HTWK Leipzig University of Applied Sciences

Insights

Research Magazine 2025

Focus:

Artificial Intelligence

Artificial intelligence would be nothing without computing technology. Civil engineer and businessman Konrad Zuse (1910–1995) is credited with inventing the first ever programme-controlled computer. He developed freely programmable machines designed to solve complex combinatorial challenges, relieving engineers of monotonous number crunching tasks. The ZUSE 3, built in 1941, is widely regarded as the world's first fully functional, freely programmable digital computer. Zuse's pioneering work laid the foundations for modern computing. That's why HTWK Leipzig has named one of its landmark buildings after him. Originally constructed in the late 1980s for the Civil Engineering Department of the Technical University Leipzig, the Zuse Building now houses parts of the Faculty of Computer Science and Media, and the Faculty of Business Administration and Industrial Engineering, as well as the Centre for Mathematics and Natural Sciences.

Dear readers,

Prof. Dr.-Ing. Jean-Alexander Müller (l.) and Prof. Dr.-Ing. Faouzi Derbel

we are delighted to present the latest edition of our research magazine *Insights*! This issue focuses on one of the most exciting topics of our time: artificial intelligence (AI).

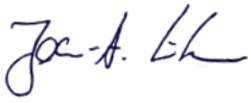
Step into the diverse research landscape at HTWK Leipzig and discover how our scientists are actively shaping the future. AI is no longer the stuff of science fiction. It is transforming almost every aspect of our lives. AI is not just a field of research in its own right – it is revolutionising how we actually conduct research. Targeted applications are opening up new perspectives and paving the way for vital discoveries. Many of our research breakthroughs are driven by the combination of intelligent digitalisation – such as process automation – and the use of advanced AI-based pattern recognition.

In this issue, we share interviews and in-depth reports on the latest AI-related research at HTWK Leipzig. We present a range of cutting-edge technological developments and critically reflect on the broader impacts of digitalisation and AI – in terms of both the research process and the application of our findings.

After all, considering key ethical questions and social developments is an essential part of the scientific discovery process. We hope this issue inspires you to join the conversation! We look forward to collaborating on innovative development projects with you. Feel free to reach out to our professors with questions or suggestions for transfer and innovation.

We hope you enjoy reading this issue!

Kind regards

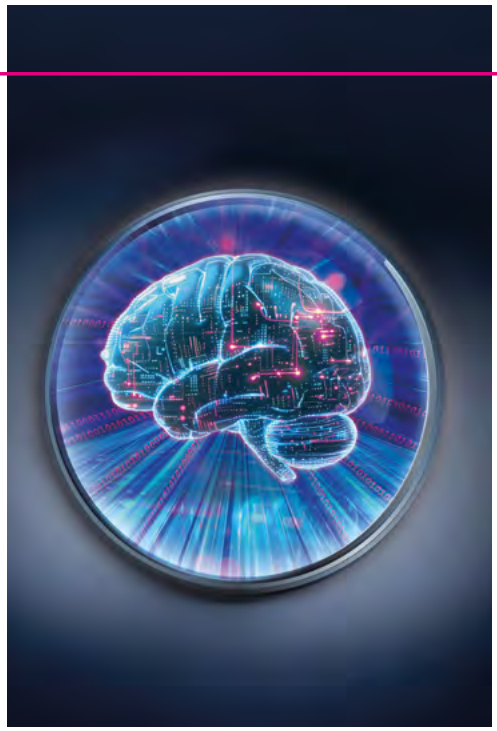


Prof. Dr.-Ing. Jean-Alexander Müller,
Rector of HTWK Leipzig

Prof. Dr.-Ing. Faouzi Derbel,
Vice-Rector for Research and Sustainability

Focus

Artificial Intelligence



In keeping with this issue's focus, we generated the *Insights* cover image using AI for the first time

Photo competition

Florian Muschka and Anika Mühl print organic electrochemical transistors

Facts and figures

S. 50 Researchers are conducting experiments in a living lab to see how pathogens spread in classrooms

Highlights

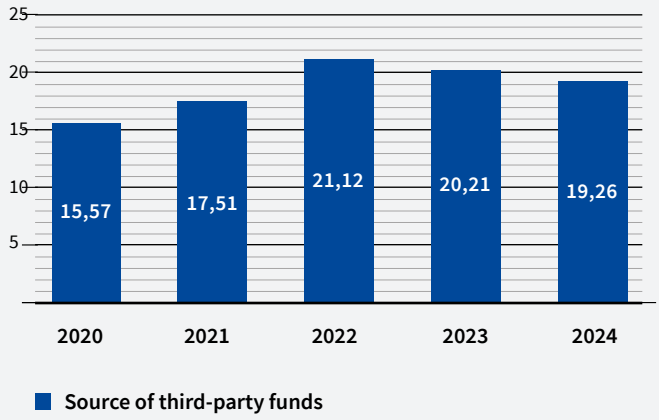
2024

19,26
million euros

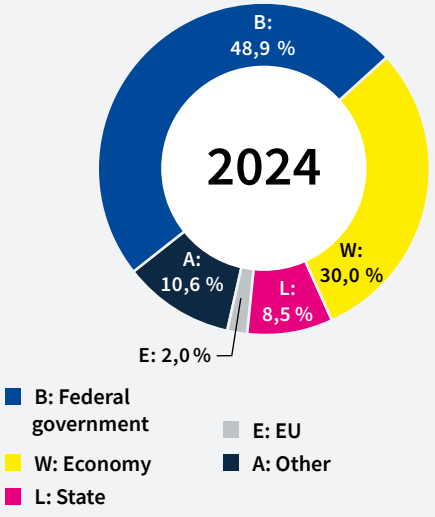
… in third-party funding was secured by HTWK Leipzig in 2024, competing with other research institutions at federal, state, industry and EU level. 3.76 million euros of this total amount were allocated to the university's Research and Transfer Centre (FTZ). Deutsche Telekom donated a further 2.87 million euros to the Faculty of Digital Transformation.

Development 2020–2024

Third-party funding in million euros

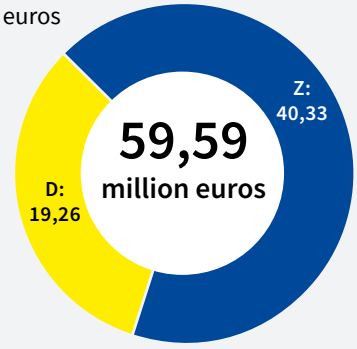


Origin of third-party funding



Financial volume

in million euros



6.431
Students[1]

1.294
Graduates[2]

[1] as of 1. November 2024 | [2] in the 2023/24 academic year

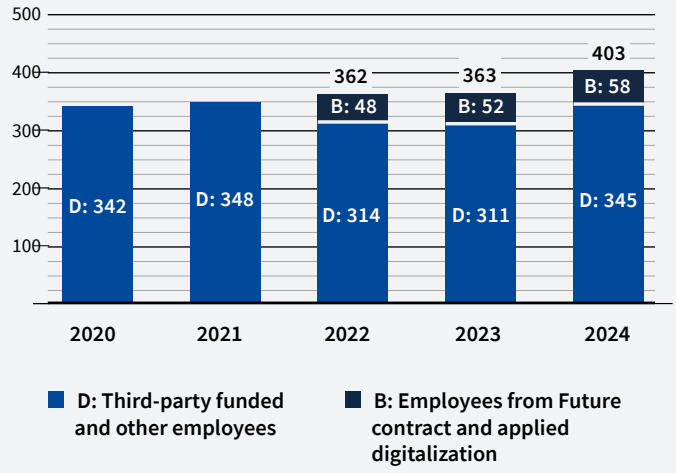
403

staff members

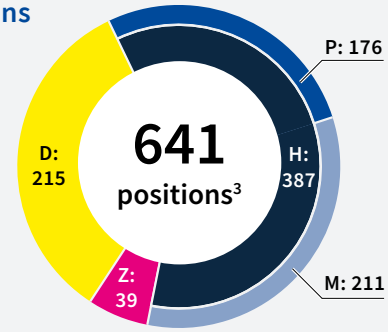
… were financed in 2024 through third-party and special funds, as well as support funds granted under the “Future Contract for Strengthening Studying and Teaching in Higher Education” and the “Applied Digitalisation” initiative. They are working on numerous research and internationalisation projects, in teaching and in various areas aimed at improving study conditions. All additional positions contribute significantly to HTWK Leipzig’s innovation potential and performance.

Development 2020–2024

Staff financed through third-party and special funds



Positions



- D: Third-party funded and other positions
- Z: Positions from Future contract and applied digitalization
- H: Budget items
- P: of which professorships
- M: of which positions are filled by employees

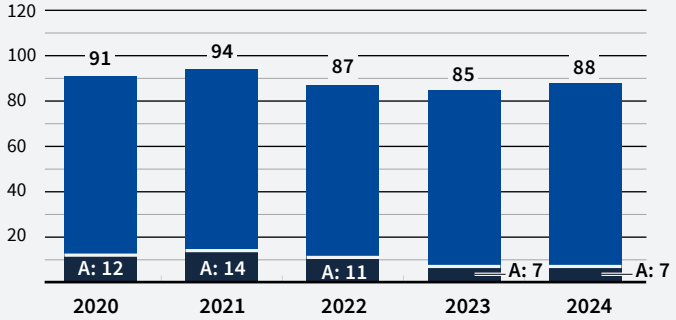
88

doctoral candidates

… were supervised in 2024 by HTWK Leipzig professors in cooperation with partner universities.

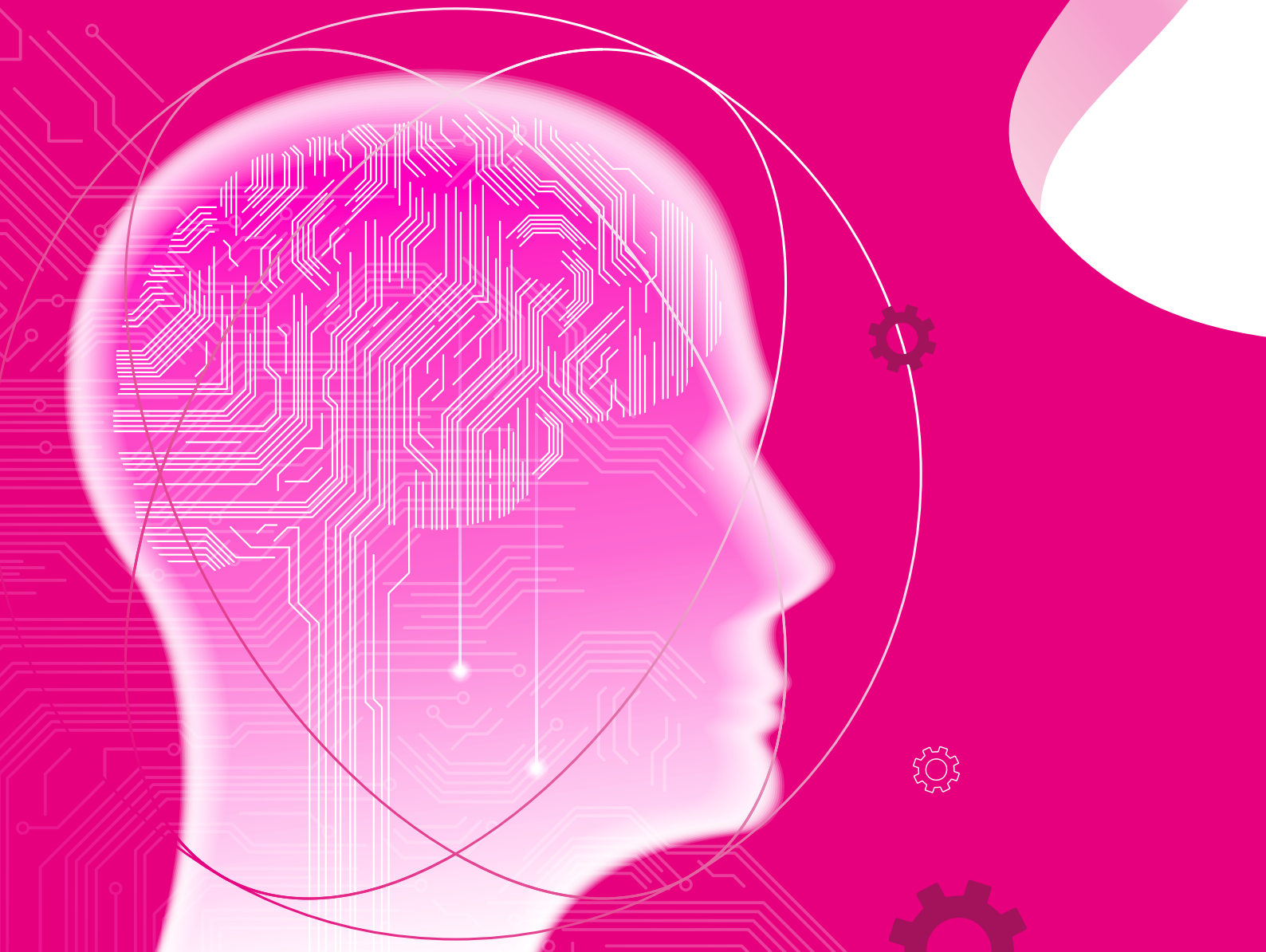
Doctoral research projects

in cooperation with partner universities



[3] full-time equivalents | All figures valid as of 31 December 2024, unless stated otherwise

Artificial Intelligence



1950

Alan Turing develops the Turing Test to determine whether machines can think

Few technical advances have captured as much attention in recent years as artificial intelligence (AI). But what exactly counts as AI? The answer isn't always clear-cut. The term is used differently in engineering, research, media and everyday life. It all depends on the context. However, artificial intelligence essentially refers to systems capable of performing tasks typically associated with human intelligence by effectively emulating cognitive functions such as reasoning, learning, planning and creativity.

AI was thrust into the public spotlight in 2022 following the arrival of text and image generators like ChatGPT. But generative AI is just the tip of the iceberg. The foundations were laid more than 70 years ago. As early as 1950, British mathematician and computer scientist Alan Turing published a seminal paper in which he considered the question "Can machines think?". The term "artificial intelligence" was coined in 1956 by American computer scientist John McCarthy in a proposal for the first ever AI conference, held at Dartmouth College.

In the early days, researchers tried to model AI using rule-based mathematics and logic. This is now referred to as "classical" or "symbolic" AI. By the late 1990s, however, the focus had shifted away from pre-defined rules, and researchers began developing methods that enabled AI to learn autonomously by analysing vast amounts of data to detect patterns and rules – what we now call "machine learning". A key concept in this approach is the use of artificial neural networks, modelled on the structure of the human brain. For example, biological inspiration is drawn from the junctions between two nerve cells, known as synapses.

