

tomorrow

Experiencing technology with Schaeffler

Tower of strength

Resilience is the key to defying
the storms of our times

re|silience; - /rɪ.zɪ.lɪ.əns/

1. (psychology, neuroscience) The mental ability to recover quickly from depression, illness or misfortune.
2. (physics) The physical property of material that can resume its shape after being stretched or deformed; elasticity.
3. The positive capacity of an organizational system or company to adapt and return to equilibrium after a crisis, failure or any kind of disruption, including: an outage, natural disasters, man-made disasters, terrorism, or similar (particularly IT systems, archives).
4. The capacity to resist destruction or defeat, especially when under extreme pressure.

From resilio + -ence, from Latin resiliō (“to spring back”).

Source:
resilience. (2022, December 1). Wiktionary, The Free Dictionary. Retrieved 09:45, December 14, 2022 from <https://en.wiktionary.org/w/index.php?title=resilience&oldid=70189403>.

tomorrow has won recognition



Special Mention
“Communications
Design Editorial”



Silver
Special Award
“International
Communication”



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”



Grand Winner
“Magazine”

Dear readers,

Oscar Wilde once wrote, “To expect the unexpected shows a thoroughly modern intellect.” These words are around 150 years old. Even so, they’re still very appropriate now because hardly anything is more expectable in today’s unsteady, complex world than for something unexpected to happen. Technological and demographic developments, climate change as well as financial and geopolitical dislocations produce the unexpected at a pace that can send us spinning. Today’s modern intellect has given a name to the steadfast expectation of the unexpected and the ability to master the challenges that may result from it: resilience. That’s precisely the term on which the new issue of our technology magazine “tomorrow” is focused to which I extend a warm welcome to you.

Resilience is generally defined as the ability of dynamic systems to recognize new challenges and to proactively prepare for them. Resilience is our anti-spin program for the wide variety of challenges posed by the volatile world of today and the near future. Resilience is relevant – for every individual, for businesses, for society. Plus, resilience has many facets as reading the following pages will reveal.

When it comes to building resiliencies pioneering technologies can be the keys to success. In a manner of speaking, they’re defenses from the world’s research and development labs, whether serving to make warehouses fit for handling the requirements of highly efficient logistics or to rid orbital space of astro-garbage. The mobility transition in the world’s rapidly growing metropolises is another example where success will only be achievable by means of innovative technologies. All these are topics covered on the following pages.

The entertainment industry has also long begun to use high tech for the purpose of attracting visitors. Museums are embracing modernity



and morphing into multimedia temples of art. In circus rings, zoos and on musical stages, 3D avatars are replacing real-world creatures. Curtain up for the holofants starting on page 62. Extremophiles, in other words life forms that are harmed neither by cold, heat, aridity or acid baths nor by years spent in space are truly grandmasters of resilience. Many microorganisms have developed amazing “superpowers.” Start reading on page 48 how we can put them to use.

Have you already decided whether powerful artificial intelligence systems such as ChatGPT are going to boost or rather challenge the resilience of modern societies? Starting on page 56, you’re going to find information assisting you in making that choice. There’s yet another article I’d like to warmly recommend to you: book author Stefan Kruecken interviewed far more than 100 captains about how they handle challenges in rough seas. You’ll find their good-read resilience lessons starting on page 70.

Enjoy your read about resilience.

A handwritten signature in black ink that reads "Klaus Rosenfeld". The signature is fluid and cursive, written in a professional style.

Klaus Rosenfeld
Chief Executive Officer

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Human workers are no longer needed in modern warehouses. High tech and AI guarantee resilient and highly efficient supply chains



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Digital technologies point the way toward revolutionary and amazing worlds to be experienced in museums, concert halls and circus rings

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Engineering

How technological progress helps us develop the resiliencies we need for mastering the challenges of the future.

Intelligent corrosion protection

Steel is a material that's used all over the world – and rust is its natural enemy. To keep that enemy in check, an **amazing annual amount of some 4,000 billion U.S. dollars is invested in corrosion protection** worldwide.

Now researchers at ETH Zurich have developed a plastic material that might be able to revolutionize corrosion protection because the so-called polyphenylene methylene, or PPM for short, covers several bases. When mixed as a paint and heated, PPM can be sprayed onto a surface where it solidifies. The fluorescent polymer makes holes and cracks visible as dark spots in the protective coating. **But that's not all: PPM even repairs any damage itself.** At the end of a product's life, the polymer can be completely removed and recycled with minimal material loss (<5%). The researchers have filed a patent application for their invention and are now looking for an industry partner to continue developing the product as well as producing it on an industrial scale and selling it.



Staying up to speed

Condition monitoring of critical powertrain components is a key contributor to manufacturing resilience in all industrial sectors.

The more detailed the insights into the condition of mechanical and electrical components in rotating machines, the better their protection against unscheduled downtimes. Since 2020 Schaeffler has been offering OPTIME, a reliable condition monitoring solution for predictive maintenance of industrial machines based on signal analysis of vibration and temperature data. Through the acquisition of French specialist ECO-Adapt Schaeffler has complemented this offering, now also **providing maintenance information based on the analysis of electrical signals** which enhances protection against potential failures of electrical components.

900 M

metric tons (992 million short tons) of food residues end up as garbage every year worldwide. That's a shame because they could be used for more sensible things – such as building houses. Researchers at the University of Tokyo have recently developed technology **enabling them to produce easily recyclable cement from dried and pulverized orange and banana peelings or other fruits and vegetables.** If the veggie cement remained untreated it could even be eaten: demolition by knife and fork. Except for one pumpkin-based version, **all veggie cement samples tested proved to be at least as bending-resistant as conventional cement.** The derivative from Chinese leaves was even three times as resistant.

“The problem is not the problem. The problem is your attitude about the problem”

Captain Jack Sparrow in
“Pirates of the Caribbean”

More female STEM power



Only 22 percent of all jobs in the fields of science, technology, engineering and mathematics (STEM) are held by women, according to an EU-wide study by the consulting firm McKinsey. That massively challenges the resilience of this economic region in terms of skills shortage. Not only that: **if the proportion of women in STEM roles were to increase to 45 percent by 2027, Europe's gross domestic product would grow by 260 to 600 billion euros,** according to McKinsey. In addition to generally supportive actions, more flexible working time models and better childcare, the consultants recommend recruiting women specifically from other talent pools of an organization and to promote the development of their technical skills.



163,000

warehouses with a footprint of more than 4,500 m² (48,440 sq ft) have been counted worldwide by market research firm Interact Analysis. By 2027, their number is supposed to skyrocket to 214,000, with a quarter of them serving online retail.

All ducks in a row

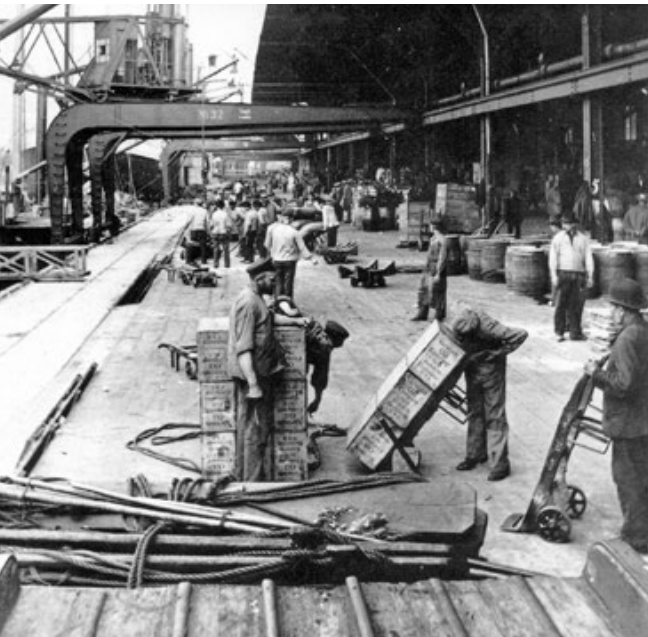
Fully automatic and highly efficient: That's how warehouses have become critical hubs of resilient supply chains.

By Daniel Hautmann

When Hamburg's Speicherstadt warehouse district was inaugurated in 1888 it was the largest and most advanced complex of its kind in the world. The area offered 300,000 square meters (74.13 acres) – equaling 42 soccer fields – of storage space. Not only its size was impressive but so was the time it took to build it: the district was completed in less than five years. On the occasion of its inauguration by Emperor Wilhelm II the citizens of Hamburg were given a work-free “Emperor's Day.”

No one in 1888 could have guessed that the Speicherstadt would one day become a UNESCO World Heritage Site and resulting tourist attraction. Whether today's record-breaking warehouse facilities will also be included on that distinguished list some day is doubtful but not impossible. Be that as it may, their humongous rack and shelf systems are awesome.

But let's stay in the here and now. The global warehouse market of 648.35 billion U.S. dollars in 2021 is expected to nearly double to 1,264.01 billion U.S. dollars by 2030, according to a study by Straight Research. “The e-commerce business that's seeing strong continuing growth and the related changes to the supply chains are key drivers



In the days of Hamburg's Speicherstadt more than 100 years ago, warehouse work was a back-breaking job. Today, machines handle strenuous lifting, sorting and transportation tasks

of this development," says Alexander Krooß from Fraunhofer Institute for Material Flow and Logistics in Dortmund.

So, it comes as no surprise that the world's largest high-tech warehouse is currently operated by e-commerce giant Amazon. The dimensions are truly impressive: with a footprint of 334,450 square meters (83 acres), the MQY1 Fulfillment Center in the U.S. state of Tennessee is as large as the entire Speicherstadt warehouse district in Hamburg. Astonishing as well is a look inside that reveals a level of hustle and bustle similar to the activities that used to take place between the warehouses in Hamburg in the old days – except that, in addition to 3,000 people and a total of 20 kilometers (12.4 miles) of conveyor belts, there are hundreds of robots involved in the hustle and bustle. Among other things, they're supposed to relieve their human colleagues of heavy lifting and hauling tasks, which in older Amazon warehouses had doubled the risk of injury compared to that in warehouses of other companies.

On five floors, each as large as a dozen football fields, millions of items with a maximum size of 45 by 45 centimeters (17.7 x 17.7 inches) are stored. They are stowed in 40,000 crates, which in turn are

placed on mobile shelves. Flat mobile robots piggyback the shelves, which are around three meters (10 ft) tall, and take them to the sortation stations where they're loaded and unloaded. The crates, by the way, are not packed according to categories of merchandise; random stowage has proved to be more efficient, so memory cards quite naturally go into the same crate as fishing accessories and children's toys.

While Amazon's mega warehouse follows a classic shelf layout with stocking from the side more and more companies are turning this concept upside down. Instead of lifting pallets from the floor using automated vehicles, modern layouts feature arrangements where the racks are filled from the top down – albeit typically not with pallets but with bins.

In such systems called cube storage, the goods are basically stored like they would be in a beer case, albeit with umpteen bottles stacked on top of each other. Warehouse robots drive on top of the grid like on a chessboard pattern and grab the boxes with their gripper plates. With the help of an artificial intelligence unit, the systems sort the goods and boxes for optimized distances and thus times – frequently used boxes are stored toward the top. "With the help of mathematical optimizations and AI-based algorithms, the systems can enhance their efficiency by relocating goods and bins to optimize the travel times of the robots," says Fraunhofer's Alexander Krooß.

How brick-and-mortar stores benefit from high-tech warehouses

AutoStore is one of the manufacturers of such cube storage systems. The Norwegian company says that it has worldwide operations and installed more than 1,000 systems in over 45 countries. A forward-thinking example is the store of sports goods retailer Decathlon in Calgary, Canada. The warehouse serves as both a warehouse for the store and as a distribution center for regional online retail. Customers find products for some 65 different sports at the store. If a customer wants to try on or try out a product, it takes warehouse robots a maximum of three minutes to pick and deliver it directly to the changing room. As another customer benefit, the store, compared to other locations, offers nearly twice as many articles, i.e.,

145,000 instead of the usual 70,000 to 90,000. “Decathlon’s goal was to create a unique, new and better customer journey in this store,” says Diba Alegha, Operations and E-Commerce Manager at Decathlon Canada. That’s how high-tech warehouses help brick-and-mortar stores become more resilient in competition with online retail.

Flexible adjustment to changing needs

Other benefits of such systems are better space utilization, by as much as a factor of 4, according to AutoStore, and the potential to expand modular warehouses in current operations: the warehouse keeps growing along with the business – a hot topic in logistics. Warehouses growing at the same pace as business help develop new markets, for instance in e-commerce that is regularly challenged to improve its response to seasonal fluctuations. For instance, when business peaks around Christmas, more robotic vehicles can be used.

E-grocery poses a special challenge in the area of automated warehouses. Electronic food retail has become firmly established not least due to covid, be it in the form of click & collect or home delivery.

The shopping carts of consumers are a motley collection of product groups. The requirements to be met by intelligent picking are more complex than in the case of retailers with a more limited sales mix because frozen food follows different logistic chains than wine, avocados different ones than cheese, and shampoos different ones than fresh meat. That’s why e-grocery in particular calls for modular systems enabling agile adjustment to changing requirements and connections via an interface – so that fresh meat from a refrigerator can be placed into the same consignment as flour from a dry store, and napkins from standard storage.

Hustle and bustle in darkness

Autonomously traveling robots that, thanks to artificial intelligence, independently haul goods and even connect to form swarms when the load becomes too heavy or bulky for a single mobile robot are another hot topic (see also page 23). In the LoadRunner project, the Fraunhofer researchers in Dortmund demonstrate what’s possible: “The LoadRunner combines the benefits of powerful sorting and conveying technology with the high flexibility and scalability of autonomous robot

In such vertical warehouses called cube storage, goods are stored in continuous rows of bins. Due to the absence of aisles, space utilization can be enhanced by as much as a factor of 4



9,200

pallets can be placed into a high-bay warehouse near Würzburg.

The 77-meter-long, 32-meter-wide, and 30-meter-high facility (253 x 105 x 98 feet) is special because it has been constructed from wood.



swarms. It thus builds on the vision of future infrastructure-reduced logistics, which is a prerequisite for flexible response to the high dynamics of today's logistics," says Krooß.

Such AI-controlled robots are another building block toward achieving so-called "lights-out warehouses" or "dark stores." The omission of lighting does not primarily serve the sustainability objective but refers to one-hundred percent automation because, unlike humans, machines do not require light for sorting and transporting goods quickly and precisely.

A look at Switzerland shows that such high-tech warehouses don't necessarily involve huge dimensions. There, in an area of just 400 square meters (4,300 square feet), intralogistics expert Jungheinrich is in the process of establishing a so-called PowerCube for a medium-sized retailer in the electrical and lighting sector. The storage capacity of the cube with a height of nearly 10 meters (33 feet) and 25 levels is 18,000 bins, each with up to 50 kilos (110 lbs) of payload. Goods are transported by small electric shuttles running back and forth between the racks. Noyes, a startup company, even offers fully automatic warehouses with space ranging between 10 and 250 square meters (107 and 2,690 square feet). This is another example where a modular design enables integration or extension in current operations, including refrigeration if desired.

Digital framework

It goes without saying that the flow of goods in high-tech warehouses requires a correspondingly powerful data stream, given the high level of automation. "Nowadays, every warehouse or logistics center has to deal with Big Data," writes warehouse specialist Mecalux in a German-language blog post. "This involves processing an inconceivably large amount of information. A distribution chain without appropriate warehouse management software is in fact unthinkable."

But the extensive Big Data collections are not only intended to help document and manage the flow of goods. The source that is constantly and abundantly bubbling up data in the logistics halls as a result of the recorded movements of goods is an enormously valuable planning tool for any company, enabling it to respond proactively to market movements. Beyond routine business, the flood of digital information helps optimize existing warehouses, including conveyor technology and the flow of goods, with the help of simulation techniques, or to construct customized new buildings quickly and at optimized cost.

Five years of construction time, as in the case of Hamburg's Speicherstadt warehouse district over 100 years ago, is something no company can afford today. The similar-sized giant Amazon warehouse in Tennessee was operational after nearly one year of construction.



The author

Journalist **Daniel Hautmann** not only writes stories and books but also produces audio and video formats focused on technology,

energy and the environment, and has repeatedly done work for "tomorrow." While working on the current subject he detected some similarities to his everyday life: in order to precisely meet his deadlines, the freelancer, husband and father of a young soccer player and a young cyclist occasionally needs to perform major logistical feats himself.



The market for automated guided vehicles is growing rapidly. Experts expect more than 1.1 million of such vehicles to already be in use worldwide by the end of 2024

Industrious speedsters

More and more automated guided vehicles – or AGVs for short – autonomously haul materials and goods to their intended places in the aisles of Schaeffler’s manufacturing plants. Currently, 100 of these industrious speedsters are deployed in the Group’s worldwide production sites. “Our goal is to implement 500 AGV applications worldwide by 2025 and to thereby save 25 million euros,” says Thomas Krämer, Senior Vice President, Advanced Production Technology. AGVs are floor-bound vehicles whose utilization is focused on in-house operations and that enable continuous, needs-based, and flexible supply to the factory floor. “The deployment of AGVs as a transportation system offers immense benefits: Besides optimizing our internal material flow using intelligently controlled vehicle fleets, they include enhanced industrial safety, better transparency within inventories, and higher availability and productivity increases due to 24-hour operations,” emphasizes Sebastian Hirschmann, Project Leader AGV@Schaeffler. “Likewise, the systems can be adjusted dynamically, flexibly and scaleably to the increasing level of automation in Schaeffler’s manufacturing environments.”

All AGVs at a site are interconnected by a fleet management system and communicate with each other. The total system consists of the vehicle fleet itself, an overall control unit, localization tools and position acquisition, a data transmission device, as well as peripherals such as charging stations. The distances traveled by AGVs vary between roughly 250 meters (820 feet) per cycle in chain manufacturing operations in Bühl and up to 1.6 kilometers (one mile) in Skalica, where a tugger train AGV is used.

Going forward, Schaeffler is planning to deploy even more flexibly usable, mobile cobots in addition to AGVs. Project DEX that was developed at the Schaeffler Hub for Advanced Research at Technical University Nanyang in Singapore (NTU) in close collaboration with Orcadesign Consultants Pte. Ltd. provides a preview of such drivable robotic platforms. The project is intended to combine functionality with intelligent social behavior and to support and increase productivity in industrial environments for a wide variety of tasks.

Caution! Fakes!

Product piracy costs billions: not only because of lost sales but also due to potential damage resulting from inferior quality of fakes. The consequences are complex – just like the related safeguards.



By Lars Krone

The statistics are impressive – but also staggering: The cross-border law enforcement officials from Europol assess the share of pirated products in worldwide trade to amount to 2.5 percent valued at 461 billion U.S. dollars. Western industrial countries are particularly affected by product piracy. According to the most recent OECD study in 2019, some 24 percent of the infringements of intellectual property rights (IPR) discovered worldwide concerned the United States, followed by France (17 percent), Italy (15), Switzerland (11) and Germany (9). Shoes, clothing, leather goods, electronics and watches accounted for the largest share of merchandise. However, product piracy not only affects luxury or consumer goods. Impacted as well are particularly critical product groups such as medicinal and safety-relevant industrial products – and, therefore, the globally operating automotive and industrial supplier Schaeffler is affected too and attaches appropriate importance to developing effective resilience against such attacks.

Strengthening resilience against fake products

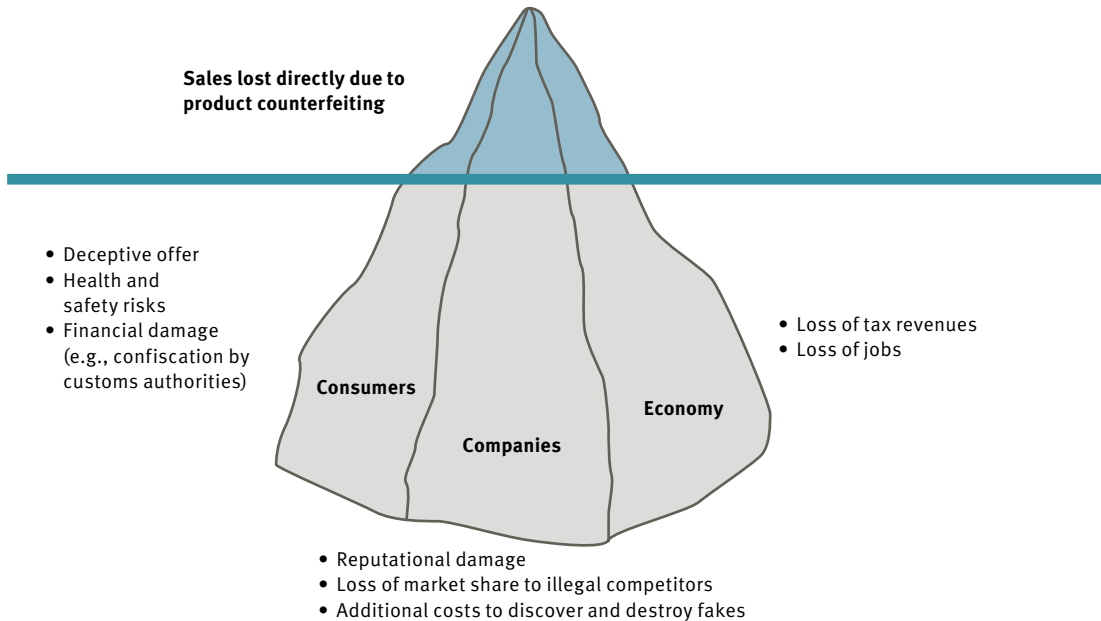
The consequences of counterfeiting are complex. Manufacturers not only lose sales or competitive advantages but are also threatened by a tarnished brand image, claims for damages, job loss or litigation. Not only major corporations are impacted: In a survey conducted by the European Intellectual Property Office (EUIPO) among small and medium-sized enterprises (SMEs) one in four companies responded that it was affected by IPR infringements.

