



tomorrow

Experiencing technology with Schaeffler

Moving forward!

How technology and creativity
propel us into the future

Op|por|tun|ity; - [ɒpəˈtjuːnɪti]

[1] Possibility of action

[2] A lucky occasion

Source: Opportunity, 2020 in WordReference.com
Retrieved August 13, 2020 from <https://www.wordreference.com>

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Dear Reader,

The corona virus confronts people around the globe with major challenges. This is also true for Schaeffler – both in terms of business and people. Many of our employees are at home in countries that have been particularly affected by the pandemic. The corona virus poses a new risk to us. It attacks not only our health, but entails a lot of restrictions in areas that actually make life worth living. It has been keeping students out of schools and children out of childcare centers. It has been separating grandchildren from grandparents, friends from friends, athletes from sports facilities and moviegoers from theaters. Needless to say, the consequences of the pandemic also pose a threat to prosperity on a global scale. I hope that you have mastered all the challenges corona has brought into your everyday life so far and that you'll continue to do so.

What has touched me personally and all of us very much over the past few weeks and months is the great solidarity among people and the will to jointly put an end to this pandemic in all parts of the

world. We have to – and should – be confident that we'll succeed in this effort. Plus, we're seeing some positive signs that we're going to recover from this crisis with new vigor: Because the pandemic has clearly exposed systemic strengths and weaknesses. Because we've become sensitized to what's important – and to what may not be. The process of making the relevant readjustments has already begun.

“Crisis as opportunity” is the optimistic central theme of this issue of “tomorrow” – and at Schaeffler. For instance, in an interview starting on page 68, our Chief Operating Officer Andreas Schick, explains how Schaeffler has kept supply chains and manufacturing operations running during the pandemic, what long-term effects corona will have on globalized processes and how we have to respond. Clearly, especially in turbulent times like these, the reliable operation of machines is an important basis for stability of supply and automated condition monitoring is the best protection against undesirable downtimes. Read more on this starting on page 56.

I can only agree with Microsoft's CEO Satya Nadella saying: “We've seen two years of digital transformation in two months.” Cobots, medical robots, telecommuting, trade shows and e-sports are relevant keywords in this issue of “tomorrow.” Honing the interaction between science and business can help accelerate all of these technologies, which is another topic in this issue. And where research and technology fail to move us forward, we can still pin our hopes on chance finds, which have resulted in quite a few inventions. The inspiring story about serendipity starting on page 36 is another read I'd like to recommend to you and hope you'll enjoy.

Stay healthy and keep the faith

Klaus Rosenfeld
Chief Executive Officer

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A glimpse of the world



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Global

A glimpse of the world

Looking deep into boundless expanses

When looking to the stars and exploring planets, black holes and other distant celestial bodies, the first thing to do is find a high vantage point. Nowhere else in Europe is the night sky as dark and clear as it is when viewed from the Roque de los Muchachos ridge on La Palma which rises to a height of almost 2,500 meters (8,200 feet) and offers professional stargazers ideal research conditions thanks to the Atlantic island's extremely low levels of light pollution. This remote location is home to a dozen impressive observatories offering astronomers and astrophysicists from different countries an infrastructure found almost nowhere

else in the world. Of the various observatories located on the Roque de los Muchachos ridge, the Gran Telescopio de Canarias (GTC) shown here stands out the most: With 36 reflectors and a diameter of 10.4 meters (34 feet), the silver-colored steel structure is one of the world's largest reflecting telescopes. Opened in 2009 at a cost of 80 million euros and weighing around 300 metric tons (330 short tons), the GTC has already spotted more than 2,000 planets and discovered distant galaxies. Now new high-precision solutions from Schaeffler (see box on the right) are intended to make this view of the universe even sharper.

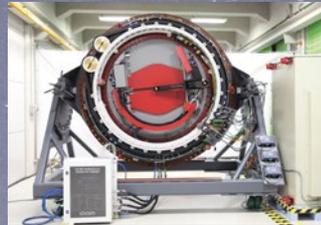
»» *I'm astounded by people who want to 'know' the universe when it's hard enough to find your way around Chinatown*

Woody Allen, American actor and director

Schaeffler's know-how for the view into space

Schaeffler Iberia contributed its specialist engineering expertise in the field of industrial drives and was involved in developing an instrument rotator for one of the GTC's focal stations, known as the Cassegrain Focal Station (CG-Set).

The instrument rotator is an important high-precision mechanism in the telescope and controls the focal tracking and rapid positioning system that rotates the two-ton telescopic camera with outstanding evenness throughout the entire observation in order to ensure its perfect alignment with the heavens from start to finish. IDOM, a Spanish company providing engineering and architecture services, was commissioned to develop this new CG set. Due to the positive experience during its long-standing collaboration with Schaeffler Iberia in various projects, IDOM decided to involve Schaeffler in the development of the instrument rotator drive. **In this specific case, Schaeffler's special drive solution not only had to ensure highly dynamic yet even camera guidance, it also had to feature a compact and lightweight design.** Therefore, Schaeffler developed a segmented, slotless RMF torque motor (pictured). Due to this design, it is easy to transport, install and service, and also operates in a very energy-efficient way. Its special feature: the motor with a diameter of more than two meters (6.5 feet) is a proven drive concept from the field of machine tools that was adapted and built for a telescope.



360°

Facts, figures, oddities – a 360-degree view of the focus topic of this issue of “tomorrow.”

Opportunities



Small worlds

What will happen when living in this world becomes too uncomfortable? Emigration to Mars (see page 74)? Just Open Architecture, an architectural studio in Rotterdam, has a different idea that envisions shifting living spaces into **self-sufficient mini-worlds**. A utopian concept? That’s at least what the architects hope, because the project tellingly billed as The Post Anthropocene is designed to draw attention

to current “pain points” of urban living spaces such as waste pollution, energy squandering, smog and the looming threat of flooding which must be dealt with before such mini-worlds become an inevitable necessity. A statement about the project cautions: “If we continue raging on our planet, the natural reaction force will push us to adjust, which results in new architecture types.”

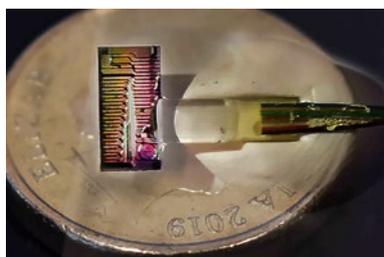
Unbreakable



Resilience is a frequently used word in the corona crisis. Fittingly, **the most resilient material the world has seen so far has been born into this period. Its name is Proteus**, taking cues from a particularly adaptable Greek god. Its parents are scientists from Durham University in the UK and the German Fraunhofer Institute for Machine Tools and Forming Technology IWU, who modeled the material on the robust skin of grapefruits and the extremely sturdy shells of mollusks. Proteus has only 15 percent of the density of steel, which makes it extremely lightweight. **The new miracle material consists of tiny ceramic balls embedded in a cell structure of metal foam. In contact with a cutting tool, it reflects the impacting force and even causes the tool to become blunt.** Protective clothing or bicycle locks are potential applications of the new material.

44.2 terrabits/s

Australian research scientists have achieved this record data transmission speed by using a newly developed chip named Micro-Comb that's able to transmit the same number of light-wave lengths as 80 individual lasers before it. The result is impressive data speed that's 44,000 times higher than the speed of current internet connections – at favorable prices. Low costs are a major advantage in increasingly close-meshed data networks with more and more nodes for which the chip is intended, making it precisely the right tool for the digital boost caused by corona.



Fast response

To further enhance the protection of its employees worldwide, Schaeffler produces its own disposable face masks at the Taicang plant in China – around 34,000 per day. **Within just a few weeks, the colleagues from Schaeffler's special-purpose machinery engineering (SMB) unit planned and launched a fully automatic production line.** The central element of the line is an ultrasonic welding machine that has been modified to meet Schaeffler's specific requirements.



Words to remember



»» *I'm normally not a praying man, but if you're up there, please save me, Superman!*

Homer Simpson

»» *Success consists of getting up just one more time than you fall*

Oliver Goldsmith

»» *Difficult roads often lead to beautiful destinations*

Hilary Hinton "Zig" Ziglar, american author

»» *Walk on, walk on – with hope in your heart – and you'll never walk alone*

From the stadium anthem "You'll never walk alone" by Gerry & The Pacemakers

»» *Those who act while others are still talking are a great step ahead in life*

John F. Kennedy

309

Innovation entries submitted by automotive suppliers competed for the coveted accolades in the AutomotiveINNOVATIONS Award 2020 – and honors went to just a few of them. The victorious technologies that won recognition for their future technical relevance and received feedback from automakers include **Schaeffler Paravan's Space Drive drive-by-wire system: The digital driving and steering system was recognized in the "Automated Driving and Advanced Driver Assistance Systems" category.** The only road-approved multi-redundant drive-by-wire system that originated in the area of mobility solutions for people with disabilities is now increasingly being used in other areas as well including motorsport (see article starting on page 84).

140 kW

of power output is said to be produced by the energy island invented by the German company Sinn Power. **The floating platform with a size of 12 by 12 meters (40 by 40 feet) not only converts wind and solar energy into electricity but also uses the power of the waves** that set the floating elements in motion. For larger power demand, several floating platforms can be interlinked as a modular system.



Learn more:
Industry Solutions,
Renewable Energy,
from Schaeffler

Bridge of hope

For Italy that was hard-hit by the corona pandemic, it was more than the official opening of a new bridge – it was a symbol of rebirth, a symbol of hope. The painful gap left in Genoa’s cityscape by the collapse of the Morandi Bridge two years ago that cost 43 human lives has been closed again **by a huge civil engineering feat**. Some 1,000 workers in three-shift operations labored 24 hours a day and seven days a week to close the gaping wound as soon possible, even when all other construction sites in the country were at a standstill due to corona. As a result, the construction period was reduced to less than ten months. Plenty of self-reliance and minimal bureaucracy – many Italians would like to see the “Genoa” model catch on.



In several days of load testing, as many as 50 trucks with a total weight of 2,500 metric tons (2,750 short tons) would cross the bridge at the same time



Learn more:
Bearing technology
from Schaeffler in
bridge construction

Playing hardball with product pirates

During the corona pandemic news of fake masks being sold caused additional concerns. Counterfeiters not only circulated pirated masks but also falsified safety certificates. The problem of product piracy is nothing new but keeps growing. The OECD estimates the resulting worldwide damage to amount to some 250 billion dollars per year, not even counting products sold on the internet. Counterfeiters have also repeatedly been targeting products from Schaeffler that are highly valued by customers. Since 2004 the Brand Protection Team has been pursuing suspected cases in concert with customs and other government authorities and developing systematic protective actions. Every year, Schaeffler checks hundreds of suspected cases reported by the company’s proprietary OriginCheck app. The app enhances the ability of distributors and end users to assess their sources of components, which are frequently safety-relevant, and increasingly assists in tracking down suppliers of fakes.





My Home is my Office

The corona pandemic has changed the world. And the world of work will not be the same anymore either. It'll increasingly shift into our own four walls.

By Oliver Jesgulke

Hand sanitizer dispensers are placed at entrances. Large signs provide rundowns of the most important rules of hygiene and behavior. Social distancing decals are pasted around cafeteria floors and acrylic glass shields are attached to desks. Millions of workers are currently experiencing their return to the office in this or similar ways. That is, if they return. Twitter recently created a buzz: The San Francisco-based microblogging and social

networking service gave its roughly 5,000 employees the option of either coming back to the office or continuing to permanently work remotely. "So if our employees are in a role and situation that enables them to work from home and they want to continue to do so forever, we will make that happen," Jennifer Christie, Vice President, People, wrote in the company's blog in mid-May. Silicon Valley neighbor Mark Zuckerberg sees working away from the office as a long-term

trend as well. Facebook's founder expects half of his staff to be working remotely in the next five to ten years. Even so, he feels that the company office will continue to be an indispensable connecting link of business life.

BMW's works council chairman Manfred Schoch doesn't advocate eliminating employee presence at the office either, but would like to clearly reduce it. Two or more days of working from home per week would be desirable, says the representative of the carmaker's employees, and not just at BMW, but generally. "Companies have to recognize that they should no longer commit their employees to a fixed location," Schoch said in an interview with the German news magazine Der Spiegel. "We should take advantage of the crisis to make this new form of mobile work the social standard."

The beneficiaries of remote work

When it comes to discussing the topic of working from home, there's one issue that's inevitably tabled: employee productivity. For a long time, lack of productivity was deemed to be a popular killer phrase that managers opposed to extensive remote-working arrangements would use. However, the experiences gathered during the initial corona months have shown that, on balance, such arrangements are panning out well, and even better than expected.

In a 2019 survey conducted by the German Institute for Economic Research (DIW Berlin), 40 percent of the respondents felt that they were less productive in their own four walls than at the office. Only one in ten judged their remote work performance to be better. A poll by the Fraunhofer Institute for Industrial Engineering IAO launched in corona times in April 2020 and published in May showed a changed picture: Nearly 40 percent of the respondents felt "significantly more productive" at home. Almost 15 percent even rated their productivity as "substantially higher." Another 25 percent viewed themselves as slightly more productive. Only one in four rated themselves worse than at the office, which, besides distractions caused by family-related circumstances, was also due to a lack of technical prerequisites and direct exchange with colleagues as well as clients or customers.

In both areas, corona proved to be a transformation turbo. "The corona crisis will substantially change the way we work. The reservations many people used to have about working from home but also about video conferencing and other means of communication have been dispelled," says Dieter Spath, Director Fraunhofer IAO and President of the German Academy of Science and Engineering (acatech). And he adds: "That's why we've come to realize that the expansion of digital infrastructure is of enormous importance; we urgently have to make progress in this area. After all, digital technologies have not just enabled us to work, but also – in spite of physical distancing – to sustain our social contacts. We can tell that businesses, schools and even government authorities that increasingly invested in digitalization in the past are more resilient in the crisis. We need to learn from this."

70 %

of the employees concerned are hoping for more generous remote work arrangements after the end of the corona crisis.

Source: Bavarian Research Institute for Digital Transformation



20 %

is the rate by which office rental fees might drop in big cities like Frankfurt, Paris, Vienna, Lisbon and Milan if the remote-work trend should continue in post-corona times. This is precisely what the German Economic Institute (IW) assumes will happen.

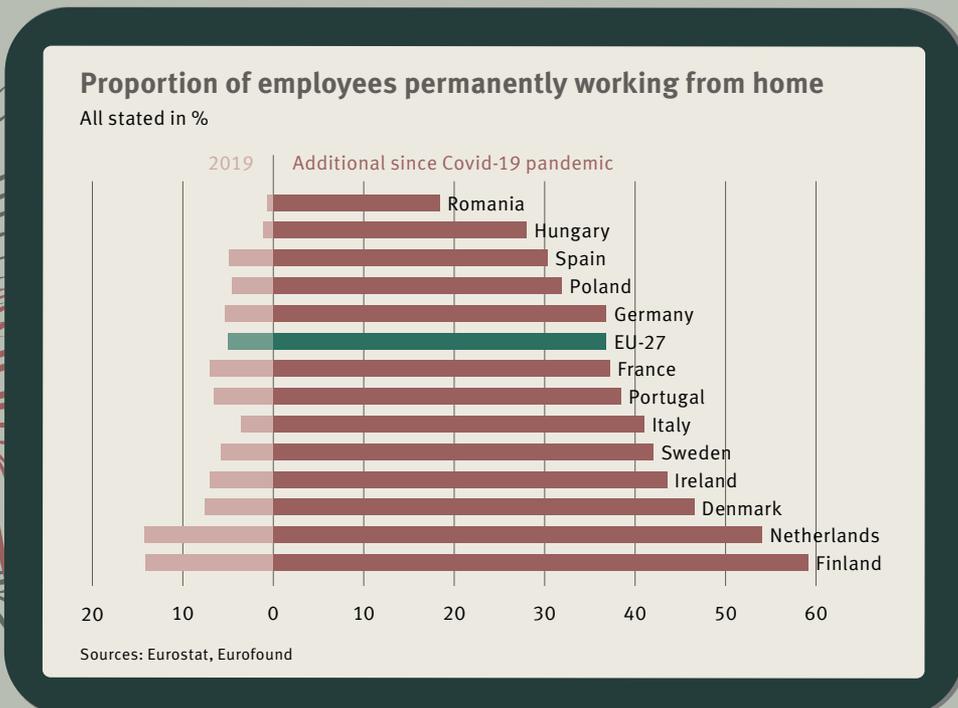
Corona has shown: communication by digital means actually works

Many workers only familiarized themselves with digital tools due to the changed work environments. Video conferencing is suddenly on everyone's lips. In June, three applications for video-based virtual meetings were among the three most frequently downloaded business apps worldwide, according to the analytics platform SensorTower. Even EU summits, party conventions and annual shareholders' meetings are now held in this way. Since March the user statistics of the Zoom conferencing app alone have risen sharply – from 10 million to 300 million per day.

Factual and mental hurdles

In spite of all the hype about working from home it shouldn't be forgotten that not even half of all jobs are fully suitable for telecommuting. The rate in industrial countries is between 24 and 34 percent. Its practical implementation differs greatly as well, at least it used to in pre-corona times: Pioneering countries in Europe are Finland and the Netherlands, where nearly one in seven people was regularly working from home even before the pandemic. However, on average, not even one in twenty was (see infographic). The positive experiences in recent weeks, though, might produce a change in thinking – particularly among senior executives, who'd sometimes find it hard to loosen the reins up to now.

Fraunhofer expert Dieter Spath hopes that the corona-induced changes to the world of work will finally result in more trust being placed in people so that self-determined work might receive a boost. Nils Brede Moe, a Norwegian research scientist and expert in teams working from home, has similar views. In his research he found that managers commonly feel the need to exercise greater levels of micromanagement when their teams are working remotely. "This is not a good idea," says Moe.



» Even though telecommuters work longer hours, their job satisfaction is higher

Labor expert Karl Brenke

“If a manager trusts that his team members are working as normal, there is no reason to assume that there is a greater need for status reports when team members are working from home.” Such trust can pay off, Karl Brenke agrees in a paper for DIW Berlin on the topic of working from home. He writes: “Telecommuters often have far above-average working hours and it’s not uncommon for them to work unpaid overtime. Even so, they’re more satisfied with their jobs than other workers,” adding with a grain of salt, “especially than those who’d like to work from home but don’t get the opportunity to do so.” Moreover, research scientists have found that besides the “where” the “when” plays a part in job satisfaction: People who are able to flexibly manage their time – which to some extent may be inevitable due to corona – have a greater zest for work and tend to be more willing to put in overtime.

The company office will survive

Notwithstanding the above: The workplace at the company office will survive – albeit in a changed form. “Forward-thinking office concepts featuring multi-space solutions flexibly adapt to agile forms of work and changing activities. As a room for opportunity they continually promote new processes, insights and outcomes because the space itself turns into a medium for opportunities,” says Timo Brehme, who implements office concepts with his company CSMM throughout Germany.

In the wake of the New Work philosophy, such flexible workplaces featuring shared-desk concepts, comfortable breakrooms as well as open spaces and lounge areas for meetings and teamwork were in vogue even before corona – including at Schaeffler (see “tomorrow” 03/2019). But maybe the pandemic will inspire a hybrid solution: the office for interaction, collaboration and creative work while routine tasks, silent work and online meetings are

handled from home or at temporary remote locations. Open seating in the world of work 2.0.

Office expert Brehme is a fan of such a flexible workplace mix as well: “Research has shown that diverse places for learning and work have a stimulating effect on the brain and thus on performance. Agile companies and employees take advantage of this by performing specific tasks at various locations.”

Work home, go green

In any event, the relief on the environment and the chronically overstretched transportation infrastructure in conurbations due to fewer commutes speaks in favor of expanding telecommuting arrangements. Statistics in an expert opinion by the Institute for Applied Labor Sciences (ifaa) show how much potential this area has. Just in Germany, some 4.5 billion kilometers (2.8 billion miles) and about 850 million kilograms (1,874 million pounds) of CO₂ per year could be saved if only ten percent of the working population telecommuted on one day per week. An argument that truly carries weight in support of working from home. But not only there. Corona has also inspired a change in thinking about business travel, conferences and even trade shows (see page 94). Following the experiences gained in recent weeks, it can be expected that the need for business travel will more frequently be reviewed against faster, more cost-efficient and more eco-friendly alternatives such as online meetings and online presentations. Sometimes it simply takes a stimulus to leave the beaten track. Corona has provided this stimulus to the world of work.



The author

Actually, not a lot has changed for author **Oliver Jesgulke** due to corona. He’s been working from home for eight years now, but is now looking for new sources

of income. Having suffered a severe decline in revenue in recent months, he started a new business as a freelance headhunter. As a second pillar for his home office.

Caring about the future

Sustainable business success means assuming environmental and social responsibility. To achieve its goals, Schaeffler keeps an eye on the big picture. How Schaeffler lives up its commitment in the areas of Customers & Products, Environment & Energy and Employees & Society is described on these pages.

In 2019, Schaeffler reduced water consumption compared to the previous year

by 5 %

Clever recycling of water

Precious H₂O cannot just be saved by turning off the faucet. Schaeffler emphasizes water recycling. For instance, to reduce consumption in electroplating operations, the water used for rinsing is treated by means of ion exchangers and recycled into the electroplating process.

Against the flood of waste

From 62 to 0! Schaeffler Brazil has pioneered the waste reduction effort. Within the space of one year, a **zero-waste-landfill** pilot project team there managed to reduce to zero the previous 62 metric tons (68 short tons) of residual waste that had to be disposed of in landfills, and simply by sorting waste and training employees. Recycling is an important global topic for Schaeffler. The Group is working on raising the reutilization rate around the globe. In Germany, for instance, it already amounts to around 93 percent.

How Schaeffler avoids waste

- Used components are reconditioned – in original quality
- Virtual Engineering eliminates the need for test series with real-world components, which saves material
- Additive Manufacturing (3D printing) simplifies processes and reduces scrap compared to conventional methods



Saving energy

The plan: By 2024, Schaeffler intends to implement actions designed to **save 100 gigawatt hours of energy per year** – amounting to the annual consumption by 30,000 three-person households.

Energy conservation measures include the utilization of energy data management, LED lighting, combined heat and power plants, and buffer storage systems. The “€CO MODE-Button” developed for this purpose turns off equipment in the production process that’s not constantly used.

Schaeffler is planning to obtain

100 %

of the purchased electricity from renewable sources starting in 2024. The target is to be achieved at the German production sites (accounting for 20 % of the CO₂ emissions from Schaeffler’s worldwide electricity consumption) by as early as the end of 2020. The share of renewable energy produced in-house is supposed to increase as well. At the same time, Schaeffler’s Industrial division ensures efficient and reliable energy production using wind, solar and hydropower with its extensive product portfolio. Thus, Schaeffler actively drives the growing use of renewable energy.

Schaeffler, for example, has achieved a

70 %

increase in the nominal life of asymmetric spherical roller bearings (pictured) serving as rotor bearing supports. Since this is where all the wind-induced forces have a direct impact, the component is of central importance and decisively helps make wind turbines more reliable and reduce the costs of renewable energy production.





Active health promotion

In the holistic view of sustainability, employee well-being plays a major role within the family-led Schaeffler Group. For good reason, because the physical and mental performance capacity and motivation of its employees are central to the company's success.

Examples of how Schaeffler actively reduces workplace stress and strain:

- Schaeffler's occupational health and safety policy targets the creation of safe workplaces as well as conditions conducive to good health in the work environment and in relation to personal lifestyles – also in countries where no relevant government regulations exist
- Personal assistance to employees in the form of health programs (seminars, training sessions, courses) that sensitize people to healthy practices at work and ergonomic workplace design, etc. – an offering that all employees of the Schaeffler Group may use during and after working hours
- “Schaeffler Health Coach” health portal for smartphones and desktops (see also page 88)
- Schaeffler has a long-standing successful track record of reducing the risk of work accidents. Last year, the accident rate (work accidents resulting in one or more workdays lost per 1 million hours of work performed) was 5.2. In 2018, it was 6.2, in 2017, 7.2. By 2024, the rate is targeted to drop by 10 percent on average per year

Creating incentives

2020 is the first year in which Schaeffler links the achievement of environmental targets directly to the variable compensation package on senior leadership levels. In addition,

Schaeffler has established a Sustainability Committee made up of members of the executive board and tier-one management. Its mission is to define corporate goals and make strategic decisions for sustainable further development.



» This provides leaders with even stronger motivation to make sustainability a natural element of their leadership work and corporate culture at Schaeffler

Klaus Rosenfeld,
Chief Executive Officer



»» *The measures taken have obvious effects. In the CDP climate rating, we clearly improved from a D to a B– for 2019. For 2021, we have set ourselves the goal of achieving an A– rating*

Corinna Schittenhelm,
responsible for Human Resources and Corporate Sustainability
on the executive board of the Schaeffler Group

Sustainability at a glance

Schaeffler has increased sales revenue in the area of electric mobility by roughly **37 percent**.

Schaeffler has placed a **350 million euro** Schuldschein loan. 300 million euros of this amount are earmarked for investment in sustainable projects such as electric motors, E-axes, wind power as well as waste and waste water avoidance projects.

In 2019, the Schaeffler Group emitted **1.9 percent** less CO₂ than in the previous year.



Schaeffler's complete
Sustainability Report
for downloading



Green potential of Schaeffler products

The fuel consumption of the worldwide passenger aircraft fleet can be reduced by up to **1.2 million metric tons** (1.3 million short tons) per year with new engine bearings from Schaeffler Aerospace, because the ball bearing only requires minimal amounts of cooling oil.

Schaeffler is a leader in the field of reconditioning aerospace bearings. Using a new and a reconditioned cylindrical roller bearing from the “most frequently flown aircraft engine in the world” (CFM56) as an example, Schaeffler demonstrates that there is no technical difference between a reconditioned and a new bearing for the aircraft operator. The environment benefits because reconditioning can reduce CO₂ emissions by up to **80 percent** compared to the production of a new bearing.

CO₂ emissions can be reduced by **95 percent** through reconditioning axlebox bearings for rail vehicles compared to producing new ones. For comparison: per repaired freight car bogie, this equates to the emissions caused by an air traveler from Frankfurt to Crete.



Sparkling e-sports world

Some gamers rise to the highest spheres of electronic sports as internationally celebrated heroes in practically no time. Sim-Racing, in which Schaeffler is successfully involved, is one of the fast-paced and increasingly professional e-sports disciplines.



A picture from pre-corona times: e-athletes battling each other in sold-out arenas

By Roland Zumsande

A new elite of athletes has entered the stage: gamers, cheered on by and scoring “likes” from zillions of fans around the globe. The players’ sports equipment is a keyboard and mouse, a gamepad or a steering wheel. The best among them are worshipped like pop stars and their competitions would fill large arenas (pictured left) in pre-corona times. What’s more, they’re planned to participate in the Olympic Games rather sooner than later. Streaming platforms have been providing electronic sports, aka e-sports, with huge coverage on the internet. The number of worldwide users of PC and video games has been increasing for years, and so has the industry’s billion-dollar sales revenue. In Germany, spending time in digital gaming worlds is more popular than ever: the GFK Consumer Panel reports more than 34 million players, from beginners to pros – almost as many as those in possession of a driver’s license.