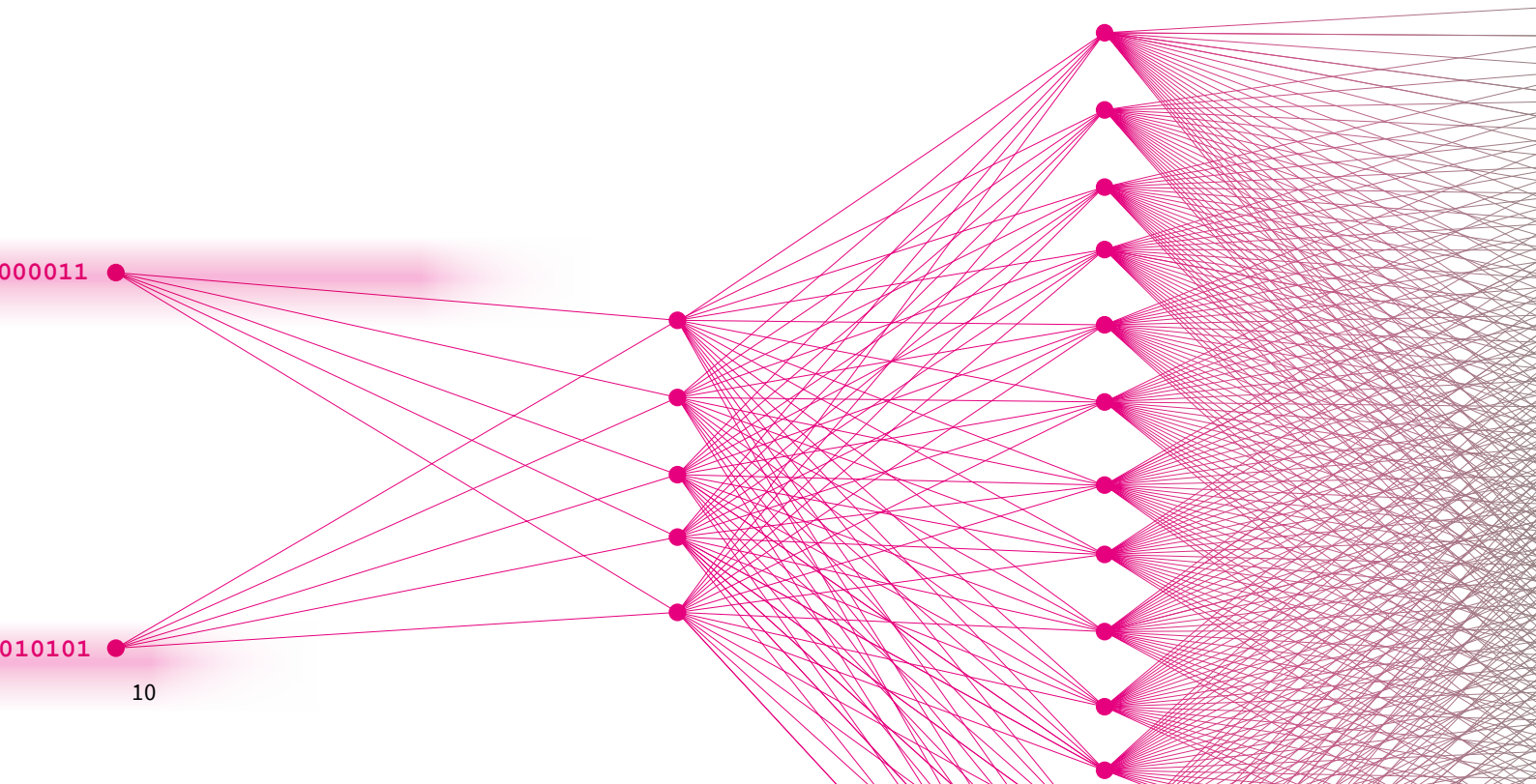
At HTWK Leipzig, a university of applied sciences, AI is primarily used in applied research contexts. For example, we are developing groundbreaking algorithms to analyse human motion in sports and medicine. We are also integrating artificial intelligence into sensor-based monitoring systems for roads and bridges to enable timely repairs and enhance infrastructural longevity. Machine learning allows systems to process massive datasets and identify patterns faster than any human ever could. As a result, researchers in almost all fields can develop novel approaches to complex problems and generate valuable knowledge. In short, artificial intelligence supports human intelligence and is steadily becoming an essential part of applied research. — *kh*

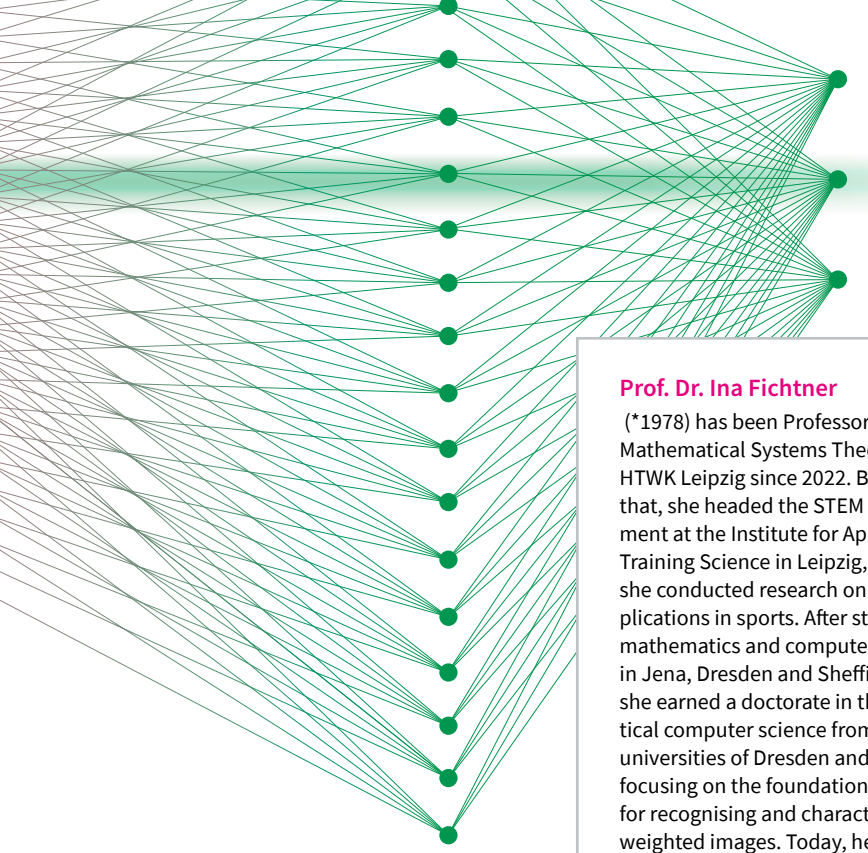
1956

The term "artificial intelligence" is coined by John McCarthy

“AI systems are still just stochastic parrots”

Artificial intelligence emerged from research and developments in mathematics and computer science. We sat down with a mathematician and a computer scientist from HTWK Leipzig to discuss the basic principles, possibilities and limitations of AI.





Prof. Dr. Ina Fichtner
(*1978) has been Professor of Mathematical Systems Theory at HTWK Leipzig since 2022. Before that, she headed the STEM department at the Institute for Applied Training Science in Leipzig, where she conducted research on AI applications in sports. After studying mathematics and computer science in Jena, Dresden and Sheffield, she earned a doctorate in theoretical computer science from the universities of Dresden and Leipzig, focusing on the foundations of AI for recognising and characterising weighted images. Today, her research centres on automata theory, image recognition and applied image analysis in sports physics.

Prof. Dr. Andreas Both
has been Professor of Secure Software Architecture at HTWK Leipzig since 2022, where he also heads the Web & Software Engineering (WSE) research group. He had previously served as Professor of Web Engineering at Anhalt University of Applied Sciences. He studied computer science at the University of Halle, obtaining a doctorate in the field of service-oriented architectures and component-based systems. Following his studies, he held various senior positions in research and development within the private sector, most recently as Head of Research at DATEV, one of the largest software providers in Europe.

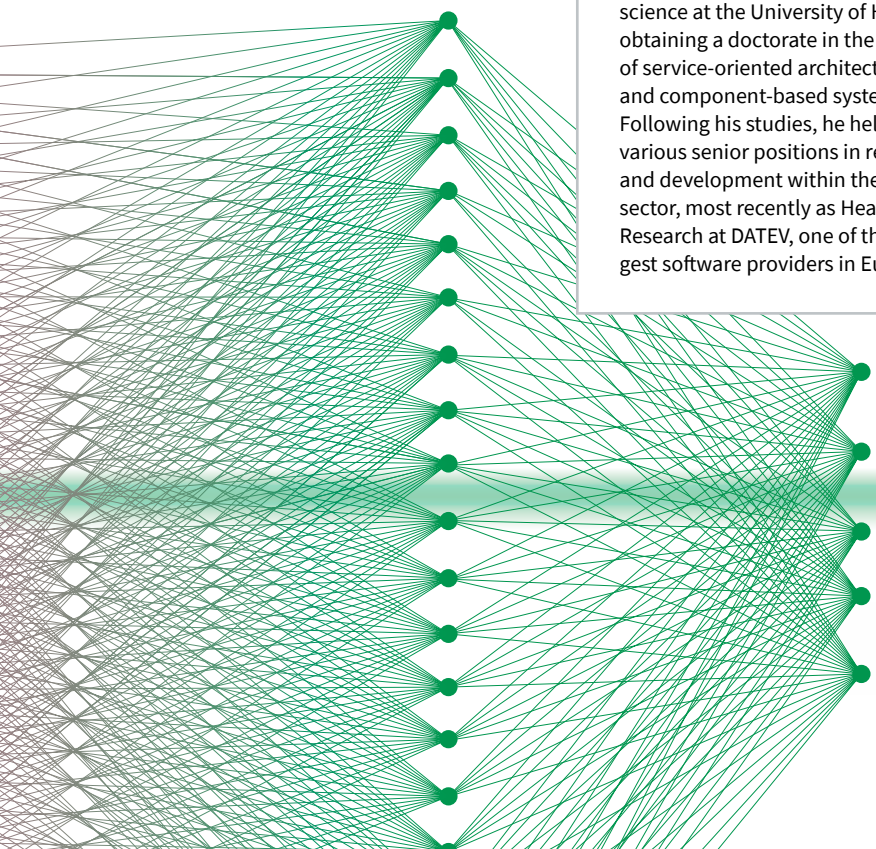
Everyone is talking about artificial intelligence – how would you define it?

Ina Fichtner: AI is a branch of computer science. It concerns the development of algorithms and systems capable of performing intelligent tasks that are normally associated with humans.

Andreas Both: I'd agree with that. AI refers to systems that can emulate or simulate human cognitive functions, including the ability to process and interpret information, learn from data and experience, make decisions and offer recommendations, and interact with people and their environment.

A distinction is often made between weak and strong AI. What does that mean?

Both: Weak AI systems are only designed to perform specific tasks. Strong AI systems, on the other hand, are capable of solving a wide range of problems across different domains – any intellectual task a human can perform. That kind of general AI doesn't exist yet. In the near future, however, it's very likely that AI systems will be capable of taking on a huge share of what humans do – and do it just as well, if not better.



1000011

Are any technologies mistakenly labelled as AI?

Fichtner: That happens quite a lot! Whether it's for marketing reasons or simply due to a lack of understanding, automated processes and statistical analyses are often labelled as AI – even though they aren't.

Both: Things like statistics, data analysis, scripted chatbots and automated applications aren't AI. Unfortunately, artificial intelligence is so hyped at the moment that many products are marketed as AI – even when there's no real technology behind them.

What are the fundamental technical principles behind today's AI systems?

Both: The most important principles behind today's AI systems are artificial neural networks and machine learning. This is where complex mechanisms are trained using extremely large datasets, forming the basis of today's most powerful systems such as OpenAI's large language model, ChatGPT.

Is it possible to build AI without large datasets, or is data-driven learning a fundamental requirement?

Fichtner: There are alternative approaches such as symbolic learning and logical learning, which are not based on large datasets. These methods use rules, formal logic and expert knowledge to develop AI models. However, data-driven approaches are currently leading the way in AI research.

"AI is currently a computational tool based on algorithms and data. There's no clear evidence that this will change anytime soon"

Prof. Dr. Ina Fichtner, HTWK Leipzig

Are mathematics and computer science inherently limiting factors in our pursuit of "true intelligence"? Or is the "intelligence" of AI applications just a matter of more data and more computing power?

Both: That's an interesting theoretical question, and I wouldn't want to give a definitive answer. The scientific

00101001010101010000011

1966

The first chatbot, ELIZA, is launched for research purposes. The machine is designed to simulate a psychotherapist

community has witnessed its fair share of unexpected breakthroughs over the years, so it's quite likely that various tasks currently reserved for humans will soon be automated. And we don't even need to develop "true intelligence" for that – just highly robust and versatile AI systems. That's exactly what my research group is working on.

Fichtner: There's a concept in theoretical computer science called "fundamental computability". It's one of my favourite topics, and I often discuss it in my lectures. That concept would suggest that there is indeed a kind of limit – but one that includes humans too. That said, I think that mathematics and computer science are capable of reaching that level of intelligence – maybe even with the help of completely new types of technology.

A Google software engineer once called for a language model to be shut down, claiming to have seen signs of consciousness. Is artificial intelligence really just a computational tool, or could it one day develop real understanding?

Fichtner: AI is currently a computational tool based on algorithms and data. And there's no sign of this changing anytime soon. But who knows what the next 200 years will bring? I think it's within the realm of possibility.

Both: By definition, it's not conscious thought – even if the texts produced by today's large language models are so coherent that the machines appear capable of thinking for themselves.

01001010101010111010101101

"The most important principles behind today's AI systems are artificial neural networks and machine learning. This is where complex mechanisms are trained using extremely large datasets"

Prof. Dr. Andreas Both, HTWK Leipzig

But that's an illusion. It's still just mathematics and statistics at the end of the day. We need to realise that AI systems are still what Emily M. Bender famously referred to in her linguistics paper as "stochastic parrots". They only seem so powerful because they've analysed more content than even the smartest human ever could.

Many AI systems are built to perform specific tasks. Where do you draw the line between traditional automation and artificial intelligence?

Fichtner: In my view, the key difference is that AI systems are capable of solving complex problems that typically require human intelligence. Traditional automation is more about applying fixed rules and algorithms to automate repetitive tasks, whereas modern AI systems can adapt to new situations and learn from data.

What technical challenges does AI still face today?

Fichtner: Key challenges include integrating AI into other technologies, ensuring the explainability and transparency of AI decisions, enhancing data quality and availability, and overcoming current limitations in robotics.

Both: AI systems are still fairly unreliable. That's why they can only be used in legally regulated fields within integrated processes where humans are ultimately responsible for making comprehensible decisions. But even this approach is reaching its limits, because we still don't have a universal method to explain how large, statistical AI systems actually behave.

AI is often criticised as a "black box". How can computer science help make AI decisions more transparent?

Both: The "opaqueness" of AI systems is a core research topic in the field of explainable artificial intelligence (XAI). The fundamental goal is to ensure that humans can stay in control over how AI systems behave and avoid the otherwise growing risk of autonomy. We don't have the tools needed to tackle this problem at the moment. That's why we often fall back on indirect methods to extract insights about the internal mechanisms behind an AI system's output. However, these methods are currently only reliable in a few specific areas.

What unresolved questions are currently driving AI research?

Both: In addition to investigating neuro-symbolic AI methods and enhancing the explainability of AI systems, researchers are also focusing heavily on efficiency – both in terms of processes and energy. If AI is to be used in all domains, as many predict, it absolutely needs to be sustainable. Beyond these fundamental issues, research into applied AI is advancing rapidly, with new applications emerging or being refined almost every day.

Where do you see the greatest potential for innovation?

Fichtner: AI will unlock its greatest potential when combined with other technologies such as robotics or automation – with the key advantage of reducing human error.

Both: I expect AI to have a growing presence in virtually all domains. In fields like medicine, for example in the analysis of X-ray images, we're already seeing how expensive procedures can be enhanced – or even replaced – by AI. This will ideally lead to

> **"AI will unlock its greatest potential when combined with other technologies such as robotics or automation – with the key advantage of reducing human error"**
>
> Prof. Dr. Ina Fichtner, HTWK Leipzig

“We’re reaching our limits, because we still don’t have a universal method to explain how large, statistical AI systems actually behave”

Prof. Dr. Andreas Both, HTWK Leipzig

a more affordable, better healthcare system. And that’s just one example – there are plenty more areas of application. Ultimately, we should view current developments as an opportunity – especially in our region – to drive economic convergence.

And what are the biggest risks?

Both: Like many other European countries, Germany has become heavily dependent on foreign AI technologies. Barring a few exceptions, like Mistral in France, the AI landscape is largely dominated by providers from the United States and China. Given the current global political climate, this dependency could be used as leverage – or even as a weapon. For example, Europe could be cut off from key technologies or forced to pay extra fees that would make our products less competitive. AI could even be used to undermine our political system. That’s a significant risk.

I’d like you to picture the AI of the future – what would you want it to do?