“Illicit trade in counterfeit and pirated goods poses a major challenge to an innovation-driven global economy,” confirms Christian Archambeau, Executive Director of the EUIPO. “It damages economic growth; poses significant threats to individual and collective health and safety; fuels organized crime; undermines sound public governance, the rule of law and citizens’ trust in government.” High time, therefore, to build up or strengthen the necessary defenses.



The most recent mass disposal: On the premises of Riwald Recycling Franken GmbH in Schweinfurt-Sennfeld, Schaeffler had some 30,000 fakes weighing a total of ten metric tons (11 short tons) destroyed. Following its compression, the scrap metal is smelted in a steel mill – as part of the resource recycling process of steel. Pictured from left: Martin Rügemer, Schaeffler Global Brand Protection, and Frank Ziegler, Riwald Recycling

Damage due to product piracy: Lost sales are just the tip of the iceberg



The aspect of safety is of particular concern to Martin Rügemer from Schaeffler’s Brand Protection Team: “Of course a counterfeit part frequently implies considerable damage to a brand’s image and lost sales for a company. But especially in the case of safety-relevant products any fake may be defective due to the utilization of inferior materials or because of design flaws – and, above all, poses a potential hazard. For instance, a bearing in a power plant may fail, but a wheel bearing in a passenger car can get stuck as well. The effects may be very serious.”

Whereas people purchasing consumer goods often just want to save money, deliberately buying fake T-shirts or watches, manufacturers of industrial components or buyers of bearings sometimes don’t even realize that their sector is a victim of product piracy as well. “Some manufacturers feel that their products featuring high levels of technical sophistication are impossible to fake, so that they’re not affected,” says Ingrid Bichelmeir-Böhn, who is also a member of Global Brand Protection at Schaeffler. “But they’re simply proceeding from false assumptions because

counterfeiters don’t care whether or not their products are replicated with technical accuracy, whether or not they function or meet industrial or quality standards. At first glance, they often look like the original part but are defective and therefore dangerous. Counterfeiters are only concerned about making money.” And that involves the entire range of the product portfolio: “There’s nothing that’s not subject to being faked,” her colleague Rügemer adds. “At Schaeffler, it actually includes everything from small groove ball bearings to wheel bearings or clutches to large bearings such as those for wind turbines.”

Extensive list of actions at Schaeffler

In order to become more resilient against product piracy, Schaeffler has implemented a whole series of measures in recent years. The focus is particularly on intensive exchange with customers. “We invest a major effort in information, for instance using info materials, presentations or posts on social platforms such as LinkedIn,” says Bichelmeir-Böhn. “On the one hand, we do that to heighten buyers’ awareness of product piracy

and, on the other hand, to enable them to recognize pirated products or to know what to do if they have doubts about their authenticity.”

For this purpose, Schaeffler rolled out the Schaeffler OriginCheck app in 2017. With it, customers can easily use smartphones to check a special and individual Schaeffler code on labels of Schaeffler products and in some cases on the products themselves. They’ll subsequently receive a notification telling them if this is a code that exists in a database maintained by Schaeffler. Should the code not appear there or have been used several times before the user will receive a warning and instructions for the next steps to be taken.

Detective work alone is not enough to put a stop to product piracy; it is becoming increasingly important to anticipate new methods and introduce appropriate protective measures. “To sustain our ability to confront product pirates going forward, we need to continue to develop ourselves along with the counterfeiters and their methods,” explains Ingrid Bichelmeir-Böhn. That includes

monitoring of digital distribution channels. “Due to e-commerce, sellers are able to offer their products worldwide with considerably greater ease,” Bichelmeir-Böhn adds. “That’s why it’s very important for us to systematically monitor these platforms, to take action against sellers of faked goods and to have their listings deleted. In this area, we’ve been seeing an increasing amount of shifting from B2B and B2C platforms toward social media, which shows that we’re successful with our actions.”

Collaboration multiplies impact

The members of Schaeffler’s Brand Protection Team also rely on support by sales employees and distributors in their resilience measures. “We’ve established a very good network that includes us online as well as in the real world and provides us with important clues that we follow up on. In addition, we work closely with customs authorities or agencies like Europol,” Martin Rügemer adds. “But that may also apply to a private citizen who has purchased something on eBay and gets in touch with us via the OriginCheck app.”

The exemplary action taken by Schaeffler’s Greek distribution partner SKAMA is a case in point. SKAMA offered a customer that had opted for an allegedly better offer by a competitor to authenticate the shipped bearings. The verification of



“Some manufacturers feel that their products featuring high levels of technical sophistication are impossible to fake, so that they’re not affected”

Ingrid Bichelmeir-Böhn,
member of the Brand Protection Team at Schaeffler

the Data Matrix codes by means of the OriginCheck app corroborated the distributor's initial suspicion. SKAMA immediately sent photographs of the goods in question to the Schaeffler team that confirmed beyond a doubt that they were counterfeits. For another suspected case, the members of the Brand Protection Team traveled to Greece and once again identified all bearings as fakes. With support by a local attorney, the shipments were immediately confiscated. Schaeffler's Turkish distribution partner Özevren Rulman had a similar experience. They had lost a range of bids in response to invitations to tender against clearly cheaper competitors. Suspecting that something was wrong, they offered the customers concerned to verify the authenticity of the cheaper bearings using the OriginCheck app, and they turned out to be fakes. Due to their intervention, Özevren Rulman even managed to extend existing business relations with its customers.

Unwitting infringement of brand rights

The German company Diehr und Rabenstein that was supposed to receive shipments from a company named Yakang, which appeared to be a respectable business at first glance, had a bitter experience of product piracy as well. The goods the company had ordered were confiscated by customs authorities at the Nuremberg airport and Diehr und Rabenstein's offices searched by authorities. It had turned

500,000

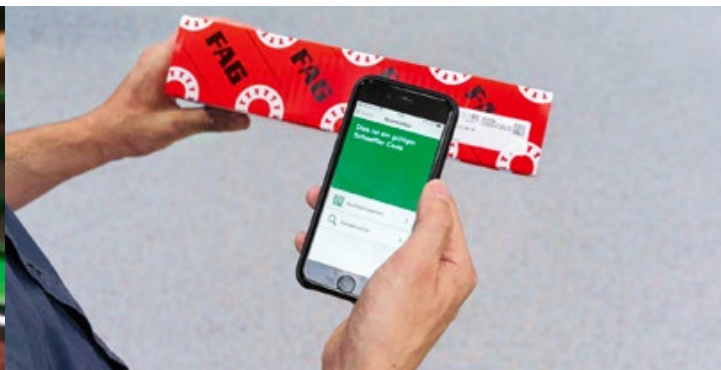
jobs are lost due to imports of fakes into the EU, according to estimates by the German Economic Institute.

7,000

cases have been investigated by Schaeffler's Global Brand Protection since the unit was founded in 2004.

15,000

faked FAG bearings and 40,000 packaging duplicates were seized by government authorities in India.



That's what a defective bearing looks like that had been faked (left). The Schaeffler OriginCheck app enables customers to authenticate Schaeffler products (above, right). After scanning this Data Matrix code (below, right) on a Schaeffler bearing by means of the app, customers will receive a message on their phone telling them if the bearing is an original

out that the company had purchased counterfeit bearings. “At first, my employees and I didn’t realize what was happening to us,” owner Wolfgang Diehr recalls. “You normally know such scenarios only from television. Suddenly, we appeared to be villains, criminals, caught in the crosshairs of investigators, bailiffs, attorneys and experts. This massive showing drove home the seriousness of the situation to us and we began to realize that we’d unwittingly infringed on brand rights. Our attorneys subsequently informed us that we had to expect anything, including prison sentences and insolvency! We were shocked. Everything that we’d worked hard to build during the past two and a half decades, our company, our homes, our standard of living ... All that was now to be lost?” In close collaboration with Schaeffler’s Brand Protection Team, the case of was ultimately resolved. “We want to create trust with our actions against product piracy,” emphasizes Bichelmeir-Böhn. “Customers can turn to us at any time and will be supported by us. They won’t be left in the lurch with such problems.”

Since it was formed in 2004 Schaeffler’s Brand Protection Team has investigated more than 7,000 cases and deliberately initiated further actions for protection against product piracy and brand right infringements. Ideally, suitable actions are taken locally, in other words on the counterfeiter’s premises, to confiscate the goods and to thereby prevent these products from entering the marketplace. As a case in point, Ingrid Bichelmeir-Böhn mentions government action taken in India when 15,000 faked FAG bearings and 40,000 duplicate packaging units were seized all at once.

But such large-scale discoveries are becoming increasingly rare. In many places, product pirates have switched to just-in-time production. Components and packaging materials are marked with fake brand symbols just shortly before they’re shipped. Most of the goods are stored namelessly in basements, so-called go-downs, which protects them against confiscation.

Again and again, confiscated products are destroyed in spectacular actions around the world – not least to deter potential counterfeiters. Schaeffler uses such conspicuous methods too but has been championing actions to prevent counterfeit scrap from ending up being treated



“There’s nothing that’s not subject to being faked. At Schaeffler, it actually includes everything from small groove ball bearings to wheel bearings or clutches to large bearings”

Martin Rügemer from the Brand Protection Team at Schaeffler

as waste. “In our case we see to it that fakes, in the best case, are melted down because the steel can be reused,” explains Martin Rügemer. For this sustainability initiative that has been catching on, a service provider of Schaeffler’s in the United Arab Emirates was recognized with the “Green Dot Award.” Of course, sustainability (and safety) would benefit even more if such counterfeits were not produced in the first place ...

“It could work out! If ...”

Transformation, change, strengthening resilience – how does that work? Andreas Hoberg, production expert and business consultant at Ingenics AG, classifies priorities and vocabulary.

Resilience – the ability to hold one’s ground against external disruptions. That’s what matters in economically turbulent times. Pandemic, war, climate crisis – those are “events” that affect the business models of practically all companies. Massive turbulence can often be managed

only by means of massive shifting – talking about transformation and change. Together with Andreas Hoberg we’re going to take a walk through the thick forest of vocabulary and context pertaining to our focus topic in this issue: resilience.

What the expert says about ...

... putting current change into a historic perspective

As humans we tend to say that precisely the times in which we live are the most challenging ones with the greatest change. However, looking at things from a perspective of larger cycles shows that there have been more radical changes and more epochal transformation boosts in the past. The invention of the steam engine or the use of IT and computers are cases in point. The major difference to today is that the cycles have become shorter, much shorter. Companies, today, practically have no more lead time and therefore cannot position themselves properly in terms of strategy and processes. Companies find themselves in a supine position far more often and that results in clearly different – higher – demands to be met by the company’s leaders and executives. The cycles are shorter and thus the necessary response speed. My impression is that partic-

“External assistance and opinion in phases like these – with multi-dynamic influences – are accelerators that enhance efficiency extremely”





ularly the last three years with the pandemic and the war have exhausted many leaders and companies. They were caught in a permanent feeling of being in a supine position even though things had really been going well up until that time and they had been in a positive and strong position to align for transformation.

... the origin of the term resilience

I think it has been around for as long as bamboo has been cultivated in China. Bamboo is characterized by extreme flexibility combined with stability. That's the synonym for resilience from nature.

In business, the subject of resilience has always been present but moved out of focus to some extent. Now, in view of the crises following each other in very short cyclical succession, some of which were or still are existential, the factor of resilience has suddenly become more important again.

... the current significance of resilience

Companies need to examine the state of their stability and flexibility. What is the foundation, what is our original, individual strength? What do we stand for? What is our core? What is our innovative prowess? And based on those answers, strengths need to be strengthened. From that, the company can build motivation toward the inside and say to the customer, "Look, that's what we're doing now!" That positive energy is necessary in an environment with so much bad news.

I feel that it's appropriate and important that the factor of resilience has increasingly moved into focus again because nothing about the approach

“Compared to the past, cycles have become shorter. Companies, today, practically have no more lead time and therefore cannot position themselves properly in terms of strategy and processes”

of combining stability with flexibility has changed. Of course, there's a wide variety of perspectives and dimensions to increase resilience.

Transformation can be driven by strength: a company knows where it stands in a business ecosystem and pursues change in the spirit of further development. That's the way I see it for some sectors such as machine tools, mechanical engineering, or process engineering. Out of this strength, a lot can be done for stability and flexibility.

However, transformation and resilience can also be an anchor of hope when a company, like a frog, is hanging onto a straw swaying in the wind in hopes that it won't break. That is the case, for instance, where the current changes or crises are impacting on entire industries or branches of industry. Two examples to illustrate the point: First, the automotive industry that's going through a process of massive transformation. What's happening there and what of that is politically driven? What effects does that have? Second, the classic department stores where we as consumers with our new purchasing patterns massively pointing toward online retail are making the changes. Particularly in the case of the latter, the call for resilience and transformation does not emanate from a position of strength.

Such a transformation process always has several dimensions as well as a superordinate level: That's the processes and workflows and the roles and people primarily related to them. Ideally, a conscious strategy process resides above all that. We need to look from all these angles before and in the process of transformation. Talking about resilience in that context always refers to the overall resilience of the company: how strong is it, how weak and how flexible?

... the biggest mistakes in building resilience

Arrogance and ducking away in line with, “Oh well, that doesn’t concern us.” That again has a lot to do with executives and their experiences. The crux of the matter is that it concerns business models that have worked for years or decades. The German “mittelstand” is a perfect example: to some extent, we have a highly diverse dovetailing supply chain. The parties know each other and it works – a German specialty and strength of the mittelstand. I continue to see that as a positive. But suddenly the overall conditions have radically changed and some products are no longer needed – that can lead to change posing an existential threat to a dependent supplier. We’re also seeing in the automotive industry with its interlinked structures that the supply chain is completely resorting itself in some areas. There’s no point in beating around the bush: some companies are going to fall by the wayside.

... key factors in building resilience

Decisiveness, willingness to take risks, error culture, conclusiveness, involvement of employees and precise, transparent information for the workforce: “That’s what we want, that’s what we’re going to do.” That releases energies. Those are the key factors in my view.



“Decisiveness, willingness to take risks, error culture, conclusiveness, involvement of employees and precise, transparent information for the workforce – those are the key factors in my view”



... the game changers waiting in the wings to enhance resilience

Digitalization, without a doubt. It's still not being used the way it should and could be. I need transparency for my decisions, digital solutions can create that and generate valuable data. With that, I can analyze and better understand my company. And then – following the analysis – I can also use digital simulation for predictive actions. That's the be-all and end-all. We're still far from any kind of automatic action or self-controlling state in that case though. Digitalization can and will be the transformation accelerant.

... the process of transformation

Today, that's a strategy process that needs to be moderated and supported by a CEO, and the transformation process must advance clearly faster than before. Decisions must be made quickly even if they're headed in a totally different direction than before – that includes quite a bit of resilience. Things often take too much time, with too many considerations and contingencies being thought through. While that's taking place circumstances have changed again or the competition makes decisions faster, thus gaining an advantage in the strategic transformation process. An automotive executive board member told me that during the coronavirus pandemic the whole board would meet for a 20-minute conference call every day, producing all decisions in a relatively short time. Now, he says, they're debating and discussing again in monthly board meetings. That goes to show that it's better to part with certain attitudes – by clearly addressing the question of what and where the current crunch points are.

... the difference between theory and practice in building resilience

In a nutshell: The actions must work. Implementation and integration into corporate routines are the crux of the matter. That's what counts at the end of the day. But, naturally – depending on the client – there are starting bases that vary significantly. In the last three or four years, the major guidelines were always defined by severe external effects. Entire business models have changed, plus many overall conditions. If you want to remain successful as a company under such circumstances you need to go ahead and implement the actions for transformation. Using the automotive industry as a case in point:

if I want to or need to part with IC engine passenger cars, moving toward electric mobility, then it's not enough to just talk about it but calls for concrete action. So, implementation is the key aspect going forward – for the companies themselves and for the consultants. With our clients, we always summarize that positively in our credo: "It could work out! If ...". And we need to find solutions for the "if." Unfortunately, there's no such thing as a single straight and right pathway in transformation and for optimizing resilience. You need to approach solutions carefully because there's a lot of new ground involved in terms of content.

... the reasons why companies contact business consultancies

In most cases it's not because they're up to their necks in water, but there are different reasons. Often it's a lack of capacity – capacity to create transparency for decision-making. In other words, for examining one's own organization for a fundamental analysis. Or the capacity to execute the resulting decisions is lacking. That's particularly the case whenever industries are subjected to, let's say, multi-dynamic influences as they are in this phase. In that case, external assistance and opinion are simply accelerators that enhance efficiency extremely.

**The expert**

Andreas Hoberg studied production engineering in Ulm. Since 2005, he has been with Ingenics AG, a consulting firm with more

than 500 employees at 20 locations in nine countries primarily serving manufacturing and logistics companies. Since 2011 he has been a managing partner with responsibility for strategy consulting, process and organizational consulting, and digitalization, among other things.

“The world of work is being upended”

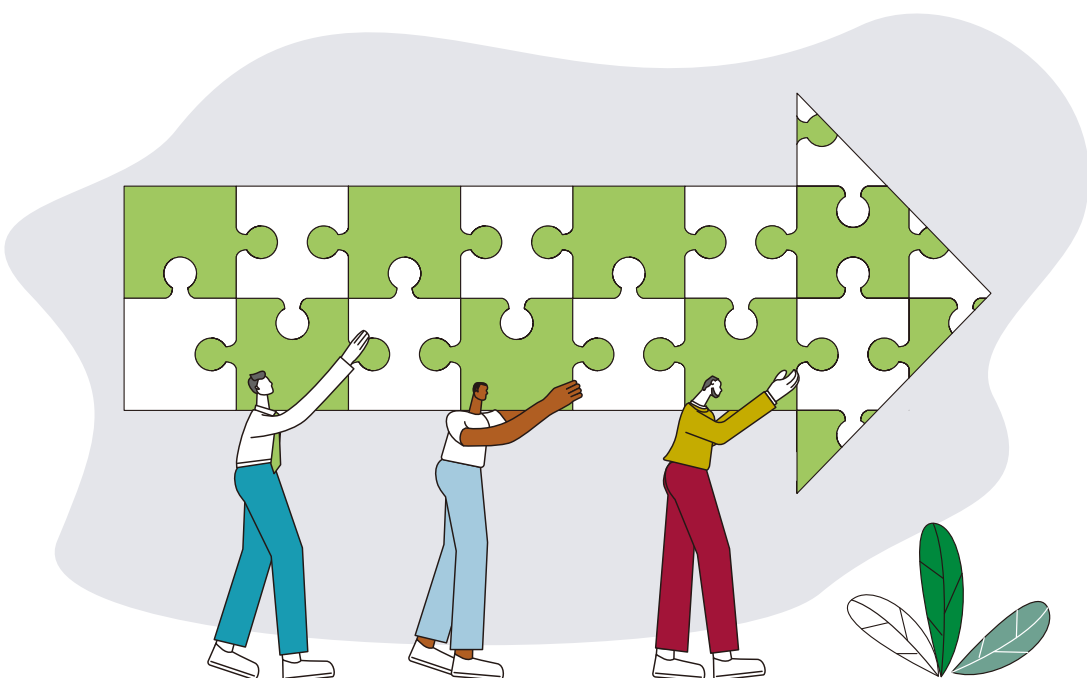
Fraunhofer research scientist Professor Roman Dumitrescu, Director of the Product Development Research Unit, explains why engineering excellence is becoming an increasingly important resilience factor for businesses.

Interview: Björn Carstens

Excellence, in addition to sustainability, innovativeness and passion, is one of Schaeffler’s corporate values. You define engineering excellence as a decisive resilience factor for businesses. Why is excellence so important?

