tomorrow

Experiencing technology with Schaeffler

Reimagined

Innovative technologies inspire new
and existing systems to flourish

Issue 3/2022 · Systems

SCHAEFFLER

Sys|tem; ['sɪstəm]

1. A collection of organized things; a whole composed of relationships among its members. [from early 17th c.] Synonyms: arrangement, complex, composition, organization, set up, structure.
   There are eight planets in the solar system.

    1. (derogatory) Preceded by the word the: the mainstream culture, controlled by the elites or government of a state, or a combination of them, seen as oppressive to the individual.
    2. (computing) A set of hardware and software operating in a computer.
    3. (mathematics) A set of equations involving the same variables, which are to be solved simultaneously.
    4. (music) A set of staves linked by a brace that indicate instruments or sounds that are to be played simultaneously.
    5. (physiology) A set of body organs having a particular function.
       the digestive system; the nervous system
    6. (psychiatry) A set of alters, or the multiple ("the individual with multiple personalities due to, for example, a dissociative personality disorder") who contains them.
    7. (astronomy) A planetary system; a set of planets orbiting a star or star system.

2. A method or way of organizing or planning.
   Followers should have a system to follow that works in their interests, not against them.

Source: system. (2022, October 2). Wiktionary, The Free Dictionary. Retrieved 07:22, November 18, 2022 from https://en.wiktionary.org/w/index.php?title=system&oldid=69424903.

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,

"Never change a running system" – that dictum originally coined in the world of IT may sound plausible but is WRONG. That said, I do admit that I've been upset now and then about my PC no longer running as smoothly as it did before installing an update. Still: "Never change a running system" can't be the way to go.

Where would humanity be if it had always stuck to the status quo? Automobiles, aircraft, the internet, X-ray machines, solar cells, hydrogen power – none of that would exist. It goes without saying that innovations entail challenges. Without industrialization that started some 200 years ago, we wouldn't have to combat climate change today. On the other hand, had we intervened with our existing systems earlier we wouldn't be under such great pressure now to achieve the 1.5 °C goal. That's why "Let's change the systems" is a call to action that's more important than ever before.

We at Schaeffler are expressly committed to the Paris 1.5-degree goal and, accordingly, have set ambitious company-wide climate goals. To support them, we've been scrutinizing our products, production operations and processes and begun to recalibrate them.

Products, production operations and processes: Starting on page 14, we present our special-purpose machinery department to you. Originally established to optimize our own production processes, our experts also increasingly apply the wide variety of their skills to advance the manufacturing operations of other companies. "Let's change the systems" – for more efficiency, for more sustainable use of resources.

Raw materials: We extract them from our natural environment to keep our systems running – often overtaxing our planet in the process. Even seemingly inexhaustible resources such as water or sand are becoming scarce. It's high time we intervened, but how? The articles starting on pages 16 and 46, respectively, provide details. The best way to ensure sustainability is to keep extracted resources in circulation for as long as possible – in viable circular systems, which is another topic covered in this issue of "tomorrow" (starting on p. 40).

Embracing new systems requires a high level of willingness to do so also on the users' side. A traffic psychologist (starting on p. 26) and a robotics expert (starting on p. 58) explain what walls must be torn down and what bridges built, providing insights beyond the areas in which they specialize. But read for yourself.

Before inviting you to immerse yourself in this new issue of our technology magazine "tomorrow" focused on "systems," I extend my best wishes to you and yours for the New Year along with my hopes that you'll be able to use the turn of the year to calibrate your own systems and to replenish your energy for 2023.

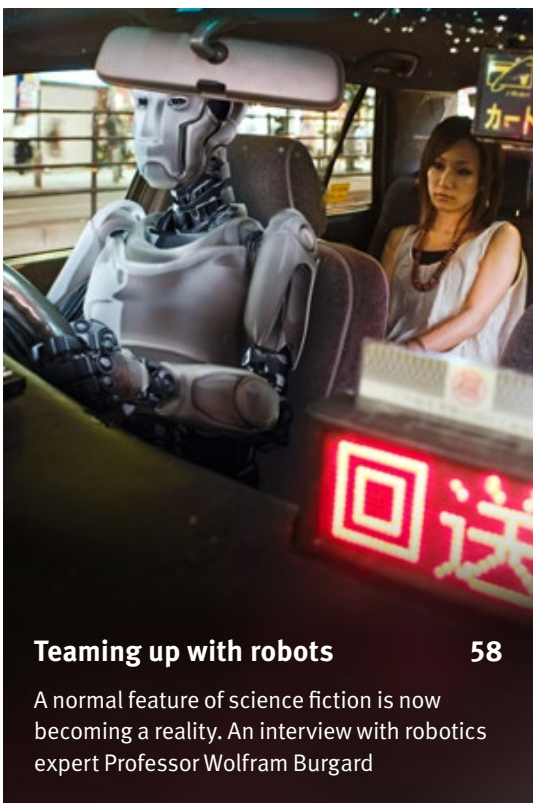
Klaus Rosenfeld
Chief Executive Officer

Engineering

In Motion

Think Green

Digital



Future Life

Engineering

Human history is a history of breakthrough inventions – their basic prerequisite is systematic knowledge transfer.

Mirror, mirror – give me energy!

It's been a long journey. Since 1995, Aldo Steinfeld, a professor at Zurich University of Technology, has been engaged in a research project dedicated to the **production of synthetic aviation fuel in a thermochemical process of water and CO_2 that's solely fueled by solar energy.** It took two decades for the first solar kerosene to be produced in laboratory conditions. In the next stage, a unique solar powerplant was built in Spain to test the technology in real-world conditions. 169 mirrors following the Sun – so-called heliostats – each with an area of three sq m (32 sq ft) direct the focused light to the top of a tower with a solar reactor. Due to the very high solar radiation intensity (2,500 times as intensive as non-focused sunlight) the temperatures of more than 1,500 °C (2,700 °F) required for the process are achieved, producing a CO/H_2 synthetic gas. Marking the next major milestone achievement, the entire process chain resulting in final kerosene was recently run by adding a gas-to-liquid transformer to the Spanish pilot plant. In the next stage, in 2023, **Swiss Air is planning to fly with solar kerosene on board.** However, the efficiency of this method is still low. So far, the scientists have managed to transfer only 4.1 percent of the solar energy into the solar kerosene while deeming 20 percent to be feasible. Steinfeld has calculated that a heliostat powerplant with an area of 45,000 km² (11,112,000 acres) (6,300 soccer fields or 0.5 percent of the Sahara Desert's area) would be needed to cover the current annual kerosene demand of 414 billion l (109 billion gals).

Microworlds at our fingertips

Japanese researchers at Ritsumeikan University in Kyoto have developed an **ultra-sensitive robotic finger** enabling them to interact with tiny insects – a tactile advance into microworlds that up to now have only been visually explorable using microscopes. The finger's tip consists of flexible stretching sensors that are moved by means of artificial muscles (pneumatic balloon actuators). The sensors, for instance, enable the scientists to measure the force that insects exert in their legs. Such values could only be estimated before. The sensors are controlled by the user wearing a robotic glove. "This kind of system allows for safe interaction with insects and other microscopic objects," says Professor Satoshi Konishi, the lead author of the study. At a later stage, **an even more sensitive successor model is intended to interact with other microscopic objects such as bacteria and viruses.**

In 2024

Hyme Energy in Denmark is planning to launch operations of the **first powerplant that has been repurposed from fossil fuel to sustainable uses.** Instead of boilers for a combustion process, storage systems for molten salt will serve to produce district heat and/or electric power. The storage systems will be heated to 700 °C (1,300 °F) using surplus electricity from renewable sources. The major benefit of powerplant recycling is that **the existing periphery such as turbines, transformers and connectors worth millions of euros can simply remain in use.**

"It is not important to run your head against the wall but to find the door with your eyes"

Werner von Siemens (1816–1892), German inventor and industrialist

Schaeffler opens technology center

Automotive progress is achieved less and less by classic mechanical engineering but increasingly by software and electronic systems. That's why automotive and industrial supplier Schaeffler is consistently expanding these areas. The inauguration of "Schaeffler Technology Solutions India Private Limited" marks an important step in that process. **At the new competence center for software and electronics development in Pune, India,** some 200 developers are working on future mobility systems – in close coordination with Schaeffler's E-Mobility headquarters in Bühl, Germany.

Joining forces for faster findings

The world’s 40 richest countries spend a total of 1.2 trillion euros per year on research and development. The money has been invested particularly effectively when academia and business act hand in hand.

By Dr. Lorenz Steinke

On May 16, 1960, Theodore Maiman, a merely 32-year-old physicist at Hughes Research Laboratories in Malibu, California, broke new ground when he and his team fired the world's first laser. The event marked a breakthrough at least from today's perspective because the modern world of technology can hardly be imagined without laser systems. The ultraconcentrated light beam is used in manufacturing technology (for cutting, drilling, welding, etc.), medicine (for cancer radiation therapy, retinal surgery, etc.), analytics and measuring technology, in everyday applications such as scanner cash registers and laser printers as well as in the field of mobility such as lidar sensors for autonomous driving. However, 60 years ago, the first laser beam in technological history ended in nothing, or, as Irnee D'Haenens, one of Maiman's assistants, jokingly said: "The laser is a solution looking for a problem," or more precisely, for a way of putting the idea to good (industrial) use.

The technology gained traction and the necessary boost for further development for other uses only in the nineteen-seventies when automotive and aircraft manufacturers recognized the value of laser systems for cutting and welding of metal. A happy ending of a late-blooming relationship between academia and business.

"In modern innovation management, research results without specific fields of application like in the case of the laser are sometimes referred to as a technology push. The opposite is referred to as a market pull, in other words a research project commissioned by industry enlisting the work of scientists to solve a specific problem. Technological evolution as we know it today would not be possible without these two variants of interdisciplinary collaboration," explains Robert Klarner, who is responsible for technology transfer and business cooperation at the Oberpfaffenhofen location of the German Aerospace Center (DLR).

Increasing focus on practical relevance

Today, in Klarner's view, it's unlikely that almost a decade will pass until a key technology such as laser light achieves its breakthrough. "There's a clear trend in technology push as well as in basic research toward proposing a project's practical relevance, in other words its application in

the marketplace, when the project is launched," says the DLR expert. As a result, the basic work of scientific research can be transferred faster into market-ready products. Dr. Viola Gerlach from the Potsdam Institute for Advanced Sustainability Studies feels that this is of vital importance as well. In an article posted in her institute's blog, she writes: "The societal relevance of scientific research processes and their results are more likely to be called into question in the future. They will be measured by their capacity to add real value to our quality of life and the sustainable development of our society."

For DLR expert Klarner, it's clear that, in addition to higher practical relevance of science, collaboration with the business community must be intensified both in the technology push and in the market pull realms. For one, because accelerated technology development coupled with increasing technological complexity requires that and for the other, because such collaborative partnerships should serve as a joint lever to achieve a successful transformation of business and society toward sustainability.

Transformation can only be achieved through collaboration

In view of the major current and future challenges, this is not only about concentrating technological expertise but – as the Fraunhofer Institute for Systems and Innovation Research ISI – notes in a position paper – also about minimizing financial risks by distributing the burden to several shoulders. Another fact that, according to Fraunhofer, makes a case for closer integration of science and business is that, in view of growing complexities, resources, both in terms of knowledge and capital, are often no longer in adequate supply for one party to handle the entire development process on its own.

Schaeffler's Chief Technology Officer Uwe Wagner emphasizes such positions: "Global challenges and transformations in mobility, digitalization or energy supply can only be mastered in close collaboration between society, science and industry," he says. Consequently, despite its high in-house development output – the company has been in the top 3 spots of the (German) patent registration ranking for years – Schaeffler has a long track record of working together successfully with scientific innovation hotbeds such as DLR, Helmholtz and Fraunhofer. The university-level collaboration project SHARE (Schaeffler Hubs for Advanced Research) launched in 2013 has evolved into a global research network with leading universities. In

"There's a trend toward greater practical relevance in scientific research"

Robert Klarner, DLR expert in technology transfer and business partnerships

these research hubs, Schaeffler employees, doctoral students and students from the respective partnering universities work hand in hand. Research and corporate infrastructures are used synergistically. The research topics are mobility, hydrogen technologies and renewable energies as well as digitalization, robotics and Industry 4.0.

The benefits in such collaborative partnerships for companies like Schaeffler are obvious: Through access to scientific expertise and technologies time-to-market for innovations can be accelerated (or even enabled in the first place), resulting in competitive advantages. The academic institution in turn benefits from know-how, prestige and particularly from financial gains. “We grant licenses for technologies for which the licensees pay market prices. For research services that we’re commissioned to provide, we charge typical market prices as well,” explains DLR expert Klarner.

As a result, scientific operations can end up with considerable cash, depending on the market success of the innovation. Karlheinz Brandenburg, who is deemed to be the “father” of the mp3 format, estimates that this invention with all related further developments and licenses resulted in earnings of at least one half to one billion euros for his former employer, the Fraunhofer Institute. He benefited from some of the income as well. “I was able to build a dream house without a mortgage and start my own

500 billion euros

per year are spent by China's National Development and Reform Commission (NDRC) and the Ministry of Science and Technology to achieve the **research goals of a five-year plan.** By 2025, China is aiming to be a global trailblazer in ten forward-thinking technologies including renewable energies and robotics.

Source: www.kooperation-international.de

66 %

of all research and development funding on average in the EU is provided by businesses. 22 % is contributed by universities and 12 % by the public sector.

Source: EU statistics

121 billion $

of the annual U.S. federal budget is spent on research and development. **45 billion dollars of that goes to the Defense Advanced Research Projects Agency (DAPRA)** of the Defense Department that has co-developed the internet and successfully (also in financial terms) migrated the Global Positioning System (GPS) to the private sector. The research institutions of the Department of Health (34 billion U.S. dollars) and the Department of Energy (14 billion U.S. dollars) are well endowed by the federal budget too.

Source: kooperation-international.de

9 **of Japan's 86 national universities enjoy a special status.** They receive additional research funds and have greater autonomy with spin-offs, collaboration with industrial companies or the founding of start-ups. In addition, Japan specifies focal areas and goal-setting frameworks for research, currently focused on the databased society.

Source: German Academic Exchange Service

16 locations belong to **"Manufacturing USA," a U.S. research and development network** that was formed in 2014. The German Fraunhofer Society served as a role model for the institutes emphasizing science-business partnerships.

small venture capital firm," he revealed in an interview with Redaktionsnetzwerk Deutschland.

No risk, no success

The development of disruptive innovations requires out-of-the-box thinking in research and development areas both in business and academia, according to DLR expert Klarner. That many disruptive innovations in the more recent past originated in the United States does not surprise him for several reasons. One of them is the fact that a culture that permits failure has evolved there also in the realm of research and science. While it's true that a venture may fail, there's equal truth in the saying "nothing ventured, nothing gained." A pioneering spirit instead of a mindset excessively focused on security. "In the United States, the fear of missing out on a technological trend with corresponding market opportunities is more prevalent with businesses and investors alike than the fear of failure," says Klarner. Accordingly, there's a high willingness to take risks with new research subjects and entrepreneurship.

The second reason is the high volume of corporate capital expenditures for research and development. According to the EU Industrial R&D Investment Scoreboard 2021, U.S. companies spending 344 billion euros per year invest more than their competitors in the EU (184 billion euros) and China (141 billion euros) combined. Klarner draws a comparison: "Money scores – in a metaphorical sense, what's true in football is also true in the area of investment."

Let's keep talking about money or, more precisely, government grants for public teaching and research institutions. In many countries, they're linked to the success of contract research. At the Fraunhofer Institute, this consistent market focus of research and development work was introduced as far back as 50 years ago, resulting in permanent and sustainable growth there. That's why in Germany the interlinking of grants with the success of science-business partnerships is frequently referred to as the "Fraunhofer model."

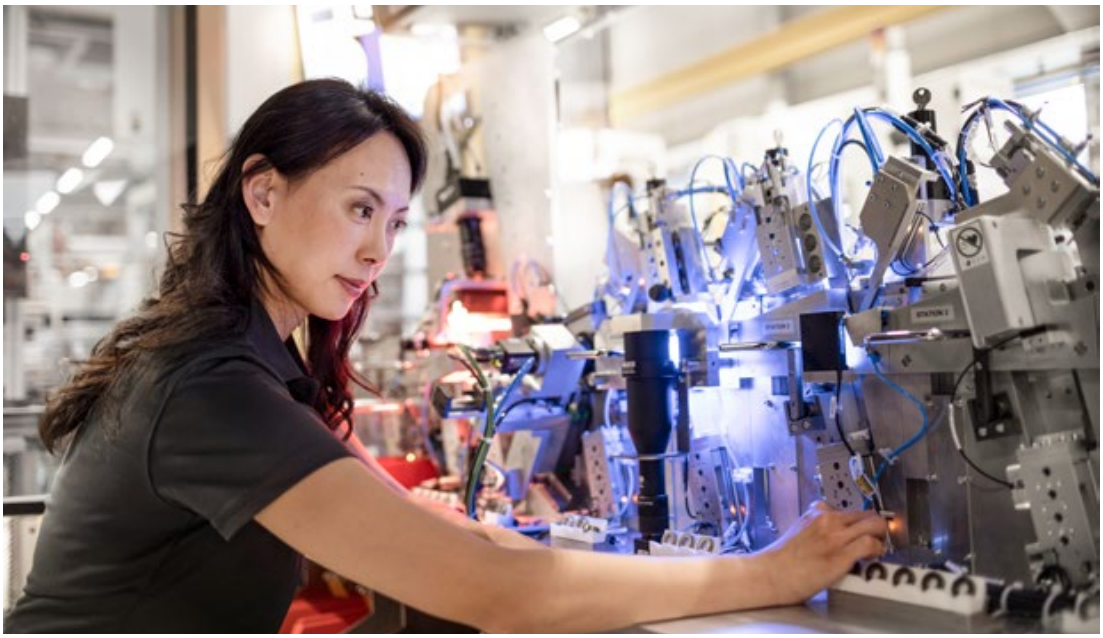
Spatial proximity promotes creativity

A creative environment is another important provider of impetus to fruitful science-business

partnerships. “Clusters, in which teaching, research, science and business are engaged in close exchanges, are real innovation boosters,” says Klarner. Birds of a feather flock together. Around the globe, theme-focused clusters have formed in fields such as medicine, biotechnology, aerospace, mobility, finance, IT, wind and solar power, telecommunications, and sensor systems. Silicon Valley is the best-known example. Decisive impetus to the cluster formation there was provided 80 years ago by Frederick Terman, then a dean at Stanford University. In 1939, the professor of engineering supported two of his students in starting their electronics company. Their names: William Hewlett and David Packard. Today, HP is one of the biggest technology corporations in the world. Motivated by that success, Terman launched a program for promoting founders in pursuit of his aim to make the region attractive to new settlements and students starting their own businesses. He even provided them with capital, today referred to as venture capital and start-ups. More than 150 companies, including IBM and Apple, soon began to establish their headquarters at Stanford Industrial Park that was founded in 1951. That Stanford University was burgeoning concurrently with the rise of Silicon Valley underscores the interaction of such science-business partnerships. Today, the university is one of the most prestigious and research-intensive schools as well as the fourth-richest university in the world.