Working at home, schooling at home, more time at home. In the wake of the corona pandemic, all things digital have become increasingly important. In addition to the active number of gamers, the passive media consumption of gaming units is skyrocketing, too. Amazon’s Twitch, the US market leader among video game live streaming services, has been reporting a massive increase of viewers since april, just like its competitors from Google, Facebook and Microsoft. In the gaming mecca China, where many of the US platforms are censored, Huya and DouYu services experienced an upswing there.

Competition in diverse genres

In times of the streaming boom, e-sports both drive and profit from the trend. A wide variety of disciplines have established themselves in the scene of the best gaming athletes: Destroying the enemy base with magic combos and teamwork is the name of the game in Dota 2, in the Counterstrike strategy shooter, adversaries must be taken out by rapid, precise use of weapons, whereas FIFA association football simulation is all about virtual goal-scoring.

On competition level, the best e-athletes perform up to 400 actions per minute. The players’ cortisol levels and heart rates rise to similar heights as in stress situations occurring in traditional sports



\$ 3 m

were pocketed by the 16-year-old American Kyle Giersdorf as the brand-new Fortnite world champion

108

billion euros in sales revenue were generated by the worldwide gaming industry in 2019. More than three times as much as movie-goers paid at all the theater box offices in the world in that year.

17,500

tickets for the 2019 League of Legends world championship in Berlin were sold out within 90 seconds.

1984

saw the market launch of Tetris, of which 495 million copies have since been sold, making it the most frequently sold game to date.

3 questions for ...



... Daniel Kohl, Director of Technical Development Motorsport at Schaeffler.

What makes Sim-Racing attractive for Schaeffler?

Daniel Kohl: Especially at the moment when all racing events understandably had to be initially cancelled due to corona, the relevance of Sim-Racing has received another major boost. Today, virtual product development is standard practice and topics like software development, system understanding and interlinked systems are fields of development and expertise we need at Schaeffler. Consequently, Sim-Racing is a suitable gateway into e-sports for us. It's impressive to see how Sim-Racing has developed in recent years.

In what other areas does Schaeffler apply simulations?

In all areas of our organization in which we develop products and systems. Let's take an example from motorsport: to compare two powertrain concepts, we could develop, design and test both of them. But we could also use simulations to calculate and predict their diverse characteristics in the virtual world. This saves money, time and a lot of power loss.

Where do you see future uses?

As before, in the transition process from conventional powertrains to hybrid and battery-electric vehicles. Plus, the fuel cell may become an interesting proposition. This means breaking new ground in motorsport as well as – to some extent – in production development. Consequently, a lot of knowledge will have to be gained on computers.

However, only a few games manage to attract tens of thousands to the venues of tournaments and – at times – more than 200 million viewers of live streams. In this respect, the gaming market is similar to traditional real-world sports, where soccer, tennis, basketball and company are the top crowd-pullers.

Easy access, tricky challenge

League of Legends is one of the blockbusters in e-sports. Due to its global attractiveness, it's also regarded as the "soccer of e-sports." The real-time strategy game belongs to the so-called MOBA (Multiplayer Online Battle Arena) genre. Visually, it's reminiscent of colorful comic worlds: Two rivaling teams of five are pitted against each other. Both aim to destroy the enemy base that's diagonally opposed on the map. Players can choose from more than 140 different characters with specific abilities, called champions: from Annie, the girl with the fire magic, to the underwater titan Nautilus to Zyra, the queen of thorns. These characters can be individualized further with so-called skins. Pros typically have most these roles down pat and are highly paid for their skills.

Fortnite: Battle Royale is another e-sport game that captivates gamers and fans galore, featuring competitive action in a colorful fantasy world, albeit in a "solo survival" mode. The game starts with 100 opponents skydiving onto a vast playing area where they're subsequently challenged to finish as the last survivor – either by sure-fire offensives or tactical games of hide and seek.

As much as the two concepts differ from each other, both are a huge success, having recorded nearly one billion viewing hours combined via streaming services in 2019. While the League of Legends attracts more than 100 million participants per month, Fortnite's monthly participation statistics reflect 80 million. Free access to most of such games is a key factor of the huge response they enjoy. Players can subsequently buy upgrades to enhance their gaming fun, which makes for a lucrative business model. In 2018, Fortnite's developer Epic Games set new financial records in this sector when such in-game sales accounted for a major share of the company's total sales revenue of more than 300 million US dollars – per month.



In 2020, Schaeffler's partner team Coanda Simsport clinched victories in the digital versions of the 24-hour classics of Spa and Le Mans (above). Full house: the ADAC Simracing Expo with its e-sports event attracts the world's best virtual racers (right)



Sim-Racing on the fast track

Sim-Racing is another up-and-coming sport. Many new series were put on the grid especially when corona stopped real-world motor racing in its tracks. Even major automotive brands such as BMW, Audi, Lamborghini and Porsche, as well as real racing stars from top-caliber series like DTM, Formula E and Formula 1, are involved in Sim-Racing. Its closeness to reality is the major characteristic that makes Sim-Racing stand out from the crowd in the e-sport universe: due to steering wheels that simulate steering forces and heavily shake when the driver hits a curb and due to hydraulic pedals requiring a sensitive foot. The handling characteristics of the race cars and the simulated circuits are amazingly authentic as well – including marketable advertising spaces. Equipment costs start in the four-digit range, while high-end sims in which Formula E teams and other professionals prepare for their races cost around two million euros.

Schaeffler is involved in this innovative racing scene, too, supporting the Coanda Simsport team in its hunt for online race victories. The driver squad is made up of international top talents and focused on races and series held on the iRacing and rFactor 2 platforms. In 2020, Coanda Simsport was victorious in the 24 Hours of Spa. In addition, the Coanda pairing of Joshua Rogers and Tommy Østgaard triumphed in the virtual one-day classic of Le Mans as part of the Porsche Esports Team. Another important competition is the Porsche TAG Heuer Esports Supercup comprising ten races, in which all nine Coanda sim-racers compete, including the German top driver Martin Krönke in a Schaeffler-branded Porsche. The field there

consists of 40 high-caliber drivers from 14 nations. Formula One star Max Verstappen also qualified for the 2020 Cup season, in which the total prize money amounts to 200,000 US dollars. That's a lot of cash, but peanuts in comparison to other e-sports leagues: In the 2019 finale of the online multiplayer action game Dota 2, players were competing for 34 million euros of prize money. Welcome to the pinnacle of high-performance sport.

When looking at such sums, if not earlier, it becomes clear that e-sports are more than mere entertainment. Dominik Rinnhofer, a professor of game design in Stuttgart, in a recent interview with *Süddeutsche Zeitung* said: "Video games are a medium and a cultural asset with a major impact. I would even go so far as to say that our future will be significantly shaped by computer games due to their huge potential of being used for changing people's awareness or sensitizing them, as gaming provides an opportunity to test utopian models of the future without having to feel the consequences right away." So, in this spirit: Let the games begin.



The author

Roland Zumsande has always been fascinated by high-performance sport. His first encounter with the emerging e-sports universe took place

during his student days at the German Sport University Cologne. The occasional gamer gathered personal experience in Sim-Racing in the #RaceHome virtual charity racing series.

“Focus on sustainable technologies”

Is the technological transformation process taking a step back due to corona or just running up to a restart with even greater momentum? Uwe Wagner, Chief Technology Officer of the Schaeffler Group, provides answers.

Interview: Daniel Pokorny

Would you have ever thought that a virus would keep the world on edge like corona has?

No, I wouldn't have. I don't think anyone was able to anticipate the impact we're seeing today.

What is your most impressive personal experience or realization in conjunction with the corona pandemic?

In retrospect, even I am amazed about how fast and effectively Schaeffler responded to the rapid developments with professional crisis management. In spite of all the circumstances, we managed to keep our operations running and, of course, kept pursuing our innovation projects, too. As a positive side effect, we intensively enhanced our skills in the area of digital applications, having worked on this at full stretch out of necessity and with great personal commitment on the part of our employees. I'd like to use this opportunity to expressly thank all our colleagues who supported this effort. It seems to me that team cohesion has increased due to corona – in spite of physical distancing.

Talking about physical distancing: person-to-person contacts have been subjected to restrictions. What is the greatest challenge this entails?

Body language, facial expressions: all of this is

often lost in purely virtual meetings, and along with it, the empathy that is a decisive element in communication. Video conferencing helps in this respect, but it does not completely replace real-life contact. That's why I really look forward to the time when physical meetings will increasingly be possible again. Direct contact between people, both in private and professional life, is clearly more important than any video conference, no matter how technically perfect it may be.

In the wake of corona, has the world become more or less open-minded regarding the pursuit of diverse technological approaches?

According to my perception, the world in general tends to have become more open-minded concerning technological preferences. The available resources have no doubt been cut to some extent at the moment. However, the commitment to achieving goals like the reduction of CO₂ emissions using a wide range of approaches, including new technologies such as hydrogen as an alternative energy source, tends to have intensified. Important political decisions about funding support for hydrogen



30 %

of the EU's 1.8-trillion-euro corona relief package is supposed to be invested in the area of **climate protection**.

€7 billion

from the German federal governments' corona economic recovery program will be invested in future projects involving **green hydrogen** to be produced exclusively by means of renewable energies.

81

leading companies in the energy, transportation and industrial sectors have joined forces in the **Hydrogen Council**, a global initiative based in Belgium. Schaeffler is engaged there as a steering member providing decisive input to the advancement of this technology. In addition, Schaeffler is a founding member of the "Bavarian Hydrogen Alliance" established in 2019.

technology – both in Germany and on the European level – are relevant proof points. In addition, I find that the general focus on innovation has been sharpened: Which innovations deserve to be given a chance? Which areas do not merit any further development? Today, these questions are more important than ever, especially due to the tougher financial conditions. This leads to a new stimulation of competition focused on innovations.

The world has changed due to corona. What were the major effects in your area of responsibility?

As an automotive and industrial supplier, our global development network was a major issue for us. Due to the regional differences of the pandemic and diverse effects on various sectors, we had to show maximum flexibility here and act with speed and agility – which we managed to do really well. We kept the global development network running, which has also provided us with valuable experiences going forward. However, we miss aspects of our local presence like direct customer contact or even the direct exchange between our international teams. As briefly mentioned before, these aspects cannot be completely replaced by purely digital meetings in the long run. Especially the beginning of this phase was difficult also for our individual development engineers, who had to leave their prototypes at the

Curriculum vitae

Uwe Wagner (b. 1964) studied mechanical engineering at the University of Stuttgart. In 1993, he started his career as a development engineer in the Control Hydraulics Automatic Transmissions unit at LuK. In the following years, Uwe Wagner held various management positions. In these roles, he implemented numerous new product developments and volume production launches together with his teams. In 2007, he assumed responsibility for the Transmission Technologies business unit. With numerous concept and product developments, such as the first Schaeffler hybrid clutch, he and his team paved the way for research and development activities in e-mobility. Uwe Wagner became a member of the management board of the Automotive division upon being appointed as Head of Research and Development Automotive in 2014. Two years later, he also assumed this role for the Industrial division. Since October 2019, Mr. Wagner has been Chief Technology Officer at the Schaeffler Group.



company and work from home. But our employees managed to adjust to this situation really well. After just a short time, the development processes were running like clockwork. In addition, we developed solutions for resuming on-site prototyping and testing in compliance with all hygienic aspects.

Digitalization has received a boost due to corona. What effects has this had at Schaeffler?

We're already in a very good position in terms of digitalization at Schaeffler, so we were well-prepared for coping with the crisis, of course not only in research and development. To name just one example: Maintenance employees were able to perform a large part of their tasks from home, even if this meant taking care of real-world machines and equipment, because we've already interlinked and virtualized a lot of our equipment. Project planning, programming, diagnoses and setup adjustments can largely be handled remotely. Obviously, the pandemic has also clearly shown how important digitalization is in all areas of the organization. That's why we'll continue to drive our agenda here.

You're the chief technology officer: to what extent have forward-going strategies changed or areas of emphasis shifted?

The significance of focusing on the right technologies has sharply increased. Here, we're benefiting from our innovation program that we've consistently continued to implement also during corona. It enables us to compare innovative ideas with Schaeffler's market potential and fields of expertise and select the technologies we're going to pursue in greater depth accordingly. However, corona has not led to any fundamental changes regarding basic technological trends. Now being massively boosted, hydrogen and electric mobility are technological trends that we've been focused on for a long time: In the context of a carbon-neutral, sustainable future, our emphasis is placed on the enormous potential of green hydrogen. As an automotive and industrial supplier, we keep our eye on the entire range of applications – from hydrogen production using electrolysis to mobile and stationary applications in fuel cells to the utilization of hydrogen-based direct-reduction steels. We're actively engaged in a large number of hydrogen initiatives in order to establish and help shape the hydrogen eco-system together with strong partners. As a supplier of systems

and key components, we're going to play an important part in this context. Plus, we're also in a very good position in other areas such as electric mobility (see page 62) and robotics (see page 78), and have frequently demonstrated the expertise we've massively expanded in the area of systems in recent years.

What are the prospects for autonomous driving, going forward?

At Schaeffler, we still believe that this will become a hot topic, albeit the question of whether this will happen sooner or later due to corona is not so easy to answer. Some players in this field have shifted this topic to a lower priority level due to the current constraints, while others are accelerating it for exactly the same reason in order to gain a competitive advantage in this way. Aside from these considerations, there are applications in which autonomous driving is going to gain traction for very rational reasons, such as in the heavy-duty field. The utilization of autonomous vehicles will really pay off here. With our drive-by-wire initiative based on Space Drive, we'll be able to offer a key technology in this area.

What does the situation look like in the industrial sector?

In the industrial sector, we're really well-prepared for the digitalization boost due to corona with proven-in use applications, too. In the area of Industry 4.0, for instance, with cloud-based services and condition monitoring solutions like OPTIME (see page 56). By enabling seamless monitoring at low costs, this plug-and-play system eliminates an important hurdle. The general idea up to now has been that condition monitoring can be costly – that's why up to 95 percent of all units in a production machine or plant are not being monitored at all or just sporadically, which entails high risks of unplanned stoppages and downtimes. We generally want to help our customers optimize their production processes, enhancing their efficiency and flexibility, and, as a result, making them more resilient against unexpected challenges such as corona.

Will it be necessary to place a greater focus on extreme situations like a pandemic in future technical developments?

I think that our well-balanced development portfolio and our global development team are crucial factors in this context. The more balanced one's



» *In my view, the climate discussion has not lost any momentum, neither on the political level nor at Schaeffler: increasing energy efficiency, driving defossilization and decarbonization – these actions are being pursued worldwide and of course here at Schaeffler, too*

Uwe Wagner

position is in this respect, the better is one's ability to respond to exceptional situations. We're in a very good position with our innovation strategy here and are therefore going to retain it as it is.

The climate discussion has faded from the spotlight to some extent due to the corona crisis, but satellite pictures and air measurements show that the lockdown measures have been beneficial to the environment. Obviously, no one would like to have an everlasting lockdown, but where have you identified corona-induced climate-friendly potential that might also be viable for the future?

In my view, the climate discussion has not lost

any momentum, neither on the political level nor at Schaeffler: increasing energy efficiency, driving defossilization and decarbonization – these actions are being pursued worldwide and of course here at Schaeffler, too. The key objective driving all of these efforts is that the energy consumed has to become increasingly carbon-neutral. And this objective should mainly be achieved by focusing on the development of sustainable technologies. In this context, the renewal of car fleets is an equally important aspect as the efficiency enhancement of existing technologies. Both are going to soon lead to positive results. Of course, aside from this, it's important to develop an awareness of our personal

carbon footprint: less travel, both privately and for business, intensified remote work, more conscious consumption, plus support for new mobility concepts are possible aspects that benefit our climate.

Around the world, a factional dispute has flared up: While one camp would like to restore the pre-corona status quo as soon as possible and pump money into existing systems, the other one views the pandemic as a turning point and advocates radical renewal, even though it may initially be painful. What is Schaeffler's position on this?

We do not see ourselves positioned in either of these camps. We stand for continuity and an unbiased view of technology. Our 30/40/30 scenario, which we continue to regard as being realistic and which in this form can make a major contribution to decarbonization, is a perfect example. For newly registered vehicles in 2030, it predicts 30 percent fully electric vehicles, 40 percent hybrid powertrains and 30 percent conventional IC engines. We include completely new fields in this, for instance in the context of hydrogen, where we've been focusing on the entire value chain from electrolysis to the fuel cell for quite some time.

In times of crisis, strengths and weaknesses are exposed. What areas proved to be strengths?



The departure from fossil fuels and the transformation of mobility continue to have the same high priority as before and require a fundamental change in the entire energy sector. Schaeffler's activities in the "energy chain" focus field address exactly these market segments – from digital solutions to mammoth bearing solutions for wind turbines

The fact that Schaeffler is an automotive and industrial supplier and that both divisions are effectively coordinated once again proved to be beneficial. Our Skalica site in the Slovak Republic is a case in point. While automotive orders declined at the beginning of the pandemic, they remained relatively stable in the industrials market. At the Skalica plant, more than 4,000 employees produce needle bearings, cages and other products for industrial applications, plus components for transmissions, as well as belt and chain tensioners for automotive customers. Besides the differences in the automotive and industrial divisions' order situations, the plant was confronted with another challenge: Within a short period of time a large number of employees – sometimes as many as 20 percent – were unable to work for reasons of infection protection and corona virus control. In order to meet all industrial customer deadlines in spite of these manpower shortages, colleagues from the automotive division stood in on short notice and helped to sustain the manufacturing operations in that way. Due to this fast support, we delivered all orders on time. One of the crucial factors in this effort was the very high skill level of our employees, plus their flexibility and willingness to help out. This example impressively shows how Schaeffler closes ranks worldwide in times of crisis and how cross-divisional teamwork has to function in order to jointly rise to the challenges. Corona has made us even stronger!

And how is the collaboration with customers and suppliers in times of crisis?

Here, the relationship with our customers and suppliers that has been growing for decades and is based on mutual trust has paid off. We have been engaged in constant exchange – in both directions: As a result, we're able to mutually assess our demand really well and respond with flexibility. This is also true for joint development projects.

Summing up our conversation in two sentences: what is the "new important?"

Flexibility, efficiency and strong judgment are more important in these days than ever. Due to our decades-long market experience and close interlinking with our stakeholders, we're able to systematically respond to all requirements and demands, and provide innovative solutions in response to global challenges.

In motion

Innovations in the course of time

» ***Everything is going to be fine in the end. If it's not fine it's not the end***

Oscar Wilde,
Irish poet and playwright

Traveling tiers

After the Second World War, the automobile became the technological center of life for many people, like the smartphone today. Many folks back then were so infatuated with their Beetles, Mustangs and Caddy vans that they practically never wanted to get out of them – and no longer had to, as “drive-in” was the marketing word of the moment that also targeted movie-goers. In their metal boxes, they’d travel to the gravel floors of drive-in theaters that had begun to boom around the world. But the boom subsided and drive-in theaters began to drop like flies or Rambo’s enemies. Then came Corona and the rebirth of an idea. In a state of shock, the event industry fished the concept out of the history books, where it had meanwhile been parked, and multiplied it: for concerts, sports events, conventions and so on. From Athens to Shanghai, creative ideas were born and vehicles changed as needed. Like here in Nuremberg. Boats instead of cars and a stage for a classical orchestra instead of a projection screen: a charming contribution to the city’s bid for “2025 European Capital of Culture” honors. The only tricky thing was that standing ovations posed the risk of capsizing.



Live pole vaulting at a drive-in theater

Spectators at the Flight Night in Düsseldorf created a special atmosphere with warning flashers and windshield wipers



Graduation ceremony at a drive-in theater

Bremerhaven's unusual high school graduation ceremony featured honking horns instead of rounds of applause and the principal's speech on car radios



Drive-in theater on tour

The Luna Drive In is the name of an event series that transforms famous places like Ascot Racecourse, Warwick Castle and London's Gunnersbury Park into drive-in movie theaters



A change of pace for theaters

Drive-in movie theaters are being repurposed in times of corona



Fly-in Cinema

A somewhat different version of a drive-in movie theater took place in the Netherlands when spectators were sitting on the wings of an aircraft or directly in the cockpit



Two instead of four wheels

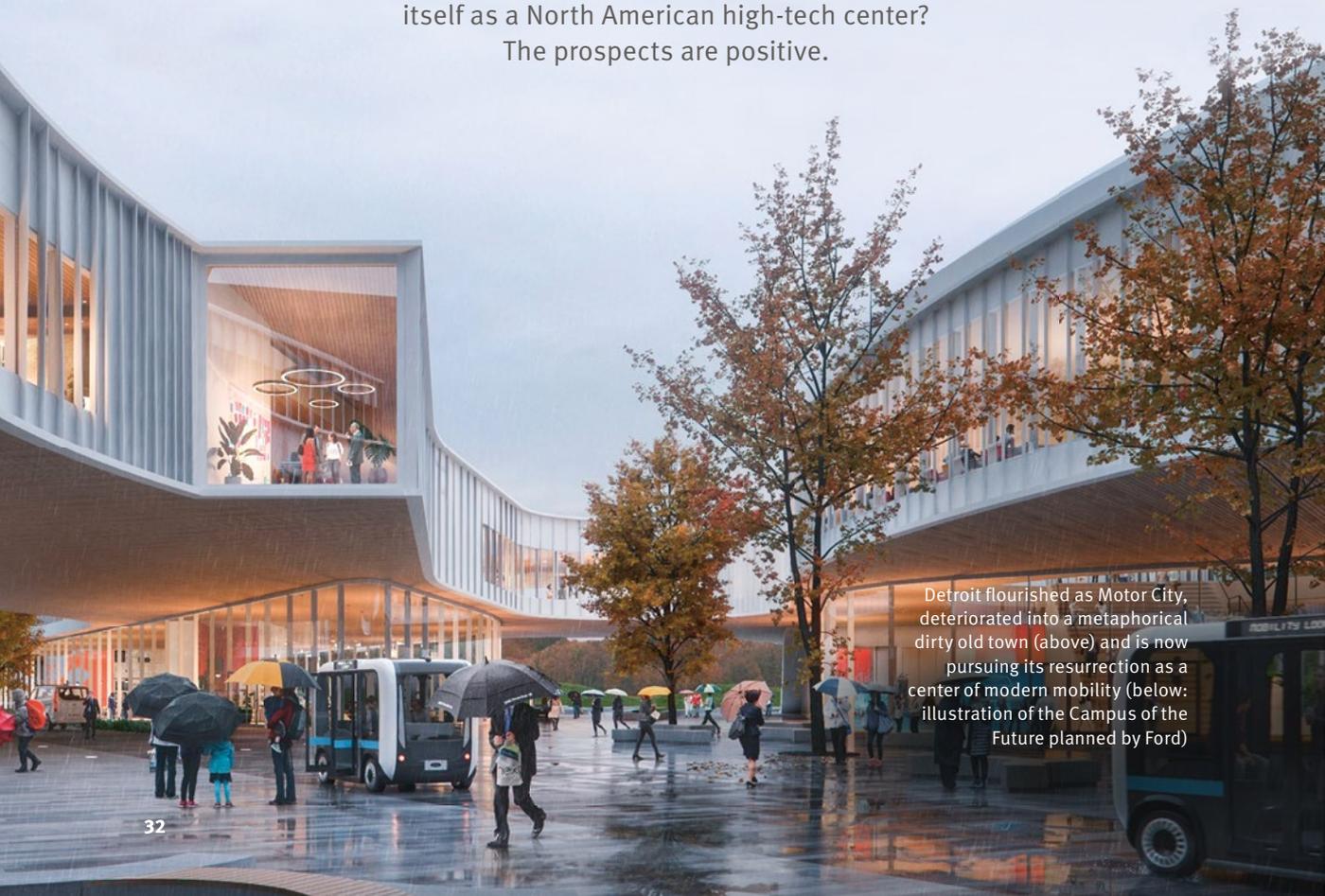
At "Electric Pedals," spectators have to mount bicycles and use pedal power to generate the electric energy for the theater





Motor City is reinventing itself

From an automotive hot spot to a mobility hub – after its bankruptcy, will Detroit manage to resurrect itself as a North American high-tech center? The prospects are positive.



Detroit flourished as Motor City, deteriorated into a metaphorical dirty old town (above) and is now pursuing its resurrection as a center of modern mobility (below: illustration of the Campus of the Future planned by Ford)

By Carsten Paulun

Practically any automobile enthusiast is familiar with Detroit, the American metropolis between Lake Eerie and Lake St. Clair. From Detroit the Big Three, Chrysler, Ford and General Motors, dominate the automotive world until far into the 20th century. In Detroit, in 1913, Henry Ford makes industrial history by introducing mass production of the Ford Model T on a moving assembly line. In Detroit, tens of thousands of immigrants from Europe in search of work arrive at Michigan Central Station that was completed in 1913 (see infobox on the following page).

Detroit's boom continues after the Second World War. Good money can be made in the busy industrial halls. Thanks to the prospering automotive industry, a solid middle class emerges in "Motor City." In the early 1950s, Detroit has a population of 1.8 million that makes the city the fifth-largest one in the United States – today, it doesn't even have 700,000. The decline of Detroit happens almost overnight. Following severe race riots in 1967, hundreds of thousands of well-paid whites move away from the city center. The oil crisis in the 1970s exacerbates the exodus: demand for the typical American V8-powered gas guzzlers from Ford, Chrysler and General Motors massively drops while the competition from Europe and especially from Japan is becoming stronger and stronger. Increasing automation costs further jobs. Especially the downtown area goes to rack and ruin – Motor City morphs into a metaphorical dirty old town.

Numerous rescue attempts

The former heavyweight has been hard hit. Detroit is tumbling, but Detroit won't give up. Various rescue attempts follow. In 1977, Henry Ford II opens the impressive Renaissance Center. The huge complex is intended to attract the arts and business and to breathe life into the downtown area – without success. In 1987, Detroit demonstrates innovative prowess as one the first cities worldwide to build a fully automated elevated people mover system. It's still traveling above plenty of bleakness. Around the turn of the millennium, Detroit tries its luck at becoming a gamblers' paradise by opening three casinos. If nothing else, more than 100 million dollars in tax revenue from the money blown there end up in the city's coffers. This slows the downward

spiral, but won't stop it: Detroit continues to perish. In 2008, during the financial crisis, homes can be bought for the pittance of 100 dollars. But who wants to live in Detroit! In the years of the crisis, the U.S. federal government has to ward off the specter of bankruptcy looming over General Motors and Chrysler with a multi-billion-dollar bailout. Ford mortgages nearly all of its domestic assets and even pledges its logo to raise money. This and the government bailouts keep the ailing Big Three alive, but Detroit's situation remains shaky. In 2013, the city topples and files for bankruptcy: a shock and perhaps exactly the loud and clear wakeup call the people of Detroit needed for a collective relaunch.