That requires clarity about the starting base. Driven by technological as well as environmental and social developments, practically all sectors of the economy need to transform themselves, and manufacturing companies are bombarded with a wide variety of engineering challenges in that regard. They need to interlink new, partly disruptive technologies with existing know-how both in

the realm of development and manufacturing as well as in terms of the product itself. To do so, development departments in volatile times like ours need to develop nearly prophetic skills to predict what the markets are going to expect in the future. Plus, there are the criteria that we’ve also referred to as excellent engineering – in other words a reliable, available and secure system as well as product quality in general. According to this mélange, it’s necessary to find increasingly interdisciplinary approaches to product solutions, not least with respect to the growing importance of the circular economy. Harmonizing all that means re-imagining engineering excellence once again. Those are incredibly huge challenges for product



developers, and only companies that master them are going to develop the resilience it takes to prevail in the marketplace.

Please specify these challenges.

Digitalization and artificial intelligence (AI), in particular, are going to lead to intelligent, connected systems based on the close interaction between many professional disciplines. That shapes virtually all forward-thinking fields such as mobility, energy supply and the circular economy. Creating such complex systems calls for a new approach based on systems theory and systems engineering for which neither industry nor universities are adequately prepared: in both sectors, the research and development activities are structured as matrix organizations according to professional disciplines and departments. There's a lack of holistic methods and thinking, but that's exactly what it takes to get a circular product off the ground, from the selection of materials to potential upgrade models to consideration of quality-assured refurbishing. The latter, for instance, is a model commonly practiced with smartphones. All that must be considered as early as in the initial design.

Can you name an example of a successful company from your practical experience?

A nice example of a product development showing the kind of potential that can be tapped when using a slightly different approach is machine manufacturer GEA – one of the world's largest systems suppliers for the food, beverage and pharmaceutical industries. For a company that mainly processes steel, delivery times, costs and the material's deep carbon footprint pose a steadily growing problem. The following is what our research scientists recently did together with the company: they included genetic, in other words continually evolving AI algorithms, in the product development process. To provide a rough idea of how that works: genetic algorithms conduct experiments, trying to find several new ways in product development. That produced some good and not-so-good solutions that employees of the company filtered out. That's where the human factor comes into play because that's the moment when the system learns. Ultimately, the suggestions generated by the genetic algorithms and selected with the help of the employees resulted in GEA using 30 percent less steel in

manufacturing its product and significantly improving its carbon footprint.

You mentioned algorithms. How does artificial intelligence impact on engineering excellence?

I'm convinced that in the future engineering excellence will hardly exist or not even exist at all without the help of AI because AI is useful in more ways than one. On the one hand, we can feed AI with the expertise of specialists who are about to retire and conserve this knowledge before it's lost. But it's also important to externalize such knowledge in order to retain interdisciplinary capabilities even in the face of skills shortage. Skills shortage is another issue anyway with which AI can help. Many industrial nations simply have problems finding young professionals, and the situation is dramatic in some cases. When there's a shortage of developers AI must ease the burden on existing capacities. For instance, as in the case of GEA, by developing a variety of approaches to solutions from which experts filter out the best ones and continue developing them. We need to manage introducing AI into the engineering process for real, and develop and deploy dedicated AI systems for that purpose.

Why are you so convinced of that?

Because AI has the potential to upend the world of work the way we know it. In information technology, it's common practice for students to run software development code through ChatGPT for analysis. It's safe to assume that in the future software developers are hardly going to document on code anymore because systems like ChatGPT can do that just as well retrospectively. The situation with failure analyses is similar. But and now for the big but, we do not have such AI solutions yet when we're talking about truly complex systems. We need to work on that. If you allow me to speak on behalf of the German perspective: not least for reasons of resilience, it would be nice for such a system to be developed in Germany first instead of in the United States or in China.

The term circular economy has been mentioned several times. What impact does it have on engineering excellence?

Traditionally, only the first two stages of a product, i.e., development and operation, used to be looked at. Now the focus is increasingly placed on upstream questions such as: what raw materials

can be used, how resource consumption can be reduced, and on downstream aspects such as recycling and the previously mentioned refurbishing. Digitalization provides us with new access to the product because we can generate data about various lifecycle phases. Manufacturers now have very detailed knowledge about how the product was made, how it was delivered, who bought it, how the consumer used it, what defects occurred, and so on and so forth. I can draw an awesome number of conclusions from that data volume. For instance, whether, as a manufacturer, I'd rather run a product upgrade or launch a new product generation. In the past, that always involved a lot of gut feeling, and now engineering excellence is moving into the process as well.

Can you name an example?

Household appliance manufacturer Miele is heading in the right direction in terms of sustainability and digitalization. Let's take dishwashers for example. In the past, the promise to the customer would probably have been that the appliance would last for 20 years. That's no longer being done because it's safe to assume that within those 20 years appliances with far higher efficiency are going to be developed. Instead, Miele provides its customers with software solutions enabling them to reduce the energy consumption during the operational stage of the appliance. Adopting such business models represents an enormous change in the entire development of a company.

But broken still means disposal on a scrapyard?

No, it's also about refurbishing. Here's an example: if the appliance is broken after ten years it will be replaced by a new, more efficient one for an additional charge; the old appliance will be taken back, provided with a newer level of technology, and resold as a refurbished appliance. However, designing appliances for repair friendliness is another hallmark of engineering excellence and a step away from the throwaway society.

You encourage companies to develop complex systems professionally and to achieve fast sustainable market success. How is "fast" compatible with "excellence?"

Fast in that context means agile development – a buzzword that's been around for a long time in software engineering. Agility only means being able to respond to new situations. That's a basic

virtue of resilience that's not at all in opposition to the meaning of excellence.

You differentiate between technological and socio-technological systems. What do you mean by socio-technological?

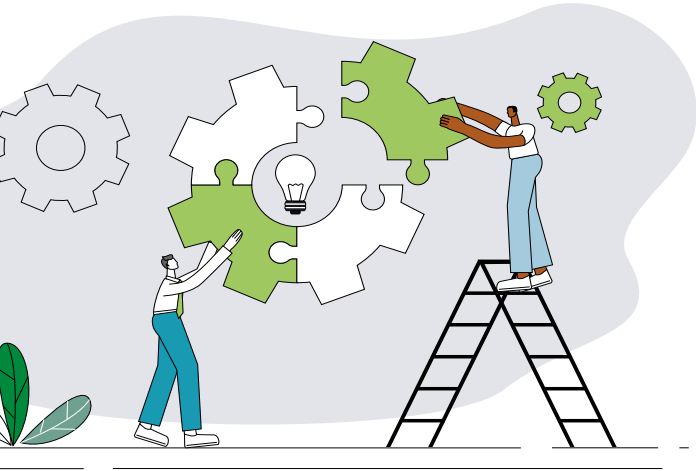
Socio-technological has two perspectives. One of them is when a system must act within an environment, meaning that there are users, that there's legislation – in other words a social environment in which the system must be accepted. In the past, there was hardly any reason to expect public expressions of outrage; the situation is different today. Take electric cars for example: Generations Y and Z are not buying electric cars weighing several tons from luxury manufacturers. That's not what the future of electric mobility can look like. That clientele of buyers may still exist now, but it's dying out. That's what I mean by including a look at the social environment in product development. The second perspective is the development process itself in which humans still play a crucial role despite all AI systems. Employees must accept new methods in the development process, they must be receptive to continuing education, but they must also find their work to be fun.

Can the innovation-related challenges only be mastered by close collaboration between policymakers, business leaders and academia?

Yes definitely. Policymakers need to create the framework for development, innovation and manufacturing locations to remain attractive. Let me provide another example: North America is currently far in front when it comes to companies selecting locations because the political situation there is halfway stable and energy costs are low. Plus, government subsidies in the United States are about six to seven times higher than, say, in Germany. But that doesn't mean that other nations now need to ramp up their subsidies. They need to pursue other pathways to keep the corporate headquarters of the large manufacturing companies from moving away. Because that's where most of the intellectual property, i.e., engineering excellence, resides.

What is the crucial role of academia?

It must inspire enthusiasm for technology in young talent. Professors should not sift out students with exaggerated math requirements right in the first semester. It's possible that we're losing



A holistic view as early as in the development process is becoming increasingly important for business success. Not only production and the product must be optimized but so must the preceding and subsequent stages

technology talent in that step. And when demographic change is so tough that a company can no longer recruit talent, it's practically forced to look for a new location. We often make the mistake of wanting to educate only top-class research scientists but instead need to think about breadth as well. I don't know if someone like Steve Jobs would have successfully completed a computer science program in Germany. Tech-based academic programs must not be reserved to elites. Universities are challenged to reimagine education in that respect.

Advanced Systems Engineering (ASE) that you've codeveloped is intended to guide a new perspective in planning, development and operation of technical systems. Why and how?

ASE can best be explained by subdividing the strategy into three conceptual pairs. The first is Advanced Systems. Future systems are going to change massively. They're going to be autonomous, intelligent and highly connected. The current state is that we're developing a product and subsequently a service. That approach can no longer be successful. The systems themselves are urging us to develop a new concept of engineering in which the product and digital extensions are fused. That takes us to the second conceptual pair, Systems Engineering. It is focused on model-based system optimization across the entire lifecycle using a digital twin. We cannot pursue development using the methods of the past 20 years. We have outstanding specialists for fluid power, for mechanical engineering, for circuit technology, but we frequently

lack interdisciplinarity in development methodology. The third part describes Advanced Engineering, which needs to be reimaged. It's essentially about two components. On the one hand, new technology such as AI or digital twins must be used. But equally important are soft subjects such as agility, creativity and social skills. Development must be fun. Development cannot only mean being an acting unit that migrates a requirements specification into a product specification. Algorithms will be able to do that equally well someday. This model of the responsibly self-determined, creative developer must find its way into the mindsets of corporate leaders because engineering provides us with the most effective leverage for achieving sustainable business success.

What does ASE mean for the labor market?

We need to learn that we've already got a great deal of experience in the labor market. We need to engage those engineers in the journey toward the future. Older colleagues can be inspired by teaming them up with young enthusiastic co-workers. But the question is, how to get ahold of them! The argument that you should study something to do with engineering and you'll be sure to find a job no longer holds water. We need to show what opportunities engineering creates, how engineering can be shaped, what can be achieved with engineering. For instance, you can study environmental engineering and work on how the control of smart grids can be improved in order to reduce CO₂ emissions by 20 to 30 percent. Without engineered solutions, we're not going to manage living together peacefully and sustainably on Earth with what will soon be twelve billion people.



The expert

Professor Roman Dumitrescu earned his PhD in systems engineering in 2010. From 2011 to 2015, he was Head of the Product Development

Department at the Fraunhofer Institute for Mechatronic Systems Design IEM. Since 2015, he has been one of the three directors at the institute and continues to be responsible for the Product Development unit.

In Motion

The modern world of today requires not only sustainable but, above all, resilient transportation systems.



Time for (quieter) rotation

Fixed wing aircraft, helicopters and multicopter drones are high-tech machines. The problem is that their propellers produce nerve-racking noise. American scientists at the Massachusetts Institute of Technology (MIT) have come up with a technical solution that might help raise the human acceptance level of these machines. They've developed a propeller that's reminiscent of a deformed eight. The research team tested the noise level on the prototype of a drone. The result was a 50-percent reduction compared to conventional rotors. **The trick**

is that the vortices are generated not only at the tip of the propeller blades but are distributed across their entire shape. Performance is another advantage. The propellers generate more thrust than conventional ones at any rotational speed. Sharrow Marine has already launched a respective product on the market – albeit for water. **The Americans sell boat propellers (pictured)** using the same toroidal principle. They're not only quieter with lower vibrations but also deliver higher speed at the same rpm. Plus, they save up to 30 percent fuel.

Railbus line

What mobility alternatives to road traffic exist out in the countryside? “None” is what many a villager might murmur in response. No, there is one, Professor Christian Schindler from RWTH Aachen would reply, there’s one that has existed before. The good old railbus. “A simply designed, one-piece economical vehicle,” Schindler explains. The researchers in Aachen have been working on the “FlexSBus-LR” (flexible railbus for rural regions) together with industrial partners (including Schaeffler) since 2021 because in Germany alone there are 300 non-electrified train tracks with a length of more than 13,000 kilometers (8,000 miles). The infrastructure would be available and **reactivating the old tracks by means of the “one-car trains” an easy way to strengthen rural areas and making them more resilient against the current urban exodus trend.** Key aspects of the mobility solution from Aachen are lightweight design, energy efficiency, a low-emission powertrain using an electric passenger car motor, noise reduction and economy across the entire lifecycle. Due to the separation of the chassis and cabin, goods may potentially be hauled as well. The project shows that even old ideas can be recycled.



World premiere for innovative E-drives

A different kind of electrification: For three customers in the compact municipal vehicles segment, globally operating automotive and industrial supplier Schaeffler is producing its highly efficient wheel hub motors. The fully electric street cleaners, transporters and snow removal vehicles operate with zero local CO₂ emissions while helping to enhance the quality of air in the city. The special feature of the innovative drive system is that all the components required for propulsion and braking are installed directly in the rim – instead of at the center of the vehicle or on the driven axles. **That saves space and makes the vehicles clearly more agile, easier to maneuver and therefore more resilient in urban traffic.** The torque generated by the electric motor is transferred by the transmission directly to the wheel. This direct transmission of power translates into particularly high efficiency of the drive system.

-15 °C

(5 °F): That’s what the thermometer could indicate even though the wet road would not cause its users to slide all over the place. At least not if the asphalt contains the invention by the Chinese university of Shijiazhuang. **There, a team has invented a more resilient, eco-friendly and effective alternative to spraying salt.** The scientists packed an acetate-based salt without chlorides into microcapsules together with other chemical compounds and mixed it into the asphalt. The road surfacing material releases the capsules across several years. In a test on the super-asphalt, water started freezing only at temperatures around minus 20 degrees centigrade (minus 4 degrees Fahrenheit).

“Only the one who walks his own way can’t be overtaken”

Marlon Brando, American actor (1924–2004)

Looking at the future on a car lift

The transition to electric mobility on our roads poses major challenges also to the spare parts market and to garages. Aftermarket CEO Jens Schüler describes how Schaeffler encourages service operations to join the automotive and industrial supplier on the transformation journey and how its spare parts division is demystifying repairs of electric vehicles.

By Daniel Zwick

The segment of the automotive market that Jens Schüler and his colleagues work in may be highly specialized, but it is one with which practically all drivers come into contact at one time or another: as a member of automotive supplier Schaeffler's management board, the 48-year-old executive is responsible for the business of supplying spare parts and repair solutions for garages, aka aftermarket.

Vehicle owners with transmission or clutch problems will more than likely have parts installed in their automobiles that have been produced by the Schaeffler Group based in the Bavarian city of

Herzogenaurach, particularly if their cars are older and being repaired by independent garages. The longer the time that cars are being driven, the higher the likelihood of such repairs.

Spare parts market is changing

The market for spare parts is changing just as much as the market for new cars. However, there are significant variations between them. According to the German Federal Motor Transport Authority (KBA), cars in Germany are 10.1 years old on average. The EU average is 12 years. Since 2010, the average age has been increasing "continuously," according to the KBA. More than one million cars on German



20 %

less: Compared to cars with IC engines, electric vehicles require fewer spare parts for various reasons, e.g., a smaller number of components, particularly in the area of the powertrain, and lower wear, especially on the brakes. However, experts expect higher wear on the tires due to higher vehicle weight and massive acceleration rates.

Source: Report "At the Crossroads: The European Aftermarket in 2030" by Boston Consulting Group

15 %

less accident repairs than today are expected to be performed by garages in 2035. The reason is that accidents will decrease due to advanced driver assistance systems (ADAS).

Source: Association of the German Insurance Industry (GDV)



“We see ourselves as a driving force behind finding a solution to the challenge of making the aftermarket fit for electric mobility. In doing so, we focus on our customers’ need for economical and future-proof repair solutions”

Jens Schüler, CEO Automotive Aftermarket at Schaeffler

roads are even older than 30 years. Consequently, Schüler’s customer base keeps growing – while the current situation in the passenger car market, with significant price increases and a shortage of new cars for sale, is also playing into his hands.

“There are some factors that will be highly conducive to the spare parts market in the near future,” Jens Schüler says. Although prices for spare parts have also gone up, they have not increased as much as they have for new and used cars. “Our business does well when times are good and even better when times are bad,” says Schüler. The demand for spare parts could only be dampened if drivers were to stop using their cars. But it currently doesn’t look that way in many countries of the world.

Supply shortages like those affecting the new car market are now having a lesser impact on garages. “Spare parts are available,” says Schüler. There might be waiting times for electric car components, but demand for those parts is still very low. Most electric cars are not old enough yet for large numbers of them needing to be repaired. Even so, Schaeffler and other spare parts manufacturers are preparing for that.

Electric cars create opportunities. Schüler shows us the box containing his company’s “repair



Two-time DTM Champion and long-term Schaeffler brand ambassador Marco Wittmann listens to explanations of the E-Axle RepSystem-G with fascination

Repair solution as a clever alternative

In 2022, Schaeffler presented the first repair solution for e-axles. Where vehicle manufacturers are currently providing their customers exclusively with costly replacements, Schaeffler’s Automotive Aftermarket is the **first supplier to offer a repair solution for e-axle drives**: the E-Axle RepSystem-G. While vehicle repairs using replacements entail the complete exchange of the powertrain, garages using the Schaeffler solution only change the relevant components or parts exhibiting the highest wear. **By saving resources and money, and reducing CO₂ emissions**, the solution supports sustainability while creating additional business potential for independent garages.

solution” for the electric drive axle of the VW eGolf that was launched on the market in 2017 but is no longer being built. “A spare electric axle costs more than 5,000 euros, whereas our repair solution will be selling for a lot less than 1,000 euros,” the executive says. “Showing garages how to repair electric cars, we aim to demystify the repair process. To support that purpose, we offer repair manuals, and trainers to teach the associated technical skills.”

In doing so, Schüler is following Roland Berger’s propositions practically to the letter. In a recent study of the aftermarket, the consultants find that the opportunity for component manufacturers lies in extending their product range by specific parts for electric cars. “This will then be especially successful if companies manage to use this transitional period to position themselves as a trustworthy, long-term partner to garages,” the consultants write in the paper commissioned by CLEPA, the European Association of Automotive Suppliers. In this way, spare parts manufacturers can also help ensure the survival of a larger number of independent garages, because there are not that many car mechanics currently available who are familiar with high-voltage technology.

Existing cars with IC engines continue to generate sales

However, this business is still a prospective one. Even if car manufacturers have largely become electric car companies by the end of the decade, as they are currently planning to, automotive suppliers like Schaeffler will still be manufacturing IC engine components for a long time. At least as spare parts.

“In 2030, perhaps only 20 percent of new cars sold globally will still be using IC engines. But the picture pertaining to existing cars will be a different one: 74 percent IC engines, 15 percent hybrids and just 11 percent all-electric. We’re currently developing a production concept that will allow us to continue supplying components for these cars,” says Schüler. However, most of these spare parts will come from Asia. “We’re no longer continuing to develop factories for clutch production in Europe, for example, but we’re developing such capacities in Asia.” Schüler does see opportunities in the anticipated shrinking of the

IC engine segment because competitors will gradually be withdrawing from it.

Garage business offers potential for growth

Schaeffler, according to Schüler’s plan, should experience significant growth in the spare parts market in the next few years, generating sales of more than 3 billion euros per year. “We’re also looking at acquisition opportunities in relation to products, market access and services to garages in that regard,” he says. Such takeovers along with organic growth should cross the sales threshold.

A new way of handling spare parts, which is actually an old way, is designed to help with this growth: In the future, Schüler wants to offer garages second-hand and reconditioned car parts again. This is still common practice in the United States where Schüler worked for a long time. “Because the under-hood technology doesn’t change as quickly there as it does in Europe, there are lots of parts in the fleet that can be used as spare parts for more recent cars. In Europe, this basically doesn’t exist any longer because here, new parts have bumped reconditioned components from the market,” says Schüler.

However, he assumes that this business will make a comeback, for two reasons: It can reduce CO₂ emissions, plus it could be an answer to the current shortages. “I assume that more than before, we’re going to have to live off the material that is already in the system,” Schüler says. This makes sense especially in the case of the high-quality components containing many valuable raw materials that are used in electric cars.



The author

Daniel Zwick has a degree in economics and works as a business journalist for “WELT” and “WELT am Sonntag.”

He primarily writes about structural change in the automotive industry and about new mobility. In Berlin, where he lives, the father of two almost always rides his bicycle.

New ways to navigate the city

Urbanization is a worldwide megatrend. However, as irresistible as the appeal of big cities may be, living together at close quarters entails social challenges. Some of the major ones revolve around hauling people and goods. Here are some examples.