The author

Dr. Lorenz Steinke regularly covers technology topics in his texts. During his work he keeps visiting research institutions such as DESY in Hamburg or the German Aerospace Center in Braunschweig. His impression is that partnerships can tap into plenty of knowledge at research locations in Germany.



Concentrated systems expertise

That Schaeffler has been supplying components and systems to industrial customers and automotive OEMs for over 75 years is commonly known. However, in another area the company is a kind of “hidden champion” – or did you know that Schaeffler is an extremely successful machine manufacturer?

By Volker Paulun

Because systems required for the company’s own production purposes were not available in the marketplace, or proprietary know-how to achieve higher quality was to be protected, Schaeffler began developing them in-house as far back as in the nineteen-sixties when the special-purpose machinery department was established. Its experts have long been offering their systems know-how to external customers as well. Battery cell stacks, electric toothbrushes, power chain saws or heat pumps for domestic uses – the list of products manufactured on systems that Schaeffler’s special-purpose machinery department has developed and delivered as turnkey solutions is long.

At 40 percent, external customer projects also account for a significant share of current order intake. The range of sectors served extends from energy storage systems, solar and wind power systems, medical device technology all the way to electric mobility.

Signs point to continuing growth for which Schaeffler’s special-purpose machinery department will evolve into a stand-alone unit within the company by 2024. “Due to the extended range of customers and industries, the special-purpose machinery department will be less dependent on market fluctuations and generally be able to act more effectively and successfully, going forward,” says Andreas Schick, Chief Operating Officer with responsibility for Production, Supply Chain Management and Purchasing at Schaeffler AG.

The special-purpose machinery department is already active at 13 international locations today and with around 4,800 projects per year completed by its 1,400 employees is a key pillar of the company’s manufacturing excellence. “The portfolio of Schaeffler’s special-purpose machinery department encompasses holistic, flexible and smart manufacturing concepts that sustainably optimize production operations in terms of current requirements such as shorter product lifecycles or increasing demands made on product diversity,”

“The portfolio of Schaeffler’s special-purpose machinery department encompasses holistic, flexible and smart manufacturing concepts that sustainably optimize production operations”

Bernd Wollenick,
Senior Vice President, Special Machinery of the Schaeffler Group

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Scalable and modular

To satisfy the requirements resulting from continuing accelerated technological progress, the volatility of the markets and sustainability factors that are increasingly becoming the focus of attention, the production experts emphasize maximum scalability and modularity in their concepts. “The utilization of standardized modules shortens the implementation times for new systems. Likewise, rising demand curves can be modeled with higher accuracy, which conserves resources and considerably cuts costs,” explains Wollenick.

Schaeffler’s special-purpose machinery department implements 4,800 projects per year with its 1,400 employees worldwide

In the development of customized production concepts Schaeffler relies on agile methods and simultaneous engineering to shorten implementation time through parallel development and early risk identification. Because Schaeffler not only is a machine manufacturer but also a developer and manufacturer of a wide variety of components and systems the company’s special-purpose machinery department can also access this know-how and offer a special value-adding service: consulting support for product design. That enables optimum ease of installation of the product which in turn provides the basis for particularly economical production. Proprietary developments of software applications enabling extensive integration and data tracing, among other things, make workflows more efficient as well and sustainably reduce CO_2 emissions in manufacturing operations.

However, making a production system more efficient and sustainable not always calls for an all-new machine design. Schaeffler’s special-purpose machinery department equally emphasizes the potential to optimize existing machines. Recently, Schaeffler’s experts achieved annual savings of around 105,000 kilowatt hours of electricity and 5,000 standard cubic meters (177,000 cubic feet) of compressed air at a plant just by retrofitting 50 assembly and inspection systems.

Learn more about Schaeffler’s special-purpose machinery department

Water = life

Eight billion people inhabit the Earth and nearly four billion of them are already living without reliable drinking-water supply today: a huge problem that is intensified by global warming. International research teams are systematically working together with NGOs and other institutions on new technologies for tapping into drinking-water sources. “tomorrow” presents some of them.

Air that’s drinkable

Air is not nothing. Besides nitrogen, oxygen and other gases, water in the form of water vapor is an essential constituent of air – and the amount of it that is present in air varies significantly. On average, the water vapor content in the troposphere – the lowest layer of Earth’s atmosphere – amounts to around 1.4 percent. The tropics with around three percent water vapor content in the ambient air and the poles with just around 0.1 percent are two extremes. In the quest for new drinking-water sources, researchers are now pursuing a strategy of harnessing this (invisible) humidity and have developed various technical methods for this purpose.

Condensation

How it works: Californian inventor David Hertz’ Skywater box uses the principle of condensation: when hot air touches a cold surface water vapor liquefies. The air is heated either by solar energy or biomass. Hertz explains his invention: “We are creating a tropical climate in the box.” The process is equally simple and ingenious, enabling water to be harvested even in very dry conditions. The collected condensation is subsequently filtered and purified.

Yield: David Hertz has shown that with his boxes – small, discarded shipping containers – he can pull up to 2,000 liters (approx. 528 gal) of water from the atmosphere within 24 hours – by using 100 percent renewable energies and at a price of merely 2 cents per liter (7.5 cents/gal). His formula: The higher the humidity and the hotter the temperature, the more water can be harvested and filtered. “We are CO_2-negative,” says Hertz, “meaning we sequester atmospheric carbon and turn it into biochar, a soil nutrient for regenerative agriculture.”

Skywater boxes suck humidity out of the air to make it available in the form of drinking-water

A super-absorbent gel that can pull water from desert air

Hydrogel

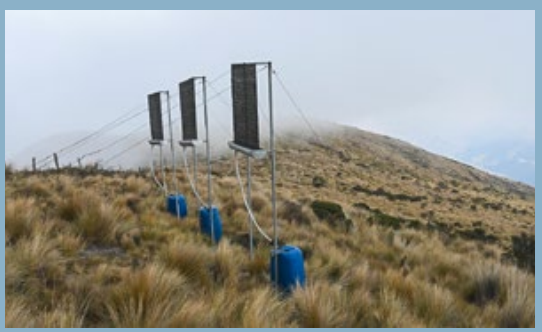
How it works: Scientists at the University of Texas have developed a gel that can pull drinking-water even from arid desert air using thermo-responsive cellulose – a material whose characteristics change, depending on temperatures. During cool nights, the material has the capacity to bind water. While being heated, the gel has a hydrophobic effect resulting in the release of the collected water. On balance, that's a particularly energy-saving and easy-to-use method for any household. One kilogram (2.2 lbs) of the gel is said to cost only two euros.

Yield: In areas with relative humidity below 15 percent, one kilogram (2.2 lbs) of the gel can pull about six liters (1.6 gal) of water from air per day, according to the U.S. scientists. In humidity conditions of up to 30 percent, it's even up to 13 liters (3.4 gal) per day. Through further optimization and thicker gel films, the amount of water can increase significantly, say the researchers.

Fog nets

How it works: Preferably installed in dry mountainous and coastal regions with ample fog and wind, fog collectors are vertically suspended nets consisting of a special mesh (such as nylon) that catch droplets which subsequently merge into larger drops. Without any energy input, strictly due to the force of gravity, the drops fall into a gutter, from where the fog water flows through pipes into a collection tank. Drinking-water has been harvested by means of fog nets for many years and, in some cases, for decades. For instance, the WaterFoundation, an independent Munich-based organization, offers such a product named CloudFisher. Fog nets are used in Bolivia, Morocco, Peru and Tanzania, for example. Chile, Eritrea, Ethiopia, Spain or South Africa are suitable for fog nets as well.

Fog nets in Bolivia



Yield: The daily water yield ranges between six (1.6) and 22 liters (5.8 gal) per square meter (approx. 11 square feet) of netting, depending on the region and season. According to the Munich Re Foundation that supports projects for harvesting drinking-water in poverty-stricken regions, hundreds of thousands of people are currently benefiting from fog nets. In addition, the specialty mesh – supplemented by horizontally installed plastic panels – serves to harvest water also during monsoon periods.

Drinking-water from the ocean

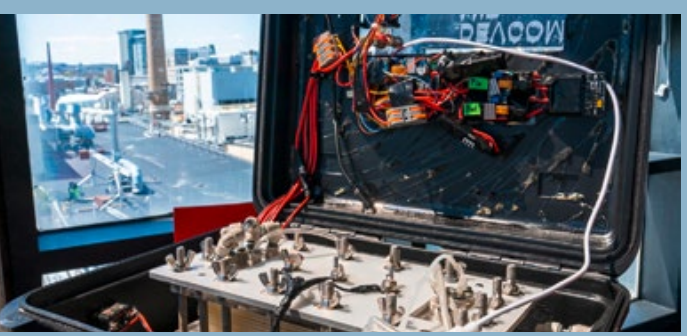
The world population is growing and so is its thirst. The solution to this problem, it seems, is obvious: 70 percent of our Blue Planet Earth is covered by water. If it were possible to tap this huge supply humanity's water problem would be solved instantly. Or perhaps not? In fact, hundreds of millions of people, worldwide, already depend on classic seawater desalination plants, while researchers are working on more profitable, sustainable and individually usable methods of removing salt from water.

Drinking-water at the touch of a button

How it works: Converting saltwater into drinking-water is not rocket science. However, that hasn't been true for private citizens so far because they'd need special filters combined with powerful high-pressure pumps. That's far too complex for the average consumer and prompted a project by a research team at the renowned Massachusetts Institute of Technology (MIT) that claims to have developed a fool-proof suitcase-like device for producing drinking-water out of saltwater – without any filters but with electric energy and at the touch of a button. The process applies an electrical field along membranes above and below a channel of water. Positively and negatively charged particles are thus repelled by the membranes while flowing past them and "filtered out." In addition to the salt molecules, this also affects other undesirable components such as viruses and bacteria. At MIT, they call this specialized technology ion concentration polarization (ICP). In a second step, a so-called electrodialysis takes place, which removes any remaining salt ions.

Yield: The researchers expect to harvest potable water that exceeds even the quality standards of the World Health Organization (WHO). In the field, this is supposed to take barely half an hour for a small quantity, according to MIT.

The "suitcase" for harvesting drinking-water weighs less than ten kilograms (22 lbs)



97 percent

of the water resources on Earth are **saline** and therefore not fit for consumption.

7 **liters (1.85 gal) of water** per day are consumed by a leaky faucet. A faucet losing 20 drops per minute wastes 2,500 liters (660 gal) per year.

6 times

more water than in 1930 was consumed on Earth in 2000, say the United Nations. The global requirement is estimated to continue increasing at a similar rate by 2050.

A piece of carbonate rock below the seabed that might contain groundwater

Drinking-water from the seafloor

How it works: A global assessment by the GEOMAR Helmholtz Centre for Ocean Research in Kiel revealed that around the globe huge freshwater reserves are hidden in the groundwater, referred to as "offshore freshened groundwater" (OFG). The crucial question is whether we can also use all these reservoirs as drinking-water sources. So far, the scientists have not been able to finally clarify which limestone rocks that store the groundwater like a sponge at a depth of down to 400 meters (1,300 feet) are already connected to land, in other words, which of them we've long been tapping, and which of them are not. Dr. Aaron Micallef at GEOMAR is optimistic, though: "The results we obtained so far are encouraging because we have been able to map OFG in very different geological settings and gain detailed knowledge on how it was deposited." However, the study also identified important gaps in the scientists' understanding of OFG such as the timing of deposition and whether recharge is currently taking place. "This information is crucial if we want to assess the potential use of OFG as an unconventional source of water," concludes Micallef.

Yield: For the study, the research team evaluated a total of 300 documented records of OFG. They estimate the global volume of these deposits at one million cubic kilometers (240,000 cubic miles). That is about twice the volume of the Black Sea and about five percent of the estimated global volume of groundwater in the upper two kilometers (1.2 miles) of the continental crust. The deposits are mainly located in areas up to 55 kilometers (34 miles) from the respective coasts and down to a water depth of 100 meters (330 feet).

Harvesting lithium from seawater

Lithium is an essential raw material for electric vehicle batteries. The demand for the "white gold" keeps growing. Research teams around the world are working on new, eco-friendlier, and more humane harvesting and mining methods. At the Leibnitz Institute in Saarbrücken, an approach to filtering lithium from seawater with low energy input and high yield was recently developed. The idea consists of a modified liquid battery with two additional chambers into which the water is pumped through ceramic membranes. During the process the liquid in the battery, in a continuous circular system, is increasingly enriched with lithium ions from which the lithium salts for the batteries are extracted.

Water management at Schaeffler

Target:
By 2030, water use is planned to be reduced by 20 percent.

Actions:
- Reuse of industrial waste water, pioneered by the plant in Taicang, China. To eliminate pollutants in the water that accumulate during surface coating (galvanization) processes, a vacuum evaporator was installed. Using downstream membrane filtration, the plant achieves a purification rate of nearly 90 percent in this way. This method will be used across the board at all Schaeffler locations in the future.
- Review and modernization of obsolete plant technology: At the plant in Elgoibar, Spain, for example, a circular waste water system is used in the needle manufacturing process.
- Modern dishwashers in cafeterias require 80 percent less water per day.
- The installation of water-reducing aerators on faucets causes consumption to drop by as much as 50 percent.

Desert greenhouses

How it works: In greenhouses in temperate climates, vegetables grow for which it's actually too cold there. In the desert, the Norwegian NGO "Sahara Forest Project" reverses this principle to produce food crops for whose cultivation it's actually too hot and dry. Their idea is to pump salt water into the Sahara Desert that vaporizes in greenhouses where it absorbs heat and thus cools the greenhouses. The intended final product – practically a byproduct – is clean freshwater because the vapor that condensates on the walls is collected and after another purification process becomes drinking-water. The necessary energy is supplied by solar systems. The project was initiated as far back as in 2008 and pilot projects have since been launched in Qatar and Jordan.

Yield: In an initial project phase, in which the plantations extended across an area of three hectares (7.4 acres), 10,000 liters (2,640 gal) of freshwater per day were produced by means of desalination using solar energy.

Cooling greenhouses that produce freshwater

3 questions for …

… Professor Steffen Krause, drinking-water supply expert at Bundeswehr University Munich.

What are the key aspects pertaining to drinking-water supply?
Making efficient use of existing drinking-water resources must become a global sustainability goal, especially in relation to farming. On a global scale, roughly 70 percent of the resources that might eventually become drinking-water are used for farming purposes. In that area, the efficiency of irrigation must be enhanced. In Europe, we virtually import water from regions in the world where irrigation is inefficient and resources are excessively used, for instance for cocoa, coffee or cotton.

But agriculture is not the only issue, is it?
Another major part of the resources that are or could become drinking-water is lost because untreated sewage is introduced into surface waters and contaminates the groundwater. Considering that surface water is polluted by textile dyeing, clothing should not just be used for a short time as fast fashion. The same applies to mindful handling of food. Foodstuffs, which account for a large part of our water footprint, must no longer spoil or be disposed of to the extent they have been.

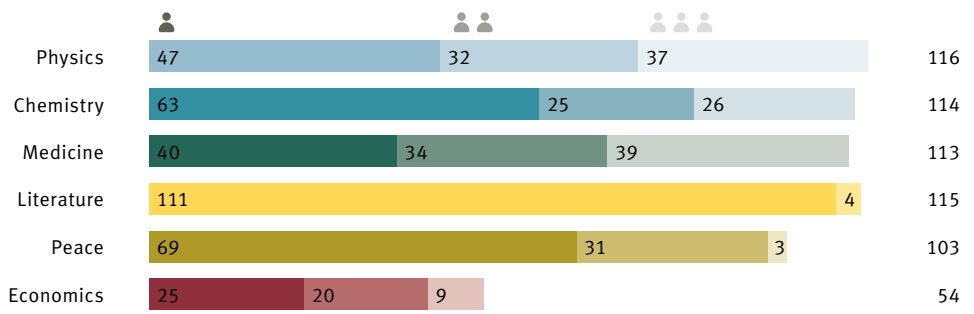
How do you assess progress with innovative methods for drinking-water production?
Solutions such as CloudFishing or various new methods for seawater desalination not only help humans harvest drinking-water but also benefit the environment as a whole – albeit only if negative consequential effects of the systems are avoided. A UN study in 2019, for instance, revealed that around the world 142 million cubic meters (5 billion cubic feet) of highly concentrated brine per day are discharged into the environment – far more than was previously thought. The fact that a large part of the brine is just fed back into the sea where it upsets the ecological equilibrium poses a serious problem. The concentrates from reverse osmosis are a real issue. In some regions of the Mediterranean Sea, the accumulation of the salts resulting from the introduction of the concentrates is already measurable. I assume that disposal of the concentrates is the biggest hurdle to overcome on the way toward large-scale installation of such systems in Germany as well. In addition, the high energy requirement of desalination plants poses a problem: Today's commonly used osmosis systems consume around 7 to 7.5 kilowatt hours of electric power per cubic meter (35 cubic feet) of freshwater. The utilization of green electricity requires either an energy storage system to buffer the lulls of wind and solar energy or large water reservoirs for storing desalinated water at times when a surplus of green electricity is produced. Either variant would drive up prices.

And the winner is … the team

Teamwork plays an important part in research, development, and science systems. A look at the Nobel Prizes that have been awarded since 1901 shows that too. Particularly in physics, physiology or medicine, and chemistry the joint work of two or three individuals has been winning the prestigious award increasingly often.

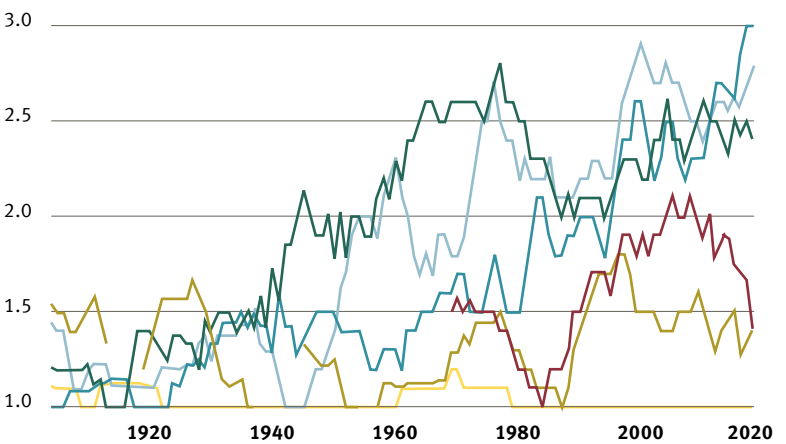
1, 2 or 3: 615 Nobel Prizes and to whom they went

Between 1901 and 2022 the Nobel Prize and the Nobel Memorial Prize in Economic Sciences have been awarded 615 times. The chart shows the distribution of prizes to sole laureates and teams



Nobel Prizes and number of laureates over time

(Color mapping as above; smoothed per year to 5-year average before and after; source: joeran.de/nobelpreis-kooperation)



3 is the maximum number of individuals that can share a Nobel Prize, except for institutions, which are rated as sole individuals. That was the case with the Nobel Peace Prize on 28 occasions, most recently in 2022: In addition to human rights advocate Ales Bjaljazki, the Russian organization Memorial and the Ukraine Center for Civil Liberties were honored.

