientists is not in large-scale use yet either. The "super enzyme" is said to be able to decompose polyethylene terephthalate – better known as PET – in a fraction of the time it takes a PET bottle to decompose naturally. In an article published by "National Geographic" last year, Professor John McGeehan who leads the research expressed optimism: "It's well within the possibility that in the coming years we will see an industrially viable process to turn PET and potentially other substrates like PEF, PLA, and PBS, back into their original building blocks so that they can be sustainably recycled."

The German company Ecogy plans to transform plastic waste into fuel: 140,000 metric tons (154,000 short tons) of plastic garbage are supposed to turn into

125 million liters (33 million gallons) of fuel. In 2018, Richard W. Roberts and Simon White pioneered the "Ocean Saviour" idea, a vessel that, while autonomously navigating the oceans, collects plastic waste and converts it onboard into the fuel powering the ship. In other parts of the world, for instance in China and India, scientists are working on the conversion of plastic waste into fuel as well. However, the high costs this entails often stifle progress. An even better solution, though, would

be to avoid the generation of plastic waste in the first place, and particularly in the form of ocean litter. In closing, here's a number that should serve as a warning: In 2016, a study commissioned by the World Economic Forum cautioned that by 2050 the amount of plastic in the oceans might exceed the amount of fish in them – a more than alarming prospect.

SUSTAINABILITY AT SCHAEFFLER

"Sustainable" is one of the four central corporate values of the Schaeffler Group. Follow the QR code and find out how the company makes its business operations as environmentally and socially responsible as possible.



THE AUTHOR

*Be it fashion, jewelry or travel: Freelance journalist **Christel Trimborn** has been writing about "green" topics focused on sustainability for a long time. Following her shocking research on plastic waste, she's planning to definitely start taking an even closer look than she used to at what type of packaging will end up in her shopping cart.*

Living with a disability entails major challenges – modern technology can assist in managing them. But even people not challenged by disabilities can benefit from such innovations.

[illegible]

commonly known, the typewriter would eventually evolve into the keyboard that today makes it possible for us to type text electronically at high speed and to operate a computer. Other sources assume that the countess' brother invented the machine to help his blind sister and that Turri merely improved it. No matter which version we choose to believe, history is full of technical achievements that had their origins strictly in the desire to help people challenged by disabilities. From transistors to scanners and touchscreens to audiobooks – they all



» The possibility of driving a car is still essential to remaining mobile, especially in rural regions

Constantin Grosch

were invented for people with special needs and later evolved into mainstream products. Even today, there are developments for challenged people that provide the basis for forward-thinking technologies.

Without a car, no job, no activities

To drive a car, Constantin Grosch from Hameln, Germany, uses a technology called drive-by-wire that enables him to operate the steering wheel in spite of an impaired arm function. "The possibility of driving a car is still essential to remaining mobile, especially in a rural region like the one I live in," says the wheelchair user who drives his automobile while sitting in his electric wheelchair. For him, he says, driving is a basic prerequisite for taking part in social life: "Without this opportunity I wouldn't be able to engage in any professional, volunteer or recreational activities on a continuing basis in my region." The technology Constantin Grosch uses is supplied by Paravan, a company specializing in conversions and modifications for disabled people. However, the technology is no longer only of interest to people with disabilities because the future market of self-driving cars requires this key technology for autonomous



DOUBLE BENEFIT

Schaeffler supports environmental protection and inclusion with used IT hardware and was presented with a certificate of appreciation for its socio-economic commitment from AfB (Work for People with Disabilities).

The reason behind this recognition was Schaeffler's donation of 8,970 IT devices, particularly PCs, notebooks, and flatscreen monitors to AfB last year. Most of the hardware removed from the company's inventory was still fully functional, and more than 83 percent of the devices were directly marketed on to other users. With notebooks the rate was even 96 percent. Defective devices

were dismantled and turned over to certified recycling companies. Due to the cooperation between Schaeffler and AfB, 611,478 kilos (1,348,078 lb) of iron equivalents, 442,108 kilos (974,681 lb) of CO₂ equivalents, and 1,362,718 kWh of energy were saved, the latter equating to an annual average electric power consumption of 648 two-person households. Since 2008, Schaeffler has been working together with Europe's largest non-profit IT organizations in that they turn over to AfB used hardware provided to them for data erasure, refurbishing, and resale. The economic recycling of the equipment avoids

electronic waste and saves natural resources. In addition, the partnership with Schaeffler makes it possible for AfB to come closer to reaching its long-term goal of creating 500 jobs for people with disabilities.



Schaeffler employee Gerd Goesswein (center) accepts the certificate from AfB



Challenged people have covered more than a billion kilometers using Paravan's drive-by-wire system. In a joint venture with Schaeffler, the technology is now making its way into autonomous vehicles

vehicles. These automobiles particularly depend on safe and highly reliable actuators such as steering functions. That's why Schaeffler in 2018 entered into a joint venture with Paravan in order to be able to use this technology in its small and agile Schaeffler Mover vehicle concept, among other things.

The technology also makes everyday life easier for Christian Bayerlein from Koblenz, Germany. His arm and hand functions are severely impaired and he uses

an electric wheelchair. The IT professional has personally optimized or simply modified many of his technical aids. By means of a mini joystick, he operates his smartphone via a Bluetooth-mouse module that's integrated in his wheelchair. In addition, he has integrated a wired receiver with a web interface into his system. "It often happens that I'd like to solve a problem and then take a look at what's possible with technology." The front door of his house is opened by a smartlock called Nuki for which he has written a web interface, so that he can open the door from his PC using voice recognition. "All the smarthome technology has its origins in the disability sector and has now been modified for the mass market," says Bayerlein.

Even so, Bayerlein doesn't feel that technology is a cure-all. "Better technology must not keep society from creating accessibility," he says. He views nurse robots and so-called exoskeletons designed to enable paralyzed people to walk with skepticism as well. "In some cases, it takes my personal assistants years to learn how to effectively help me without causing me pain and to seat me in stable and comfortable ways," he explains. An assistant needs to know exactly how to handle him, for instance when lifting him into a wheelchair. "I also feel that the human factor is important, I'd miss that in a nurse robot." Exoskeletons, he feels, are a hype. "For

APPS FOR THE BLIND

Seeing AI – a vision aid based on the smartphone

Since it was invented, the smartphone has become the number one aid for blind people. With its "Seeing AI" app, Microsoft has created kind of a Swiss Army Knife for blind and low-vision users. The app uses artificial intelligence to read signs or documents. It recognizes barcodes and persons if they've previously been stored in it. It's able to classify money and describe scenes in photographs. In addition, it serves as a color recognition system and is able to convert light intensities into sound: the brighter the environment the higher the pitch. The app is able to issue all this information within a matter of milliseconds and, as a result, has become an

important tool for visually impaired people in everyday life.

Aira – the airport navigator

Visually impaired people having to find their way around airports used to practically always require on-site assistance in order to find their departure gates or the security checkpoints. The app "Aira" uses artificial intelligence (AI) and remote assistance (RA) to help visually impaired people to orient themselves in places like airports or with other challenging everyday situations. Users are connected to specially trained staff, who via the smartphone camera or a set of camera glasses are able to see what's happening around the user. They can point out the way or assist with other problems.

Artificial eye: the "Seeing AI" app translates images into speech



Looks cool and is even able to climb stairs: the Scewo wheelchair concept



» All the smarthome technology has its origins in the disability sector

Christian Bayerlein

some people and for some applications, they may be great, but they also strike me as being somewhat of a normative fetish,” Bayerlein says.