Challenge New ways

People have been attracted by cities ever since the beginning of industrialization. Many would find work there but they'd be living in miserable dwellings, breathe industrial air and hardly get to see any green. Influential urban planners and architects counteracted those developments with the "Athens Charter" published in 1933. Their idea was to physically separate the areas dedicated to dwelling, working and recreation. To connect those functional areas, the concept of the automotive city was created – featuring road axes up to and including freeways. The consequences included air and noise pollution – plus automobiles increasingly encroaching on public space. The time had come for a mobility transition. In 2020, the EU ministers responsible for urban development agreed on the "New Leipzig Charter." It says that urban mobility systems should be "multimodal," that more people should be using public transportation, walk or ride bicycles, emphasizing the "compact city." Some cities have already begun to implement this concept. They include Portland and Houston in the United States, Bogotá in Columbia, Melbourne

in Australia, Shanghai in China and the European metropolises of Barcelona and Paris. The term "15-minute city" has been coined for them: residents are supposed to be able to access the most important daily necessities and services within 15 minutes on foot or by bicycle. Not everything but many things are supposed to be available practically "around the corner."

70 %

of the **greenhouse gas emissions worldwide currently emanate from cities**, a third of them from means of transportation that today are powered near-exclusively by engines burning fossil fuels.

Challenge Becoming greener



While urban transportation decisively contributes to climate change cities are also particularly affected by its consequences. Not only do they have to cut emissions quickly but they must also adjust to climatic changes that have already become inevitable. Torrential rain and heat waves being the relevant threats. Rainwater on roofs, streets and squares cannot seep into the ground. Instead it flows into sewers whose capacities soon reach their limits in the event of heavy rain, subsequently flooding streets and basements. In addition, rising temperatures turn cities into heat islands. The extent of “overheating” compared to surrounding regions may amount to as much as six to eight degrees centigrade (12–16 °F). One of the reasons is that buildings and streets absorb solar radiation, store the energy and then release the heat again. Green and blue infrastructures promise to provide some relief: planting of trees and bushes, plus ponds, lakes and canals. Urban planners gain the requisite space for all this by repurposing traffic areas.

80 %

of the vegetables it requires: that's how much a city like Berlin could cultivate itself if flat roofs, parking spaces and other traffic areas were used in addition to existing grassy areas, according to a study by the Potsdam Institute for Climate Impact Research (PIK).

Challenge

Economic and social participation

Chinese researchers have investigated urban growth in the Pearl River Delta with the fast-growing metropolises of Guangzhou, Shenzhen and Zhuhai. They wanted to find out how the quality of the transportation system impacts the economic development of megalopolises. The results published in 2022 confirm that prospering areas can promote the economic development of surrounding peripheries when powerful road axes accelerate the flow of goods and labor.

According to the United Nations World Cities Report 2022, cities are recording massive growth especially in poorer countries, at a rate of 65 percent by 2050 compared to just

twelve percent in countries with tendentially medium and higher incomes. Especially in Africa, urbanization processes are taking place at a pace that has never been seen on other continents either. That growth occurs in uncontrolled ways and is typically horizontal resulting in a high demand for mobility. However, short-haul public transportation enabling affordable locomotion and thus upward mobility is in short supply particularly in those areas due to lack of funding. No money, no public transportation. No public transportation, no affordable mass mobility. Private-sector sharing taxis often provide the only opportunity to cover longer distances in the metropolises

of the Global South, but many people don't have the means to pay for them. People having to spend 20 to 50 percent of their income on commuting, which applies to considerable parts of the population in the Global South, can at some point no longer afford going to work and will drift further into poverty.

66%

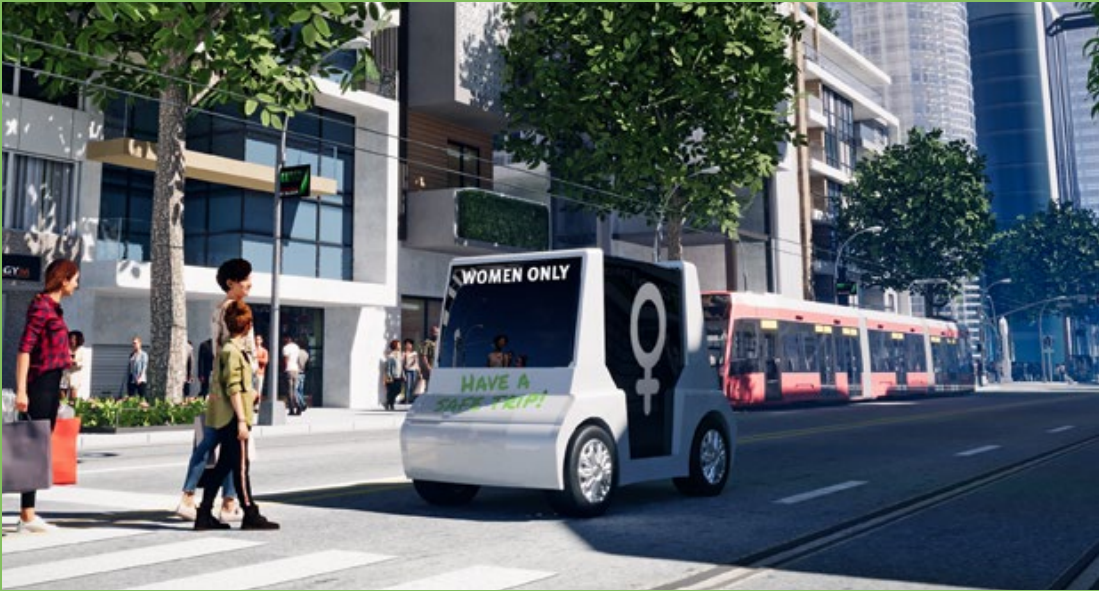
of the urban space that Africa will have in 2050 **does not exist yet today**, according to a forecast of the "Africa's Urbanisation Dynamics 2022" report.

Challenge Funding

A metropolitan area not only has to want a public transportation system but must be able to afford it. In Germany, for instance, revenue covers only around 75 percent of the costs. Profits cannot be generated anyway or only at the expense of reliability, headway and safety. A worldwide study conducted by the British University of Greenwich which concluded that an efficient public transportation system cannot be operated without government-controlled grants.

But how are cities supposed to fill their public transportation coffers? A few ideas suggest how: London, for instance, invests in public transportation revenues from the congestion charge for passenger cars that was introduced in 2003, with additional emission taxes now

complementing those revenues. Fines, parking fees, car and mineral oil or carbon taxes can be used as funding sources for public transportation as well. Cities like Mumbai, New York, Osaka and Barcelona require real estate owners to help defray the costs. In Brazil, every company with more than ten employees must pay a per-capita contribution into a public transportation fund. This model is based on a World Bank recommendation that says, "those who profit must pay," which applies to passengers who pay through their ticket prices as well as to indirect beneficiaries such as retailers, event organizers or employers. Since the government also profits due to the social benefit of a functioning public transportation system a contribution by the treasury is justified too.



Challenge Gender justice

Women navigate cities in different ways than men. Men typically go to work in the morning and home at night. Women move around in more complex ways. They shop on their way to work, take children to school or family members to doctor's offices. They walk or use public transportation more frequently than men, according to a comparative investigation conducted by Danish consultancy Ramboll. However, in the planning stage of the current transportation infrastructure, the "bread winner's mobility," i.e., the commutes of men and thus use of roads, was given priority.

But it's not just the lack of suitable mobility options that limits women's opportunities to move around and thus their social participation. Safety plays a role as well. Women fear assaults while walking and using buses and trains and are afraid of sexual harassment and attacks especially at night. In Latin America, six in ten women have already been attacked physically. In Germany, only one in three women feels safe using public transportation at night, according to a Bundeskriminalamt (BKA) study; consequently, more than one in two women avoids riding buses and trains at night.



Challenge Delivery vehicles

In 2003, London, suffering from massive congestion, was the first western metropolis to introduce a congestion charge. Even so, London is in the top spot of the Inrix Global Traffic Scorecard congestion ranking 20 years later. How could that be? In addition to the approximately 15,000 classic London taxis, more than 80,000 cars from private chauffeuring services such as Uber inundate the streets of London, but the decisive congestion factor is delivery vehicles. In London just like in other cities in the world. According to some estimates, the number of delivery vehicles in the 100 biggest cities worldwide will see a 36-percent increase by 2030.

Potential countermeasures are centered on the idea of concentrating delivery transactions. That may be done at city terminals, i.e., larger handling areas preferably provided with siding tracks. Equally required are micro depots, i.e., smaller handling areas for instance in vacant retail shops

in which goods are collected for hauling on the last mile. The ultimate destination can then be reached in eco-friendly and space-saving ways using cargo bikes.

It's also possible that drones will be used for last-mile hauling in the future. They have the advantage of not having to struggle with ground-bound obstacles – and faster delivery processes promise to save costs. According to some estimates, around 80 percent of all domestic parcel deliveries are theoretically suitable for airborne transportation using drones.

4.8 billion

kilometers (2.98 billion miles) per year are covered by the **delivery vehicles** traveling on London's road network with a length of nearly 15,000 kilometers (9,300 miles).

Challenge Electrification

Motorized personal mobility will have a place also in urban mobility of the future. However, in view of climate change, only if privately owned passenger cars – just like shared and delivery vehicles and buses – emit neither toxic pollutants nor greenhouse gases. That the worldwide sale of electric vehicles has gone up by some 60 percent in 2022 gives rise to optimism. But electric vehicles are no cure-all either. They congest our streets and require parking spaces as well.

Electric mobility is picking up pace in many countries and

metropolises of the south as well – albeit more often on two or three wheels than four. Mopeds, motorcycles and three-wheeled tuk-tuk auto rickshaws have played an important part in the economic development of many Asian megalopolises. They've traditionally been powered by internal combustion engines (ICEs) but electric versions have been available for some time now as well. Accounting for more than 56 percent of new registrations in India in May of 2022, more electric three-wheelers were sold than those using ICEs. The African market for such low-cost vehicles is large as well.

\$1,500

and, therefore, in the price range of an ICE version: that's how much the **Roam Air electric motorbike** costs that has been developed and is being built in Kenya for the African market.



Challenge Engaging citizens

The call for fair distribution of space poses a risk to privileges for people's privately owned vehicles, which provokes resistance. "The automobile is an important element of social participation," says traffic psychologist Wolfgang Fastenmeier. That explains the fear of loss. Even so, in a (non-representative) survey asking about examples of good transportation policy in European cities, Copenhagen, Vienna and Zurich each took one of the top ten spots although all three of these big cities widely use restrictive parking space management and urban transportation policy grants public transportation and bicycles priority over personal automotive mobility. In 2013, Suwon, South Korea, hosted the first EcoMobility World Festival: in one of the big city's districts, IC engines were banned in the streets for one month. Initially, there was major resistance against the

ban but then people began to also see the benefits: sidewalks were widened, flowerbeds planted, street lamps installed and opportunities created for children to play. Shuttle buses ran every 15 minutes. The noise level dropped and quality of life increased. Although the project is deemed to be a resounding success, the execution of a parallel project failed in Berlin in 2015 due to lack of acceptance. "The car-free month was not seen as an opportunity but as a threat," it says in a brochure published by the German Federal Environmental Agency. The lesson to be learned from that is that it's difficult to take something away from urbanites without engaging them – without providing them with the prospects of personal benefits: better bicycle and pedestrian paths, shorter headway schedules for public transportation, less noise, more safety.

Challenge

Rail vs. rail vs. rail

In 1863, London was the world's first metropolis to shift some of its transportation infrastructure below the ground. The subway mobility concept went on to become a global success but it's an expensive one. A single kilometer (0.62 miles) can cost as much as 300 million euros. Due to that price tag and because the soil in many areas does not permit tunneling, another classic on rails has been experiencing a revival: the streetcar, the oldest means of public transportation that has even been propelled by electric power for more than 140 years. After having been displaced by seemingly better and more advanced means of transportation, i.e., the automobile and the subway, it recently started seeing a second spring, from Addis Abeba to Wuhan. France, where completely new streetcar systems have been established in more than 20 cities, pioneered this revival. The rediscovery of the tram is no accident: streetcars are city-friendly and efficient. They have high hauling capacity but require lower capital expenditures than subways. However, trams compete with pedestrians, car drivers and green areas for scarce public space. That's where another alternative for urban public transportation systems comes into play: cable cars. Although every single car can accommodate only few passengers

cable cars, due to short frequencies, enable high hauling capacities. They can overcome obstacles without major investments in construction measures while the capital expenditures per kilometer (0.62 miles) are on the level of streetcars but personnel and energy costs are lower. Even so, they're not commonly found in urban public transportation yet. Most of them are in South American cities, in Caracas, Cali, Medellín and La Paz. Cable car engineers are already thinking beyond the purely suspended operating mode. That, however, has the disadvantage of poor cornering ability. The plan is for the cars to be forwarded – at a station – to an autonomous vehicle that will continue to travel with them on a dedicated track that's also routed around corners.

4.5 km

(2.8 miles): That's the length of the distance to be covered by **Câble 1, a cable car in Paris** that connects a suburb to the metro network serving five stations and has a hauling capacity of 1,600 passengers per hour. The cable car is planned to start its service in 2025.



Challenge

Use of digital opportunities

There's no way around digitalization and automation of transportation. While partially automated driving is already part of everyday life, automatic parking, braking or accelerating are just the beginning. What sounded like science fiction until recently is going to radically change road traffic in a few years from now: autonomous driving. People will then only be passengers. Autonomous vehicles may make road traffic safer – and faster. The reason is that the gaps between vehicles in moving traffic can be cut in half as a minimum just like the time gaps between vehicles approaching intersections. That means that clearly more vehicles could be traveling on roads without causing traffic jams. Researchers think that a 40-percent capacity increase is possible. Even so, autonomous vehicles will more than likely provide relief to congested cities only if they're shared and if their utilization is integrated with the utilization of other means of transportation. In any event, there's agreement among traffic experts that integration of an increasingly modular transportation offering in big cities must – and can – be enhanced. Systems operating as isolated solu-

tions hardly have a future. An app enabling users to tap in their departure point and destination and immediately providing them with the optimal mobility mix available, preferably updated in real time, is deemed to be ideal. The app would also automatically handle the billing process for the means of transportation the user chooses.



The author

Berlin-based journalist **Fritz Vorholz** has been writing for more than 30 years, 27 of them as an editor of the weekly paper *DIE ZEIT*, about topics relating

to environment, energy, climate and natural resources. In summer 2016, he joined the *Agora Verkehrswende* (Agora Transportation Transition) initiative where he was responsible for strategic communication for four years. Since 2020, he has been working as a freelance writer and consultant in the extensive field of “new mobility.”

Think Green

Resilience and climate protection go hand in hand. Only sustainable value chains remain strong and intact in the long run.



Crop protection without collateral damage

Almost 80 percent of all flowering crops and native plants are pollinated by insects. Without pollination, there would be no seeds, no fruit, no propagation – no resilient ecosystem. Even so, pesticides in industrialized farming continue to make life difficult for bees performing the lion's share of pollination work and for other insects. **A British-American research team has now opened a new chapter in plant protection.** They discovered an enzyme that releases limonoids, a family of natural pesticides that don't harm bees and company while protecting farmers' plantations against pests. For industrial-scale harvesting of limonoids, the research scientists genetically implanted the enzyme into a tobacco-like plant that subsequently produced two different limonoids in large, extractable quantities. Floral factories for eco-friendly plant protection.

Green forward-thinking markets

Nature and climate protection strengthens not only our planet's resilience but – in the medium and long run – the economy as well. The German Environmental Agency even forecasts that enhancing energy and material efficiency might become a crucial factor of international competitiveness in the 21st century. **The so-called green economy also causes new megamarkets to emerge.** The volume of central “green” forward-thinking markets such as energy efficiency, eco-friendly energy production, sustainable water management and mobility, material efficiency, waste management and recycling could more than double worldwide, according to expert estimates: from 4.6 trillion euros in 2020 to 9.3 trillion euros in 2030. A rosy outlook for the green economy.



“Be the change you want to see in the world”

Mahatma Gandhi (1869–1948),
Leader of the Indian independence movement

50 %

cheaper than pure e-fuels: That's what a fuel is supposed to be that's produced from **waste such as old deep-frying fat, slaughterhouse waste or used tires** by means of a clearly lower input of electricity and hydrogen than for conventional e-fuels. READi-Powerto-Liquid is the name that the Hamburg University of Applied Sciences HAW has given to the technology it has developed and **with which everything that's being produced from petroleum today is supposed to be producible** – albeit with a clearly reduced carbon footprint. As an additional benefit, a system with an annual production capacity of 5,000 liters (1,320 gallons) is so compact that it can be taken to the places where the waste is generated. That conserves resources too. The first commercial systems are planned to be launched at the end of 2023/ beginning of 2024.

Green corridors

Cities are increasingly sprawling into natural environments, even splitting them up. Other human interventions such as road construction and deforestation intensify the **fragmentation of natural habitats**. To conserve biodiversity, an idea that emerged as far back as in the 1990s has been gaining ground around the globe: **“green corridors” with a width of several hundred meters that as natural habitats pervade urban and other denaturalized areas,** thereby enabling “animal crossings.” The benefit for Homo sapiens: artificially created natural environments such as the 25-kilometer (15.5-mile) long Rutas Naturbanas in San José, Costa Rica can be used as local recreational areas and enhance the microclimate.



Green journey

The resilience of a company will increasingly be linked to the question of how sustainably it is positioned. Schaeffler continued honing its sustainability strategy throughout 2022. Read about the steps that the company has already taken and the ones that it is still planning to take.

By Jan Horst

The climate crisis is one of the world's most pressing challenges. Like many other companies, the Schaeffler Group has adopted the objective of climate-neutral operations, going forward. That plan is intended to be implemented by 2040. The greenhouse gas emissions that Schaeffler wants to reduce both in its manufacturing operations and in the supply chain are crucial to achieving the plan. For that purpose, the Group established a Climate Action Plan in 2022. At this point, we mention just one, albeit substantial, component of the plan: the development of green products.

Here, Schaeffler is working on a comprehensive concept for automated and holistic calculations of carbon footprints to ensure emission reductions also on product level. "Sustainability starts with product development. That's where a large part of the carbon footprint is determined," emphasizes Schaeffler's Chief Technology Officer Uwe Wagner.

To meet its environmental and social responsibilities, Schaeffler, throughout 2022, aligned its sustainability strategy consistently with three dimensions: Environment, Social and Governance (see chart at right).

Action fields

The ten fields take the content-related focus areas of the sustainability strategy into account as well as the requirements of external stakeholders.



Environment

Schaeffler wants to minimize the environmental impact of its business activities.

- 1 Climate neutrality
- 2 Circularity
- 3 Resource efficiency and environmental protection
- 4 Green products



Social

Schaeffler, among other things, wants to support the professional and personal development of its workforce.

- 5 Diversity, employees and people development
- 6 Occupational health and safety
- 7 Responsibility in society and supply chain
- 8 Product safety and integrity



Governance

Schaeffler has established a Compliance Management System.

- 9 Corporate governance
- 10 Business integrity



“At Schaeffler, we want to achieve climate-neutral operations by 2040. That calls for determined, fast and target-oriented actions across all areas of the company”

Klaus Rosenfeld,
Schaeffler CEO

In 2022

Schaeffler presented a **new tapered roller bearing** with which the **carbon footprint can be reduced by 70% compared to a standard component** due to the use of CO₂-reduced steel, higher material utilization and inductive curing.

1,850 m²

(19,900 square feet): That's the size of the area covered by the **solar power system on the roof of Schaeffler's group headquarters** in Herzogenaurach with a total capacity of 375 kilowatts. Around 340,000 kWh of electricity per year can be produced by the system.

69

energy conservation actions were implemented at Schaeffler in 2022. Together with the 204 energy conservation actions from both previous years, **a cumulative amount of 64.2 GWh will be saved per year starting in 2023** – as much as the annual consumption of residential energy of 7,300 people across all household sizes in Germany (Source: Federal Statistical Office of Germany).

Schaeffler on the way toward climate neutrality

2022 milestones

April 2022

Sustainable supply chain for e-motors

Schaeffler purchases rare-earth oxides from REEtec A in Norway in order to make e-motors for hybrid modules, hybrid transmissions and fully electric final drive systems even more sustainable.

EcoVadis Platinum Status 2022

Schaeffler improved in EcoVadis' sustainability rating to a total of 76 out of 100 points.

July 2022

Climate Action Plan

To provide employees with the necessary guidance on the way toward climate neutrality, Schaeffler developed a holistic Climate Action Plan in 2022.

December 2022

CDP Sustainability Rating – top “A” rating twice

In the prestigious international CDP (Carbon Disclosure Project) rating, Schaeffler in 2022 achieved the top “A” rating in terms of both climate change and water safety. As a result, Schaeffler belongs to the top one percent of participating companies.

Hydrogen producer Lhyfe and purchase of a solar park

Schaeffler enters into a cooperation agreement with French hydrogen producer Lhyfe for building and operating an industrial electrolysis plant with a capacity of up to 15 megawatts in Herzogenaurach. In addition, Schaeffler acquires a solar park that will cover two percent of the electricity requirement of Schaeffler's German locations. By 2030, the company is planning to produce around 25 percent of the electric power required worldwide in-house.