Fichtner: I’d want it to be capable of solving complex problems – supporting and enhancing human intelligence – without threatening our autonomy and dignity. And that includes tackling the major global challenges of our time.

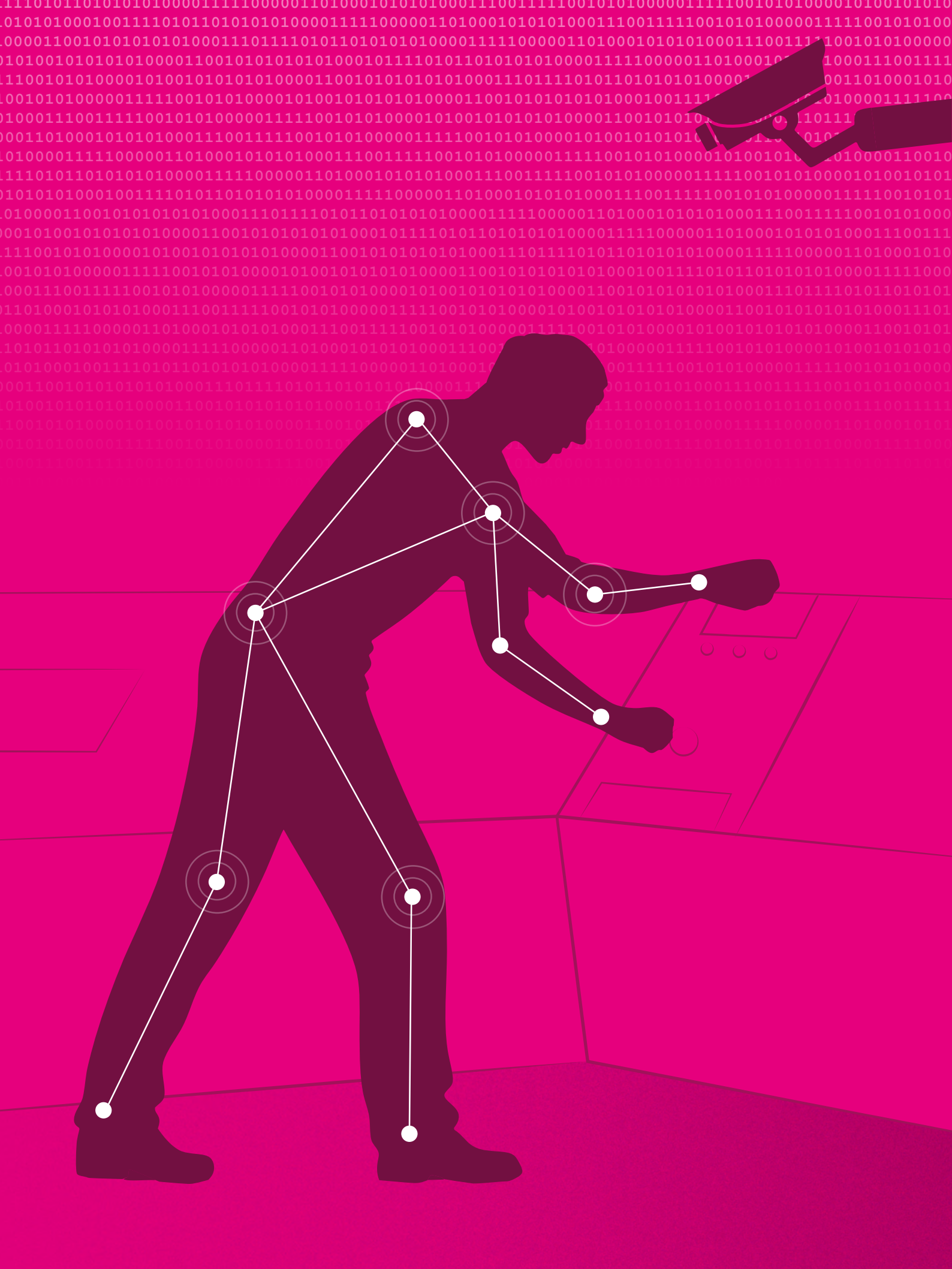
Both: My vision of future AI is one that can integrate a multimodal context – including environmental data – and can work transparently and collaboratively with humans while strictly adhering to predefined rules and instructions. If that becomes reality, I believe AI could be used safely and autonomously within existing systems, helping to push our economies, societies, scientific communities – and even humanity itself – far beyond what we can currently imagine.

Thank you for talking to us.

Interview conducted by Katrin Haase.

1991

Jürgen Schmidhuber develops a network architecture featuring dynamically adaptable connections



How AI analyses our movements

Text: Sven Heitkamp

Researchers at the Laboratory for Biosignal Processing are using artificial intelligence to analyse how our bodies move – whether in sports, medicine or the automotive industry. We saw them in action on the Eilenburger Straße research Campus of HTWK Leipzig.

It feels a bit like a scene from Harry Potter… Prof. Mirco Fuchs steps in front of a mirror with a thick wooden frame. Moments later, a green sine wave appears on the screen. It shows his heart rate. And nobody has even touched him. But this isn't magic. It's a piece of signal processing software with elements of artificial intelligence. A small camera above the mirror detects tiny changes in light reflected off the skin, caused by fluctuations in blood oxygen levels. The software, developed by Fuchs and his team, uses this data to calculate the heart rate and display it on the screen.

Not just a pretty face: The LaBP's "magic mirror" uses camera data to measure vital signs

From the lab to the winner's podium

This "magic mirror" isn't tucked away at Hogwarts. It's in a red-and-yellow brick building on the HTWK Leipzig research campus at Eilenburger Straße. That's where Fuchs heads the Laboratory for Biosignal Processing (LaBP), a research group focused on the acquisition, processing and analysis of image, video and sensor data. Their work has long centred around AI and machine learning. Thanks to its specialised, practice-driven approach, LaBP is now a go-to partner for institutions and companies across Germany – including the country's elite canoeing teams. The research team has spent several years refining a piece of technology that enables paddle and arm movements to be analysed in great detail, helping to optimise sporting performance and boost the chances of success. At the national training centre in Leipzig, "Team Fuchs" is helping elite athletes chase new records, win world championships and achieve Olympic glory.

If you've ever strolled along the Elster basin in Leipzig, a popular training ground for canoeing teams, you might have seen a canoe followed closely by a motorboat, with coaches filming the canoeists in action. These videos are now an essential part of elite sports training – but analysing them is an extremely time-consuming process. Even seasoned experts can only examine a few split seconds closely with the naked eye, explains Fuchs. But the algorithms developed by his team spot everything – from skeletal movement and paddle positions to entry angles and boat alignment – and can evaluate entire sequences automatically. "Our system generates rich data that offers valuable insights for both professionals and up-and-coming athletes looking to refine their technique", says Fuchs.

1997

Reigning chess champion Garry Kasparov is defeated by IBM's Deep Blue supercomputer – powered by classical AI

What is machine learning?

Machine learning (ML) is a field of study in artificial intelligence where computers are not simply programmed to perform a task by following a set of rules; instead, they learn how to solve problems on their own by training on large datasets. ML systems use algorithms and artificial neural networks to detect patterns and correlations – and then make predictions or decisions based on this data.

Smart coaching in real time

This software solution was developed in close collaboration with the Institute for Applied Training Science (IAT), a national centre of excellence based in Leipzig. A few years ago, Fuchs presented his laboratory's capabilities to various sporting experts. What started as a brief demonstration has since blossomed into a productive partnership. "The head coach of the German Canoe Federation is now using our technologies to push his team's performance to the next level", explains Fuchs. Even the Federal Ministry of the Interior (BMI), which oversees national sports funding, has backed several research projects related to this technological innovation. One of the systems has since been installed in the flow channel at the Olympic training centre in Potsdam, where two cameras capture 3D footage to provide athletes with personalised feedback in real time. The new software also enables international races to be recorded from the shoreline, so that canoeists can receive tactical suggestions to improve their racing strategies. And it's all powered by AI. After all, what seems like a simple task for humans, such as viewing an image and recognising someone's hands or picking out a paddle, is initially just a massive cloud of numbers to a computer. If it wasn't for modern AI-supported pattern recognition, we wouldn't be able to analyse images and videos in an automated process. Thanks to these methods, we can now process video data consistently, objectively and on a scale that far exceeds human capabilities.

"The head coach of the German Canoe Federation is now using our technologies to push his team's performance to the next level"

Prof. Dr.-Ing. Mirco Fuchs, HTWK Leipzig

→ A canoe sprint qualifier is filmed by HTWK researcher Daniel Matthes. The athletes' paddling movements and speed are analysed in real time by a piece of software developed by the LaBP

Fuchs launched the research group back in 2010, when he was still working as a doctoral researcher, alongside his supervisor Matthias Sturm – then Professor of Microcomputer Technology and Digital Signal Processing – and colleague Daniel Matthes. They initially focused on medical applications, much like other teams who gradually transformed Eilenburger Straße into a research hub at HTWK Leipzig. "We're now the longest-running group on the Eilenburger Straße campus", he says proudly. In 2022, he was appointed Professor of Computer Vision and Machine Learning. Today, his group includes three research associates, a doctoral candidate and several students working on a range of research projects. All are funded through third-party grants.

Advanced crib monitoring

The success story began 15 years ago with the development of sensors capable of detecting bioelectrical signals. That's where the Laboratory for Biosignal Processing got its name. This soon resulted in camera-based solutions for monitoring vital signs on neonatal wards. Fuchs and his team installed a regular video camera above a crib to track things like a baby's heart rate. This was done wirelessly – and without actually touching the newborn – to minimise stress. A conventional pulse sensor attached to the baby's foot served as a reference. The technology behind that monitoring system would ultimately form the basis for the team's "magic mirror". The research group went on to launch additional projects with the University of Leipzig Medical Centre and the Heart Centre Leipzig. One project explored how the facial expressions of patients under partial anaesthesia could be captured and analysed to monitor pain levels.

What are artificial neural networks?

Artificial neural networks are computer programmes designed to imitate how the human brain works. They are made up of numerous interconnected junctions, known as "artificial neurons", which process information. They are capable of identifying complex patterns in data, such as recognising whether a photograph shows a cat or a dog.

Success story: "Humen dynamics"

Following a few early research projects, various industrial partners have started to take note of the HTWK team's expertise. In a bakery, for instance, they recently ran a feasibility study where cameras were used to track how employees moved through the workspace and how machines were being used – with the aim of streamlining operations. A pivotal breakthrough came when they were approached by a major car manufacturer. The company wanted to use video footage to

← A sedated patient lies on an operating table during surgery (staged scene). A camera analyses his facial expressions and other vital signs such as heart rate and breathing. Based on this data, the software can determine whether the patient is in pain and provide medical staff with recommended painkiller dosages via the monitor

objectively analyse repetitive movements on its assembly lines and evaluate workplace ergonomics. And the LaBP found just the solution: Using simple camera recordings, the software detects the workers' shoulders, backs and knees, and calculates joint angles and movement patterns. The AI then compares this data to established ergonomic guidelines and visualises physical strain using a traffic light system.

This enables the company to detect "red flags", i.e. postures that put too much strain on the body, helping to prevent injuries and maintain long-term employee health and productivity. The system, known as "Humen dynamics" (a play on "human engineering"), offers a more comprehensive approach compared to traditional ergonomic assessments conducted by occupational health and safety specialists, explains Fuchs. And it's become a real success story. Since 2019, "Humen dynamics" has been distributed across Germany in partnership with the Institute for Health and Ergonomics (IGR) in Nuremberg, forming an integral part of many ergonomic training programmes. "Humen dynamics is already being used by lots of companies in Germany", says Fuchs. The revenue generated from such projects is helping to fund new research at the LaBP. And there's no shortage of ideas – the team has a long list of potential research topics and has already submitted a proposal for a project that aims to analyse team tactics in collaboration with the German Handball Association (DHB) and the IAT. With a bit of luck, this research could even help the German national team take down the dominant world champions from Denmark. Not with a magic mirror, but with cutting-edge motion analysis – powered by AI. —

Prof. Dr.-Ing. Mirco Fuchs

Prof. Dr.-Ing. Mirco Fuchs
(*1982) has been Professor of Computer Vision and Machine Learning since 2022. As a local, he studied electrical engineering at HTWK Leipzig and later completed his doctoral and postdoctoral research, working closely with the Max Planck Institute for Human Cognitive and Brain Sciences. In 2010, he co-founded the Laboratory for Biosignal Processing. Fuchs is currently using artificial intelligence to develop algorithms that can extract insights from camera imagery. In late 2023, he was appointed Vice Dean for Research at the Faculty of Engineering.

2012

A neural network uses deep learning to identify objects in images for the first time

How AI is making roads safer

Text: Dr. Franziska Böhl

Artificial intelligence is paving the way for smarter road maintenance. At HTWK Leipzig and the university's Research and Transfer Centre (FTZ), geotechnical and electrical engineers are developing a sensor-based system that uses AI to monitor real-time traffic loads and proactively schedule road repairs. We stepped outside the laboratory and observed the system's first real-world trial.

2017

Google presents its Transformer architecture – an AI model capable of processing language with high efficiency

A sudden burst of activity erupts as a truck hauling hot asphalt announces its arrival with a loud honk. We're on the Arlt company grounds in Frohburg, roughly 40 kilometres south of Leipzig, where the construction firm is about to pave over sensitive equipment. HTWK researchers scurry along the freshly milled road surface, straightening cables that lead to a monitoring station and removing weights from fist-sized sensors. The moment of truth is upon us… the first field test is officially under way.

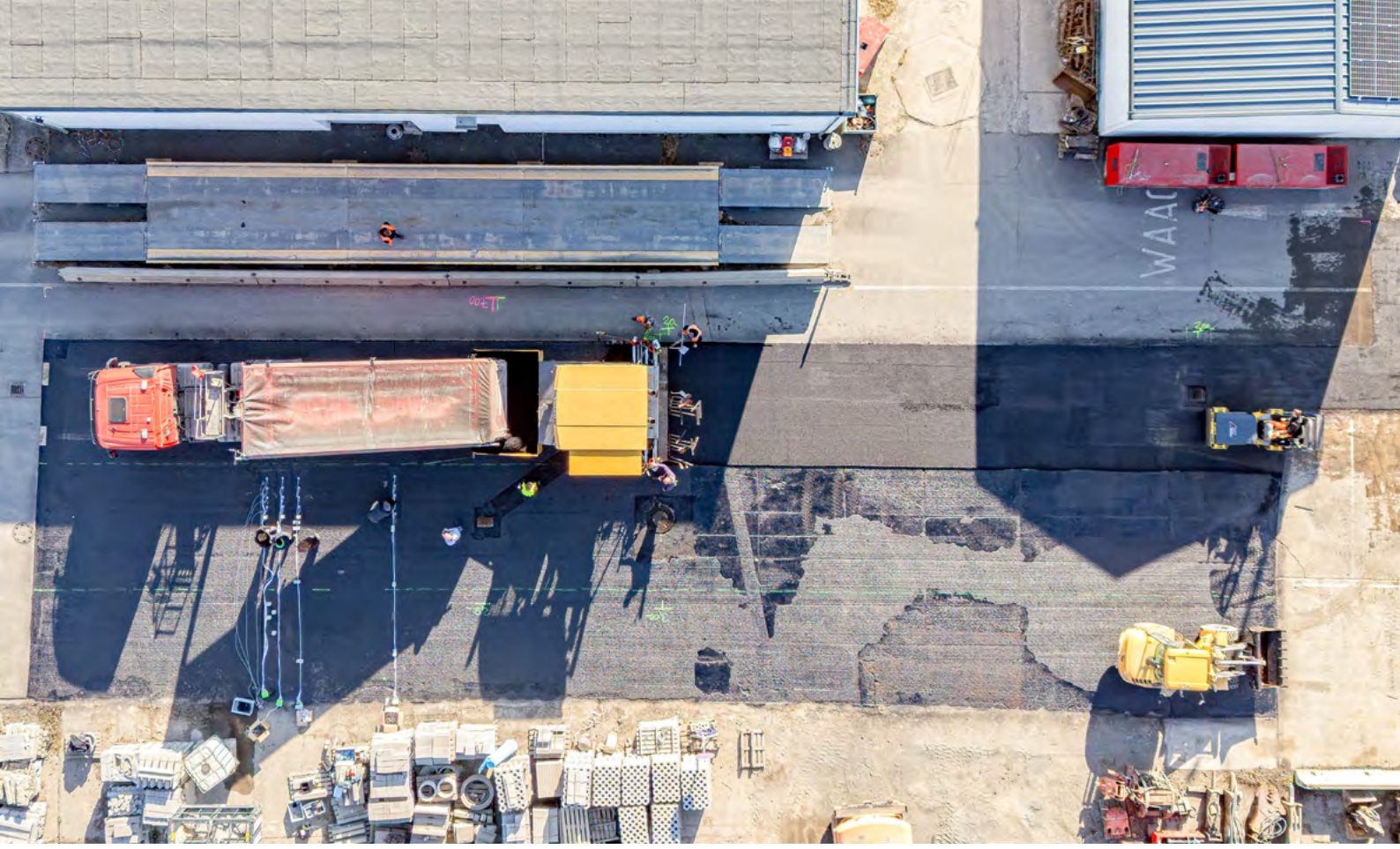
"The monitoring system developed by our electrical engineers worked perfectly in the lab. Now we're finally testing it in the real world – on a private road provided by our industry partner", explains Lorenz Spillecke from the Institute of Geotechnical Engineering (IGL) at HTWK Leipzig. Since 2023, geotechnical and electrical engineers at HTWK Leipzig have been working with industry partners on the "RoadIT1.0" project to develop a smart monitoring system for road construction. The system is based on sensors embedded in the road and artificial intelligence that analyses data. The goal is to measure real-time traffic loads and predict the ideal time for repairs – before roads start falling apart. The project will be funded by the Federal Ministry for Digital Transformation and Government Modernisation (BMDS) until the end of 2025. "The sensors provide us with data on the number and weight of vehicles travelling over a road. The AI then uses that data to calculate the actual stress on the road infrastructure. Traffic loads have been rising steadily for years, and both the number and weight of vehicles have reached levels far beyond what most roads were originally designed to withstand", says Ralf Thiele, Professor of Geotechnical Engineering, who is heading the research project.