Up and down stairs in a wheelchair

A development from Switzerland inspires much greater enthusiasm with him. Scewo is an all-new concept of an electric wheelchair that’s planned to be delivered to its first customers before the year is out. Scewo, for one, is able to operate on stairs, which is definitely practical in non-accessible environments. But that’s not even the main thing that thrills Christian Bayerlein about the Swiss vehicle. Above all, he’s taken with its

stylish design: “This wheelchair doesn’t have any kind of medical look. To me, that’s truly innovative.” The styling of the wheelchair, he feels, truly has to do with inclusion because disabled people want to be “cool” too. He’d like to be able to identify with his wheelchair and that’s simply the case with Scewo. That’s also why he could imagine that this wheelchair at some point in time would not just be used by disabled people, but simply as a means of moving around by anyone who’d rather sit than walk. In the light of an increasingly older population, he feels that this would definitely be conceivable. And in that case, another invention for challenged people would have morphed into a mainstream product for everyone.



THE AUTHOR

Journalist **Christiane Link** grew up in the German states of Rhineland-Palatinate and Hesse before studying political science at Hamburg University. Today, she lives in London and calls herself a geek.

She enjoys trying out new technologies and regards her wheelchair as an accessory. As a child she had one of the first colored wheelchairs on the market that were supplied that way by the manufacturer.

The data management challenge: how companies focus on IT security without shutting themselves off from the outside world.

— by Lorenz Steinke



— For many years, computer networks were of interest only to scientists and the military. Mainframes were located in hermetically sealed research centers – effectively protected against external access – at least that’s what everyone thought. Then a seven-year-old boy came along and became the world’s first hacker.

In 1957, Josef Carl Engressia, a blind U.S. grade schooler blessed with absolute pitch whistled a tone of 2,600 hertz into the mouthpiece of his parents’ phone just for fun and to his amazement found out that the AT&T operator cut off the connection due to his signal. Engressia had accidentally discovered that control codes in the American telephone network were exchanged via simple sound sequences. Initially, Engressia used his discovery merely to make free phone calls but soon he and many hackers (aka phreakers in the context of telecommunications) inspired by him learned how to gain control of other devices by means of sound. When mailbox networks came up in the 1980s as forerunners of the internet, phreakers would dial themselves into data networks by whistling and cover their tracks by making phone calls

on lines other than their own. Some of them experimented with electronic sound generators or used toy whistles that came with cereal boxes. Even trained canaries were purportedly used.

4,600 billion euros of damage worldwide

Today, sound hacking aka phreaking is possible only in few telephone networks anymore, but along with the security standards of the networks the technical means available to hackers have grown as well. In a survey conducted by the German digital association Bitkom, 70 percent of the companies surveyed stated that they’d been victims of data theft, industrial espionage or sabotage in the past two years. Another 19 percent of companies weren’t sure – hacking attacks are not always detectable after the fact. Small and medium-sized businesses (SME) in particular are frequent victims. The business consultancy Accenture estimates that cyberattacks will cause worldwide damage to the incredible tune of 4,600 billion euros in the next five years.

» We can make sure that we’re a difficult target and that attackers quickly give up their intrusion attempt again

Marc Votteler, Vice President Global Technology Services at Schaeffler

Attacks against companies in manufacturing industries by malware that wasn't created by ordinary hackers but – presumably – by foreign governments or their intelligence agencies have repeatedly been reported in recent years as well. The fact that the software used was simply too good and too complex to have been the work of an individual gave rise to this suspicion. Thus, businesses are exposed to a two-fold threat: by privately and by government-organized attacks.

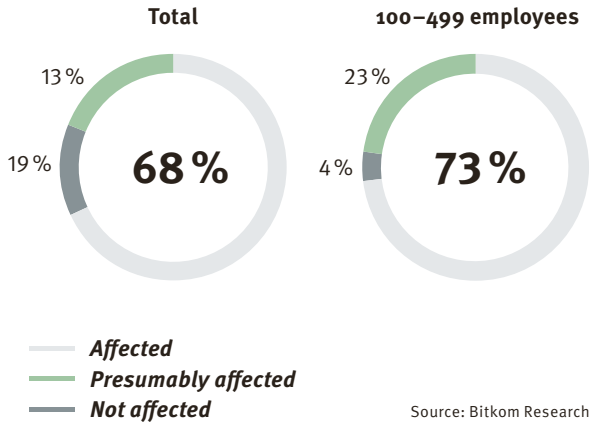
In spite of cyber threats, in the age of the Industrial Internet of Things (IIoT), isolation from the outside world is no solution – but IT systems with powerful protection and well-trained staff are. However, Marc Votteler, Vice President Global Technology Services at Schaeffler, cautions: “No company is able to protect itself 100 percent. But we can make sure that we're a difficult target and that attackers quickly give up their intrusion attempt again.”

Still, many SMEs, and even large corporations, for instance in many production environments, are using obsolete operating systems. Microsoft just announced that they will stop providing any updates for Windows 7. Business clients can still buy a final support period until 2023. After that, this wide-spread operating system will become a gateway for hackers.

In Germany alone, some 60,000 computers per day are infected by malware, the Federal Office for Information Security (BSI) warns – worldwide it's hundreds of thousands. Many of them become part of bot nets waiting to be activated by secret signals of their programmers. It's not uncommon for affected systems to be around for years unnoticed – for instance at training facilities or in control systems of assembly lines that, for operational reasons, are not updated or made virus-proof because the operating software is not compatible with newer operating systems. Also, seemingly harmless devices like coffee machines are connected to company networks and, consequently, able to reveal

SMES SPECIFICALLY TARGETED

Was your company affected by data theft, industrial espionage or sabotage in the past two years?

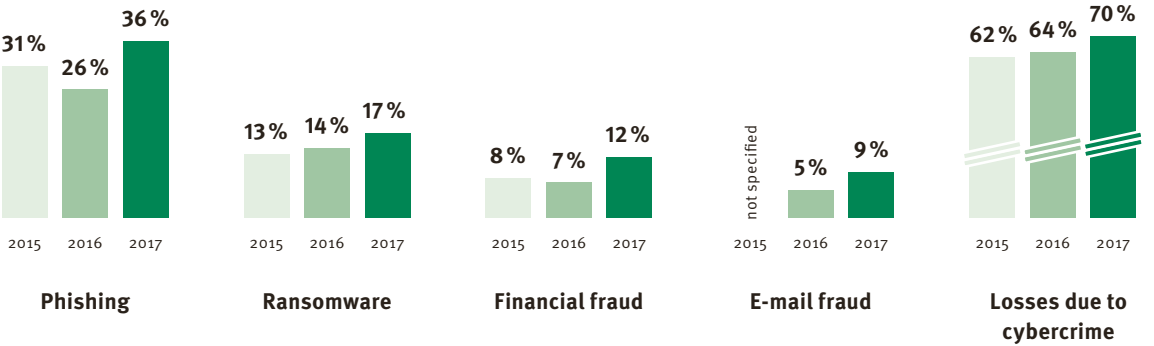


passwords to hackers, warns Kaspersky Lab, a provider of anti-virus software.