June 2022

Climate Action Day

Global Climate Action Day with roughly 23,000 ideas from the Schaeffler world to reduce greenhouse gas emissions. In addition, the new Climate Action training program has been supporting all Schaeffler employees in their climate protection commitment since October 2022.

September 2022

Long-term supply of solar power

Schaeffler entered into a supply agreement with Statkraft Markets GmbH covering eleven percent of its electricity demand in Germany from PV power, going forward.

Future goals

2025

Diversity in top management

Increase of women in top management to 20 percent.

Production

As an intermediate target, Schaeffler wants to avoid 75 percent of its manufacturing emissions.

2030

Production

Climate-neutral manufacturing in terms of emissions from the consumption of energy sources at Schaeffler locations (Scope 1) and of indirect greenhouse gas emissions from purchased energy such as electric power or district heat (Scope 2).

Fresh water

Reduction of fresh water purchases by 20 percent compared to 2019. Just on this journey, Schaeffler has implemented 2022 actions that are going to lead to a subsequent annual reduction of 150 million liters (40 million gallons) of water. That would be enough to fill 75 50-meter (164-foot) swimming pools. Those actions include utilization of condensation as well as equipment and process optimizations e.g., for coolant circuits and service water treatment, etc.

Steel

Every year, Schaeffler uses flat steel with a weight equaling that of 92 Eiffel Towers. By 2030, the company wants to reduce 25 percent of the related greenhouse gas emissions, e.g., by using steel that has been produced with reduced emissions as well decreasing material consumption and avoiding scrap.

2024

Energy efficiency

Implementation of energy efficiency actions by 2024 aimed at subsequently saving 100 GWh of energy per year.

Renewable energy

100 percent of the electric power purchased worldwide will be from renewable sources by 2024. All European and Chinese plants have been buying electric power from renewable sources since 2022. That has been one of the reasons why in 2022 greenhouse gas emissions were reduced by around 530,000 metric tons (584,000 short tons) compared to 2019.

Occupational Health and Safety

The Schaeffler Group has set itself the goal of reducing the frequency of work accidents by around ten percent per year on average by 2024. In the reporting year, the accident rate dropped by 25.6 percent compared to the prior year.

2040

Climate-neutral

The Schaeffler Group has set itself the goal of achieving climate-neutral operations starting in 2040 and reducing greenhouse gas emissions in its own manufacturing operations as well as in the supply chain, for instance by using renewable energies.

530,000

metric tons (584,000 short tons) of greenhouse gases: that's the **reduction** Schaeffler achieved in 2022 compared to the base year of 2019 by using renewable energies, for example.

10,000 kWh

per machine and year can be achieved in the field of industrial automation due to **novel concepts from Schaeffler for linear and rotary direct drives.** These drives incur **30 percent less power loss** and therefore require significantly less energy.

95 %

less CO₂ is emitted by the **reconditioning process of a bearing** compared to the production of a new one.



Schaeffler's complete Sustainability Report for downloading



Surviving in extreme environments

They're found in volcanic rock, in the deepest submarine canyons and under the ice of Antarctica: creatures called extremophiles that are highly resistant in extreme conditions. Their unique abilities have repeatedly resulted in new biotechnology applications.

Some like it hot

One reason why heat is used in cooking is to kill off all microbes. Book-knowledge used to tell us that life requires water, so there's no life beyond the boiling point. However, as early as around the middle of the 19th century, the first research about heat-resistant forms of life emerged. Today we know that thermophiles not only survive hot conditions but thrive particularly beyond 50 degrees centigrade (122 degrees Fahrenheit). Organisms whose optimal temperature range is above 70 degrees centigrade (158 degrees Fahrenheit) are called hyperthermophiles. The current record holder is *Methanopyrus kandleri*, an archaeon that was discovered in 2008. It can reproduce at 122 degrees centigrade (252 degrees Fahrenheit) under application of the pressure prevailing in its habitat at an ocean depth of 4,000 meters (13,120 feet), i.e., about 400 bar (5,800 psi).

Archaea such as *Methanopyrus kandleri* are particularly popular with researchers exploring the origins of life, because these unicellular organisms are found in hot springs, geysers and submarine volcanic pipes, in other words in places where billions of years ago life on Earth more than likely began.

Because many industrial processes are accelerated by high temperatures there is strong interest in making use of the abilities of heat-resilient microorganisms. Or, more precisely, those of their enzymes, i.e., the molecules that activate and sustain metabolic processes. Such thermophilic enzymes enhance detergents or help shift industri-

al synthesis processes from refineries to bioreactors. Temperature-resistant enzymes can also be of valuable help in separating emulsified greases and oils in sewage. Researchers also see great potential in the area of renewable energies, whether in high-temperature fermentation for biogas production or glucose cracking as a biofuel precursor.

In the fight against the coronavirus pandemic, the thermophilic *DNA polymerase* enzyme did an important job – as an actor of the polymerase chain reaction, or PCR for short. PCR serves to reproduce the sample material obtained so that a laboratory can work with it. In a high-temperature step at around 95 degrees centigrade (203 degrees Fahrenheit), the DNA double helix of a sample is melted into two strands and, based on two synthetically created counterparts (primers), doubled at temperatures between 45 and 68 degrees centigrade (113 to 154 degrees Fahrenheit). One million copies exist as early as after the 20th PCR cycle, and 100 billion in one afternoon. If this chain reaction does not occur in the case of a covid test, the PCR test is negative.

Prior to the coronavirus pandemic hardly anyone outside of laboratories knew the abbreviation PCR even though biochemist Kary Mullis, who died in 2019, had discovered the polymerase chain reaction as far back as in 1983, which earned him the Nobel Prize in Chemistry ten years later. With good reason because hardly any bioscientific field is conceivable without PCR – from medicine to paleontology to genetic fingerprinting in forensic science.



2,000 years. That's how long the extremophile plant *Welwitschia mirabilis* can live. It can do so even in one of the most inhospitable places on our planet, the Namib Desert, with **daily temperature fluctuations of more than 50 degrees centigrade (122 degrees Fahrenheit), frequent sand storms and decades-long dry phases.** Its survival trick: In addition to a tap root with a length of 15 meters (50 feet), the plant forms a delicate root crown with a diameter of up to 15 meters (50 feet). With it, the plant absorbs night and morning dew. ***Welwitschia mirabilis* is one of the plants that have existed on Earth for the longest time.** Scientists assume that it has been around for more than 100 million years.

No fear of freezing

Coldness doesn't offer as much scope for evolution as high temperatures do. The reason is that at freezing temperatures ice crystals form also in cells and can mechanically destroy them and other structures of living things. That's why in laboratory settings crystallization is avoided by immersing microorganisms or tissue in liquid nitrogen for flash freezing. The cooling process below the freezing point is so fast that crystals cannot grow large and the frozen water forms a uniform phase.

In nature, two opposite strategies for avoiding frost damage are found. Psychrophiles, i.e., organisms that are optimally adapted to temperatures of 15 degrees centigrade (59 degrees Fahrenheit) and below rely primarily on the use of anti-frost proteins (AFPs). They prevent the formation of ice crystals. AFPs were first discovered in arctic fish but are also found in insects, plants, fungi and bacteria.

In some countries, anti-frost proteins from fish or AFPs produced using genetically modified yeast are already being added to food, for instance to make ice cream particularly creamy. Anti-frost proteins could also curb freezer burn of frozen food, i.e., the drying of external layers during thawing processes.

Cryophilic organisms can even withstand -10 degrees centigrade (14 degrees Fahrenheit) and below. Their trick is ice nucleation. During this natural flash freezing process proteins accelerate the formation of ever new ice nuclei (nucleation), thus preventing the cell-destroying growth of crystals.

This strategy is found with frost-tolerant insects. Even some frogs can freeze and unfreeze a large part of their water content unharmed in that way.

There are potential biotechnical uses in that area as well. The ice nucleation protein of the *Pseudomonas syringae* bacterium, for instance, triggers the ice formation of water drops already at -2 degrees centigrade (28 degrees Fahrenheit), which makes it a perfect helper in the production of artificial snow. For comparison, the freezing process of natural snow caused by condensation germs such as mineral dust or soot begins only at -15 degrees centigrade (5 degrees Fahrenheit). On YouTube, impressive videos can be accessed in which the protein causes water in test tubes to freeze within fractions of a second. The problem is that *P. syringae* can damage plants. Although devitalized bacteria are used for artificial frost acceleration this technology is prohibited in some countries due to its potential damage to nature.

Natural surfactants that form bacteria in extreme cold to dissolve their food as easily digestible droplets have major economic potential as well. Such cold-resistant surfactants, for instance, could be used to prevent thickening of biodiesel at low temperatures. Or to enhance the effectiveness of detergents at lower temperatures. Cold-resistant surfactants could also be used for clean-up purposes in the event of environmental catastrophes in cold regions. Cold-resilient surface coating, of aircraft wings for instance, would be another biotechnical application in this area.



Due to natural flash frosting, cryophilic life forms such as some frog species survive temperatures of -10 degrees centigrade (14 degrees Fahrenheit) and below



A salt-resilient and rust-eating bacterium with the fitting name *Halomonas titanicae* is supposed to have decomposed the wreck of the Titanic by 2030

Living in salt

Salts not only flavor our food. As a building block of the body and metabolic players, they're even of vital importance. But only in small doses. In humans, a mere 0.5 to 1 gram of common salt per kilogram of body weight can lead to death. However, there are countless microorganisms that can live in dry or wet habitats with a high salt content such as the Dead Sea. They've developed special protective mechanisms with which they optimize their salt balance. The names of many of these microorganisms contain the stem *halo* from the Greek word *halos* for salt, such as the *Halomonas* bacterium. It has developed ways enabling it to compensate for changing salt concentrations between 0.5 and 25 percent.

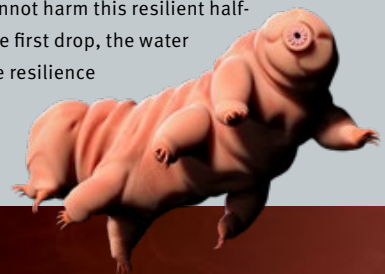
A key compound that biotech professionals find particularly exciting protects bacteria such as *Halomonas* against UV radiation, extreme temperature fluctuation, dehydration and high salt or acid concentrations. It is called ectoine. Ectoine has a hydrating effect and forms a very stable yet air-permeable layer of water around the bacteria – characteristics that the cosmetics industry likes to use. Thanks to its anti-inflammatory and nourishing properties it is added to creams and ointments. The pharmaceutical industry is a

fan of ectoine as well. There, it is a component of many eye and nose drops as well as of medicines against respiratory diseases such as asthma.

To access ectoine in industrially usable quantities, the bacteria are “milked.” To do so, they're initially placed into an environment with an extremely high salt content so that they'll form lots of ectoine. That is followed by a bath in a salt-free solution. To survive there, *Halomonas* has to rid itself of the excess ectoine again and releases it into the solution from which it can be extracted.

The *bacteriorhodopsin* membrane protein from the extremely salt-resistant *Halobacterium salinarum* on the other hand fascinates many scientists because of its special abilities to react to light. Since as far back as the end of the 1990s, *bacteriorhodopsin* has been in biotechnical use, as a security pigment and as the first biomolecular data storage medium, among other things. In addition, the discovery of the *bacteriorhodopsin* of *Halobacterium salinarum* has opened the young research field of optogenetics. The bacterial building block resembles a rhodopsin in the human eye. Researchers therefore think it's possible that this similarity may open pathways to curing neural disorders.

1.2 millimeters (0.05 inches) is the maximum size of tardigrades (aka water bears). **Aside from that, tardigrades are pretty spectacular.** They're deemed to be the most extremophile animal with good reason. 100 degrees centigrade (212 degrees Fahrenheit) or -273 degrees centigrade (-459 degrees Fahrenheit) – no problem. Even vacuums and cosmic radiation cannot harm this resilient half-pint as tests in space have shown. A decade without food and water – easy. After the first drop, the water bear wakes up as if nothing had happened, metabolizes and procreates. Its extreme resilience is based on sacrifice: tardigrades have no heart, breathe through their skin and use individual cells that can distinguish between bright and dark as their eyes.



Acidity boosts ingenuity

We tend not to spend a lot of time thinking about the acid-base equilibrium of our environment except perhaps when choosing plants for our gardens. The normal pH in most biological contexts is 7.0 to 7.2. However, acidophile microbes are also found in extremely acidic milieus down to pH 0, and their alkaliphile counterparts in extremely alkaline environments of up to around pH 12.

Acidophiles often appear in context with volcanic activity, for instance near volcanic springs emitting hydrogen sulfide, among other things. As a result, acidophiles are usually extremely thermophile as well. They've already been in use for centuries in mining, in so-called bioleaching. In bioleaching, low-concentration ores are heaped and irrigated, which arouses the microbes that already exist within the ores. They attack the rock and release the desired metal that can ultimately be extracted from the draining slurry.

The underlying microbiological processes remained obscure for a long time. It was not

until the late 20th century that the operation of the acidophiles began to be understood and known strains were systematically used. Today, for instance, microbes make extremely hard-to-access gold resources accessible in industrial tanks. In uranium mining, the injection of suitable culture media into underground deposits is common practice.

Alkaliphiles can be used industrially as well. The enzymes of alkaliphile bacteria are of particular interest to detergent manufacturers. The amylase enzyme decomposes carbohydrates, protease deals with proteins and lipase cracks greases. Heat reinforces their effects – and that's where things become complicated. Unlike many acidophiles, alkaliphiles are not very heat-resistant. Exactly that is where researchers took action and developed the *Thermopallium natronophilum* bacterium in the genetic laboratory. Its enzymes are also active at high washing temperatures up to the limit of 100 degrees centigrade (212 degrees Fahrenheit).

The Conan bacterium

Arnold Schwarzenegger became world-famous due to his role as the hulky and invincible Conan the Barbarian. That *Deinococcus radiodurans* is referred to as the Conan among bacteria says a lot about its resistance. Some representatives of *D. radiodurans* survived a radiation dose of 17,500 Gy. For comparison, humans die within one to two weeks following exposure to a radiation dose of 7 to 10 Gy. In addition, "Conan," as a polyextremophile organism, is resistant against dehydration and enjoys very good protection against UV rays. A working group at the University of Vienna has already tested these bacteria outside the International Space Station (ISS) for their resilience in space – the microbes survived a stay there for three years. Astrobiologists therefore consider it possible that life can spread from one planet to another through the transportation of germs. In that way, some of them might have found their way to Earth about 3.5 billion years ago and formed the origin of life on this planet.

Due to their resilience, *Deinococcus radiodurans* could also be of interest as a highly resilient data storage medium. The idea is for data to be stored in the bacteria in the form of artificial DNA. Initial successes have already been achieved. High storage density is one of the advantages of artificial DNA as a data storage medium. According to more recent research from the United States, one billion gigabytes of data can be stored on one cubic millimeter (0.00006 cubic inches) of DNA. The entire internet could be stored in a medium the size of a shoe box and infinitely replicated by means of DNA sequencing.





Don't crack under pressure

Under the ocean surface, the hydrostatic pressure increases for every ten meters (33 feet) of depth by one atmosphere (approximately one bar/14.5 psi). Consequently, in the deepest depressions of the Pacific (Challenger Deep: 10,929 m/35,586 ft) pressures of more than one kilobar (0.1 GPa), equating to the weight of one metric ton (1.1 short tons) per square centimeter (0.001 square feet) prevail. Yet even there, living organisms known as barophiles, which have adapted to those conditions that would be fatal for us surface inhabitants, are found.

Many deep sea creatures are found in the vicinity of hot springs and are adapted to high temperatures accordingly. The energy supply in the deep sea is based on chemosynthesis – such as oxidation (“combustion”) of reduced metals that escape from hydrothermal springs. However, a diversity of species that as yet has been largely unexplored is also found in the vicinity of manganese nodules that are lying around in some places of the sea bottom and planned to be mined commercially in the near future.

Contrary to expectations, living things that can cope with conditions far away from sunlight and under high pressure exist even in deep rock strata. Both the bottom of the deep sea and the deeper substratum are some of the least explored parts of the Earth's biosphere. The large-scale Deep Carbon Observatory (2009–2019) project that was run for a period of ten years came to the

Astrobiologists consider it possible that underground life in the form of pressure-resistant microorganisms also exists on Mars

conclusion that at least two billion cubic kilometers (0.47 billion cubic miles) of biotopes are located underneath our feet – equating to more than twice the volume of all oceans combined. The extrapolated biomass of the underground rock dwellers amounts to around 20 billion metric tons (22 billion short tons), a multiple of the total mass of the human population on Earth.

Some of these microbes are of industrial interest because they're involved in the production of oil and gas deposits. Others assist in mining uranium ores. Subterranean life is particularly exciting for astrobiology as well because comparable biotopes definitely exist on Mars too.

Desulforudis audaxviator, a species initially found in South Africa at a depth of 2.8 kilometers (1.73 miles), where it appeared to be the only microbial species in its habitat, caused a sensation. Does it really operate an ecosystem all by itself? Or might other species be so firmly anchored in the rock that they couldn't be extracted? Further surprises followed when *D. audaxviator* was found on other continents. How the species that is killed off by atmospheric oxygen managed its long-distance travel remains to be resolved.



The author

Anglo-German science journalist and author of popular science books **Dr. Michael Groß** lives and works in the university city of Oxford and keeps encountering

overlaps between astrobiology, nanoworlds and extremophiles. In 2014, Groß was recognized by the German Chemical Society with the GDCh Award for journalists and writers.

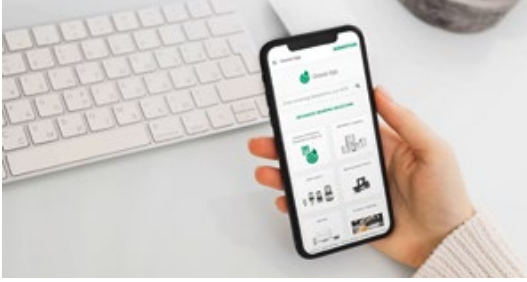
Digital

Digital technologies are instrumental in responding quickly and effectively to changing situations.



Preparation for Q-Day

Cryptography, the study of keeping information under wraps is as old as humanity itself. Even the ancient Romans would encrypt their messages whereas in our high-tech digital world of today countless cybersecurity strategists around the globe are racking their brains about post-quantum cryptography. **The reason is that quantum computers with their mammoth processing power that are about to be launched might be able to crack established encryption codes in next to no time.** That would be the worst case for any data protection officer. “Certain operations, for which conventional computers would need tens of thousands of years, can thus be solved by quantum computers in just a few seconds,” says a statement published by Ruhr University Bochum. Hackers, for instance, might use these powerful computers to intrude into banking, hospital, power grid and transportation networks. A horror scenario that needs to be prevented in a hurry. Consequently, the U.S. National Institute of Standards and Technology (NIST) is aiming to publish specific encryption standards that even quantum computers would not be able to crack before the year is out or by 2024 at the latest.



Better lubrication with the Schaeffler app

Up to 80 percent of all premature bearing failures are caused by improper lubrication. The grease app issued by globally operating automotive and industrial supplier Schaeffler addresses that issue by identifying the ideal type and amount of lubricant, duration of lubricant use and relubrication intervals for the customer's initial lubrication and relubrication jobs of rolling bearings after tapping in operating conditions such as loads, rotational speeds and ambient influences. To perform the calculations, the software uses data from the Bearinx in-house rolling bearing calculation tool. **That prevents over- or under-lubrication and premature bearing failures.** In addition, the app provides information on the selection of suitable lubricants.