A stimulating shock

The relaunch is also based on the fact that deprived Detroit has something to offer at a much lower price than other big cities: real property. Whether wasteland, industrial halls or residential buildings: the city government is still auctioning abandoned buildings with minimum bids set at 1,000 dollars. Artists find affordable studios, exhibition and practice facilities. They're following in the footsteps of famous performers such as Diana Ross, who was born in Detroit, and Michael Jackson, who made his debut there in 1969. Another tradition is being revived as well: industrial design. In 2015, Detroit is the only city in the United States to be named a City of Design by the UNESCO and joining the Creative Cities network. "The industry of design has been a driver for the city's urban regeneration and represents today a significant lever for employment and an economic engine by employing more than 45,000 people and generating 2.5 billion U.S. dollars in wages," the UNESCO praises Detroit.

Along with the arts young, hip and, above all, highly educated people are moving to Motown, which is

An early harbinger of Detroit's transformation from an automotive to a mobility center: the fully automated elevated Detroit People Mover that was officially opened in 1987





Michigan Central Station in the year of its inauguration (left). When Ford buys the building in 2018, it's practically in ruins (center). The digitally retouched image (right) shows its actual state in 2018 and what it's planned to look like in 2022

Central station for the journey into the future of mobility

When Michigan Central Station is officially opened in Detroit's Corktown district in 1913, the mammoth building, due to its add-on office tower, is **the tallest train depot building in the world**. In the wake of the automobile's rise after the Second World War, the importance of this impressive cathedral of mobility begins to fade. In 1988, the last train leaves the tracks. In the following years, a number of investors' flights of fancy start haunting the abandoned architectural monument: a casino, a police station, a cultural center – **many ideas for its new utilization are born, and none of them put into action**. Even the demolition that's decided in 2009 fails. In 2018, Ford acquires the building that by then has fallen into disrepair and develops great plans for it: starting in 2022, **Michigan Central Station is intended to become the centerpiece of**

a 1.2-million-square-foot (111,500 m²) innovation hub for which additional old buildings will be repurposed and new ones built. The construction work has long begun and Ford is planning to invest 740 million dollars in its Corktown Campus in the coming years. 2,500 Ford employees and a similar number from partnering companies are planned to create the future of mobility there. Recently, a project partnership with the New Lab tech incubator that is currently supporting 155 startups was announced. In addition to offices, plans for Corktown include retail spaces, apartments, parks and community facilities to develop the city's oldest district into its most dynamic one. Mayor Mike Duggan hopes that the revival of Detroit's landmark will inspire other projects of similar magnitude and thus make it a **symbol of the city's comeback**.

Detroit's second nickname from the glorious 1950s. Plus, intellect and innovation bring money to the city as well. Detroit billionaire Dan Gilbert, for instance, is actively engaged in revitalizing the desolate city center with its ornate office towers from the 1920s – with lots of money and success. Now tourists overnighting in carefully restored or newly built hotels are again strolling along the once-famous boulevard of Woodward Avenue. In addition, Gilbert founds the Detroit Ventures incubator in 2010. With ambitious aims. The tech startups supported by him and his partners are intended to do no less than “move the world forward.”

Since, as everyone knows, one dollar tends to be joined by a second dollar, another billionaire, Stephen Ross, makes a commitment to Detroit's resurrection. At the beginning of this year, the tycoon who's known as a philanthropist donates 100 million dollars to support the construction project of the University of Michigan's Detroit Center

for Innovation. Dan Gilbert contributes the land, which used to be the site of a jail. Digital transformation instead of iron bars – construction is scheduled to start in 2021. “Detroit has always been an incredible place of innovation and opportunity,” enthuses Ross, who went to school and university in Detroit, “and the Detroit Center for Innovation will usher the city into a new era of leadership in technology.” Mayor Mike Duggan expects the future innovation center that's planned to combine research, teaching and entrepreneurship to become the beacon of a Detroit 2.0.

Mobility across land, air, sea & space

Innovative startups that were either established here or attracted by a digital gold rush that's in the offing in Motor City are already starting to sprout: potential skyrocketers such as Karamba Security, Derq and Guardhat. While Karamba Security develops security software in motor vehicles and IoT

control units, Derq is dedicated to making precise predictions of traffic movements using artificial intelligence: an important element for smart roads and autonomous vehicles. Guardhat is focused on the utilization of highly sensitive electronics as well. The company's novel wearables warn operators and personnel of hazardous areas, for instance in automated production facilities.

Chris Thomas is one of the people who firmly believe in Detroit and its transformation from a crashed auto to a high-tech mobility town. The entrepreneur, who grew up in Waterford, one of Detroit's many suburbs, and used to be a Ford executive for a number of years, is almost euphoric: "I want to found and bring the most dynamic mobility start-ups in the world to Detroit. Metro Detroit is the deepest transportation technology cluster in the world and is perfectly positioned to leverage their current assets to create the future of mobility across land, air, sea and space."

Thomas recently co-founded the Assembly Ventures incubator, in which Berlin venture capital specialist Felix Scheuffelen is engaged as well. It is generally notable that the Detroit innovation drivers like to network with other tech hot spots such as San Francisco, Tel Aviv, London and Dubai.

Chris Thomas is also on the team of the Michigan Mobility Institute that's planning to offer the first Master of Mobility program together with select university partners starting in 2021. The idea behind this is clear: in addition to cash and courage, innovative companies need a large talent pool of experts in artificial intelligence, robotics, cyber security and similar fields.

Big business has fallen in love with Detroit again, too

However, college grads aren't just in demand for the purpose of driving the success of startups. Large corporations need young, highly educated innovation drivers for growth as well. Fiat Chrysler is investing two billion dollars in its plant in the eastern part of Detroit, creating 4,000 jobs. The telecommunications company Verizon has launched its 5G network in collaboration with the University of Michigan and is developing various 5G solutions in Detroit to enhance automotive and pedestrian safety. They include 5G cameras that

identify traffic and pedestrian patterns in order to avoid collisions.

Japanese electronics giant Panasonic intends to grow at the automotive site in nearby Farmington Hills that the company moved into in 2012. Tom Gebhardt, then President of Panasonic Automotive Systems Co. of America, commented on the move: "Reaffirming our commitment to the region, Panasonic Automotive's position is to take advantage of the deep talent pool located in Southeast Michigan as we seek to further expand our business."

Irish connectivity provider Cubic Telecom recently opened an office in Detroit in order to be close to customers from the mobility world. New colleagues are planned to soon join the initial team of five. In a press release announcing the new office, the company refers to a statement by Detroit Mobility Lab: "Detroit is poised to become the epicenter for mobility in the US."

Ford is another company leaving no stone unturned to make this vision a reality. In 2018, the reinvigorated auto giant bought the run-down Michigan Central Station, planning to establish an innovation center for testing mobility solutions there and in the nearby Corktown district (see info-box). Concurrently, Ford is turning its 66-year-old development center in the Dearborn suburb inside out. After completion of the Campus of the Future, more than 20,000 employees are planned to work in a flexible, high-tech environment on creating new mobility solutions including electrified bicycles, scooters and shuttles.

Maybe Detroit will make history again – albeit a totally different, a digital one.



The author

As head of the motoring editorial teams of BILD and BILD am SONNTAG **Carsten Paulun** has traveled to the Detroit Motor Show, to interviews and car tests on

countless occasions since the 1990s and been keeping track of Detroit's equally countless revival attempts.

He'd be happy for the city and particularly for its friendly and spirited people if it all worked out this time.

Lucky coincidences

Pursuing a clear goal ... and discovering or inventing something totally different. This is referred to as serendipity. Legendary examples from laminated glass to Viagra.

By Wiebke Brauer

Rubber eraser

The plan

Erasing a writing error.

The coincidence

To understand the mistake, one should know that breadcrumbs were used to remove graphite marks since about the middle of the 16th century. In 1770, the British optician and instrument maker Edward Nairne is sitting at his desk, makes a writing error – and doesn't grab a breadcrumb, but – inadvertently – a piece of rubber. Now that raises the question of why a piece of rubber is lying on Nairne's desk. The reason is that 30 years earlier the Frenchman Charles

Marie de La Condamine while traveling in Amazonia in far-away Brazil has described the Indian method of producing natural rubber as well as its properties. This sparks enormous curiosity about the new substance and inspires numerous strategies concerning all the things it might be used for. Considering this, it wouldn't be unusual for a piece of rubber to be lying around on master craftsman Edward Nairne's (obviously very cluttered) desk, which by chance turns out to be extremely effective for error correction.

The outcome

Nairne names the new tool rubber and goes on to sell the half-inch (a little more than one centimeter) cubes for the relatively high price of three shillings.

By the way ...

Because Joseph Priestley, a highly popular U.S. natural explorer and theologian, was the first to write down the principle of the rubber eraser, he was deemed to be its sole inventor for many years.



Velcro closures

The plan

What kind of a plan? For starters, the Swiss engineer Georges de Mestral while hunting in the Alps in 1941 is strictly upset about the large number of burs clinging to his pants and his dog's coat. In case anyone should ask: the dog's name was Milka.

The coincidence

Georges de Mestral has had an interest in the way technical things

function from an early age. While inspecting the burs he took home in detail under a microscope he soon comes to realize that the tiny, elastic hooks might serve as a closure system to connect two materials in a simple way.

The outcome

Ten years later, Georges de Mestral has his connecting invention legally protected under the name of Velco,

a portmanteau combining the words "velours" (French for velvet) and "crochet" (French for hook). Today, his company of the same name is still the world market leader with more than 2,500 employees worldwide. And if anyone should happen to be asked for a brief explanation of the term bionics: pesky burs are an excellent example showing how nature (very profitably in this case) can be converted into technology.

Laminated glass

The plan

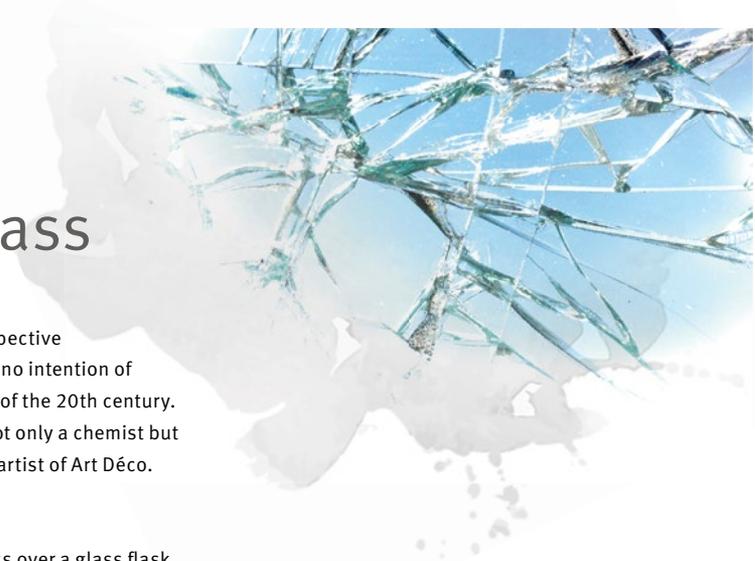
Although it's a fact that escapes retrospective investigation, Édouard Bénédictus has no intention of inventing safety glass at the beginning of the 20th century. Another fact is that the Frenchman is not only a chemist but also a composer, writer and influential artist of Art Déco.

The coincidence

In 1903, Bénédictus accidentally knocks over a glass flask in his laboratory. The flask doesn't shatter because it's covered with a thin plastic layer on the inside: a residue of evaporated liquid celluloid. Purportedly, Bénédictus jots down the incident and then forgets about it again. He'll only remember the event with the flask when reading in a Paris newspaper about a car accident in which a girl was severely injured by the splintering glass of the windshield.

The outcome

Following numerous experiments, Bénédictus is awarded a patent for his laminated glass in 1909. In 1910, he develops a three-ply safety glass called Triplex that will be installed in aircraft and gas masks in the First World War. Two years later, Triplex Safety Glass Co. Ltd., a company founded in the UK, produces laminated glass using the method developed by Bénédictus and advertises it with the slogan: "Fit Triplex and be safe!"



»» *The more human beings proceed by plan, the more effectively they may be hit by accident*

Friedrich Dürrenmatt

Bubble Wrap

The plan

Packaging material is far from being on the minds of the American Al Fielding and the Swiss Marc Chavannes. They're in pursuit of a different strategy: the Bubble Wrap they invented is meant to provide a low-cost and, above all, washable textured wallpaper, an idea that's assumed to have at least partly been owed to the questionable styling of trendy wallpapers in those days. The prototype consists of two shower curtains sealed together including the air bubbles trapped between them. On November 27, 1959, the two inventors file for a U.S. patent and establish Sealed Air Corporation a year later.

The coincidence

Unfortunately, customers aren't inclined to paste this innovation to their walls, so a new strategy is needed. Now, its inventors attempt to sell the wrap as greenhouse insulation. This plan doesn't pan out really well – but the young company's marketing expert, Frederick W. Bowers,

subsequently has an even brighter idea for a happy ending: using the wrap as a protective packaging material. Bowers contacts IBM when the company is in the process of preparing deliveries of the new IBM 1401 mainframe computers. This marks the beginning of the popping wrap's success story.

The outcome

Today, Bubble Wrap – not least thanks to the burgeoning online retail business – is so successful that its annual production volume is said to suffice for wrapping around the Earth ten times. Sealed Air has become a global packaging corporation with 4.7-billion-dollar annual sales and some 15,000 employees. Notwithstanding the environmental aspect, Bubble Wrap is not only successfully used as a stress reducer but, in 2004, is even included in the New York Museum of Modern Art's collection. There's even a day dedicated to Bubble Wrap, the Bubble Wrap Appreciation Day, held on the last Monday in January. Pow!

» *Nutella consists of 60 percent vegetable oil, so it's practically a salad*

Unknown source

Nutella

The plan

After the end of the Second World War, Pietro Ferrero is standing in his pastry shop making chocolate confection. However, the pastry maker is faced with a problem: the strict rationing rules of the post-war era. In 1946, cocoa beans are hard to come by in Alba, Italy, so Ferrero adds ground hazelnuts to extend the paste. He calls the finished product delivered in loafs and sold in small slices pasta gianduja.

The coincidence

But how do the chocolate loafs turn into Nutella? That's when coincidence comes into play – in the form of hot Italian days that cause the chocolate to melt. Legend has it that retailers fill the viscous paste into jars during the hot summer of 1949. Pietro Ferrero's son, Michele, adopts the idea, adds a more liquid vegetable oil to the crumbly chocolate mixture – et voila, he's come up with the brown creamy spread.

The outcome

In 1951, the supercrema gianduja spread hits market, albeit has to be renamed in 1962 due to a new Italian law prohibiting the use of the super prefix in brand names. The portmanteau "Nutella" is invented, combining the English word for nut and the Italian feminine diminutive -ella. In 1964, an Italian designer with the fitting name of Lelo Cremonesi creates the jar for the chocolate spread.



Teflon

The plan

... starts with Roy Plunkett, an employee of the U.S. chemical corporation DuPont, who is conducting research with tetrafluoroethylene in search for a new refrigerant for refrigerators in 1938.

The coincidence

Legend has it that the young chemist froze the gas in a pressurized canister that lost pressure overnight. The next morning, Plunkett discovers white, wax-like crumbs inside the canister. The molecules of the gas had bonded into long chains. The resulting polytetrafluoroethylene is highly inert and heat-resistant, and has minimal surface adhesion. Plunkett names the new polymer Teflon – and has no idea of what it may be used for.

The outcome

In 1941, Plunkett has the material with the abbreviation PTFE patented – and is still at a loss about what to do. Purportedly, in the 1950s, the French engineer Marc Grégoire had the idea of coating a fishing rod with the substance so that detangling the rod would be easier. However, only Grégoire's wife, Colette, comes up with the right strategy of coating pots and pans with PTFE. In 1956, Grégoire founds the company Tefal in Rumilly. The word Teflon in turn becomes a generic term in modern use of language – as a synonym for people's ability to simply let things slide off them.

By the way ...

The fact that Teflon was the result of NASA research has long been debunked. A New York retailer of household goods used this lie to promote its frying pans in 1970.



Microwave

The plan

In a laboratory of Raytheon, a U.S. company in the business of manufacturing refrigerators and transformers during peace time, Percy Spencer, in January of 1945, is experimenting with a secret weapon intended to lead the allied forces to victory at the battlefield. The device with the aptly sounding name of magnetron is a tube whose radiation enables radar systems that are able to track down bombers and submarines.

The coincidence

Nothing happens during the trials with electromagnetic radiation – except that a chocolate bar in Percy Spencer's pants pocket melts in practically no time. Following tests with bursting corn kernels and exploding eggs, Spencer, in 1947, develops the first microwave oven: 1.80 meters (6 feet) high and weighing 340 kilograms (750 pounds). The oven has a cooking output of 3,000 watts – three times as much as today's typically used ovens.

The outcome

1954 sees the launch of the first mini-series. The oven is named 1161 Radarange and sells for a current equivalent of roughly 20,000 dollars. But prices drop quickly and the microwave oven starts conquering more and more professional and domestic kitchens. Employer Raytheon makes a one-time payment of two dollars to Spencer for his discovery of the kitchen aid, the contractual standard for patents. However, Spencer, at some point in time, becomes a member of the company's executive board. Today, Raytheon is one of the top defense contractors in the United States – with an old Radarange model on display in its lobby.



Viagra

The plan

The substance sildenafil is originally tested for the purpose of developing a medication to treat coronary heart disease. The research scientists at Pfizer are hoping that the substance might be able to relax the blood vessels in the heart to alleviate the pains caused by angina pectoris.

The coincidence

The clinical trials are rather disappointing, especially because the substance degrades too quickly in the human body and interactions with nitroglycerin, the standard angina pectoris medication, are discovered. In addition, many of the trial patients report strange side effects. The whole project takes a truly remarkable turn when many men refuse to return the remaining drugs after the trial has ended, claiming that the medication somehow made them feel generally well. Subsequently, unknown perpetrators even break into a sildenafil laboratory. Pfizer launches a new clinical trial, this time with patients suffering from erectile dysfunction ...

The outcome

Commonly known blue pills. In 1998, Viagra is approved in the United States and Europe.

By the way ...

A second career for failed medications is not uncommon: Prozac, now known as an anti-depressant, was originally developed as a drug against hypertension. The clinical trial patients suddenly found themselves in high spirits. The pharmaceutical industry refers to this (cost-saving) strategy as drug repositioning.

»» *Surprise always happens where it's not expected*

Wilhelm Busch

Cornflakes

The plan

Dr. John Harvey Kellogg intends to bake a bread that will be conducive to digestion and sexual abstinence. Perhaps it should be mentioned in this context that the deeply religious Kellogg, in 1876, was the director of a then small health resort in Michigan, the Battle Creek Sanitarium, where he treats patients with a strict vegetarian diet, electric shocks, laughing therapies and ice-cold baths. Sounds curious, but the health resort will subsequently enjoy enormous popularity – even with Henry Ford and Thomas A. Edison.

The coincidence

The idea with the bread doesn't really pan out, albeit Kellogg, in 1894, inadvertently leaves some cooked wheat to sit overnight. Instead of throwing away the stale dough the next day, he forces it through rollers in hopes of obtaining long sheets of it. However, instead of sheets, he obtains flakes. The first ones are served (with a little salt) at the Sanitarium on March 7, 1897 under the name of Granose – and are well received as a medicinal form of nutrition.

The outcome

That the accidental invention of Granosa would turn into the world's most successful breakfast cereal is owed to Kellogg's brother, Will Keith, who's responsible for marketing. First the crumbs are converted into appetizing flakes made from tasty corn instead of from bland wheat. However, a huge market only develops when Will Keith Kellogg, in 1906, to the chagrin of his brother, mixes cane sugar into the recipe – the two brothers have a falling out and will never talk to each other again.





Friction match

The plan

The Briton John Walker is in search of a flammable substance for munitions production. For this purpose, the pharmacist from Stockton-on-Tees mixes sulfide of antimony and chlorate of potash with gum and starch.

The coincidence

The stuff burns better than expected. When residues of the compound stick to the stirrer Walker tries to wipe the paste off the rough surface – the stirrer bursts into flames – marking the birth of the friction match.

The outcome

Walker's idea doesn't make him a wealthy man. Instead, a Londoner named Samuel Jones hears about the accidental invention and files a patent application for it in 1828. He calls it Lucifers – due to its unsavory sulfur smell.

By the way ...

In 1930, the Swedish industrialist Ivar Kreuger develops a clever marketing strategy for matches: He grants large loans to Germany and 16 other countries at favorable terms. In return, he's awarded the "state monopoly on matches" and able to sell them at excessive prices. When the monopoly expires in Germany in 1983 prices drop by more than 30 percent.

Chewing gum

The plan

The New Yorker Thomas Adams, who has tried his luck in many areas from photography to selling glass, purchases a gum-like paste called chicle from the former Mexican general Antonio López de Santa Anna, who's living in exile in Staten Island. His objective is to produce low-cost tires from the milky sap of the Mexican sapodilla tree.

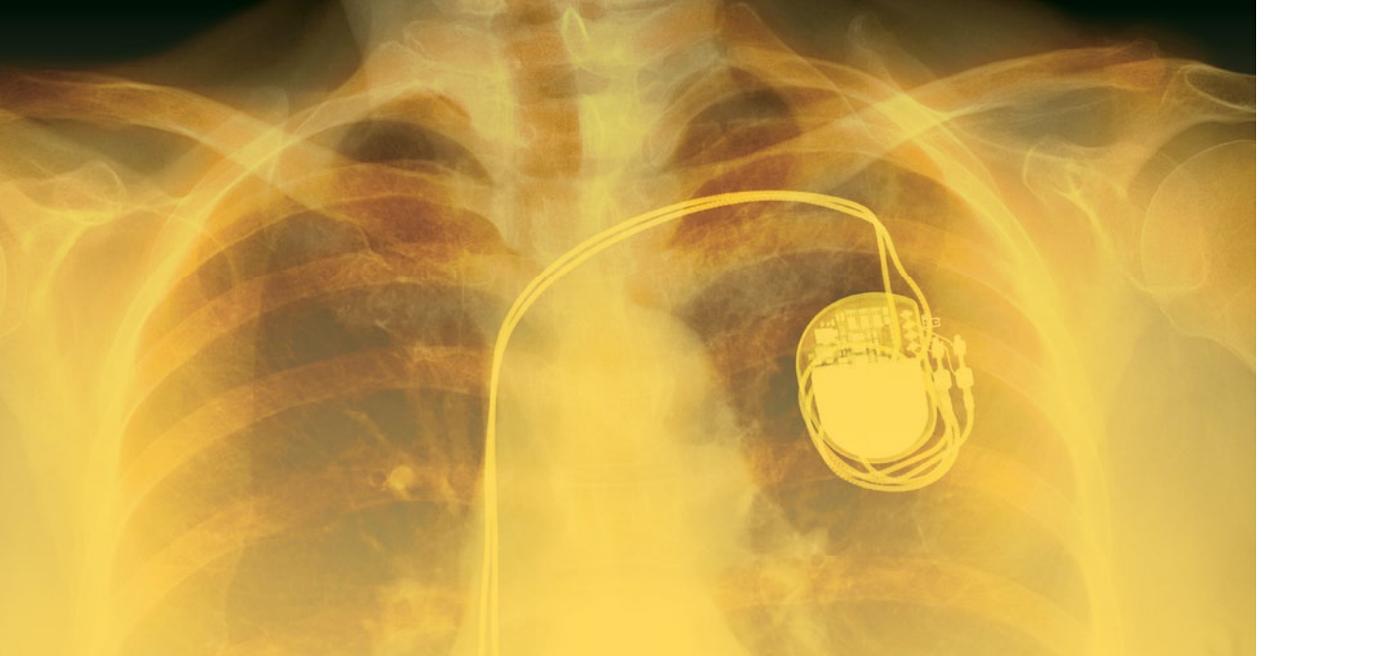
The coincidence

All attempts to vulcanize chicle in order to use it for horse and cart wheels and to become rich in that way are doomed to fail. No chance. However, at some point in time, Adams observes a girl in a drugstore buying paraffin wax for chewing. He recalls having heard that the Maya peoples were already chewing chicle. He puts a piece of it in his mouth – and has found the perfect use for this raw material.

The outcome

In 1869, the first patent for the production of chewing gum is filed. The first chicle balls are sold in a drugstore in Hoboken, New Jersey, in 1871. They're tasteless. Adams will only mix flavorings into the gum at a later point in time. As a result, "Black Jack" that hits the market in 1884 tastes like licorice. Today, 379 billion chewing gums are sold worldwide every year.





Cardiac pacemaker

The plan

Design an oscillator that records heartbeats – that was what two physicians commissioned the American electrical engineer Wilson Greatbatch to do in 1956.

The coincidence

While working on the project, Greatbatch, from a box of resistors, grabs a cylinder marked brown-black-green and 100 times higher resistance instead of the right combination of brown-black-orange. A fortunate mistake. Greatbatch, an inventor who filed a total of 325 patents, recognizes the potential of the failed oscillator (which pulses for 1.8 milliseconds and then stops for a full second) as a cardiac pacemaker and founds a company.

The outcome

Initially, there's no interest in the product – until Greatbatch meets Dr. William Chardack in 1958. The chief of surgery at the Veterans Administration Hospital in Buffalo asks Greatbatch to help him with a defective oximeter. Greatbatch is unable to comply with the request and instead asks the surgeon if he'd be interested in a cardiac pacemaker the size of a matchbox. Chardack tells him: "If you can do that, you can save 10,000 lives a year." On June 9, 1960, Chardack implants the first cardiac pacemaker in a patient.

By the way ...



More or less at the same time as Greatbatch, the Swedish physician Åke Senning together with engineers develops an implantable pacemaker as well and implants it in a patient in 1958. Even so, Greatbatch today is deemed to have provided the key impetus and to have been the sole inventor of the fully implantable pacemaker because he complements the device by a crucial innovation: Only a long-term lithium battery turns the cardiac pacemaker into an autonomous endurance runner. By contrast, the version developed by the swift Swedes requires regular external charging of the battery (which doesn't have a long life in the first place) – and, consequently, imposes severe constraints on the patients.

Battery



The plan

On a day in 1780, Luigi Galvani plans to eat frog legs cooked in oil.

The coincidence

Galvani places the dissected frog legs next to an “electrifying machine” – a very popular gadget among techies back in those days. Galvani’s frog legs start twitching as soon as he touches them with a knife. Based on his observation, the natural scientist establishes the theory of animal electricity, assuming that by using the knife he was able to dissipate the residual vitality from the animal. Today, we might refer to this as electrical discharge.

The outcome

When Galvani’s treatise of animal electricity is published in 1791, his compatriot Alessandro Volta repeats the experiment. According to the physicist’s theory, the metals are responsible for the twitching instead of an electrical fluid in the animal itself. Volta combines diverse metals, wets them with acids and finds that electrical voltage is generated in the event of contact. The voltaic pile has been invented – the prototype of the modern battery.

Smoke detector

The plan

In the late 1930s, the Swiss Walter Jäger is working on a poison gas sensor. The physicist ionizes air in a measurement device and applies voltage. Gas entering the device is supposed to bind the ions and thereby reduce the electrical conductivity of the sensor. That’s the plan.