Automation as a gateway for hackers

Increasing IIoT automation opens up new gateways for hackers. What happens if a self-driving shuttle bus is tampered with on company premises, causes an accident, and people are harmed? Risks like these have to be simulated in periodic security training sessions conducted by the company's IT team and any gateways detected must be immediately shut. Many companies have already responded to this as part of their IIoT and smart factory transformation processes. “Information security and cybersecurity are important topics for us and will play a key role in the coming

CYBERATTACKS AGAINST COMPANIES ON THE RISE



Source: survey conducted by IT services provider IDG among 510 top U.S. executives from various sectors

IT SECURITY SCHAEFFLER'S APPROACH



"This is not only about technology and processes but also about people. To strengthen cybersecurity at

Schaeffler, we need employees that have the requisite know-how and are the best in this field – which is not easy in the current competitive conditions. On the other hand, we also need an awareness and acceptance among all employees of how important this issue is to Schaeffler."

Georg F. W. Schaeffler, Shareholder and Chairman of the Supervisory Board

— Since 2014 **Schaeffler has had an in-house Chief Compliance Officer (CCO)**, responsible for business security and cybercrime, among other things, who reports directly to the CFO.

— To protect the company's own and its customers' data, Schaeffler maintains an **Information Security Management System (ISMS)** that is oriented to the ISO/IEC 27001 standard.

— **Internal and external experts periodically sensitize** employees to IT security issues in training sessions based on case studies of the latest scams used by cybercriminals, such as **CEO fraud or smuggling viruses,**

worms, and ransomware (extortion programs that capture company data and release it only against payment of ransom) into IT systems.

— To implement its Digital Agenda, Schaeffler systematically scouts for **digital talents and digital natives**, who share their data management and data security knowledge also internally.

— Schaeffler is **a member of the German Association for Data Protection and Data Security (GDD)** and engages in regular exchanges with government authorities and other companies concerning current cybersecurity risks and issues.

years," says Klaus Rosenfeld, Schaeffler's CEO, "not least under the aspect of progressive digitalization as part of our forward-thinking program Agenda 4 plus One with which we continue to consistently drive Schaeffler's transformation."

Large sums transferred from company accounts

The latest hacking trend is CEO fraud: Hackers spy out internal processes and data, pass themselves off as the company's CEO, and then get employees to transfer company funds to the hackers' accounts. The U.S. Federal Bureau of Investigation (FBI) reported some 78,000 cases of CEO fraud in the past five years. The Austrian-Chinese aerospace industry supplier FACC became a victim of such a scam in 2016 and transferred 50 million euros to criminals. Consequently, for protection against CEO fraud, Schaeffler also relies on modern Information Security Management Systems (ISMS) that safeguard sensitive company data against third-party access and use smart technology to define the contents that may be maintained on company smartphones and computers – and how to store them there in encrypted form.

Employees themselves have to be sensitized to the issue of IT security over and over as well. Every privately owned end device with a camera and microphone

taken onto company premises poses a security risk. And although the danger of viruses emanating from ownerless USB memory sticks found lying around is a topic of any security training, some 45 percent of all the sticks put out in a test by the University of Illinois were inserted into computers by their unsuspecting finders. Thus, humans continue to be the most vulnerable link in the security chain.

Even back in the days when seven-year-old Josef Carl Engressia called the AT&T troubleshooting service to ask questions about the 2,600 hertz trick the operators readily revealed additional information – unwittingly helping the phreaking scene to refine their phone tricks and to defraud telecommunications companies by "whistling their way" to free long distance calls worth millions of dollars.



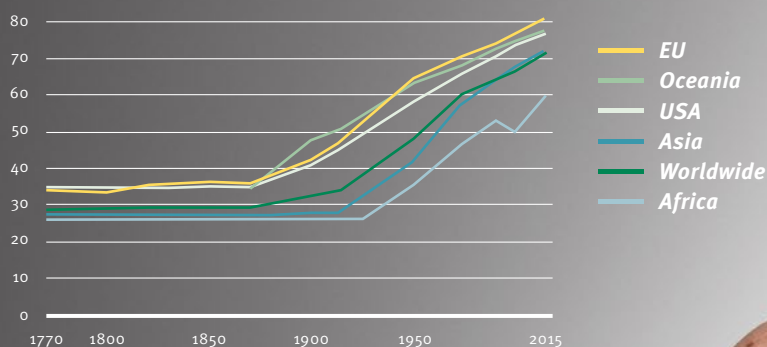
THE AUTHOR

*Journalist, communications consultant, and ex-Telekom spokesman **Dr. Lorenz Steinke** grew up with 8-bit computers. The croaking sounds of datasettes and acoustic couplers were the music of his youth that brings back fond memories – unlike the phone bills he ran up in those days.*

WHO WANTS TO **LIVE FOREVER?**

— *Eternal life – serious scientists and charlatans have been looking for a fountain of youth since time immemorial – from the ancient Egyptians to Chinese natural healers to Botox-injecting cosmetic surgeons. The problem is that aging is a complex process with countless “players” involved in our body. At least, even without snake oil, human life expectancy has been increasing from generation to generation (see chart) thanks to steadily improving healthcare and healthier lifestyles. However, the still young sector of anti-aging medicine is not inclined to settle for these advances, but determined to keep putting the brakes on aging. *Caenorhabditis elegans*, a nematode, is an important helper in this endeavor. The genome of the tiny mollusk is not unlike that of humans and in its short lifespan of only two to three weeks it ages in fast-forward mode. Anti-aging scientists at The Scripps Research Institute in the United States have now managed to block an enzyme in *C. elegans* and thus increase its life expectancy by 45 percent: after 30 days, half of the worms actively tested were still alive while all those in the control group had died long before them. Although it’s still a long journey from *C. elegans* to *Homo sapiens*, who knows, maybe this dialog between immortal Connor MacLeod and pathologist Brenda Wyatt in the movie “Highlander” will one day not sound like such a fantasy anymore: “I’ve been alive for four and a half centuries, and I cannot die.” – “Well, everyone has got their problems.”* —

INCREASE IN LIFE EXPECTANCY SINCE 1770



Currently, Iceland is the country with the highest life expectancy: men live for 81.3 and women for 87.3 years there. The Central African Republic is in the bottom spot of the ranking (50.3/54). In most cases, the difference between men and women is 4 to 8 years, and around 10 years in many countries of the former USSR.

Sources: pre-1990 statistics 1990 James Riley; post-1990 WHO and World Bank



A close-up portrait of a woman whose face is split horizontally. The top half of her face, including her eyes and hair, appears youthful and smooth. The bottom half, starting from her nose, shows significant signs of aging, including deep wrinkles and sagging skin. She is using her hands to hold her nose, which serves as the dividing line between the two contrasting states of her face. The background is a plain, light gray.

outlook

Technology for tomorrow

» *Youth is wasted
on the young*

George Bernard Shaw



From the road up into the air and back:
modular mobility concepts interlink vertical
and horizontal mobility – at prices predicted
to be acceptable to the market

RISING TO THE **CHALLENGE**

Clogged roads and railroads at their capacity limits – the conquest of airspace may help decongest traffic on the ground. Vertical mobility using drones is a promising complement to the portfolio of urban and interurban mobility – also for Schaeffler.

— by Carsten Paulun



— The Port of Hamburg: Huge cargo ships are moored alongside their berths while heavy containers are being unloaded from them. The port bustles with activity and the noise interferes with the buzz from above where drones are busy doing their job. Two years ago, the local terminal operator HHLA started using the small aerial vehicles for visual maintenance checks. The Hamburg Port Authority has been using drones to inspect the nearby 135 meter (443 foot) high Köhlbrand Bridge for damage for several years as well. The unmanned airborne spies have also been monitoring train tracks, pipelines, the façades of buildings or offshore windfarms, and law enforcement agencies are increasingly enlisting the aid of this type of air support too.