The grease app for downloading can be found here

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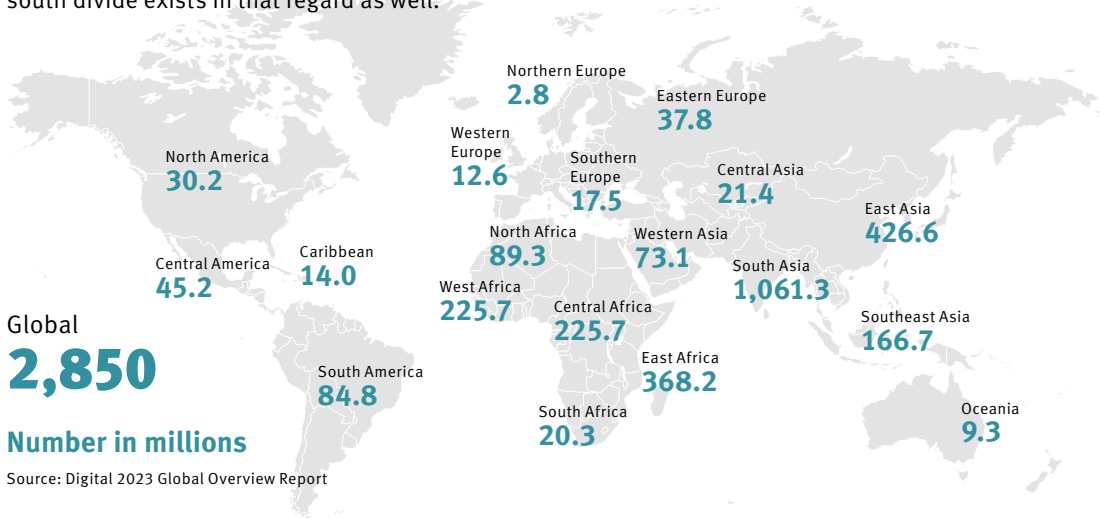
registered AI influencers already exist worldwide, according to a study conducted by advertising agency Ogilvy. These virtual influencers – the most successful one is Lu from the Brazilian magazine Luiza with more than 25 million followers – are becoming increasingly attractive for brands. **Their advantage over human influencers: no contractual agreements and full control of communication.**

“I cannot say whether things will get better if we change; what I can say is that they must change if they are to get better”

Georg Christoph Lichtenberg, German writer and first professor of experimental physics in Germany (1742–1799)

The offline atlas

The internet connects people worldwide – connectivity and access to knowledge are instrumental in enhancing the resilience of the population. However, more than one third of the world population does not access the internet, according to current estimates. The reasons vary and a north-south divide exists in that regard as well.



The AI revolution

The force with which artificial intelligence is penetrating nearly all areas of life is awesome. Self-learning systems are fundamentally rearranging everyday work as well. What adjustments do employees and their leaders need to make to master that transformation?

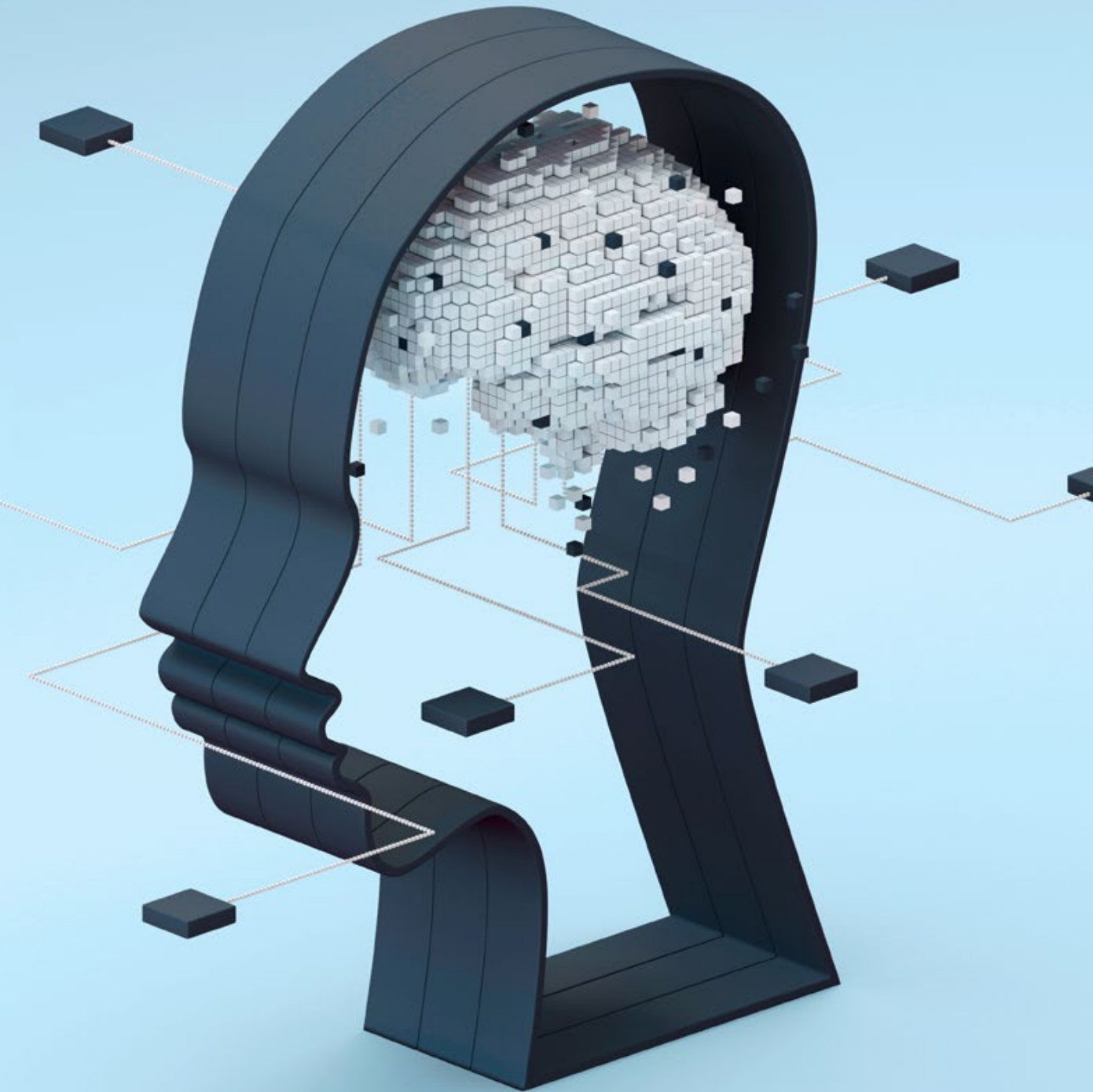
By Christian Heinrich



In industrialization, the development of the steam engine was a game changer replacing tedious manual work by automated processes. The development of electricity, of assembly lines, robots and computers resulted in further radical changes. So, now artificial intelligence is upon us and if we choose to believe the global tech elite and the headlines of the news channels this technology will not just entail radical change but unleash centrifugal forces.

The rotational speed at which AI is radically changing life on our planet is so high that the said global tech elite just recently called for hitting the development brakes. 1,000 individuals signed a corresponding manifest of the Future of Life organization: Apple founder Steve Wozniak, Tesla CEO Elon Musk, deep learning pioneer Yoshua Bengio and several developers from Google's AI subsidiary DeepMind. Their core demand is that "Powerful AI systems should be developed only once we are confident that their effects will be positive and their risks will be manageable." The main reason for their concern is that AI programs such as ChatGPT can simulate human interaction and create text, images and even videos based on a few cues. Those are skills that in combination with criminal energy pose a risk to our society particularly since legislation governing the use of AI hardly exists anywhere in the world. Such legislation is urgently needed because the AI genie has long been released from the bottle and may possibly be tamed but not be locked up again.

AI has long arrived in the world of work as well. As translators, as programmers, as analysts – AI is doing some of our work in all kinds of areas. Some people would tend to say that AI is taking work away from us. In fact, some jobs will cease to exist – but other and new professional fields will emerge. Provided that artificial intelligence – and let's just be optimistic in that regard – is properly deployed in business organizations it can raise not only productivity but also the influence and roles of nearly all employees by a few notches: many an ordinary team member may turn into a kind of team leader controlling the work of the AI system while massively boosting their own output. Join us in peeking at the near future that's already emerging today and that concerns all of us: the following elements describe how artificial intelligence could shape and change the world of work in the short and medium run or is already doing so.



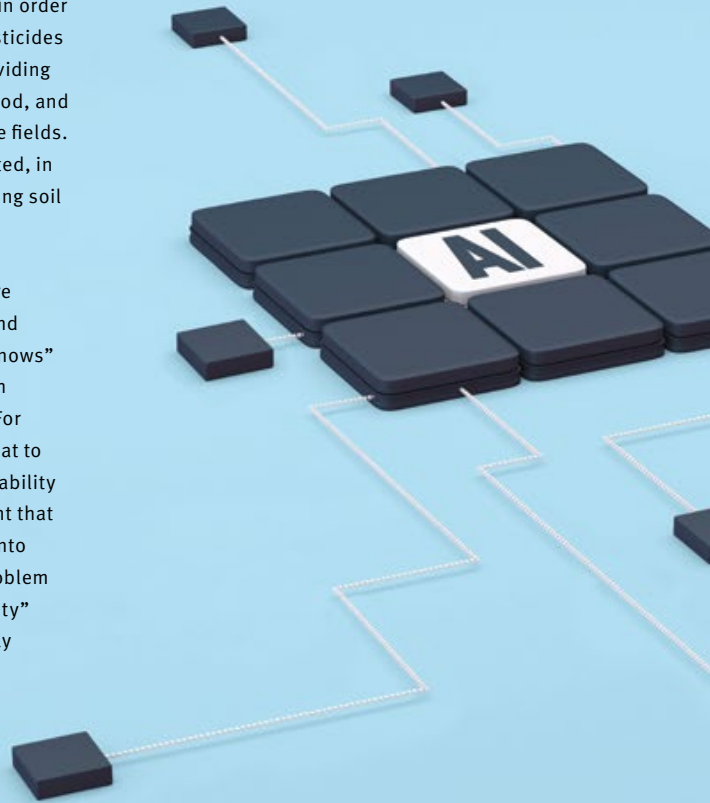
100 million

That's how many active users the ChatGPT AI software had after just two months, **making the program the fastest-growing computer application** in IT history.

1. AI makes machines smarter

Organic farming may become even more organic going forward – thanks to artificial intelligence. Programs are already in the making that automatically analyze lettuce heads in a field in order to provide them with just the right dose of eco-friendly pesticides that they need. Not to even mention feeding machines providing farm animals with the ideal quantity and composition of food, and smart combines that autonomously harvest the grain in the fields. The general rule applies that the more data is being collected, in this case for instance by regularly weighing animals or taking soil samples, the sooner artificial intelligence can be used.

This principle applies to many other fields as well. The more sensors are being used, the more data is being captured and analyzed, the more extensively an artificial intelligence “knows” what’s going on and can act accordingly. However, a wealth of available data is not always a prerequisite for using AI. For instance, simple transfers of documents from one file format to another don’t require any big data analysis but merely the ability to recognize a document and its characteristics and content that exists in a specific format and to subsequently transfer it into another format. In that way, with the help of AI, a major problem of our time can be addressed: the so-called “interoperability” of data, which refers to the challenges of data being equally readable on different systems.



2. AI as assistants to humans

Not only machines can benefit from AI but so can humans. Here are a few examples of AI uses: For attorneys, AI can sift through archives in a matter of seconds to search for previous judgments on comparable current cases. Translation programs such as DeepL help disentangle Babylonian confusion, thus reducing barriers. In financial institutions, artificial intelligence units develop investment strategies and recommendations. And in the field of human resources, AI units search thousands of job applicant profiles and help find suitable candidates.

Basically, the utilization of artificial intelligence is conceivable almost anywhere. Only the scope of its utilization varies. In a software firm, for instance, AI might be doing the main job: programmers assign programming tasks to an AI system that does the programming while humans just check to see where some fine-tuning may be necessary. However, experts issue warnings: Because an AI unit is only as good as the

data with which it has been fed it’s essential to check the results of such systems for plausibility and validity. The tricky part about that is that current AI systems such as ChatGPT know no doubts. When they’re convinced of knowing an answer they’ll announce it with trust-inspiring self-confidence – even if the answer is completely wrong. Since putting ChatGPT to the test has become a popular pastime the internet is full of such false statements issued by the AI. In addition, the utilization of AI increasingly raises ethical questions. Consequently, AI experts not only need to have technical skills but also act according to ethical principles, norms, values or virtues in order to recognize undesirable or even unlawful developments and to curb them if necessary.

And what about an AI system learning so quickly that it no longer wants to be the horse but become the rider? That’s another question requiring clarification in which we should not allow ourselves to be stripped of the reins.

3. Why AI already has more revolutionary energy than automation

The robotic arm on the factory floor that paints one car after the other without complaining. The copying machine at the office that not only copies individual pages but glues them together into a book. The robo chef that stays cool while cooking up one fast food menu after the other at a hot deep fat fryer. Due to progress in automation, humans over the past decades managed to delegate more and more routine jobs – in other words recurring identical “moves” that are clearly defined and delimited – to machines.

AI dramatically extends the opportunities of delegating – beyond the processes that emphasize purely physical action to those of assistive work including participatory thinking. The reason is that AI can handle tasks for which humans would have to spend months or even years on analyzing information and performing calculations. “The strength of AI systems is their ability to analyze and assess large data volumes,” says Rahild Neuburger, a tenured lecturer and researcher at Ludwig-Maximilians

University Munich and member of the Learning Systems platform. “Especially with recurring leadership tasks such as creating and managing duty rosters and shift schedules, assignment of tasks, composition and configuration of teams or budget controls, AI systems can be supportive,” she adds.

Beyond routine business functions, AI can be included in mid- to long-term strategic planning. “AI-supported process mining solutions can map, analyze and sustainably optimize business models and processes, Rahild Neuburger explains. AI-created analyses would enable executives to make relevant operational and strategic decisions in less time, estimates the expert. Such agility decisively promotes a company’s resilience. For Rahild Neuburger it’s clear that, “AI systems are not just a new technology. Due to their ability to learn and to draw conclusions practically on their own, they represent a novel element in the organizational and work-related world.”

4. How AI is changing our daily work and distribution of tasks

“AI changes daily work in various ways. When smart machines assist humans, job profiles, in particular, change,” says Wilhelm Bauer, Director of the Fraunhofer Institute for Industrial Engineering IAO, who, like Rahild Neuburger, is active in the Learning Systems platform where he co-chairs the Work/Qualification, Human-Machine-Interaction working group.

When AI assists humans, the potential for action of every individual clearly increases. “When companies roll out AI, agile project work becomes more important. This is where social, communicative and self-competencies such as self-initiative, creativity or problem-solving skills are in demand,” says Bauer. “To the extent that independent, problem-finding and problem-solving behavior becomes increasingly important, skills that are required for the diligent performance of uniform routine jobs fade from the spotlight,” he adds.

An example from the field: While warehouse workers used to drive their forklift trucks around the aisles and move articles themselves, AI-controlled vehicles are increasingly doing those simple routine jobs for them

now. For warehouse workers, that means that they’ve been promoted to the role of team leaders in a manner of speaking: several AI-controlled forklift trucks can work for them while they just monitor the trucks and lend a helping hand in case of problems. The warehouse workers’ productivity increases – as well as their responsibility and use of self-initiative.

This example shows a basic tendency that emerges as a result of the increased use of AI in the world of work: Humans are going to do less and less work themselves, instead using the freedoms gained for greater delegation, checking, problem solving, becoming creative and interacting. And all of it faster and better than ever before.

What may sound like a sobering truth to some craftspeople who enjoy performing hands-on work themselves is of immense and usually welcome help to others because work is not always as poetic and inspiring as it may sound. Warehouse workers are probably happy about no longer having to drive forklift trucks back and forth.

5. How AI changes the job market

Neither industrialization, nor automation nor digitalization have bumped humans out of the world of work. The opposite is true: People have never worked more than today. But, like other technological innovations, AI is going to change the world of work. Some jobs entailing plenty of routine work are going to disappear while new ones will be created. An example is data scientists, i.e., specialists creating and maintaining the high-end data bases without which AI applications cannot operate.

“I’m not worried that we’re going to run out of work due to AI deployment,” says human-machine interaction expert Bauer. Employee know-how will continue to be an important asset going forward. Bauer refers to so-called sector or domain knowledge in that regard and gives an example: “For instance, if you want to use AI in industrial manufacturing you need to have in-depth manufacturing know-how.”

On the face of it, a job that used to be performed by three workers now being done by just one thanks to AI doesn’t

sound like a socially compatible proposition. However, in view of the shortage of skills in many sectors, efficient use of human resources is the only possible way to sustain processes in the first place.

Rahild Neuburger cautions that management needs to consider the fact that impending changes might give rise to employee concerns such as the question if AI deployment will lead to external control including fears of losing one’s scope of responsibilities. “Recognizing such fears early on and counteracting them is one of the key prerequisites for a successful rollout of AI systems and exploiting their potential. For starters, that calls for appreciating employees and their concerns; as well as for constructively dealing with the resulting anxieties. Such anxieties may possibly be prevented if the benefits and relieving effects of an AI system as a tool can be successfully highlighted. The clearer the value becomes for every individual combined with the reduction of their fear of losing their job, the greater the receptiveness and acceptance among employees are likely to be,” says the expert.

6. How are we becoming fit for AI?

Central to successful collaboration with AI systems is the qualification of employees. But how can that be achieved? “Including humane job design in the conceptualization right from the beginning is important,” emphasizes Nadine Müller, who leads the Innovation unit at United Services Trade Union ver.di and is also a member of the Learning Systems platform. Müller considers it to be enormously important that employees have influence on the deployment of AI from the outset – because that would prevent them from developing a feeling of subjection. Ideally, management should not just announce the rollout of an AI system in certain areas or processes of the organization but give employees the opportunity to influence and optimize such a rollout. As a result, employees feel less as victims of an externally driven action but as part of a renewal that they decisively co-determine.

Labor scientist Bauer has observed that employees basically are positively disposed toward AI. He says, “The high intrinsic motivation of many AI users when it comes to acquiring new skills is notable. Excellent career opportunities may also be a crucial factor in that regard. That makes it easier for people to successfully master the learning-related requirements.”

A survey among companies has revealed that current qualification concepts emphasize the integration of on-the-job learning and acting, according to Bauer. That should promote the systematic translation of new experiences into practical application. “AI qualification preferably takes place as task-specific on-the-job training or in the form of in-house seminars. Extensive globally available online training programs support such efforts,” says Bauer.



7. What AI can do for work-life balance

The deployment of AI technologies by businesses could increase their rates of profitability by an average of 38 percent by 2035, according to Accenture research. That's another number indicating that AI is going to significantly boost per capita productivity. On the one hand, experience has shown that productivity increases don't necessarily mean less work in the long run. However, because productivity increases are expected to be so extensive this time around it could be that the number of hours to be worked by people will in fact decrease in general. That would support the current trend of younger employees – particularly those of generation Z born around the turn of the millennium – attaching greater value to good work-life balance. One of the most massive changes caused by AI on the job might be that it gives people more free time.



The author

For his research for this story, author **Christian Heinrich** tried out the ChatGPT AI. At first, he was impressed by the smart and creative answers he received even in response to complex questions such as how to get out of having to do gardening work together with his wife. Then he wanted to demonstrate ChatGPT to his eight-year-old daughter. She asked the chat program what the name of Benni's magical animal in the children's book series "Die Schule der magischen Tiere" ("The School of Magical Animals") was. It was the penguin Oskar, ChatGPT answered confidently. Wrong, it's Rabbat, the fox. That was disappointing – yet somehow reassuring. It goes to show that to err is not only human ...

AI glossary

Chatbots

Systems **that can dialogue with humans using natural language** – creating a bridge of communication so that AI and humans find it easier to engage in exchanges.

Cognitive Advisors

They can **recognize context and correlations in larger data volumes** enabling them to perform complex tasks and analyses.

Robotic Desktop Automation

Description of the process in which activities of any level of complexity are **fully delegated to an AI system**.

Machine Vision

A subsystem of AI in which **image context and correlations can be detected and classified**. Is used in quality inspections, for example.

Culture goes digital

New technologies sweep through frequently antiquated museums, concert halls and circus rings. They make cultural activities fit for the future and thanks to bits and bytes win over new groups of visitors.

By Björn Carstens

A visit to a museum doesn't necessarily inspire a euphoric mood in many post-millennials, so how can the interest of young audiences in old masters be attracted? Eike Schmidt, the German director of the world-famous Uffizi Gallery's art collection, is someone pursuing new pathways. The museum in Florence, Italy, is one of the pioneers in this area. The treasure trove of the Medici opens its doors to the social media world without any reservations. "Our collections belong to everyone, not only to the members of a self-appointed elite, but above all, to the young generations," says Schmidt, who in the art scene is regarded as a progress-driven enfant terrible.

Schmidt likes to craft new concepts. His motivation is to enhance the visibility of art, and to leverage the world wide web as a multiplier including all the related technologies for networking and interaction. Because there are hardly any areas left that do not have to use the gamut of digitalization to keep up in a world in which everything is connected with everything else and everyone with everyone else. Museums have long ceased to be merely archiving and exhibition institutions that

exclusively collect and preserve. Like other organizations, they need to take on the innovation-focused challenges of digital cultural management.

Altered art memes on TikTok

The Uffizi Gallery's Tiktok page displays videos in which the painting of the young Pope Leo X performs the "Happy" song while making animated faces at viewers. What some art lovers cringe at seems to appeal to the target group. Over 140,000 followers and 1.6 million likes don't lie. "If we want to get in touch with the younger generation, we need to speak their language," says Schmidt. The Uffizi Gallery has been active on Instagram for years. The museum regularly extends invitations to online events where philosophical discussions take place. Talking about interaction – many of the more than 700,000 followers now actively participate in intellectual debates. The simple equation behind it: every user equals a potential visitor to the museum.