Errors in the Nobel Prize system

In 1938 German chemist Otto Hahn and his assistant Fritz Strassmann experimented with uranium 239, causing it to "burst," as Hahn described their observation. Unable to really interpret it, he wrote to his friend, **physicist Lise Meitner, who was living in exile,** asking for help. And help she did: In February 1939, together with her nephew, Otto Frisch, and based on Hahn's observations, she provided **the first explanation of nuclear fission based on theoretical physics.** That makes it particularly hard to understand that Otto Hahn, in 1945, was solely honored with the Nobel Prize in chemistry for the discovery of nuclear fission. Stranger yet is the fact that Lise Meitner was nominated for a Nobel Prize for her research in chemistry and physics a total of 48 times, on seven occasions by theoretical physicist and 1918 Nobel laureate Max Planck, and always came away empty-handed. She died in 1968, shortly before her 90th birthday.

In 1958 **British biophysicist and X-ray expert Rosalind Franklin,** who had won acclaim for her groundbreaking investigations of the structure of DNA, died. One of her laboratory partners was Maurice Wilkins but the chemistry between them was not good. Franklin, Wilkins complained, was an obstinate know-it-all. Unbeknownst to her, he – unethically – showed X-ray images clearly showing the double helix structure of DNA produced by Franklin to two other fellow scientists engaged in the same research. The two cribbers' names were James Watson and Francis Crick – "two clowns," as the famous DNA researcher Erwin Chargaff once disparagingly called them. Chargaff unintentionally supplied them with knowledge as well, namely the conclusion that DNA is made up of four bases. Using Franklin's structure and Chargaff's rules, **Watson and Crick put together proof of the double helix structure of DNA** and were awarded the Nobel Prize in physiology or medicine together with Wilkins in 1962. In their acceptance speech, they failed to make any mention of the decisive preliminary work done by Rosalind Franklin, who had already passed away by that time. Perhaps out of embarrassment about the knowledge theft?

In 1967 **Joycelyn Bell Burnell**, a young Northern Irish **astrophysics student,** made one of the most important discoveries in astronomy of the 20th century when she was the first to qualify special beams of radio waves as **signals emitted by a pulsar**, a neutron star that rotates at extremely high speed. Seven years later, that discovery was recognized with the Nobel Prize in physics – albeit not for Burnell but for her PhD supervisor, Antony Hewish, and for Martin Ryle, another astronomer engaged in the research. The omission provoked a scandal.

In Motion

Emissions, efficiency, safety, ease of access – the world's mobility systems must change to satisfy new requirements.

Offroad extreme – Schaeffler technology passes endurance test

The steer-by-wire system "Space Drive" from Schaeffler By-Wire is a key technology for autonomous driving. The digital steering system of the future has already demonstrated its functionality and reliability today: with more than one billion kilometers (630 million miles) clocked in the mobility sector for disabled persons and in numerous runs on racetracks including the Nürburgring-Nordschleife. **Now "Space Drive" has passed its next endurance test.** On board of a Porsche 911 tuned for offroad driving and with three-time Le Mans winner Romain Dumas at the wheel, the steering system from Schaeffler ascended to an elevation of more than 6,000 meters (19,700 feet) in the Andes in Chile for the first time, **setting a new altitude record for Porsche as well.** The original plan had been to climb even higher – up to the summit of Ojos Del Salado, the highest active volcano on Earth (nearly 6,900 meters / 22,640 feet). However, a huge ice wall obstructed the plan. Even the best technology could not handle that hurdle.

E-mobility from Africa for Africa

Rugged and affordable: Experts tell us that vehicles should have these two characteristics for electric mobility to have a chance in Africa. Kenyan start-up Roam has put precisely that kind of vehicle on wheels. Not on four but on two. **An electric motorcycle built in and for Africa.** A motorcycle that due to the frequently lacking paved roads is hard-wearing and costs no more than the cheapest alternatives with IC engines. Roam Air sells for no more than 1,500 euros. Two batteries hidden in its steel frame enable a range of 180 kilometers (112 miles). In total, the bike weighs 135 kilograms (298 lbs.) and accelerates in five seconds from 0 to 90 km/h (56 mph). Roam Air is just one element in the electrification effort for Africa: **the start-up's product range also includes electric buses and solar modules.**

"You can't understand a city without using its public transportation system"

Erol Ozan,
Professor of Intelligent Transportation Systems,
East Carolina University

56 decibels

That's the minimum sound level requirement for an electric vehicle in the EU. The sound design of battery-electric vehicles is a hot topic, also for Schaeffler. **The automotive supplier recently presented sound synthesis software** combining, in real time, vehicle data (motor speed, motor load, brake pressure) with a sound profile specifically developed for racing. Going forward, Schaeffler will offer the software also to automotive OEMs for electric road-going vehicles, enabling carmakers to freely choose the driving sound of their brands.

Ships from a kit

The battery-electric MS Medstraum (pictured) from Norwegian shipyard Fjellstrand AS is not only **the world's first zero-emission fast-ferry** but its design could also become a model for others. MS Medstraum was designed and built based on ideas of the TrAM (Transport: Advanced and Modular) research project. This Pan-European science-business partnership aims to accelerate the development and production of zero-emission high-speed passenger ferries using a cost-effective modular design. Due to TrAM, MS Medstraum's production time was cut in half, from two years to one. The lower costs help make electric ferries competitive. The demand for them exists: in view of the climate goals to be achieved, many cities with waterways are planning to replace existing ferry transportation by fast electric vessels.

Mental block

The systems that will have to contribute to sensible and sustainable future mobility include Homo sapiens. Can traffic psychology help break down mental barriers to change?

By Roland Löwisch

German Emperor Wilhelm II purportedly was not convinced when the automobile gained traction at the end of the 19th century. The following quote is attributed to him: “The automobile is a transient phenomenon. I believe in the horse.”

A mental block? That would be typically human, because Homo sapiens is not a unit but a system consisting of mind, body and soul. That, for instance, can manifest itself by the mind knowing that global warming must be stopped but the body being too lazy to walk to the bakery and instead plopping itself down into the seat of a car with an IC engine …

Electric vehicles, car sharing, priority for bicycles – to name just a few hot topics – are far from having entered everyone’s mindset and may even be totally rejected for fear of change. What are the underlying reasons? How can such blocks be dissolved? Plus: Does every older man with a low income living in the country typically suffer from a mental block? Because he feels that he’s too old for change, can’t afford his personal mobility transition and isn’t able to use an electric car in the country anyway?

“No,” says distinguished traffic psychologist Ulrich Chiellino, who oversees transportation policy at ADAC, Europe’s largest mobility association. “Any change entails certain risks for the individual, and such risks vary. However, that doesn’t necessarily have to do with where people live, how old they are or other characteristics. The key aspects are how relevant it is for an individual to refocus their behavior and to engage in a process, and what prerequisites must be created to win over as many people as possible.”

Prospects are important

For that to happen, prospects must be put forth that bring home the related changes to everyone. Chiellino: “Disruptive events such as the pandemic have shown how fast people can adjust as well as how fast a technology shift can be achieved. In terms of digitalization, it created a new relevance

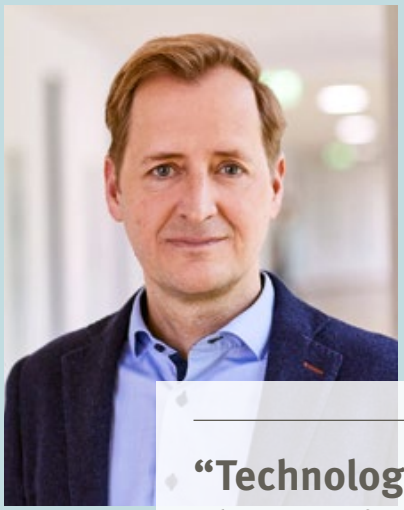
for action in every individual's life. By contrast, the situation with climate protection differs to some extent. It tends to be more of a journey that must be made jointly. Very few people have doubts about its necessity – the discussion is not about the 'if' but the 'how.'" In addition, he continues, the options that are available are crucial: "Because people want to continue to be mobile, they want reliability, they appreciate availability, plus the options must be affordable and, last but not least, a certain level of security is needed."

That said, Chiellino feels that quite a bit has already been accomplished, electric cars being a case in point: "At first the discussion was always focused on inadequate range and high risk of fire. Now you hardly hear or read anything about that anymore. When issues like charging infrastructure are resolved at the same time, the trust of individuals can be gained step by step so that transformation is ultimately achieved and adopted."

Step by step – that also applies to familiarization with new technologies. Experience has shown that resistance often crumbles when people have personally experienced the benefits of innovations. That also explains why so much resistance still exists against automated driving. Chiellino: "Our surveys have shown that only very few drivers have ever been in contact with that technology. They haven't been able to deal with it because they don't have any access to such vehicles yet. Knowledge about the technology is inadequate and therefore its benefits aren't tangible yet. So, it's no wonder that many people are still skeptical."

Benefits vs. bias

That was the case even before Emperor Wilhelm – for instance, in the days of the industrial revolution that started with steam engines. While English miners were skeptical at first because the boilers exploded around them it soon became clear how much easier the machines made mining because they took care of the necessary drainage work. "Consumers always eyeball changes skeptically at first," says the traffic psychologist, "because while walking on a familiar path I feel safe, know my way around and therefore am not inclined to leave it



> **“Technology always wins out when it makes daily life easier”**
>
> **Traffic psychologist Ulrich Chiellino**

just like that. Why should I take an additional risk? Entrepreneurs, though, need to think beyond that. To them, the rule applies that if you don’t move with the times the times will move on without you, and in most cases, you can’t make up the resulting disadvantage.”

However, at the end of the day, history proves that technology always wins out – even against all blocks in various brains, or not? “It always wins out when its design is user-friendly and attractive, and when it manages to make daily life easier,” says Ulrich Chiellino, pointing out a comparison with digitalization: “The first iPhone hit the market in 2007, which is just 15 years ago. Even so, almost everybody today has internalized the benefits of the smartphone because it makes our daily lives more efficient. Technology can fascinate us, win us over for innovation again and again, and even make us happy.”

Driving pleasure redefined

Apropos “happy:” Is it okay today to keep talking about “driving pleasure” in the face of all the climate discussion? Because the loss of driving pleasure is an argument put forth by some mobility transformation skeptics. Chiellino responds diplomatically: “It’s possible that in the future ‘driving pleasure’ will have a different meaning than it does for us today. For instance, driving pleasure may be the personal break we can take in a self-driving vehicle, in other words a gain in free time. But climate-compatible transformations in technology may also cause the original ‘driving pleasure’ to be preserved, or even enhanced – when people realize how agile electric vehicles can be.”

The traffic psychologist’s advice for anyone trying to overcome their barriers: “Start looking at your own daily and local mobility needs and check which means of transportation make sense for what. Structures keep changing, spaces change. That calls for trying things out, opening one’s mind to new perspectives and prospects, and then adopting the outcome into daily life.”

By the way, that’s what Emperor Wilhelm did too – he ultimately owned a respectably motorized fleet …

The author

30 years of writing about automobiles leaves its marks, at least with **Roland Löwisch.** Luckily, dealing with the transformation of mobility for professional, if for no other reasons, provides him with a trove of knowledge that busily nibbles away at any barriers in the brain. Even though at this stage of the game he can’t imagine a car promoting the pilot to the role of passenger providing him with driving pleasure …

Mobile medicine

Emergency ambulances, flying pharmacies, ORs on wheels – mobility has become an integral component of today's healthcare systems. Digitization and artificial intelligence pave the way for further fields of application.

By Volker Paulun

Voice commands instead of floored pedals and wailing sirens – the first ambulances were drawn by horses. Later, the internal combustion engine replaced the horse as the power source. Technological progress spawned further ideas: In 1938, Martin Kirchner, a professor of surgery in Heidelberg, in an essay titled "The Mobile Surgical Hospital" said that pre-clinical medical treatment could save more patients. Theoretically true but, unfortunately, not feasible back then.

Today, ECGs, defibrillators and respirators are standard ambulance equipment. On board of helicopters, ambulances have long conquered the skies as well.

With two horses and no blue light:
A Berlin ambulance around 1900

Kirschner's vision of a "mobile surgical hospital" has also long become a reality. For instance, as early as in 2008, a hospital on wheels made in Germany consisting of three Mercedes buses was delivered to the Centre of Ambulance Services in Dubai. Such mobile medical centers are deployed to the scenes of major incidents, such as accidents or catastrophes with many casualties, to provide fast on-site medical assistance. The centerpiece of the high-tech mobile hospital in Dubai is an intensive care unit including a fully functional operating room that's integrated in one of the buses.

Mobile CT scanners in truck trailers or ORs in containers have been gaining traction too. Such mobile units help compensate for capacity shortfalls in hospitals, for instance during modernization projects. Such projects are rolled out clearly more often than they used to be 50 years ago because, due to accelerated technical progress, the service life of an OR has shrunk to between 10 and 15 from the previous 30 to 35 years. Mobile units help sustain hospital operations.

Mobile Medicine 4.0: Clinic on wheels summons itself

So much for the current state. By now, visionary brains of various research and development disciplines are working on Mobile Medicine 4.0, focused less on mobile intensive care units of the kind in Dubai but mainly on diagnostic and medication-related areas. "Mobile" in this context doesn't necessarily mean "vehicle." Smartphones and wearables, that is applications that are integrated in clothing etc., are becoming

AI, augmented reality and an on-board pharmacy: That's how the American technology design agency Artefact imagines a self-driving clinic

"The Future of Mobility will transform health care delivery, accelerating the use of distributed care models and changing where new facilities are built and how they are designed"

From Deloitte's document "Mobility will change the future of health care"

increasingly important mobile components of modern healthcare.

Artefact, an American technology design agency, has this vision of such a comprehensive medical use case: Using various ambient sensors distributed in areas such as a home or office, wearables or connections with the Internet of Things, a smartphone constantly collects health-related data. When values of concern are measured the system can summon a mobile, self-driving clinic. This uncrewed mobile clinic has further diagnostic equipment on board. Using augmented reality for a visual projection of their body, patients can pinpoint the location of their health issues to complement verbal descriptions. Based on all parameters, an artificial intelligence then provides a diagnosis and recommends an appropriate

therapy. Ideally, the system's on-board pharmacy can dispense the required medication. Should a real physician be needed, they can be included by video conferencing.

Many diagnostic and monitoring functions can also be integrated into other vehicles – combining the daily commute to and from the office with a routine checkup. However, a question not to be ignored in this regard is whether people are going to approve of such permanent physical monitoring and the related sharing of data. But then again, aren't many of us already tracking physical performance indicators using a fitness app?

AI delivers better diagnoses than assumed

Another question that's crucial not only for the previously described mobile use case is whether an AI will be able to truly replace a real physician in the future. In some areas, AI is already on an equal footing with human doctors. Especially in diagnostics, when it comes to matching an existing symptom with other cases and drawing conclusions from such comparisons, artificial intelligence systems have delivered better results in some tests than real physicians, for instance in skin cancer screening. Since a well "trained" AI accesses hundreds of thousands if not millions of comparison data items that's not surprising. So, why shouldn't we stand inside a mobile box during our lunch break and have our body scanned instead of waiting for months to see a specialist?

Flying Doctors

Air rescue using so-called multicopters – vertical take-off and landing aircraft propelled by several electric rotors – is possible, makes sense and improves emergency medical care of the population: In a nutshell, those are the results of the world's first feasibility study on the use of these new aircraft that was commissioned in 2018 by the German Automobile Club ADAC. ADAC expressly states that multicopters are not intended to replace rescue helicopters but to complement their fast assistance from the air. Initially, multicopters are not planned to transport patients.

In an operating radius starting at 25 kilometers (16 miles), multicopters flying at a speed of up to 150 km/h (93 mph) can take emergency physicians to the scene of an emergency faster than ground-bound ambulances having to fight their way through urban traffic. Because average arrival times of emergency physicians in Germany have increased by almost 40 percent in the last 20 years, this is an important advantage. Another one is that emergency physicians can work more effectively and the multicopter can adequately mitigate the lack of emergency physicians existing in many areas. As a third benefit, the positive image of rescue missions can help increase public acceptance of multicopters as a new means of mobility.

Be it a mobile OR for response to major incidents in Dubai (l.) or a clinic on wheels for people needing care in Berlin: Around the world, converted buses have established themselves as mobile medical centers

Mobility connects medicine with people

That, precisely, is the major benefit of mobile medicine: It delivers healthcare to people including those who normally don't have access to it. Or to people who neglect having checkups due to lack of time or plain laziness. "In the individual case, this can mean that people suffer while unable to find a means to get to a medical expert and their ailment can progress beyond the point of using simpler methods to solve their health problem," writes Dr. Lance B. Eliot, a specialist in AI and machine learning, in an article about mobile medicine in "Forbes" magazine. From a macroeconomic perspective, he continues that "In the aggregate, this means that as a society we are inadvertently increasing our costs of healthcare since we aren't catching health issues early and thus having to pony up more medical care and more expensive medical care once the health issue finally starts to get resolved." Hence investments in mobile healthcare applications can pay off not only in a humanitarian sense but also financially.

Delivering healthcare to people: That's the approach that by now has been driving more than 2,000 mobile clinics through the United States, where they've become a pillar of the healthcare system. Besides residents of rural areas, low-income earners, homeless people, and those without health insurance particularly use this mobile medical service. In Germany, so-called Medibuses have been traveling through big cities like Berlin and Hamburg since summer of 2022. The vehicles have equipment like a complete doctor's office and are intended to provide medical assistance primarily to refugees as well as poor people in their immediate living environment. If necessary, the teams can access medically trained video interpreters for several languages and other resources. There are many reasons for deploying such a service: They include shortages in specialist medical care as well as language barriers and lack of information and guidance pertaining to the legal and health systems. As a fast mobile task force, the Medibus teams circumvent such hurdles with their unbureaucratic services. After all, the best physicians are of no use if they're not accessible.

29 %

of all Africans live two or more hours away from a hospital, according to a study by the World Economic Forum. However, mobile services can massively improve healthcare not only in Africa but also in other rural areas without adequate medical infrastructure.

