



University of Stuttgart  
Germany

# forschung leben

March  
2022

## Public Engagement

Creating knowledge together

### Innovation aid

Advancing the transfer of  
knowledge and technology

### Real-World Laboratories

Experimental fields for  
future questions

### Artificial Intelligence

Constructive dialog  
on the use of AI



Prof. Wolfram Ressel

“It is becoming increasingly important to get people involved in order to spur on research and innovation. This development is reflected in keywords such as public engagement and citizen science.”

## Dear Reader,

Over the past two years, the voice of science has become far more important in political and public discourse: not only did the Covid-19 pandemic result in a new quality of political consultancy, but the presence of researchers in daily newspapers, talk shows, and social media was also very marked. This not only has implications for politics, society, and the economy, but also for the science community itself, which now more than ever needs to address questions concerning its relevance to society.

It is becoming increasingly important to get people involved in order to spur on research and innovation. This development is reflected

in keywords such as public engagement and citizen science. This is why the German Federal Ministry of Education and Research (BMBF) has chosen the motto “In demand!” for the 2022 Year of Science. The University of Stuttgart too has incorporated the dialog between science and society in its mission statement. Our International Center for Cultural and Technological Studies (IZKT), which will be celebrating its 20<sup>th</sup> anniversary this year, has carried out some pioneering work in this area.

So the time has come to make space in »forschung leben« to discuss the interdependence of science and society. We would invite you to experience the citizen-oriented research of our Real-World Laboratories (reallabs), hear from our Prorector Prof. Peter Middendorf about how the University of Stuttgart is advancing the transfer of knowledge and technology, and read in Jens Rehländer's exciting guest article why the science community should learn to become more resolute.

I hope you'll enjoy this fascinating edition.

Yours sincerely,

*Wolfram Ressel*



Photo: Matthias Schmiedel

**Prof. Wolfram Ressel**  
**Rector of the University of Stuttgart**

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**VISIONARY**

**Moving rapidly forward to the application stage**

Photos: Sven Cichowicz, University of Stuttgart/SI, Robert Neuber  
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## EXPERIENCE RESEARCH

Experimental fields for future questions

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# NOTE PAD

## AWARDS

### ERC STARTING GRANT

Perovskites are the “rising stars” of semiconductor technology and are a promising base material for solar cells, light-emitting diodes, and the sensors used in medical technology, whereby thin sheets of the material can be extracted from a solution. However, it is difficult to control the film formation using current crystallization methods. **Prof. Michael Saliba** of the University of Stuttgart’s Institute for Photovoltaics (ipv) is aiming to use light to precisely control this film formation and has received a Starting Grant worth 1.5 million euro from the European Research Council (ERC) for this purpose.

In his LOCA-HEAT project, Saliba is planning to use light to control the nucleation and crystallization behavior of semiconductor films during the transition from the liquid to the solid phase. The idea is that this light will generate local heat pockets that will ultimately produce granules in a precisely controlled manner, which will enable the production of thin films.



### SILVER FOX AWARD FOR »FORSCHUNG LEBEN«



Major kudos for our own publication: »forschung leben« received the silver prize in the FOX AWARD for the “Intelligent Systems for a Sustainable Society” edition from March 2020, which was the first to be produced in collaboration with the Fazit and 3st agencies. The prize is awarded in recognition of outstanding communication media whose impact is deemed to be far above average based on at least four efficiency criteria. In their verdict, the jury referred to »forschung leben« as “an outstanding example of accessible science writing – a masterpiece both visually and in terms of content. “This publication,” they continued, “makes it easy to immerse oneself in the research being conducted at the University of Stuttgart, and appeals to both academics and interested laypeople alike.”



## INTO THE HEAVENS

Hands on astronomy – that was what was on offer at the *himmelwärts* (heavenwards) exhibition in February 2022 at the “Haus der Wirtschaft” in Stuttgart, a project run by the University of Stuttgart’s 5<sup>th</sup> Institute of Physics in collaboration with the Kepler Society in Weil der Stadt and numerous other partners. The exhibition marked the 450<sup>th</sup> birthday of the astronomer and natural philosopher, Johannes Kepler. Numerous experimental setups provided visitors with insights into Kepler’s inventions and thought processes and to discover, for example, how a so-called Jacob’s staff can be used to determine the position of a star and how the Kepler telescope works. Visitors could even learn how to tile a bathroom Kepler style.

In addition to the experimental displays, the exhibition also provided details about Kepler's life, who was born in the then imperial city of Weil der Stadt in 1571 and originally had his heart set on becoming a professor in Tübingen, but instead, he ended up working in Graz, Prague, and Linz, albeit rarely by choice: the quiet life as a scientist he so desired was stymied by the Reformation and Counter-Reformation, expulsion, unpaid salaries, high infant mortality, war, and witch hunts. His dream of flying to the moon was brought to life in an imaginative illustrated story and an animated film. His long-distance relationship with the planets was echoed by electronic sounds combined with music from 17<sup>th</sup>-century Tübingen.

## MADE IN SCIENCE

A headline in the “Stuttgarter Zeitung” in January read “Podcasts from Stuttgart that you should know” and included the University of Stuttgart's “Made in Science” podcast in the top ten. In his English-language podcasts, Dr. Wolfgang Holtkamp, Senior Advisor International Affairs, talks with researchers, alumni, staff, and students about their current projects, but also about what inspires them and how their careers have developed. He asks how they became what they are and what they would do differently in retrospect. Spätzle or Maultaschen? All interviewees either studied or worked at the University of Stuttgart in the past or are still doing so today, which makes them “Made in Science”.



“Made in Science” –  
The official podcast of the  
University of Stuttgart  
([uni-stuttgart.de/en](https://uni-stuttgart.de/en))



## CLOSER COLLABORATION WITH UNIVERSITY OF BERGEN

The University of Stuttgart is expanding its collaboration with the University of Bergen in Norway. The collaboration will focus on such issues as energy storage in porous media, wind energy, visualization and simulation technology, the digital humanities, bioinformatics, and systems biology, as well as issues relevant to infrastructure such as IT, research data management, and high-performance computing, in addition to the reflection of intelligent systems. The University of Bergen, which has a strong focus on basic research and refers to its strategy as “science that shapes society”, has four centers of excellence in Norway and works in a highly transdisciplinary manner.



## PAVILION ON DEMAND

On offer: one pavilion, seeking users – this is the idea behind a new space in an attractive location within the University of Stuttgart's Vaihingen Campus known as the ITECH Campus Lab. This 37 square meter timber pavilion, which features a novel, flexible timber construction system incorporating computer-aided design and computational methods, robot-assisted fabrication, and innovative material applications and joining techniques, embodies some of the core themes being explored in the Integrative Computational Design and Construction for Architecture (IntCDC) cluster of excellence.

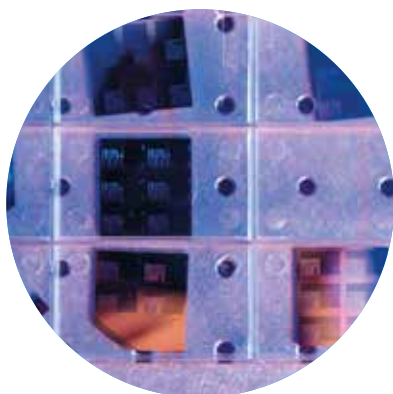
The idea is to fill the pavilion with life through a double opening: on the one hand, the building is open to the surrounding space, and on the other, the project is open to meeting the needs of potential users via an online survey of students and staff. The mood of the 384 survey participants was very clear: the majority would like the ITECH Campus Lab to serve as a study, meeting, and exhibition space in the center of the Vaihingen Campus. Based on these results, the project team developed a usage and operator concept in agreement with the university building authority and chose a location close to the guest lecturer's building, where the prefabricated lab is scheduled for completion in spring 2022.





## **THE WORLD'S FIRST ADAPTIVE HIGH-RISE BUILDING OPENS**

The opening ceremony for the world's first adaptive high-rise building took place at the University of Stuttgart's Vaihingen Campus in October 2021 in the presence of the Baden-Württemberg Minister of Science, Theresia Bauer. Researchers there are investigating how buildings could actively adapt to changing environmental influences under real conditions on a scale of 1:1. The prototype is being built at the University of Stuttgart as part of the "Adaptive Envelopes and Structures for the Built Environment of Tomorrow" Collaborative Research Centre 1244, which is funded by the German Research Foundation. The prototype high-rise (D1244) was also selected as an IBA project for the International Building Exhibition 2027 StadtRegion Stuttgart (IBA '27).



## **16 MILLION EURO FOR PHOTONIC QUANTUM PROCESSORS**

It is hoped that quantum computers will one day be able to rapidly solve problems that cannot be processed by conventional computer systems. However, such computers will have to process a significantly higher number of qubits and be prone to lower error rates before they will be of any practical use. To this end, a research network led by Prof. Stefanie Barz from the University of Stuttgart's Institute for Functional Matter and Quantum Technologies (FMQ) is currently developing a photonic quantum processor that will enable quantum algorithms to be implemented with a small number of qubits and, eventually, to be rapidly scaled up to qubit counts of practical relevance. Researchers in the PhotonQ project, which receives funding of around 16 million euro from the German Federal Ministry of Education and Research (BMBF), are trying to develop a processor for a photonic quantum computer. At the heart of this quantum processor is an integrated photonic chip.



## QUANTUM LEAP THANKS TO QUANTUM SENSOR TECHNOLOGY

The new Centre for Applied Quantum Technology (ZAQuant), a superlative research building at the University of Stuttgart, was handed over in October 2021 in the presence of the Baden-Württemberg Minister of Finance, Danyal Bayaz, and other prominent representatives from politics and business. Researchers at the University of Stuttgart want to work together with the industrial sector at the ZAQuant to raise quantum technology research in Germany to a new level and focus on practical applications. Four high-precision test boxes in a three-story high structure form the core of the research facility. To exclude any influence on the measurements through external vibrations, each of the ten-meter-high laboratories is built on a 150-ton concrete foundation slab, which in turn is supported on six pneumatically controlled springs. A fiberglass composite was used to reinforce the concrete in one of the research laboratories rather than steel, in order to exclude magnetic interference.

## THE FEHLING-LAB TURNS 20

Every year the “Fehling-Lab” experimental laboratory is visited by around 6000 children and young people, all sporting little white coats and huge lab goggles on their noses. There, they can explore nature and technology using everything from simple scientific activities to complex microwave experiments. The project, which is a collaboration between the Universities of Stuttgart and Hohenheim is celebrating its 20<sup>th</sup> anniversary this year. To mark the anniversary, it received 20,000 euro from the Chemical Industry Fund (FCI) and the Baden-Württemberg Chemical and Pharmaceutical Industry Associations. The Fehling-Lab was founded as a school laboratory for the natural sciences, with a primary focus on chemistry, as well as a training center for educators and teachers.