Two tons of payload

The areas in which drones are used are practically growing by the day. In Singapore, Airbus recently launched the transportation of goods by drones to ships berthed in the city-state's coastal waters. Up to four kilos (8.8 lbs) of payload and distances of up to three kilometers (1.9 miles) are already possible today, so that spare parts, medicines, money or documents can be flown to the vessels, which is routine business in major global transshipment hubs such as Singapore. With drones this can be accomplished six times faster and 90 percent cheaper than by boat, according to Airbus. In the Port of Hamburg, even large containers are supposed to be flown back and forth by drones in the foreseeable future. "In our operations, the boxes are learning to fly," promises Angela Titzrath, CEO of Hamburger Hafen und Logistik AG (HHLA). Considering that some quadcopters are already able to lift up to two tons (2.2 short tons), one is inclined to believe her promise.

All of these examples are just the beginning of a vertical mobility offensive. As the size of drones keeps growing, so do their possible uses. Prof. Dr.-Ing. Tim Hosenfeldt, Senior Vice President Technology, Strategy & Innovation at Schaeffler, is convinced: "The future of urban mobility will increasingly be airborne." At a congress about urban mobility concepts of the future, the Schaeffler expert described the wide range of possible applications: from delivery services, medical care and interurban mobility all the way to motor racing (see also infographic on page 84).

Democratization of vertical mobility

Vertical mobility has already become reality today in megacities such as São Paulo, Mexico City, London, and New York – with helicopters. However, only the

» The future of urban mobility will increasingly be airborne

Prof. Dr.-Ing. Tim Hosenfeldt,
Senior Vice President Technology,
Strategy & Innovation

wealthy can afford this convenient, congestion-free, and thus punctual service. Drones may help democratize this form of mobility. Mobility services provider Uber expects initial costs for Uber Air drone taxis to amount to 5.73 dollars per passenger mile with a mid-term target of 1.86 dollars and ultimately 0.44 dollars, which would roughly amount to the costs of a passenger mile in a privately owned car. Porsche Consulting has costed some routes for Hamburg such as a drone flight from the airport to the city's new landmark, the "Elbphilharmonie" concert hall. The result: 30 euros for 12 kilometers (7.5 miles) on a 30-minute flight – faster and cheaper than the ground-bound taxi competition.

Drone technology fascinates political leaders

These figures almost sound like bargains not to be missed, so the question is when drones in passenger and freight transportation will actually get off the ground. "We expect the breakthrough in 2025," says Schaeffler expert Hosenfeldt. Sebastian Thrun, a long-standing Google VP and Fellow, and current CEO of air taxi startup Kitty Hawk, is convinced that "in a few years' time, this will be the hottest topic on the planet." Such predictions are supported by the large-scale efforts currently being made to vigorously drive the technology forward. Established companies in the aviation sector like Airbus, Bell, and Boeing or startups such as Lilium, eHang, Kitty Hawk, and Volocopter are at the ready and political leaders provide tailwind. On the occasion of the Airbus flying taxi presentation, German Transport Minister Andreas Scheuer was almost euphoric: "We want to take drones and flying taxis out of the laboratory into the air – in the spirit of Germany as a strong place for innovation." His Austrian colleague, Norbert Hofer, verbally goes full throttle as well in expressing his hopes for Austria to be among the first countries to see drone taxis



Fast and efficient: drones are already used in delivery operations and in the future will even be operating with large (albeit empty) containers suspended from them



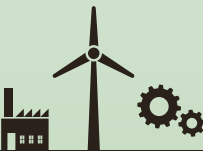
Drones picking up **cargo or passenger boxes of the Schaeffler Mover** and taking them from A to B even faster: this is how the supplier can imagine an interlinking of vertical and horizontal mobility.

SWISS ARMY KNIFE OF MOBILITY

Drones are fast, agile, safe-in-flight, and available in diverse sizes and price ranges – which makes them extremely versatile.

INDUSTRIAL APPLICATION

- Cargo/intralogistics
- Inspection
- Observation
- Mapping



URBAN MOBILITY

- Super-fast commuting
- Tourism
- Interlinking of horizontal and vertical transport
- Airport-to-city flights
- Rescue services



INTERURBAN MOBILITY

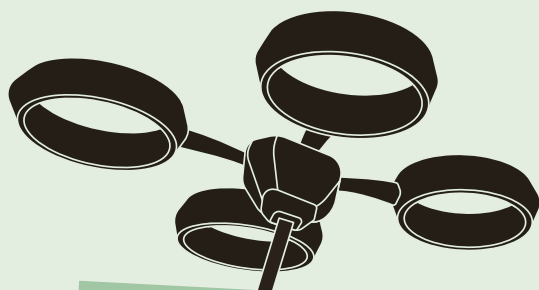
- Domestic flights
- Charter flights
- Cargo transport
- Disaster relief



FORMULA AIR RACING

- Drone racing series
- Marketing
- Research and development





1,000 flights

were cancelled at London's Gatwick airport in 2018 shortly before Christmas **due to an intrusion of drones into the airspace.** More than 140,000 passengers were affected.

15 million

flight hours: **worldwide, urban airspaces are expected to account for this number by 2035:** 3 billion by 2050, and 12 billion by 2070.

Source: "Urban Air Mobility Study Report 2019" by Horváth & Partner

23,000

drones or similar **unmanned aerial vehicles could be produced by 2035.** The numbers will massively increase by 2050 (3 million) and 2070 (7 million).

Source: "Urban Air Mobility Study Report 2019" by Horváth & Partner

flying through the cities. The competition is fierce, as vertical mobility projects are being launched in as many as 50 cities around the globe.

The vigorous enthusiasm displayed by legislators fuels the fantasies of drone companies for good reason: without the necessary legal frameworks urban airspaces will remain off limits. Lilium CEO Daniel Wiegand cautions: "The technology is not our problem. Rather it's the things we're not in control of ourselves, such as aviation rules and the development of the new infrastructure with takeoff and landing stations."

Whether local politicians, environmental organizations, and residents of the "droned" cities share this

euphoria is at least questionable. The airspace in densely populated urban areas is particularly critical. Noise pollution and environmental protection are equally sensitive subjects as the aspect of safety. Nobody wants to see congested airspace on top of the traffic jams on the roads below and definitely no aerial vehicles crashing over bustling neighborhoods. Respondents to a survey conducted by the University of California, Berkeley, expressed serious concerns when asked about aspects like safety, noise, and invasion of privacy. The thought of putting one's fate into the hands of an autonomously flying machine evokes ambivalent feelings as well. Moreover, the majority of the respondents felt that passenger flights with drones made more sense in interurban than urban travel.

Schaeffler leverages expertise

In order to prevent accidents, the technical requirements to be met by the unmanned aerial vehicles are extremely high as well, which is an advantage for Schaeffler. "We've been active as a supplier to the aerospace sector for four decades and are certified accordingly," says Hosenfeldt. "This facilitates our access to the expanding market of drones." The company's experience in the Formula E electric racing series is valuable as well, particularly in the area of heat development. Manufacturers struggle with this issue time and time again during test flights, up to and including damage caused by fire. Hosenfeldt: "In Formula E, we've been gathering important experience also in the area of thermal management because in racing the drive systems we've co-developed have to deliver maximum performance and resist the resulting loads for extended periods of time."

Schaeffler is currently engaged in discussions with various manufacturers. The people at the technology group can imagine supplying complete propulsion systems in addition to bearings, electric motors, and power electronics. And why not let passenger or cargo boxes of the Schaeffler Mover urban and autonomous mobility concept become airborne with drones? As the saying goes in the industry: "The sky is the limit."