Roads in poor condition

It's no coincidence that roads in many German states and municipalities are in urgent need of repair. This was confirmed by a study conducted by the German Institute of Urban Affairs (Difu) on behalf of the German Construction Industry Federation (HDB), the Association of German Transport Companies (VDV) and the ADAC. The study estimates that Germany will need to invest more than 370 billion euros in infrastructure by the end of 2030 to maintain and expand the country's rail network, roads and pedestrian routes. According to the report, one in three municipal roads has serious defects.

At present, only highways and federal roads benefit from automatic monitoring systems that flag when repairs are urgently needed. There is no such system in place for the secondary road network. This is simply because the monitoring systems are too expensive to be rolled out on all roads. "Our innovation aims to offer an affordable yet robust solution that can be used on a wider scale", explains project manager Philipp Methfessel.

→ Lorenz Spillecke holds up a palm-sized sensor before it is integrated into the asphalt



This road in Frohburg is the first real-world testing ground for the sensors and AI built by HTWK researchers

From the lab to the streets

Today's first real-world trial marks an important milestone. The researchers are embedding sensors into the road's base course – just beneath the surface. This is a critical moment for the technology; it has to withstand the 150°C heat of the fresh asphalt and the mechanical pressure of the roller used to compress the surface course. Over the next few weeks, the researchers will be testing various prototypes featuring different sensors as part of a feasibility study. They want to see how the new system holds up to determine its medium-term viability.

"We compared the performance of expensive and affordable sensors and looked at how they responded to forces. A good sensor system needs to deliver reliable results – but it also has to be economically viable"

Prof. Dr.-Ing. Gerold Bausch, HTWK Leipzig

The monitoring system was developed by Gerold Bausch, Professor of Embedded Systems and Signal Processing, and his team from the Electronic Engineering Lab (EEL) at the FTZ. They started the project by evaluating various acceleration sensors, exposing them to different motion scenarios in a laboratory set-up. "We compared the performance of expensive and affordable sensors and looked at how they responded to forces. A good sensor system needs to deliver reliable results – but it also has to be economically viable", says Bausch.

Once the asphalt has hardened, the heavy bricks can be removed

What do the sensors measure?

In Frohburg, the asphalt has cooled and the road can be used again. And what about the sensors? A quick look at the monitor confirms that they have survived the installation and are now ready to deliver a constant flow of data. Four measurement lanes – each with five sensors – have been installed in the road to capture every passing vehicle.

Every time a vehicle rolls over the surface, the sensors will continuously record data by combining various measuring principles: acceleration signals, magnetic field strength and temperature. The AI will use this data to determine axle loads with high precision. By comparing readings across the measurement lanes, it can also calculate speed and axle configuration, allowing the system to identify different vehicle types. "Our monitoring system enables us to estimate vehicle weights with a relative accuracy of under one tonne. We can also measure axle spacing to within ten centimetres", says electrical engineer Michael Eiserbeck.

Processing large volumes of data with AI

The 20 sensor nodes used in the feasibility study can generate vast amounts of data – each one can capture up to 3,000 acceleration signals and 600 magnetic field readings per second. This presents its challenges for subsequent processing and analysis. AI plays a key role in sifting through the data: "In this project, we're testing the use of AI and machine learning to interpret the sensor signals. We're also analysing data with more traditional methods, but these reach their limits when dealing with complex correlations. AI allows us to identify patterns and deliver more robust results", explains geotechnical engineer Hermann Busse. In addition to ensuring high precision in complex scenarios, AI methods are also highly flexible and adaptable to different road structures.

The data is displayed in real time on a web-based dashboard. The geotechnical team isn't working alone on the project; the researchers have partnered with Infratest Digital Solutions, which transmits the sensor data to the dashboard, and N4 Leipzig is responsible for visualisation and real-time display.

Outlook

Until now, the researchers have been able to verify exactly which vehicles are passing over the test section, as reference data is provided by video recordings and integrated scales. But things are about to get real – in summer 2025, the system will be deployed on a public road in the south of Leipzig. "We want to see whether our AI model – which has only been trained on known data – can also handle unknown vehicles", explains Busse. The aim is to develop a self-learning system that can reliably capture the actual stress on our roads.

When the project comes to an end, the data will also be incorporated into an analysis tool developed at TUD Dresden University of Technology, where asphalt engineering researchers are using temperature data to map how roads age over time. They will

2020

GPT-3 is capable of generating a diverse range of coherent texts, marking a major breakthrough for large language models

evaluate the data from the “RoadIT1.0” project to predict the degradation and lifespan of roads.

“We want our system to support modern, proactive and efficient road monitoring in towns and cities across the country. Affordable technology and the smart use of artificial intelligence will pave the way for nationwide coverage”, says project manager Ralf Thiele. If every municipality is able to monitor its roads cost-effectively in the future, patchwork repairs could be replaced by proactive maintenance. As such, the research project has the potential to address the infrastructural problems observed throughout the country – making roads safer, smarter and more sustainable. —

Prof. Dr.-Ing. Ralf Thiele (l.) and Prof. Dr.-Ing. Gerold Bausch

↓ Traffic loads are captured by sensors and AI

Prof. Dr.-Ing. Ralf Thiele
(*1963) has been Professor of Soil Mechanics, Geotechnical Engineering, and Rock and Tunnel Engineering at HTWK Leipzig since 2006. He holds a doctorate in civil engineering. He has established a research area at HTWK Leipzig dedicated to geotechnical engineering, including the “G2 Geotechnical Group” and the “Geonetic” research transfer group. These efforts led to the creation of the Institute of Geotechnical Engineering Leipzig (IGL) in 2024. Thiele also served as Vice Rector for Research at HTWK Leipzig from 2019 to 2023.

Prof. Dr.-Ing. Gerold Bausch
(*1979) has held the endowed professorship for Embedded Systems and Signal Processing at HTWK Leipzig since 2019. He holds a doctorate in electrical engineering and he had conducted research in the Laboratory for Biosignal Processing from 2013 onwards. Since 2020, he has led the “Electronic Engineering Lab”, focusing on the development of sensor systems based on embedded technologies and the analysis of measurement signals.

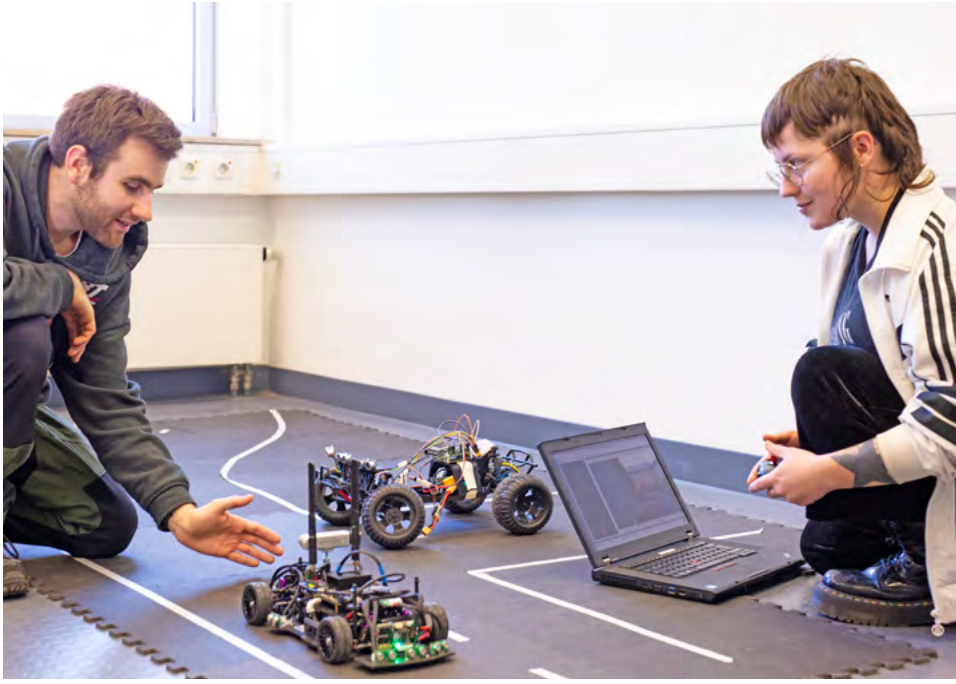
Ready for the next race

A group of student researchers in the Smart Driving Team at HTWK Leipzig are using model vehicles to test various AI approaches to autonomous driving. They look forward to showcasing their programming skills in upcoming competitions.

Autonomous driving is increasingly becoming part of everyday life in various levels of automation. For example, subways in Singapore and Nuremberg are monitored solely from central control centres, ships and aeroplanes mostly run on autopilot, and China and the United States have even rolled out self-driving taxis. Private transport, on the other hand, is lagging behind – especially considering the fact that autonomous driving pioneer Ernst Dickmanns sent an unmanned vehicle down a German highway way back in 1987.

Driver assistance systems are now standard in private vehicles, helping drivers stay in lane and maintain a safe distance from the car in front. In contrast, fully autonomous driving is where automated systems take complete control – with no human intervention required. However, a growing number of vehicles are being fitted with rule-based, symbolic AI technology to help them observe traffic regulations and manage tasks like changing lanes. Static, rule-based AI methods also help vehicles identify objects on the road and react to certain traffic situations, such as stopping at a red light. “Teaching an autonomous vehicle to be cautious and considerate is extremely challenging”, says Sibylle Schwarz, Professor of Theoretical Computer Science at HTWK Leipzig. And that’s exactly what her student-led Smart Driving Team is trying to achieve.

Schwarz established the research group in 2014 alongside five highly motivated students – in the run-up to the inaugural Audi Autonomous



→ Will the model car spot the hand in its path? Team speaker Jan Philipp Seeland and computer science student Sophia Lachmann put it to the test at the Hackathon on 3 March 2025

2024

The AI Act introduces a harmonised legal framework for the use of artificial intelligence in the European Union

Driving Cup (AADC). That same year, they became the only team from an East German university to make it into the competition. “In the years that followed, it was always a great feeling to be one of only ten teams chosen to take part in the AADC”, says Schwarz.

These competitions consist of various courses designed to replicate real-life traffic scenarios, where young developers can demonstrate their programming skills and showcase the software used to control the model cars provided by the organiser. For example, the vehicles have to autonomously handle complex parking manoeuvres and avoid sudden obstacles. As well as showing off their skills, participants can use the competition as a platform to connect with potential employers. After all, the knowledge required in the challenges is highly valued in the automotive industry.

The COVID-19 pandemic sadly brought things to a halt. The AADC was cancelled, and the Smart Driving Team took a break. The group got back together in the summer of 2022, welcoming new faces in the process. “Right now, we’re focused on upgrading our older model vehicles with new hardware and software”, explains Jan Philipp Seeland, who is organising and managing the project as part of his master’s thesis. The team is also working on vehicle and fleet simulation in configurable environments, as well as safety systems for autonomous driving. These topics feed directly into student seminars, projects, bachelor’s dissertations and master’s theses.

Prof. Dr. Sibylle Schwarz

The student research group is currently working with five model vehicles, each with its own design and technical set-up. They are testing a variety of approaches, though not every configuration can handle the complex computations required by today’s large AI models. But that’s where the latest addition to the team’s fleet comes in… Supplied in 2024 by Sedenius, a Leipzig-based developer of driver assistance systems, the new vehicle is capable of such processing. The 1:10 scale, radio-controlled car is fitted with a high-performance processor and also features essential components for autonomous driving such as LiDAR sensors, cameras and ultrasound sensors. “As the model vehicle is so technologically advanced, we can fully focus on software development”, says Jan Philipp Seeland. They want to continue working together and get back to competing in the near future. — *frb*

Prof. Dr. Sibylle Schwarz

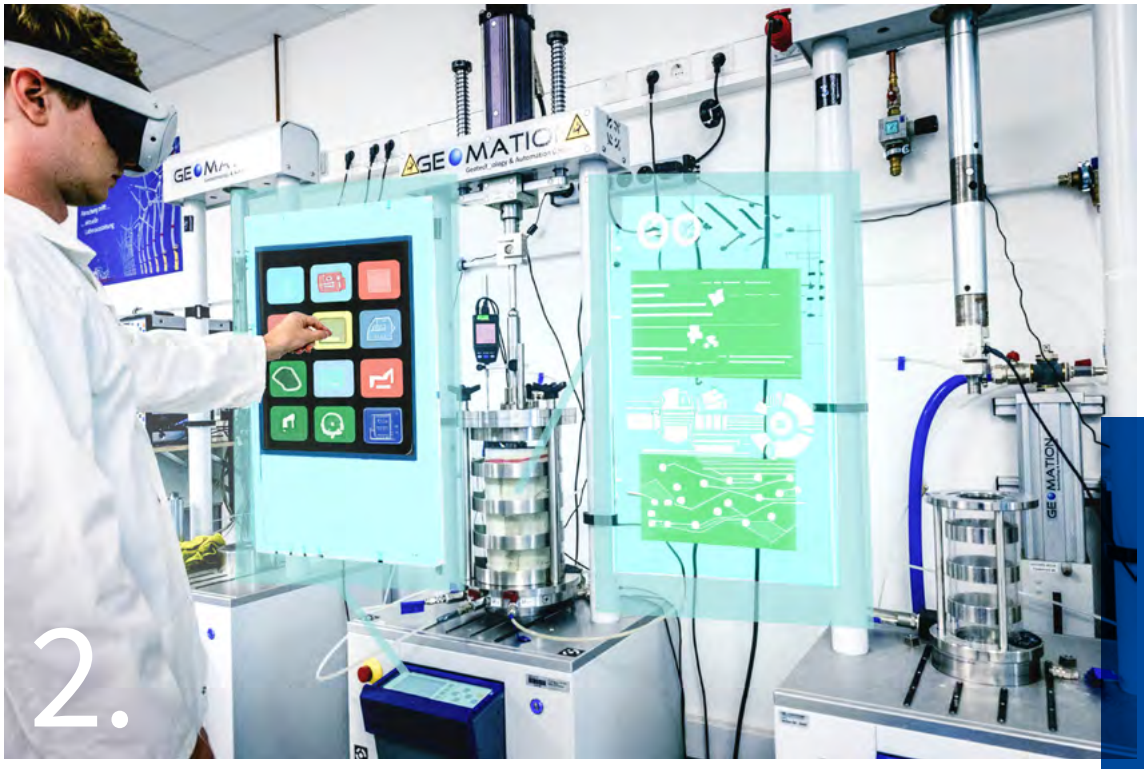
(*1966) has been Professor of Theoretical Computer Science at HTWK Leipzig since 2013. Before that, she held a professorship at the University of Applied Sciences Zwickau from 2008. Her wide-ranging research includes autonomous driving, theoretical computer science, ethical reasoning in logic systems, artificial intelligence, and how to bring cutting-edge robotics into the classroom. From 2016 to 2018, she also launched a robotics school lab at HTWK Leipzig called “RobertaRegioZentrum” (now known as “RoboCreators”).