## SOFTWARE-DRIVEN AUTOMOBILE PRODUCTION

The University of Stuttgart and the Karlsruhe Institute of Technology (KIT) will be implementing two major joint projects in the coming years in the collaborative environment at the Mobility of the Future Innovation Campus (ICM): the “Software-Defined Car” (SofDCar) project team is carrying out pioneering work within the automotive IT jungle. The aim is to create standardized rules and processes to ensure that the electronic components in the vehicle interact smoothly, and can be updated at any time to ensure they continue operate safely. Participants in the “Software-Defined Manufacturing for the Automotive and Supplier Industry” (SDM4FZI) project are responding to the challenges confronting the industry, due to such things as fluctuations in demand, supply bottlenecks, and increasingly customized production, and are developing solutions for rapid, flexible, and efficient production. The objective is to plan, control, and change individual production system components, up to and including entire factories, in a flexible manner by decoupling software and hardware. This would enable automotive manufacturers to change between models and products more rapidly and also to produce more variants. The consortium leader in both projects is Bosch.

Photos: p. 6 Uli Regenscheit, p. 7 ESO, Canva, p. 8 University of Stuttgart/ICD/ITKE  
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# QUESTIONS FOR

## THE WINNERS OF THE GIPS-SCHÜLE RESEARCH PRIZE

**Prestigious award for three researchers at the University of Stuttgart: Prof. Dr. Harald Gießen of the 4<sup>th</sup> Institute of Physics, Prof. Alois Herkommer from the Institute of Applied Optics, and Dr. Simon Thiele from the startup Printoptix GmbH were all awarded the Gips-Schüle Research Prize, which is endowed with 50,000 euro, in October 2021. Together, they developed a 3D printing technology as well as novel materials and processes to produce the world's smallest miniature optics.**

**What innovations are you currently working on in the field of micro-optics?**

**GIESSEN:** We put together the smallest endoscope in the world, with a diameter of just 125 micrometers, which is about three times as thick as a human hair. We can use it, for example, to probe tiny blood vessels following a stroke, peer into the smallest glandular ducts, or even into the root of a tooth. The challenge was to build an optical system capable of being fitted to a fiber optic cable whilst still providing good quality images. Our goal, was to produce a lens that retains its shape particularly well at the micrometer level.

**HERKOMMER:** 3D printing gives us many options when it comes to designing surface shapes and mounting devices. Rather than having to mount the optics, we print the mounts at the same time.

**THIELE:** The imagination is no longer limited. It is now possible to conceive of and implement systems that were previously impossible, which is exactly what attracted me to this field.

**What are the benefits of using a 3D printer to manufacture micro-optics?**

**HERKOMMER:** The process is extremely fast. To give you an idea, we design the optics and create the simulation in the morning before printing the optical system in the afternoon and have the end result by the evening. This is a wonderful example of collaboration between engineering and physics.

**Where do we go from here?**

**THIELE:** Once our research had demonstrated that the process works, we decided to take it to industry and founded the startup Printoptix GmbH. We are currently collaborating with our first customers in pilot projects and medical professionals are already testing our first endoscopes.



Scan the QR code to view a video about this award-winning work in micro optics

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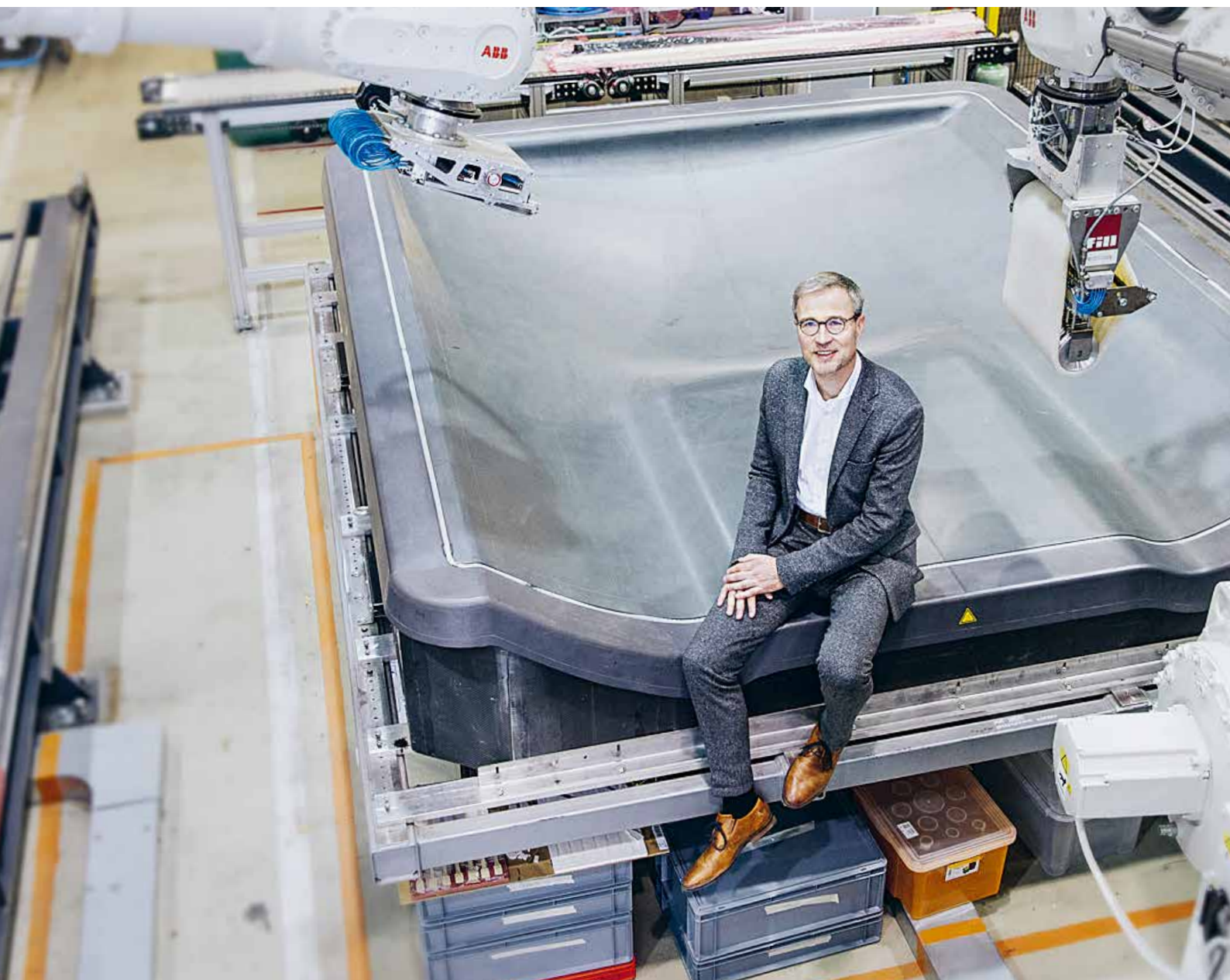
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# Moving **RAPIDLY** forward to the application stage







Lightweight construction  
using flax fibers

TEXT: Andrea Mayer-Grenu

PHOTOS: Sven Cichowicz

**The lightweight construction expert Prof. Peter Middendorf researches fiber composite technologies and, in his capacity as Vice Rector at the University of Stuttgart, is championing the transfer of knowledge and technology, whereby speed is of the essence.**

“Successful technology transfer requires a common mindset on both sides, and that always depends on people.” Aerospace engineer, Peter Middendorf, had already come to this conclusion prior to his time at the University of Stuttgart. Middendorf spent ten years in the industrial sector, initially at the aerospace company EADS, which is now the Airbus Group, and most recently as head of research programs with the helicopter manufacturer Eurocopter – effectively on the consumer side of university research. In fact, in his experience, there are significant differences in the respective mindsets: “The focus of university research is long-term,” he explains: “Time frames are often based on the amount of time it takes to complete a doctorate, which in engineering is three to five years, whereas issues arising in the industrial sector tend to become acute very rapidly and at ever-shorter intervals, and need to be addressed extremely swiftly.” These differing expectations present a challenge to both parties: “Industry partners need to understand that research is risky and that things don't always go as planned. On the other hand, the university partners must make every effort to deliver – even when, for example, someone has completed his or her doctorate and left the institute.”

Prof. Peter Middendorf

**“Successful technology transfer requires a common mindset on both sides, and that always depends on people.”**

#### FOSTERING A SPIRIT OF ENTREPRENEURSHIP

Middendorf brought an awareness of this conundrum with him when he took up a post as Professor of Aircraft Design at the University of Stuttgart in 2012 and became head of the Institute of Aircraft Design (IFB). It was a stroke of luck that the ARENA2036 research campus, whose declared objective is to unite the different stakeholders and speed up technology transfer, was planned at the same time. The original focus was primarily on the automobile of tomorrow, but this had to be made lighter, which meant that the expert in fiber composite technologies was in great demand: “Composite lightweight design originated in the aerospace sector, and the auto industry was soon beating a path to our door.”

There was no need to encourage technology transfer at the IFB itself. “Research at the IFB has always had a strong application focus and is characterized by numerous collaborations with industry partners”, says Middendorf, adding with a chuckle: “It was more a case of me having to fight my way through to the basic research side and, for example, establishing a track record with the German Research Foundation.” But the enthusiasm for knowledge sharing remained, as evidenced by an average of three to four invention disclosures and one spin-off per year. While Middendorf encourages the spirit of entrepreneurship, he also thinks of himself as a cautionary voice: “Notwithstanding my →

→ great enthusiasm,” he explains, “I also see it as my duty to critically question the business model to ensure that a given project has a chance of succeeding. And, of course, the PhD has to be completed or the paper written.”

## CREATING STRUCTURES

This passion turned into an official mission in 2018 at the latest, since which time, Middendorf has been the Vice Rector for Knowledge and Technology Transfer at the University of Stuttgart. Even at that time, outsiders perceived the university as a strong transfer engine in an innovative region, yet the existing structures were heterogeneous, and certain things, such as entrepreneurship, were still in their infancy. Middendorf's predecessor Prof. Thomas Graf had already advocated increasing and centralizing technology transfer and raising its profile. The task now was to set up the necessary structures for this. “This first involves developing a strategy, but also communications, fundraising, and reviewing the organization, including in comparison with other universities,” Middendorf explains.