THE AUTHOR


When mobility and technology journalist Carsten Paulun is stuck in traffic he sometimes wishes a drone would pick him and his vehicle up and fly them to their destination. Fearing that noise and costs may

prove to be the greatest challenges posed by vertical mobility, he wouldn't want to see an isolated jet set high society buzzing above his head.

PLEASANT PROSPECTS?!

The challenge to Africa: A young tech-savvy generation is surging ahead, aiming to change Africa's image of a backward continent. However, large hurdles remain.

— by Claudia Bröll

A young woman with dark hair in a bun, wearing a grey and white sweater and blue jeans, sits on a yellow patterned blanket on a rocky ledge. She is holding a yellow and black cup and looking out over a vast cityscape (Cape Town) and the ocean under a clear blue sky. A camera and a black bag are on the blanket next to her.

A view of the South African metropolis Cape Town; besides tourism and financial services, information technology is one of the region's major economic sectors

— Peter Kariuki was 11 years old when he taught himself to code. In his village in Kenya, the internet was unknown at the time. Most of the villagers not even had access to the power grid. By chance the son of small farmers met an IT student at a copy shop, who was the first person to talk to him about computers. His enthusiasm was instantly inspired, says Kariuki.

The young boy printed out 400 pages of a C++ programming guide on his uncle's creaking printer and got started. Today, the Kenyan is 25 years old and co-founder of SafeMotos, a kind of Uber for motorcycle taxis in Rwanda. The startup is so successful that it's been attracting international attention. Its current statistic reflects 600,000 trips – and SafeMotos keeps growing.

Kariuki is a perfect example of the young generation of entrepreneurs that's surging ahead in many places of Africa. They're well-educated, full of zest for action, with a contagious kind of optimism. Kariuki's generation is no longer willing to accept Africa's image of a backward continent: "The future is African," he says.

The power of youth

The forecasts of the global population development prove him right. Four in ten people in the world will be living in Africa by 2100, according to United Nations estimates. Even at this point, the continent has the world's youngest population. In 2015, 226 million people in Africa were between 15 and 24 years old. By 2055, this number is likely to have doubled.

The population growth goes hand in hand with increasing migration from rural to urban areas. New megacities are developing, which entails enormous



» *The future is African*

Peter Kariuki,
Young mobility entrepreneur

socio-economic challenges to the continent, as well as business potential. Technological progress plays a key role in Africa's future: The industrial revolutions of the past largely bypassed Africa. South of the Sahara, only South Africa has seen an appreciable industrial development.

Today, renewable energies, the internet, and mobile telecommunications offer opportunities also in the remainder of Africa that would have been inconceivable just 20 years ago. According to Dianna Games, CEO of business consultancy Africa@Work in Johannesburg, particularly the young population in Africa is pushing for modern technology and innovations.

Development leaps instead of steps

Leapfrogging is the keyword, skipping development levels: from chaotic share taxis to app-based local public transportation, from smoking kerosene lamps to households supplied with solar energy, from traditional farmers' markets to online shops modeled on Amazon.

In some areas, Africans are even surging ahead of people in other parts of the world. The M-Pesa money transfer system enabling bank transfers via smartphones that was launched in Kenya in 2007 is a case in point. Millions of people use M-Pesa, not only in Kenya, but also in other African countries. In fact, 49 percent of Kenya's economic output is transacted via this system. A large proportion of Africans has no access to conventional banking services, but almost everyone has a smartphone. Ironically, Africa's backwardness provides

54 countries

make up Africa. Clearly higher is the number of languages spoken and ethnic groups, each exceeding 2,000 – from the Berbers in the north to the Khoisan in the south. During and after the colonial period little if any consideration was given to inter-societal compatibilities and incompatibilities when borders were drawn up, which has led to many conflicts on the heterogeneous continent that still exist today.

the greatest boost in some areas, according to Dianna Games. United Nations statistics reflect twelve percent of adults in Africa using a mobile bank account, compared with a worldwide average of two percent.

Be it in Rwanda, Uganda, Kenya or Nigeria – tech centers are emerging all over the continent. They’re called Silicon Savannah or, in the case of South Africa, Silicon Cape. Thousands of young software developers are working on solutions of how to move even the remotest corners of the continent into the 21st century. The push for innovation attracts venture capital companies, international corporations, and non-government organizations. “It’s not a market that’s easy to develop, but for companies like ours, Africa offers incredible opportunities,” says Prof. Rainer Lindner, Schaeffler’s regional CEO (see interview on the right).

A blessing and a curse: the Fourth Industrial Revolution (4IR)

But will the Silicon Savannahs and mobile app developers bring about the big upswing? Like in Europe, the digital age is moving forward in Africa. The Fourth Industrial Revolution is in full swing, for instance in South Africa’s automotive industry, and classic economic sectors such as mining and farming are experimenting with



4IR as well. However, as Dianna Games points out, most African countries are not prepared for 4IR, so the large number of jobs promised by Chinese infrastructural projects might in the end be lost to automation.

The educational system is one of the big hurdles since millions of children in Africa have no proper classrooms, no access to the power grid, and no computers, according to Games. Teachers impart factual knowledge to their students, but they’re not learning to develop ideas of their own. Governments in most of the countries are just beginning to address the challenges posed by a digital world, but far too little is happening outside the conference rooms. It’s not enough to view everyone in Africa as a potential startup entrepreneur. The continent needs a lot more innovations and economic activity in order to create jobs and policymakers have to establish the right conditions to support this evolution.

Rwanda as a role model

However, the first “champions” have emerged among policymakers as well: Rwanda, the scene of a brutal genocide only 25 years ago, is now regularly making headlines with new initiatives, from a telecommunications satellite of its own, the country-wide utilization of drones, expansion of internet capabilities, through to an innovation center in the country’s capital Kigali that’s intended to become a pan-African technology hub. Rwanda’s president, Paul Kagame, is chairman of the Smart Africa Initiative that aims to advance Africa’s digital economy.

Young mobility entrepreneur Peter Kariuki hopes that other countries will follow suit. In 2015, he and SafeMotos’ co-founder, Barrett Nash, deliberately chose Rwanda as their starting and learning base. However, they see larger potential elsewhere, planning to soon roll out the SafeMotos motorcycle app also in Kinshasa, the capital of the Democratic Republic of the Congo. In a city of 15 million where traffic is an absolute nightmare, a

4.1 billion

people might be **living in Africa by 2100**. Nigeria alone, which is as large as Texas, may have a population of 1 billion by that time.

Source: worldpopulationreview.com

29th place

Rwanda is ranked in the top spot of **list of Continental African countries on the Ease of Doing Business Index** regularly published by the World Bank. This puts Rwanda ahead of Spain, France, Switzerland, Japan, and others. However, seven of the ten countries with the poorest ratings are located in Africa as well.



African contrasts: a young businessman in Cape Town's Township and the business center of Rwanda's capital, Kigali, towering above a deprived area of the city

lot can be achieved, Kariuki feels. Even though transportation is just one of many issues on the continent, he's convinced that they can be tackled: "Problems facing the developing world will be solved by those staring out of windows and seeing problems; then deciding to do something."



THE AUTHOR

Shortly after Nelson Mandela's election as the first black president of South Africa, author **Claudia Bröll** went to the Cape for the first time. The African continent has captivated her ever since. Particularly the success stories of young entrepreneurs keep fascinating her. For eleven years, she's been living in South Africa and writes about the continent's economy.

3 QUESTIONS ...

... for Prof. Rainer Lindner, CEO of the Central & Eastern Europe/Middle East & Africa subregions of the Schaeffler Group.



What are Schaeffler's plans for Africa?