Research Perspectives

The “Research Perspectives” photo competition provides a platform for scientists at HTWK Leipzig to share an inside look into their research activities. Here are the award-winning entries from 2024.

1.

Transistors in pad printing – Florian Muschka, Anika Mühl, Sammy Schließer



Mixed reality in the laboratory – Herrmann Busse, Lorenz Spillecke

The first prize in the photo competition was awarded to Florian Muschka (left), Anika Mühl (right) and Sammy Schließer (photographer). Their photo shows the researchers in printing and packaging technology at work as they characterise printed organic electrochemical transistors (OECTs). These transistors are ideal for sensor applications, such as glucose monitoring in medical technology, thanks to their high sensitivity and compatibility with aqueous environments. The researchers produced the transistors using pad printing, a gravure printing process used in the graphics industry that is particularly suitable for curved and uneven surfaces. As part of her master's thesis, Mühl is examining the influence of process parameters on the print quality and conductivity of silver structures in pad printing. Muschka is researching the printing process for sensor systems integrated into seals. — *kh*

Civil engineers Herrmann Busse (photographer) and Lorenz Spillecke (editor) came in second place for a photo montage depicting their vision of the future working day in a soil mechanics laboratory. Through mixed reality, where real and virtual objects interact in real time, laboratory technicians could be provided with contextual information in addition to the real-world situation. With a mixed reality headset, for example, it would be possible to see inside a soil sample. This concept could make information more readily available, allow for better data integration and even support remote training opportunities. Busse is currently completing his doctorate on the interpretation of cone penetration test data at TU Berlin and HTWK Leipzig. He and Spillecke are involved in a research project with the aim of developing a system to measure the stress on the road network (see p. 22 ff.). — *kh*

Research Perspectives
Since 2015, all researchers at HTWK Leipzig have been invited to submit outstanding photographs from their daily work to the "Research Perspectives" photo competition. The jury, comprising research officer Dirk Lippik, research communications specialist Katrin Haase, research marketing expert Dr. Franziska Böhl and photographer Swen Reichhold, selected not just one, but four winning images in 2024. Each entry is evaluated based on photo quality, creativity, uniqueness and composition. This time around, two images tied for second place.

Reaching out and touching innovation – Karl Marbach

Joint second place was awarded to Karl Marbach, a student assistant at the Chair of Production and Logistics Systems. As part of his master's project in industrial engineering, he is generating automated methods-time measurements (MTMs) from video sequences using various methods such as motion capture and object recognition. MTM analysis is used in industrial environments, in particular when planning and evaluating manual assembly activities and determining operational schedules. In addition, assembly processes are evaluated from an ergonomic perspective. Marbach is developing an algorithm that uses the captured movements to improve existing assembly processes. The photo shows him compiling an extensive set of training data. The processed image shows the measured moving areas of the hand. — *kh*

Third place in the photo competition went to Niels Clasen, a research associate in the "FLEX" research group. As part of a research project and his master's thesis, the civil engineer investigated the clamping effect of glueless and separable dowel joints made of wood. He tested rod-shaped dowels made of round timber, which were spread out with nails made of synthetic resin densified wood and were firmly inserted in the drill hole of a piece of laminated veneer lumber (LVL). In a series of experiments, Clasen analysed the load-bearing capacity of 80 test specimens with various dowel modifications. The first attempts to drive the nail into the face of the dowel were unsuccessful; dowels tore, panels split and nails broke, as can be seen in the picture. But these failures led to valuable insights. Further experiments revealed the solution: Pre-drilling, refining the dowel-to-nail ratio and using LVL panels with cross layers ultimately perfected the connection. — *kh*

Shiver me timbers – Niels Clasen

Doctoral Thesis Award 2024

Stability for brittle bones

In his award-winning doctoral thesis, Dr. Christoph Oefner bridged the gap between mechanical engineering and medicine

Osteoporosis is the most common skeletal disease in older adults. In Germany alone, it affects more than six million people over the age of 50. As bones become porous, the risk of fractures increases. Patients with osteoporosis often require implants to stabilise their bones. But when bone material is brittle, conventional screw anchors often fail. So how can implants be anchored safely and durably?

Dr. Christoph Oefner explored this question in his doctoral research – with a focus on the spine – and was honoured with the 2024 Doctoral Thesis Award from the HTWK Foundation. A mechanical engineering graduate of HTWK Leipzig, Oefner completed a cooperative PhD programme at HTWK Leipzig and the Faculty of Medicine at Leipzig University between 2017 and 2023. He was supported by a doctoral scholarship from HTWK Leipzig. His research combined engineering methods with medical questions. By transferring structural durability concepts in mechanical engineering to the human skeleton, he developed a digital model to estimate the lifespan of implant anchors and outlined methods to assess the validity of this model. He also examined how specific parameters, such as larger screw diameters, could help extend the longevity of implant anchorage.

He validated the results of his novel approach using data from body donors. His research has practical relevance for clinical work. In the future, physicians could use the digital model to tailor implant choices to each patient, plan surgeries more effectively and, for the first time, make concrete predictions about the anchorage lifespan of implants. That would be a clear benefit for patients.

The 34 year-old is now a calculation engineer at Siemens Energy in Leipzig, where he is responsible for rotor dynamics and strength analysis of turbo compressor assemblies – a field which, much like his doctoral research, revolves around loads and simulations. —*frb*

Career paths

There are many reasons why people pursue a doctorate at HTWK Leipzig – and just as many career opportunities afterwards. Four doctoral graduates share their stories.

Dr. Edgard Marx

"It's a fascination that continues to this day", says Dr. Edgard Marx, recalling the fateful day in the 80s when his father brought home the family's first computer and declared: "This is the future". Raised in a Brazilian village, the computer scientist, now 44, was equally drawn to the cultural heritage of his family, which had emigrated from Zwickau to Brazil in 1885. That's why, after studying computer science in Rio de Janeiro, he decided to pursue a doctorate in Germany. With a scholarship in hand, he began his doctoral research at Leipzig University in 2013. Shortly before submitting his doctoral thesis, his supervisor passed away. Thomas Riechert, Professor of Computer Science at HTWK Leipzig, stepped in as his new supervisor and also hired him for a DFG-funded research project on academic career patterns in historical databases. The project revolved around linked data and the Semantic Web – and these concepts were also central to his doctoral thesis, which he completed in 2024 with magna cum laude. In a subsequent DFG-funded project, he worked with chemists from São Paulo to link databases of natural products from the Amazon and make them more accessible. Marx has since published more than 30 academic papers and ranks among the 20 most-cited researchers at HTWK Leipzig. Since 2021, he has also been a data analyst at Eccenca, a data management company that helps businesses make better decisions. His next big goal is to establish his own research group at the Institute of Computer Science at Leipzig University. *— kh*

Dr. Rokan Osou

"The Old City of Aleppo shaped the way I view architecture", says Dr. Rokan Osou. Born to Kurdish parents, she grew up in the Syrian city – one of the oldest in the world – and developed a deep interest in historical buildings. This early fascination led her to study architecture at the University of Aleppo, where she specialised in the rehabilitation of historic urban areas. After her studies, she spent five years working on a rehabilitation project in the Old City of Aleppo. "That had a profound impact on me and deepened my appreciation for architectural heritage", she says. A trip to Berlin to visit her sister, who was pursuing her own doctorate, inspired Osou to follow a similar academic path in Germany. Thanks to the EU's academic exchange programme, Tempus, she was able to do just that. At HTWK Leipzig, she found an "inspiring and experienced supervisor" in architecture professor Annette Menting. She completed her doctorate at HTWK Leipzig and the Brandenburg University of Technology, exploring how traditional Arab architecture could be sustainably incorporated into contemporary design. Even before successfully completing her doctorate in 2024, she moved to Canada to begin a new degree in early childhood education. "Holistic education matters deeply to me because it reveals how children's psychology can guide the way we shape the built environment in educational spaces". When she is not busy with her studies, she likes to spend time with her 9-year-old son, plays table tennis and expresses her creativity through glass painting. And what about her long-term career goals? She would like to hold a professorship in architecture – either in Germany or Canada. *— kh*

Fabian Görgen

Too hot, too dry, too much particulate matter… Many urban spaces are ill-equipped to handle the effects of climate change. Fabian Görgen is on a mission to make them more liveable. Born in Stuttgart, he developed an early interest in mathematics and physics, loved being in nature and had a soft spot for architecture. That's what led him to study civil engineering; a bachelor's degree in his hometown was followed by a master's programme at HTWK Leipzig. "I didn't want to work as a site manager. I've always been more drawn to things like building physics and urban climate", says Görgen. After a brief stint as a planning engineer in the private sector, he wanted to explore his interests in greater detail and ultimately returned to HTWK Leipzig in 2020 to pursue a cooperative doctorate with the Brandenburg University of Technology. There he developed a simulation-based approach for optimising water-retaining facade systems to improve urban climates. To implement his ideas in the real world, he teamed up with a friend in 2024 to found Komfortscape, a start-up that helps local authorities develop climate-resilient cities that are fit for the future. Following an initial site analysis, the engineering specialists design climate adaptation strategies and simulate their potential impact on the local environment. They can influence the microclimate in a number of ways, such as by planting more vegetation, carefully selecting the right materials and colours, and installing shading systems. The start-up founder, now 32, has spent the past year living with his partner in Vienna, where he enjoys exploring the city and countryside after work. He is particularly drawn to modern architectural styles like Brutalism: "There's a lot of it to discover in Vienna". — *kh*

Prof. Dr. Ulrike Igel

"A day spent with a drug addict was a turning point for me". Prof. Ulrike Igel recalls the time in her life where she had left high school in Altenburg and ended up dropping out of a humanities degree. She felt completely lost. That chance encounter with a stranger opened her eyes to the daily struggles of addiction and ultimately led her to study social work at HTWK Leipzig. After graduating, she joined the "Social Work and Health" research group at HTWK Leipzig in 2007, where she developed a project focused on community-based health promotion in the east of Leipzig. She later expanded her research to examine how children's body weight is influenced by where they live. This topic was the focus of Igel's doctoral research at HTWK and Leipzig University, where she proposed strategies for promoting public health through urban planning, using Leipzig's Grünau district as a case study. She defended her exceptional work in 2019 – and was honoured with the Doctoral Thesis Award from the HTWK Foundation. "Writing my thesis while juggling other research projects and two small children was pretty challenging, so I was especially proud to receive the award", says Igel. Her very first application for a professorship was successful; since 2021, the 43-year-old has been Professor of Social Work in Social Settings at the University of Applied Sciences Erfurt, where she also heads the bachelor's programme in Social Work. In 2024, she reduced her working hours to spend more time on her partner's farm by the Baltic Sea. She is actively involved in various working groups dedicated to "social farming", a field that combines social work with agriculture. — *kh*

The waste from demolished buildings typically ends up in landfills or is downcycled for road construction

Recycling concrete

The construction industry consumes half of all raw materials mined around the world, so reusing building materials is essential to conserve resources. For several years now, the Structural Concrete Institute at HTWK Leipzig has been researching concrete reinforced with carbon fibres as a more environmentally friendly alternative to traditional steel reinforcement. And now the research team is taking things one step further, investigating whether crushed old concrete and recycled textile fibres could be used in the production of carbon-reinforced concrete. Klaus Holschemacher, Professor of Structural Concrete, and research associates Dr. Steffen Rittner and Robert Kraft have secured funding from the Federal Ministry of Research, Technology and Space (BMFTR) and are now teaming up with regional partners to explore how construction debris can be reused. At present, demolition waste is mixed together indiscriminately and either ends up in landfills or is used in road construction. This is a textbook case of downcycling. “Our goal is to develop a high-quality construction material”, says Rittner. To achieve this, construction companies need to take concrete samples before demolition to determine the materials used and check for harmful substances. During demolition work, the materials then need to be carefully separated by type, as mineral, non-contaminated components can still be put to good use. In experiments, Kraft has discovered that old concrete can be processed into coarse aggregate or even ultra-fine dust, both of which are suitable as supplementary cementitious materials in the production of recycled carbon concrete. In fact, the tensile strength of recycled concrete exceeds that of conventional concrete. This is likely because the larger aggregate particles in recycled material interlock more effectively than the rounder particles found in standard concrete. “With carbon concrete, we can increase the proportion of recycled concrete aggregate to as much as 60%. That’s twice as much as we’ve ever managed with recycled steel bar of steel mesh reinforced concrete”, says Holschemacher.

In their investigations, the researchers not only examined the concrete itself, but also focused on the reinforcement materials, with the goal of replacing them with recycled fibre-reinforced composites. “Yarns made from recycled fibres are harder to process because of their ‘open’ surface structure”, explains Rittner. Further research is needed in this area. That said, small structural elements can already be produced using carbon concrete reinforced with recycled textile fibres. — *kh*

Organic photovoltaics

Prof. Mathias Rudolph and Laura Ruminger check the measuring devices installed in the lettuce greenhouses

Germany aims to cover nearly all of its electricity needs with renewable energy by 2035, with a particular focus on wind and solar power. However, conventional solar panels made of silicon are heavy and bulky – and rely on precious raw materials. A promising alternative could be found in the form of organic photovoltaic cells (OPV), which use carbon-based compounds to convert sunlight into electricity. This would make it possible to produce solar cells that are lighter, thinner and more flexible. Their semi-transparency also makes them well-suited for applications like agrivoltaics, where the same plot of land is used for both agriculture and solar energy production.

As part of the "Organic Photovoltaic" research project, Mathias Rudolph, Professor of Industrial Metrology, and his research associate Laura Ruminger conducted a study from February to December 2024 to investigate whether OPV modules could be effectively utilised in agrivoltaic systems. The researchers set up three small greenhouses on the rooftop terrace of the Nieper Building at HTWK Leipzig. OPV modules were installed in two of the greenhouses, one of which also had LED lamps intended to operate for one hour a day using the electricity generated. A third greenhouse without any solar modules served as a control. The experiment was continuously monitored using sensors, and the collected data was subsequently analysed.

The results showed that the shading provided by the solar panels had a positive effect on the lettuce yield; both biomass and leaf health were better in the OPV greenhouses than in the control greenhouse. The plants grown in the OPV greenhouse also required 20% less water than those in the control greenhouse. However, the energy output from the organic photovoltaic modules was significantly lower than expected; instead of powering the LED lamps for an hour a day, they only managed a maximum of ten minutes.