The resulting strategy is focused on start-up-based transfers and continuously promotes entrepreneurship at every level – from the “Let US start!” teaching program, which is designed to awaken the entrepreneurial spirit among students, and the “Let US elevate!” start-up program, to hands-on start-up support in the technology transfer initiative (TTI), through to partner programs such as “Startup!Autobahn”, which promotes practical implementation in collaboration with industry partners as part of the ARENA2036 initiative. The new Chair for Technological and Digitalization Entrepreneurship, which is currently held by Prof. Alexander Brem, was established as a platform for start-ups with the support of the Daimler Fund in the Donors' Association.

## INITIAL SUCCESSES

These efforts quickly proved successful: the university was able to launch the EXi+ project in collaboration with the Stuttgart Media University almost from a standing start, with the aim of networking and supplementing existing opportunities in the field of entrepreneurship within the region. And the Donor Association's “start-up radar,” a ranking system that compares universities' efforts to boost their startup cultures, also shows a steep upward curve: the University of Stuttgart improved its ranking by 14 places in 2020 compared to 2018 and is currently ranked 12<sup>th</sup> among the 42 major universities in Germany. “We are delighted that the focus on entrepreneurship and →



**With an eye on both research and industry: lightweight construction expert Prof. Peter Middendorf researches state-of-the-art fiber composite technologies and promotes the transfer to practical applications.**



**Propelled by wind power: Middendorf and research associate Johannes Bauer tinkering with the Vento-mobil headwind vehicle**





Prof. Peter Middendorf

**“The purpose of the transfer center is to support university staff and, at the same time, to facilitate communications with external partners.”**

→ start-ups set out in our knowledge transfer strategy is bearing fruit so quickly,” says Middendorf.

At the research level, too, new lights are shining on the horizon in terms of knowledge sharing: the QSens future cluster, which is headed up by Professors Jens Anders and Jörg Wrachtrup, is developing quantum sensors for everyday applications in medicine, Industry 4.0, mobility, and sustainability. And researchers from the University of Stuttgart and the Karlsruhe Institute of Technology (KIT) are collaborating on breakthrough technologies in the fields of mobility and production at the Future Mobility Innovation Campus (ICM). As Middendorf emphasizes: “Both alliances are prime examples of how basic research and knowledge transfer can be tightly integrated.”



**Precision engineering:  
carbon fibers being  
mechanically splayed.**

#### **NEXT STEP: A CENTRAL TRANSFER CENTER**

Together with the so-called WTT round, he already has his eye on the next “construction site”: “We have to consider how we could better organize knowledge and technology transfers at the University of Stuttgart.” The concept of a central transfer center emerged from a thorough analysis of the potential structures and models. As of mid-2022, all instruments and contact persons will be brought together there under one roof, and previously underdeveloped elements such as a career service, technology scouting and start-up advice will be expanded along with the creation of a platform for strategic partnerships. The offices of major transfer projects such as the ICM or QSens could also be housed in the new center. “The purpose of the transfer center is to support university staff and, at the same time, to facilitate communications with external partners,” says Middendorf, pointing out the added value.

Furthermore, greater emphasis is to be placed on knowledge transfer and consequently on the topic of public engagement, particularly through collaborations with the University of Stuttgart's International Center for Cultural and Technological Studies and Interchange Forum for Reflecting on Intelligent Systems (IRIS), whose mission is to promote critical reflection on intelligent systems. Science communication should also become more important in this context, Middendorf is interested in more than just operational communications: “We also have an urgent need for research relating to science communication,” he explains. This is a hot topic, and not just since the new German government included science communication in its coalition agreement for the first time. As Middendorf stresses, you need to be quick off the mark if you want to get in on the action: “There’s no low-hanging fruit, but that just makes it all the more alluring.” →

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# INNOVATION AIDS



Supporting new ideas: among other things, an internal university fund provided financial support for a robot-assisted welding gun for lightweight vehicle construction.

Another project being advanced to market readiness with the aid of the fund is HygroShape, a concept for self-forming wooden furniture.

TEXT: Michael Vogel

**Numerous scientific findings have already been lost in the mire between the research phase and commercial implementation. The University of Stuttgart has set up its own knowledge and technology transfer program to counteract this trend.**

As Martin Werz and his team are well aware, research results are far from being a golden ticket to the commercial success of new technologies. Werz holds a doctorate in welding engineering and heads up the Department of Joining Technology and Additive Manufacturing at the University of Stuttgart's Materials Testing Institute (MPA). The technology developed to patent maturity by Werz' team in 2018 involves a new approach to so-called friction stir welding. "Whilst friction stir welding is beneficial from a process engineering perspective, we lacked a flexible, cost-effective plant technology," Werz explains. This is relevant in the field of lightweight vehicle construction, for example. Yet to raise awareness of the development within the industrial sector, Werz and his team needed more than laboratory results and a patent: "We developed and built a prototype."

This stage was funded by the university's internal funding program for knowledge and technology transfer. "Universities primarily conduct basic research with a focus on scientific discovery and application," explains Dr. Ralf Kaun, Head of Knowledge and Technology Transfer. "Further development work and practical prototypes are required to get the industrial sector interested in research findings and inventions and to prove →



→ the benefits.” This would go beyond the possibilities of normal research projects, he continued, which is why obtaining funding from the relevant funding sources would be virtually impossible. The Stuttgart program, which was launched in 2014, bridges this gap. As Kaun explains: “The projects we fund must have a clearly defined transfer-oriented objective.”

## **RAPID IMPLEMENTATION OF RESEARCH RESULTS**

The university has already funded 32 projects, and the approval rate is 41 percent. Only around ten applications a year were submitted in the first few years, but this had increased significantly by 2019 and 2020. The sums allocated per project usually range between 30,000 and 70,000 euro. “That may not sound like much,” says Kaun, “but it also serves as a disciplinary factor, as we want research results that can be implemented quickly.” Experience has shown that, in many cases, this does not require large sums of money. It also became clear that it is by no means just the engineering and natural science institutes that are confronted with the problem of bridging the “valley of death” between basic research and industry. “As the applications we receive illustrate,” says Kaun, “the humanities and social sciences face very similar problems.”

Werz’ team at the MPA team received 78,000 euro for the development of their prototype. “Previously,” Werz recalls, “companies merely shrugged their shoulders at our idea, but that changed abruptly once we were able to present them with components welded together using our prototype.” The approach has since been included in a project scheduled to start in 2022, for which an application has already been submitted to the German Federal Ministry for Economic Affairs and Climate Action (BMWi). “The objective of the project is to significantly reduce the number of components in a vehicle body by producing larger cast parts,” Werz explains. “Our technology will be used to weld these large castings to the adjacent chassis structures.” The project partners include material suppliers, foundries, and plant manufacturers as well as the University of Stuttgart’s Institute for Control Engineering of Machine Tools and Manufacturing Units (ISW). The declared goal is to get the system ready for series production.

## **PATIENCE REQUIRED EVEN AFTER INITIAL FUNDING**

As Kaun has found, the way things often go is that: “Funding through our program enables teams to take an important step, but they will still need staying power because it may not have been the final step.” In the case of MPA, the BMWi-funded project could well be the final step for the novel welding technology. “But we’ve also already been funding certain projects for a number of years that are now reapplying with a new focus in order to satisfy the transfer objective”. Says Kaun.

One such example is being implemented at the University of Stuttgart’s Institute of Machine Components (IMA), where a concept was developed a few years ago for a novel sealing ring type for rotating parts, such as those used in vehicle transmission systems and crankshafts. “Our sealing ring itself,” explains Lothar Hörl, senior engineer for sealing technology at IMA, creates an air cushion on the shaft itself, so there is barely any friction, but it still prevents any lubricant leakage.” Hörl and his team used 35,000 euro from the Knowledge and Technology Transfer Fund to produce a prototype back in 2017. A second grant of 34,000 euros, which they received in 2019, then enabled the team to develop and test another shaft seal prototype that works in both rotational directions. Finally, the team developed and tested a frictionless version using their own funds. “We now hold patents for Europe, China, and Japan,” says Hörl, “and our application in the USA is currently being processed.” Talks with industry are ongoing. →

## **CONTACT**

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# Using Kintsugi for greater climate protection

TEXT: Claudia Zöller-Fuß

**One of the aims of the "Greenesto - advance your mindset" project is to use a Japanese repair technology, to raise awareness of climate change among schoolchildren and to search for solutions.**



**Golden fracture: Kintsugi is a Japanese repair technique in which ceramic shards are turned into something new.**



Scarlett Spiegelers Castañeda

**“Kintsugi involves the creation of something new in a process that still fulfills the original purpose, but at the same time is completely different.”**



**Engineer and design  
thinking expert:  
Scarlett Spiegelers  
Castañeda**

A loud bang, followed by the sound of breaking pottery – shards of a shattered mug scattered all around. Scarlett Spiegelers Castañeda’s description of what sounds very much like the end of her favorite mug is actually the start of the so-called circular mug method, which plays a central role in the workshops of the “Greenesto – advance your mindset” project. The shattered mug serves as a metaphor intended to stimulate new thought and learning processes. Engineer Spiegelers Castañeda is head of the Design Factory Stuttgart and is breaking new ground with innovative approaches, such as the circular mug method, in the Greenesto project to raise public awareness of climate change and sustainability and to support people in their search for individual solutions. The workshops, which are initially aimed at schoolchildren in Stuttgart, will commence in the spring of 2022.

Greenesto is a collaborative project involving the Arena2036 Design Factory, the University of Stuttgart's Institute of Entrepreneurship and Innovation Science (ENI), and the Green Office. It is sponsored by the City of Stuttgart's Climate Innovation Fund and its aim is to develop sustainable mindset changes and climate awareness among the general public. “Technological developments and policy guidelines,” as the organizers of Greenesto explain, “are not enough to halt climate change in a sustainable manner. What is required is an awareness of sustainability concepts among the community, which has been sensitized to the subject and feels a sense of responsibility for the future of its city.” Workshops are at the core of this concept. The Greenesto team will use an e-van to travel primarily to schools. The eponymous mascot and symbol of Greenesto – a figure representing a muscular brain protectively holding a blue-green globe in its hands – is always present. On the one hand, the project team wants to raise awareness of the issue of sustainability among children and young people. On the other, the goal is to jointly develop ideas for how they could behave in a more climate-friendly manner in their everyday lives.