Schaeffler puts medicine in motion

With its Industrial division, the supplier has been active also in the medical device technology sector for many years. Components from Schaeffler are used particularly in medical imaging such as C-arms, X-ray tubes and CT scanners.

"Leading equipment manufacturers rely on our low-noise CT bearings and drive systems to achieve high levels of scanning quality, for example," says Ralf Moseberg, Senior Vice President Industrial Automation at Schaeffler. In the OR area, especially in ceiling-mounted swivel arms, Schaeffler products are used as well: rotary bearings, brakes and, again, drive units. Moseberg: "No matter where linear and rotary guides up to and including robotics applications are used in healthcare settings, you'll almost always find our motors, gearboxes or even complete kinematic systems." Medical device technology is a strategic growth field for Schaeffler. The company intends to significantly grow its business in that sector and make it one of the key pillars in the Industrials market. Moseberg and his colleagues also emphasize in-house mobility in that regard: CT scanners using drive systems from Schaeffler can be moved quickly from one room into another one, which increases patient throughput and enhances treatment efficiency. The recently announced acquisition of linear technology specialist Ewellix underscores Schaeffler's ambitions. Ewellix is one of the market leaders in the field of electromechanical industrial actuators, lifting columns and planetary roller screws, among other things. In addition to robotics and mobile machines, they're used primarily in medical device technology – in dental medicine, care for preterm and newborn babies or in surgical as well as in rehabilitation and fitness equipment.

Surgical tables, monitoring screens, diagnostic equipment: When it comes to motion in medical equipment, components from Schaeffler are almost always involved

Think Green

Rethink the systems: Easing the burden on the environment calls for imagining and shaping innovations with sustainability in mind.

Heating with bits and bytes

In Germany's financial center, Frankfurt, the "Westville" construction project recently made positive headlines. **More than 1,300 apartments, childcare centers, schools and offices are planned to be heated using waste heat from a data center across the street.** The project is a showcase looking to be copied by others because there's huge untapped potential in waste heat. For instance, by consistently using the waste heat from all of the 60 data centers in Frankfurt all residential and office buildings in the city with a population of 750,000 could be provided with carbon-neutral heating by 2030. As a key prerequisite, the systems would have to be converted from inefficient air cooling to water cooling. **Low-temperature waste heat from energy-intensive industrial plants that can no longer be used for in-house processes can be harnessed very effectively for heating purposes as well,** especially when the distance between the source and the user is not too long. A copper-smelting plant in Hamburg, for instance, heats 5,000 apartments and offices in the nearby HafenCity district. Because output and utilization of heat are not always identical a buffer tank had to be installed between the plant and the district. However, many companies are (still) reluctant to intervene with established production processes to use waste heat, or are deterred by high capital expenditures. Yet price increases for fossil fuels make the utilization of waste heat increasingly attractive in many sectors.

Super-filtering plant

Tuning for your ecosystem at home: French start-up Neoplants has bioengineered a "superplant" that **filters indoor air 30 times more effectively than the original natural plant** whose genes were not modified, according to information released by the company. "Neo P1" is planned to be launched in 2023. The new variety is said to remove even more pollutants (formaldehyde etc.) from the air than conventional technical air cleaning systems. As a base plant, the company chose the popular, easy-to-care for Pothos plant. The idea behind "Neo P1" is that the plant does not store any pollutants like a normal houseplant would but recycles them into useful metabolites. The rest is decomposed by special microorganisms in a specialty potting soil.

"Tiny steps will be better than none"

John P. Murphy,
American author

21,500 km

or 13,360 miles of motoring matches the environmental burden of keeping a horse, according to a calculation made by consulting firm ESU Services as part of a study. **Who would have thought that a horse has the same environmental footprint as a trip in a passenger car halfway around the globe?** Its high requirement for feed and "emissions" in the form of climate-killing methane spoil the horse's environmental footprint. When it comes to pets or other companion animals, the environmental footprint of a dog has a motoring distance equivalent of 3,700 kilometers (2,300 miles).

Award-winning technology

Automotive and industrial supplier Schaeffler with its Enertect PC+ coating solution won second place in the 2022 CLEPA Innovation Award competition in the "Clean and Sustainable Mobility" category. CLEPA, the European Association of Automotive Suppliers, recognizes outstanding innovations for smart and sustainable mobility with the prize. The three top technology entrants selected from a total of 104 were invited for the finalist round in Brussels. **Enertect PC+ is a new high-performance coating system making metallic bipolar plates, a key component for fuel cell systems, more efficient, cost-effective and sustainable.** Instead of titanium or graphite, which have a larger carbon footprint, the coating uses steel as a base material. With that innovation, Schaeffler makes an important contribution to establishing hydrogen technology in mobility of the future.

Prof. Dr.-Ing. Tim Hosenfeldt, Head of Corporate Research and Innovation & Corporate Competence Center Central Technologies, accepted the CLEPA Innovation Award

Economy in a circle

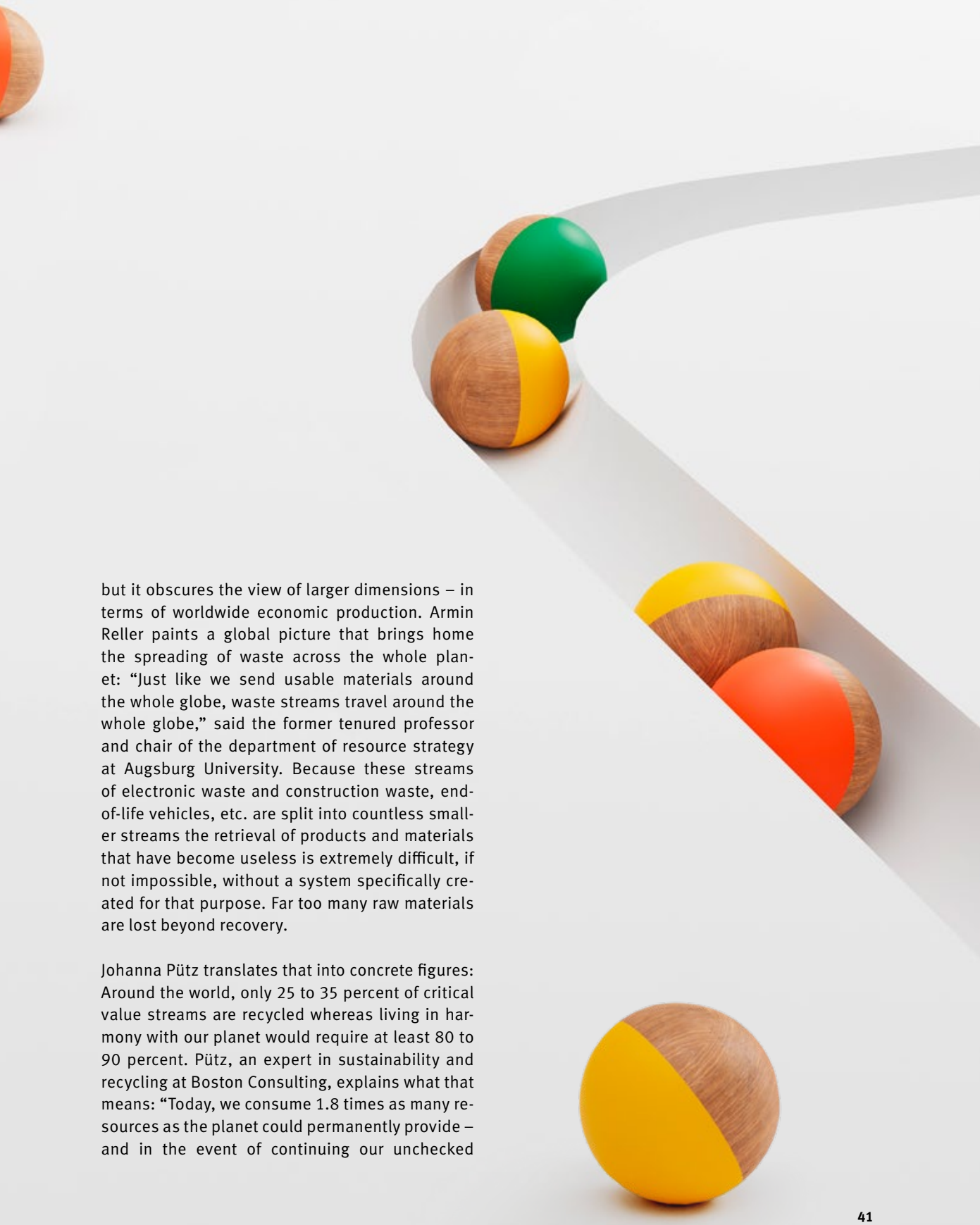
Whenever an object ends up in the garbage it ends up in the wrong place. The pace at which the amount of garbage is growing matches the pace at which important raw materials around the globe are dwindling. Consuming instead of using is a thing of the past: the future belongs to the system of a circular economy.

By Kay Dohnke

Initially, the number of activists was small but then it kept growing: In the summer of 1970, members of the Ecology Action Movement began meeting in a yard in Berkeley, California, gathering empty bottles, stacks of old newspapers, beverage cans. These regular recycling happenings held by environmentalists back then are deemed to have been the nucleus of American recycling programs because the idea caught on. Today, blue curbside bins for used glass, wastepaper, scrap metal and plastic packaging can be seen practically throughout the country on collection days. Curbing waste was in the wind back then: The Netherlands was another country in which engaged citizens started collecting old glass and forcing local governments to act, as well as people in Austria, later in the UK and in Scandinavia. In Germany, today, nearly 300,000 collection bins are regularly filled by millions of participating consumers.

Dazzling successes

Recycling of old glass and wastepaper can be seen as a successful model in many countries,



but it obscures the view of larger dimensions – in terms of worldwide economic production. Armin Reller paints a global picture that brings home the spreading of waste across the whole planet: "Just like we send usable materials around the whole globe, waste streams travel around the whole globe," said the former tenured professor and chair of the department of resource strategy at Augsburg University. Because these streams of electronic waste and construction waste, end-of-life vehicles, etc. are split into countless smaller streams the retrieval of products and materials that have become useless is extremely difficult, if not impossible, without a system specifically created for that purpose. Far too many raw materials are lost beyond recovery.

Johanna Pütz translates that into concrete figures: Around the world, only 25 to 35 percent of critical value streams are recycled whereas living in harmony with our planet would require at least 80 to 90 percent. Pütz, an expert in sustainability and recycling at Boston Consulting, explains what that means: "Today, we consume 1.8 times as many resources as the planet could permanently provide – and in the event of continuing our unchecked

overexploitation it would be 2.3 times as many by 2040. To prevent that, prudent resource management is imperative."

Raw materials under pressure

Rising prices, dwindling inventories and geostrategic changes are currently showing the importance of raw materials for economic production with striking clarity. A fact that tended to be ignored in times of cheap supply: all products are processed raw materials – and remain raw materials! However, instead of recovering and reusing them as effectively as possible we push them into a dead-end street. End-of-life products – from TV sets to smartphones, from furniture to packaging materials – are suddenly regarded as useless at the end of their direct utilization phase and end up in humongous quantities on landfills, in the countryside or in the furnaces of incineration plants, worldwide. In the worst case, they're deemed to be hazardous or special waste.

Waste: That's a concept provoking Michael Braungart to voice vigorous protest: "As soon as you even accept waste as a fact you've lost," postulates the Hamburg chemist and originator of the cradle-to-cradle principle. "Nature knows no such thing as waste; we're the only creatures producing waste. Nature knows only nutrients." Based on that notion, he advocates a system in which all raw materials approaching the end of their utilization phase can start a new product life again as a raw material. Cradle-to-Cradle instead of Cradle-to-Grave like today.

New ways to mine raw materials

While the incessant search for new raw material deposits continues around the globe and their extraction under increasingly difficult conditions often entails massive encroachments on nature, while mining corporations practice "second mining" by digging through their dumps in search of residual ore to be recovered in enhanced extraction processes, prices at raw material exchanges keep rising. Yet there's an obvious solution to the problem: urban mining, in other words harvesting of residues from our consumption-focused world can feed materials back into production circuits – provided they can be captured.

However, at this juncture, urban mining is facing several hurdles. Although all concepts such as Duales System, Sero, Upcycling, Zero Waste or Cradle-to-Cradle are committed to the idea of a circular economy none of them can solve existing practical problems, because:

- Not enough products are returned into recycling processes for materials.
- Product design massively complicates recovery of secondary raw materials or often makes it uneconomical.
- There are not enough recycling technologies available yet for complex products.
- New, i.e., primary raw materials are still too cheap – not least because the total environmental and social costs remain ignored.

In fact, we operate with a system that's neither logical nor functional. As long as growth is deemed to be the desirable maxim of the economic system the players pushing products onto the market with shorter and shorter lifespans and

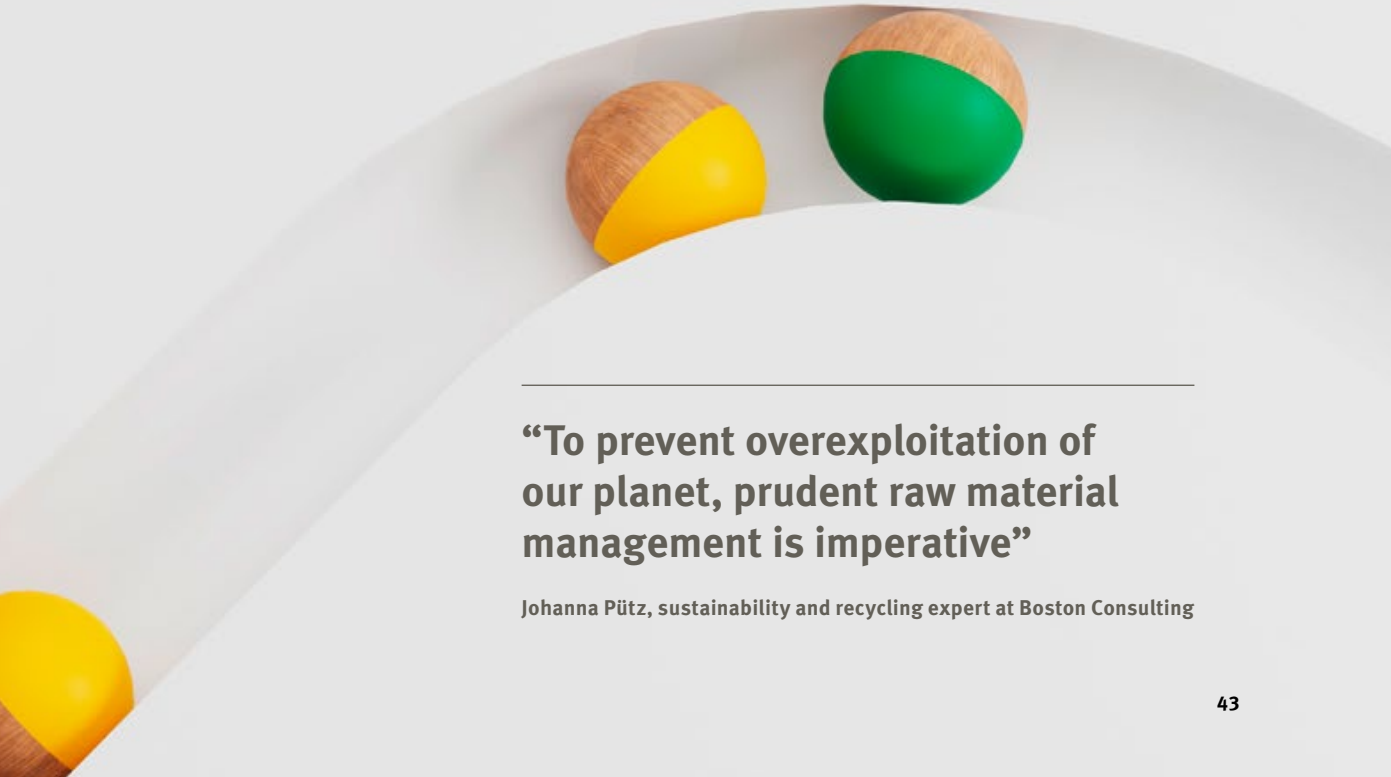
increasingly higher replacement rates will be rewarded with economic success. Why should I care about keeping yesterday's smartphone when a phone with even more features and gimmicks will hit the market tomorrow? Or larger TV sets or all kinds of gadgets?

Taking an interest in history

However, labeling consumers as naïve, shopping-frenzied resource hogs does not find favor with Heike Weber. The history of technology professor at TU Berlin understands the establishment of a recycling system for raw and therefore usable materials as a project for society as a whole, in which consumers increasingly act as important players and even drivers of progress. The reason is, says Weber, that people have a growing interest in the whole history of a product, including its previously ignored pre- and post-utilization phase. Knowing under which conditions and with what material and energy input a product is created, and what happens to it at the end of its useful life intensifies a consumer's relationship with the product. Which, she adds, also generates a sense of responsibility – otherwise people wouldn't care about a meaningful continuance of their obsolete objects, nor would products designed for greater sustainability but selling for a higher price find any buyers.

Knowledge breeds a sense of responsibility which in turn leads to active participation in recycling of materials – while enhancing the market opportunities for products manufactured in smarter ways.

That's where Michael Braungart vigorously takes a stand in the raw materials discourse as well: Besides conscious consumers, enlightened producers making new product design a reality are needed. Currently, he criticizes, the focus with practically all products is placed on the actual utilization phase. They're predominantly designed to be thrown away although the requisite materials could be installed in them for easy subsequent recovery – through reduced material diversity, bonds that are easier to dissolve and elimination of unnecessary additives. Largely homogeneously



"To prevent overexploitation of our planet, prudent raw material management is imperative"

Johanna Pütz, sustainability and recycling expert at Boston Consulting

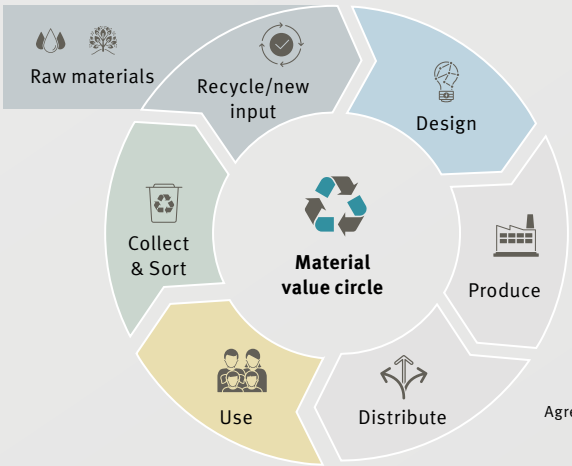
recoverable recyclates could easily be sold in the marketplace, he says.