We want to extend and strengthen our commitment on the continent. The reason is that our previous activities are not in line with the opportunities that present themselves in Africa. By the end of the century, about 4 billion people will be living on the continent. There will be numerous

megacities such as Lagos or Cairo. This entails countless challenges in terms of food, mobility, infrastructure, and energy supply. We want to take part in and contribute our share to solving them.

Schaeffler's only production site for the automotive industry has so far been in South Africa. Is Schaeffler keeping an eye on the rest of Africa as well?

Absolutely. By 2030, the number of new cars sold in Africa can be expected to amount to 10 million, which are twice as many as today. Also, in the long run, several manufacturing hubs will emerge: in the southern part of Africa, in East Africa, and in North Africa. Wherever our customers have production sites we need to be present as well. Besides direct shipments to car manufacturers, the automotive aftermarket is an important business sector. However, we not only see opportunities in the automotive market but also in other

infrastructural areas: from rail technology, agriculture, energy supply, and oil production to road, bridge, and harbor construction.

Africa has been regarded as the world's last major growth market for a long time, but many national economies continue to be crisis-stricken. Even South Africa is unable to guarantee electric power supply by its own grid. When will the upswing come?

We shouldn't forget that Africa consists of 54 countries. If you want to be successful in Africa as a company, you need to pursue a focused approach, concentrating on specific markets, products, and customers. Our focus countries include Nigeria, Algeria, Morocco, Kenya, Ghana, and Ethiopia. In spite of the current electricity crisis, South Africa as a heavyweight on the continent is included as well. In addition, it's an important location with a long tradition for the German car industry.

AUTONOMOUS – BUT HOW?

Manufacturers, insurance companies, and accident researchers are dreaming of autonomous vehicles. Are drivers sharing this dream? What are the implications for our cities? And who will be liable for accidents?

— by Rita Cyganski, Kerstin Stark and Lars Kröger



— Automated driving is a trend going forward. Research scientists and engineers by and large agree that automated driving will make road traffic safer and more efficient. However, there's considerable discord about when a large-scale rollout – particularly in urban areas – of highly and fully automated vehicles will become feasible. Plus, there are many uncertainties concerning the effects on traffic, traffic demand and infrastructure, local residents, and the economy. The introduction of automated vehicles is closely linked to legal and technological challenges, and particularly to questions of social acceptance (see page 93).

Currently, most vehicles on the road are privately owned, so the extent to which private users are going to overcome their reservations about the new technology, and accept the costs of such vehicles, is a key question. Lack of confidence in the technology and its reliability,

privacy protection concerns, fear of control loss, plus the fear of sacrificing driving pleasure are examples of such reservations. Research has shown that an understanding of the technology and, above all, personal experiences with advanced driver assistance systems (ADAS), help enhance acceptance. Even so, the high public visibility and media presence of automated driving – perhaps also due to a certain disillusionment following initial reports of accidents involving self-driving vehicles – has not yet led to higher acceptance.

Autonomous but without driving pleasure?

The advantages of automation that respondents to surveys have primarily named include currently used ADAS functions for specific situations perceived as onerous – first and foremost, parking and traffic jam

THE 5 LEVELS OF AUTOMATED/AUTONOMOUS DRIVING

1. Assisted driving

- ▶ Full vehicle control by the driver
- ▶ The driver constantly keeps his/her eye on the traffic situation
- ▶ The driver is liable for traffic violations and damage
- ▶ Individual ADAS such as adaptive cruise control and lane keeping assist support the driver

2. Partially automated driving

- ▶ Full vehicle control by the driver
- ▶ The driver constantly keeps his/her eye on the traffic situation
- ▶ The driver is liable for traffic violations and damage
- ▶ In specific conditions, the vehicle will act autonomously (e.g. traffic jam assist, emergency braking)

3. Highly automated driving

- ▶ In clear traffic conditions (e.g. on highways) the car will operate autonomously
- ▶ The driver may temporarily turn his/her attention away from traffic but must be able to immediately take control again when prompted to do so by the system
- ▶ The driver is only liable if he/she fails to heed the system's prompt. However, one of the issues yet to be resolved is who will be liable if the system violates speed limits

4. Fully automated driving

- ▶ The driver is able to completely relinquish control
- ▶ Not liable as a passenger, but legal situation is still vague
- ▶ The vehicle handles trips on specific routes (e.g. on highways, in parking garages) fully autonomously, possibly even without occupants
- ▶ The system recognizes its limits early enough to achieve a compliant, safe condition

5. Autonomous driving

- ▶ The on-board technology masters even the most complex traffic situations on all types of roads, in all speed ranges, and in all environmental conditions
- ▶ All occupants are strictly (non-liable) passengers without any driving tasks; or the vehicle may operate without occupants
- ▶ Operators or manufacturers will be liable



In early 2019, VW launched test operations with five self-driving electric cars of the Golf model range in Hamburg. In order to be able to guide the vehicles with the necessary data, 37 traffic lights plus one bridge on the nine-kilometer (5.6-mile) test route have been upgraded to the tune of 21.8 million euros, which equates to 2.4 million euros per kilometer

assist systems. Going forward, the possibility of drivers turning their attention to other activities might enhance acceptance of autonomous vehicles, particularly for long-distance travel. However, the predicted improvements in terms of safety and traffic flow are contrasted by perceived sacrifices, for instance regarding the personal pleasures of driving: briefly stepping on the gas pedal on a clear country road without heeding the speed limit or crossing the center line in a speedy cornering maneuver – neither would be possible in autonomous mode.

The cost challenge

In the early stages, due to the initially high costs of fully automated mobility, the utilization of self-driving vehicles will likely be limited to car sharing fleets. They include both car sharing and ride sharing services, with a positive side effect: Various surveys predict a substantial decrease in private car ownership in urban areas in favor of smaller sharing vehicles. One of the challenges facing city governments will be to integrate shared mobility in ways that meet this objective without cannibalizing local public transportation systems. In rural regions, there's a lesser risk of this happening because automated services could complement local public transportation in more effective ways and thus even enhance its attractiveness.

In addition, cities will have to safely combine automated driving, be it individual or shared, with their existing traffic systems, in other words with a mix of

cyclists, pedestrians, as well as manually operated and partially automated vehicles.

Vehicle developers demand that a “smart” infrastructure supporting the vehicle's onboard sensors be established so that automated driving can be rolled out in an early development stage of the technology. However, the high costs this entails, as well as interventions with public space and cityscapes, pose a problem to such transitional solutions.

Cities could mitigate the aforementioned issues by allocating dedicated lanes to automated vehicles. This, however, would be the worst kind of news for urban societies because the separation would considerably impair the freedom of movement particularly for pedestrians and cyclists, and revive the idea of the car-friendly city believed to have become obsolete.



THE AUTHORS

Rita Cyganski, Kerstin Stark and Lars Kröger investigate the subject of automated driving at the German Aerospace Center (DLR) with

a primary focus on questions relating to user acceptance and utilization, implications for mobility behavior in general, car ownership, and the overall traffic system.

DATA, ETHICS, AND HACKING

Autonomous driving raises a whole host of questions. Even though numerous answers are still lacking around the world, at least some recommendations exist.

ETHICS

If an accident cannot be avoided, for instance on a narrow street, how will the system decide whether to hit the child that suddenly runs into the street or the two senior citizens engaged in a conversation at the curb? The Ethics Commission of the German Federal Government says that “any qualification according to personal characteristics is strictly prohibited.”