## **PROMOTING NEW WAYS OF THINKING AND BEHAVING**

The experiential circular mug method, which design thinking expert Spiegelers Castañeda and her team have adapted to different target groups for the Greenesto project, plays a key role in this process. This method, which places the same value on the process as on the result, is based on the Japanese repair technique known as Kintsugi and so-called mindset muscle training, the intention of which is to promote new ways of thinking and behaving.

Kintsugi translates as “golden joinery”. The process involves gluing ceramic shards together using Urushi lacquer and replacing missing parts with Urushi putty, into which gold powder or some other metal, such as silver or platinum, is sprinkled. This →

Scarlett Spiegelers Castañeda

**“Because taking care of our environment results in something valuable.”**

→ gold compound clearly highlights the break. “Kintsugi involves the creation of something new in a process that still fulfills the original purpose, but at the same time is completely different,” says Spiegelers Castañeda, explaining the underlying concept.



## INITIATING CHANGE IN FIVE STEPS

### 1. BREAKING THE MUG

The five-step circular-mug method begins with breaking the mug. “The circular mug method begins with a familiar situation that everyone can relate to, such as dropping their favorite mug,” Spiegelers Castañeda explains. “This unintentional action causes a palpable pain. In terms of sustainability,” she continues, “this pain can present itself in a variety of ways: the piles of trash in the park, water wastage, or simply the frustration of not being able to influence the food served in the refectory.”

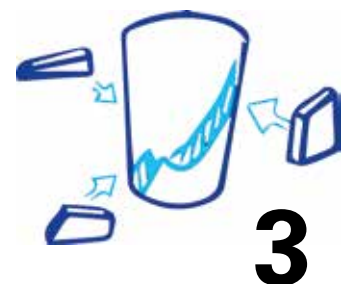
### 2. SHARDS FACILITATE A CHANGE OF PERSPECTIVE

Empathy, visual communication, and metaphors are core elements in Design Thinking; thus, sifting through and tidying up the broken pieces in the second step also symbolizes the gathering of information and research. This could involve some very practical questions from the schoolchildren, such as “how did we end up with piles of trash in the park?” or “why does nobody ever turn off the faucet in the school restroom?”. The purpose of this step is to facilitate a change of perspective and it also plays an important role in terms of the team dynamics within the group. “It's especially important for us to encourage sharing through this format; for the pupils to listen to one another and allow other points of view to be heard,” says Spiegelers Castañeda. “Developing a sense of empathy for the particular concerns and problems of their classmates is crucial.”



### 3. ALLOWING NEW THINGS TO EMERGE

The focus of the third step, in which the shards are put back together, is on the various potential ways in which each individual could make a very practical difference in his or her environment – and there are no limits to creativity. “You have to feel secure in order to want to change behaviors and creatively find new opportunities for change,” Spiegelers Castañeda explains. “So it is important to teach schoolchildren that there is no right or wrong and that everyone is accepted. No one should feel uncomfortable. Even if someone simply doesn't want to talk about their personal concerns.”



### 4. MAKING PERSONAL DECISIONS

The fourth step involves the subsequent individual recombination of the fragments with the help of creative design thinking techniques – and making a decision at the same time. All participants describe what they would like to do differently in the future, which could involve anything from water conservation to getting involved in the local environmental group. →



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→ The fact that something is changing both with the mug and in real life is primarily shown by the shiny gold that appears on the mug during the exercise: “We want to show that we’re changing something,” explains Spiegeler Castañeda, “because taking care of our environment results in something valuable.”

#### 5. BLUEPRINT FOR A SUSTAINABILITY DIALOG

Finally, in the fifth and final step, the new mug is used. “That’s the really nice thing about the Japanese idea,” says the engineer. “I don’t have to hide it if I do something different than usual or, for example, if I like to wear secondhand clothes.” Teamwork also creates a feeling of being stronger together and being able to influence things.

The “Greenesto - advance your mindset” team will start the circular mug method workshops in the spring of 2022. A concept book for coaches and a workbook for pupils are also to be produced at the same time. In the longer term, the project team intends to develop a blueprint for a sustainability dialog, because in addition to technological solutions and political guidelines, the main thing needed in the fight against climate change is a shift in the way the general public thinks. →



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# MAKING URBAN PLANNING TANGIBLE

TEXT: Michael Vogel

**One goal of many communities is to better involve local residents in the urban planning process, digital technologies with realistic 3D visualizations can facilitate this. The High Performance Computing Center Stuttgart (HLRS) is supporting such approaches in several research projects.**

Marienplatz is a central location in the southern district of Stuttgart, where there is a subway station, bus stops and taxi ranks, as well as the terminus of the “Zacke”, Stuttgart's cog railroad. One of the main routes of the cycling network in Baden-Württemberg's state capital also runs through this area. The square is also part of a main pedestrian route in the south of Stuttgart. Weekly markets attract even more people. Marienplatz is a popular meeting place and a vibrant urban center, but this also leads to conflicts between road users, which is felt by pedestrians and cyclists in particular, who are, of course, the most vulnerable road users. The City of Stuttgart wants to reduce the dangers and inconveniences faced by these groups at Marienplatz, to which end it is being transformed into a Real-World Laboratory.

## **IMPROVING CONDITIONS FOR CYCLISTS AND PEDESTRIANS**

“Choosing a mode of transport not only depends on cost and time, but also on whether a particular form of mobility is perceived as particularly pleasant,” explains Dr. Fabian Dembski, a research associate at the HLRS. “This is heavily influenced by any conflicts experienced along the way and subjectively perceived stress.” So anyone who wishes to promote cycling and walking would do well to reduce such inconveniences.

To this end, the HLRS is coordinating the “Cape Reviso” research project, which is funded by the German Federal Ministry for Digital and Transport, the aim of which is to improve the situation for the most vulnerable road users with the aid of digital technologies and the involvement of social groups. The Karlsruhe Institute of Technology (KIT) and the German Bicycle Club (ADFC) are involved in the project, as are other associated partners such as the City of Stuttgart. In addition to the one in Marienplatz, more Real-World Labs are planned in Stuttgart, Karlsruhe, and Herrenberg. The “Cape Reviso” project was launched in the summer of 2020 and is scheduled to run for three years.

## **ANALYZING THE TRAFFIC SITUATION WITH THE AID OF A DIGITAL TWIN**

“We make use of various methods in the project, which we then make freely available to the extent that this is possible,” says Dembski. “Community planners can then use this toolbox and expand as they see fit.” The project participants operate on two levels: →





**Citizen participation 2.0:**  
Traffic simulations using a  
model of the Marienplatz  
in Stuttgart



→ First, they use a digital twin of Marienplatz and use sensors and artificial intelligence (AI) to record and analyze the traffic situation.

The HLRS had already produced a digital model of Stuttgart in an earlier project, upon which the digital twin of Marienplatz will be based, which will be a virtual representation of the actual square that can be zoomed into from various perspectives. “We will then be able to perform various network analyses to see, for example, exactly which routes cyclists prefer to follow, which will enable us to identify potential danger zones,” Dembski explains.

At the same time, volunteers will equip their bikes with distance sensors, which were developed as part of the “Open Bike Sensor” volunteer project. Participants will be able to detect dangerous situations just by pressing a button on the handlebars. This will produce useful information when used in conjunction with distance and GPS data. “We will use a similar approach with pedestrians,” says Dembski. The KIT has developed a stress meter for this purpose. Sensors on the wrist record physiological data such as the pulse and the electrical resistance of the skin. A distance sensor and camera will be carried in a backpack so that the measured physiological data can be associated with external events. “It’s clear from the details that collecting data is easier for bicycle traffic than it is for pedestrian traffic,” says Dembski. “The reason we go to such lengths to collect data in the first place is simple: the statistics don’t reflect such events such as near misses.”

## PUBLIC INVOLVEMENT

The project participants are also planning to install cameras at Marienplatz which will automatically record bicycle and pedestrian traffic movements. “Because the data is processed directly in the camera units, there is no need for them to store images,” Dembski explains. “They will only store anonymized metadata about road users and their behavior, such as whether someone is walking, riding an e-scooter, or cycling, and whether they are moving, braking, or standing still.” The HLRS team will first have to train the AI algorithm to recognize these things. “We will also be asking the public for their support for this,” Dembski adds. “They can manually link exemplary imaging data with metadata.” The AI algorithm will then automatically analyze the situation at Marienplatz and produce meaningful data over a longer period.

“Thanks to all this data, people will then be able to try out the virtual 3D representation of Marienplatz to see how certain traffic control measures would affect the number of conflict situations,” says Dembski. The camera network will also be able to perform similar analyses when these measures are field-tested. “We also plan to set up a large-scale physical model in Marienplatz to give citizens the opportunity to share their visions.” After all, they know the place best, he said.

“Thanks to digital technologies,” Dembski explains, “we are able to involve the public in the design of urban spaces to a much greater degree, and in such a vivid manner that everyone will understand.” Rather than presentations and plans, the planned changes are shown in three-dimensional representations, in which the people merge with the scenery.

## THE GREEN TWINS PROJECT IN ESTONIA AND FINLAND

The HLRS is also involved in another participation project in Tallinn and Helsinki: The EU-funded “Green Twins” project was launched in January 2021 and is scheduled to run until May 2023. Dembski holds a research professorship at the Tallinn University of Technology in Estonia, which is leading the project. The Aalto University is also involved the Finnish side. Whilst it is true that Tallinn in Estonia and Helsinki in Finland are separated by the Gulf of Finland in the Baltic Sea, the two cities are only 80 kilometers →

Dr. Fabian Dembski

**“Thanks to digital technologies, ...we are able to involve the public ... to a much greater degree.”**





**Finding the best routes:**  
digital twins are designed  
to help ensure that roads  
are well designed for all  
road users

**Out and about in  
Marienplatz with the  
skateboard simulator.**



→ apart and share a very similar climate, fauna, and culture. The aim of the “Green Twins” project is to create a digital twin of the urban green spaces and then to analyze their interrelationships with the built environment in 3D visualizations and simulations, whereby as Dembski explains, referring to application examples, “key issues include plant care, root growth, as well as the urban micro climate. “The HLRS is contributing its knowledge of highly detailed digital twins to this effort.”