Wanted: innovative methods

Talking about technology. That's currently one of the key challenges confronting the establishment of a comprehensive material recycling system. Recycling simple fractions such as glass or paper is child's play compared to recycling products with a complex design, says Baumgart. Even so, he's confident that the necessary methods – such as the current practice of decomposing PET plastics using enzymes – will emerge. Innovative companies as well as consumers want to be part of the solution and no longer be part of the problem.

That said, is it conceivable that manufacturers and consumers can solve the problem of a circular economy on their own? Without any statutory provisions or regulatory controls? Heike Weber, Armin Reller and Michael Braungart unanimously take a

Key challenges to circularity across industries



Source and Copyright: Study "A 'Paris Agreement' for recycling the Earth's resources" by World Business Council For Sustainable Development and Boston Consulting Group

Steel & Aluminium
Lack of waste collection infrastructure and appropriate sorting technology to avoid downcycling in recycling process.

Paper
Contamination of paper from production (coating of paper), use, and disposal into single-stream waste bins.

Cement
Technical limitations on recycled concrete aggregate; virgin material input is required.

Wood
Challenge to repurposing. Most recycled wood is down cycled and applied in a limited range of wood products.

Biowaste
High food loss and waste at consumer stage (especially in developed markets).

E-waste
Frequent replacement of personal electronic devices (e.g., cell phone, laptop) due to low awareness of e-waste impact.

Plastics
Complexity of products—seven main plastic grades with thousands of polymers—makes it dicult to sort and recycle.

EV Batteries
Technological uncertainty associated with converting batteries for second life usage.

Annual global waste generated today and in 2040
(in metric/short tons)

	2020	2040	Increase
Construction waste	2.2 bn / 2.4 bn	3.3 bn / 3.6 bn	approx. 50 %
Metals	750 mn / 827 mn	1.1 bn / 1.2 bn	approx. 30 %
Paper	400 mn / 440 mn	530 mn / 584 mn	approx. 30 %
Plastics	270 mn / 298 mn	560 mn / 617 mn	approx. 110 %
E-waste	54 mn / 60 mn	100 mn / 110 mn	approx. 95 %

Source: Study "A 'Paris Agreement' for recycling the Earth's resources" by World Business Council For Sustainable Development and Boston Consulting Group

dim view of bringing about secondary raw material production by means of laws and regulations. Simply put, because no one likes to have requirements imposed on them, let alone be forced to do something. Plus, the higher the pressure the greater the resistance.

Regarding the economy, Johanna Pütz points out another sphere of influence: Requirements might be constructive in the pre- and post-utilization phase, for instance by eliminating approvals for material- and energy-intensive manufacturing methods and harmful substances. The fast international phase-out of CFC production under the Montreal Protocol that largely stopped the depletion of the ozone layer is a case in point. The obligation imposed on retailers to take back discarded objects free of charge is also a helpful form of political control, according to Pütz. Policymakers – preferably on an international scale – issuing framework conditions and development targets could accelerate the shift from linear thinking, producing and consuming toward the circular system. The actual utilization phase, though, should be free from constraints – enlightened consumers, she feels, act reasonably anyway whereas enabling low-threshold participation in the circular economy for everyone is the responsibility of the business community and public administrations.

Waste incineration as a killer concept

However, there's one area in which Reller, Braungart and Pütz view the current handling of "waste" to be on a totally wrong track: Waste incineration, they say, is the biggest mistake that can be made because it destroys secondary raw materials all but completely or makes them unusable. The aspect of energy production – misleadingly labeled as "thermal recycling" – is the wrong way to go, emphasizes Braungart, because the production of practically all materials consumes more energy than the amount that's gained by burning them. Hence longer utilization of raw materials is clearly an imperative also in view of energy-related aspects.

"Which raw materials and resources will be important for the future, for the next generation of technologies," Reller cautions," is not foreseeable yet. "Waste contains many key substances, especially metals, that may still be insignificant now but may become incredibly important later. We may not have the technology yet to recover them but new technologies for selectively recovering such usable materials will be available in the future. We're going to see a wave of new methods that are very exciting."

Dumping instead of burning? The future calls for different concepts – and only the circle makes new beginnings possible.

The author

As a freelance journalist, **Kay Dohnke** feels committed to covering sustainability topics. He's always felt that recycling of wastepaper and empty bottles is important. However, the research for this article taught him that his German compatriots – contrary to frequently being touted as such – are not the world champions in garbage separation. That title belongs to the Japanese who collect secondary raw materials in 14 different categories.

Sand is becoming scarce!

It's hard to believe that something that has always been thick on the ground has now become extremely scarce. The system of our modern society is literally built on sand. Here's the lowdown on the second most important resource after water.

Who are the major sand consumers?

Almost every day, children on a beach or in a sandbox show us how they create the most beautiful harbors, castles and other buildings from sand. There's no way around using sand to build things in the real world either. Whether in asphalt or concrete – everything contains sand. **About two thirds of the global sand consumption go to the construction sector and to land reclamation.** The volume of required construction material alone increased 34-fold in the last century. In less than one decade, China consumed as much sand as the United States did in the entire 20th century.

Where a tropical sea used to splash against Singapore's coastline there's dryland today – nourished by imported sand

The biggest "consumer" in terms of land reclamation is Singapore. The city-state has grown by 130 square kilometers (50 square miles) since 1973, which equates to the area of 18,207 soccer fields – and more than 500 million metric tons (550,000 short tons) of sand that Singapore imported from its neighboring countries and poured into the sea. But Singapore is not alone in this. Bahrain, China, Doha, Dubai, Lagos, Tokyo and many other countries and metropolises are also pouring zillion tons of sand into the ocean to reclaim land.

200 metric tons

(220 short tons). That's how much sand the construction of a **normal single-family home** devours, for a one-kilometer (.62 mile) stretch of highway it's an incredible 30,000 metric tons (33,000 short tons).

What else is sand needed for?

Worldwide, we use sand also for filtering water, for cosmetics, photovoltaic systems, microchips and glass production. Fracking, especially of natural gas, is impossible without sand as well. **The process refers to accessing gas that's trapped in or underneath impermeable bedrock formations such as shale and involves the high-pressure injection of a mix of water, sand and chemicals that fractures those rock formations and releases the natural gas in them.** The sand contained in the mixture prevents the channels created by fracturing from immediately closing again. This requires a special type of sand that "supports" the channels while leaving enough space for the natural gas to flow.

3/4

of its mined silica sand, the United States uses for fracking, which is even more than it uses for manufacturing glass products and microchips.

Where does sand come from?

Sand is so commonplace that hardly anyone asks themselves where it comes from. Sand mostly stems from mountainous regions. Freezing temperatures, heat, water and wind, as well as the roots of plants and creatures cause rocks to break down from rock formations and to subsequently become smaller and smaller. Rivers then wash the sediments into the ocean while they're increasingly being ground down. In addition, there's sand that has formed from shells or corals. In this case, fish are of help that eat and grind them while digesting them. A green bumphead parrotfish produces 90 kilograms (200 lbs) of beautifully white beach sand per year in this way. **The Amazon River is regarded as the biggest "sand factory" in the world.** About one billion metric tons (1.1 bn short tons) of sediment are washed into the Atlantic Ocean by the many tributaries and ultimately the Amazon River.

Rivers wash sediments into the sea

7.5 quintillion

grains of sand are located on all of the world's beaches, according to estimates by scientist Howard McAllister at the University of Hawaii. However, the scientist himself admits that he may be off by one or two quadrillion.

Sand can have different shapes, grades and sizes

Why isn't all sand created equal?

Size matters less than shape and quality because the "tasks" of sand vary, depending on its use. **The grains of construction sand must be angular so that the sand will bond well with other materials.** Sand that's needed in glass production typically has to contain at least 95 percent pure silicon dioxide and be free of certain contaminants. Consequently, such quartz sands are more expensive than sands used strictly for construction – their price is about eleven times higher. The quality of the silicon contained in the sand also matters in microchip manufacturing. Especially the production of ingots in chip manufacturing requires absolutely pure silicon. That's extremely expensive. Manufacturers are currently paying the equivalent of about 7,700 euros for one metric ton (1.1 short tons) of silicon, which roughly equates to the price for pure copper.

2 millimeters

(0.08 in) is the maximum size of a single grain of sand, the smallest one measures 0.06 mm (0.0002 in). A grain of sand consists mostly of quartz, i.e., silicon dioxide aka silica.

How much sand is being consumed?

The amount of sand consumed worldwide per year roughly corresponds to a wall once around the equator with a width and height of 27 meters (89 feet). Consequently, the current annual consumption is about twice as high as the amount of new sand that rivers are washing into the oceans – provided the sand even makes it that far. **Human-made dams and locks interrupt the flow of sand.** In addition, sand is being mined in rivers by means of huge dredgers – both legally and illegally.

› 50 billion

metric tons (55 billion short tons) of sand per year are consumed by humanity around the world.

Why is sand such a scarce raw material?

When looking at the deserts on Earth it's hard to believe that we don't have enough sand. **But only one fifth of even the vast Sahara Desert consists of sand.** And that sand, which is typical for deserts, has been ground to such roundness by repeatedly occurring erosion processes of various kinds over hundreds of thousands of years that it's suitable neither for building nor for land reclamation. So, it's no wonder that even countries with deserts have to import sand.

360,000 metric tons

(397,000 short tons) of sand from Australia were used in the construction of the world's tallest building, the Burj Khalifa in Dubai.

Because desert sand is not suitable as a building material Dubai has to import sand to erect its skyscrapers

What damage does sand mining cause?

The extent of damage is huge: Beaches disappear either due to legal or illegal sand mining or as a result of changes in ocean currents that are influenced by buildings. Without protective beaches or dunes, hurricanes, tsunamis and even smaller storms can have devastating effects on the coasts concerned. **In 2012, Hurricane Sandy caused 65 billion dollars of damage on the United States East Coast,** primarily in areas where the beaches had eroded. No wonder that local governments try to counteract such losses with beach nourishment – albeit at massive costs, especially since the nourishment projects have to be repeated frequently.

Sand pumped off the ocean floor causes countless reefs to die and destroys the habitats of many plant and animal species. The same applies to sand mining in rivers. The Mekong Delta in Vietnam, for instance, has been shrinking – after having steadily grown due to sediment deposits for millions of years. Some 20 million people live there whose food staple largely depends on local rice cultivation. The lack of sand causes the water level of the Mekong River to drop and more and more seawater to enter the delta – along with dangerous saltwater crocodiles.

Hurricanes and tsunamis can have devastating effects on coastal areas

1.3 billion

dollars of additional damage that would have been caused by Hurricane Sandy were prevented by previously nourished beaches, according to estimates by the U.S. Army Corps of Engineers.

How can we curb our sand consumption?

For starters, the world needs to be sensitized to this issue. Why conserve something that's literally "thick on the ground?" However, we do need to handle sand – like any resource we take from the Earth – sparingly and mindfully. **Government regulations are helpful,** but only if compliance with them is enforced. In many regions, rivers are still being excavated without any kind of permits and the ocean floor is relentlessly dredged. Sand trade has to be controlled as well. What good does it do if one country bans sand mining but the sand is imported from illegal sources? "Illegal sand mining is a multi-billion business with mafia-like structures. In Jamaica, sand thieves stole the beach of a fishing village for building an artificial bay in a new luxury resort. They came at night with heavy-duty equipment – and rifles," according to a Deutschlandfunk radio report aired as far back as in 2016. Using rifles to rob sand – that, too (unfortunately), shows how valuable it is.

50 %

of Morocco's beaches have already been removed by illegal mining.

What alternatives are there to sand?

Numerous researchers are working on sand alternatives. But, as we've read earlier, all sand is not created equal. **In some types of concrete, flue ash, slag and rock particles can substitute sand.** Shredded plastic waste is another option. Even shredded concrete, albeit with limitations, can be reused, for instance as a supporting layer in road construction. A Swiss startup has developed a method for depositing CO_2 in shredded concrete. This reconditioned concrete granulate is supposed to be used in road construction as well as being recycled into new concrete instead of sand and gravel. In Australia, experts are working on the production of pavement consisting of a mix of coffee grounds and waste products from steel production. Even asphalt is well-suited for reuse.

Nearly all resource problems concerning sand could be solved by an idea from Germany: A Munich-based company has developed a method for grinding fine desert sand down into even finer rock flour and subsequently compressing it into pellets with chemical binding agents. Together with cement and water, these pellets can be blended in a high-speed mixer to create concrete. That concrete is said to be stronger than conventional concrete while requiring less cement.

Others are developing bricks formed from desert sand resembling the well-known Lego bricks, either with the help of bacteria or by adding polyester resins.

In fact, even climate change is helping in sand production because glaciers that are shrinking due to global warming are washing plenty of sand into rivers and oceans. In Greenland, this environmental lose-win situation has caused some river deltas to grow into the ocean by up to two kilometers (1.24 mi) in the past 80 years. A raw material gain that comes at a price …

73 million

metric tons (80 million short tons) of recycled asphalt are already in use per year today.

Clever companies develop bricks formed from desert sand, resembling the popular Lego bricks

The Author

While doing his research about the subject of sand journalist **Carsten Paulun** – who grew up in a sandbox and on the beaches of the Baltic Sea – discovered many facts he was previously unaware of. Especially the mafia-like structures of sand mining all over the world are a cause for alarm to him.

Digital

Digitization increasingly penetrates existing systems while creating new ones.

“Super GPS2” sans satellites

We use the services of satellites supporting the Global Positioning System (GPS) for navigation practically every day. GPS works well but sometimes lacks precision, particularly in the street canyons of densely built-up conurbations or in enclosed areas such as underground garages or tunnels. A Dutch team of researchers at Delft University has developed an alternative positioning system. Using cellular and increasingly prevalent fiber optics networks, it operates **up to 100 times more accurately than GPS** especially in urban areas. However, the developers don’t necessarily regard their “Super GPS” as a replacement for the existing GPS but as a high-performance complement or backup solution. Especially **in relation to the development of self-driving mobility solutions, the novel technology could unlock new opportunities.**

In 1999

British technology pioneer **Kevin Ashton coined the term "Internet of Things"** for interconnected machines. He also created Santiago Swallow, a Mexican social media guru who, before being outed as a fake, had 90,000 Twitter followers as a presumably true technical authority and a highly credible biography on Wikipedia. With that experiment, **Ashton impressively proved that the number of followers says nothing about the credibility of the person being followed.** As an expert in radio frequency transponders and sensors, Ashton is involved in the development of the "Internet of Things" the name of which he invented.

"There's no one with whom we're as honest as with Google's search field"

Constanze Kurz, German author and spokesperson of the Chaos Computer Club

Digital diplomacy

Artificial intelligence systems compose complex symphonies, write books and as speech recognition features have long become part of our daily lives. All that is common knowledge. Now the AI system Cicero from Facebook's parent company Meta **for the first time (and not just once) beat human opponents in the online version of the strategic board game Diplomacy.** Winning the game primarily calls for negotiation and collaboration skills, which so far have not been core competencies of AI systems. Cicero was more successful in that respect because its developers combined strategic thinking and speech processing in one application. Meta fed its AI with more than 2.7 billion parameters. The speech module was trained with more than 40,000 parameters from previous Diplomacy sessions. **Cicero not only achieved the major feat of negotiating skillfully but its opponents didn't even detect that it was an AI.** In most cases, Cicero even responded authentically to colloquial language. Meta plans to use the findings for the further development of chatbots that currently still appear awkward.

Cloud atlas

Cloud computing is a multi-billion-dollar industry that keeps growing year after year. Facts and figures about the virtual world.

› 168 billion U.S. dollars – that's how much the worldwide market for cloud applications is expected to be worth by 2025.
Source: Apps run the world

3 % of the global energy consumption is caused by cloud data centers.
Source: BMC

60 % of worldwide business data is stored in clouds.
Source: 2022 Thales Data Threat Report

200 zettabytes of data (200 trillion gigabytes) will be stored in clouds by 2025.
Source: Cybercrime Magazine

Team players wanted

For a long time, PC gamers were deemed to be nerdy loners. Now, science provides new findings about them. Their experiences in virtual worlds often make it easier for them to access the systems of modern worlds of work. That makes gamers attractive also to employers.

By Dr. Lorenz Steinke

Deafening noise from the stage shows of game producers and huge video screens showing scenes, plus long lines of visitors in front of the latest consoles for video and computer games: when Gamescom, the world's leading games show, opens its gates at the Cologne Trade Fair halls a festival for the senses awaits the growing gamer community from all over the world. In the future, the show might also be of interest to recruiters.

Top 3 of the best-selling computer and video games:

- Minecraft (238 million copies sold)
- Grand Theft Auto V (around 170 million)
- Tetris (EA version) (around 100 million)

In 2021, the games market generated worldwide sales of 180 billion U.S. dollars , long having outperformed other sectors of the entertainment industry such as sports, music and movie theaters. According to a survey by the consulting firm PWC, the gaming sector might achieve sales of around 320 billion U.S. dollars by as early as 2026. The coronavirus pandemic proved to be a booster for business because a lot of other entertainment options were not available.

While entertainment formats such as movies, comics or all forms of popular music have long been accepted as part of the cultural universe, computer games still have a perception problem. The industry benefited from the pandemic in that respect as well – at least that's what Bartosz Skwarczek, co-founder and CEO of online gaming marketplace G2A.com, has observed: "Gaming has so often been painted with the wrong brush – stereotyped as being isolating and unsociable. However, the pandemic has shown that this could not be further from the truth." Because gamers not only worked their joysticks to a red-hot glow but also avidly chatted.

For a long time, job applicants were advised to highlight hobbies like sports or practicing a

110 million

subscribers make the Swede Felix Kjellberg, better known as **PewDiePie** on YouTube, the most successful influencer in the gaming world.

2.5 billion

dollars were paid by Microsoft in 2014 for the **gaming studio Mojang** ("Minecraft") that made Swedish founder Markus "Notch" Persson the richest game programmer in history.

40 million

dollars of prize money was in the pot in 2021 at the world's so **far highest-endowed gaming duel,** the Dota 2 duel "The International."

7 million

dollars of prize money Johan Sundstein from Denmark has won that amount in Dota 2 tournaments. No other e-gamer has earned more than 28-year-old Sundstein.

musical instrument rather than gaming on their resumes. That might soon change as the most recent research results have shown. For a study conducted by Georgia State University, gamers and non-gamers were tested in a magnetic resonance imaging system (MRI). Because the gamers were clearly better at activating certain areas of the brain, they showed significantly better response times.

Neuroscientists at Universitat Oberta de Catalunya (UOC) in Barcelona obtained similar outcomes. Video games, the researchers found, can not only train cognitive skills. Once acquired, people will retain such skills beyond their active gaming careers.

As far back as in 2014, researchers at the Max-Planck-Institute for Human Development encouraged non-gamers to play daily and measured their brains using MRI during the study. They concluded that individuals regularly playing virtual games build up gray matter in the so-called hippocampus, which translates into better spatial orientation, a more powerful working memory and enhanced fine motor skills.