Nevertheless, in agrivoltaic applications in particular, the advantages of OPV modules outweigh the drawbacks; thanks to their flexibility and semi-transparency, they allow more light to reach the plants than conventional silicon panels. The colour and transparency of OPV modules can also be tailored to the requirements of specific crops. As the technology is still in its early stages of development, further research is needed to enhance its efficiency and boost its electrical output. — *lr*

Why climate action has to be a collective effort

Ahead of the 2024 United Nations Climate Change Conference (COP29) in Baku, three environmental economists published a policy brief outlining potential solutions to close the gap in international cooperation. Their key recommendation was that policymakers should draw more heavily on insights from behavioural economics to help mitigate issues related to incentives.

COP29 brought together 35,000 people to discuss how to stop global warming

Bodo Sturm, Professor of Economics and Quantitative Methods, stands on the Global Warming Stripes on the Sachsenbrücke in Leipzig

At the 2024 United Nations Climate Change Conference (COP29) in Baku, Azerbaijan, more than 35,000 international participants were under immense pressure to deliver results. After all, if we want to curb climate change, we need to significantly reduce global greenhouse gas emissions – and fast. If things keep moving this slowly, projections indicate a global temperature increase of approximately 2.8°C by the end of the century.

Back in 2015, nearly 200 signatory states reached an agreement in Paris to limit global warming to a maximum of 2°C. "But the voluntary pledges and reduction targets adopted at the time are not sufficient to meet that goal", states the policy brief authored by Bodo Sturm (Professor of Economics and Quantitative Methods, HTWK Leipzig,) Dr. Carlo Gallier (Environmental and Climate Economist, Free University of Bozen-Bolzano) and Axel Ockenfels (Professor of Economics, University of Cologne).

The three researchers are currently analysing how environmental problems can best be addressed in a world where resources are limited. Their policy brief was intended to share findings from several years of research with delegates at COP29. In it, they advocate for a stronger focus on the principle of reciprocity. "This is currently lacking in international climate policy", says Sturm. Reciprocity refers to mutual exchange or interaction. In the context of climate action, this means that all member states should commit to more frequent negotiations and climate contributions. More regular interaction would effectively allow those countries to take small, low-risk steps towards climate action. "That kind of repeated engagement can ultimately build the mutual trust and reciprocal cooperation we need", says Sturm. This approach would also protect participants from exploitation and create stronger incentives to cooperate. With this in mind, the authors urged the heads of state in attendance at COP29 to give greater consideration to the literature on cooperation science and to recognise the key role that reciprocity can play in solving global cooperation problems.

Specifically, the three authors took a closer look at recent research findings and, in a discussion paper published in October 2024, provided an evidence-based evaluation of the measures outlined in the Paris Climate Agreement. One key focus of their paper is the Nationally Determined Contributions (NDCs) under the Paris Climate Agreement, including the "ratcheting-up mechanism", which requires participating countries to gradually increase their climate contributions over time. In practice, however, this increase has been insufficient. And the mechanism may even be counterproductive – for example, if countries set unambitious initial targets for strategic reasons or become increasingly reluctant to cooperate. In such cases, even subsequent increases in climate contributions may not be enough to compensate for the early lack of ambition. The mechanism also makes it easier for free-riders to take advantage of countries that are already doing their part.

The researchers based their findings on theoretical models, simulations and empirical data obtained under controlled conditions during an economic laboratory experiment.

Sturm: "Unfortunately, the principle of reciprocity seems to remain largely absent from international climate policy. It's business as usual. And I'm not sure that will be enough to stop climate change". — *frb*

Scan here for the policy brief
↗ **https://shorturl.at/PfxHq**

How radars detect drones

Researchers from Leipzig and Tokyo are teaming up to build networked radar systems powered by software-defined radios. These systems are designed to detect even small drones with pinpoint accuracy using spatially distributed units.

In the absorber chamber at the Electronic Navigation Research Institute in Japan (from left to right): Dr. Naruto Yonemoto, Dr. Morioka Kazuyuki, Dr. Junichi Honda, Prof. Robert Geise, Nikolai Mareev, Prof. Michael Einhaus, Masahiko Sato, Konstantin Schmidt and Ola Bidhan

A radar system sits atop every airport traffic control tower. It never stops turning, day after day, emitting electromagnetic waves and then receiving and processing echoes from objects to determine their position. Mechanical surveillance radar has been a basic component of airport infrastructure for decades. Now, researchers from HTWK Leipzig and the Electronic Navigation Research Institute (ENRI) in Japan have joined forces to enhance this technology. The project is supported by the German Academic Exchange Service (DAAD), which is funding several reciprocal research visits over a two-year period. In April 2024, Robert Geise, Professor of Electrical Engineering, joined doctoral candidates Ola Bidhan and Nikolai Mareev on a two-week research trip to ENRI in Tokyo, where they conducted wave propagation measurements using new systems in the institute's laboratories. And four ENRI researchers visited HTWK Leipzig in October 2024, using laboratories and technologies at the Faculty of Digital Transformation to carry out additional joint measurement campaigns.

With their measurements and calculations, the German-Japanese research team aims to develop novel radar systems for enhanced airspace surveillance. Airports have traditionally used radar systems in which the transmitter and receiver are located at the same site. However, this set-up limits the chances of detecting flying objects and pinpointing their location. Conventional radar systems can only detect small objects like drones if they strongly reflect the radar signal – and that depends on the object's size and material. For example, a large metal aircraft reflects signals far better than a small drone made of carbon – and those types of drone are becoming increasingly common. "That's why we suggest using several transmitters and receivers – placed at different locations and operating at higher frequencies – so even small flying objects can be detected", says Geise. A spatially distributed radar system would not only improve detection, but also enable higher-resolution imaging – even in three dimensions instead of two.

The researchers plan to implement the transmitting and receiving components of the distributed radar system using software-defined radios. These are high-frequency transmitters and receivers where some of the signals are processed by software. This technology is already common in things like Wi-Fi routers and smartphones. The researchers conducted their initial test measurements and programming work in a 30-metre-long absorber chamber at ENRI. This low-reflection, interference-free environment enables highly accurate and isolated testing of radar systems during development. Geise: "As the absorber chamber is so large, we were able to pinpoint objects to within about two to three metres during our initial measurements".

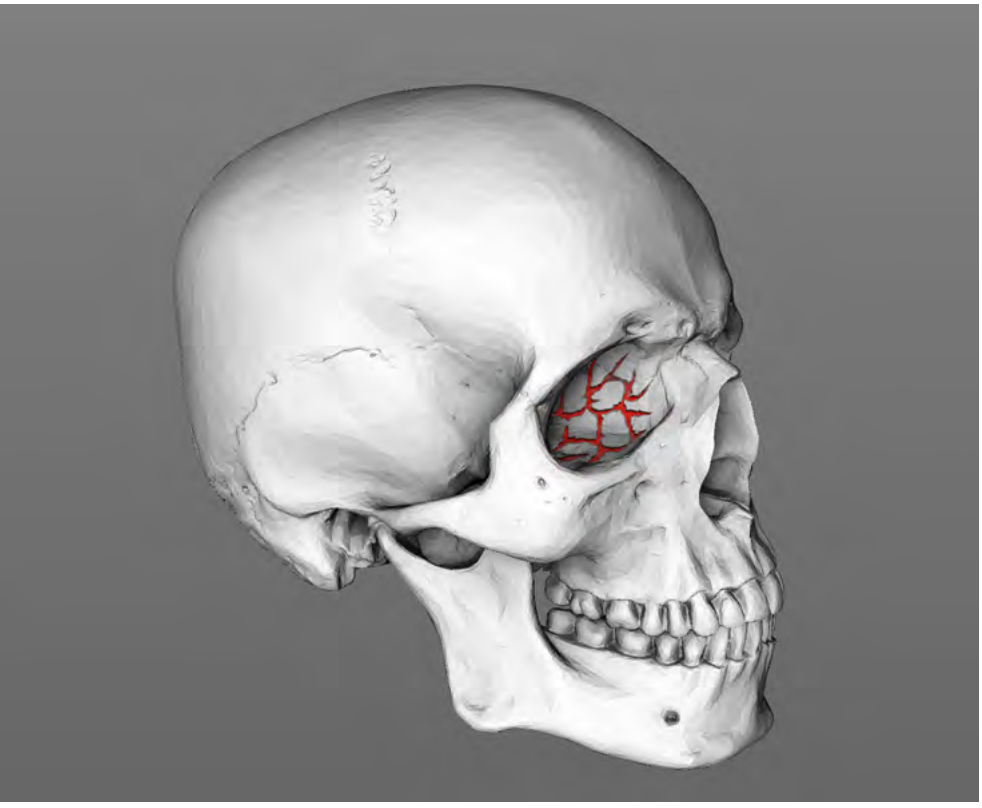
In addition to testing their new radar system, the project group is also aiming to put together teaching materials on software-defined radio and radar – in English, Japanese and German – by the end of the year. These resources will facilitate continued collaboration in teaching and research. — *kh*

Gently does it

If your eye gets hit in a fight, accident or fall, you can fracture your eye socket. Orbital wall fractures are the third most common cause of oral and maxillofacial surgery (OMFS) in Germany, as the bones around the eye are particularly thin. The instruments traditionally used in such procedures date back to the 1970s and are often too narrow, too small or too pointed. Soft tissue like muscle or fat can sometimes bulge over the retractors, obstructing the surgeon's view of the fracture site. In response to this challenge, and following consultations with medical professionals, medical device manufacturer Anton Hipp has initiated a redesign in collaboration with HTWK Leipzig and the university's Research and Transfer Centre (FTZ).

Since 2023, the project partners have been developing new surgical instruments under the direction of Martin Gürtler, Professor of Production and Logistics Systems at HTWK Leipzig, and with funding provided by the Federal Ministry for Economic Affairs and Energy (BMWE). The project started with 230 anonymised CT scans that were publicly accessible. Dr. Daniel Kruber used these datasets to generate 3D average models and analysed anatomical variations. HTWK Leipzig laid the groundwork for Anton Hipp, combining expertise in image and data analytics with engineering competence in design and development. This resulted in pre-shaped tools made of flexible stainless steel, tailored to the human anatomy. These retractors hold back soft tissue and give surgeons a clear view of the fracture site, thereby shortening surgery times. They also reduce pressure on surrounding tissue, helping to minimise complications, accelerate healing and potentially eliminate the need for follow-up procedures.

Gürtler's team also evaluated how much the instruments obstruct the surgeon's view during procedures, in order to assess their clinical suitability. The findings indicate that the new set of tools improves visibility at the fracture site and enhances the overall quality of operations. And their application isn't limited to fractures; the instruments could even be used to remove foreign objects or tumours from the orbital cavity. The prototypes developed during the project are now being prepared for the market – the medical device manufacturer plans to launch them by 2027. — *kh*



When you fracture the thin wall around your eye socket, surgery is the only option. HTWK Leipzig has teamed up with a medical device manufacturer to develop new surgical instruments

Two boats from HTWK Leipzig's concrete canoe team slowly sink into a sea of green. The races are over, new boats have been built, and the next generation is already out on the water

On the legacy of research

HTWK Leipzig is undoubtedly a university with a strong research profile. If you don't believe me, just flick through this issue of *Insights*. Or take a stroll through campus and look around – the signs of our research are plain to see. I did that just recently, and my eyes landed on two concrete canoes in the courtyard of the Trefftz Building, which are now just collecting rainwater. And it got me thinking:

What becomes of the objects we create in our research? Who takes care of them afterwards? What milestones do they represent? How long do we keep them once the project is long over? After all, research always leaves a legacy in the form of physical artefacts. While good scientific practice requires results to be documented and safeguarded, those concrete canoes aren't exactly the kind of items you might hand over to the university library for archiving…

Those abandoned vessels reminded me of a mysterious box I found 30 years ago, when I was finally given my own desk as a graduate student at my university. My new colleagues had just cleared out the previous occupant's workspace. A variety of experimental physics paraphernalia – electronic components, an acoustic lens, brass fittings – had been collected and placed into a cardboard box labelled "Sylvia's legacy". Nobody knew whether any of it was important. The researcher herself now lives and works in the United States. The research group no longer exists, and the cardboard box is probably still lurking in some basement. Its contents remain a mystery: valuable research documentation or just a pile of junk? — *Dr. Martin Schubert*

Dr. rer. nat. Martin Schubert (*1969) has been running the Studium generale programme at HTWK Leipzig since 2010. After studying physics in Frankfurt am Main, he moved to Leipzig in 1996. While working on his doctorate in ultrasonic microscopy, he founded a measurement technology start-up. In 2004, he took up a role in Saarbrücken, developing educational initiatives in nanotechnology, before his interdisciplinary perspective eventually brought him back to Leipzig.

Column

Start-up support – in the *Makerspace*

HTWK Leipzig's start-up support service, Startbahn 13, offers more than just useful tips and tricks for aspiring entrepreneurs. It also runs a Makerspace, where you'll find the facilities, tools and hands-on guidance you need to bring your ideas to life.

Julius Zeng programmes an embroidery machine in the Makerspace

The scent of fresh sawdust fills the air as a laser cutter moves quietly along its path. 3D-printed components lie on a nearby table, still warm from the printer bed. A few metres away, a CNC milling machine hums in the background while a team at the workbench tightens the final screws on their prototype. Welcome to the Startbahn 13 Makerspace – where ideas take shape.

From screwdrivers to waterjet cutters

Startbahn 13 has been helping all members of HTWK Leipzig get their business ideas off the ground since 2020 – with workshops, one-on-one coaching and a growing network of contacts. But even the best ideas need somewhere to take shape. And since 2024, the Makerspace on the Eilenburger Straße research campus has been exactly that place – where people can try things out for real.

From classic workbenches and electronics stations to high-tech tools like waterjet cutters and laser cutters – the Makerspace has everything aspiring entrepreneurs, researchers and students might need. Mehrab Moradi Nasrabadi, who studied bionics and now runs the Makerspace, makes sure everyone gets the support they need – both creatively and technically.

This rotor blade segment is about to become a table. Dimitrij Seibert starts by scanning the piece with a 3D scanner to digitally plan the next steps

Prototyping Day: experimentation encouraged

Curious about the Makerspace? Prototyping Day is a great place to start! Once a month, anyone can sign up and use the full range of equipment under expert supervision – free of charge. No red tape. Just hands-on support. A small community is forming where people can exchange thoughts and ideas to help bring their projects to life.

In addition to Prototyping Day, Moradi Nasrabadi and Julius Zeng also run workshops in the Makerspace, covering everything from basic electrical engineering and microcontroller programming to CAD modelling, 3D printing and vector graphics. You can even try your hand at machine embroidery! They also offer advice on choosing the right software and provide tailored access for students and university staff.

What's in the Makerspace?

- ✔ 3D printer
- ✔ Waterjet cutter
- ✔ CNC milling machine
- ✔ Electronics workstations
- ✔ Sewing and embroidery machine
- ✔ Conventional workbench

Sustainable innovation: a second life for old rotor blades

The wide range of equipment in the Makerspace is also used by researchers Dimitrij Seibert, Andrej Fehler and Philipp Johst from the Composite Circularity Lab, part of the "Lightweight Engineering" research group. They regularly work there on the "ValidFloatingPV" project, creating flotation devices and furniture from decommissioned rotor blade material sourced from wind turbines. Their aim is to validate their research into composite material recycling and apply their findings in the real world. The Makerspace provides the mechanical engineers with the facilities and tools they need to digitalise rotor blades, generate digital models and mill or cut custom parts. This results in functional everyday products made from fibre-reinforced composites – materials traditionally known for their limited recyclability. The researchers are testing how feasible and cost-effective their reuse concepts really are.

Innovation needs space and creative freedom

"This project shows how creative ideas can transform old materials into new, functional products – a perfect example of sustainable design and innovative applications in the Makerspace", says Moradi Nasrabadi. From complex research projects to creative design solutions and preliminary technical trials – the Startbahn 13 Makerspace is the place for everything. "Sometimes the hardest step is just getting started. That's exactly what this space is for – playing around with things, experimenting and creating something new", says Moradi Nasrabadi, as he welcomes the next team. — *fo*

Living lab for advanced timber construction

Wood is seen as a beacon of hope for a more sustainable construction industry. At the HolzBauForschungsZentrum, a timber construction research centre that opened at HTWK Leipzig in 2024, researchers can develop and test modern concepts and builds designed to save resources – at full scale and application level.