There are also plans to establish a permanent public participation and collaboration center in the Tallinn city center, where, members of the public will be able to preview future urban planning measures via two large 3D displays. “In this way, the City of Tallinn wants to bring about a permanent improvement in the respective planning processes,” Dembski explains. “The aim is to get the general public, architectural firms, academia, and city government talking to each other.” →

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Photo: Philip Bartz for the Volkswagen Foundation

**GUEST ARTICLE:** Jens Rehländer

**The Covid-19 pandemic and the increasingly heated debate about the appropriate measures to take have made many people more critical of science – which also poses an enormous challenge for science education. Jens Rehländer, head of communications at the Volkswagen Foundation, discusses what will be required to make science communication more resilient and more oriented towards the public interest.**





# **“The science community should learn to become more resolute”**

Christian Drosten has 900,000 fans on Twitter (#TeamDrosten; “Drosten Ultras“). You can buy vegan T-shirts featuring his quotes (“Oh dear. At this rate, we aren't going to even be able to discuss things.”). Early in the pandemic, ZEIT magazine asked: “Is he going to be our new chancellor?”

The virologist, who works at the Charité hospital in Berlin, was the first researcher to achieve cult status as a pandemic expert. Since then, representatives of other disciplines have entered the public arena advising politicians, appearing on TV talk shows, answering questions from the media, and launching their own podcasts and social media channels.

They partially account for the fact that the most recent “Science Barometer 2021” indicates a gratifyingly high level of trust in science and research among the population (61 percent). But they are unable to prevent 39 percent of respondents from leaning toward the view that: “scientists are not telling us everything they know about Covid-19.”

There is no doubt that, after more than two years of the pandemic, attitudes toward science have become more critical, and more distrustful. Early on in the crisis, when there was no empirical evidence, politicians, the media, and the general public followed the crisis management rules derived from the recommendations of virologists with almost no objection. Today, research findings are having to compete with broad debates about ethics, impositions, and trade-offs. A maelstrom of divergent opinions, including those from the various disciplines, is increasingly pushing researchers into role conflicts – for example, when rather than limiting themselves to scientifically justifiable statements, researchers start advocating measures that are the sole responsibility of politicians, who have to weigh up the general welfare aspects. By expressing their personal opinions in public, scientists set themselves up as targets for their critics, especially for those who, in spite of all the scientific evidence, choose not to be vaccinated against Covid-19.

The challenges facing science educators have never been greater than they are at present. In order to continue to have an influence in the discourse on future societal →

JENS REHLÄNDER

“In order to continue to have an influence in the discourse on future societal issues, those involved in the science system need to come up with a master plan.”

Jens Rehländer is head of communications at the Volkswagen Foundation in Hanover, Germany's largest private science funder. He is involved in funding programs and committees, and attends professional events in addition to writing articles to promote quality-assured science communication. Until 2010, he was an editor at GEO magazine from the Hamburg publishing house Gruner + Jahr.

→ issues, those involved in the science system need to come up with a master plan. If they wish to remain a respected voice in the next inevitable transformational crises, such as the climate crisis, the transformational use of artificial intelligence, global health issues, etc., the scientific community needs to be convincing in its ability to engage in dialog. And ultimately, they must be more resolute in defending the freedom and independence enshrined in the Basic Law against those who want to take it away. This is still just a radical minority within the overall population. Still.

### **What needs to be done to make science communications more resilient and oriented towards the common good?**

One fundamental requirement was recently formulated by #FactoryWisskomm an initiative of the German Federal Ministry of Education and Research (BMBF). In the introduction to the June 2021 report, which summarizes the findings of six working groups comprising 150 experts, it states programmatically that: science communication has to be treated as an “integral element of the science system” and “is subject to the same expectations and standards that are applied to good research and teaching.”

As simple as it may sound, this sentence holds enormous potential for reform, provided that this aspiration is put into practice at all universities and in all fields of research. It is a standard that reflects a shift away from marketing-driven science PR toward public-spirited enlightenment as a programmatic mandate for both researchers and institutional communications departments. →

→ **Which conditions would have to be met in order to achieve this paradigm shift? The list is long – here are just a few examples:**

#### **CREATING A CULTURE OF SYSTEMIC RECOGNITION**

Researchers who enter the public arena still do so at their own risk. However, they need to be assured that their public service commitment will be rewarded and that they will be able to rely on the backing of their universities should any conflicts arise. Some good approaches to a credible appreciation of value already exist: communications professionals were appointed to the top management level at German universities for the first time in 2021.

#### **SCIENCE COMMUNICATION AS A COMPULSORY MODULE**

All students should be taught the basic tenets of science communication as part of the curriculum. As of the postdoc career stage, media training should supplement continuing education, albeit on a voluntary basis: not all researchers are talented science communicators, and it is not possible to communicate all research topics to lay people.

#### **LEARNING TO UNDERSTAND TARGET GROUPS**

The proverbial "dialog with the public" was never really taken seriously by the scientific community and was only ever intended to satisfy a political expectation. It's high time to take a closer look at the realities and expectations of target groups and how to get them involved – even those who are skeptical about science. Under the motto "In demand!", the 2022 Year of Science offers a test site subsidized by the BMBF where experience can be gained.

#### **STRENGTHENING INTERDISCIPLINARY COMMUNICATIONS RESEARCH**

It will only be possible to tackle the major challenges of the future through global and interdisciplinary collaboration. Even the view of virologists on the pandemic is only one perspective. Perspectives from the fields of psychology, sociology, and human medicine, for example, are just as indispensable when it comes to viewing the phenomenon in a differentiated manner. Yet how does one communicate this accumulated expertise in a way that has an informational impact? This is where communications researchers could play a key role in future – provided that they finally succeed in transferring their research findings to practical applications.

#### **EXPLAINING THE RULES-BASED COGNITION PROCESS**

What the pandemic has shown is just how underdeveloped scientific literacy is among the general public, including decision-makers in politics and business. There is little awareness beyond the scientific community of the fact that rather than being phenomena of academic disorientation, disagreements among experts, uncertainties, and the provisional nature of research results are characteristics of the rules-based knowledge acquisition process. Those involved in the scientific system must therefore do an even better job of explaining how it works. Transparency creates trust and facts alone are not very convincing.

The list of potential improvements could be extended considerably. At the moment, however, the most important thing is to focus on action rather than debate. The science community should learn to become more resolute – and fast: the stakes are high. →

Wide bandwidth:  
Real-World Laborato-  
ries are about modern  
sensor systems as  
well as concepts for a  
sustainable mobility  
culture.



# Experimental fields for future questions



TEXT: Jutta Witte

PHOTOS: Sven Cichowicz

**Whether we're talking about climate change, the energy transition or digitization, researchers must also try new approaches to tackle the major challenges of our time, for example, in so-called Real-World Laboratories, the purpose of which is to forge new links between the world of science and that of the people who use it.**



An innovative mobility system for the University of Stuttgart's Vaihingen Campus was developed in the "MobiLab" project.

The thing that unites all those involved in the "CampUS hoch i" Real-World Laboratory is the vision of a climate-neutral, sustainable campus. The interdisciplinary team from the fields of engineering, sociology, and sustainability management is breaking new ground to achieve this goal. Under the auspices of the University of Stuttgart's Institute for Energy Economics and the Rational Use of Energy (IER), the aim is to develop specific proposals for how the university buildings on the Vaihingen Campus could be renovated and redesigned in a climate-neutral, intelligent, and cost-effective manner – and to do so in collaboration with the people who study, teach, conduct research, and work there.

According to IER Director, Prof. Kai Hufendiek: "Fifty percent of energy use in this country is for heating buildings and hot water generation, and buildings currently account for almost half of the emissions throughout Germany." At 75 percent of the greenhouse gas emissions, he adds, the figure is even higher at the Vaihingen Campus. There are many ways to incorporate more sustainability and energy efficiency within the construction sector, he continues; these range from the use of waste heat and the installation of solar systems and heat pumps, to smart building management systems and innovative construction materials. "We can already do this well in new buildings." However, as the energy systems expert predicts, "although existing buildings present a considerable challenge, they also have great potential."

#### INVOLVING ALL STAKEHOLDERS IN THE DESIGN PROCESS

One way to make existing buildings more energy-efficient is to incorporate novel technologies, but this can only be done sustainably if users are involved in the design process from the outset. "The Real-World Laboratory has been guided by this idea right from the start," says Hufendiek's project partner, the sociologist Prof. Cordula Kropp, Director of the University of Stuttgart's Center for Interdisciplinary Risk and Innovation Studies (ZIRIUS). "Our starting point is the perspective of the various stakeholders, and we specifically ask them what they need so that we can meet their space requirements whilst minimizing the buildings' CO<sub>2</sub> emissions," she explains.

This approach typifies the Real-World Laboratory concept. Real-World Laboratories promote transdisciplinary and transformative research, i.e., they leave the academic cosmos behind to meet people in the reality of their everyday lives in order to experiment together and address the urgent issues of the future. The state of Baden-Württemberg is vigorously pushing this concept under the motto "Science for Sustainability" and is one of the pioneers of Real-World Laboratory research in Germany, having set up 14 Real-World Labs between 2015 and 2020. Science Minister Theresia Bauer sees the "made in BW" Real-World Labs as a model of success.

#### THE UNIVERSITY OF STUTTGART WAS AN EARLY ADOPTER OF REAL-WORLD LABS

With two Real-World Laboratories that addressed the processes of change and transformation in the city, the University of Stuttgart has been involved right from the outset. For example, the (Future City Lab\_University of Stuttgart - Real-World Laboratory for →

→ Sustainable Mobility) examined various facets of mobility development in urban areas, whilst the City:Quarters 4.0 Real-World Laboratory was focused on innovative digital tools for urban planning. The “CampUS hoch i” Real-World Laboratory is currently focused on combating climate change in the construction sector.

The yellow brick building that houses the University of Stuttgart's Institute of Construction Materials (IWB) is a good example of how the various stakeholders interact in this context. Built in 1959, it is now due for a comprehensive refurbishment, particularly with regard to fire safety and prevention and power supply. The actual conditions of use will be taken into account during the planning and implementation phases in order to ensure the success of the construction measures, which is why the ZIRIUS not only asked students and staff at the IWB about their expectations of the building, but also worked out how to align these expectations with the needs of the administration and planning authorities.

### FROM ECOLOGICAL CONCRETE TO SMART SENSORS

The project partners are studying various perspectives on what will be possible in buildings of the future. Among other things, for example, IWB Director Prof. Harald Garrecht and the two PhD students Christien Hein and Lisa Hoss are working on ecological concrete types, which are designed to provide load-bearing capacity, insulation, and a pleasant indoor climate in lightweight buildings using as little material as possible. For instance, a modular “room cell” is being planned in the course of the lab, the purpose of which is to enable people to actually experience the effect of the new building materials. Just how important intelligent technologies are for achieving a climate-neutral energy supply can also be seen at the Institute for Building Energetics, Thermotechnology and Energy Storage (IGTE), where, scientist Sven Stark introduces visitors to the world of sensor systems that, for example, can detect whether doors and windows are open or closed, analyze the indoor climate, and even record how many people are in a particular room and where, which makes for optimal control of the energy demand and supply.