The coincidence

Albeit, the measurement device measures nothing. Nothing at all. Frustrated, Jäger lights a cigarette – and the ampere meter records a drop in electric current. The smoke from the cigarette has achieved what wasn’t possible in that way with poison gas: The ions cling to the smoke particles. Which proves that smoking is a health hazard but in rare cases leads to inventions protecting us from death by inhaling smoke.

The outcome

However, there’s a catch to the contraption: Because ionization smoke detectors contain minimal amounts of radioactive materials, they’re prohibited for private use in Europe. The idea, though, lives on: Today, optical smoke detectors are commonly used. In them, emitted light rays, which are normally absorbed, are deflected by smoke particles toward a photo lens, thus triggering an alarm. In addition, app-based WiFi smoke detectors are now available that transmit warning signals to smartphones.



The author

Hamburg-based author **Wiebke Brauer** (ramp, ADAC Motorwelt, spiegel.de, and

other publications) is still trying to perfectly pronounce the word “serendipity.” In the event that she should succeed, it would be a lucky coincidence.

A win-win situation

When business and science successfully work together, hands-on knowledge from the industrial world is combined with the latest academic findings to create products with added value. But how do such university-business partnerships succeed – and how can they be systematically promoted?



By Denis Dilba

Professor Marion Merklein knew practically everything there was to know about Tailored Heat Treated Blanks (THTB). After all, the materials science engineer, who's currently the chair of manufacturing technology at Friedrich-Alexander University Erlangen-Nuremberg (FAU) and was recognized for her work with the prestigious Leibnitz Award in 2013, had been instrumental in inventing the heat-treated aluminum blanks composed of diverse material grades and thicknesses, as needed. For years, she'd been conducting relevant basic research, supervising master's and doctoral theses on the subject, and performed countless experiments and simulations. She knew exactly how and where the aluminum blanks had to be heated so that they'd subsequently be easier to form into fenders or B-pillars. Plus, she knew

that this special heat treatment made it possible for industry to use thinner sheet metal, lower-cost material grades and simpler tools without loss in quality.

However, only the cooperation with a potential industrial user of her high-tech blanks made the professor realize that the components formed from the blanks had to be "washed" in a subsequent process step. Otherwise oils and greases used in the forming process would make painting them near-impossible – not good for automotive body parts. "Examples like this show why university-business cooperation is so relevant: we were a little too enamored with the pure formability and had ignored the rest," says the professor. The technology only lent itself to successful use in high-volume production after being combined with

the input of her business partner, who, in turn, could not have developed the THBT.

Lack of motivation and closed societies hamper collaboration

Professor Thomas Baaken, Director of the Science-to-Business Marketing Research Center at Münster University for Applied Sciences, investigated the state of university-business cooperation (UBC) for the European Commission. Based on more than 17,000 interviews in 26 languages and 33 countries, the results of the most comprehensive relevant survey to date show that the top spots are held by Finland and Denmark, followed by the United Kingdom, Ireland, the Baltic States, the Netherlands and Germany, with Southern Europe lagging behind. The open culture of the Scandinavian countries is one of the factors contributing to this significant north-south divide, according to Baaken. In Scandinavia, he reports, the professors' doors are basically open to anyone, while the further south you go, the less cooperation on an equal footing is detectable. On the other hand, there's often a lack of trust and motivation on both sides in countries ranked in mid-field: the companies as well as the cooperating scientists there feel that they can only derive minor personal benefits and may even incur risks from UBC, according to the survey.

Owning patents doesn't necessarily mean using them

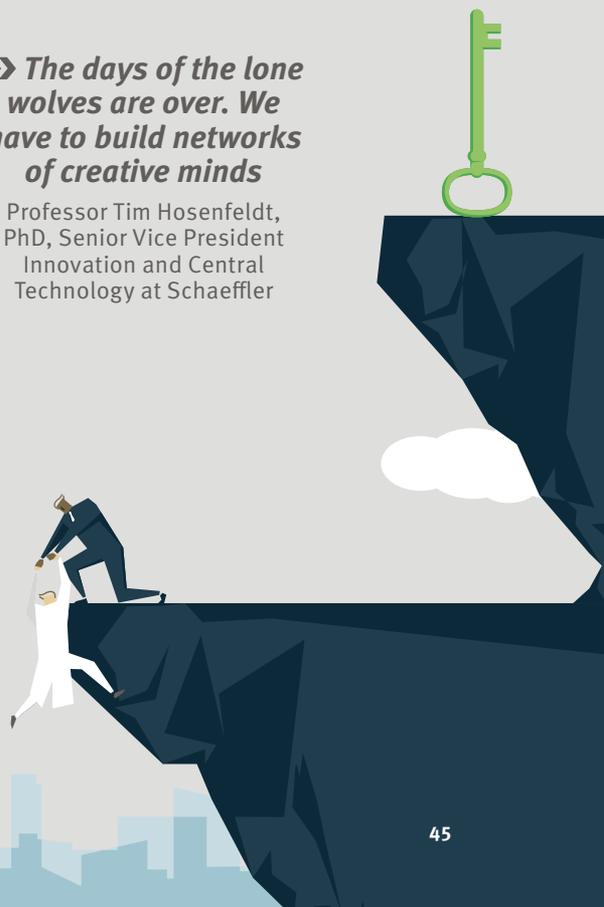
In the area of UBC, says Baaken, the United States fares no better than Europe. The system there is based on patenting and licensing scientific developments. It's focused on commercialization via licenses and much less on cooperation and joint success. Obviously, the expert says, patents per se aren't a negative, except when they're just gathering dust in a filing cabinet. It's not uncommon in the United States for patents to be bought for the sole purpose of being able to use them at some future point in time. It's commonly known that owning is better than needing. However, as a result, it's not uncommon for technologies to be kept away from the market rather than being put to use. "Because in early stages it's often unclear whether economically feasible use of a patent will actually be possible, many patents remain unused due to the financial risk – and thus, strictly speaking, are

flops," says Baaken. "The success stories of many large tech companies in the United States obscure the fact that transfer into business via patents doesn't work in 99 percent of the cases." In Baaken's opinion, this makes the frequently praised US system successful only to a limited extent. By contrast, European UBC project partners are increasingly filing for patents as a consortium after having previously agreed on the various forms of remuneration and commercialization. However, the requisite openness must be based on mutual trust within the cooperation, says the expert.

But how can the number and scope of successful UBC partnerships be systematically improved? Baaken's study provides a surprising answer: In the past, it was assumed that fewer barriers would result in more partnerships, but the survey showed that "when barriers against UBC are eliminated, nothing will happen at first – but when the drivers and motivation are strong enough, barriers are just overcome." Therefore, the researcher from Münster advocates motivational systems that will entice universities and businesses to enter into UBC partnerships. For instance, by increasing the

» *The days of the lone wolves are over. We have to build networks of creative minds*

Professor Tim Hosenfeldt,
PhD, Senior Vice President
Innovation and Central
Technology at Schaeffler





budgets of academic institutes and departments that are successfully engaged in UBC and by supporting the participating scientists in their career development – so far, only their output published in prestigious professional journals has been of relevance in this respect. The business community, on the other hand, might be granted special tax incentives for UBC research activities.

Long-term relationships between partners create the requisite trust

Marion Merklein shares the view that incentives make sense. Plus, she has another piece of advice she feels could be decisive for UBC success: “All the players involved in a project have to know in advance what’s possible in it and what to expect from it, and leave their egos at the door,” says the professor. Drawing up a roadmap in advance describing what will happen after completion of the project is helpful, too, “otherwise everyone will be hanging in the air,” Merklein warns. And how can a project become successful? “When the partners trust each other,” she says. “That’s why it’s best to build long-term relationships with business partners.” Schaeffler came to this realization years ago, too, and began to establish a

global cooperation network with universities (see right-hand page). “The days of the lone wolves are over. We have to build networks of creative minds,” says Professor Tim Hosenfeldt, PhD, Senior Vice President Innovation and Central Technology at Schaeffler. Thomas Baaken underlines this notion: “It’s important that, as a company, you start cooperating with universities to begin with – and vice versa.” In what areas, he adds, is not important at first. “Once trust has been established, the collaboration will soon spread to other fields – and may even result in real strategic partnerships.” With its SHARE projects, Schaeffler has already achieved this goal.



The author

Author **Denis Dilba**, who specializes in topics from the fields of science and technology with relevance to mobility, is familiar with cooperation

between business and academia from personal experience: while pursuing his degree, he developed an improved air intake system for a four-cylinder gasoline engine. Today, the system is used in mid-size models of a German automaker.



Joint efforts accelerate new products

What's the best way for UBC partners to maintain the close contact that's necessary for successful collaboration? Schaeffler's answer: by not allowing distance to develop in the first place. In its **Schaeffler Hub for Advanced Research (SHARE)** initiative, the technology group based in Herzogenaurach pursues the company-on-campus concept. "The idea is to have Schaeffler employees and researchers from the respective partner universities work together in an office on the local campus," says Dr. Michael Schlotter, Director of Applied Research – Innovation Networks at Schaeffler. "You can't cooperate more intensively than this." The SHARE projects are focused on application-oriented research intended to be fed into and accelerate pre-development and product development activities. Currently, there are four SHARE locations – each one with specific focal areas.

- SHARE at KIT (Karlsruhe Institute for Technology) has been working on projects in the fields of electric and automated mobility since 2013
- SHARE at FAU (Friedrich-Alexander University) Erlangen-Nuremberg specializes in digitalization topics and artificial intelligence
- SHARE at NTU (Nanyang Technological University in Singapore) is dedicated to questions of robotics and Industry 4.0 (see also "tomorrow" issue 2/2018)
- SHARE at SWJTU (Southwest Jiaotong University in the Chinese metropolis of Chengdu) is focused on interurban mobility, specifically rail transportation.

"With these SHARE projects, we're covering a large part of the innovation fields of strategic importance to Schaeffler," says Michael Schlotter. "However, if a demand for other focal areas emerges, we may establish additional locations. One or two may follow in the coming years."



The great reset?

How crises as catalysts accelerate innovation and transformation. Economic historian Robert Peters points out parallels between the past and present.

By Robert Peters

“Crisis as opportunity” is one of the dominant narratives in the current debate about the corona pandemic. In June, the World Economic Forum announced that its 2021 annual meeting would be billed as “The Great Reset.” The title of the conference takes its cue – presumably on purpose – from Richard Florida’s same-named work published in 2009. In his book, the American economist describes how crises spawn social and economic progress. Maja Göpel, Secretary General of the German Advisory Council on Global Change, echoes this view. “The experiences gained from the corona crisis can help bring the allocation of roles between government and the business community in line with the central challenges of the 21st century,” she believes. Together with Achim Truger, a member of the German Council of Economic Experts, she ventured the proposition that an “economic miracle 2.0” was possible as far back as in April. But can crises in view of the dramatic consequences of the corona crisis truly be opportunities and promote innovations? A look at history shows: yes, they can!

Historic and contemporary crises have in common that, time and again, their effects have massively influenced future social, economic and technological developments far beyond their direct impact which, in the case of the corona pandemic, means the consequences to the health of those contracting the disease. Here’s a case in point:

A structural crisis as an accelerator: Transformation in the textile industry

While in the wake of the economic upswing of the young Federal Republic industrial wages rapidly developed from the 1960s onward, the textile industry came under increasing pressure due to international competition, which led to an existential structural crisis. In response to it, the textile industry began to increase its capital expenditures in the 1980s and systematically pursued a path of seeking specialized niches while moving away from the globally competitive mass markets. Leveraging the existing know-how in this sector, efforts to develop new technologies for the – then still small – technical textiles market intensified. Thus, the industry emerged from the crisis by creating the decisive mid- to long-term prerequisites for shifting its traditional business models from

the clothing, home and household textiles markets to new ones in the technical textiles market. Today, the industry, which is characterized by small- and medium-size companies, generates around 60 percent of its sales in this country with the production of components and products for medical device technology, personal protective equipment (PPE), lightweight elements for the automotive sector, the aerospace industry and other high-tech textiles. Thanks to this successful transformation, Germany follows Italy in second place of the European ranking of countries generating the strongest sales in textile production.

What we learn from history: Recognizing and shaping change

This example shows that crises open up rooms of opportunity for shaping transformation. A parallel between the example of the German textile industry and the chains of effects described in this article is the fact that, irrespective of their actual core, crises can trigger push-effects in other areas. In the case of the corona pandemic – in other words, a global health emergency – we’re observing a significant digitalization boost, the consequences of which we’re only going to grasp and comprehend completely a few years from now.

A look at the history books shows that companies which recognized opportunities early on, responded with agility, adjusted their products and adapted new (efficient) processes were nearly always the ones that emerged from a crisis as winners. In the case of the textile industry, the companies

»» Life can only be understood backwards, but it must be lived forwards

Søren Kierkegaard,
Danish philosopher

How one thing leads to another

Two chains of effects in history whose developments have helped shape today's world.

The path toward a divided world

1769

The Scotsman James Watt is awarded a patent for the “double-acting steam engine” in which the cylinder in the piston is moved in both directions by steam. This increases the engine's efficiency six-fold compared to the previously used atmospheric steam engines (developed by Thomas Newcomen in 1712 and others). At the same time, Watt establishes horsepower (hp) as a unit of measuring power.



1807

The steam engine accelerates the industrial revolution – quite literally: The world's first steamship navigates the Hudson River and 18 years later, the first steam engine travels on an English railroad – ushering in a transportation revolution that makes it cheaper and faster to haul raw materials and goods. For instance, while 1,300 metric tons (1,430 short tons) of cotton were processed in England in 1760, 190,000 metric tons (210,000 short tons) were in 1860.



Early 19th century

The industrial revolution fundamentally transforms society. Self-employed craftsmen are frequently unable to withstand the competitive pressure and forced to give up their business. Large numbers of journeymen, farmers and their

families move from the country to the city in search of work. Labor is available in abundance, so factory owners often pay only poverty wages. Many people in rapidly growing cities are malnourished and the hygienic conditions are horrible. Diseases like tuberculosis spread like wildfire.



From 1830

The first labor movements begin to form.



1871

The Paris Commune is deemed to be the first proletarian – albeit unsuccessful – revolution in the world.



1883

Otto von Bismarck introduces health insurance (1883), accident insurance (1884) and social security (1889) in Germany – not least in order to curb the growing influence of social democrats and unions.



1891

Pope Leo XIII issues Rerum Novarum, the first social encyclical, which is deemed to have originated Catholic social teaching, a key pillar of European People's Parties with a Christian-Democratic character.



1917

Due to the October Revolution backed by the bolsheviks, Russia becomes the communist Soviet Union – ushering in a deep ideological divide in the world.

The path toward a globalized world

13th century

Princes of Turkish origin take advantage of the faltering Byzantine Empire in the west and the Mongolians in the east and start establishing small dominions in the conflict area.

July 27, 1302

Osman I is one of these princes. The victory of his soldiers against

a Byzantine army in the Battle of Bapheus marks the founding day of the Ottoman dynasty.

1453

Osman's descendant Sultan Mehmed II conquers Constantinople, sealing the rise of the Ottoman Empire to the level of a major power.

1492

The power gained by the Ottomans makes European trade with Asia on land more difficult. Accelerated by this trade crisis, the motivation to find a fast sea route to India increases. Christopher Columbus embarks on the

journey – and discovers America, an event that's also deemed to mark the transition from the Middle Ages to the Modern Age.

After 1492

Columbus' discovery initiates colonialism and European expansion. The consequences are massive worldwide migration of populations and the forcible spreading of European culture. Maritime trade lays the foundation for the development of worldwide economic relations for progressive international interlinking that will subsequently be referred to as globalization.

that successfully transferred their manufacturing and processing know-how in traditional textiles to new, functional materials and gathered experience in the development of technical textiles were the winners.

Such transformation processes also required employees to be highly flexible in terms of further education, retraining or even relocating or changing employers to avoid emerging from the crisis as losers.

This is what looking back teaches us

Consequently, for decision makers in business and politics, learning from history means amplifying the momentum of progress resulting from the current crisis by offering investment incentives and providing small companies and startups in particular with certainty and freedom of opportunity to shape change in their sectors. At the same time, it is necessary to mitigate negative social effects

by strengthening education, training and development. This is not just a question of justice. After all, social convergence is a key prerequisite for economic prosperity. A relaunch from the crisis can be achieved only by a joint effort and only a joint effort may make the "economic miracle 2.0" invoked by Maja Göpel and Achim Truger a reality.



The author

Robert Peters did research work as an economic historian at RWTH Aachen. Today, as a futurist at the Institute for Innovation and Technology (iit)

in Berlin, he works as a consultant to key players in business and politics. For him, it's clear: "It is up to us to decide whether our actions will renew existing structures or merely reproduce them."

Here and now

Living with progress

Electricity from an e-car

A large high-voltage battery like the one in the Audi e-tron stores up to 95 kWh of energy. Theoretically, this is enough for operating various appliances around the clock.

9,500 times

Charging a **smartphone**

5,700 minutes

Operating a **1,000-watt electric water kettle**

544 hours

Running a **washing machine**

95 times

Turning on a **convection** for 30 minutes

40 hours

Vacuum cleaning

31 days

Operating a **refrigerator**

The e-car as an energy supplier

Blaring TV sets, humming dishwashers, glowing toasters: none of these would be possible without electric energy. In the future, power might be supplied directly by our own electric cars, provided that they're not just plugged into regular outlets but integrated into the electrical systems of our homes via wallbox chargers. The technical term for this is bi-directional charging or Vehicle to Home (V2H). The battery of an electric car as a smart and decentralized storage medium is a really hot topic in the energy transition context. The reason is that increasing registrations of electric

cars logically increase the number of mobile storage systems as well. Audi and the Hager Group are currently pursuing this vision in an innovative research project. V2H offers major advantages particularly in interaction with domestic photovoltaic systems. Surplus power can be fed into intermediate storage and supplied as needed, for instance at night when solar collectors don't produce any electricity. For example, the 95-kWh battery of an Audi e-tron would be able to self-sufficiently supply a one-family home with green electricity for roughly one week.



**» Today the utopia of
the morning is the reality
of the afternoon**

Truman Capote,
American novelist

The belt-driven starter generator (BSG) replaces the starter and the alternator, assists the IC engine in starting (“boosting”) and allows the car to coast when the IC engine is completely turned off

The de-coupling tensioner aka ring tensioner: using a bow spring and two tensioner pulleys, it provides the required tension and damping of the V-ribbed belt in both directions of the force flow

Crankshaft of the IC engine

The bearings of the pulley decoupler have to resist the higher torque requirements of the 48-volt hybrid system

Auxiliary component, e.g. an air conditioning compressor, lubricant pump or brake booster

The **pulley decoupler** sits directly on the crankshaft, absorbs the vibrations of the IC engine by means of bow spring elements and reduces the loads acting on all components in the auxiliary drive

All **belts** are not created equal: the FEAD version is not a conventional V-ribbed belt but a wider 48-V belt with fiber-reinforced tension cords

Preventive action

The transformation toward e-mobility doesn't stop at the gates of the spare parts market. Schaeffler Automotive Aftermarket is gearing up for the demands of tomorrow.

The key question is: what spare parts and services will still be needed in the future? Even though hybrid and battery-electric vehicles – irrespective of their type of powertrain – only become relevant to the independent aftermarket at an age of more than five years, Schaeffler's Automotive Aftermarket business unit is gearing up now to serve coming needs: it's the first supplier to offer a repair kit – even before 48-volt hybrids start hitting the garages for routine repairs.

On 48-V hybrids, the conventional alternator is replaced by a belt-driven starter-generator – a so-called PO architecture. While switching from the charge phase to the boost phase, the direction of the belt drive's torque is reversed. In addition, this directional change and the higher output of the generator result in higher loads acting on the V-ribbed belt, bearings and other components. Therefore, the INA FEAD KIT repair solution (FEAD = Front End Auxiliary Drive) for 48-V hybrids developed by Schaeffler additionally includes a decoupling tensioner and a pulley decoupler to absorb these special loads in the auxiliary component drive. This makes it possible for garages to perform fast and professional repairs in the event of damage to the auxiliary component drive.

48-V hybrid powertrain systems deliver

7%

better **fuel economy** compared to a conventional IC engine.

Source: Schaeffler

More electrical output

The 48-volt mild-hybrid technology opens up new opportunities: while the conventional alternator is a simple generator of electricity, the FEAD system morphs into a bi-directional energy supplier.

Conventional alternator



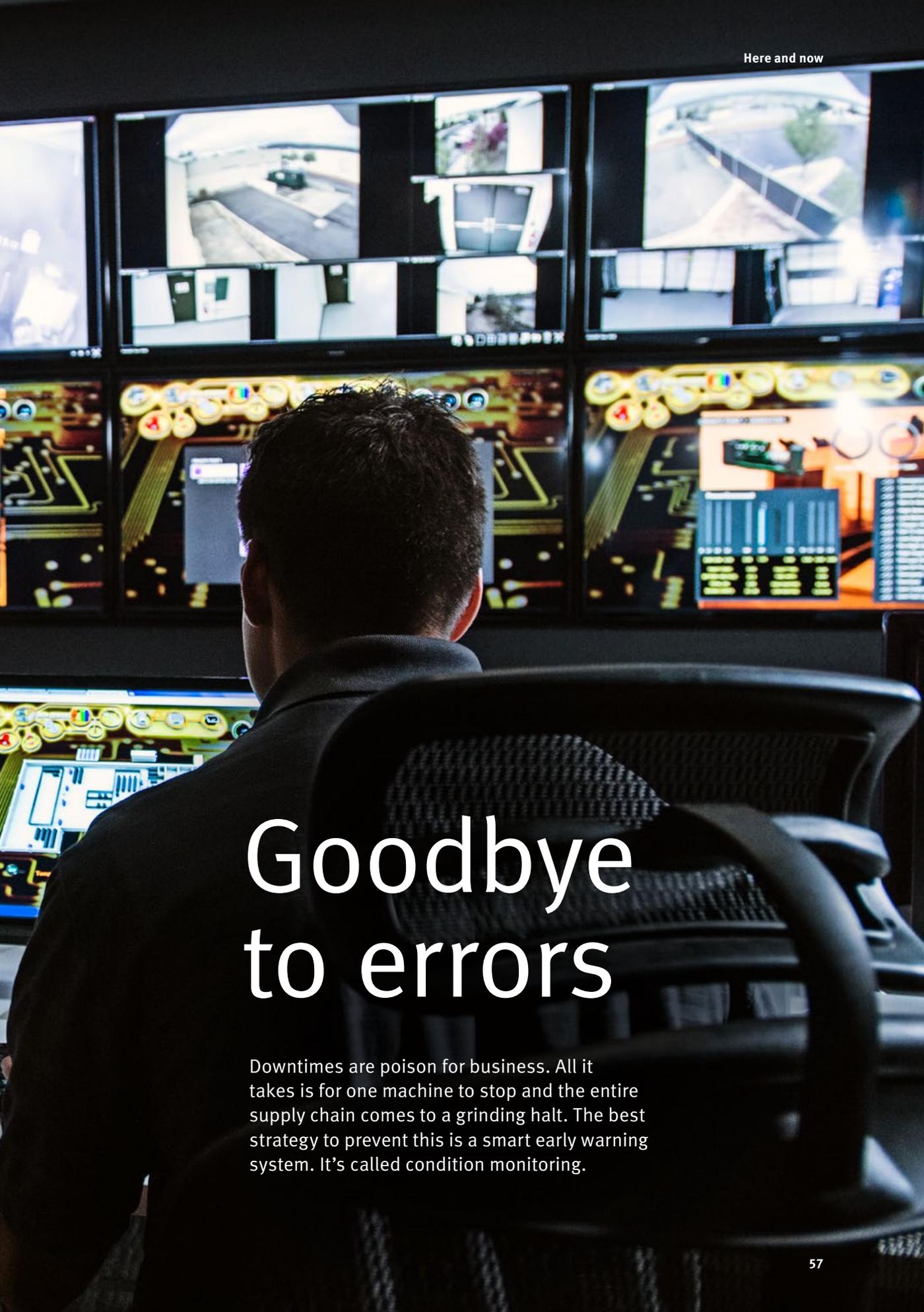
Output **approx. 2 kW**
Torque **approx. 7 Nm**

Belt-driven starter generator (BSG)



Output **approx. 15 kW**
Torque **approx. 50 Nm**



A person is seen from behind, sitting in a control room. They are looking at a wall of multiple monitors. The top row of monitors shows various video feeds, including what appears to be a train and some industrial or outdoor scenes. The bottom row of monitors displays complex data dashboards with numerous gauges, graphs, and charts, typical of a modern industrial or transportation control center. The person is wearing a dark jacket and is seated in a black office chair.

Goodbye to errors

Downtimes are poison for business. All it takes is for one machine to stop and the entire supply chain comes to a grinding halt. The best strategy to prevent this is a smart early warning system. It's called condition monitoring.

Today, more than ever, modern societies are dependent on technology and machines. We travel in cars and on buses and trains. We rely on the turbines of airplanes and on power grids. Combines harvest our grain crops and trucks deliver our food to refrigerated supermarkets. It's easy to forget how much our life relies on machines – until they happen to fail. Care, maintenance and servicing are crucial. While companies rely on a certain amount of planned downtime to inspect machines for safety and necessary repairs, unplanned downtimes and sudden trouble can lead to enormous losses. They upend production plans, bring considerable costs and also result in loss of customer confidence. Developing and implementing suitable maintenance strategies is more important than ever – and the trend here is toward proactive maintenance.