Wood has been used as a building material since the dawn of time. And it could play a pivotal role in transforming the construction industry, as its production and use have a much smaller carbon footprint compared to materials like cement, steel and aluminium. As a result, demand for timber construction has been increasing steadily for years – and is rapidly on the rise. To meet this growing demand, we need new architectural solutions that save on materials. After all, wood itself is also a finite resource.

Since the Timber Construction Research Centre (HolzBauForschungsZentrum) officially opened at the InnovationsPark • Bautechnik • Leipzig/Sachsen on 22 August 2024, researchers at HTWK Leipzig have been able to push their projects even further. In the new research and production facility in Leipzig's Engelsdorf district, the FLEX research group aims to develop and prototype automated manufacturing strategies.

"The HolzBauForschungsZentrum will put Saxony on the map as a hub for innovative timber construction research that shines across Germany", said Sebastian Gemkow, Saxon State Minister of Science, at the opening ceremony. Together with Thomas Schmidt, Minister for Regional Development, he also presented HTWK Leipzig with an approval from the European Just Transition Fund – granting five million euros in funding. This will enable the new research centre to purchase high-precision, digitally controlled manufacturing equipment, accelerating the transfer of knowledge and technology from applied research to industrial practice.

Alexander Stahr, Professor of Structural Engineering at HTWK Leipzig, was particularly pleased to see the facility open its doors and receive funding. As the scientific director of the HolzBauForschungsZentrum, he has headed the FLEX research group for more than a decade, working with his interdisciplinary team to develop pioneering strategies for individualised automated manufacturing concepts in timber construction. He wants to create geometrically and structurally customised building elements based on precisely defined digital standards. These production processes rely on numerically controlled manufacturing technology, making them considerably more efficient than conventional manual methods. This could pave the way for prefabricated timber construction to make it into practical applications.

With over 1,000 m2 of space to work with, Stahr and his team can now test and prototype their construction concepts at full scale. Parametric digital

Around 200 guests from the worlds of business, politics and science came together in August 2024 to celebrate the opening of the new research and production facility

The then-rector of HTWK Leipzig hands over the “key” to the HolzBauForschungsZentrum: a wooden root made with a 3D printer (from left to right): Prof. Alexander Stahr, Sebastian Gemkow, Prof. Mark Mietzner, Thomas Schmidt

models play a key role in seamlessly linking every step – from design and planning to efficient prefabrication, logistics and on-site assembly. The aim is to allow timber construction to capitalise more extensively on the benefits of digitalisation. “What really sets our model factory apart in terms of its technology is the prefabrication strategy that cuts down on lots of space. This system enables us to access every point in the facility and manufacture bespoke timber components”, says Stahr.

The FLEX research group wants to take collaboration with regional and national partners in the timber construction industry to the next level. The centre’s unique technological capabilities will be used in a variety of joint projects, with the aim of incorporating existing industry expertise into research and developing practical solutions away from the time pressures of everyday construction workflows. With the new concepts and construction methods developed and tested at the HolzBauForschungsZentrum, researchers and industry partners hope to strengthen modern timber construction in Saxony, contributing to a more environmentally friendly, sustainable, circular and modular building culture. — *frb*

“We need more time for in-depth research”

Democracy thrives on a diversity of opinions. But today’s society is caught between filter bubbles, a growing number of distribution channels and constant battles over who gets to shape the narrative. What does this mean for how we consume media? We sat down with Gabriele Hooffacker, Professor of Media-Compatible Content Creation, to talk about her latest book.

Your book is called “Why We Don’t Understand the Media – and They Don’t Understand Us”. Is that really the case?

Prof. Gabriele Hooffacker: It’s more about not knowing than not understanding. Take journalism, for instance. There are lots of strange misconceptions surrounding entry into the profession. So, one last time for the record: There is no ideological screening process, and you don’t need a state licence. Everyone is free to practise journalism. This right is protected under Article 5 of the German constitution. That rule was put in place to avoid repeating the mistakes of the Nazi era, when the media were under state control. On the flip side, journalists themselves are often frustrated by unfair criticism. Don’t shoot the messenger!

How did the book come about? Do you have a personal connection to the topic?

In conversations with editorial teams, I’ve sometimes sensed a quiet frustration, even resignation: “We do everything we can to present a range of perspectives, but the audience still isn’t satisfied…”. Once you understand the “hostile media effect”, the audience’s criticism starts to make

“Why We Don’t Understand the Media – and They Don’t Understand Us” was published by Springer in 2024
↗ **https://shorturl.at/Y3539**

Prof. Dr. Gabriele Hooffacker in conversation with Franka Platz

more sense. Most people like to see their own views reflected in the media – and tend to reject content that challenges their beliefs. And the stronger someone's opinion, the stronger their reaction tends to be.

Why is that a problem?

Plenty of the criticism levelled at journalists and the media is justified. It helps editorial teams improve the quality and accuracy of their work. But sweeping statements about "the media" simply echoing the views of "those in power" – whoever that may be – have the undertones of a conspiracy theory. These generalisations don't help anyone.

Discourse is a fundamental aspect of democratic societies. What role does journalism play in that?

Journalism is meant to help society understand itself and provide a solid foundation for informed decision-making. That means openly engaging in dialogue – even when it's tough to deal with someone who holds very different views. But that's the only way we can negotiate and find solutions that everyone can live with. But in the age of populism and hate speech, it's hard to get people on board with the idea of negotiation and compromise. That's why I want to reach out to people on both sides: dedicated journalists working in editorial offices and reflective members of the public.

What do you think are the biggest challenges facing the media right now?

There are fewer and fewer journalists in editorial offices – and they're up against more and more highly paid PR professionals in the corporate sector. It's almost impossible to see through the PR strategies of energy providers, car manufacturers, healthcare corporations and other big companies. Even increased use of artificial intelligence in editorial work can only help to a limited extent. We need more time for in-depth research!

Thank you for talking to us.
Interview conducted by Franka Platz.

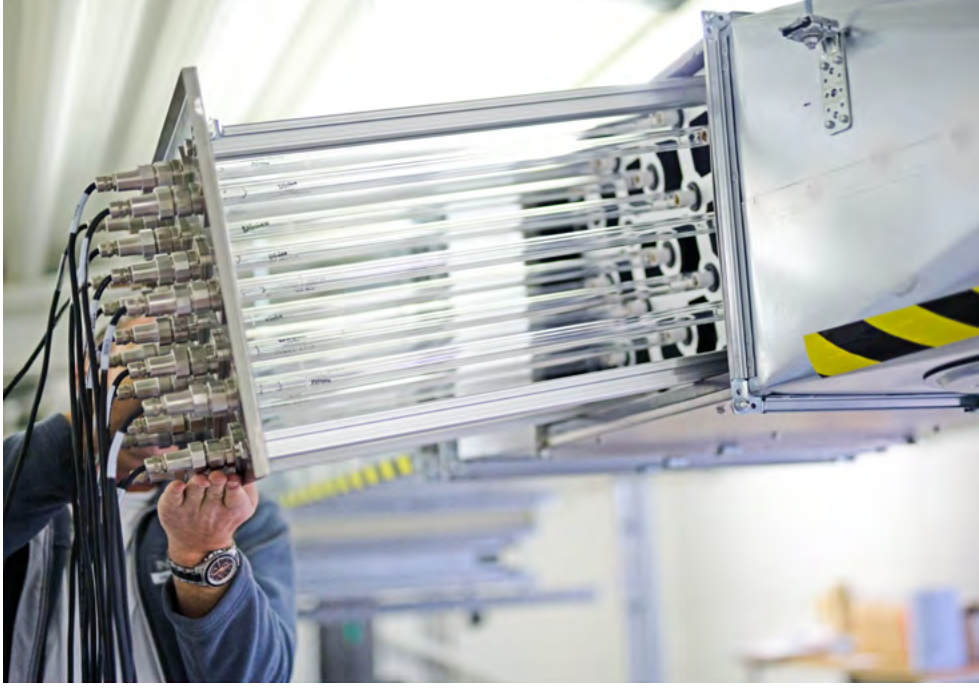
Prof. Dr. Gabriele Hooffacker
(*1959) is a journalist and author. Since 2013, she has also been Professor of Media-Compatible Content Creation at HTWK Leipzig. After completing her doctorate at the Ludwig Maximilian University of Munich, she worked in journalism and journalism education. She launched the "Long Night of Computer Games" at HTWK Leipzig. She is editor of the textbook series Journalistische Praxis and Leipziger Beiträge zur Computerspielekultur. She also co-edits the open-access journal Journalism Research. Even after retiring in autumn 2025, she plans to continue her publishing, teaching and research.

Light Against Viruses

Opening a window isn't always enough to limit the spread of airborne pathogens. The research project BeCoLe is breaking new ground in infection prevention: by using targeted UVC irradiation to disinfect indoor air, researchers aim to significantly reduce the risk of airborne infections. The technology could be life-saving for vulnerable patients in hospitals—and may also help make classrooms, theaters and public offices safer.

The COVID-19 pandemic exposed major weaknesses in indoor air quality. In many settings, regular ventilation is impractical or insufficient, highlighting the need for alternative approaches. This is where the collaborative research project BeCoLe comes in. Its aim is to harness UVC radiation to reliably eliminate pathogens from indoor air. While UVC has long been used to disinfect water and surfaces, its potential for air purification has remained largely untapped—mainly because solid data on its performance and safety in occupied indoor spaces has been lacking. The project partners want to change that. With funding from the Federal Ministry of Research, Technology and Space through mid-2026, Leipzig's major research institutions—HTWK Leipzig University of Applied Sciences, Leipzig University, the Helmholtz Centre for Environmental Research, and the Leibniz Institute for Tropospheric Research—have joined forces with industry partners S&P Sahlmann Planungsgesellschaft Leipzig für Gebäudetechnik mbH, NEL GmbH, and Dinies Technologies GmbH to create a real-world test laboratory. Built on the premises of lighting specialist NEL in Leipzig-Heiterblick, the facility features a central air ventilation system supplied by Daikin.

→ Mobile UVC units can clean the air in classrooms and waiting rooms



UVC lamps can also be integrated into ventilation systems to improve overall hygiene

Caution: Contagious!

The real-world laboratory, measuring nearly 200 cubic meters, can be reconfigured to mimic a classroom, a waiting room or other everyday environments. It is equipped with valves, tubing and sensors that allow researchers to trace how aerosols—tiny airborne particles capable of carrying viruses and bacteria—spread throughout a space. In a series of scenarios, they release weakened microbial particles via small tubes placed at mouth height and then measure how concentrations evolve at various points in the room. All collected data feeds into an advanced simulation model designed to support evidence-based strategies for air disinfection and aerosol control. The goal: practical, scalable measures that can be used in sensitive environments—or deployed rapidly in the event of a future pandemic.

Airflows in Motion – But Where to?

The simulation model was developed at HTWK Leipzig under the leadership of Stephan Schönfelder, Professor of Simulation Methods in Energy and Mechanics. It allows researchers to calculate how aerosols move within a room and how concentrations change when UVC devices are in operation. “Using numerical flow simulations, we showed that mobile UVC air-disinfection units can significantly reduce pathogen concentrations in aqueous aerosols. Key infectious agents—such as the tuberculosis bacterium, the influenza A virus, and SARS-CoV-2—can theoretically be neutralized by an average of up to 99.99 percent,” says Dr. Florian Wallburg, a research associate on the project. “Our results also reveal that the actual UVC dose reaching a pathogen fluctuates widely—and can only be estimated realistically through simulation.”t.

Keeping Society Open

Schönfelder’s team extended previously published aerosol models to incorporate targeted UVC air disinfection. “This allows us not only to calculate airflow patterns in detail, but also— for the first time—to simulate infection risks under realistic conditions,” he explains. “The model accounts for room layout, technical equipment and expected germ-reduction performance. It represents an important step toward robust, scientifically grounded indoor-air protection concepts and future pandemic planning.” A wide range of institutions—from hospitals to schools, theaters and public authorities—are expected to benefit from the project’s findings through practical recommendations. Industry partners such as UVC device manufacturer Dinies Technologies have already developed market-ready solutions.

The payoff is clear: the more precisely these systems are adapted and validated, the more effectively they can help protect public life—without resorting to renewed closures in the event of a pandemic. — *kh*

↗ doi.org/10.3390/ijerph19106279

How realistic are James Bond films?

HTWK professor Guido Reuther uses James Bond films to illustrate complex concepts in theoretical physics. His trailblazing approach to science communication earned him the inaugural HTWK Teaching Award in 2023. In December 2024, he then captivated a large audience at our “Science Cinema” event, breaking down iconic film scenes and answering other questions using formulas and physics calculations. Here’s what went down.

Prof. Guido Reuther fielded lots of detailed questions from hardcore James Bond fans. He explained which of 007's action scenes could actually happen in real life

James Bond, the fictional secret agent, is known for his spectacular action scenes. Take, for example, the legendary chase in "GoldenEye", where 007 plunges off a cliff in the Swiss Alps to catch up with a plane in free fall. Is that realistic? Or just cinematic trickery? "Well, theoretically, it is possible", says Guido Reuther, Professor of Applied Physics at HTWK Leipzig. But only if Bond's body were 32 times more aerodynamic than the aircraft.

At the "Science Cinema" event on 10 December 2024, held at the Zeitgeschichtliches Forum in Leipzig, Reuther presented three more action scenes from James Bond films to an audience of around 180 people – and broke down the physics behind them. "My main goal is to show young people that physics isn't hard or confusing at all", said Reuther.

Reuther often brings up James Bond action scenes in his lectures at HTWK Leipzig, where he is responsible for foundation-level physics courses aimed at engineering students in their first and second semesters. He uses these movie clips to make theoretical lessons more engaging and easier to understand. His outstanding teaching methods earned him the inaugural HTWK Teaching Award in 2023.

Reuther drew inspiration from Metin Tolan, who was Professor of Experimental Physics at TU Dortmund University until 2021 and President of the University of Göttingen until November 2024. Tolan is the author of numerous works, including "The Physics of Star Trek" and "Titanic: The Physics Behind the Sinking". Reuther chose James Bond for his popular appeal – not to mention his uncanny knack of pushing the boundaries of physics.

James Bond isn't just famous for his daring action scenes – he also has a wide array of intriguing gadgets. These intricate contraptions are developed by Q, the head of the fictional research and development division of the British Secret Service. A fan favourite is the magnetic watch that featured in "Live and Let Die" (1973). In a scene shown at the "Science Cinema" event, 007 uses it to snatch a coffee spoon from his boss several metres away – and to unzip a woman's dress. In sticky situations, the watch was also designed to deflect bullets at short range. "Impossible, I'm afraid", says Reuther. In order to produce such a strong magnetic field, the watch would have to be way too large and heavy to wear.

While Q's inventions are the product of his infinite ingenuity, Reuther's presentation at the "Science Cinema" event was backed up by scientific formulas and calculations that demonstrated how some of those action scenes would play out in real life. His explanations kept the audience on the edge of their seats – especially as some of the most spectacular stunts that everyone considered impossible were shown to be theoretically plausible within the laws of physics.

To wrap things up, Reuther addressed perhaps the most famous question of all: Why does the secret agent prefer his vodka martini shaken, not stirred? The audience was surprised to learn that this question had even been the subject of a scientific paper – who would've thought it? According to the research, the harmful free radicals in a vodka martini can bind more effectively when the cocktail is shaken rather than stirred. There is also a slightly more tongue-in-cheek explanation called "granular convection" or the "muesli effect", whereby shaking causes larger flavour molecules to rise to the top of the glass, while smaller alcohol molecules settle at the bottom. This way, Bond can enjoy the taste without getting drunk – after all, he always has to be ready to fight the bad guys. — *frb*

Reusing wind turbine blades

What are we supposed to do with old wind turbine blades? Instead of just throwing them away, a pan-European consortium of 20 academic and industrial partners is working together on the “EuReComp” project to find sustainable ways to reuse composite materials from the wind energy and aviation industries. The main objective is to establish a circular economy that reduces waste and produces high-quality recycled products.