“What we can do with sensor technology is virtually unlimited,” says Stark. But how do people cope with it? Do they feel overwhelmed or as if they are being monitored? Such questions will be addressed through focus group analyses that include ideas and past contributions from campus members regarding ecological transformation. “We're combining technology and user worlds, which ultimately changes both,” says Kropp.

### STIMULATING LASTING CHANGE

Prof. Martina Baum, head of the University of Stuttgart's Institute of Urban Planning and Design, has also set herself the goal of creating experimental spaces in real contexts to stimulate lasting change and is already very experienced in Real-World Laboratory research, for example, as a member of the aforementioned Lab for Sustainable Mobility Culture. Researchers there have joined forces with other Stuttgart-based associations and institutions, the City Council and the public, and together they have been exploring ideas and concepts that could help return space to people in a car-oriented city, or even open up new spaces. Some large-scale practical experiments and many smaller projects have been conducted there, some of them with a tremendous amount of commitment from the students. Some of these “temporary interventions” are now being continued by the general public or are being incorporated into urban development plans. “It was clear that the sensitization we initiated through this lab actually had an impact,” says a positive Baum. →



Looking to the future:  
Presentation on the  
"Stadt: quartiere 4.0"  
(Urban District 4.0)  
Real-World Laboratory



→ As the expert observes, the success of a Real-World Lab will always depend on the specific conditions and the people involved. The key thing, according to him, is communication, but also the synchronization of the scientific, social and, administrative processes and, last but not least, accepting failure. Consequently, the University of Stuttgart has already accumulated a considerable amount of expertise in the planning and implementation of Real-World Laboratories.

Researchers at the International Center for Cultural and Technological Studies (IZKT) are now planning to use and keep this knowledge alive in the course of an initiative known as the "Knowledge transfer reloaded. The Stuttgart Real-World Laboratory research project". Not only will the resulting "lab literature" be analyzed, but also the lessons learned from the workshops. The current focus is on launching a website where knowledge, for example about good practices for real experiments, can be collated and presented in a way that is specific to the relevant target group. "We want to highlight the successes, but also the challenges," says Natalia Pfau, a scientific coordinator at the IZKT. One important element will be a "method case" in which the various approaches used by the individual disciplines will be brought together. "Because," as Pfau explains, "it always has to do with craftsmanship, too."

### NO SOLUTIONS FOR THE IVORY TOWER

But what happens after the project and presentations are over and the reports have been written? "That's when you need anchor points in the community – groups of people and institutions that will commit to the cause over the long term," says urban planner Baum. As energy systems expert Kai Hufendiek emphasizes, the aim of "CampUS hoch i" is not to develop solutions for the ivory tower, but rather for broad, long-term application: "Rather than building high-end model buildings, we want to create something that is realistic and affordable."

And community participation is absolutely necessary, which is why Cordula Kropp and her team, as well as Birgit Mack, Karolin Tampe-Mai, and Michael Ruddat, have set up a very special real experiment. A permanent site hut on the Vaihingen Campus will in future enable visitors to experience what sustainable and climate-neutral construction means in practice. "We are actually continuing the age-old cultural tradition of cathedral building lodges," Kropp explains. Craftsmen in the Middle Ages were able to study and test innovative technologies and new materials in these site huts (or lodges as they were known then). And like the Real-World Laboratories, they created novel insights from real-world experience that could be put to use directly in the field. →

### CORDULA KROPP

"We're combining technology and user worlds, which ultimately changes both."

Prof. Harald Garrecht,  
Christien Hein and Lisa  
Hoss examining intelligent  
roof tiles.

Among other things,  
ecological concretes will  
ensure a pleasant indoor  
climate in lightweight  
buildings.



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## ACTIVE LABS

### **MobiLab (Mobility Living Lab): The emission-free campus as a laboratory for research and innovation**



The purpose of this Real-World Laboratory at the University of Stuttgart is to promote climate-neutral mobility and eliminate car traffic from the Vaihingen Campus.



**Coordination:** the Institute for Road and Transport Science (ISV) at the University of Stuttgart

### **Real-World Laboratory for industrial-scale heat pumps in district heating networks: installation, operation, monitoring, and system integration**

This Lab focuses on municipal heat supply and is investigating the contribution that industrial-scale heat pumps could make to the energy transition.

#### **University of Stuttgart project partners:**

Institute of Energy Economics and Rational Energy Use (IER)



**Coordination:** AGFW |  
Der Energieeffizienzverband für  
Wärme e.V.

### **Climate RT LAB: Climate-neutral Reutlingen: Transformation of the City Corporation to a shaper of climate neutrality**

The aim of this Real-World Laboratory is to support the transformation of Reutlingen into a climate-neutral city in various arenas.

#### **University of Stuttgart project partners:**

Institute of Energy Economics and Rational Energy Use (IER)



**Coordination:**  
Reutlingen University

### **CampUS hoch i: CampUS made intelligent**



The aim of this Real-World Laboratory is to explore ways in which the university's own buildings on the Vaihingen Campus could be renovated and redesigned in a climate-neutral and sustainable manner.



**Coordination:** Institute of Energy Economics and Rational Energy Use (IER), University of Stuttgart





### Instrumentation scheme for standard operational railroad vehicles

An AI-based process is being developed and tested in the context of this Real-World Laboratory, with which track faults can be detected at an early stage as well as during normal rail operations.

**Coordination:** the Institute of Railway and Transportation Engineering (IEV) at the University of Stuttgart



**Video** about the Real-World Laboratory

## COMPLETED LABS



**Stadt:quartiere 4.0** - Early formative citizen participation for sustainable development in Baden-Württemberg



**Future City Lab** - Real-World Laboratory for a sustainable mobility culture



**Real-World Laboratory Schorndorf** – trend setting public transport.

Citizen-oriented optimization of local transport capacity, efficiency and attractiveness



Photo: private

# “MOVING FROM KNOWLEDGE TO ACTION”

INTERVIEW: Jutta Witte

**Dr. Elke Uhl is head of the administrative office of the University of Stuttgart's International Center for Cultural and Technological Studies (IZKT). She explains what sets Real-World Laboratories apart and why they form an important component of the university's transfer strategy.**

**“Research is not done on people, but with them.”**

**Dr. Uhl, what is the idea behind the Real-World Laboratories?**

**DR. ELKE UHL (EU)** The basic idea behind them is the realization that we need to use other forms of research support to address the major challenges facing our society. This is why the state of Baden-Württemberg has been promoting this format since 2015 on the initiative of the Sustainability Advisory Board. Just how important this research is in terms of sustainability has once again been highlighted by the Covid-19 crisis.

**How do Real-World Laboratories advance this kind of research?**

**EU** The short answer is that they help us to move from research to application. Real-World Labs combine the science of systems and objectives with the practice of transformation – in other words, knowing how we can break through our usual routines, adapt regulatory conditions to meet the challenges we are facing, and involve people from different spheres, including the public sector, politics, and administration.

**What is the difference between real-world laboratories and traditional laboratories?**

**EU** Three things. First, research in traditional labs is carried out behind closed doors and under controlled conditions, whereas Real-World Labs take place in the complex reality of life, where they serve as experimental spaces. Second, Real-World Laboratories enable stakeholders from outside the scientific community to get involved. Research is not done on people, but with them, whereby completely new alliances are formed along the way. And third, real-world laboratories are very much characterized by a transdisciplinary approach. →

### → What makes a Real-World Laboratory successful?

**EU** Communication, which is something we should really take seriously: building trust, always engaging in dialog, cultivating networks, and being prepared for the fact that there may be conflicting agendas in play, in which case it is extremely important to ensure that not only the various scientific disciplines but also that all stakeholders find a common language, whereby the respective positions should be discussed in an open manner.

### Do the framework conditions also need to change?

**EU** Until now, younger researchers have not been particularly enthusiastic about getting involved in Real-World Laboratories. If they want to make a career in science, the most important thing is to publish their findings in accordance with the standards of the “scientific community”. Research in Real-World Laboratories, takes a lot of time and effort, but the rewards of our research system are not yet particularly forthcoming in return, which I hope will change. Formats such as Real-World Laboratories will become more important simply because the challenges facing science as a source of knowledge for social decision-making are currently greater than ever. →

“Real-World Laboratories take place in the complex reality of life, where they serve as experimental spaces.”

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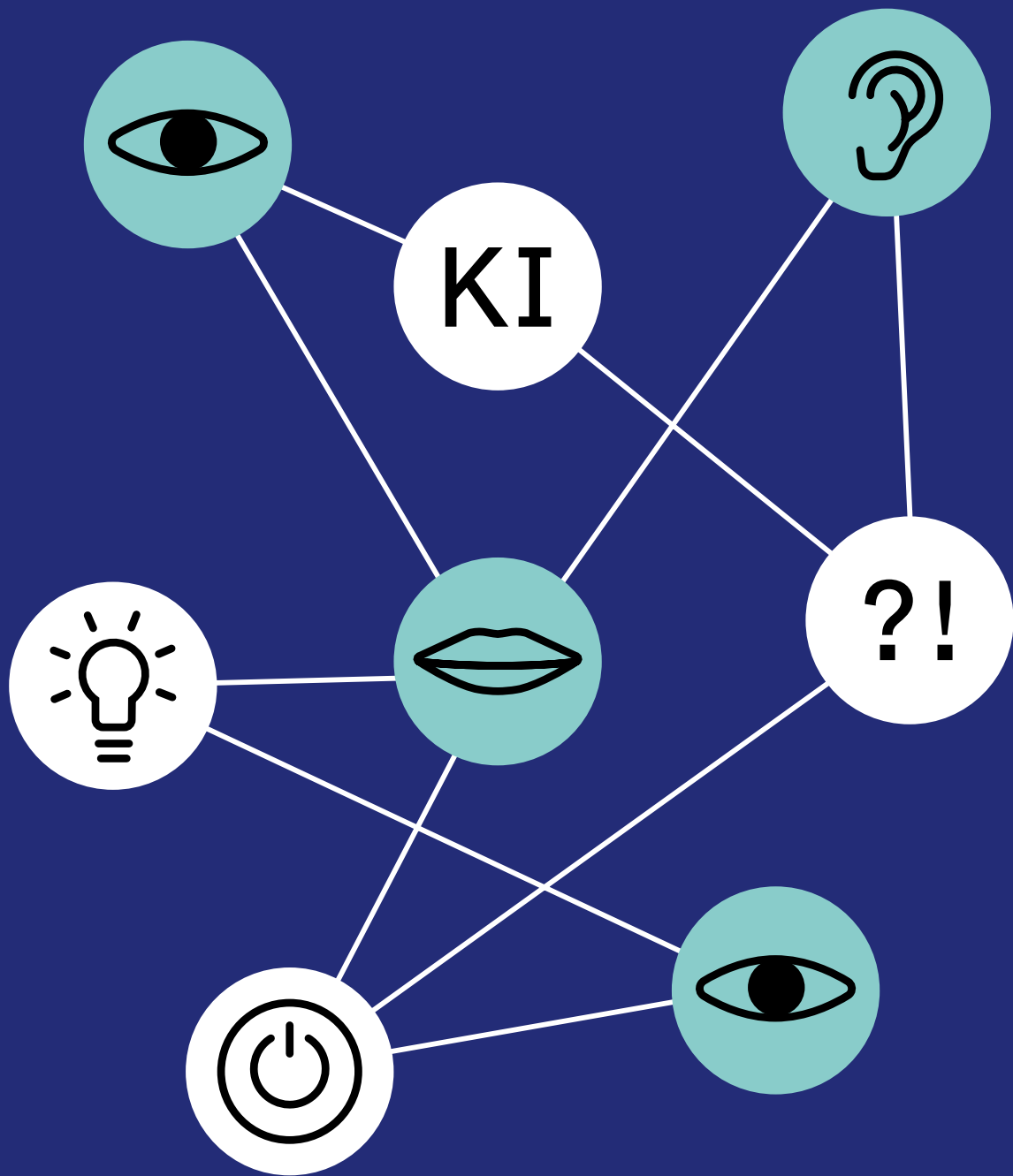
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# Getting to know the new coworker – AI