Schmidt is not afraid that an omnipresent digital display of art would come at the expense of "analog" in-person visitors: "It's already foreseeable that the metaverse will significantly increase



people's desire to see the originals. The greater the presence of a work in the digital world, the stronger the demand for the physical original. The aura of a digitally reproduced work of art is growing due to digitalization," Schmidt is quoted as saying in an interview with "Handelsblatt." The fact that museums can also be visited online doesn't mean that they're eliminated as physical locations of experiencing art.

Making art accessible worldwide

All over the world, museums and exhibition halls have long ceased to perceive digital formats as a threat but are using them as opportunities. Clicking on the art platform Google Arts & Culture, in which more than 2,000 museums worldwide are already participating, delivers an experience of "Street view"-style virtual tours. For some exhibits, high-resolution photographs and detailed information can be accessed. At the same time, Google Arts & Culture is a form of archiving and making art accessible – after all, who can visit thousands of museums around the globe in a lifetime?

The Graphic Collection of the Swiss Federal Institute of Technology (ETH) in Zurich, which has digitized 50,000 works of art and made them freely accessible, takes a similar approach. "We make works by artists accessible that might otherwise remain undiscovered, and put art into context. In this way, visitors automatically receive even more information and establish new connections between the works of art," says Director Linda Schädler on the ETH homepage. In addition, digitalization brings further advantages: "In our case, the medium of the artwork is almost always paper, which means the pieces are sensitive. We have to keep them well protected from light by placing them in boxes. Due to digitization, these works of art are visible even when they happen not to be on display."

Virtual concerts

Change is the essence of art. That is true also of the music industry. Streamed concerts were nothing unusual in the recent years when all of us were deprived of live events, but now the stars of the

65 million

pixels make the pop band from the 70s ABBA say hello once again on a huge screen. Industrial Light & Magic did a brilliant job. **They scanned, analyzed and digitized thousands of old 35-mm negatives of the band and countless hours of concert footage and TV performances.** Hair, fingernails, make-up – every single detail was to be exactly right to make the concert experience appear as real as possible.



11

laser beamers were installed at the Roncalli boxes to make the holograms visible on the circus ring (around 300 degrees)



international music scene are going one step further and performing digital shows as avatars in colorful gaming worlds, such as US superstar Ariana Grande or rap icon Travis Scott, whose digital appearances were performed in the popular video game Fortnite, backed by real-world live recordings. The audience, of course, also consisted of avatars. To old-school concertgoers, who aren't into game consoles, the virtual reunion of ABBA would tend to be more appealing. Their band members, who are getting on in years in real life, have been on stage since the summer of 2022 as younger holograms of their own selves.

Welcome to the holofants

High-tech holographic technology is used in other genres of performing arts as well. In 2018, the audience at the German Circus Roncalli got to marvel at the world's first holographic performance in a circus ring. It was a small sensation. "More than 150 countries carried reports about it on their evening news," Ringmaster Bernhard Paul recalls. For almost five years now, Roncalli has exclusively been displaying imaginary animals such as elephants, horses and birds. They also perform tricks that real-world animals would not be capable of even after perfect training – without interfering with animal welfare. Eleven 360-degree projectors bring the luminous animals to life. Sometimes in realistic, sometimes in fantastic ways – and always in impressive style.

The benefit for the circus besides enthusiastic spectators: it saves costs for food, accommodation and transportation. Besides that, many spectators – especially animal rights activists – feel that the use of real animals in circuses is a cruel anachronism. Many cities and regions already ban the use of living animals in shows. Using Roncalli-type holograms, the entertainment industry is transforming its traditional program elements into the 21st century by means of state-of-the-art technology.

In the French L'Ecocirque Bouglione, polar bears dance through the ring as holograms as well and virtual killer whales glide totally relaxed through dry air space. Magic worlds are created on

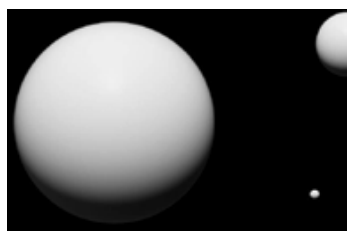
“Due to digitization, these works of art are visible even when they happen to be not on display”

Linda Schädler,
Director, Graphic Collection
ETH Zurich

The most expensive NFTs of all time

Digitally certified works of bits and bytes, known as non-fungible tokens (NFTs), are revolutionizing art dealing. These are the most expensive transactions.

Source: Bitcoin2Go

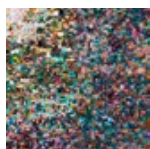


\$91.8 million

make it the most expensive NFT of all time – so far: 28,983 collectors bought a total of 312,686 shares in the artwork **“The Merge”** by **“Pak.”**

\$69.3 million

was generated by the sale of **“Everydays: The First 5000 Days.”** In 2007, the artist **“Beeple”**



decided to put a new piece of art online every day. For 5,000 days, he created a new digital image every day. The result was **“Everydays: The First 5000 Days.”**

\$52.7 million

was the amount for which the **“Clock”** NFT sold – a timer counting the number of days **WikiLeaks** founder **Julien Assange** spent in prison. When the NFT was sold in early 2022, Assange was facing a long prison sentence in the US. The anonymous artist identity **“Pak”** and Assange raised money at the auction for Assange’s legal defense.



projection screens in the background. Former animal trainers Sandrine and André Bouglione spent four years fine-tuning their show. Sandrine says that one of the reasons for the transformation is that they’re artists and entertainers from the bottom of their hearts who want to thrill also younger generations that, for ethical reasons, have major problems with them working with real animals.

High-tech zoo instead of cage housing

The zoo industry has already jumped on the holographic bandwagon too – either as a complement to real-world animal life or as a purely virtual show. The **“Hologram Zoo”** that was opened in Brisbane, Australia, in December 2022 invites its visitors to immerse themselves in a holaverse created by high-precision laser light. There they walk across canyons, watch blue whales and dinosaurs, or cross a river at night on which pink-shining lotus blossoms are floating and in which three-meter (10-foot) goldfish are swimming. Besides the suitable sound, natural-simulating scents and wind machines condense the atmosphere into a perfect copy of nature.

The project was launched by Axiom Holographics, an Australian company that normally tends to work for high-caliber academic institutions, governments, or the military. CEO Bruce Dell is so thrilled by the holo-zoo idea that he has already announced branches to be established in Japan, Texas, and Europe.

SwimVR invites its clientele to virtually dive into virtual animal worlds. Instead of a diving mask the snorkelers put on a waterproof virtual reality mask. Then they’ll enter a swimming pool where instead of blue tiles they get to see a colorfully shimmering underwater world. Colorful coral reef fish are moving around colorful coral reef branches, while a sea turtle slowly swims past them and an anemonefish defends its territory. **“Finding Nemo” 4.0.** – without intervening in sensitive eco-systems and without CO₂-emitting long-haul flights. Plus, there will be no attacks from Jaws – or, if so, only in virtual ways ...

Digital paintings put cash in the coffers

Trading of counterfeit-proof, blockchain-based digital certificates, aka non-fungible tokens (NFTs), has been stimulating the art scene for some time (see facts on the left). That's another area in which Uffizi Director Eike Schmidt has developed a concept for his organization of how the opportunities of the digital world can be monetized for the purposes of a museum.

More than 500 years after Michelangelo Buonarroti painted his masterpiece "The Holy Family" (Tondo Doni) on a round wooden panel, Italian pixel artists in collaboration with the Uffizi Gallery recreated the painting – as an ultra-high-resolution image file encoded by means of a method specifically developed for that purpose. Art

lovers dug deep into their pockets to acquire a Tondo Doni avatar changing hands to the tune of 140,000 euros. The Uffizi Gallery and Cinello, the company responsible for the digitization, split the profit. Particularly for museums, that's an attractive sideline source of income, especially in view of the coffers that in many places have been emptied due to covid restrictions. Besides the rights to digitization, there's nothing the art houses need to contribute – they just collect. Unsurprisingly, Cinello works with other world-class museums as well.

It takes a specialty decoder and an app to make such avatars of masterpieces visible on an ultra-high-resolution monitor. In addition to providing an

analog certificate, this complex encryption guarantees the digital copy's authenticity and provenance, and protects it against tampering attempts.

Schmidt can also imagine selling blockchain-based minority shares in physical works of art with participatory arrangements. Shareholders can, for example, secure the right to host a dinner for an exclusive circle under the Tondo Doni. Also conceivable are special exhibition revenue sharing schemes or even the sale of licenses. Schmidt: "I think that's an attractive opportunity even if the participatory rights would still have to be defined precisely."

Schmidt sees the greater potential in art that has been created exclusively for the digital realm: "When we think of artworks that are created specifically for the digital world, limitation and authentication through the blockchain naturally offer opportunities to finally make them collectible, tradable and also lendable. That has already resulted in sustainable business models for individual artists and galleries concerned," says Schmidt.



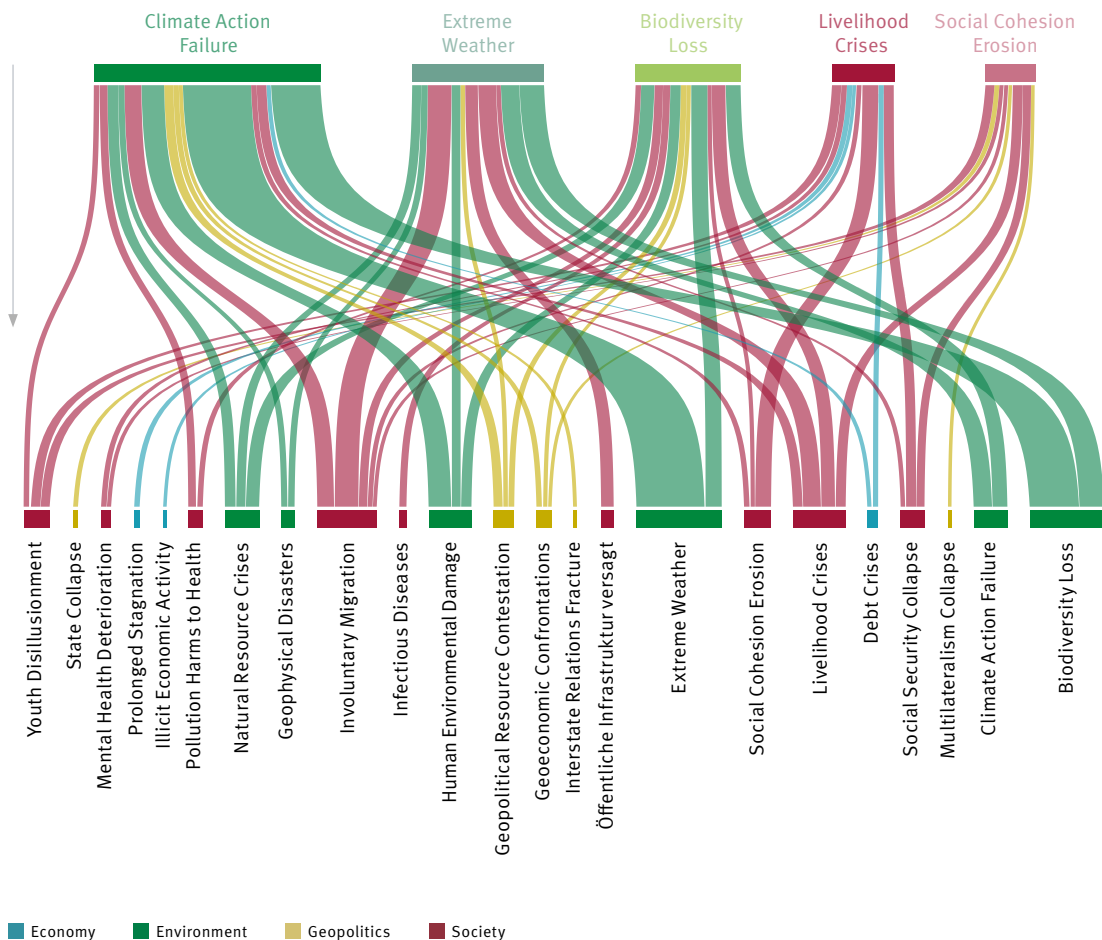
Uffizi Museum Director Eike Schmidt in front of Michelangelo's masterpiece "The Holy Family" (Tondo Doni)

Future Life

In a more and more complex and unpredictable world it's becoming increasingly important to be prepared for every contingency – to be resilient. There are many approaches to achieving that.

Crises never come singly

Climate protection actions are crucial contributors to our planet's resilience. This chart shows the correlations between the currently five major threats to the world identified by the World Economic Forum's "Global Risk Report 2022" (top row) and other risks that trigger or aggravate them (bottom row). Interestingly, climate action failure represents the major threat multiplier. Climate change is not only an environmental problem. It poses a problem to (just about) anything.



Source: Global Risk Report, World Economic Forum



Food out of CO₂

Is a **protein powder out of carbon dioxide** going to be one of the problem solvers for global food supply? Solein, which is the name of the mustard-yellow powdery invention of Finnish startup Solar Foods, requires no space-hogging agriculture and could be produced in laboratories anywhere in the world, which is highly conducive to a resilient food chain. How does that work? The method resembles the fermentation process that's used to produce wine or beer. But instead of sugar the bacteria, with the help of green electricity, primarily feed on carbon dioxide, dissolved hydrogen and nitrogen. That mix is then metabolized into amino acids, vitamins, greases and carbohydrates resulting in an **all-new substitute for protein suppliers like meat or milk** that causes no harm to either animals or plants. In Singapore, the climate-friendly powder is supposed to hit the market in 2024.

> 92,000

bacterial strains and thus 90 percent of all described species have been catalogued in the BacDive database at the Leibniz Institute in Braunschweig. **The world's largest knowledge database of its kind** offers researchers around the world access to phenotypical data in response to queries such as "Show me all the strains that grow under specific conditions" or "Show me all the strains that have been isolated from a marine environment." **For scientific research, knowledge about bacteria is essential** because bacteria are far from acting only as pathogens but can in fact be very useful – for instance, in food production, in medicine or in water treatment plants. In the human body, bacteria perform vital functions as well.

"A crisis is a productive state. You simply have to get rid of its aftertaste of catastrophe"

Max Frisch, Swiss novelist and architect (1911–1991)

Flowing fabric

Exhaustion raises the risk of injury – both in sports and while working physically. Research scientists at ETH Zurich have developed a specialty yarn that can measure bodily movements. Integrated into work clothes, the smart textile sensor can predict the wearer's fatigue during exposure to physical strain and warn them in time against impending exhaustion – **without requiring electronic components such as batteries or chips**. The yarn expands when being pulled producing an electrical signal in the process. Via a specialty antenna the signals are transmitted to a smartphone for analysis by an app (yet to be developed). In the next stage the prototype is to be turned into a marketable product.



Be brave!

Traits that characterize captains at the helm of a ship in a storm include resilience and pragmatism. What can people at the helm of businesses and all of us learn from mariners in terms of resilience? Quite a bit, says maritime expert and book author Stefan Kruecken.



By Stefan Kruecken

I've interviewed more than 150 captains over the years. Much of what they weathered out in the eye of a storm – with composure, courage, conviction and confident energy – can be applied to life in general – including business life. Captains coping with heavy seas can serve as role models for business leaders that need to resolve conflicts and crises.

Sometimes it's a matter of life and death, like in the case of Captain Emil Feith from Hamburg, who safely navigated the Svea Pacific bulker through a hundred-year storm. The hurricane at that time was roaring with a ferocious force that even this seasoned sailor had never experienced before. In front of the bridge, a mix of foam and waves formed a gray wall. Bangs were resounding through the ship and the steel was screaming. An officer asked the captain to go to the lounge, one deck below the bridge, where the international crew had gathered. The men, paled with fear, were staring at the inferno outside. They were wearing life vests.

All that happened in the fall of 1991. On the North Atlantic, a hurricane and an arctic low-pressure area had united into what meteorologists would call the "perfect storm." Hollywood turned that tempest into a blockbuster movie starring George Clooney as the doomed protagonist. It was in the thick of this rough reality that the Svea Pacific bulker, with Captain Feith on the bridge, was torn back and forth by the breakers. My admiration of his resilience, of his tenacity and of his gift of seeing his ship and his crew through tough times keeps growing with each word that he's telling me.

Just whistling fright away

"I wasn't sure we were going to make it," said the old seafarer. "To be honest, I believed less and less that we would with each passing hour." How that feat was achieved anyway? It was done wave by wave. To prevent a panic from breaking out, Feith reached for a cassette his wife had packed for him. It was a recording of Johnny Cash singing a song about rising water: "Five feet high and rising." The captain whistled the tune as if the ship were cruising in the Hamburg harbor on a summer day instead of navigating the hostile Northern Atlantic. When the chief engineer entered the lounge, asking – in German – what the situation was like,

Feith responded, "Doesn't look good." Then both men grinned as if they'd been telling a dirty joke – and bawled the crew out in English for being such sissies. The red herring worked.

Now, following the coronavirus and in a global geopolitical situation that has become more critical due to the war in Ukraine, all of us are caught in a massive storm. Uncertainty can be felt everywhere and deeply affects our professional and personal lives. Our jobs, our families, our friends. Many people are asking themselves how do I navigate my ship – my business, my family – through the storm in reasonably safe ways? If there's anyone who's intimately familiar with that question it's captains.

I can detect patterns in their actions. How they prepare for rough weather. How they guide their crews and navigate their ships through a tempest. I'm convinced that the calm actions of captains contain approaches that can be applied to daily life. That applies to anticipating a hurricane and taking appropriate precautions just like it does to the question of how to keep cool amidst the greatest chaos. How to project authority, strong leadership and thus confidence without acting like a dictator. How far you trust yourself and others and whether you allow your own emotions, particularly fear, to get the best of you.

Clear thinking, clear actions, clear messages

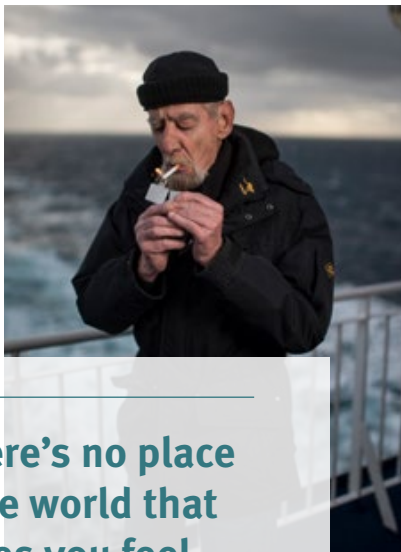
Which takes us to the subject of the "service face." At times, a captain needs to be an actor, Captain Feith told me. In critical situations there's no room

"At times, a captain needs to be an actor"

Captain Emil Feith

for emotions – and it’s generally inappropriate for captains to share their emotions with others anyway. “Emotions,” the way he said it, sounded like something repulsive you wouldn’t want to have under your shoe.

Clear thinking, clear actions, clear messages, time for the “service face.” I like the concept not least because it seems to be so anachronistic today when everyone turns their inside out in social media. In turbulent times, when people are worried, excessive emotionalism exacerbates things, whereas the “service face” communicates calmness and determination. Determination to fight for the ship and crew up to the last minute. That the captain’s leadership role is not about wielding power is an important aspect in this regard. The opposite is true. Not being full of themselves is a special trait of many old captains. More “we” and less “I” because even the most seasoned shellbacks



“There’s no place in the world that makes you feel as small and insignificant as the North Atlantic in a storm”

Captain Jürgen Schwandt



realize that they cannot safely steer a ship to the nearest port without the backing of a loyal crew. That’s why, as an exemplary leader, it’s crucial especially in turbulent times to get your team to back you unconditionally – come hell or high water.

Many stories that captains tell are about highly dramatic events between life and death. About fierce storms, about monster waves, about problems with cargo, but to most of the mariners I talked to it was extremely important that their stories would not come across as boastful tales.

Obviously, no one weathers a storm solely with a captain’s acumen. Another matter of vital importance is the ship’s technical condition – which is why most captains I know are sticklers at sea. The ship, especially the engine, must be in good state of repair, and it’s all about details. Whether I joined them on board of a cruise ship, on a freighter or for an



excursion on the Elbe River, the first thing the captains would inspect was the condition of the lifeboats. They'd check if the davits were lubricated and if the escape routes were clear. They'd complain whenever someone ignored the safety information.

Catastrophes are not monocausal

While I was traveling on a cruise ship with Captain Jürgen Schwandt, he got upset about the safety officer having long hair and wearing an untucked shirt. Another time he complained about the presence of a potted plant on an escape route. That's a no-go! He immediately demanded to talk to the duty officer and asked him if in case of an emergency he really planned to take care of that rubber plant. The potted plant was gone shortly afterwards. There's a simple notion behind this putative pedantry. Catastrophes typically are not monocausal events but the sum of many minor mistakes. It follows that if minor

mistakes are corrected major failures are less likely. From that perspective, a minor problem already starts with a safety officer not caring about whether his shirt is tucked in.