LIABILITY

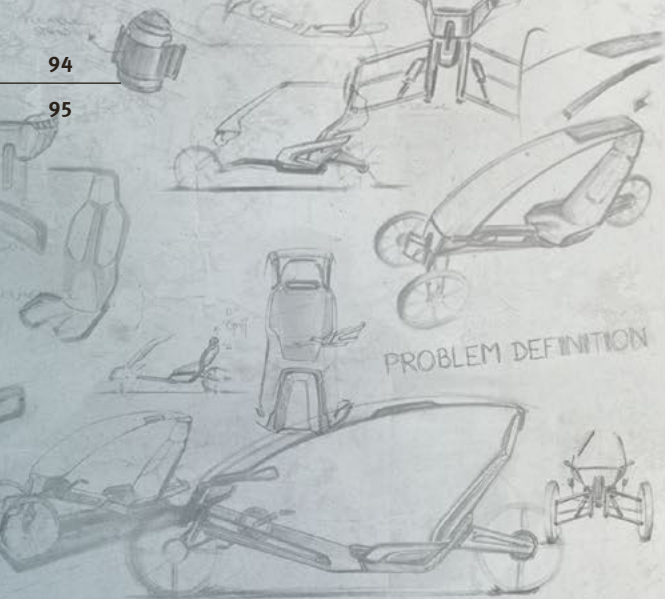
Who will be liable in an accident if the vehicle was traveling autonomously? There are no binding regulations for this yet. However, insurance companies like German Allianz see liability resting with the vehicle owner, irrespective of who's at fault. A technical defect would be an exception to this rule. In this case, the manufacturer's product liability would apply.

DATA PROTECTION

Who owns the data collected during a trip? And what will happen to it? In Europe, the General Data Protection Regulation (GDPR) applies. All data may only be collected for a specified purpose and not be processed or transferred without the driver's permission.

HACKING

Autonomous vehicles will become targets of hacking attempts. “Consequently, we must accept,” says IT security expert Marcus Völp from the University of Luxembourg, “that attackers will find gateways and hack cars. This means that we need systems that are capable of responding in real-time and restoring themselves while being attacked.”



ABOUT A CAR THAT ISN'T A CAR

The Bio-Hybrid is more than a vehicle somewhere between a bicycle and an electric car – it's the missing link in future micromobility. From the end of 2020 on, the e-bike on four wheels is supposed to do no less than revolutionize urban transportation.

— by Björn Carstens, Roland Löwisch and Volker Paulun

By taxi the trip from the central station in Nuremberg to the headquarters of the young Schaeffler Bio-Hybrid GmbH takes ten minutes. The address is part of a former factory building: vintage red brick behind which people are busy designing mobility for tomorrow. The vehicle that everything in the modernly furnished facilities revolves around is omnipresent: as a model, as a full-scale prototype, as a drawing, and on monitors – a four-wheel pedelec with a roof. A mobility concept that still requires its drivers to pedal but that assists them with a 250-watt electric motor and provides the luxury of weather protection. A vehicle for which no driver's license is necessary and that's slim enough to travel on bicycle paths. A vehicle of a kind that doesn't exist yet. To get the novelty rolling, the startup with its still small current staff of 15 is tackling three challenges at once: building an independent business, getting an all-new vehicle concept off the ground, and establishing a new market segment.

Challenge 1: building an independent business

Bio-Hybrid? Vehicle? Schaeffler? Wait a minute. Since when has the giant in the supplier business been building complete vehicles? This would indeed be an absolute first – with far-reaching implications that raise a number of questions such as: What about a consumer-focused sales and support network? How can people's enthusiasm be inspired for an attractive product with lifestyle appeal? Neither of these have answers that really fit a company with 92,500 employees that's used to manufacturing product volumes in the 100,000 or million range, serving customers up to and including large conglomerates. By contrast, the mid-term plan for the Bio-Hybrid targets a production volume of "only" 10,000 units per year.

Consequently, as the idea was maturing, it became clear that the 4-wheel pedelec would have to get off the ground elsewhere – in spite of having been born under the Schaeffler umbrella. Still, the people at Schaeffler did not want to entirely part with the Bio-Hybrid because, as a lighthouse project for the company's pursuit of mobility for tomorrow, they'd become fond of it. The solution was to form a startup: Schaeffler Bio-Hybrid GmbH. "Actually, it's more of a spin-off than a startup because we've emerged



Bio-Hybrid employees Patrick Seidel, Josef Hackner, and Dr. Simon Opel are working with a passion on getting their innovative pedelec ready for market launch

from within the Schaeffler Group," says Jakub Fukacz, who's responsible for PR and Marketing. The communication pro's enthusiasm for the Bio-Hybrid project is instantly obvious when he welcomes us and then takes us on a spirited tour of the offices the startup has just moved into. An office area on the premises of the Schaeffler Group's headquarters in Herzogenaurach was no option, as Fukacz explains: "We want to get a vehicle for urban mobility off the ground and that can best be achieved in an urban environment." The parent company supports the process of cutting the cord so that the Bio-Hybrid idea can come to full fruition. "We have to communicate our own messages and ideas, address different target groups," says Fukacz. It's about communicating in other ways – more emotionally. The informal style in which Bio-Hybrid GmbH addresses visitors and prospective customers on its website and in social media is hard to imagine at Schaeffler, but has been deliberately chosen by the startup.

In addition to the Bio-Hybrid product, it's necessary to get the startup company itself off the ground: structures and processes have to be put in place, work-flows defined, work schedules established. "Doing your job as an employee in an existing environment totally differs from building this environment from scratch," says Gerald Vollnhals, CEO of the young limited liability company. "That alone would be an all-day challenge, but we more or less handle it on the side." Rolling up your sleeves and taking action: the spirit of a startup!

Vollnhals is a startup pro, who launched his first business while he was still studying for his degree. In addition to fiber-optic networks and "Immobilien Scout," an online real estate platform, in 2009 he started a company for electric scooters that was responsible for the electrification of the German cult moped

Schwalbe. Meisterwerk Ventures, which is active in the field of medical device technology in Berlin, complements the portfolio of his business biography. So now it's Bio-Hybrid. Vollnhals is an electric mobility enthusiast and has traveled a distance of 14,000 kilometers (8,700 miles) in his

400 euros

per month is the average cost of ownership for a small car used as a delivery vehicle – up to ten times more than for a cargo bike.

6 km/h (3.7 mph)

is the average speed of automobile traffic in Mexico City.

native Munich propelled by electric power. He's convinced: "There's no faster and better way to get from A to B in a city than by using an agile electric vehicle."

Challenge 2: getting a new vehicle concept off the ground

The history of the Bio-Hybrid starts in the parent group in 2014. The challenge to be mastered back then and today: taking urban mobility to a new level. How can gridlock be prevented in growing cities? What does personal mobility look like, going forward? The answer the innovation drivers at Schaeffler come up with is an electric bicycle with weather protection and stowage space like the Renault Twizy, albeit without dependency on a charging column infrastructure and with greater agility in reduced-traffic areas. Voilà: the Bio-Hybrid. After countless discussions with government authorities, engineers, and potential consumers, it was clear: we're going to pull this off. The key aspect in pursuing the project was to avoid a cardinal error that's apparent in vehicles of similar categories: their rather plain and pragmatic look. "We found at the time that lifestyle and stylish design are important to people in the context of innovative mobility concepts. An all-new field for Schaeffler," admits Bio-Hybrid chief strategist Patrick Seidel. For this reason the team enlists support for initial designs from a design school in Graz, Austria, early on. Finally, at a congress in April 2016, the first concept vehicle sees the light of day in the mobility world. "An emotional experience," Seidel says, still filled with obvious enthusiasm today, even though not everything was perfect yet at the time. Since then, the megaproject has been picking up momentum and arrived

» Our production target is a minimum of 10,000 units per year and we're convinced that this business potential exists

Gerald Vollnhals,
CEO

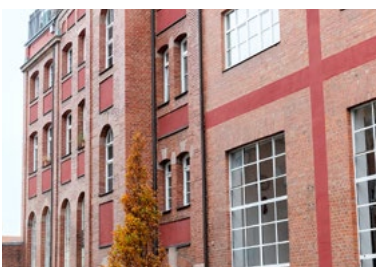
at the offices in the heart of Nuremberg – albeit far from having crossed the finish line. At least, though, a cargo version with high versatility has by now joined the original model for passenger transportation. At the beginning of 2019, the non-identical twins made their world debut as near-production prototypes at CES in Las Vegas, the world's leading innovation show.