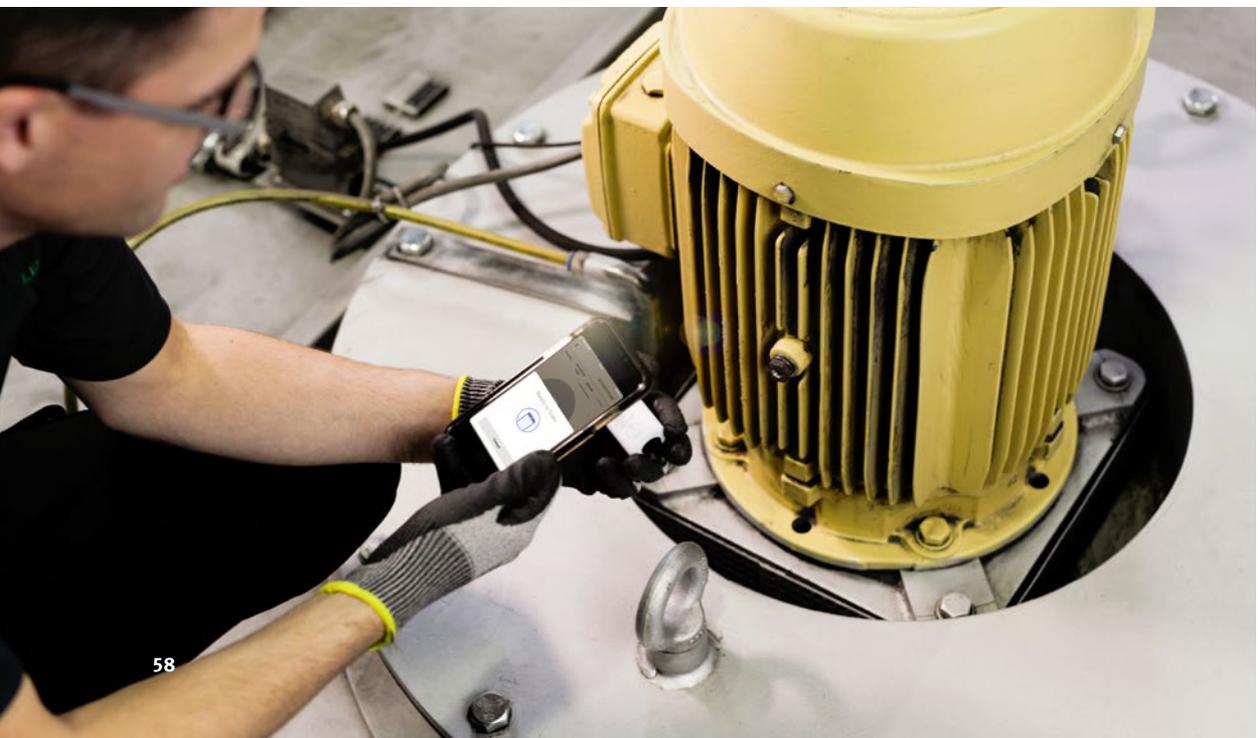
Condition monitoring is just such a proactive tool: Sensors monitor units or individual components directly at the machine by measuring temperatures, rotational speeds or vibrations, for example. Algorithms analyze the data in real time and provide information about wear. This prevents or shortens downtimes, produces less scrap and reduces maintenance costs. Actually, condition monitoring

is nothing new. In the 1960s, the first oil warning lights appeared in premium automobiles, and aviation nearly perfected the systems. Aircraft are equipped with thousands of sensors. In cruise flight conditions, pressure, rotational speed, oil and kerosene flow, vibrations and exhaust temperatures are measured on the engines. Operators can then draw conclusions about how much longer an engine might last and whether early signs of wear or defects are emerging. This pays off – after all, every hour of downtime on the ground costs an airline tens of thousands of dollars or euros.

Transparency is key – industry-wide

In contrast, reality in the industrial world is different – still today. The cost and effort involved in integrating such solutions into production environments is often a hurdle to machine monitoring. In addition, setting up and operating these solutions requires in-depth know-how. Smaller and medium-size enterprises (SMEs), in particular, shy away from incurring the costs for condition monitoring. As a result, their use of condition monitoring is limited primarily to individual, process-critical machines. “In the process and automation industry, it's not uncommon for up to 95 percent of equipment units to not be

Analysis in the cloud: The data captured by condition monitoring is processed by requisite algorithms – based on Schaeffler's extensive know-how in condition monitoring of rolling bearings, developed over decades



monitored at all or only through routine manual measurements, which occur at intervals of four to six months, for instance,” says Rauli Hantikainen, Senior Vice President Industry 4.0 at automotive and industrial supplier Schaeffler. In Germany alone, several million so-called brown-field machines lacking sensors and software interfaces are in operation. But this doesn’t have to be a showstopper.

Schaeffler has clearly identified the key strategic growth field of “Industry 4.0 Service Solutions” and, accordingly, launched OPTIME, an efficient and easy-to-use condition monitoring solution in an attractively priced segment. With its OPTIME solution of wireless, battery-operated vibration sensors, combined with digital services and analytics in the cloud, Schaeffler removes commonly known barriers (see also infographic on next page). Whereas monitoring solutions for process-critical machines with variable operating conditions may cost tens – or even hundreds– of thousands of euros, OPTIME monitors at 30% of the cost compared to route-based or online measurement systems, making it economical even for smaller drive units and motors. By spending just a few cents per day, the customer can monitor up to ten times more machines than just a few years ago. “You can equip an entire plant with OPTIME, including all subsystems and ancillary components,” says Hantikainen. “We’ve designed the solution as a practical plug-and-play system: Users don’t need any in-house knowledge about condition monitoring.” The sensors are activated by means of near-field communication via the app, allocated to the machine and subsequently bolted to the equipment. Even with little or

» Unplanned downtimes can be reliably avoided only when keeping an eye on the condition of all machines

Rauli Hantikainen,
Senior Vice President Industry 4.0
at Schaeffler

Three examples from the Schaeffler world

Sector: Drinking water production

A Schaeffler customer purifies up to 200 million liters (53 million gallons) of water per day. It’s filtered, chlorinated, ozonized and biologically activated. The customer was looking for a smart condition monitoring system in order to prevent failures of its 15 pumping stations. The Schaeffler solution monitors the most important units with 84 sensors and thus supports reliable water supply to the region.

Sector: Facility engineering

Assisted by Schaeffler, Engie Cofely, a major European facility management services provider (3,000 employees) switched from decentralized, temporary monitoring to permanent, centrally controlled condition monitoring, initially of its own facilities. Routine walkthroughs with long distances between buildings to inspect critical equipment are no longer necessary. Utilized in customer buildings, several million euros per year could be saved in this way.



Sector: Wood industry

Some 240,000 cubic meters (8.5 million cubic feet) of sawn lumber per year are produced by the Norra Timber sawmill in Kåge, Sweden. Especially the saws have to run without interruptions for the business to be profitable. Unplanned downtime will quickly cause costs of several thousand euros. That’s why the fact that not a single unexpected failure has occurred since the rollout of a condition monitoring solution from Schaeffler is all the more gratifying.

almost no training an employee can perform the task in just two to four minutes. All sensors autonomously connect to each other and – via the gateway – create an independent mesh network.

Millions of units could be managed in just one network, with enormous benefits for customers: no insertion of cables, no complex configuration, just plug-and-play using a smartphone. The data are available shortly after installation. In this way, a large number of machines and equipment can be reliably connected irrespective of their control units and without requiring hundreds of meters or yards of cable ducts or wireways and technical conversions. Naturally, there are exceptions, which Schaeffler investigates on-site together with the customer in order to apply other

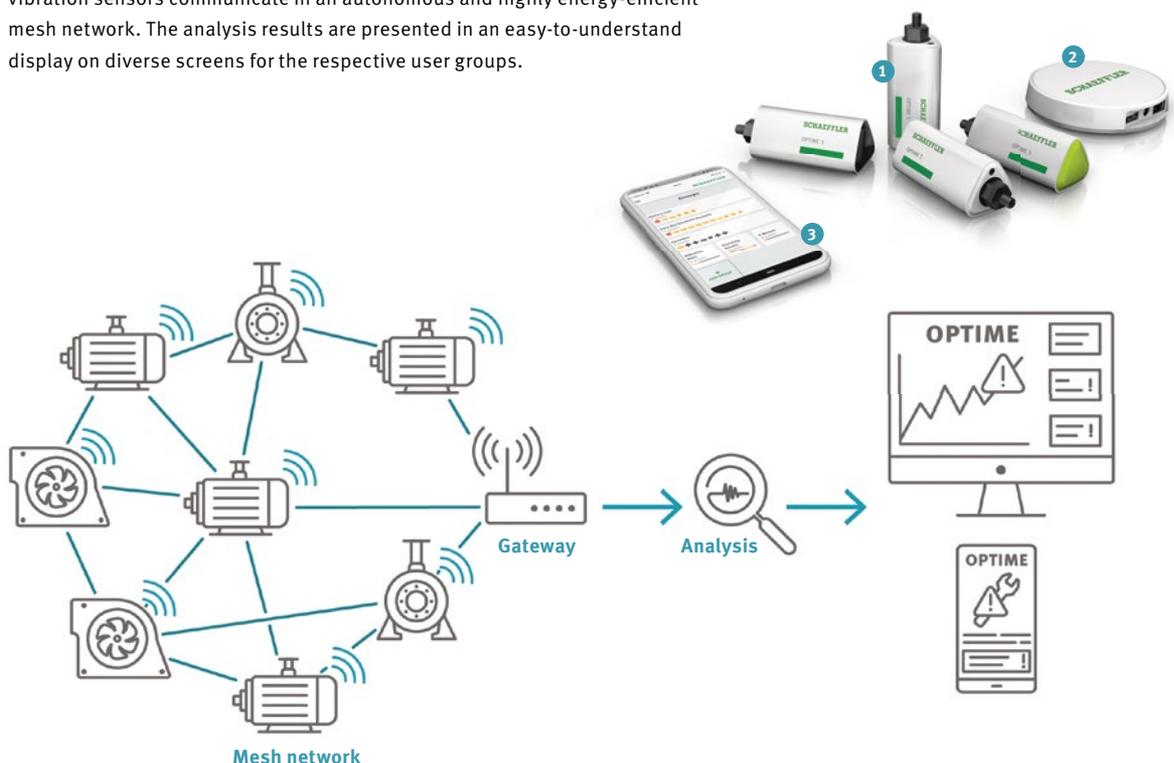
solutions. One of these is ProLink, a cable-bound condition monitoring system for up to 16 measuring points that captures and analyzes vibrations as well as other measurands

“Monitoring fever” – with a pay-off

With OPTIME, Schaeffler emphasizes scalability: Monitoring can be implemented in an exemplary pilot project and its operational economy demonstrated. Based on this, the subsequent approach can be scaled and rolled out across the entire plant or even across locations. Rauli Hantikainen relates the situation of a customer who originally wanted to install 150 sensors. When the installation of the sensors proved to be so simple and uncomplicated, the customer decided to install as

Hundreds of machine types can benefit from Schaeffler’s solution

In addition to the sensors (1), the innovative OPTIME system consists of a gateway (2) and an app (3) for visualizing the results. With plug & work, the condition monitoring system is configured with a few clicks in a matter of minutes and suitable for early detection of damage on a wide variety of machines. The wireless vibration sensors communicate in an autonomous and highly energy-efficient mesh network. The analysis results are presented in an easy-to-understand display on diverse screens for the respective user groups.



The data captured by condition monitoring are analyzed in a cloud. Schaeffler has developed requisite algorithms based on decades-long know-how in condition monitoring of rolling bearings



many as 300 within three days. A “monitoring fever” had broken out at the plant. And on day four, an impending downtime was prevented thanks to the newfound ability to quickly identify and thoroughly eliminate the trouble sources. “Condition monitoring detects damage to the respective components weeks ahead of time, identifies and prioritizes the critical machines in the app and issues specific recommendations for actions,” explains Dr. Philipp Jussen, Head of SaaS & Digital Services at Schaeffler. The recyclable disposable sensors with a battery life of approximately five years provide relevant vibration and temperature readings six times a day as well as other key performance indicators (KPIs) to Schaeffler’s IoT hub.

Data analysis is performed in the cloud. “Our algorithms are based on decades-long development of physical models and experience gained in condition monitoring of rolling bearings,” Jussen adds. “Merely gathering data is not enough. The way in which data are interpreted is crucial. This requires suitable algorithms.” Even at this juncture, many different types of algorithms are interlinked to form a complex kind of analytics, including artificial intelligence. Schaeffler is continuously pursuing the further development of such analytics. After all, the application is intended to make the jobs of maintenance crews easier and to

ensure timely and cost-efficient planning of maintenance work, manpower and spare parts procurement. For its own Industry 4.0 business unit, Schaeffler targets to create a significant installed base with lead customer by the end of 2020.

“Condition monitoring can be deployed outside of production halls as well – in the chemical industry, in wind farms and on oil drilling platforms; the scope of its utilization is almost limitless,” says Hantikainen. “And needless to say, the systems are in operation at Schaeffler’s production sites as well. We only offer what we use ourselves.”



The author

The pursuit of efficiency has also spread to personal lifestyle choices. For some time now, people have been trying to meticulously monitor and control

their bodies, like one of **Oliver Jesgulke’s** friends. Adopting a preventive lifestyle from morning to night? That’s not a good choice for the author, who’d rather enjoy a private downtime here and there.

The future wound in a coil

Be it in cars, trains or airplanes, in systems ranging from hybrid to fully electric, using batteries or fuel cells: mobility of the future requires electric motors. But how does an electric motor actually work? And how can the technology be optimized?

By Franz W. Rother

Why an electric motor?

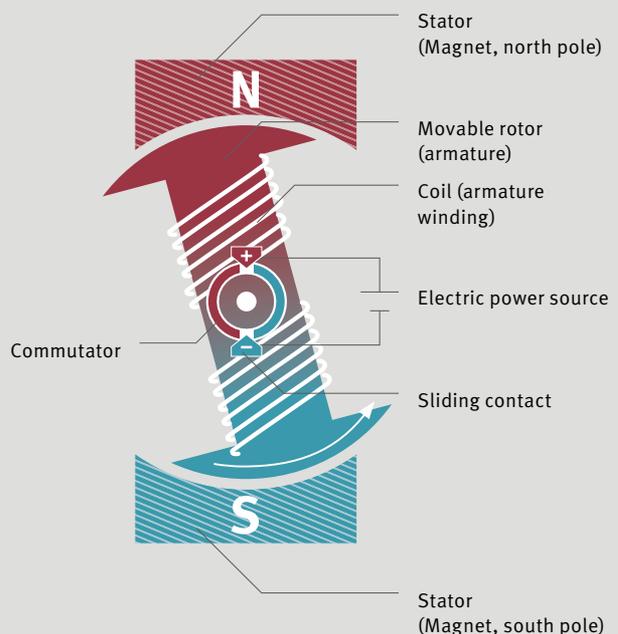
After the internal combustion engine provided practically unrivaled propulsion in personal mobility over the past 130 years, a paradigm change is currently emerging. To curb climate change and to noticeably reduce the high levels of noise and air pollutant emissions in big cities, not only new mobility concepts are needed. Needed as well are drive systems that don't use fossil fuels and operate with zero emissions, at least locally. This puts the focus on a propulsion

system which the German automotive industry ever since the construction of the Flocken car in 1888 had lost sight of to some extent: the electric motor. On a small scale, it's been operating in billions of household appliances of all kinds, be it in washing machines or blenders. On a large scale, it's been propelling trains, moving people in elevators and lifting loads in cranes. Now it's about to see a revival in automotive engineering.

How an electric motor works

Our physics teacher used to explain it like this: Simply put, an electric motor consists of three components: a stator, a rotor and a commutator. The stator is a magnet that's permanently connected to the housing. The rotor is located between the north and south sides of this magnet. It sits on the motor axis and consists of iron around which copper wire is wound. When current flows through the wire the rotor becomes an electromagnet that also has a north and south pole. Because the same magnetic poles repel each other the rotor rotates as soon as the same poles of the rotor and stator are in proximity of each other. However, after half a rotation, the mutually attractive north and south poles of the two magnets would be next to each other and the rotation would instantly stop.

That's why, after half a rotation, the direction of the electric current in the rotor's copper wire is simply reversed. This reversal of polarity is achieved by means of the sliding contacts in the commutator. In the case of AC motors, the polarity of the magnetic field automatically reverses in sync with the cycle of the grid frequency, which at 50 hertz occurs 50 times per second.



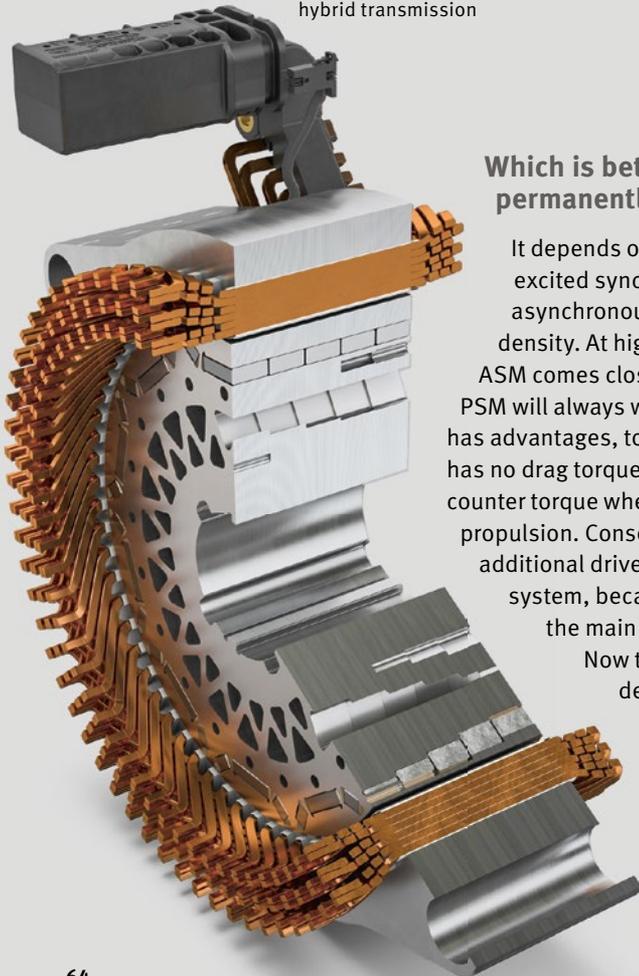
Which motors are used in electric cars?

DC electric motors no longer play any part as traction motors in today's passenger cars. They're only used as servo motors, for instance in power windows. Electric vehicles use AC motors for propulsion. In spite of their greater technical complexity, they offer a range of advantages: long life and low maintenance and, above all, high levels of efficiency and power density. Unlike those of DC motors, the stators of AC motors consist of at least three coils. Together, they generate a rotating magnetic field corresponding to that of the rotor.

Are all AC motors created equal?

No, AC motors are classified either as synchronous or asynchronous motors. In a synchronous motor, the magnetic field moves in synchronicity with the rotor speed. The excitation of the rotor may emanate from permanent magnets. In this case, the motor is referred to as a permanently excited synchronous motor (PSM). Or the excitation is caused by currents induced in the windings, in which case the motor is a separately excited synchronous motor (SSM). The magnetic rotation force is generated by the current flowing through the windings of the stator. In the case of the asynchronous motor (ASM), the magnetic field moves in interaction with the excitation field of the rotor, i. e. asynchronously. In this case, the current in the rotor windings generates the magnetic rotation force with the excitation field.

Compact e-motor from Schaeffler in a hybrid transmission



Which is better – an asynchronous or a permanently excited synchronous motor?

It depends on the purpose for which it's used. A permanently excited synchronous motor (PSM) is basically superior to an asynchronous (ASM) unit in terms of efficiency and power density. At higher rotational speeds, the efficiency of an ASM comes closer to that of a PSM. However, a well-designed PSM will always win out as a traction motor, although an ASM has advantages, too: It doesn't require expensive magnets and has no drag torque. The latter means that it doesn't produce any counter torque when it's not energized – and thus won't slow down propulsion. Consequently, an ASM is ideally suited for use as an additional drive motor, for instance in an electrical all-wheel system, because the vehicle in large part is driven only with the main drive axle and the ASM just runs in parallel.

Now the benefits of both sides, i. e. high-level power density, good efficiency, no magnets and no drag torque, need to be combined. "In this direction, we can expect considerable potential of the separately excited synchronous motor. There's a lot happening in this area at the moment," says Thomas Pfund, who leads Schaeffler's E-Systems business unit.

How can the e-motor still be improved?

Ever since the auto industry has rediscovered the electric motor as a propulsion machine, vehicle manufacturers and suppliers have been busy exploring ways to optimize this technology. Expert Pfund outlines the challenges: “Efficiency and power density must be enhanced, production costs reduced by new manufacturing technologies and optimized material utilization, and noise emissions minimized” – after all, an electric automobile should not be humming like a streetcar. Even more important, he adds, is another effect: “Due to the growing efficiency of the motor, future electric vehicles will require less energy and, as a result, deliver much greater range on a single battery charge.”



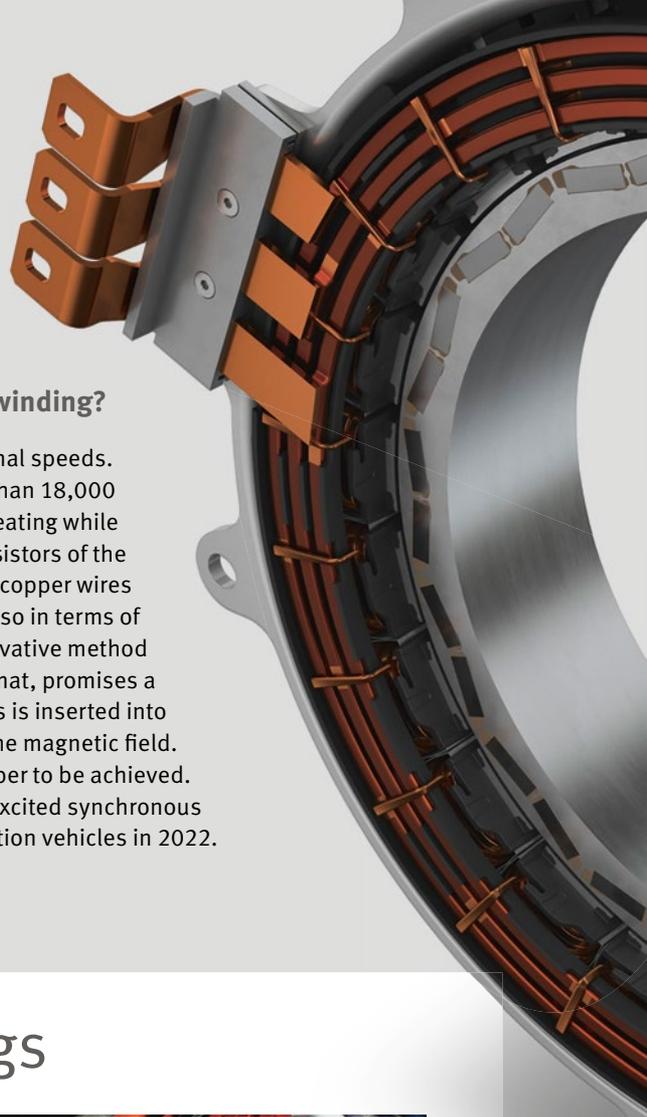
Schaeffler offers e-motors in a capacity range from 15 to 300 kW

Is Formula E helping to optimize the electric motor?

In motor racing, the auto industry tests the limits of what’s technically feasible. This applies to Formula E as well. The PSM electric motors in the race cars of the Audi Sport ABT Schaeffler team are among the most efficient power-plants in the entire field, but also extreme units from a detailed perspective: The steel panels making up the steel packages of the Audi e-tron FE06 have a mere thickness of 0.05 millimeters (0.002 inches) in order to minimize losses induced by “dirty air.” Obviously, this comes at a price. The steel sheets currently used in production cars are about five times as thick. Such examples

show where materials and production processes reach their limits and result in important findings that Schaeffler contributes to mass production of e-motors. Another topic with production relevance is the fact that SiC semiconductors operate with clearly higher cycle frequencies and therefore also have effects on electric motors. Formula E started using this technology and now SiC inverters have found their way into production, too. Clever designs, e. g. for cooling systems, have great potential for adoption by mass production as well. Schaeffler’s expert Pfund is sure that “the race has just begun.”





What's the role of coil winding?

Traction motors for electric cars operate at high rotational speeds.

The rotor may be spinning around its own axis more than 18,000 times per minute. To keep the motor from overheating while continuously delivering high power density, the resistors of the energized coils must be minimized. The winding of the copper wires is a science unto itself and highly sophisticated also in terms of manufacturing technology. Bar wave winding, an innovative method developed by Schaeffler's subsidiary Elmotec Statomat, promises a development leap in this area. A braided band of flat wires is inserted into the steel sheet package of the stator that generates the magnetic field. This principle allows a very high fill level of energized copper to be achieved.

Thomas Pfund is expecting initial permanently excited synchronous machines using bar wave winding to appear in production vehicles in 2022.

Types of coil windings



Single tooth winding requires the smallest design space and offers production benefits for winding-heads



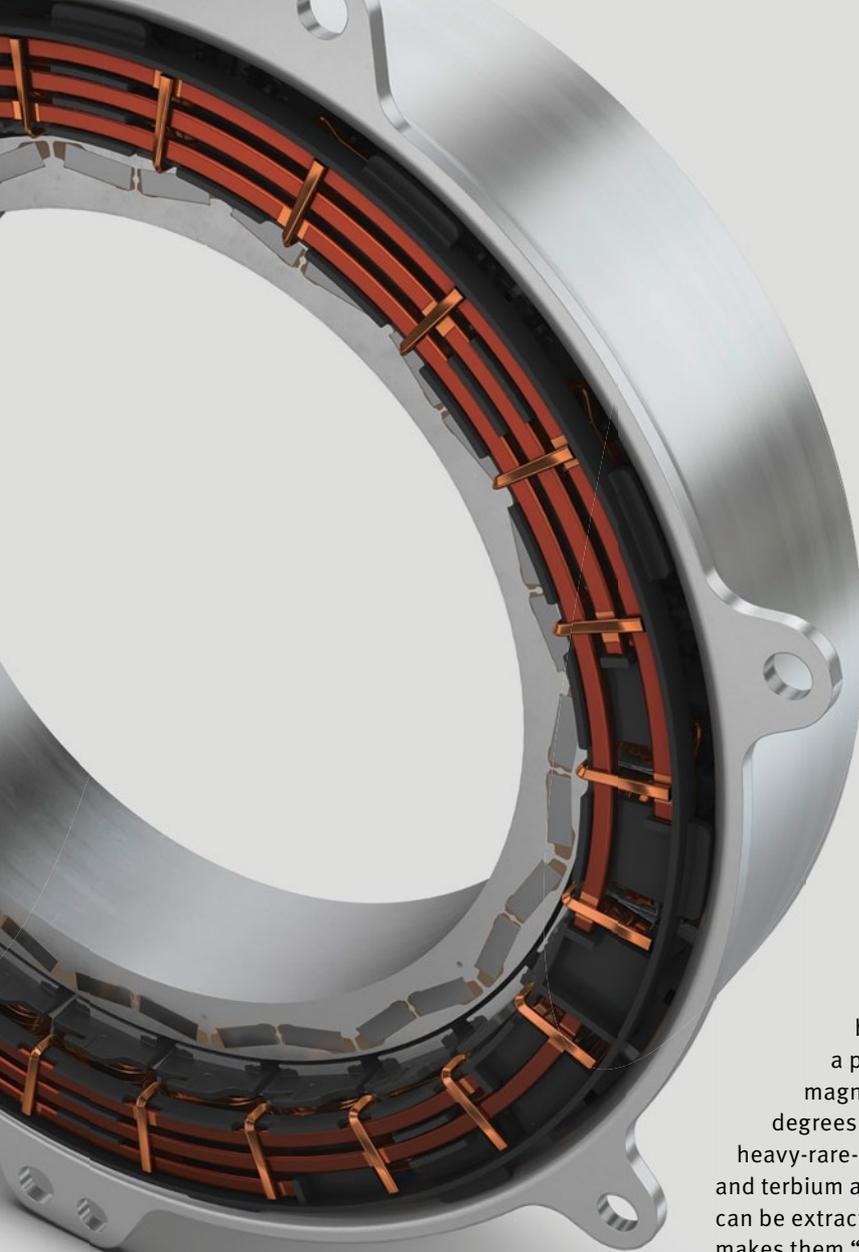
In the **hairpin method**, a large amount of copper is inserted into the coil. The fill factor is respectively high



Low frequency-dependent losses and cost-efficient production are the fortes of **round wire winding**



The high fill factor of **bar wave winding** developed by Schaeffler's subsidiary Elmotec Statomat provides higher power density



Hybrid module
from Schaeffler with
minimal axial length

Is there still potential in terms of environmental protection and cost reductions?