Gaming worlds as a team task

In today's specialized world of work, project management skills, organizational and communication skills are increasingly in demand. Applicants with gaming experience often have a home advantage in that respect because many online gaming worlds require comparable abilities.

In the increasingly popular fantasy role plays, for instance, gamers regularly agree to meet for group adventures. Teams of up to 100 gamers are pitted against superior virtual opponents or other teams in coordinated ways. The team can only be successful in the end if all the team members perform their tasks precisely over long periods of time and help their fellow gamers in the event of problems.

As a result, even young gamers learn to keep highly heterogeneous teams together across linguistic and cultural barriers, to mediate in the event of conflicts and to find fast solutions for technical issues. For instance, when an important part of the globally connected team is incapacitated in

> **“Individuals achieving good gaming results usually already have good management skills as well”**
>
> **Professor Markus Weinmann, economist at Cologne University**

the middle of a pixel competition due to a local internet problem.

At the same time, the gaming groups are in fierce competition with each other. If a team scores no successes the team members may threaten to switch to other teams. That calls for negotiation skills to keep them on board. Consequently, there are many parallels to the world of work.

Developing management skills in playful ways?

That’s why HR professionals and digitalization experts like Franziska Gerner value the practical soft skills of young team players. As Head of Digital Competencies at Schaeffler AG she knows that “Digitalization and gaming are a good fit because both are based on modern technologies, often require team spirit, a focus on problem solving and communication – and sometimes out-of-the-box thinking too. Those are precisely the kinds of skills we seek.”

Professor Markus Weinmann, an economist at Cologne University, has similar views: “In a study we showed that gamers who do well in strategy games such as ‘Sid Meier’s Civilization’ have higher organizational and planning skills in assessment centers. Consequently, HR professionals might be able to draw conclusions about specific management skills of candidates from their gaming experience.”

Even so, Weinmann doesn’t see computer games as training tools. Frequent gaming alone doesn’t unleash good leadership skills. Conversely, though, he says that there’s a conspicuous correlation: individuals achieving good gaming results usually already have good management skills as well.

Maybe headhunters will soon start looking for promising young professionals with outstanding team skills on the front runners’ lists of particularly challenging online games.

The author

As a technology journalist, **Dr. Lorenz Steinke** has written a lot about gaming and the gaming culture. At press events and gaming shows in Berlin, London and Los Angeles he has repeatedly met with masterminds, game designers and developers from the gaming industry. As a result, he feels that gaming is far more than a pastime. The first-ever game he personally played was Pong.

Here’s hoping for successful teamwork

Leibniz Prize winner Professor Wolfram Burgard is one of the leading researchers in the field of artificial intelligence (AI) and robotics. Since 2022, he has been Founding Chair of the Department of Engineering at TU Nuremberg. In an interview, he looks at robots and AI as potential teammates in tomorrow’s working world system.


MENU
メニュー
三種盛丼 ¥900
まぐろ丼 ¥700
うに丼 ¥2000
ねぎとろ丼 ¥700
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サーモン親子 ¥800
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サーモンいくら ¥1000
サーモン甘えびつり ¥1000
お祭り丼 ¥1300
No.1

Interview: Dr. Lorenz Steinke

You've been engaged in AI research for many years. Are we going to see mixed teams of real people and artificial intelligence systems at work in the near future and feel that that's completely normal?
A world of work with such mixed teams would truly mark a major step forward for robotics and manufacturing in line with the hope that the utilization of workplace robots will enable us to enhance the effectiveness of many processes.

From the steam engine to inspection robots in a nuclear powerplant: Again and again, we've invented machines that perform dangerous or monotonous jobs for us. Going forward, what kinds of jobs will AI and robots be handling for us?
That's hard to predict. Currently, the deployment of robots in large logistics or distribution centers is being pursued intensively. The people working there must handle many parcels and sometimes cover longer distances on foot. That's where robots can take a load off the workers and enhance efficiency. Other trials are focused on robots performing complex assembly processes in collaboration with humans. However, we still have a long way to go in that area.

Can you understand that some people are afraid of a world with intelligent machines? Or is our idea of robots excessively influenced by movies and dystopic fiction?
I think that people generally have fears and concerns when it comes to the impact of innovations. That's understandable because it's never completely clear how changes resulting from an innovation will affect a person's life. Robotics and AI have great potential for innovations. However,

The expert

Wolfram Burgard is a German computer and robotics scientist.

From 1996 to 1999, he led the research laboratory for autonomous mobile systems at the University of Bonn that in 1997 deployed the first interactive mobile museum guide "Rhino" at Deutsches Museum in Munich. Burgard, from 1999 to 2022, was a professor at Albert-Ludwigs University Freiburg, where he chaired the Working Group for Autonomous Intelligent Systems at the Institute for Computer Science. During that period, his developments included systems for autonomous driving such as, in 2008, for navigation in the complex environment of a parking garage. In March 2009, Burgard was awarded the Leibnitz Prize by the German Research Foundation. In 2012, he was a founding member of the Open Source Robotics Foundation (OSRF) that is dedicated to virtual test environments and the propagation of the Robot Operating System (ROS). In 2014, he was elected to the German National Academy of Sciences Leopoldina. Since February 2022, Burgard has been Founding Chair of the Department of Engineering at Technical University Nuremberg.

movies and science fiction novels have a considerable impact and, unfortunately, not necessarily a positive one. In that genre, robots rarely play the role of the 'good guys.' Especially in Europe, that probably contributes to a somewhat negative image of robots.

Robots never get sick and are never in a bad mood. What characteristics must robots have for people to enjoy working together with them?
First, they must be reliable and perceived to be truly assistive. That's a major challenge because robots are machines and therefore prone to wear. Their dialog or interaction with humans is particularly challenging. In fact, a lot more needs to be done to make robots easy to instruct and understandable. That's a key prerequisite for acceptance of intelligent robots.

Will the feelings of their human co-workers need to be considered in the design of future workplace robots?
Robots should be responsive to humans, which, ideally, means that they should also respond to the feelings – and individual skills – of their users. In the context of human-machine interaction, the Turing test is a keyword. It's based on the assumption that a system is truly intelligent when, in a dialog with it, it's no longer possible to tell whether it's a human or a machine. However, we're still very far from having reached that level. The capabilities of smart voice assistants that are increasingly being used are a case in point.

What does an ideal robotic co-worker look like from a human perspective? What must a hotel or hospital robot look like for us to accept it?
That's a very good question that I can hardly answer. We don't know what the optimal bike or car looks like either. However, from a user's point of view, robots should be versatile, flexible, effective and easy to instruct. For starters, their design must be functional and costs obviously play a role as well.

Are we going to sit in the virtual metaverse having a cup of coffee with our robotic co-workers someday?
I don't really think so. Machines are primarily focused on work-related activities. When it comes to communication, I feel that, in most cases, we're going to prefer another human being to a machine.

3.5

million industrial robots worldwide were working at plants and factories in 2021. 517,000 more than the year before, marking the highest increase in history.

37

percent. That's how much worldwide sales of professional service robots increased in 2021. 121,000 units were sold. More than one in three robots produced was intended for hauling goods or cargo.

19

million robots for household chores (vacuum cleaning, floor mopping, gardening) were sold worldwide in 2021, a twelve-percent increase. IFR experts assume that this market will be seeing average annual growth in the lower double-digit range in the next few years.

Source: IFR, International Federation of Robotics

“I think that people generally have fears and concerns when it comes to the impact of innovations. That’s understandable because it’s never completely clear how changes resulting from an innovation will affect a person’s life”

Professor Wolfram Burgard,
Computer and robotics scientist

Is there such a thing as a psyche or conscious mind of an artificial intelligence? Are machines going to enjoy working because they feel motivated?
There are scientists teaching robots and dialog systems emotional skills, which might in fact make them resemble us more closely. The question about consciousness is obviously very exciting too. However, I doubt that we really need that with robots. Even if robots are going to be careful not to damage themselves, I don’t feel that that requires a conscious mind.

Do robots need social workers or teachers to train and teach them social behavior?
In my view, they won’t need any social workers but will need people to teach them things. The question of how people can easily and intuitively train robots to carry out an activity is a current research topic. This is another area with some intriguing problems. For instance, a robot should be able to judge whether or not it’s allowed to do certain things. Learning rules and social norms is a major challenge.

Some researchers anticipate a future devoid of any human work. Is AI going to put humans out of work in the long run or are there any jobs that a robot will never be able to do?
Well, you should never say never. I think that it’s highly unlikely that people will be completely out of work in the future. Take progress, for example. It decisively depends on human intuition and creativity. To emulate that with a robot is a challenge for which I personally don’t see any solutions even in the very distant future. In addition, there’ll always be things we won’t want AI systems to handle, such as administration of justice.

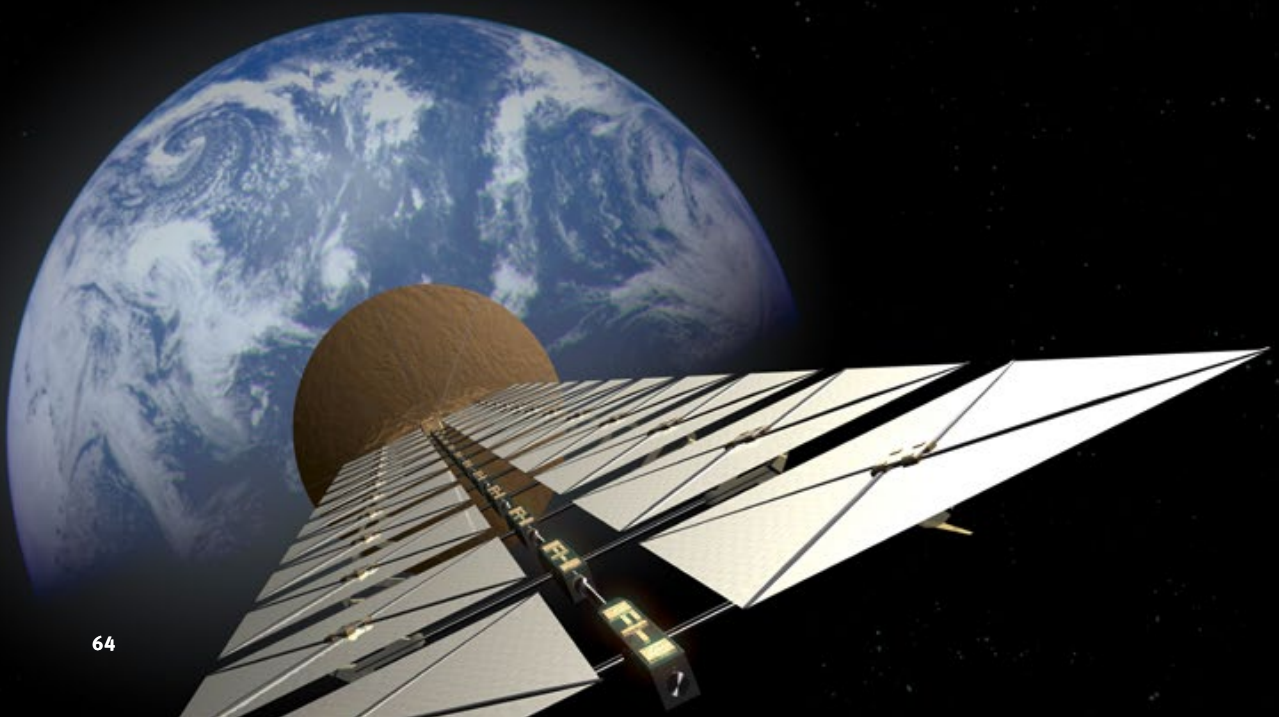
Schaeffler offers far more than just a wide range of rolling bearings for robotics. Additional information can be found here

Future Life

What does the world look like that we're going to live in tomorrow? What systems will change? Which ones will arrive and which ones disappear? Technical progress plays a crucial role in answering these questions.

Space-based power – a viable option?

Why not install huge solar collector systems where the Sun shines 24 hours and with high intensity? That is in outer space. Researchers at the European Space Agency (ESA) had the feasibility of their mammoth project "Solaris" investigated in recent studies revealing that **the technology has potential – and hurdles.** ESA's idea is to have microwaves in an imaginary column with a diameter of about two to three kilometers (1.2 to 1.9 miles) hit an antenna with similar dimensions on Earth's surface and to feed the resulting electric power into the grid from there. **The value generated by such a system would be equally huge as the system itself.** An analysis by Frazer-Nash, one of the consultancies commissioned to study the project, revealed that by means of space-based solar power stations 800 terawatt-hours of clean energy per year could be harvested starting in 2050. That would amount to around one third of the European Union's power production in 2020. However, the project parties would still have to overcome a few hurdles for that to be achieved. In addition to the **humongous costs, the spatial requirements on Earth and in the orbit pose a problem.** Solar panels the size of 200 soccer fields would be orbiting the planet, exposing them to the risk of being hit by some of the currently 32,000 space debris objects. As enticing as such a space-based solar system may be, its realization entails massive complexity.



Shark tech for the climate

In measuring the world, animals might be performing an important task in modern research work going forward, as demonstrated by an international team that has availed itself of the tiger shark's preference for seagrass habitats. The researchers tagged 15 individuals of that species with cameras and transmitters to map one of the world's largest seagrass ecosystems around the Bahamas. Why? **Because seagrass stores massive amounts of atmospheric carbon and knowledge about the size of seagrass meadows can be helpful for climate protection purposes.** Using the sharks has led to a ten-fold increase of existing surveys for seagrass meadow mapping. In an earlier study, manatees and green sea turtles employed in mapping seagrass meadows provided their animalistic assistance.

Golden Rice fights Hidden Hunger

Sometimes researchers need plenty of patience. Following more than 30 years of development work that in part was held back by reservations about genetic engineering, farmers in the Philippines were able to **harvest the first modified "Golden Rice" on a larger scale.** The story of the genetically modified (GM) food began at Zurich University of Technology as part of a research project dedicated to fighting malnutrition – aka "Hidden Hunger" – of children. The yellowish grains of the rice – which GM food opponents continue to reject – contain higher levels of beta-carotene aka provitamin A. Especially in developing countries with growing populations, many people suffer from vitamin A deficiencies. "Golden Rice" is intended to help strengthen the immune system.

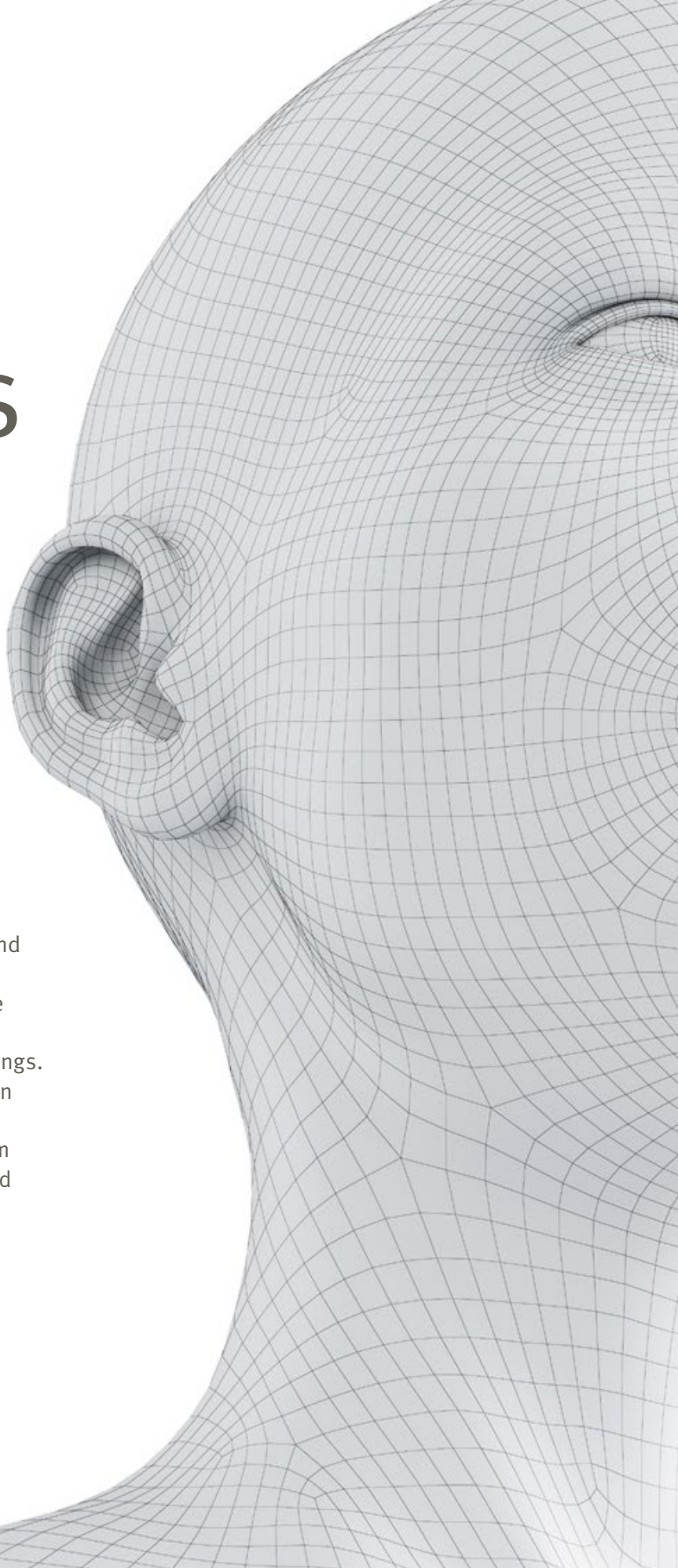
"The times are very bad. Very well, you are there to make them better"

Thomas Carlyle (1795–1881), Scottish essayist and historian

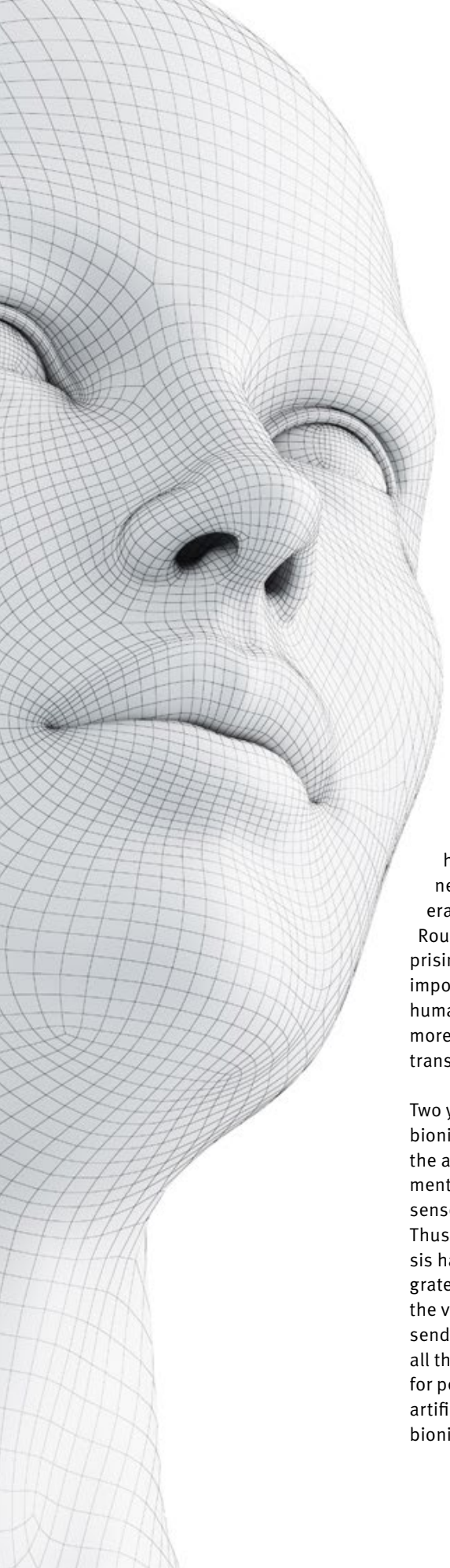
3,300

trees are intended to find a new home at the "International Forest Stadium," a planned eco soccer arena in Milan. **The concept proposes a system of ample vegetation planted on façades and spectator seating areas** including a "running track through greenery" on the stadium's top level. The arena that's supposed to bind about 160 metric tons (176 short tons) of CO_2 per year would be available to citizens not only during games. It's planned to include museum halls, gyms, bars and restaurants and, by the way, intended to not only make human visitors feel at home but also more than 70 animal species.