**Prof. Dr. André Bächtiger**

“What I'm interested in is how interacting with a virtual host influences the outcome, and how satisfied people are with it.”

TEXT: Daniel Völpe

**Although artificial intelligence (AI) has long been part of our everyday lives, it still raises many questions. One research team from the University of Stuttgart now wants to discuss the possibilities and limits of the technology with members of the public.**



Flawed digital facial recognition in train stations, automated application selection programs that tend to discriminate: there are various concerns about the use of AI. On the other hand, its use in everyday life has long been a matter of course, for example in Internet searches or email spam filters. A research team consisting of researchers from the University of Stuttgart and the Stuttgart Media University (HdM) now wants to discuss this widespread technology and the associated ideas and expectations with members of the public in the *Fragen an Kollegin KI* (Questions for Colleague AI) project. This is one of two projects that the German Federal Ministry of Education and Research (BMBF) is funding in the context of the 2022 Year of Science under the motto “In demand!”.

“People feel a strong need to have a say in determining the research agenda,” says Dr. Elke Uhl, Executive Director of the University of Stuttgart’s International Center for Cultural and Technological Studies (IZKT). As Uhl explains, this project is about “the fears, hopes, anxieties, and visions associated with the use of AI in the workplace and in everyday life. “Hence the name colleague AI: will we have to accept its widespread use in the workplace? What will be the consequences?”

#### **INITIATING A BROAD DIALOG ABOUT THE USE OF AI**

The project comprises three pillars in order to discuss these issues on a broad basis under the first of which experts will be presenting and discussing their use of AI applications with the public in a series of public discussions at the Stuttgart Public Library. The second pillar will involve a project seminar organized by the HdM and the University of Stuttgart, in which students from the natural sciences, engineering, and media sciences will collaborate to address issues relating to the use of AI. This might include, for example, video or multimedia reports that will be shown during the discussion series.

The aim is for students to learn how to refine their science communication skills in a more dialog-oriented way,” as Dr. Alexander Mäder of the HdM explains. Mäder will be →

→ leading the seminar together with Elke Uhl. “What I’m seeing is that there’s an increasing interest in engaging with the audience,” says Mäder. Which is why these budding media professionals are not only expected to report on AI, but also to moderate, network, and elaborate on different positions. The project is being supported by the university radio station HORADS and the “future reporters” on the [riffreporter.de](https://riffreporter.de) journalism platform.

### SUPPORTING LEARNING PROCESSES WITH NEW TECHNOLOGY

AI may also be used as a teaching format during the seminar: Jun.-Prof. Maria Wirzberger and her team at the University of Stuttgart’s Department of Teaching and Learning with Intelligent Systems (LLiS) of the Institute of Educational Science are studying the development of adaptive educational technologies that provide effective support for the learning process. The smart teaching systems in question are based on AI. “But these are not threatening in any way,” Wirzberger says. “Nevertheless, one needs to put some thought into it: what data do the algorithms collect? What happens to it? And what long-term effects might this have on students?”

### OPENING A WINDOW ON AI

The third pillar of the project will involve the use of student input on example AI use cases to initiate discussions, to which end the so-called AI Citizen’s Council will be bringing 300 representative people from all over Germany together in a virtual space. A team led by political scientist Prof. André Bächtiger, Executive Director of the Institute for Social Sciences, is hoping that the “Democracy Factory” program will encourage participants to explore AI in depth. All questions raised by the study group are sent in a distilled format to the experts, who then respond to them, which leads to the next discussion round.

“There’s always a risk when developing new technologies that the respective systems will be over and above what is actually needed,” explains psychologist Wirzberger. “The only way to avoid this is to involve the perspectives of future users in the process right from the outset. This is precisely where I see the project’s great potential for opening a window on AI.”

Wirzberger is the spokesperson for the Stuttgart Research Focus “Interchange Forum for Reflecting on Intelligent Systems” (SRF IRIS), which was founded in 2021, and the director of the “Reflecting on Intelligent Systems In the Next Generation” (RISING) teaching and learning forum, which includes the seminar in its event calendar. →

### Jun. Prof. Dr. Maria Wirzberger

**“What data do intelligent systems collect? What happens to it? And what long-term effects might this have on students?”**



### Dr. Alexander Mäder

“The aim is that students should learn how to refine their science communication skills in a dialog-oriented way.”

→ Researchers from almost all faculties of the University of Stuttgart are represented in the IRIS. The Questions for Colleague AI project was born out of this association and therefore benefits from an ongoing creative exchange of ideas. For example, Bächtiger, another member of the IRIS Board of Directors, is able to find specialists on the topics discussed in the Citizen's Council. “The unique thing,” he says, “is rather than presenting a number of paternalistic experts, who simply dictate to the public, our specialists have to respond to comments from the public.”

#### **PROMOTING FACTUAL DISCUSSIONS**

Students in the project seminar will host one of three Citizen's Council groups. Mäder plans to focus on how to promote factual discussions in a series of editorial meetings. “My envisioned goal is to work out the really critical issues after clarifying the purely technical ones,” he says. An artificial moderator named Sophie will host the second group in order to compare AI with this. The third group will serve as a control group and will not be overseen by a specific host. Sophie, the intelligent chatbot, will prompt people to read posts from others or respond to questions, among other things. The benefit of this would be a significant reduction in personnel costs. At the same time as Bächtiger emphasizes: “I want to know how interacting with the virtual host will affect the outcome and how satisfied people are with it.”

At the beginning and end of the experiment, the participants in the council will respond in writing to the question: what would you like to see from colleague AI? “We will be able to run computational linguistic text analyses on the responses,” says Bächtiger, who is also scientific director of the University of Stuttgart's Center for Interdisciplinary Risk and Innovation Studies (ZIRIUS), which will evaluate the questionnaires and forward the results to the BMBF. In this way, the wishes of the public will also be taken into account in decisions on research funding. In addition, as Bächtiger says, it will be possible to determine the degree to which people have thought about AI. “If for example, we find that the group has developed a very complex view of the world but has not changed its mind, that would also be a very important finding. Policymakers will be interested to see what conclusions people arrive at when they consider the issues in depth.”

Because as Uhl emphasizes, the purpose of the AI Citizens' Council is not to provoke confrontation, but rather to encourage differentiated points of view. “Our concept is based on the notion of countering polarization and increasing resentment.” →

#### **CONTACT**

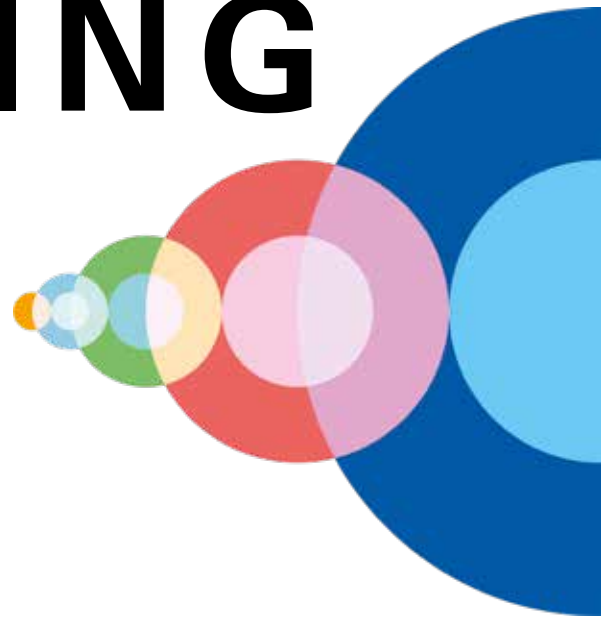
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# DISCUSSING AI



TEXT: JENS EBER

**The buzzword AI evokes both euphoria and anxiety. Public engagement managers in Cyber Valley are trying to bring about a constructive dialog between the science community and the general public.**

Will our lives soon be ruled by artificial intelligence (AI) or will technology primarily benefit people? 27-year-old Rebecca Beiter, a public engagement manager at Europe's largest AI research consortium, Cyber Valley, is well aware that: "AI evokes strong emotions amongst the general population." Cyber Valley was founded by the Universities of Stuttgart and Tübingen as well as other research institutes, the state of Baden-Württemberg, and industry partners such as Daimler, Bosch, and Amazon.

Beiter is responsible for managing public relations in the Stuttgart region, whilst her colleague Patrick Klügel is working at the University of Tübingen to build bridges between the scientific community and the general public. Their task is not to project a positive AI image, but to engage both the general public and researchers in a dialog about this technology with the ultimate aim that both sides should be able to learn from each other.

"Our goal," says Beiter, "is to establish a long-term network" in which researchers will keep the public abreast of developments in the field of AI whilst the general public will be given the opportunity to discuss their opinions, concerns, and hopes with the scientific community. Whilst comparable roles have existed at international level for some time, Beiter and Klügel are among the first professional public engagement managers in Germany to focus on the dialog between the research community and the general public.