High field strengths like those required for traction motors can only be generated with rare-earth magnets. A commonly used light-rare-earth element is neodymium, which, in the right combination ratios with other elements such as iron or boron, becomes a magnet. However, a pure neodymium magnet loses its magnetization at temperatures of 80 degrees centigrade (176 °F). To prevent this, heavy-rare-earth elements such as dysprosium and terbium are added. These are truly rare and can be extracted only by a complex process. This makes them “brutally expensive,” according to expert Thomas Pfund. However, a clever design of the electric motor and an intelligent cooling concept has clearly reduced the proportion of these critical materials. Also, work to achieve new material combinations is in progress – although rare earths cannot be completely dispensed with.



The author

Franz W. Rother is publisher and editor-in-chief of Edison, the lifestyle magazine for new mobility and connected life. He's been covering the topic of electric cars ever since a 1992 visit to the island of Rügen, where the German

federal government was running a large-scale EV pilot test. An electric Renault Zoe has recently found its way into his garage.

“Not a single supply shortage to date”

Smart, global, efficient, agile: Schaeffler’s production system defies the crisis. An interview with Andreas Schick, Chief Operating Officer with responsibility for Production, Supply Chain Management and Purchasing at Schaeffler.

Corona has led to growing reservations about an increasingly globalized world. Do you think that we are going to see a phase of deglobalization in response to the crisis?

I think I do, but let me start by emphasizing that Schaeffler remains firmly committed to its international orientation. Know-how from all over the world continues to be crucial for a technology group like ours. However, looking at the area of supply chains, Schaeffler will also intensify its efforts of developing local and efficient solutions: due to corona, as well as in line with the increasing importance of sustainability and for economic reasons. How can we make routes even shorter? How would we prefer to handle our future shipments? Here’s a case in point: When it became clear during the crisis that bans would be imposed on loading and unloading container ships and that some ports would be closed, we switched from ship to rail. This not only turned out well, but also enabled us to clearly reduce our delivery times to Asia. And time is money, as everyone knows.

What is the situation in manufacturing operations?

That a worldwide production network offers clearly more advantages than disadvantages was also evident during corona. Take the “asynchronicity” of the crisis, for example: It began in China, where the situation has since become less severe, and subsequently migrated to Europe, America and the rest of the world. Thanks to our worldwide production network, we are able to compensate for local

shortages by shifting our resources. This is an advantage that provides stability not only during corona but also in other crisis situations.

Are there any other examples of “successful learning” due to corona?

One of our positive learnings is that Schaeffler has sufficient stability to cope with corona-related challenges such as volatile demand thanks to its diversified and global production network. However, we have intensified our focus on agility and efficiency in this complex system; and this will become even more important in the future. For instance, when it comes to optimizing setup times and batch sizes. The crisis also showed the importance of implementing the appropriate actions with the requisite resolve and consistency. In our case, this meant that we purposely pursued a path of countercyclical controlling right at the beginning of the crisis. In other words, we deliberately included goods and suppliers in our operations in order to back up a potentially destabilized supply chain and to be well-prepared for the relaunch.

Has Schaeffler taken any additional actions?

Yes, we have. Timely and constructive communication as well as close, cooperative partnership with our suppliers played a decisive part in the fact that we have not had a single supply shortage to date. For example, we regularly hosted supplier conferences at which we discussed the current situation. In other words, the capacity utilization



Curriculum vitae

Andreas Schick (b. 1970) studied Automotive Engineering at the University of Munich. In 1994, he joined the Schaeffler Group as a development engineer in Bühl. In the first years of his professional career he developed new simulation and testing methods. In 1996, Andreas Schick transferred to Schaeffler Brazil where he became production manager of the clutch plant and plant manager of a gray iron foundry. Within three years he managed to turn the foundry operations into a profitable business for gray iron brake systems. In 2004, Andreas Schick was appointed President LuK North America where, among other things, he was responsible for restructuring the area of torque converters in the Wooster plant. In 2008, Andreas Schick assumed the position of President of the business unit Transmission Applications. In 2009, the Schaeffler Group introduced a lean program under the name of "MOVE" and Andreas Schick was responsible for the launch of this program. From 2014, he was Regional CEO Asia/Pacific and based in Singapore. In April 2018, Andreas Schick became a member of Schaeffler AG's Executive Board in the role of Chief Operating Officer and is responsible for Production, Supply Chain Management and Purchasing within the Schaeffler AG.



» Before the corona pandemic, we used to talk about disruption all the time. Now we've got this disruption. It is here, and right now our behavior is changing on a global scale

Andreas Schick

of the plants, the demand reported to us, as well as general aspects such as how we protect our employees against infection with the corona virus. We are delighted to see that our suppliers and partners respond really well to these regular meetings, which is a prerequisite to predictive controlling and securing the supply chain. Of course, all of these conferences took place without person-to-person contact on digital platforms, which we've come to greatly appreciate during this period as well. In this context, I would like to mention that we are also going to shift our Supplier Day, to which we traditionally invite suppliers from the whole world to our headquarters in Herzogenaurach, into the virtual space this year. Our recently introduced Risk Towers (see info box on the right) are a very important digital tool in these weeks and months. All the relevant information converges at these virtual supply chain control centers and the systems alert us in the event of impending shortages. Today, we can say that our set of measures – in other words, timely action, business travel bans, predictive control and backup of the supply chain as well as transparency, both in-house and in dealing with our suppliers – has been a total success. To date, we have not only been spared from shortfalls, but, comparatively, also have a very low incidence of infections among our worldwide employees. This is particularly important to me!

Corona has been a worldwide driver of digitalization. How has this affected Schaeffler?

In a variety of ways. Like many other companies, we have massively extended the availability of remote work, redesigned the relevant arrangements and created the technical prerequisites. However, what has massively changed in this context due to the crisis is the willingness of our employees and leadership to embrace this digital form of working as an opportunity and to actually make use of it. We are also using many other digital solutions, from simple applications such as live tracking of containers to the previously mentioned analysis and control tools for securing the supply chains. With a view to the future, digital twins will no doubt become increasingly important. Using the Digital Master, which is a virtual reflection of real-world manufacturing, employees can capture the entire factory floor at a glance. This image is complemented by real-time information about position and capacity utilization or parameter measurements of individual machines. Work processes are planned with accuracy down to a second, continuously improved and extended by new applications. In interaction with other digital tools, this assists us in estimating demand, short-term planning, optimizing the order planning process, making joint decisions with suppliers and customers, and responding based on data. Ultimately, all this results in greater efficiency and agility which, in turn, secures Schaeffler's future viability.

On page 78, "tomorrow" covers collaborative robots. What makes these nimble assistants so exciting?

At Schaeffler, we view cobots as another key technology enabling us to become more agile, more efficient and, ultimately, more resilient. In our Smart Factories, mobile robots are going to perform process

steps in places where they are needed, which includes collaboration with humans. Cobots are able to learn from each other by means of Machine Learning and they can form networks with digital twins as well as communicate with us. They will specifically support humans so that they are free to focus on making important decisions. Cobots are masters of agility and efficiency. They minimize inventories, throughput times and space requirements, and in the long run even reduce capital expenditures.

Machine setup times are a key factor enabling flexible response on the shop floor. How do modern technologies assist in this context?

New technologies assist us in executing projects from the planning stage to completion and beyond. Let me explain this based on three examples. So-called Business Intelligence (BI) applications capture all the key performance indicators related to setting up the machines in our worldwide plants, analyze them with practical relevance and identify areas with the greatest optimization potential. Subsequently, digital applications such as the Digital Tool Setup Assistant (DiToS) are used for the physical setup work to visually guide the operator through the setup process step by step. Meanwhile, digital documents can be retrieved if additional information is required. In addition to reliable compliance with the specified setup time, this ensures the optimal sequence of process steps and thus the quality of the work results. We are planning to significantly expand the use of VR headsets, because augmented reality can guide workers through the process steps even more effectively. The MS Holo-Lense II VR headset is already available at all of our plants today, because it has systematically been pushed in the wake of the corona crisis. This technology enables location-independent, in-depth examinations. As a result, we have remained fully capable of acting in response to maintenance support inquiries, for example, in spite of the travel restrictions due to the pandemic.

Your words resonate a certain excitement. In summary, can we take it that you don't just attribute negatives to corona, but also see some positive aspects?

Before the corona pandemic, we used to talk about disruption all the time. Now we've got this disruption. It is here, and right now our behavior is changing on a global scale. We are beginning to truly work

Everything in view, everything under control



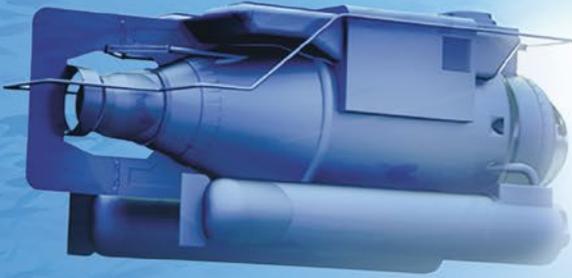
Schaeffler is a global group with 75 plants and thousands of customers and suppliers. In this worldwide network, Schaeffler has managed to keep its supply chains running without any supply shortfalls during the corona crisis to date – thanks to digital Risk Towers.

The **Supplier Risk Tower** monitors and assesses the risks on the receiving side. During the analysis, three dimensions are evaluated: Which segment of goods do the risk-prone suppliers come from, which countries do they reside in and which plants are exposed to serious risks as a result? Algorithms match a variety of parameters in this process and alert the company as soon as critical parameters have been reached. The **Logistics Risk Tower** assesses the sea, rail and road routes most frequently used by Schaeffler according to capacity and lead-time risks. Both tools provide a minimum forecast of four weeks enabling Schaeffler to act predictively in the event of impending problems.

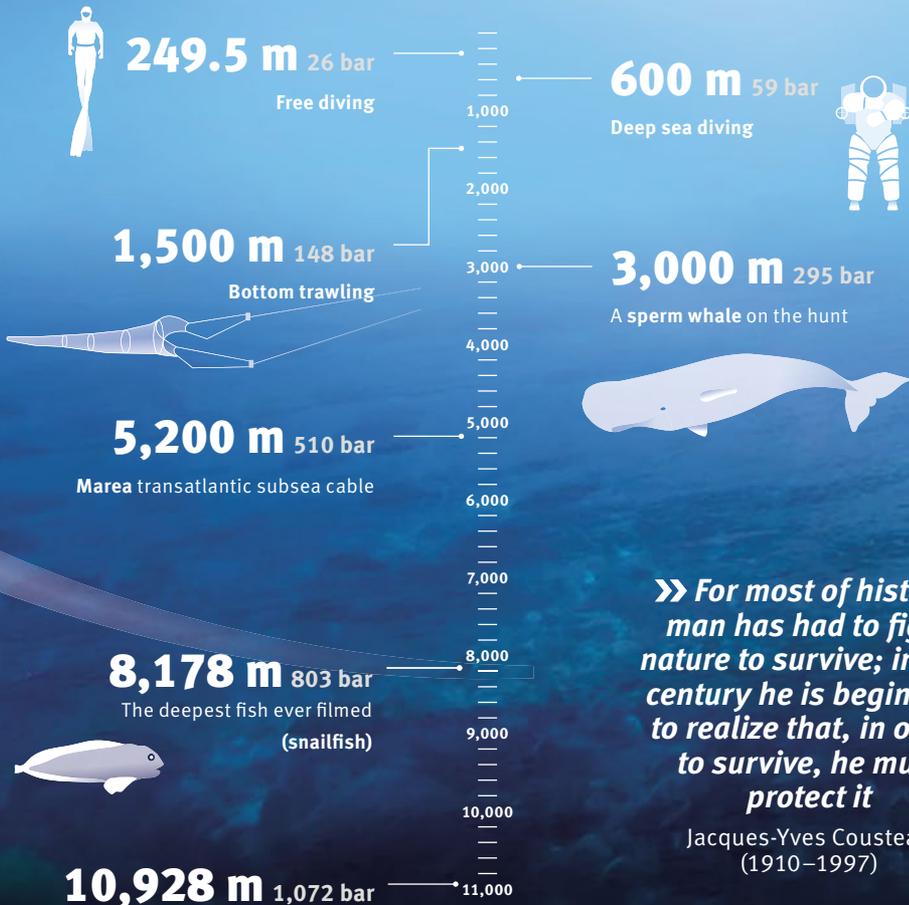
digitally. The utilization of networks keeps growing. Plus, we are making use of the digital tools that are available. All of this entails major change – in the way we live as well as in the way we work. And, yes, in spite of all the negative aspects of corona, I do feel that this is a gratifying development.

Outlook

Technology for tomorrow



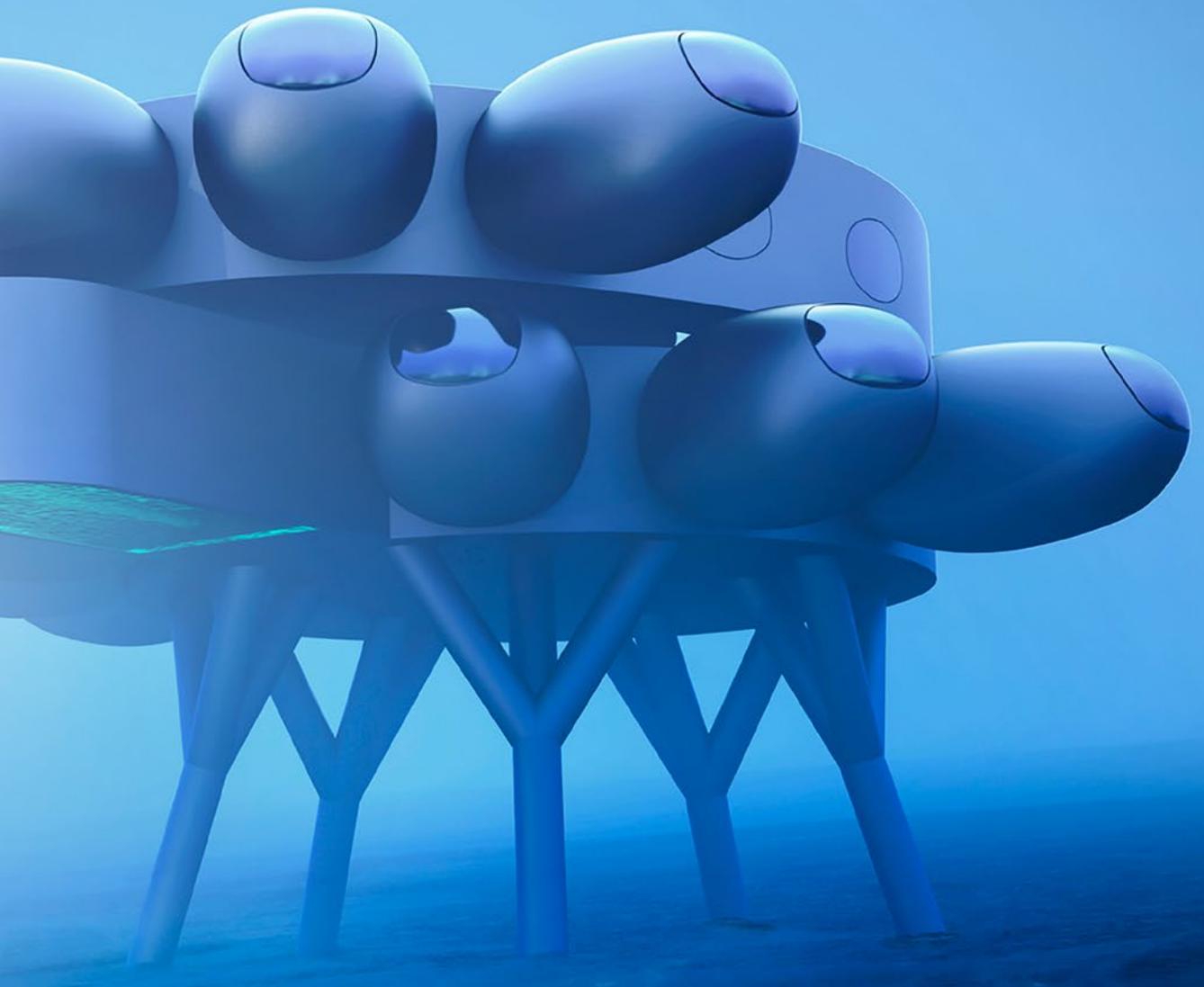
Underwater depth records



» For most of history, man has had to fight nature to survive; in this century he is beginning to realize that, in order to survive, he must protect it

Jacques-Yves Cousteau
(1910–1997)





The dream of a subsea space station

As an explorer of the underwater world, Jacques-Yves Cousteau was a pioneer. Now his grandson, Fabien Cousteau, intends to go down in history. With his Fabien Cousteau Ocean Learning Center, the Frenchman, together with Swiss industrial designer Yves Béhar, initiated the Proteus underwater base project that's planned to become the ocean's equivalent of the International Space Station (ISS). While such an underwater habitat is not new per se, Proteus – with a size of 380 square meters (4,000 square feet) – will be the largest of its kind. For comparison: the Aquarius Reef Base operated by Florida International University has a usable space of just around 37 square meters (400 square feet). In the new Proteus base off the coast of Curaçao in the Caribbean, scientists

will be able to live and do research work: in addition to a laboratory and a medical bay, there'll be social, sleeping and storage areas, plus a subsea hydroponic greenhouse – the first of its kind – to secure the supply of food. About 18 meters (60 feet) below sea level, a futuristic structure will be resting on the ocean floor with a spiral center surrounded by pods featuring a modular design that allows for expanding the station as needed. Initially, it's planned to accommodate twelve research scientists. Climate change, water pollution, rising water levels and extreme storms are some of the phenomena to be explored in greater depth there. But before this can happen, Cousteau has to resolve the crucial issue of how to raise the 135 million dollars to finance his dream.

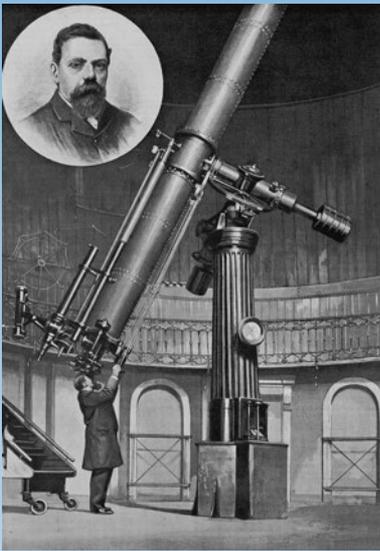


Emergency escape into space

Will humans eventually be forced to colonize Mars? When problems like climate change, overpopulation and diseases make life on Earth impossible? “tomorrow” talked to a NASA expert about extraterrestrial life and its hurdles. A cosmic mix of facts on the current state of research.

By Björn Carstens





1877 – the beginning of the Mars hype

That countless authors have been writing about extraterrestrial life for more than a century has a lot to do with a stargazer from Turin – and a major misunderstanding. Giovanni Schiaparelli (pictured left), a teacher-turned-astronomer, drew a more detailed map of the Mars surface than anyone else before him. It included huge depressions of up to 4,000 kilometers (2,500 miles) in length. Schiaparelli thought they were of natural origin and used the Italian word *canali* for them. Translated into English, they became channels, thus referring to artificial waterways. Logically, these waterways must have been created by extraterrestrials, a piece of sensational news that spread around the globe like wildfire. Obviously enjoying the fame, Schiaparelli didn't show much interest in resolving the misinterpretation. Critical voices were ignored until the Mariner 4 NASA mission in 1965 provided certainty. Schiaparelli's "canali" were optical illusions, but that did not mar the fascination with "life on Mars," especially since the Red Planet does lend itself to human "invasion."

NASA expert Claas Olthoff: "Mars is the most Earth-like planet in our solar system and our direct neighbor. We know that Mars used to have a dense atmosphere and liquid water on its surface. This makes it a very interesting target in our quest for life. It's the next logical step for humanity in space exploration."

In 1898

H. G. Wells was inspired by Schiaparelli's Mars discoveries and published his novel **The War of the Worlds** in which Martians attack the British Empire.

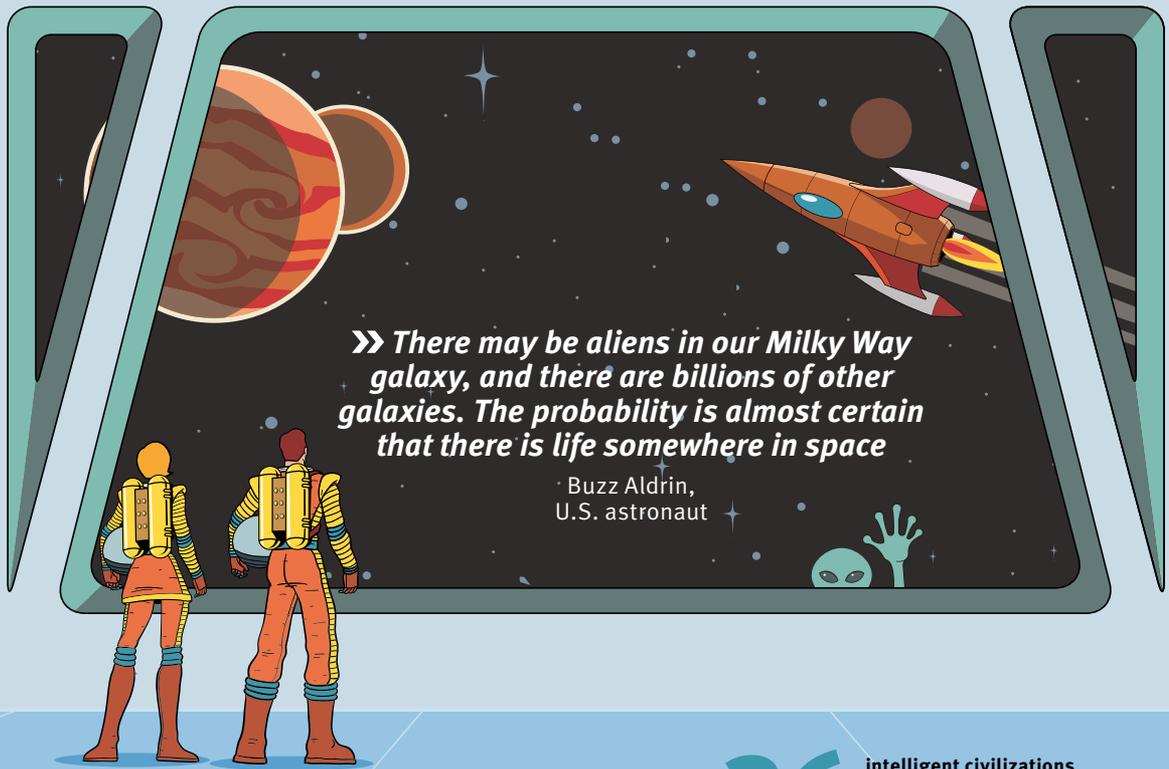
To Mars and back in 1,000 days

Since both Earth and Mars move in elliptical orbits, the distances between the two planets are not always the same, varying between 56 and 401 million kilometers (35 and 250 million miles). That's why Mars missions are always launched when Earth and Mars are closest to each other. Such a window of opportunity only opens up every 26 months, like this summer, when several organizations sent robots on a journey to Mars. Besides the United States, they included space agencies from China and the United Arab Emirates for the first time. None of the spaceships had an astronaut of flesh and blood on board. The flight to Mars and back in a crewed spaceship takes between 450 and 490 days, while the whole journey takes about 1,000 days, depending on a favorable constellation for the return flight. Sounds like a physical ordeal and an extremely costly proposition estimated to amount to 500 billion to one trillion dollars, according to Claas Olthoff. **A sum, though, he says, that's not impossible to finance: "Several countries could share the costs like in the case of the International Space Station. But there must be a larger group of countries where the political and social will to bear these costs exists at the same time. And that's precisely where I see the biggest hurdle."**

50,000 km/h

(31,000 mph) would be the speed of a space capsule on its **return to Earth**. A huge stress test for humans and hardware.

5 Mars robots have been deployed to Mars by NASA – three of them with Schaeffler technology on board. The current Perseverance rover is the first to take pictures with a zoomable camera. In addition, it's equipped with a super-lightweight helicopter – **the first ever extraterrestrial flying object.**



Buzz Aldrin,
U.S. astronaut

36

intelligent civilizations
might exist in our home
galaxy of the Milky Way.

About searching or creating a second Earth

A Mars colony as an extraterrestrial backup for the human species. For NASA expert Claas Olthoff, that's an exciting idea: **"I believe that colonizing Mars is desirable in the long run. Chances are that the Earth will eventually become uninhabitable, be it due to our own (in)action in combating climate change or due to natural disasters. I think we're going to see the first crewed Mars mission within this century."** But how should life on a desolate, very cold planet without an atmosphere be possible? One possibility is so-called terraforming, which is supposed to enable human life on other planets by means of

technological interventions. The imagination this concept inspires is as boundless as space. The range of ideas extends from using tiny microbes and bacteria to space mirrors with a burning lens effect to artificially induced asteroid impacts. Another idea is to coat the icy surfaces on Mars with carbon black which would cause them to become hot and melt. All of these scenarios are inspired by the objective of releasing the carbon dioxide that's bound in the surface of Mars into the atmosphere in order to warm up the planet so that water will flow again allowing plants to be grown that inhale CO₂ and exhale oxygen. In a nutshell: An adequate greenhouse effect must be created because that's exactly what makes life possible for humans. Although a greenhouse effect already exists on Mars, it's minimal in spite of its high CO₂ content of about 95 percent. The reason is that the planet's lower gravity binds less gas, which makes the atmosphere lighter and thinner compared to Earth. The lower air pressure makes it easier for thermal energy to escape into the universe. Some research scientists have doubts about the methods of terraforming. Mars more than likely does not even have enough CO₂ for this plan. The situation on Venus is even more complicated. The average temperature there is around 450 degrees centigrade (842 °F). Any form of life would immediately be carbonized.

95 %

of the atmosphere on Mars
consists of **carbon dioxide**.

-55 °C (-67 °F)

is the **average temperature** on Mars.

Space simulation in the desert

In the desert, under water or in caves: around the globe, astronauts are in the process of intensively preparing the departure for Mars in various training camps, like in Oman: For three weeks, away from any type of civilization, six so-called analog astronauts of the Austrian Space Forum simulated the conditions on Mars there – with a tracked vehicle, igloo-like tents, helmets with solar energy, 3D printers for spare parts production and by growing their own vegetables. NASA, on the other hand, practices in the ocean as well, at a depth of 20 meters (65 feet) off the Florida coast, where the astronauts spend one to two weeks in a 37-square-meter (400 square-feet) capsule, simulating gravity conditions under water like those in outer space. Space training in cave systems in Slovenia or Sardinia looks a little different. In an ESA project, astronauts have to perform a variety of tasks in unusual surroundings, completely autonomously and in an extremely confined space. Participants report that this is how living on another planet must feel. Actually, that’s how all astronauts training for a self-sufficient life in space feel, be it in detritus-covered terrain in Hawaii or in the Gobi Desert in China (pictured right). Claas Olthoff: “It takes at least 100 to 200 persons to establish a self-sufficient colony on Mars, according to relevant studies.” Technically, he says, that’s possible, if there were enough people to pay for this. **How many people could actually live on Mars, Olthoff can’t say: “The human body has adapted to the environment on the Earth’s surface due to evolution. Exactly the same conditions do not exist anywhere else in the solar system, so there’d always have to be some kind of life support system for humans on other planets.”** At this juncture, he adds, a prediction of whether such technologies could be scaled up to supporting several billion people is not possible.