That makes sense



Sight, hearing, touch, smell and taste – these five senses not only have biological relevance for us human beings but also connect us with our surroundings. Consequently, disorders within the sensory system have a serious impact. High tech from the kits of the laboratory world can provide relief.



I can see what you can see

Enabling blind people to see again is a noble goal that science and medicine have been pursuing for centuries. Currently, 43 million people worldwide are blind and 295 million suffer from severe visual impairments. The magnitude of the wish to help them is matched by the magnitude of the related challenges. Initial approaches to emulating the miracle of sight by means of technology already exist. Artificial retinas have been implanted in patients with retinal damage for several years. A chip does the job of the defective photoreceptors and converts light signals into electrical impulses which are then transmitted to the brain via the patient's natural optical nerve. Initial progress has been achieved in this area both in terms of image sharpness and use of the human eye's optical system instead of camera glasses. However, the patients' visual perception is still poor. Rough outlines are recognized in shades of gray, which is not surprising since the sense of sight is not only regarded as the most important one for humans but also the most complex one. The human eye can distinguish between 600,000 colors and absorbs more than ten million items of information per second that are transmitted to the brain where they're filtered and processed.

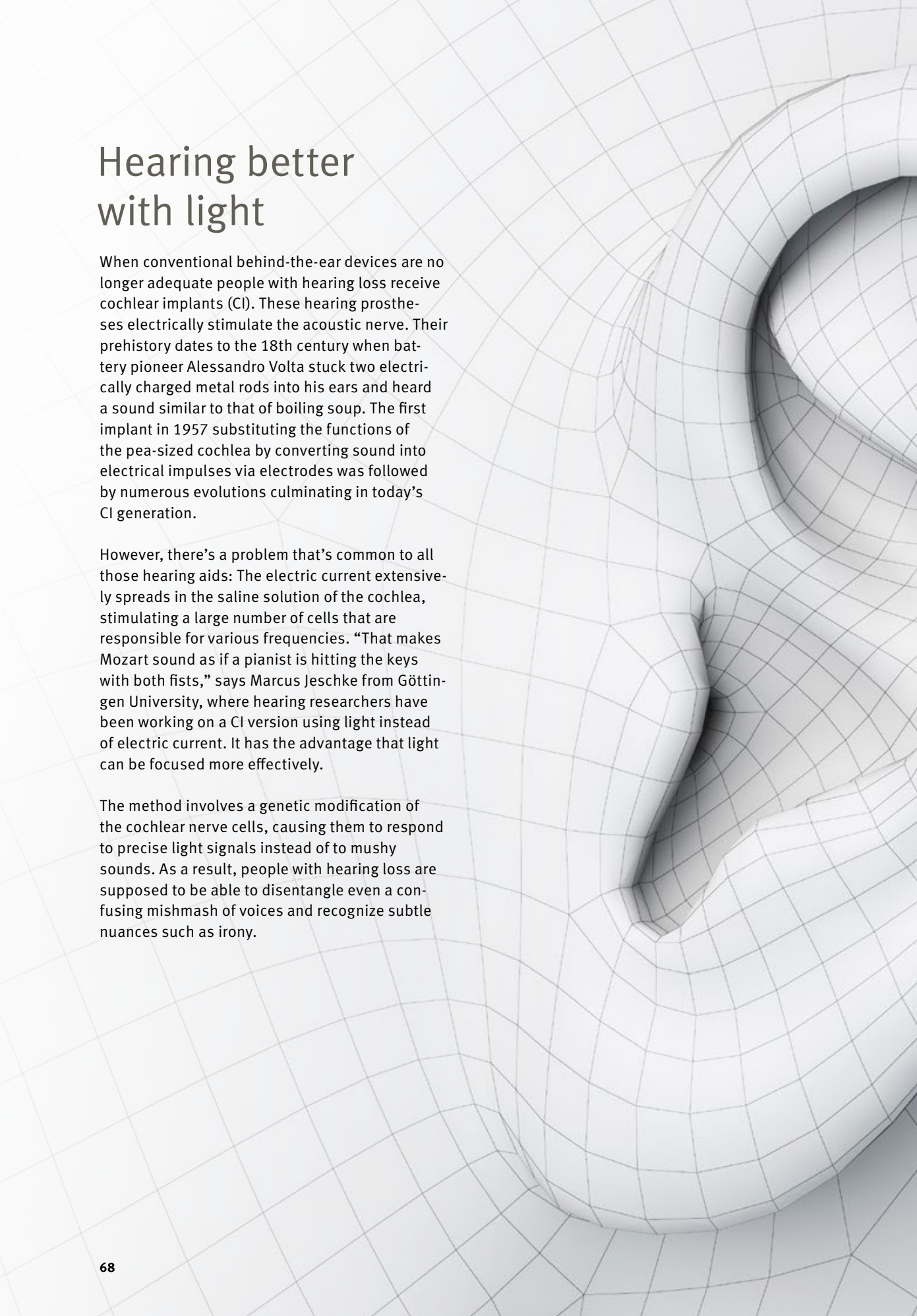
Two years ago, an international research team presented a complete bionic eye with greater visual acuity than its human counterpart and the ability to see color spectrums such as infrared light. Its core element is a spherical artificial retina whose ultra-delicate nano-wire sensors are more sensitive to light than human photoreceptors. Thus, the technical foundation for a high-resolution ocular prosthesis has been laid. Yet a lot more work remains to be done to integrate it into the human visual system, particularly to connect it with the visual cortex. Apropos connectivity: The artificial eye could also send real-time signals to friends or post things on the internet. For all these visions to become true, a feasible solution must be found for permanently satisfying the high energy requirement of such an artificial visual system. Due to those hurdles, it's possible that the bionic super eyes will initially be used in machines.

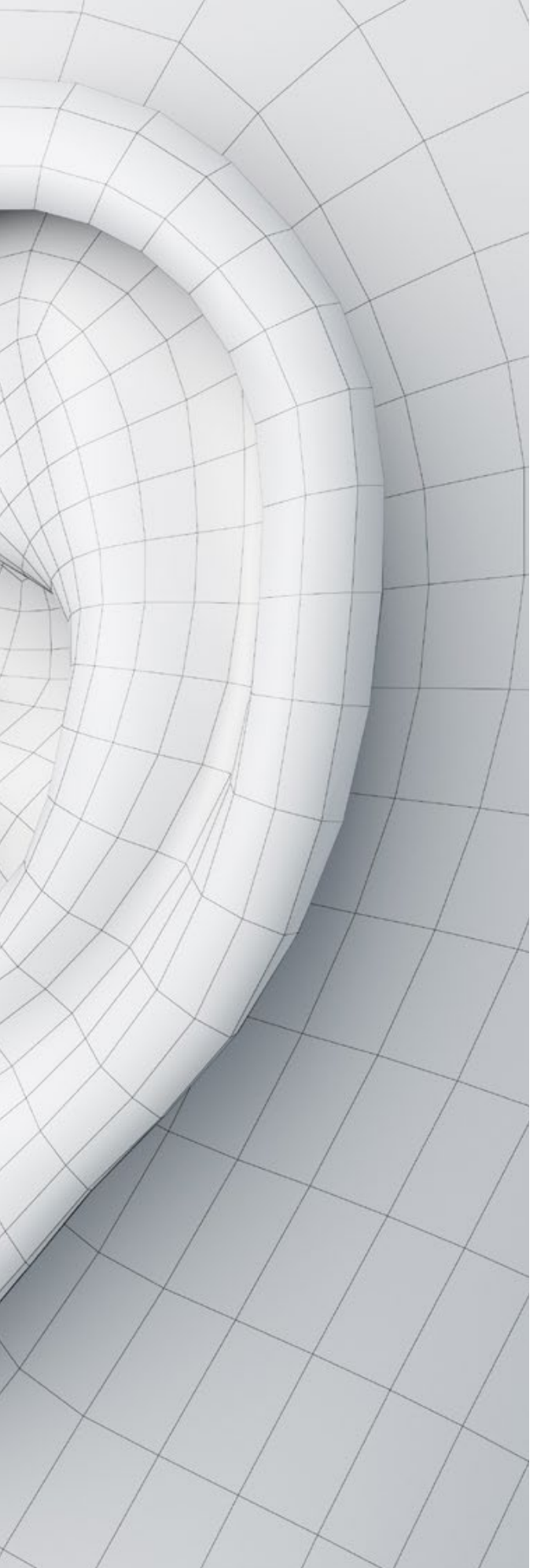
Hearing better with light

When conventional behind-the-ear devices are no longer adequate people with hearing loss receive cochlear implants (CI). These hearing prostheses electrically stimulate the acoustic nerve. Their prehistory dates to the 18th century when battery pioneer Alessandro Volta stuck two electrically charged metal rods into his ears and heard a sound similar to that of boiling soup. The first implant in 1957 substituting the functions of the pea-sized cochlea by converting sound into electrical impulses via electrodes was followed by numerous evolutions culminating in today's CI generation.

However, there's a problem that's common to all those hearing aids: The electric current extensively spreads in the saline solution of the cochlea, stimulating a large number of cells that are responsible for various frequencies. "That makes Mozart sound as if a pianist is hitting the keys with both fists," says Marcus Jeschke from Göttingen University, where hearing researchers have been working on a CI version using light instead of electric current. It has the advantage that light can be focused more effectively.

The method involves a genetic modification of the cochlear nerve cells, causing them to respond to precise light signals instead of to mushy sounds. As a result, people with hearing loss are supposed to be able to disentangle even a confusing mishmash of voices and recognize subtle nuances such as irony.





Feel the squeeze

People in Ancient Egypt already used effective walking aids 3,000 years ago. Today, thanks to sensors and tiny electric motors, high-tech prosthetic devices enable complex movements. However, there's one thing people still don't have after amputations: a sense of touch. Researchers are now raising hopes of enabling tactile sensation especially for artificial hands. Scientists at Stanford University in California have developed a sensitive rubber skin with electrically conductive mini-tubes as sensors. The stronger the squeeze (of the hand) the more tubes contact each other and the more current is transmitted to the nervous system by the artificial sense of touch.

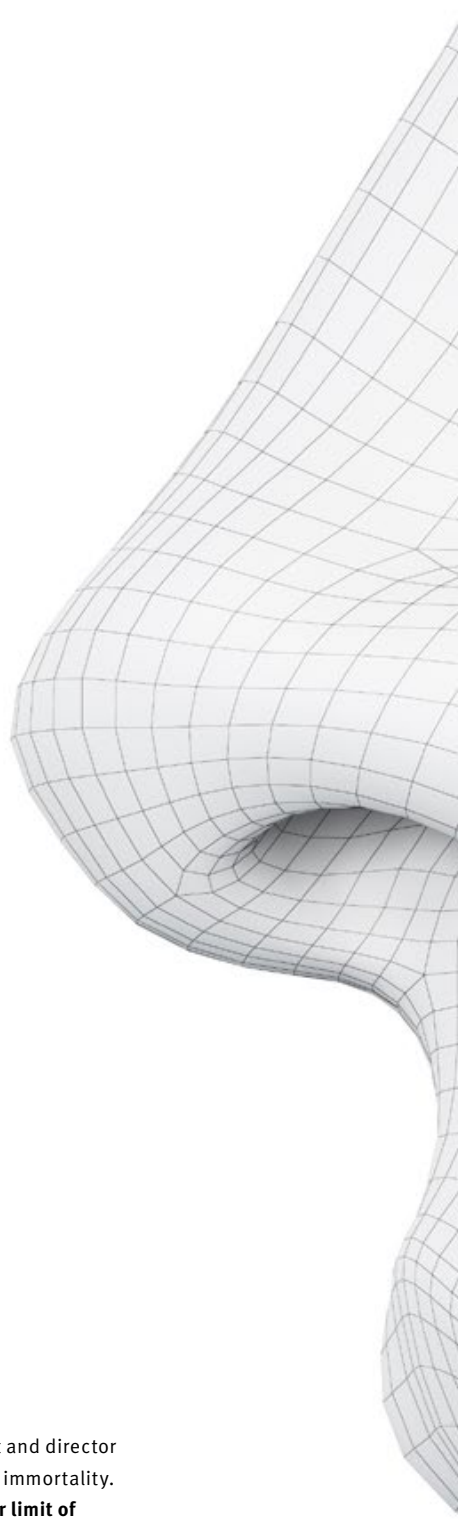
A UK research team at the University of Bristol has developed artificial fingertips produced by 3D printing. The printed papillae mimicking the dermal papillae underneath the outer layer of human tactile skin can "feel" shapes and transmit this information via artificial neural signals.

Such an artificial yet sensitive tactile sensation could help people with nerve damage as well as open up new opportunities in robotics, another area to which research is dedicated around the globe. For instance, researchers at the Max-Planck Institute for Intelligent Systems in Stuttgart have developed a thumb-like sensor that processes light patterns created by pressure-dependent surface deformation and transmits them to neural networks. Although quite a bit of research work is yet to be done robots may soon have something that used to be a human privilege: a delicate sense of touch.

A really good nose

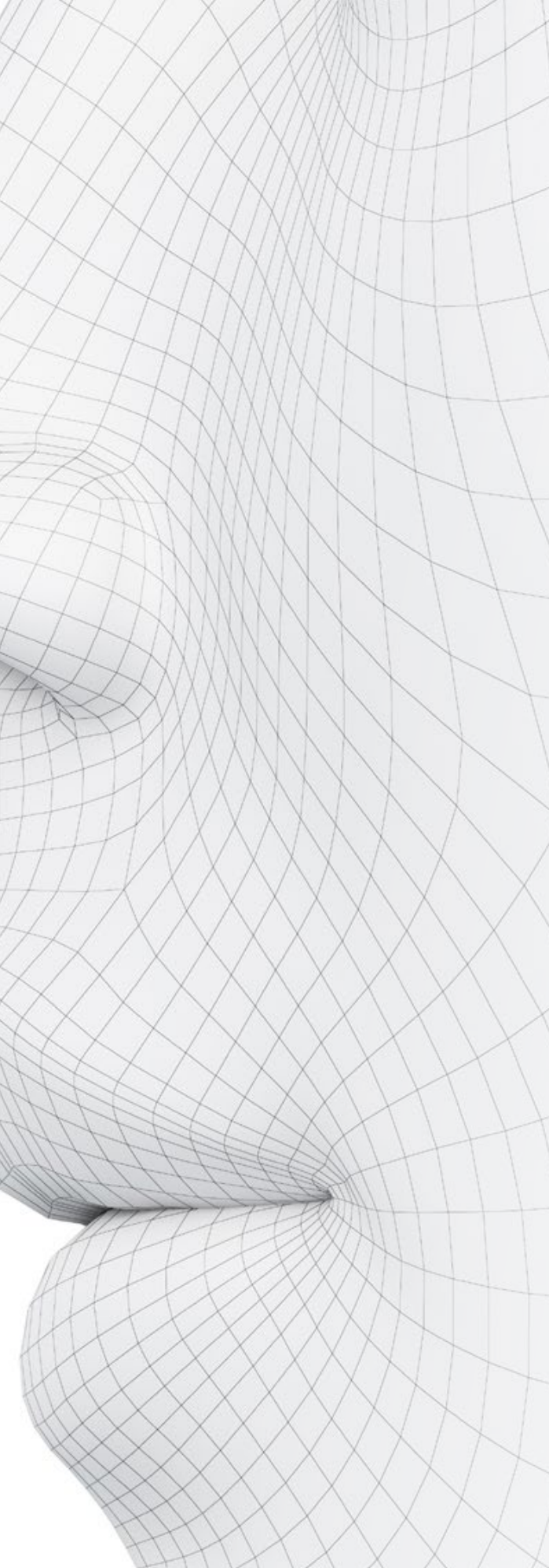
Artificial noses can already sniff out explosives, for instance during security checks, or identify chemicals in laboratories. Researchers are even working on “super noses” that can smell diseases such as dementia, cancer or covid. But can an artificial sense of smell also help people suffering from anosmia, i.e., a partial or total loss of the ability to smell? Eric Holbrook at Harvard Medical School in Boston wants to eliminate such impairments. He’s already succeeded in manipulating olfactory nerves with electrical impulses so that a study participant’s brain structure known as the olfactory bulb, which is responsible for the sense of smell, detected an onion-like odor that didn’t really exist.

However, a few more issues must be resolved before an artificial sense of smell will be able to substitute the natural human sense: for instance, the precise positioning of the electrodes on the olfactory bulb and sensitive sensors that can absorb, analyze and convert into electrical impulses a wide range of odors. By comparison, restoring an impaired sense of taste is a lot more difficult because, from a scientific perspective, it involves a complex interaction of taste, odor, tactile and temperature perception in the oral cavity.



In 2045

death will be optional – says Raymond Kurzweil. In making that statement, the futurist and director of engineering at Google announces the fulfillment of a human dream shared by many: immortality. By contrast, an extensive study conducted in 2021 considers **150 years to be the upper limit of human life span**, although some of the scientists involved in the research say that, with a little help, a few more years might be possible. In an interview, mathematician David Wood, who co-authored the book **“The Death of Death”** together with engineer José Cordeiro, said, “What is within our reach is overcoming the major cause of death, which is biological aging.” The key to that is supposed to be provided by the tiny jellyfish Turritopsis dohrnii. It can rejuvenate itself and therefore be potentially immortal. Cordeiro wants to decode the jellyfish’s formula for eternity and, based on that knowledge, start decelerating the human aging process at an early age so that life can be extended at least in the direction of infinity. Whether that will be possible by 2045, as predicted by Kurzweil, the two scientists aren’t ready to confirm. Wood’s recommendation is **to live long enough in order to live forever.** However, whether people will really want to do that is an altogether different question.