"With a functioning crew and a strong ship, I can pull through anything. There's no need to worry in that case," Johannes Hritz, a trawler captain from Bremerhaven, told me. During his daily routines on the North Atlantic, he's sometimes confronted with waves as tall as seven-story buildings. That's no problem when all hands on deck work together and are on guard the way they should be.

Hritz told me that that's the reason why he likes to work with sailors he's familiar with. He also said that he paid attention to people on board treating each other respectfully. Resilience is part of the job – as is a certain toughness. In the event of a suspected heart attack, in cases of broken bones or renal colic,

“With a functioning crew and a strong ship, I can pull through anything”

Captain Johannes Hritz



he heads for a port. But in case of, say, cuts? They can always happen. “For such cases, we’ve got a stapler on board,” he says. I can imagine how that would go over with people working in any kind of on-shore job.

Another thing I like about the attitude of the old captains is their active pragmatism. They’ve charted a course. They’ve got a plan. But when it’s necessary they’ll change it as needed. That makes captains true resilience pros – even though that expression hardly rings a bell with them.

I remember the story of a mariner from Hamburg who during a severe hurricane in the Bay of Biscay came to the rescue of a motor vessel from Denmark in response to a mayday signal. The ship reported engine trouble and inrush of water. “Please pick me up, sir,” the fellow captain was pleading over the radio. That, however, appeared to be near-impossible in the heavy swell. The Danish crew ultimately boarded an inflatable rescue raft that the storm quickly caused to drift away. After realizing that a line connection with the raft could not be created in any other way, Captain Peter Steffens put his ship in reverse in the crucial moment. Steering a freighter in reverse – in a hurricane? Unconventional but successful. A maneuver for which other captains no doubt criticized him, Steffens said. So what? The Danish crew was out of

danger. Steffens and his crew managed to pull the shipwrecked sailors up on their ship’s side.

Reaching the next port is the top priority for all captains, as is the safety of the crew. For most captains, the thought of losing a crew member at sea is unbearable. When it does happen, it continues to trouble them even decades later.

Captain Feith, with whom this story started, was one of the mariners making it through the hundred-year storm. In spite of engine failure. In spite of an inrush of water below the water line which the pump just barely managed to keep in check. When Feith and his freighter arrived in Liverpool the angry hurricane had knocked all the paint off the ship. Bare steel was visible in many places, and the cargo – T-beams for a high-rise building project – was reduced to scrap value because its exposure to salt water would cause the construction material to corrode. Steel may be tougher than sailors but it’s not more resilient ...

The most important thing, though, was that they’d survived.



The author

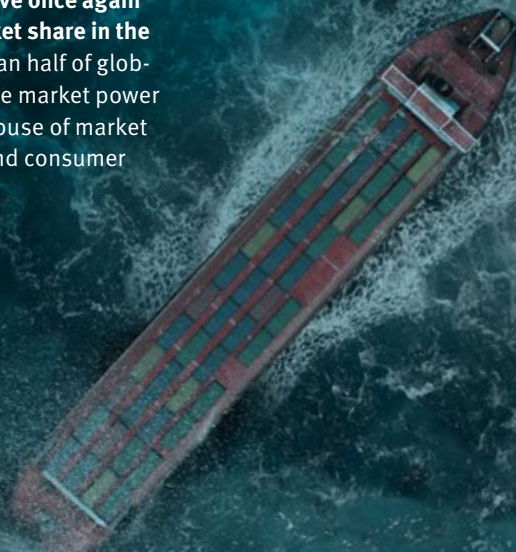
Stefan Kruecken, born in 1975, and his wife, Julia, run Ankerherz Verlag, a publishing company founded by the couple. Prior to that,

Kruecken worked as a police reporter for the Chicago Tribune and as a reporter for magazines such as max, Stern and GQ from Uganda to Greenland. His latest book titled “Das muss das Boot abkönnen” (“The Boat has to withstand that”) was recently published.

On course for resilience

Ocean shipping accounts for more than 80 percent of global trade. Consequently, the resilience of the fleets is one of the crucial connecting links to prevent a disruption of strained supply chains. The UN's 2022 Maritime Transport Report points out vulnerabilities.

- **The international ocean fleet is getting on in years.** The current average age of all freighters sailing the seas is almost 22 years. Putting age in relation to cargo capacity, the average drops to 11.5 years, which means that bigger ships are younger on average than smaller ones. But that's no reason to give the all clear because **many shipping companies are shying away from capital expenditures** due to uncertainty regarding technological developments, frequently changing environmental requirements, increasing borrowing costs, and blurred economic prospects.
- Despite new technologies the **CO₂ emissions of the worldwide ocean fleet went up by 4.7 percent between 2020 and 2021**, with container ships, bulk carriers and general cargo vessels accounting for the lion's share of that. The UN Conference on Trade and Development (UNCTAD) demands more capital expenditures to be dedicated to reducing the carbon footprint of maritime transportation.
- Between 1996 and 2022 the top 20 carriers increased their share of container transportation capacity from 48 to 91 percent. **The four largest container shipping companies have once again dramatically extended their market share in the past five years** to control more than half of global capacity. The top 4 carriers have market power of 58 percent which can lead to abuse of market power, charging of higher rates and consumer price increases.
- Oversizing of ships is another reason for concern. Between 2006 and 2022 the size of the world's largest container ships more than doubled from 9,380 TEU (standard containers) to 23,992 TEU. Besides posing problems to some ports and sea lanes, **the size of the ships grew faster than the volumes of cargo that filled them.** The resulting market consolidation may also lead to a more limited offering as well as higher rates and consumer prices.
- Rising **freight rates clearly pose a higher burden on the economies of poorer countries** than on those of medium- and high-income countries.
- For 2022, UNCTAD forecasts moderate growth of global maritime trade to 1.4 percent. For the period from 2023 to 2027, annual average growth of 2.1 percent is anticipated, **a slower rate than the average of 3.3 percent during the last three decades.**



Houston, we have a garbage problem

The number of satellites in space is rising rapidly. But what if these high-tech objects go to pot? Then they orbit the Earth at high speed as dangerous space debris, threatening the increasingly expanding utilization of orbital space. But how can the problem of astro-garbage be managed? “tomorrow” has embarked on an exploratory journey for answers.



By Björn Carstens

Even non-astronomers with a naked eye occasionally discover unusual things in a nighttime sky: brightly shining flying objects that at first glance seem to resemble the beauty of shooting stars. Responsible for them is an equally enigmatic, albeit controversial, American multi-entrepreneur called Elon Musk. His Starlink satellites spin around our planet like an independent web of stars.

According to “Jonathan’s Space Report,” Musk’s SpaceX company in the middle of January this year owned 3,374 of these artificial flying objects in the orbit, and 3,338 of them were active. Growth of that sector is remarkable. In 2019, SpaceX only had 67 satellites in orbit, according to online space news source Spaceflight Now. Today, their number has increased 50-fold. Thousands of other ones are planned to follow. The responsible U.S. government agency FCC just recently approved the deployment of 7,500 second-generation Starlink satellites.

The SpaceX example illustrates the fact that space is becoming an increasingly busy place. Rockets are shooting new satellites into Earth’s orbit almost on a weekly basis. Since Sputnik rang in the race to space in 1957, around 6,400 rockets (as of December 2022) have lifted off and hauled more than 15,000 satellites into the universe, according to information released by the European Space Agency (ESA). Around 9,800 of them are still in space – and about 7,200 of those are still functional. They cover a wide variety of uses: from weather reports and climate data to telecommunications to navigation – everything is handled via outer space. The remaining number of roughly 2,600 satellites have either completed their mission or are defective. They would in fact have to be caused to fall back to Earth so that they would ablate upon re-entering the Earth’s atmosphere. Otherwise, there is a risk of them increasing the amount of space debris by colliding with other objects. The problem is that there is no international space legislation yet. Many satellites are left to their own devices.

More space activities, more garbage

The challenge of managing astro-garbage is not expected to diminish as more and more companies are pushing into cosmic spheres. While

Heading for a collision

More debris means higher risk – collisions in space are becoming more and more likely.

In 1995

the French military **reconnaissance satellite “Cerise”** was struck by a piece of debris from an Ariane rocket that had exploded ten years earlier. The impact speed was 50,000 kilometers (31,000 miles) per hour.

In 2007

China deliberately pulverized an obsolete satellite, **resulting in 3,000 larger pieces of debris** in space.

In 2009

two satellites collided with each other for the first time – the American communications satellite **“Iridium 33”** and the Russian military reconnaissance satellite **“Kosmos 2251.”** The impact speed at an altitude of nearly 800 kilometers (500 miles) was almost twelve kilometers (7.5 miles) per second. The energy released by the crash corresponded to roughly ten metric tons (11 short tons) of TNT explosives.

In 2020

at an altitude of about 400 kilometers (250 miles), **more than 220 dangerous encounters** occurred between the international space station ISS and space debris.

“When an aluminum ball of just one centimeter in diameter strikes a satellite, it has the energy of a mid-range car driving into it at about fifty kilometers per hour”

Heiner Klinkrad, Space Debris Manager at ESA

government organizations such as ESA and NASA still account for the lion's share of the worldwide space investments of roughly 78 billion euros in 2021, private-sector players are increasingly reaching for the stars as well. In 2021, companies like SpaceX, Amazon founder Jeff Bezos' Blue Origin and many others invested 13 billion euros, according to ESA – equating to around 14 percent of global space investments. By 2040, say U.S. investment bankers from Morgan Stanley, sales in the space industry are expected to roughly triple from around 340 billion dollars in 2016 to more than one trillion. Experts estimate that space start-ups around the globe are planning to launch 100,000 satellites into space in the next ten to 15 years.

Behind the United States and China, which has the second-largest number of satellites in space after the U.S., countries and regions that have so far developed little thrust are aiming to join the action in Earth's orbit. Rwanda, for instance, is gearing up to become a center of an African space industry, having launched initial satellites in 2019. The ambitious aim of the Ruanda Space Agency is to shoot another 330,000 satellites into space. Awesome numbers!

In addition, there are many other activities taking place in space: French startup Space Cargo Unlimited, for instance, is planning to open an uncrewed space factory in 2025. “Space offers ideal conditions for producing more efficient products,” says businessman Nicolas Gaume. “New Space” is the name of that journey on which the space industry has embarked. At the end of 2022, the private

space company ispace embarked on a trip to the Moon. By 2040, the Japanese startup is planning to build a city on Earth's satellite. NASA's lunar mission Artemis (see info box on page 81) is in full swing as well. There's a lot going on up there above our heads – and that entails major risks. The space explorers are only realizing at a late stage of the game that they've been underestimating the astro-garbage problem for a long time.

Risk of a chain reaction

Even at this juncture, experts are afraid that due to the large amount of astro-garbage space flights may hardly be feasible anymore unless corrective action is taken. At a speed of several tens of thousands of kilometers per hour, even the tiniest particles turn into destructive projectiles. That means that the damage resulting from a crash with an extremely expensive high-tech satellite can easily be in the range of billions of euros or dollars. Not to even mention the disastrous consequences that a collision with astro-garbage might have for astronauts.

The Kessler syndrome – developed by then NASA employee Donald J. Kessler in 1978 – describes the risk that the debris in orbits around the Earth multiplies in a chain reaction – each collision generates new debris and the larger the number of debris the higher the probability of collisions. Most collisions occur when small objects encounter large ones. Kessler warned of a self-intensifying cascade effect resulting in exponential growth of debris. At some point – Kessler mentioned around one hundred years – any crewed

space flight would be impossible due to an excessive collision risk.

According to the German Aerospace Center (DLR), many pieces of debris are located at an altitude of around 36,000 kilometers (22,400 miles) and more, where they pose a risk primarily to TV and telecommunications satellites in a so-called geostationary orbit. But even in the low Earth orbit, i.e., up to an altitude of 2,000 kilometers (1,240 miles), tens of thousands of hazardous pieces of astro-garbage are circulating our planet.

These are the space cleaners

In 2021, ESA inaugurated its new Space Safety Center. Besides monitoring cosmic weather and investigating solar storms, the center is mainly focused on fighting the problem of space debris. “We demand that from 2030 the object must disappear at the end of every mission,” says Holger Krag, Head of the Space Safety Program at ESA. The implementation of such end-to-end space cleaning requires a competitive landscape of several providers in order to develop price-reducing routines and scaling effects.

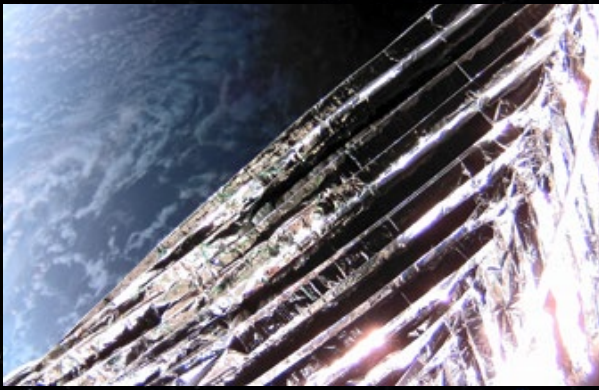
An idea: Robots with gripper arms could haul pieces of debris into the Earth’s atmosphere where they ablate

90 %

The most effective way to slow the growth rate of space debris is to ensure at least 90 % of new objects we launch **are removed from busy orbital highways** at the end of their mission.

Source: 2022 Environment Report of ESA’s Space Debris Office





A kind of aluminum-plated braking sail could gently push satellite parts out of their orbit

Sea of debris

Millions of scrap particles rush through the orbit

Circa 32,300

pieces of debris bigger than ten centimeters (four inches) have been registered by ESA in space at the end of 2022. **Typical of such derelict objects** are disused upper stages of rockets, deactivated and destroyed satellites and tools lost by astronauts.

Circa 1,000,000

smallest parts larger than one centimeter (0.4 inches), scientists estimate based on statistical model calculations, are whirring through the orbit. Another 130 million of these tiny particles are supposed to be only slightly bigger than one millimeter (0.04 inches). Those particles may be frozen fuel residues or chipped paint.

More than 640

events have been recorded by ESA to date in which astro-garbage has been created by so-called fragmentations, i.e., due to **collisions and explosions**.

Circa 10,600

metric tons (11,760 short tons). That is how much the garbage is assumed to weigh in total, according to ESA.

Together with Swiss startup Clearspace, ESA intends to launch a robot into orbit that removes pieces of debris and defective satellites with its gripper arms. A kind of cosmic garbage removal service that hugs the debris using a space probe and then hauls it toward the Earth where it ablates in the atmosphere. That is no joke because the first satellites already have a “throw-away handle” installed on their outer shell to facilitate their disposal.

Another ESA idea is an aluminum-plated braking sail (“Drag Augmentation Deorbiting System”) that is supposed to gently push satellite carriers from their orbits in the direction of the Earth’s atmosphere where they burn up. Currently, the model has been developed for “deorbiting” small satellites in a range of up to 100 kilograms (220 pounds). However, the same project is also conceivable for medium-sized to large satellites, according to ESA.

The German Aerospace Center (DLR) is working on space debris disposal technologies as well. One of the ideas being pursued is to decelerate pieces of debris using a high-performance laser until they drop into the Earth’s atmosphere where they burn up. However, such powerful lasers would need their own powerplants. Another DLR approach is not to have defective satellites crash to Earth right away but to try to repair them first. For this “on-orbit servicing” a safe approach to the defective satellite using a flying service unit including a robotic arm must be achieved. That’s not an easy objective but initial tests with partners on the ISS have already been run.

To collect garbage or otherwise dispose of it, the garbage must first be localized. This is the approach pursued by German startup Vyoma. The company intends to gather real-time data with its own satellites to localize astro-garbage. Plus, the data helps predict and thus prevent potential collisions. However, at speeds of several tens of thousands of kilometers per hour, that poses a major challenge. The first of the two Vyoma satellites is planned to be launched in 2024. Commercial and institutional customers are said to exist already. “That will be sufficient for developing a catalog of objects that are larger than 20 centimeters,” according to Vyoma. Subsequently ten other monitoring satellites are planned to follow. All of them are supposed to be ablated in the atmosphere without any residues at the end of their mission.

Startup Okapi Orbits is gathering data as well – not for disposing of astro-garbage but for preventing accidents. The data is migrated into collision avoidance software for satellites. An artificial intelligence analyzes the information and in case of an emergency recommends a potential evasive maneuver to customers.

Manuel Metz from DLR views the many different approaches in a positive light. “My impression is

that industry is seeing a prospective market here. There are various approaches in several countries that are being tested.” Exactly that is the right course of action, says the expert. In view of the complexity of the task, it’s only logical that there must be more than one appropriate solution. Maybe an unbiased approach to technology will also be the key to success in resolving this extra-earthly problem.

Technology from Schaeffler on board of the lunar mission

With Schaeffler Aerospace GmbH, the Schaeffler Group has been an important partner for aerospace companies for more than half a century. A few weeks ago, the “Artemis 1” lunar mission of Schaeffler’s partner NASA was successfully launched. Also on board was technology from Germany’s Lower Franconia region. Engineers from Schaeffler Aerospace in Schweinfurt developed ball bearings for high-speed engine pumps and delivered them to the United States. All of it top secret!

The engines are supplied by Aerojet Rocketdyne. “With more than twelve million horsepower, the Aerojet Rocketdyne RS-25 is the most powerful propulsion unit existing on our planet,” says Armin Necker, Managing Director of Schaeffler Aerospace. The rocket is equipped with four RS-25 engines. Each has a weight of more than three metric tons (3.3 short tons) and a diameter of around two and a half meters (eight feet). The

turbo pumps in which high-precision bearings from Schaeffler Aerospace are installed perform a particularly important job of pumping the fuel at a pressure of around 450 bar and the oxidator oxidation at around 300 bar into the combustion chamber. The high-pressure pumps achieve speeds of around 35,000 and 24,000 revolutions per minute without being lubricated by oil or grease because

liquid hydrogen and oxygen are colder than –200 degrees centigrade (–328 degrees Fahrenheit). The bearings are lubricated only by the rocket fuel, i.e., liquid oxygen and hydrogen, cooled down to –200 degrees centigrade. For the rolling bearings, Schaeffler developed the extremely robust and corrosion-resistant material Cronidur 30 that is also being used in many other applications.



Rocket engines with Schaeffler bearings in the turbo pumps

Masthead

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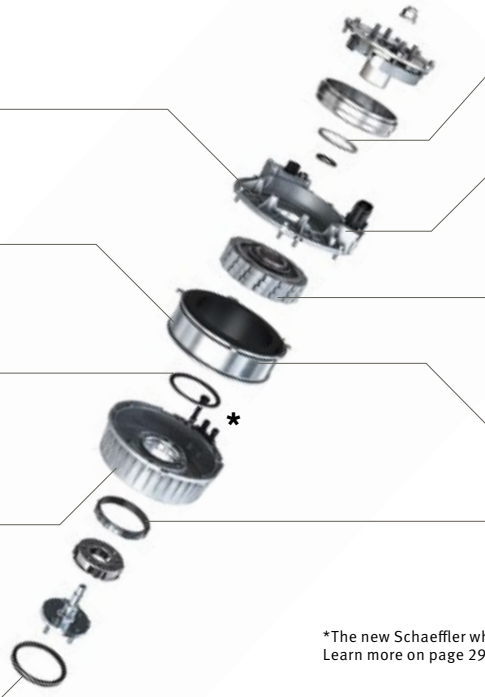
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*The new Schaeffler wheel hub motor.
Learn more on page 29.

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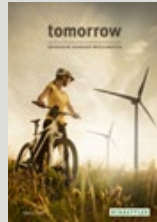
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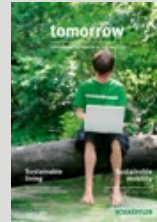
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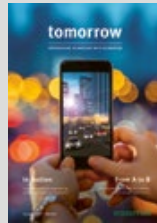
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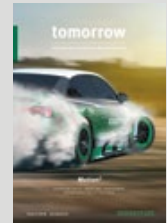
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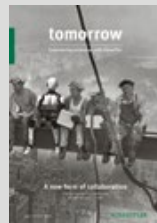
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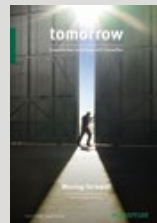
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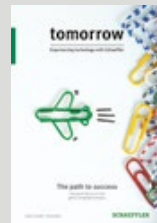
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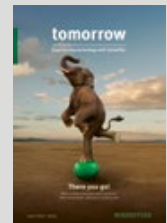
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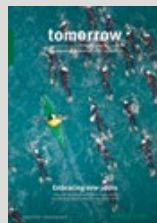
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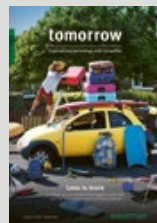
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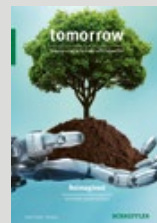
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