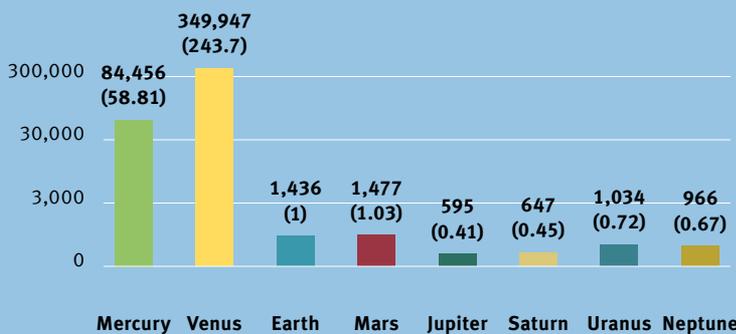
Up to
\$ 10 trillion

is the purported cost of Elon Musk’s planned futuristic city on Mars. By 2050, the SpaceX CEO intends to build a colony on the Red Planet accommodating up to 1 million people.

100 times

That’s how much higher the radiation exposure on Mars is compared to Earth. In space, it’s even 300 times higher. At least 70 percent of the galactic cosmic radiation penetrates the typical outer walls of a spaceship.

Duration of a planetary day in minutes (days)



The expert

Claas Olthoff was five years old when he visited the Kennedy Space Center in Florida together with his father and has been fascinated by space travel ever since. Following his studies and earning his PhD at Technical University of Munich, he

moved to the United States, joining NASA’s Johnson Space Center in Houston. He’d like to spend a few years on Mars, but permanently living in a climatized habitat? Perhaps even in a cave protected against cosmic radiation? No thanks! He already misses the German seasons in Texas.



The end of the cage age

Cobots, the smaller, more agile siblings of gross-motor industrial robots, are making a name for themselves. The specialists at Schaeffler have found a way to make this new generation of automated workers perform faster and with greater precision.

A shop floor employee assembles a smartphone, assisted by a robot that hands parts to him or holds the component, freeing up the worker's hands to do his or her job. Should a hazard arise, the machine stops in time to prevent an accident. It is even able to learn from its mentor – the human – by observing them on the job.

The magic word here is cobots – short for collaborative robots. Working alongside humans, they're designed to assist and to handle increasingly complex routines – today on the factory floor, tomorrow in workshops, logistics, operating rooms and even in offices. Many manufacturing companies are pursuing new paths, upgrading or transforming their operations. Especially when it comes to repetitive, tiring and physically strenuous jobs, cobots can take over some of the tasks and enable employees to concentrate on more sophisticated process steps. Another advantage of cobots: They're suitable for automating small-batch production down to batch size 1 – in other words highly customized production runs. The classic industrial robot, which performs repetitive, staccato-like movements, segregated from the human workers in a cage or behind acrylic glass, is clearly at a disadvantage compared to a robot that can collaborate. In Industry 4.0, the traditional robots are losing importance.

Tailwind: a driver for Industry 4.0

With annual sales increasing by 50 percent, the cobot market is already growing faster than that of classic industrial robots. "We can enhance this dynamic market with highly specialized capabilities," says Ralf Moseberg, Vice President, Industrial Automation, where innovations for various sectors

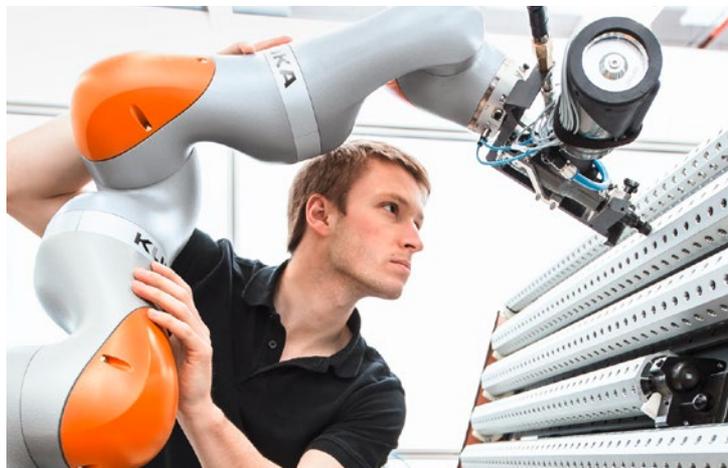
are being developed. "Robotics are an important driver for Industry 4.0 and a central element of our diversification strategy," says Moseberg. Our experience and know-how in the field of precision manufacturing and the automotive sector can be transferred into this new, competitive field.

A case in point: Schaeffler recently launched a double-row conical thrust cage needle roller bearing for articulated-arm bearing supports. To date, such applications have mainly relied on crossed roller bearings. Schaeffler's new conical thrust cage needle-bearing solution enables an increase in the number of load-bearing rolling elements, resulting in greater rigidity. Consequently, the robot manufacturer can select smaller bearing sizes, thus saving design space and reducing weight. The movements of the articulated arm gain precision and speed, making the production process significantly more efficient. Additional benefits of this design principle include enhanced sealing performance and avoidance of grease seepage, thereby reducing contamination of the production environment. Schaeffler's 70 years of experience in needle bearings are brought to bear in this solution.

Extended capabilities: cobot optimization

The precision, strength and agility of cobots are highly dependent on the gearbox solutions employed. The gearbox is, after all, at the heart of any cobot. With its DuraWave RTWH series precision gearbox, Schaeffler sets new standards. As a result, the robot is able to perform smooth, controlled movements. This design makes the cobot practically maintenance-free and allows its life-cycle to be prolonged. Another Schaeffler innovation makes cobots mobile: Thanks to a range

Intelligence integrated: Cobots not only work directly with human beings, but can also learn from them autonomously



extender, cobots travel on a linear path to various workstations as needed. As a result, smaller cobots can be used for tasks that are close by, for instance, and other cobots can be reserved for remote requirements where they must travel further.

Using plug & play connections, cobots can easily be integrated into existing production environments. And this is just what robotics customers – like all customers – are looking for: solutions that offer easy integration, without the need for major conversions.

Right from the RoboLab: up-and-coming tech

“Schaeffler will not become a full-range supplier of cobots and lightweight robots. However, we are planning to be an important partner in this market in a few years with solutions for bearings, components and sub-assemblies,” says Moseberg, explaining the strategy that is being pursued by his unit. “The fact that we use our solutions in our own manufacturing operations – in keeping with a time-tested Schaeffler tradition – is another unique selling proposition,” he adds. With a worldwide network of 75 plants, Schaeffler obviously has considerable in-house demand. In Herzogenaurach and Schweinfurt, some 50 cobots are already being used in operations that include parts feeding, assembly processes, quality assurance and logistics.

In addition to developments in Germany, Schaeffler has been operating its “RoboLab” in the Japanese metropolis of Yokohama since 2018. There, specialists are focused on developing mechatronic solutions for a new generation of robot arms. Having a presence where a particularly large number of robots are at work is obviously an advantage for Schaeffler. Asia is the fastest-growing market for cobots, and Japan is the cradle of robotics. 75 percent of the robots used worldwide are “Nippon Made.” They not only handle a growing number of functions in industrial operations, but also pick up the slack in a country that is suffering from a labor shortage, primarily caused by demographic change. Personal assistant robots are part of everyday life in Japanese stores, schools and nursing homes, and the island state is home to as many as five manufacturers of world renown: Fancu, Mitsubishi Electric, Yaskawa, Kawasaki and Denso.



On the safe side

How Schaeffler uses modern robotic and control technology to enhance the safety of existing plant and equipment.

Even though cobots are gaining ground, heavy-duty industrial robots, when properly used, continue to play a role in the modern world of work – not least of all in the area of occupational safety. A perfect, award-winning example: the forge at Schaeffler’s Schweinfurt location, where an industrial robot assists employees working in conditions of high heat. Whereas in the past, components with a weight of up to 300 kilograms (660 lb) and a temperature of about 1,200 degrees centigrade (2,200 °F) had to be manually placed into the press, this is now done by a robot, which also forwards the components to the next process step. Safety light curtains monitor the hazardous area. The technical challenge in this case was to optimize the control electronics in a way that would ensure trouble-free permanent operation in spite of heat radiation, smoke, scaling or flames due to flash fires. The Wood and Metal Occupational Insurance Association honored Schaeffler with the “Smart Fox” safety award for the plant’s superior work safety.

Sales of

\$24 billion

are expected in the worldwide cobots market (arms, add-ons, software) by 2030. With an **annual growth rate forecast of 28.6 percent**, cobots represent the fastest-growing market in robotics.

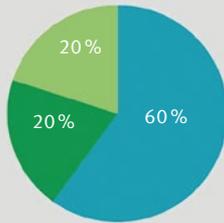
Source: ABI Industrial Collaborative Robots Market Tracker



Kinetic talents

A rising level of automation and higher production volumes presuppose reliable robotics. Articulated-arm bearing supports from Schaeffler are decisive in determining the load-bearing capacity, dynamics and precision of robots – and thus make a significant contribution to increased productivity.

Market share of robots by type



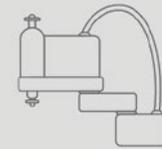
60%

Articulated-arm robots



20%

Cartesian robots



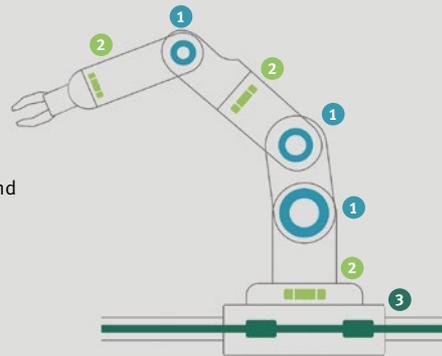
20%

SCARA & delta robots

The ideal solution for any movement



1 Conical thrust cage needle roller bearing
Schaeffler's new XZU conical thrust cage needle roller bearing is used in lightweight robots and cobots as an articulated-arm bearing support and as a main bearing support for Schaeffler's new RTWH precision gearbox. XZU reduces friction by 20 % and is 30 % more rigid than the crossed roller bearings that were previously used.



2 Precision gearbox

For use in robot articulated joints, Schaeffler offers silk-hat-type speed reduction gears, also known as speed reducers. Due to the functional principles of strain wave gearing, high gear ratios and correspondingly high torques are achieved, combined with a relatively lightweight design. The new RTWH precision gearbox from Schaeffler is characterized by clearance-free operation, high positioning accuracy, compactness and long service life.



3 Range extender

For linear travel of cobots to various workstations, Schaeffler offers a plug-and-play-ready linear system (range extender). It contains both the mechanical and electrical drive technology with customized interfaces. The Schaeffler range extender is optionally available with a tooth belt or ball screw drive up to a maximum travel distance of 18 meters (60 feet).





774

industrial robots and cobots per 10,000 industrial workers in South Korea: No other country has a higher “**robotic density.**” However, in terms of numbers, China (154,000) is by far the largest market for robots, followed by Japan, the number one robot manufacturing country (55,200), the United States (40,400) and South Korea (37,800).

Source: World Robotics Report 2019

Goodbye to awkwardness: a graceful colleague

Many of the robots produced so far lack fine motor skills. There’s still plenty of development potential in this area. The specialists in Schaeffler’s RoboLab are optimizing the interaction of precision joints and sensors to enable them to operate in the micrometer range. For this purpose, a sensor system integrated in the flexspline has been developed for the new DuraWave precision gearbox. It enables torque to be captured precisely where it is generated and to thus provide cobots with a kind of tactile sense. For instance, when a cobot touches a human who is standing in its vicinity, the sensors are able to capture the change in torque and to immediately stop the system.

Increasingly attractive: affordable and safe solutions

In this context, connectivity with smart software and the artificial intelligence that moves the mechatronics is important as well. Just like a human being uses diverse senses simultaneously and interlinks individual perceptions to create a total picture in the brain, a cobot can perceive, analyze and

respond to a variety of events by means of multi-modal sensing. This is advantageous, especially in applications involving complex movements and unpredictable events. Schaeffler’s objective in this context is to enhance the safety and collaboration between humans and machines while reducing costs and making the solutions available to a wider market. The goal is to make cobots attractive for small and medium-size companies as well.

Proven success: pilot projects

Obviously, all this can’t be achieved without strong partners. Schaeffler’s Industrial Automation business unit collaborates with universities, research institutions, start-ups and established companies in the fields of microelectronics, software and production technology. Renowned manufacturers are already relying on Schaeffler’s expertise. The robot arms are currently being tested in pilot projects like smartphone assembly and pick & place operations. Schaeffler’s experts have also had initial success in having cobots analyze returned components. The cobot automatically removes the parts from a box, takes a picture of them and puts them back into the box. This reduces defects and enhances manufacturing quality. In view of these developments, Ralf Moseberg has no concerns about the rollout of cobots leading to a large-scale loss of jobs. He even expects the use of cobots to enhance the working conditions for employees. This is an additional side effect that drives him and his colleagues.



The author

How cobots are transforming the industrial world is a fascinating topic for **Oliver Jesgulke.**

However, at home, he’s so far chosen not to use little helpers

like robotic lawn mowers and vacuum cleaners. For him, the busy assistants are just tripping hazards and pose a risk to hedgehogs just like to his toddler.

Embarking on a new age

The world is in a state of technological change it has never seen before and this is also true for motorsport. How can the high-speed and high-tech racing categories transform themselves and concurrently take part in shaping the transformation of mobility?

By Carsten Paulun

Race driver Lucas di Grassi, who is regarded as a pioneer in the field of forward-thinking technologies and competes in the Formula E electric racing series for the Audi Sport ABT Schaeffler team, is perfectly clear about it: “Motorsport has to adapt to what’s relevant to industry or else the large financial investments will disappear.” Timo Bernhard, a two-time winner of the 24 Hours of Le Mans plus a World Endurance champion in the Hybrid-Porsche together with Schaeffler, regards motorsport as being able to fill the role of a laboratory also with prospects for the future: “Technical innovations need an environment in which they can be fully tested and motorsport provides the ideal competitive conditions for this.” That’s exactly why Bernhard with his KÜS Team75 Bernhard is fielding a Porsche GT3 R using Schaeffler Paravan’s Space Drive drive-by-wire technology. In this sports car, the mechanical connection between the steering unit and the steering transmission is replaced by digital technology (see infobox on the following double page spread).

E will be followed by H. And by what else?

Motorsport has always been the nucleus and test bed for innovations. Should it lose this dual role, it will lose relevance to automakers and industry, which might have far-reaching consequences

because, without money from industry, top-class motorsport can hardly be financed. The International Automobile Federation (FIA) is well aware of this, too, and therefore willingly paving the way for forward-thinking technologies into professional racing. For instance, the electrification of motorsport, jump-started by Formula E, is picking up more and more momentum. Even youngsters in karting are already using electric power. In Germany, the ADAC motoring association together with carmaker Opel are organizing an Electric Rally Cup for young talents. Following Formula One, the World Rally Championship will begin to be partially electrified using hybrid powertrains in 2022 – with know-how from Schaeffler (see infobox).

Going forward, other powertrain concepts are going to play a role as well. The organizers of the 24 Hours of Le Mans are planning to launch a racing category for hydrogen-powered cars. Interest in the technology is huge: Seven automobile manufacturers and suppliers are involved in developing the regulations. “Over the decades, the laboratory that motorsport provides has driven forward the development of technology and safety that has a direct benefit to all of us,” says FIA President Jean Todt. “... and the inclusion of a class for hydrogen technology ... is the next, important step on the road to a cleaner and sustainable future.”

But motorsport is providing new impetus not only to the powertrain side and to other classic realms of mobility. As an innovation platform, it's able to occupy other globally relevant forward-thinking trends. So-called Roboracing with autonomous race cars is an ideal playground for developments in the areas of digitalization and automation. The partial automation of classic racing series is conceivable as well. For instance, future race cars might be driven by means of automation technology during safety car periods or pit stops. Tire changes and refueling using robots are conceivable as well. The urbanization of our planet and the concurrent development of micromobility as a vehicle class is addressed by the planned racing series for e-scooters with a speed of up to 100 km/h (62 mph). Like in Roboracing, Lucas di Grassi is one of the driving forces here. For the trendy topic of vertical mobility with a market volume of 75 billion dollars in 2035 anticipated by Porsche Consulting, another motorsport equivalent is on the starting grid: drone races with crewed multicopters. The electric racers of the airways are called Airspeeders. Airbus has caught the race fever bug as well. The aircraft manufacturer is involved in Air Race E, a competition for electric propeller aircraft. The experiences gathered here are intended to help optimize range, automation and costs of electric aircraft in order to make this form of interurban transportation accessible to a broader clientele.



Alternative powertrain trend: hydrogen as an energy source for endurance racing

» The passion for racing and adrenaline will always remain, even if motorsport will cover a far wider spectrum in the future. Traditional racing, Formula E, Roborace or drone races – all of these types of racing will have their fan base and coexist

Lucas di Grassi



Vertical mobility trend: races with crewed drones

In terms of lightweight design, motorsport has traditionally been a pioneer for production vehicles as well, initially using aluminum, followed by carbon fiber reinforced plastics. The latest trend in race car construction is biofiber materials, which, going forward, are supposed to not only reduce the weight of production cars but to also enhance sustainability aspects. Motorsport also plans to become an accelerator of innovative production methods, spearheaded by 3D printing. This is another technology intended to see further trimming toward the production side of the house due to its use in motorsport.

Diversity wins

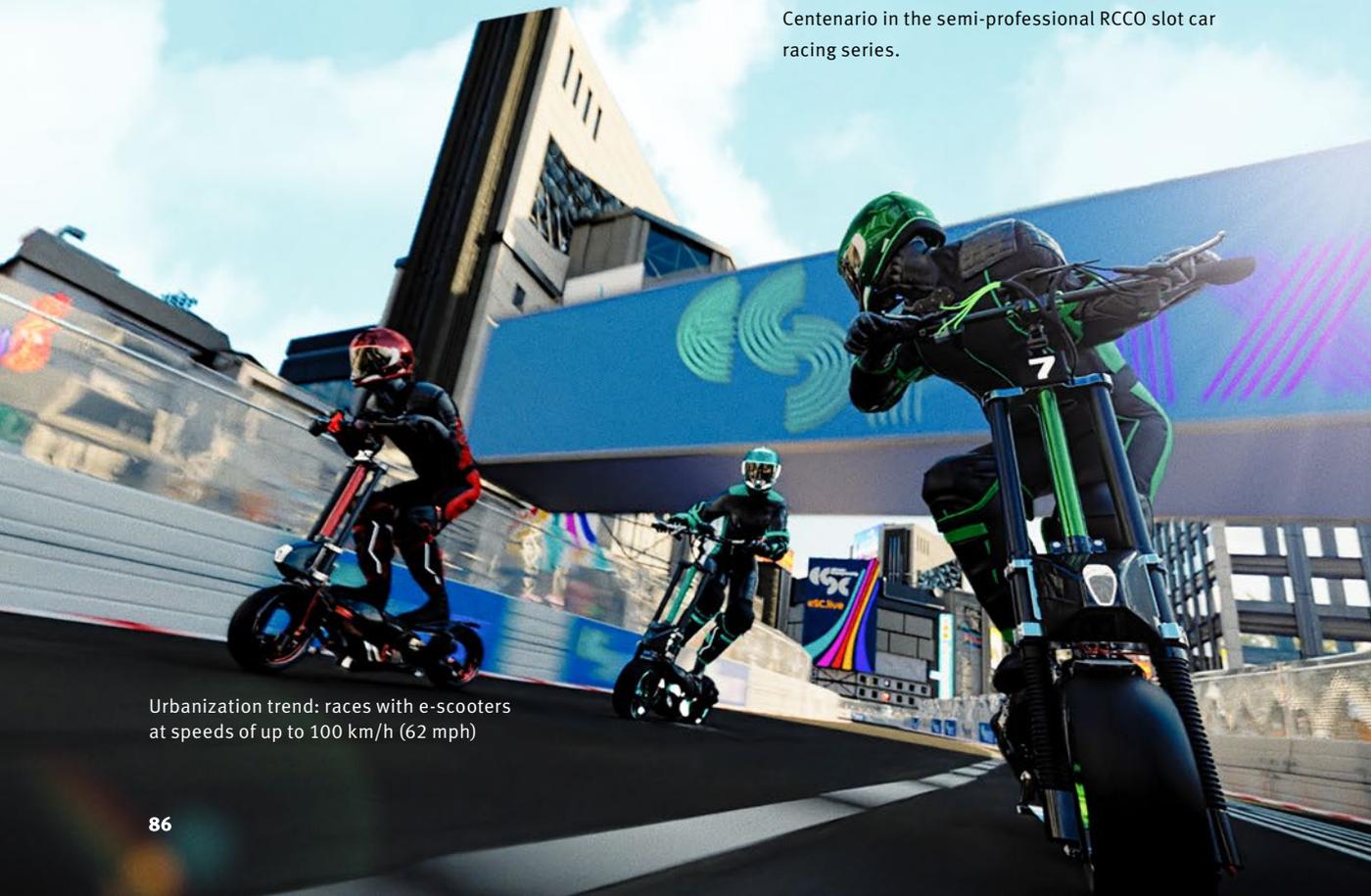
“Motorsport has so many disciplines with diverse challenges that can be superbly used to optimize technologies,” Bernhard says. The horsepower pro can only understand the sentiments of conservative motorsport fans complaining about driving skills increasingly losing importance in the technology arms race to a limited extent. He feels that the competition among technologies is part of modern motorsport and no less exciting. Even so,

the pro emphasizes that motorsport’s justified existence goes far beyond just serving as a technology incubator: “It’s also justified because people around the world from all walks of life and from all age groups have chosen motorsport as their sport, their hobby and their passion. In my view, this is a crucial factor that continues to give major social relevance to motorsport.” Bernhard refuses to offer a prediction of whether racers in 30 or more years’ time are going to battle it out in cars gliding on magnetic fields or in pod racers such as those in the Star Wars movies: “Actually, such a prediction is impossible to make because technology development progresses far too rapidly.” Not least thanks to motorsport ...



The author

Carsten Paulun has a 30-year track record of writing about technologies and cars and gathered racing experience in the Nürburgring 24 Hours and other events. At the moment, he’s competing in an electric race car – a 1/24-scale Lamborghini Centenario in the semi-professional RCCO slot car racing series.



Urbanization trend: races with e-scooters at speeds of up to 100 km/h (62 mph)

Schaeffler: Toward the future with motorsport



The E badge

Schaeffler has been using the opportunities provided by motorsport to test innovative technologies for many years. Formula E is a perfect example. **“The know-how gained in Formula E is fed directly from the race track into production development, for instance in the areas of the E-axle, hybrid transmissions and electric motors for electric powertrains,”** says Dr. Jochen Schröder, who leads Schaeffler’s E-Mobility business division. But this is not only about system understanding, material testing or efficiency increases – Schaeffler also pursues the objective of positively associating the topic of electric mobility with emotions in public perception.

The best of two worlds

In 2022, Schaeffler is opening up a new, forward-thinking motorsport chapter: The Group’s subsidiary, Compact Dynamics, prevailed against a high-caliber field of competitors and will become the exclusive supplier of the hybrid system to be used by the FIA World Rally Championship (WRC). **The high-performance hybrid system featuring P3 topology (electric motor behind the transmission) combines the motor-generator, control unit and externally supplied battery in an extremely small space – with maximum power density.** Initial vehicle tests are scheduled for 2021.



Trailblazer for autonomous driving

Digital instead of mechanical: Drive-by-wire systems like Space Drive from Schaeffler Paravan are a key technology for autonomous driving. In order to further optimize this innovation that has already achieved a high level of maturity (more than 1 billion kilometers (0.62 billion miles) of failure-free operation in road traffic), Space Drive is also used as an electronic steering system in motorsport, for instance in the Porsche 911 GT3 R fielded by KÜS Team75 Bernhard and in a rally Fiesta of former WRC driver and long-standing Schaeffler brand ambassador Armin Schwarz. **The objective in either case: combining the**



unfiltered, full sensitivity of a mechanical solution with the digital opportunities provided by Space Drive. For instance, drivers should be able to select an individual steering map that will automatically adjust to changes in vehicle map during the race and thus clearly reduces tire wear. Space Drive is also utilized in fully autonomous racing: it is planned that Schaeffler Paravan will equip all teams in the Indy Autonomous Challenge. In the event endowed with 1.5 million U.S. dollars, for which entries of students from a total of 37 colleges and universities have been submitted, autonomous roboracers are planned to contest a 20-hour race. The venue will be the legendary Indianapolis Speedway.



Dr. Digital

Digital transformation in the healthcare sector is in full swing and receiving a boost due to the corona pandemic. Here are a few examples.

By Carsten Paulun

Teamwork in the OR: robots assisting surgeons

Dr. Robot is gaining traction in operating rooms. To date, more than six million robot-assisted surgical procedures have been performed worldwide. The emphasis here is on “assisted” because a robot doesn’t think or control anything but merely carries out the commands issued by a surgeon sitting at a console away from the operating table and using a joystick to steer the robot’s arms. **One of the arms guides a 3D camera whose images display the surgical field with tenfold magnification.**



The surgeons (left) manipulate the four arms of the OR robot using joysticks

Due to exact mathematical scaling, the surgeon’s movements are not just transmitted but executed with three times higher precision. Even a potential tremor of the surgeon’s hands is filtered out. Currently, there’s just

one surgical robotic system on the market: da Vinci made by Intuitive Surgical, an American company based in California. **Experienced surgeons can perform nearly any surgical procedure in the pelvic area, the abdomen or the thorax using da Vinci.** Obviously, like any surgery, robot-assisted operations require a certain amount of practice. Especially the lack of haptic feedback during the procedure takes some getting used to.

Robots are increasingly finding their way into other areas of healthcare, too. At the university hospital in Aalborg, Denmark, mechanical assistants sort thousands of blood samples per day, robots holding screens in their hands make it possible for quarantined residents in nursing homes to stay in touch with their families using video-based communication (see section on caregiving). In clinics in the Spanish cities of Palma de Mallorca, Barcelona and Madrid robots are planned to perform corona tests. The 100,000-euro systems are able to take and analyze up to 2,400 samples per day.

Organic material can already be produced today using 3D bioprinting technology



Digital consultation

These numbers underscore how corona has accelerated the digital transformation process in the health-care sector. While in February 2020, 1,700 doctor’s offices in Germany were offering video-based consultation, this number had increased to 25,000 by April, equating to 1,470-percent growth. **Europe-wide, interest in video consultation skyrocketed by 1,000 percent just in the month of April.** Zava, an online medical services provider based in London and Hamburg, reported a surge in demand as well, stating that the number of telephone and online consultations had gone up by 60 percent in the first few months of corona – reflecting higher growth than in the ten previous years combined.