The energy transition has given wind power a major boost in recent decades. However, the rotor blades on wind turbines are often made of glass fibres and thermoset composites and are designed to last only 20 to 25 years. With large numbers of these high-performance materials nearing the end of their lifecycle, there is an urgent need to develop viable reuse strategies. That’s where the “EuReComp” research project comes in. It was launched in 2022 – with the aim of developing innovative solutions to promote a circular economy – and has been granted 8.9 million euros in funding from the European Union, to be spread over a four-year period.

Turning old into new – with an eye on quality

The main goal of the European research consortium is to recover and reuse materials from the wind power and aviation industries. By implementing targeted circular economy strategies, they aim to reduce waste, conserve resources, cut emissions and lower energy consumption. “For the energy transition to succeed on the road to net zero, we need a circular economy with minimal resource consumption, waste production, emissions and energy consumption – and with closed-loop systems for materials and energy”, emphasises Robert Böhm, project manager and Professor for Composite Lightweight Engineering at HTWK Leipzig.

Around 60% of fibre-reinforced composite waste in Europe currently ends up in landfills. This causes serious environmental and societal problems. The EU plans to reduce the landfill rate to 10% and boost recycling efforts. The research consortium is helping to achieve that goal by developing new, advanced technologies and end-of-life strategies aimed at improving the recycling of carbon fibres and other composite materials.

Kevin Strödter (left) and Philipp Johst inspect a solar panel floating on part of an old wind turbine blade

Conventional recycling methods such as thermo-chemical pyrolysis (where plastic is converted into oil) use a lot of energy and are often harmful to the environment. They are also not suitable for all types of materials. One major challenge in recycling composite materials is their complexity – different materials are tightly fused together, making separation difficult or even impossible. That's why the research team is focused on developing more sustainable alternatives – with the aim of transforming old aircraft and wind turbine components into new, high-quality products for the automotive sector, shipbuilding and other industries. Three specific recycling processes are currently being tested and validated.

Flotation devices and filler materials

One of the approaches taken by the HTWK Leipzig research team involves repurposing rotor blades to build flotation devices for photovoltaic systems. Given their lightweight and robust design, rotor blade segments can be used as floater for solar installations on lakes and coastal waters. The first prototypes have already left the research campus on Eilenburger Straße; once Böhm and his colleagues Philipp Johst, Kevin Strödter and Dimitrij Seibert had cut and processed end-of-life rotor blades, they joined forces with a Portuguese research institute within the consortium to put one of the prototypes to the test. The trials were conducted on a lake in Leipzig and in a wave basin in Portugal – and they went well.

Another approach to reusing rotor blades involves mechanical recycling. Here, the blades are shredded into granulate, which can then be used as filler material in the construction industry. The research team at HTWK Leipzig is currently developing appropriate concepts in this area.

At the same time, the project partners are developing new components made from carbon fibre-based materials. To demonstrate how practical and effective their new recycling methods are, they are producing five prototypes, including a 3D-printed steering wheel for IndyCar racers. — *kh*

Climate action in business

Sustainability remains a key issue in society, yet political and regulatory pressure on businesses is easing in many places. With the US withdrawing from international climate agreements and the EU debating whether to relax existing regulations, such as through the "Omnibus" package, the writing is on the wall. "This reduces the pressure on companies to do more for the environment", warns Ronald Bogaschewsky, Professor of Industrial Management at the University of Würzburg, in the foreword to a study entitled "Sustainability and Carbon Management 2025". But decisive action is urgently needed – especially in global trade.

As part of this ongoing study, launched in 2023, Bogaschewsky has been working with Holger Müller, Professor of Supply Chain Management at HTWK Leipzig, to explore how companies approach their environmental responsibilities. The latest findings, based on a 2024 survey of 89 companies from various industries, focus on how businesses track greenhouse gas emissions and implement carbon management measures along their supply chains.

Two-thirds of the companies surveyed are subject to legal requirements such as the German Supply Chain Due Diligence Act (LkSG), as they have more than 1,000 employees. They report increasing market pressure, with approximately 70% observing increased customer expectations around the carbon footprint of their products. Even smaller businesses are starting to feel this shift.

Nearly three-quarters of the companies have set emissions targets – and around half of them have made those targets binding. However, implementation remains a challenge, with a lack of data, significant staffing requirements and inconsistent standards representing some of the biggest obstacles. It is particularly challenging to collect data on purchased goods – only 60% of the companies track the full supply chain in such cases.

When it comes to managing suppliers, corporate efforts tend to focus on education and awareness-raising, while concrete measures during negotiations remain rare. Yet many companies do recognise the benefits of sustainable business practices: 72% anticipate rising costs for inaction, and 67% identify positive effects on recruitment and employee retention. The study highlights that the core challenge doesn't lie in awareness, but in consistent implementation. — *kh*

Read the full study: "Sustainability and Carbon Management 2025"↗ **https://shorturl.at/tfqYQ**

How seriously are companies taking climate action? A new study offers valuable insights

It's been a real knowledge transfer journey: from a fashion photo featured in a 2015 issue of *Insights* (right), to the Cube, the world's first building made of carbon concrete (left), to the Carbon-reinforced Concrete Technikum at HTWK Leipzig

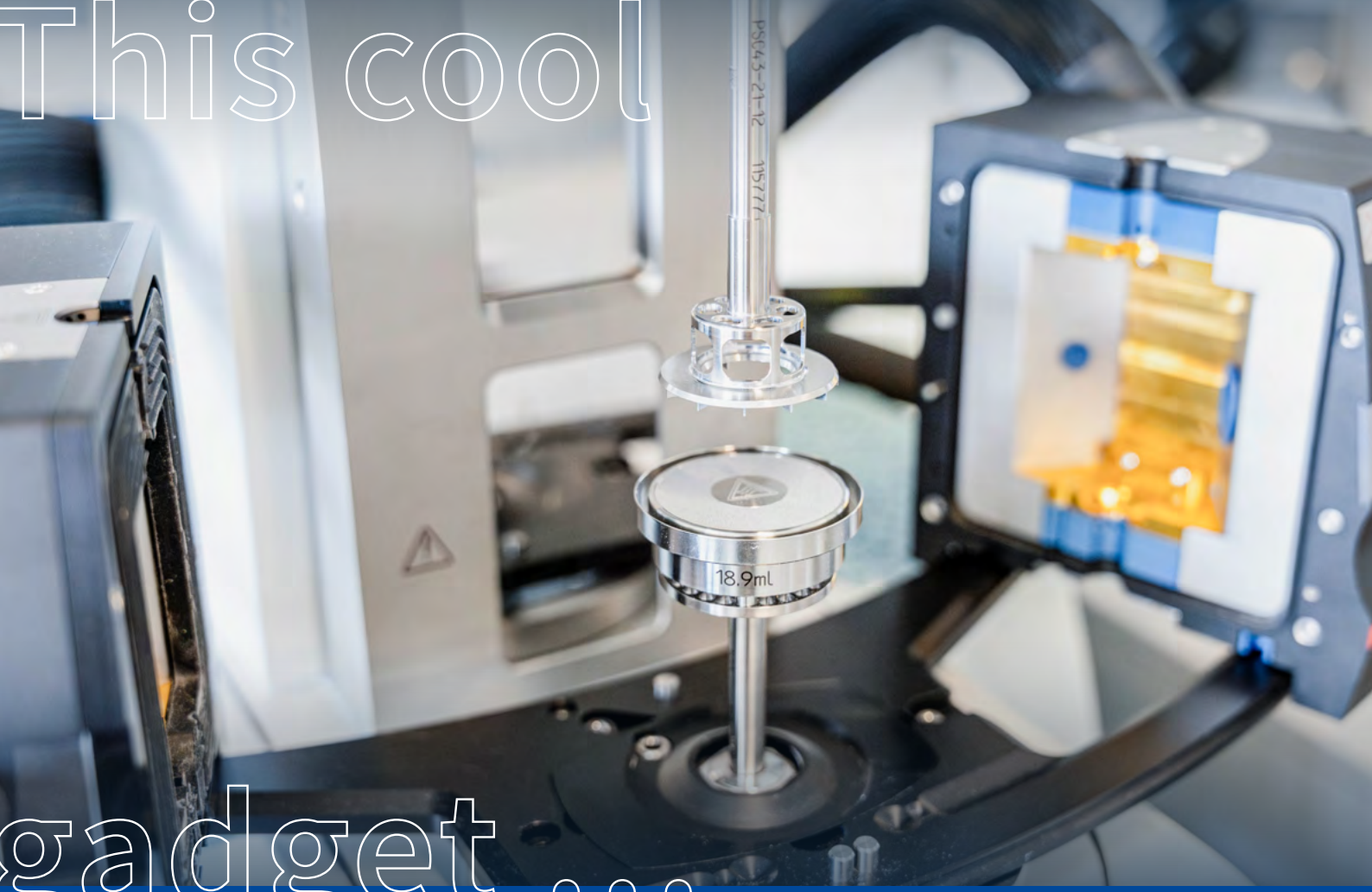
Concrete couture

Flipping through the issue of *Insights* from ten years ago, you may be surprised to see a full-page fashion photo – an unusual sight in a research magazine. The model in the photo is wearing a dress – made of concrete! She is draped in a soft, grey, shimmering carbon textile, which was originally produced by Gerster TechTex for technical applications. Her apron area reveals a sculpted fold made of rigid yet ultra-thin carbon-reinforced concrete. It's just 7 mm thick and weighs 2.5 kg. We asked Dr. Alexander Kahnt, head of the "Sustainable Building" research group at HTWK Leipzig's Institute of Concrete Construction, what this was all about. "We conceived the concrete dress in collaboration with designers Laura Krettek and Beatrix Krause to highlight the potential of the composite material carbon-reinforced concrete. It was created back in 2014 when we launched our major Carbon Concrete Composite (C^3) research project".

The carbon-reinforced concrete dress made its debut in 2015 at BAU, the world's leading trade fair for the construction industry in Munich. There, a model clad in concrete caught people's attention, drawing them to the consortium's exhibition stand. This inspired a curator from the Futurium in Berlin – located right next to the Ministry of Research, Technology and Space (BMFTR) – to send Kahnt an enquiry. The curator wanted to know whether HTWK Leipzig would be interested in exhibiting a carbon-reinforced concrete piece at the Futurium to showcase one of the most promising building materials of the future. The component remains on display there to this day. A decade of research by the C^3 consortium and knowledge transfer initiatives like this culminated in the construction of the Cube in Dresden, the world's first building made of carbon-reinforced concrete. "Just like the concrete dress, the Cube consists of very thin and partially curved carbon-reinforced concrete elements. Our next goal is to get this composite material standardised for widespread use. Since 2022, we've been testing automated production of carbon-reinforced concrete components at the Carbon-reinforced Concrete Technikum at HTWK Leipzig", says Kahnt. A team of twenty under the direction of Klaus Holschemacher, Professor of Reinforced Concrete Structures, is working alongside a research group headed by Tilo Heimbold, Professor of Process Control Engineering, to explore efficient, sustainable and cost-effective production methods for carbon-reinforced concrete. The researchers regularly give practical demonstrations to industry partners, showing how concrete plants have to be configured to enable automated production of carbon-reinforced concrete elements. So, in many ways, the fashion photo featured in Insights marks the start of a successful knowledge transfer journey – from the concrete dress, to the Futurium, to the Cube, and finally to the Carbon-reinforced Concrete Technikum at HTWK Leipzig. — *kh*

A look back

This cool gadget ...



... is a powder shear cell with a built-in climate chamber, hooked up to an MCR 102e precision rheometer made by Anton Paar.

... measures the flow properties of powders under controlled temperature and humidity conditions.

... supports researchers in optimising powder deposition for 3D printing, enabling the development of functional material composites and components In.

... is used by the Multimaterial AM research group at HTWK Leipzig, bringing together experts in additive manufacturing, printing technology and materials science.

... cost € 74,000 (including licence), funded through a major equipment grant from the German Research Foundation (DFG) for universities of applied sciences.

Project partners and funding

Many of the projects featured in this research magazine are supported through public funding programmes. They are carried out at HTWK Leipzig and the university's Research and Transfer Centre (FTZ). We would like to thank all funding bodies for their support. We also extend our appreciation to the numerous industry partners involved in our collaborative projects

Page numer	Funding agency
P. 16 ff.:	Funded by: Federal Institute of Sport Science; Federal Ministry for Economic Affairs and Energy; on the basis of a decision by the German Bundestag
P. 22 ff.:	Funded by: Federal Ministry of Transport; mFUND Funding Future Mobility; on the basis of a decision by the German Bundestag
P. 36, S. 50 f., S. 57:	Federal Ministry of Research, Technology and Space
P. 37:	ELSTATIK Stiftung
P. 40 f.:	DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service
P. 42, P. 44:	Supported by: Federal Ministry for Economic Affairs and Energy; on the basis of a decision by the German Bundestag
P. 44 f.:	Supported by: Federal Ministry for Economic Affairs and Energy; on the basis of a decision by the German Bundestag; Co-funded by the European Union; eXIST; The programme "EXIST – University-Based Business Startups" with its projects is funded by the Federal Ministry for Economic Affairs and Energy and the European Union through the European Social Fund Plus (ESF plus).
P. 46 f., P. 54 f.:	Funded by the European Union
P. 58: Funded by the German Research Foundation (DFG) – Project number 533332757	DFG Deutsche Forschungsgemeinschaft German Research Foundation

This issue of Insights was funded through the Saxony⁵ project as part of the Innovative Hochschule initiative run by the federal and state governments.

Innovative Hochschule

With funding from the: Federal Ministry of Research, Technology and Space; Gemeinsame Wissenschaftskonferenz GWK

Saxony⁵

Imprint

Publisher
Leipzig University of Applied Sciences (HTWK Leipzig), Research Office
PO box 30 11 66 | 04251 Leipzig

Editorial team
Katrin Haase (kh) (responsible),
Dr. Franziska Böhl (frb) and Dirk Lippik
Phone: +49 341 3076-6101
E-mail: einblicke@htwk-leipzig.de

Editorial deadline
April 30, 2025

Additional authors
Sven Heitkamp, Florian Oberkrome (fo), Franka Platz (fp), Laura Ruminger (lr), Dr. Martin Schubert

Corporate Design
wenkerottke GmbH

Graphic design, layout, typesetting and printing
Aileen Burkhardt, punze typografie

Print
SAXOPRINT GmbH, Enderstraße 92c, 01277 Dresden

Print run
300

ISSN
Print: 2194-4067, Online: 2195-9420

Image credits
Cover image, P. 4 (u.): *Aileen Burkhardt (Adobe Firefly)*
P. 2, 3, 18, 24–26, 27 (d.), 47: Swen Reichhold
P. 4 (d.): Sammy Schließer
P. 5, 12–13, 39, 50–51: Katrin Haase
P. 19–20: Patrick Frenzel
P. 21: Omid Arabbay
P. 27 (u.), 33, 34 (l.), 35 (r.), 43 (d.)–45, 52–53, 58: Saskia Pramor
P. 28: Dr. Franziska Böhl
P. 29: Kristina Denhof
P. 34 (r.): privat
P. 35 (l.): Sandra Schartel
P. 36: Dr. Steffen Rittner
P. 38: UN Climate Change – Kiara Worth
P. 42: Dr. Daniel Kruber
P. 43 (u.): Dr. Martin Schubert
P. 48–49: Jan Urban
P. 56: Jana Schönknecht / Adobe Stock
P. 57 (l.): Stefan Gröschel, IMB, TU Dresden
P. 57 (r.): Laura Krettek

Unless stated otherwise: HTWK Leipzig

↗ htwk-leipzig.de/insights