Giving a voice to those who have lost it

Although people who have lost their ability to speak can already be assisted in various ways today, such artificial verbal communication does sound somewhat clumsy. The best-known example is the world-famous physicist Stephen Hawking, who died in 2018 and during the last 20 years of his life "talked" by using a computer interface, which sounded rather robot-like. Also, entering words on a PC keyboard makes speech dialog difficult.

Scientists of various disciplines are working on convenient ways to provide those who've lost it with an authentic voice again, for instance at Tsinghua University in China. The research team there has recently developed flexible, stretchable sensors with carbon nanofiber membranes placed on the face where they capture movements that typically occur during the formation of phonetic sounds. The signals are transmitted to a microcomputer and an AI unit converts them into audio signals for the loudspeaker. The sensors also capture the person's entire facial expression, temperature fluctuations and pulse, and can even integrate emotions in the voice output. Initial tests showed promising outcomes but there's still a long way to go before the technology is fit for field use.

Researchers at the University of California are still in the early stages of their development project as well. They're working on tapping electrical impulses that the brain transmits to the articulatory system for speech output into an artificial voice. The brain formulates, the technology articulates. Using this method, initial study participants managed to audibly produce simple test sentences such as "Tina Turner is a pop singer." Joseph Makin from the University of California says, "We are not there yet but we think this could be the basis of a speech prosthesis."

Hello, holo!

Beaming like in the science-fiction saga “Star Trek” will more than likely remain pie in the sky. Or maybe not? Canadian researchers recently managed to teleport the hologram of a person in real time. Together with “tomorrow,” Professor Metin Tolan, an eminent physicist and avowed Trekkie, ventures a look at the systems of the future: what types of virtual encounters are conceivable and what will remain utopian ideas?

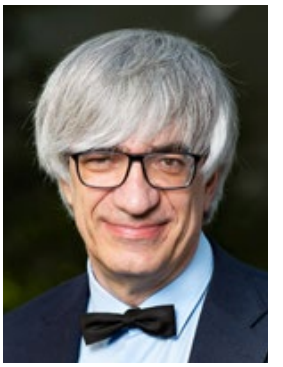
Interview: Björn Carstens

At the Institute for Earth and Space Exploration at Western University in Canada, students, by their own account, have achieved the first international teleportation – the hologram of a person was instantaneously teleported across borders. Do such headlines wow you?
Wow may be an exaggeration because NASA had teleported an astronaut to outer space three-dimensionally several months earlier. Obviously, it would be fantastic if in the future we were able to interact with others in 3D, as if they were standing in front of us, and practically being able to walk around them instead of just talking to them on a flat screen like in a Zoom conference. Truth be told, though, the vocabulary calls for clarification. What was achieved in Canada has nothing to do with teleportation because there was no person physically taken from one place to another but a 3D image. That's no doubt an amazing feat too, but, from a technological perspective, teleporting would be dramatically different.

Star Trek fans would call it beaming.
Right. By contrast, physicists tend to use the term quantum teleportation, which, essentially, is about creating entangled photons. These light particles are coupled in a way that when the state of one changes it will automatically cause the state of the other, spatially separate, partner to change. Irrespective of the distance. This technology is an enabler of superfast quantum computers and bug-proof communications. Today, that's probably more important than ever.

But doesn't beaming entail a lot more than that? Matter would have to dematerialize.
Yes, it does. From a purely physical perspective, that's conceivable. According to Einstein's theory of relativity, every form of mass has a corresponding energy. Consequently, according to his famous formula E = mc2, the mass of a human being would have to be multiplied by the speed of light – squared. That's where the problems start, if not earlier. Mathematically, this dissolution process would release enough energy to supply an industrial nation like Germany for one year. That humongous amount would then have to be controlled somehow. Technically, that's hard to imagine from today's perspective, aside from the fact that, before assembling them, the locations of all the human atoms would have to be determined precisely. All in all, these are huge hurdles. But Neanderthals couldn't imagine a Concorde either. I predict that beaming will not be feasible in the next 100 years.

Let's beam ourselves back into reality. In the so-called two-way teleportation that was achieved in Canada, a special camera was used for filming from different perspectives. The user at the other end of the "line" has to wear a mixed-reality headset creating the three-dimensional impression. Why is that HoloLens headset still necessary?
Because otherwise the person's information could not be transmitted. You see, you need a special laser light to generate a holographic image. That requires so much information to be sent that its transmission in real time without a headset would not be possible today. The headset could perhaps be designed in even smarter ways, or be integrated into normal glasses.



The expert

Metin Tolan, born in northern Germany in 1965 as the son of a German mother and a Turkish father, was Professor of Experimental Physics at Technical University Dortmund for 20 years, and, since 2021, has been President of Göttingen University. In addition to his research work, he appears on stage as a business comedian delivering keynote speeches on topics like "The Physics in Star Trek," in which he investigates inventions and film effects, including teleportation, in terms of their physical feasibility.

In 1993

Viennese quantum physicist Anton Zeilinger successfully **teleported a photon.** In 2004, he achieved the transmission of the quantum state of an atom about 600 meters (656 yards) across the Danube and, in 2007, a quantum teleportation from La Palma to Tenerife, roughly 140 kilometers (87 miles). In 2022, he was awarded the Nobel Prize for his experiments in quantum teleportation.

400

deceased celebrities could be projected onto a stage as holograms by Worldwide XR. The American company acquired the corresponding rights. In Japan, singer Hatsune Miku, a human-made holographic avatar – has already been filling concert halls.

1948

was the year in which **the concept of holography** was invented by Hungarian physicist Dennis Gabor, who was awarded the Nobel Prize in Physics for his paper titled "The Distorted Front of Electromagnetic Waves." However, three-dimensional photographs were not possible yet. The first holographic image – of a model train – was only achieved in 1962, in conjunction with the invention of laser light.

10^{-15}

seconds or just a few quadrillionths of a second is the time it takes for a laser developed by Japanese researchers to generate a freely suspended hologram. The laser fires impulses causing air molecules to ionize. In the process, they release energy in the form of light dots and condense into a mixture of positive and negative particles – also known as plasma.

What would it take to eliminate the need for headsets?

A further acceleration of data transmission speed and a technology enabling holograms to be projected in a room, just like that. It would take a technology that makes laser light visible in a room. In the case of a hologram, that would be something three-dimensional.

Even with these headsets a hologram "sent" in real time that you can think of as a digital twin is a technological step ahead, isn't it?

Absolutely. I don't mean to play this experiment down. Imagine a doctor having a three-dimensional image of you. In that case, he or she could examine you at least externally, anywhere, and much better than in 2D on a screen. The doctor could see discolorations on your skin or if you perspire in unusual places. That's a huge step forward, for instance enabling medical care in remote areas. That can mean massive cost savings for the healthcare system.

Then it would obviously be optimal if haptics became an additional element.

Clearly, the hurdles with holograms are high in that case. But not too high. Let's assume the doctor applies pressure against your kneecap. You'd have to wear a suit triggering a corresponding impulse. Unfortunately, you can't apply pressure just with the help of light. Concerning those headsets, it might be possible to integrate biosensors in them that additionally monitor a patient's heart rate and oxygen saturation in the blood.

So, such holograms are more than a social "nice to have?"

Yes, of course. But even if the headsets delivered no more than social value I'd say, wow! It would be great if everyone had such a headset at home as a normal item like a computer or smartphone. Imagine your uncle from the U.S. virtually standing in front of you on your birthday. Or an astronaut in space visiting their family at night. Or a concert by your favorite star transmitted live to your living room as a hologram. There are infinite conceivable scenarios. Also, how great would it be if a personal trainer could join their client in 3D for a realistic workout session? That would make sense especially in times of a pandemic.

Do you see other specific applications in business and industry?
Yes, I do. Obviously, once this technology is able to transmit an entire room, a wide variety of assistance can be provided. Like, you need to tighten that screw here, you need to connect that cable there. I can imagine a lot of applications along those lines. For example, the columns of a spreadsheet could project from a meeting room. Or a machine in a factory hall could actively alert me to a problem and I'd ask a technician to join me – no matter where he or she may be located at that time. People building a house can digitally walk through their new life-size home in advance. Or I could create virtual office floors and lecture halls. 50 years from now, that may be part of normal, everyday life for all of us.

Thank you very much for the interview.

"How great would it be if a personal trainer could join their client in 3D for a realistic workout session!"

Professor Metin Tolan

A hologram visits a doctor: What sounds like the beginning of a joke might soon become a reality. Several decentralized physicians could contribute their expertise

Sci-Fi Kids

How are demographic change and technological progress going to change the family system? Together with the specialists at Z_punkt foresight consultancy SOS Children's Village Hamburg ventured an outlook for the year 2070, outlining some eminently provocative future scenarios to encourage related discussions.

Fitness until old age, childbirth at 60, and it practically goes without saying that great-grandma is part of the family – will that be the new reality?

Future scenario: "120 plus"

In 2070, the average life expectancy of populations in affluent nations amounts to 120 years, and for 2100, it is predicted to be 135 years. Prosperity in such countries allows many people to benefit from geriatric therapies enabling them to enjoy a longer and healthier life. Policymakers promote such therapies through funding support to counteract the effects of a shrinking population on the economic system. People's lives change radically: Retirement age is raised to 87, and younger people are afforded more time for schooling and professional education to optimally prepare for a career based on a multi-perspective approach. Medical progress prolongs fertility, and more and more women focused on their professional careers have children increasingly later in life. Women typically have their first child at age 50 or 60.

What does that mean for children? Children spend more years of their lives with their families than they used to in the aughts. The average age of children moving out of their parents' home is 30. Due to longer periods of schooling and professional education, their development can be promoted in more personalized ways, and there is more time for foreign and other exchange programs.

What does that mean for families? The parent-child relationship changes. The longer life span and state of health enjoyed by parents, grandparents and great-grandparents enhances the potential of sustaining family traditions and reviving extended family histories.

Future scenario: “Classroom in motion”

In 2070, hydrogen-powered, autonomous pods are a popular means of transportation. Especially parents of young children like summoning them to safely haul their kids from A to B rather than having them travel on public means of transportation. Despite the opportunities available in virtual realities, experiences in the real world continue to be highly valued – children are frequently out and about, getting together at school or in their free time. Field trips with practical experiences are important elements of curricula.

Many services offer special pods focused on children: Examples include comfortable seating for kids and a large offering of child-oriented entertainment. In addition, the pods can feature personalized styling, for instance in terms of colors and digital decoration of interior walls, enabling children to feel at home and comfortable in them almost like in their own rooms. Smart-controlled lighting and musical design elements additionally make parents feel that their children are in good hands and well cared for.

What does that mean for children? Even young children enjoy ample freedom of movement and may travel on their own to visit friends. Due to the positive and familiar atmosphere in the pods, kids like roaming around and going to new places. Mood optimization makes for plenty of pleasant days and positive experiences but may prevent children from truly acting out and processing their emotions.

What does that mean for families? As a result of autonomous pods, parents relinquish a lot of control and promote their children’s independence early on while gaining time in daily life that they can spend more freely with their children at other times. In some parents, the mood optimization feature for children raises unrealistic expectations that may result in pressure to perform or in toxic positivity.

Will autonomous shuttles be the next-generation “parent-taxi?”

Future scenario: “Edu Bot”

In 2070, Edu Bots are wide-spread and socially accepted. The traditional idea of family began to dissolve as far back as in the 2050s when Edu Bots emerged, ushering in a further dissolution of classic parent-child relationships. Established as far back as at the end of the 19th century, socio-pedagogical principles focused on parenting, education and government intervention have continued to evolve into the year 2070. Now the role of raising and educating children no longer needs to be assumed solely by parents and educators. As additional educators that can support established pedagogical concepts according to the parents’ choice, Edu Bots assist in performing the parenting and educational mission. Child development is promoted individually as needed, enabling kids to get their bearings in an increasingly complex world. As a result, all children have equal opportunities for a self-determined life, irrespective of their personal starting bases. A heretofore unknown form of freedom exists for both parents and children.

What does that mean for children? On the one hand, children can enjoy a highly personalized form of development and new opportunities of a kind that a lived-in world without Edu Bots could not offer. On the other hand, children may be subjected to massive control and performance pressures because a large part of their daily life is being tracked for personalizing the developmental activities of the bots. In some children, this may lead to developmental disorders because extensive periods of time spent with an Edu-Bot can slow their pace of learning to understand human emotions and facial expressions.

What does that mean for families? Edu-Bots redefine parenting and educational patterns. Parents are no longer performing the key parenting and educational roles, which results in a clearly diminished level of interacting with their children. The resulting frictional losses also entail a loss of attachment, with the diminished dependency of kids on their parents leading to increasing alienation. Consequently, the “substitution” of parents by Edu-Bots weakens parent-child attachment.

Edu-Bots can turn into omniscient 24/7 parents 2.0

Going offline as a digital detox – already a trend today

Future scenario: “Offline Village”

Subjectively, the whole world in 2070 is constantly online, and the physical world is permeated by digital levels. Even the human body has become a cyber-physical system that has been optimized and interconnected by a variety of implants. When such corporeal interventions became normal in the 2050s, more and more long-standing anti-digital movements chose to establish their own colonies and social systems emphasizing interpersonal relationships and unity with nature. They deal with new technologies mainly to keep them out of their villages and as enablers for cutting off their connection potential by means of their filters.

Even so, such communities are not completely isolated – they are tolerated socially and politically, and supported in their efforts to provide their residents with high quality of life and to implement their own educational models, for example. In addition, the villages welcome all visitors seeking to try out a life according to their values or desiring to take a digital break.

What does that mean for children? Children in Offline Villages grow up in completely different ways than those in the rest of society. Without the wide-spread implants, they differ even physically. Due to the village visitors, they are keenly aware of such differences, which is difficult to cope with for some of them. Should they decide to leave their village as adults, they often have problems integrating themselves with the digital world.

What does that mean for families? Family relationships within and outside of Offline Villages may vary significantly as a result of being affected by the presence or absence of a variety of technologies and implants. In some families, the differences between life within and outside of the villages causes disputes between parents and children about which is the better life model.

Future scenario: “Reality Filter”

In 2070, highly developed mixed and digital realities exist in which almost anything is possible. People spend a lot of time there to experience and discover new things. That is exciting especially for children, and they love being there as much as in the real world.

However, there are many things they should not be seeing yet or that are difficult to understand – in digital worlds, for instance, it may be hard to know what is normal or realistic. Reality Filters protect children from hazardous or overwhelming experiences so that they can safely embark on discovery tours without being accompanied by an adult.

Many parents rely on this technology and it is largely accepted. A large part of society agrees on the specifications of what should be filtered or shown at what age. Designated expert councils review and update the recommended settings regularly, and parents can tighten or loosen the programming within an established framework to support their own parenting philosophy.

What does that mean for children? Children can explore the real as well as the mixed and digital worlds much more independently and pursue their personal interests. Because hazardous or troubling elements are filtered out kids can be carefree and live in an “ideal” world. On the down side, though, some children will have a harder time coping with such issues when being confronted with them at a more advanced age.

What does that mean for families? Reality Filters directly and unnoticeably implement many things that might otherwise be subject to dispute as rules or bans. As a result, parents are less intensively engaged in an actively perceived parenting role. At the same time, children have no means of circumventing the filter settings so that their idea of reality is specified by their parents’ filter configuration.

Just tuning out adversity in the world – censorship or youth protection?

Future world: “Resilience Kid”

The effects of climate change make human life on the planet nearly impossible in many places. Regional requirements for adapting to climate change enabling a trouble-free life vary. “Resilience Kid” is a costly way chosen primarily by parents with the requisite financial means seeking to provide and secure a carefree and livable future for their children. Genetic or technological modifications made before or right after birth make it possible for their children to live comfortably in harsh conditions. Due to continuous innovation and adaptation of such solutions to new climatic change challenges, children are often better adapted than their parents. The process is very expensive and performed primarily in the Global North. NGOs campaign for making such assistance available to all children.

Prenatal genetic engineering to boost defenses – will “superhumans” become a reality?

What does that mean for children? Children are modified in terms of character traits before or shortly after birth, thus experiencing an intervention with their innate abilities and personality. Inequality between kids increases massively and is linked to the affluence of their families. “Resilience Kids” have a longer life expectancy and higher certainty of enjoying better quality of life by birth but are born with a high level of responsibility for their families.

What does that mean for families? The responsibility of parents for their children grows massively. Even before their children are born, they must provide for the safety of their children. Family and child planning often depend on whether parents can afford the modification opportunities. In addition, many families depend on the modified abilities of their children to remain viable. Children increasingly secure their families’ livelihood which, in some cases, results in a reversal of the parent-child relationship.

The authors

The authors, **Annika Bach** (SOS Children’s Village Hamburg) and **Clarissa Schmitt** (Z_punkt), expressly emphasize that the scenarios are not desirable or realistic ideas of the future but purposefully provocative speculations that can be interpreted in various ways. Z_punkt extrapolated both longer-term megatrends and weak indicators as well as germinating seeds of innovation into fictitious artifacts from the future for children and families that SOS Children’s Village Hamburg classified based on socio-pedagogical expertise. The resulting future scenarios are intended to inspire a process of viewing current developments and potential forms of the future from new perspectives, and of challenging and discussing them.

Masthead

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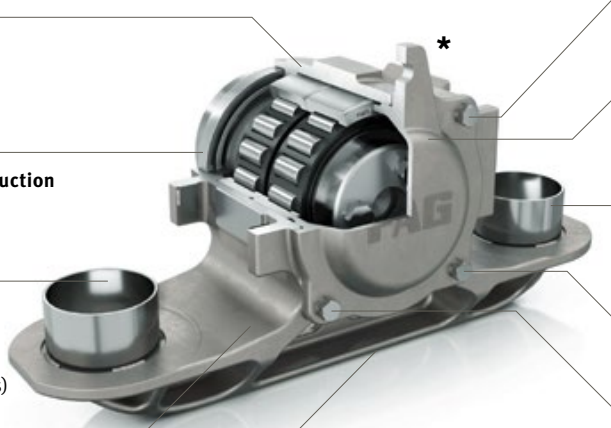

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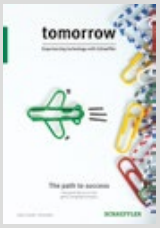

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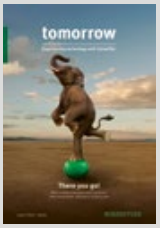

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