Zava’s CEO David Meinerz is convinced that, due to the kind of digital consultations offered by his company or competitors such as Teleclinic and Kry, the number of physical visits to doctor’s offices will decline from an average of ten to four or five, at least in Germany. The uncomplicated procedures speak in favor of digital consultation: Patients use an app to directly select the physicians and specialties they need and make an appointment which, due to the significantly longer office hours, will more than likely be easier to get than with a doctor in private practice. Zava, for instance, offers consultation from 6 in the morning to 10 at night and from 8 in the morning to 8 at night on weekends – in German, English and French. These large time windows not only benefit patients but also doctors who prefer flexible working hours and **might even introduce resources into the system that are currently untapped** such as physicians taking care of their children at home, who may be able to work during specific hours. If patients find it more convenient to obtain an initial online diagnosis, the crowding issue in hospital emergency rooms could be mitigated as well.

Extensive data protection measures (see info box on the following page) and lack of clarity regarding the assumption of costs by health insurance systems have proven to be a **hurdle against further high-speed growth** of telemedicine. Telemedicine providers are working at full stretch to eliminate both of these obstacles.

Organs from a 3D printer

Hardly anyone is astonished anymore about spare parts for cars and household appliances being produced by 3D printers. Also known as additive manufacturing in industrial environments, the digital technology enables the production of personalized, individual aids and products, **extending from prosthetic devices such as artificial joints and dentures to individualized anatomical models** on which surgical teams practice complex procedures. Using a 3D-printed lung tissue model, researchers are able to more effectively determine how the Covid-19 virus acts in the human body. Together with American universities, the digital manufacturing company Carbon 3D has developed a filter that removes excess chemotherapy drugs administered to cancer patients and thus prevents damage to healthy tissue. Thanks to 3D printing, these filters can be individually adapted to any patient.

Even the **production of personalized pharmaceuticals has become established practice thanks to additive manufacturing.** As early as in 2015, Spritam, a drug used to treat epilepsy, was the first personalized 3D-printed tablet to be marketed, with tablet dosages tuned to suit the personal needs of any patient.

Research scientists are already working on the **additive production of organs and parts of organs**, enabling bioprinting of the heart, liver and other organs cloned from DNA stem cells. This might put an end to waiting lists for organ transplants.

80 %

of patients in Germany who have visited a digital doctor’s office would do so again.

Source: Telemedicine Report Germany 2020

Data protection vs. data flow

German Federal Minister of Health Jens Spahn likes to put the dilemma in a nutshell: Data protection, he says, is something for those who are healthy. Conversely, this means that those who are ill would benefit from a largely unbridled flow of data. Because AI-based diagnostics require data of equally high quality as research databases or the developers of medical device technology. Because interlinked medical devices have to be able to exchange

data on the Internet of Things. And because effective exchange of data in emergencies can make the difference between life and death. However, precisely this flow of data is not only hampered by decades-old doctor-patient confidentiality but also by an impenetrable jungle of privacy protection laws worldwide, notwithstanding the fact that the protection of personal and medical data is no doubt important.

In a Digital Health Roadmap, the Bertelsmann Foundation points out approaches to potential solutions:

- Standardized electronic patient files as a therapy management platform with controlled access rights.
- An at least countrywide data linkage infrastructure modeled on the Australian Population Health

Research Network. The network in Down Under enables the exchange and interlinking of data between data producers and data managers as well as the parties that want to use the data. The latter have to obtain consent from all relevant data managers plus an ethics committee of the network. Linkage IDs ensure that an individual's data can be linked in a pseudonomized

form but that no third party has access to personal information.

- Enabling voluntary data donations.
- A coherent legal framework providing access to routine data as well as to other anonymized or pseudonomized data of the healthcare system to parties that have a socially relevant interest in using such data.

AI in diagnostics

In various studies, artificial intelligence has already achieved success rates equating to – or even surpassing – those of experienced physicians. In a pilot study conducted by the University of California, AI detected early stages of Alzheimer's disease based on brain scans with a 100-percent success rate, even six years on average before the actual diagnosis. In an international study in 2018, 58 dermatologists were pitted against an AI system in the field of skin cancer detection. The physicians achieved a success rate of 86.6 percent while the AI scored 95 percent. Researchers at New York's Mount Sinai School of Medicine developed a method using natural speech analysis to predict the onset of psychosis in at-risk youths within the next two years. The AI diagnoses presented in January 2018 achieved a success rate of 83 percent. Compared to humans, AI has the advantage of being able to analyze complex data in a matter of seconds, plus, unlike the human brain, AI neither gets tired nor is prone to distraction. Research projects have also shown that **AI is able to deliver diagnoses earlier and with greater precision than established methods in some cases**, plus this know-how can be cost-efficiently used anywhere in the world. AI can be involved in the analysis stage of pharmaceutical developments and thus save a lot of development time and, ultimately, costs. The



business consultancy PwC estimates the **savings potential due to AI just in the areas of dementia, obesity and breast cancer in the next ten years to amount to 172 billion euros**, even though the development of artificial intelligence in diagnostics is still in its infancy. The more complex the systems become, the more effectively various data sources (CT, MRT, DNA analysis and cell research, patient data and even hand-written files) can be combined for the assessment of a disease. **While the medical profession is going to lose its monopoly of knowledge due to AI, it won't lose its importance in general.** AI will assist physicians in the diagnostic process in that the system proposes a diagnosis based on its experience. However, the attending physician will continue to be indispensable for checking, confirming or, as the case may be, rejecting the AI's hypothesis as well as for the therapy.



Interlinking of medical devices in IoT opens up all-new opportunities, from health condition monitoring to remote treatment of patients in real time

IoT in medicine

Medicine has long recognized the benefits of the Internet of Things for its purposes as well and is developing more and more applications. **This field of Industry 4.0 is referred to as Healthcare 4.0.** Diabetics, cardiovascular or dialysis patients – like many other chronically ill people – depend on constant monitoring of individual physical parameters and functions: a medical form of condition monitoring for which interlinked devices are tailor-made. Remote therapies and diagnoses are enabled as well, which is ideal for emergency patients and those living in remote areas. In February 2020, **Chinese doctors at the hospital in Zhejiang controlled an ultrasonic examination in Wuhan – 700 kilometers away from Zhejiang and a locked-down corona hotspot at the time – via a 5G high-speed data network.** Due to the high transmission rates of the new mobile telecommunications technology, the physicians were able to look at the huge data volumes of the images almost in real time.

Robotics in rehabilitation

As early as in the 1990s, therapists used robotics to assist them in their work, which makes them members of the group of pioneers in healthcare. By now, a wide variety of robots are used in rehabilitation worldwide for training

patients to walk, move their arms or speak again after having suffered neural damage. **Like in surgery or in diagnostics, robots assist and ease the workload of healthcare professionals, but do not replace them.** Science has confirmed that intensity, repetition and an early beginning of rehabilitation massively increase the chances of recovery. **Untiring and always ready robots can be of great help in this context.** By recording specific training parameters such as the number of steps, force exerted or coordination of movements, the machine can provide direct feedback which can have a motivating effect.



Machines accelerate the recovery process and are able to motivate



In the interest of health

Schaeffler provides to its employees at German locations an extensive health portal, the “Schaeffler Health Coach.” The company’s health management team is able to reach all Schaeffler employees via this portal that can be used as both an app and a desktop version. All health-promoting programs, which employees can freely choose from, can be viewed in the Schaeffler Health Coach. In addition, updates on health-related topics and tips are uploaded at regular intervals. The tool has been active since the end of 2018 and was extended by the important factor of telemedicine in April 2019. As a result, employees are able to receive medical advice around the clock.

54%

of people worldwide are willing to engage with AI and robotics in healthcare.

Source: PwC Germany



Virtually human: today, robots are already used as substitutes for social contacts where caregivers lack the time for personal interaction

Robotics in caregiving

As life expectancy keeps growing so does the need for delivering care to the elderly. But even at this juncture, there's a shortage of nursing staff – and the shortfall keeps increasing. **In 2030, there'll be a shortage of 500,000 nurses in Germany alone, according to a study by the Bertelsmann Foundation, and nearly 400,000 in Japan, according to government estimates there. Robots might provide a remedy**, offering a wide range of possible uses, from so-called exoskeletons assisting nurses in lifting patients and machines delivering meals, beverages or laundry. During the corona pandemic, Chinese hospitals ordered 2,000 disinfection robots from the Danish manufacturer Blue Ocean Robotics. There are robots that demonstrate gymnastics exercises and socially-assistive humanoid robots which, through their interaction with patients, are able to compensate for lacking social contacts and – as strange as that may sound – even for human affection and warmth.

The robotic seal Paro with big round eyes and a fluffy white fur is a global bestseller of this robotic species. **More than 4,000 of these therapeutic animals that cost 5,000 euros are in interactive use worldwide** with cancer patients, autistic children or Alzheimer patients. The high purchasing costs of these machines are contrasted by a number of key benefits: robots can be used around the clock, they don't get sick, and they don't go on vacation.



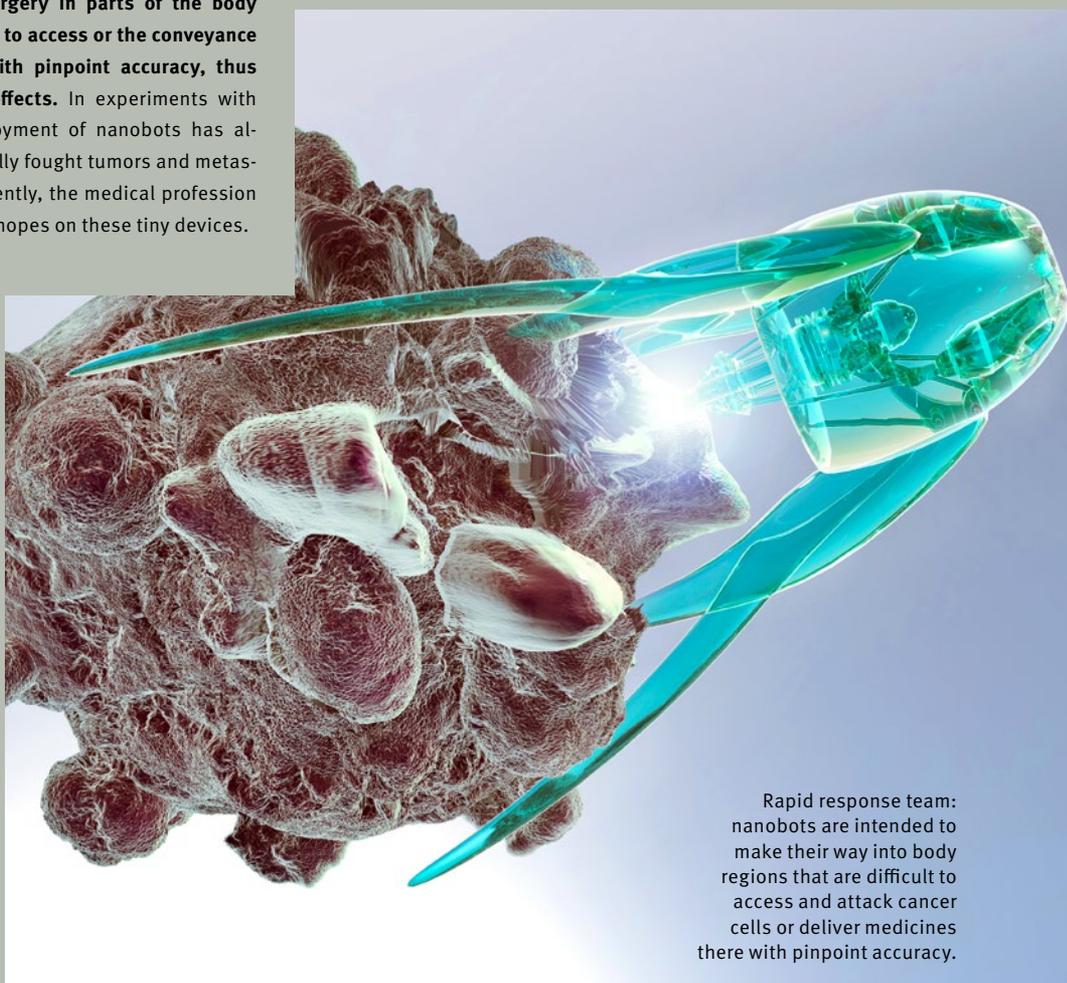
Spick and span: a robot disinfects a hospital room using UV light

Nanorobots glide through the body

In 1966, a team of research scientists shrunk itself to virus size and navigated a human body on board of a micro-submarine – at least in the science fiction movie “Fantastic Voyage.” While we’re still far away from shrinking physicians, **doctors have in fact successfully maneuvered the first tiny nano-robots through human vascular systems.** The propeller that drives them is 200 times smaller than the diameter of a human hair. **The distant aim of this high-tech medicine is to enable surgery in parts of the body that are difficult to access or the conveyance of medicines with pinpoint accuracy, thus reducing side effects.** In experiments with mice, the deployment of nanobots has already successfully fought tumors and metastases. Consequently, the medical profession is pinning huge hopes on these tiny devices.

New professions

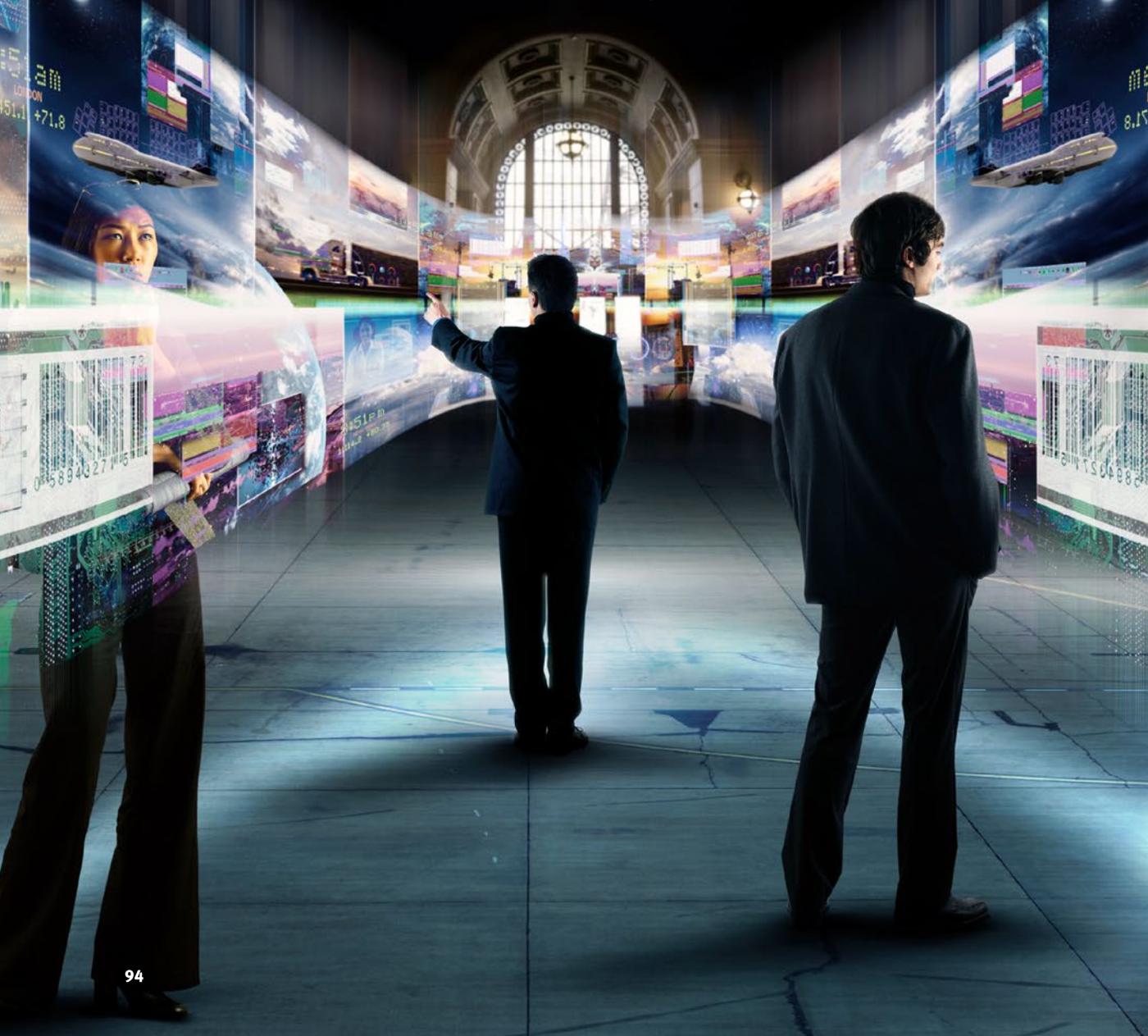
Due to the development toward digital healthcare systems, new professional fields might emerge. The Münch Foundation advocates the establishment of three new healthcare professions: specialists in digital health, process managers for digital health and system architects for digital health.



Rapid response team: nanobots are intended to make their way into body regions that are difficult to access and attack cancer cells or deliver medicines there with pinpoint accuracy.

Trade shows quo vadis?

There's hardly another sector that has been hit as severely by the corona pandemic as the events industry. Plus, there's hardly another sector in which Covid-19 has triggered such a disruptive digital transformation.



By Oliver Jesgulke

It's the end of February 2020: Trade show booth builders and event managers have been working at the Palexpo Congress Center for weeks on end. The mundane brightness of construction site lighting is still engulfing the workers who are busy hammering, cutting, drilling and polishing to put the final touches on the booths. It feels like everything on this Friday in February is just about ready for the 85th Geneva Motor Show. Most of the vehicles – still under covers – are standing in their assigned spaces. Choreographies for unveiling them are being rehearsed. All of a sudden, when the Swiss government announces a ban on events with more than 1,000 participants until further notice, there's an eerie silence. The teams setting up the booths immediately stop working. The Motor Show is now suffering the same fate as the Mobile World Congress in Barcelona or the ITB travel fair in Berlin before it. Caution dominates everything these days – and an end is not in sight. The ExpoDataBase industry portal provides daily statistics about the continuing misery of the events industry: 3,300 trade fairs and exhibitions worldwide were cancelled by the end of June, with losses running into billions. Germany as the leading trade show location with more than 400 million visitors per year is hit particularly hard. Normally, about two thirds of all global trade shows are held here, according to the Association of the German Trade Fair Industry (AUMA). More than 650 trade shows to date have been cancelled, postponed or rescheduled for a second time. Some will probably never come back. Prospects for the Geneva Motor Show, for instance, are bleak. Even the date for 2021 has already been cancelled.

The value of trade shows is diminishing

Organizers in many places are worried about their economic survival. Marketing departments around the globe are currently at odds with in-person

events and reducing or scrapping their trade show budgets. At the same time, the digital is competing with the analog world: “Both availability and quality of free virtual seminars and conferences are going to massively increase along with a decline in willingness to pay for classic in-person events. The current economic losses are going to exacerbate this trend,” says Stefan Rief. As Head of the Organizational Development and Work Design Research Unit at Fraunhofer IAO in Stuttgart his work involves studying the challenges and future scenarios of the event industry. “People are beginning to get used to taking advantage of virtual offerings. This will also be reflected in future event formats.”

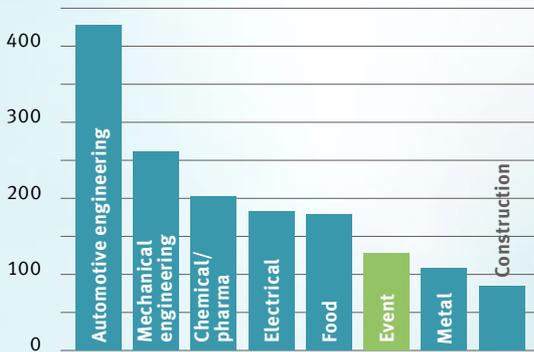
The fact that, like in Geneva, no covers had to be pulled off the new models anymore more than likely did not impair public awareness of them. For years, most consumer goods premiering at trade shows have been unveiled in advance in news media. Plus, an exhibitor at a trade show is just one of many vying for the visitors' attention, which has been fueling the question of whether elaborate trade show presentations are still appropriate in this day and age. Brands like BMW, Audi and Mercedes-Benz simply shifted their planned premieres to the internet and during live-streamed digital press conferences unveiled their latest vehicle generations. Social media channels such as Facebook and Instagram with the requisite reach make for an audience of millions of viewers. The responsibility has shifted from trade show booth builders and scenographers, caterers and hostesses to 3D artists, camera people and IT security.

Corona accelerates transformation

“The industry is going through a process of fundamental change of the kind the media sector has been experiencing for years due to the growing number of online offerings. This will mark a leap

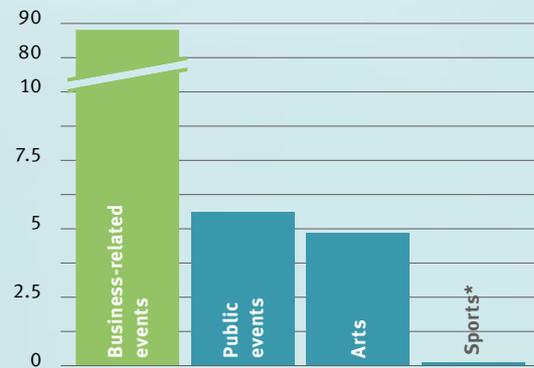
Events as an economic factor

Strongest sectors in Germany in terms of sales (in billion €)



Sales by event areas

Statistics for Germany (in %)



*only visitor revenues

Source: Research Institute for Exhibition and Live-Communications

into the future, because even though people will continue to get together in person, we're going to see new formats, services and business models," Stefan Rief adds. This transformation process is considerably accelerated by the corona crisis at the moment. All of a sudden, formats like the controversial subject of online annual meetings work: legislators are now giving corporations the opportunity to hold their annual meetings completely online and without direct shareholder presence until the end of 2020. By June, almost three dozen shareholder meetings had been shifted to the worldwide web, including Schaeffler's.

Among other things, websites launched specifically for this purpose offered multimedia information and corporate experts discussed special topics for shareholders, who were able to enter their questions using dialog tools. While in 2019 about 1,000 participants attended Lufthansa's annual meeting, some 10,000 shareholders clicked themselves into the virtual version this year. At Bayer, the number increased from a little more than 3,000 to just under 5,000 attendees. The corporations are increasingly finding favor with the new format, according to initial surveys.

Technically sophisticated

Be it virtual annual meetings, interactive workshops, live-streamed product presentations or multi-day online conferences with forums and group chats being run in parallel: the technical tools supporting such formats have been around for quite some time. Countless platforms with diverse functionalities are wooing customers. They may be discussion panels with voting and Q&A tools or networking rounds with one-to-one video chats. Due to virtual whiteboards including digital post-its and real-time dot-voting, workshops with brainstorming sessions no longer pose a challenge either. Even entire trade fair and exhibition areas can be digitally modeled in 3D enabling virtual visits including walks from booth to booth in the "trade show hall from the cloud." Avatars act as guides and booth presenters. Augmented Reality and Virtual Reality applications add further value vis-à-vis reality. Plus, success can be measured on the spot.

Another aspect not to be neglected is the fact that in spite of the considerable programming effort and expense involved virtual trade shows and congresses are significantly cheaper than their real-world counterparts – for both exhibitors and visitors. Schaeffler is increasingly conducting events using digital formats as well. The next major virtual event at Schaeffler will be the Supplier Day this fall.

The future will be hybrid

In spite of all the fascination with the digital world, the real world, the haptic experience will continue to exist in the events sector. Industries in which feeling, smelling or tasting matter, in which fascination is more important than information and

direct customer contact makes the difference, will only be able to inadequately present their products using current means of virtualization. Here classic trade show formats continue to be the most effective choices.

Or organizers may mix the best of both worlds, in other words, extending the physical event with elements from the digital trade show toolbox in the worldwide web. Experts regard such hybrid events as having the greatest mid-term potential, offering everyone the opportunity to attend in the way they like best: live at the venue or interactively online. Thus, “local” easily turns into “global” – thanks to “digital.”



The author

Real surprises, spontaneity, adventure: In spite of his enthusiasm for digital technologies, author **Oliver Jesgulke** is currently missing

all of these at virtual events. Especially personal contacts cannot be substituted by anything else as far as the Berliner is concerned.



Masthead

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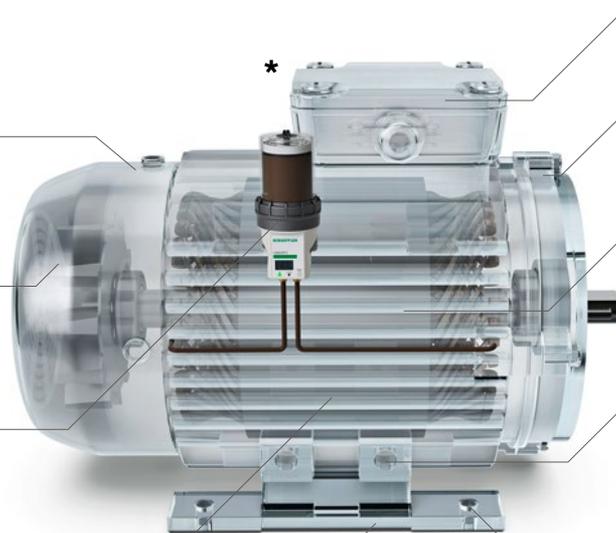
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*Schaeffler has developed an 'e-kit' specifically for electric motors. This kit is suitable for use with the automatic CONCEPT2 lubricator from Schaeffler which can independently supply up to two lubrication points with lubricant and provides electric motor operators with an economical way to upgrade the CONCEPT2 system.

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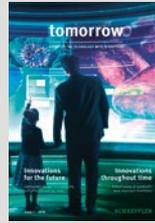
01/2015
**Mobility
for tomorrow**



02/2015
Productivity



03/2015
On the move



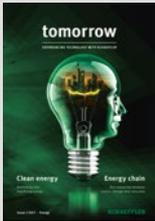
01/2016
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02/2017
Motion



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Machines



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02/2018
Urbanization



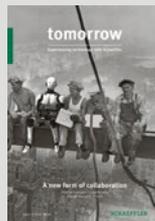
03/2018
Acceleration



01/2019
Challenges



02/2019
Holism



03/2019
Work



01/2020
Opportunities

tomorrow has won recognition



Special Mention
“Communications
Design Editorial”



best of
content marketing
Silver 2017

Silver
Special Award
“International
Communication”



german
brand
award
17
special

Special Mention
for “Outstanding
Branding”



Award of Excellence
for Cover (2/2017)
and cover story
“Electric Leader”



Gold Winner
“Websites:
Customer Magazine”



Award of Distinction
“Cover Design, Overall
Design, Corporate
Communications,
Copy/Writing”



Gold Winner
“Websites,
Feature Categories,
Best Copy/Writing”



Gold Winner
“General Website,
Categories-
Magazine”



Silver
“Writing:
Magazines Overall”



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