Due to the Bio-Hybrid's uniqueness, almost every component is purpose-built, featuring a mix of passenger car and bicycle technology that in this respect combines the best from two worlds as well. Some of the required components can be picked from the diverse Schaeffler shelves, which is helpful. Others have to be supplied by external specialists. "We're still in the process of exploring options," says production manager Josef Hackner. In considering them, Hackner constantly liaises with his colleagues, including Dr. Simon Opel, who is responsible for development. In his specifications, Opel has underlined a particular word in bold font: safety. Fully laden, a Bio-Hybrid tips the scales at 300 kilograms (660 pounds), so it has to be strong enough to support this load. Although crash tests are not officially prescribed for pedelecs – and



START-UP WITH DEDICATED CORPORATE DESIGN

At the end of 2017, Schaeffler Bio-Hybrid GmbH saw the light of day in the startup world. Although its "parent" is still part of its name, the young company operates autonomously and flexibly – with its own look & feel. That the team has ready access to the technology expertise of the Schaeffler Group is a major advantage.



**Length/width/height:**

2,180 (2,595*)/855/1,530 mm.
7.15 (8.51*)/2.8/5.0 ft.

*Cargo

Muscle power paired with electric assistance:

Two electric motors on the rear wheels deliver output of 250 watts. Top speed (electrically assisted): 25 km/h (15.5 mph)

Display or hooked-up smartphone:

Wi-Fi, GPS, Bluetooth and 4G turn the Bio-Hybrid into a digital platform.

The tires are custom-made. Rim size: 24 inches.

The purpose-developed battery

offers 50 km (31 mi) of range (100 km (62 mi) with second battery).

Styling is a key consideration for the Bio-Hybrid.

the Bio-Hybrid belongs to this category – Simon Opel has extensive simulation tests run on the computer. Offset impact, vibration tests, vehicle dynamics, curb crossings, and stress tests of individual components: every element is put through its paces countless times. In this respect, the Bio-Hybrid is more of an automobile than a pedelec. “As a Schaeffler subsidiary, we have a responsibility. We have to put safe vehicles on the road,” says Opel. The Bio-Hybrid is intended to clearly stand out from the competition as a benchmark both in terms of technology and quality. The team doesn’t mind that, consequently, the vehicle it’s pinning its hopes on may hit the market a little later than the competition. “Quality is more important than speed,” Opel promises.

Challenge 3: establishing a new market segment

The third playing field on which the Bio-Hybrid squad has to prove its prowess is introducing this new vehicle category to the markets. Secretly, its makers are hoping that “Bio-Hybrid” will become no less than a synonym for this vehicle category – like “Kleenex” for tissues or “Pritt Sticks” for glue sticks. But where are the markets? What customer segments could/should be targeted? Strategist Patrick Seidel points out: “To achieve the

targeted production volumes, the Bio-Hybrid shouldn’t address a niche group, but a broad customer segment: hotels and delivery services, sharing companies, tradespeople or commuters. This is also the reason behind a Passenger and a Cargo version.” The Bio-Hybrid is planned to embark on its success journey initially in Europe, logically and preferably in big cities suffering from congestion, and primarily serving the business-to-business segment. This has the advantage of facilitating sales and support, which can be managed more centrally in this way. For the business-to-consumer segment, a close-knit network has to be established first. Initial ideas for this already exist as well. Half of the car dealerships contacted in a survey indicated that they could imagine selling the Bio-Hybrid. However, its makers are receptive to sales and support partners also from other sectors and are even actively looking for them.

Pricing is another key aspect. The price is oriented to the competition,” says CEO Vollnhals. “Electrified cargo bikes today cost between 8,000 and – with integrated cargo boxes – 15,000 euros. The Bio-Hybrid is planned to be priced in between.” In return, the customer will receive an innovative vehicle featuring sophisticated technology and styling that easily connects with digital worlds. Plus, on request, the car that isn’t a car will even be fitted with doors.

MASTHEAD

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Schaeffler Communications

Thorsten Möllmann (Senior Vice President Global Communications & Branding)
Martin Mai (Head of Newsroom, Global Editor-in-Chief Schaeffler Group)

Executive Editors

Volker Paulun, Stefan Pajung (Deputy)

Coordination

Carina Chowanek, Jana Herbst,
Julia Schneider

Pre-press Stage

Julien Gradtke, Mathias Mayer,
Diana Schröder

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Authors

Wiebke Brauer, Christoph Brix, Claudia Bröll, Björn Carstens,
Rita Cyganski, Denis Dilba, Kay Dohnke, Lars Kröger, Christane Link,
Roland Löwisch, Carsten Paulun, Kerstin Stark, Lorenz Steinke,
Christel Trimborn, Alexander von Wegner, Leopold Wieland

Editor-in-Chief

Martin Mai

Editorial Team and Production

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Copy Editors

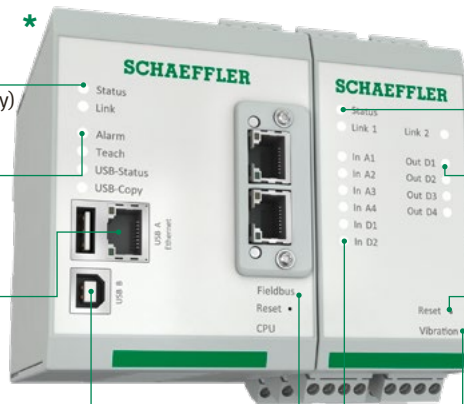
David Feist, Volker Hummel,
Christoph Kirchner, Martin Knopp

Graphic Design

Manuela Mrohs (AD),
Gökhan Agkurt,
Ivo Christov, Janina Roll,
Mariessa Rose,
Julian Schmaljohann,
Thomas Wildelau

English Translation

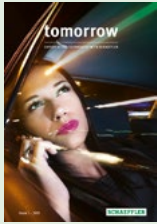
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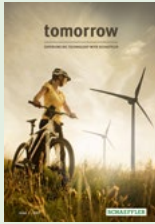
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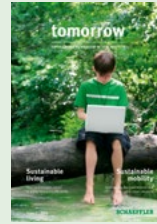
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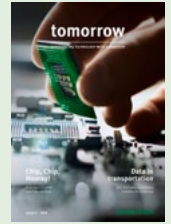
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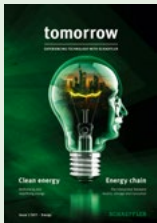
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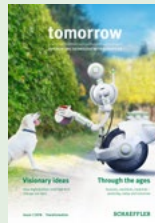
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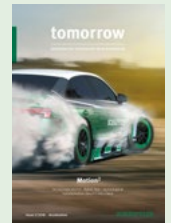
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