There are some good reasons why this pioneering work is focusing on AI: "The general public is insecure about AI," Beiter acknowledges. One concern, she says, is that this technology could make certain professions obsolete. At the same time, however, some people have unrealistic, almost utopian hopes about it. "I think it's important to convey realistic narratives," she says. One example she cites is Annika Liebgott, a scientist at the University of Stuttgart's Institute of Signal Processing and System Theory, who is researching the automatic detection of motion blur in MRI images. It is hoped that this development will help to ensure that blurred MRI images can be detected and recreated immediately. "This is an application that will save resources and protect patients, but it's taking a very long time to develop the necessary AI to achieve this," →



Rebecca Beiter

**"What we want to do ... is to promote more dialog with the public."**



→ says Beiter, who adds that “When you see that, you realize that AI can do a lot, but it's nowhere near what many people think it is.” However, AI can provide valuable support wherever structures need to be recognized in large datasets.

### PODCAST AND AI SURGERY

The public engagement strategy that Beiter and Klügel are pursuing at Cyber Valley has already produced a number of interesting building blocks capable of bringing the scientific community and civil society together. One example is the *Direktdurchwahl* (direct line) podcast, in which researchers discuss specific AI research projects and the challenges they are facing with members of the public. Another service that is attracting growing interest is the AI surgery, in which interested parties can put their questions to specific research teams. Beiter is planning to launch a short story contest in 2022. Schoolchildren will be invited to write down their thoughts about AI, and researchers will be able to refer to their stories in follow-up events.

Beiter and Klügel are currently focusing on preparing a professional code of conduct for public engagement managers. “What we want to do,” Beiter, a qualified corporate communicator, explains, “is to promote more dialog with the public, to which end we plan to create a core set of values, which would facilitate this.”

This code will include such things as a so-called controversy principle. “What that means is that we would present topics that are controversial within the scientific community as exactly that – controversial,” Beiter explains. The core values of public engagement will also include a prohibition on “overpowering”, the purpose of which would be to prevent the imposition of certain views on the general public. Instead, the aim would be to provide all the information necessary for the formation of public opinion. The two want to develop a broad enough definition of the code that it can be applied to science communications other than AI. At the same time, they want to extend the concept of public engagement to other universities. →

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Photos and illustrations: Cyber Valley, private

**Podcast about AI: public engagement manager**  
Beiter discusses research at Cyber Valley.



# UNRESTRICTED INTERNET

For several years, the Semanux team has been conducting joint research in the field of human-computer interactions.



## ACCESS

INTERVIEW: Daniel Völpe

Through their spin-off company “Semanux”, Raphael Menges, Ramin Hedeshy, Florian Lerch, and Lukas Schmelzeisen want to make the Internet inclusive. The team is developing the necessary software at the University of Stuttgart’s Institute for Parallel and Distributed Systems (IPVS) thanks to a 645,000 euro grant from the German Federal Ministry for Economic Affairs and Climate Action’s EXIST research transfer program and the European Social Fund.

**What is our current situation in terms of inclusivity for people with disabilities?**

**RAPHAEL MENGES (RM)** Many efforts are currently being made to include people with disabilities, but we feel that the online sphere is still too often neglected. Although systems exist that use gaze, voice or mouth control to operate the mouse, they always involve some form of mouse and keyboard simulation. What we are trying to do is to create a deeper level of customization by understanding web page content. Our goal is to enable the alternative input devices to be directly combined with the ways in which one can interact with a web page, for example, by entering text or selecting objects.

**How far have you got with the software you are developing to achieve that?**

**RM** The respective research transfer only started in September 2021. We’re building on our past research and have already developed the gaze-controlled “GazeTheWeb” Internet browser. We also have a prototype for text input, which involves looking at the letters of a word on the keyboard one after another and marking the beginning and end of the word →



→ on a touch pad, such as the ones incorporated into cell phones. We had also tried using a buzzing sound to mark the beginning and ends of the words. We will be providing our test subjects with a prototype in the spring after which we're planning to gradually introduce our AI algorithm during the course of the year.

**FLORIAN LERCH (FL)** Our study will be based on about 20 test subjects and we will record their interactions with both the software and various input methods: How intuitive will it be for users to combine these? Well, we will also be looking at how websites are used in the first place. If, for example, we see that nobody ever clicks on a given icon then we would conclude that there is no function linked to the icon. Our plan is to use the feedback to fine-tune the product. But initially it will be possible to use the site reliably and conveniently without the additional AI-based insights.

Florian Lerch

**"We want inclusion for everyone: people should be able to interact with the Internet and computers in a more convenient and flexible manner."**

#### **What will the finished product be like?**

**RM** We plan to make the software available as a subscription app that will be updated on a regular basis and will combine it with existing hardware devices, such as those used for gaze control systems, which people with severe physical handicaps are willing to acquire. The second direction in which we would like to go would involve everyday office ergonomics, to which end, we would like to use the same software, but adapt it to the needs of corporate customers.

**FL** We want inclusion for everyone: people should be able to interact with the Internet and computers in a more convenient and flexible manner.

#### **How will this human-machine interaction evolve?**

**FL** It won't be long before gaze control will be available using off-the-shelf cameras. Voice control technology is opening the door to an ever deeper understanding of language. We are still brainstorming how best to use the software. For example, some research has been done on looking at an item, pressing an alternative button, and using that to click on it without having to use a mouse, although this has not yet been implemented for everyday use.

#### **How did you first get started in this field of research?**

**RM** I developed a game that used gaze control back in 2013 during a project internship with Prof. Steffen Staab, which was exhibited at the Landesgartenschau (state garden exhibition) in Landau. When I was working on my PhD at the University of Koblenz, I was involved in a research project entitled "GazeTheWeb", which forms the intellectual basis for Semanux. A member of our research group, Ramin Hedeshy, developed a gaze-controlled video player and wrote his master's thesis on gaze control with touch confirmation. Lukas Schmelzeisen is studying natural language processing, i.e., how computers "understand" language. For example, say you want to search the railroad website for a particular train connection – intuitively, you'd probably say something like "select a specific date." However, the calendar shows two small icons, which indicate that there is an outward and a return journey. We want our program to be able to capture the calendar and combine it with a voice command, such as "date", and the user's action of gazing at the icon.

#### **And what does "Semanux" stand for?**

**FL** Semanux stands for Semantic User Experience, and refers to the meaning of web page content, in other words, what the site contains and how it can be used. We then use this knowledge and various input devices to create the user experience. →

**Raphael Menges and his colleagues are trying to make the Internet accessible to all.**



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# Rethinking mobility with digital twins

TEXT: Jens Eber

**A fundamental change in mobility is currently taking place. Researchers at the University of Stuttgart are using a digital twin in the "Savenow" project to investigate future concepts and how people can be included in these change processes.**

In the movie "The Fifth Element", which was made almost a quarter of a century ago, actor Bruce Willis piloted an air cab through 23<sup>rd</sup> century New York. Our concepts of future mobility are informed by this kind of science-fiction vision. Researchers working on the "Savenow" project at the University of Stuttgart are exploring the question of what future automated mobility systems would have to be like in order to appeal to as many people as possible.

Admittedly, it will be several years before we see flying cabs, but self-driving vehicles have long been in the test phase, which raises some fundamental questions: how can we make autonomous mobility systems as safe as possible, and how could people be persuaded to use these new forms of transport?

Fabian Schlichtherle, a research associate at the Chair of Interior Design Engineering at University of Stuttgart's Institute for Engineering Design and Industrial Design (IKTD), is currently working on the second question. The core focus of the chair, which was founded as recently as mid-2020 and is headed by Prof. Wolfram Remlinger, is on the design of vehicle interiors. "At present it is common for many cars to be empty except for the driver," says Schlichtherle. "If we could make it so that new mobility systems →



The digital twin will also take account of rain: representation of an intersection in Ingolstadt.

Realistic images of roads will be used to explore new mobility options.



## Fabian Schlichtherle

“If we could make it so that new mobility systems would be occupied by at least two people, then car traffic would theoretically be reduced by half.”

→ would be occupied by at least two people, then car traffic would theoretically be reduced by half.” However, he continues, this is actually one of the major challenges facing traffic development, because many people still value the privacy of their own cars. Women, Schlichtherle explains, are often reluctant to share vehicles as a matter of subjective security. That is why Schlichtherle is working on designs for car interiors of the future in the “Savenow” project, whereby

“Savenow” is an acronym based on letters from words included in the German version of Functional and Traffic Safety for Automated and Connected (=Vernetzte) Mobility – Benefits (=Nutzen) for Society and Ecological (=oekologische) Impact (=Wirkung). The research consortium is spearheaded by the Audi car company. One of the project goals is to create a “digital twin,” i.e., a detailed digital representation of the transportation system of an actual city – Ingolstadt – which was not only chosen because Audi happens to be headquartered there, but also because there are so many company vehicles on the road there fitted with state-of-the-art technical equipment in a density not found elsewhere, which means that the researchers in the “Savenow” project can draw on what Schlichtherle refers to as a “globally unique” data pool.

The “digital twin”, which the “Savenow” project team plans to have completed by 2023, will map the Upper Bavarian city’s entire traffic system, which will include all roads, intersections, traffic lights, and crosswalks as well as the surrounding buildings, and extensive auxiliary data about such things as shop opening hours and work hours that have an impact on pedestrian traffic and activities such as parking spot searches. The calculations used in the model will also take account of the consequences of the measures introduced to deal with the Covid-19 pandemic, whereby the researchers will be using the results from the predecessor project, SAVe.

### CREATING A BLUEPRINT FOR OTHER CITIES

The project team is planning to use the Ingolstadt model to determine how new mobility services would affect traffic flows. “Ultimately,” Schlichtherle explains, “the digital twin will serve as a blueprint for other cities.” If it proves possible to map a city in its entirety, he continues, it will be possible to apply the model to other larger or smaller systems. The “Savenow” consortium makes no bones about their plans for the commercial exploitation of such models. According to Schlichtherle, digital twins could provide an important planning basis for municipal authorities and public transport operators, but also for other research projects.

Schlichtherle and his colleagues at the Chair of Interior Design Engineering are providing the “Savenow” team with data from online surveys, which will shed some light on public acceptance of autonomous mobility systems. Initial findings suggest that both the speed of the vehicles and the cost of use are important considerations. “Another concern is privacy,” says Schlichtherle. The fact is that many road users just like being alone in their cars, innovative vehicle concepts must go hand-in-hand with appropriate incentives to facilitate the switch.

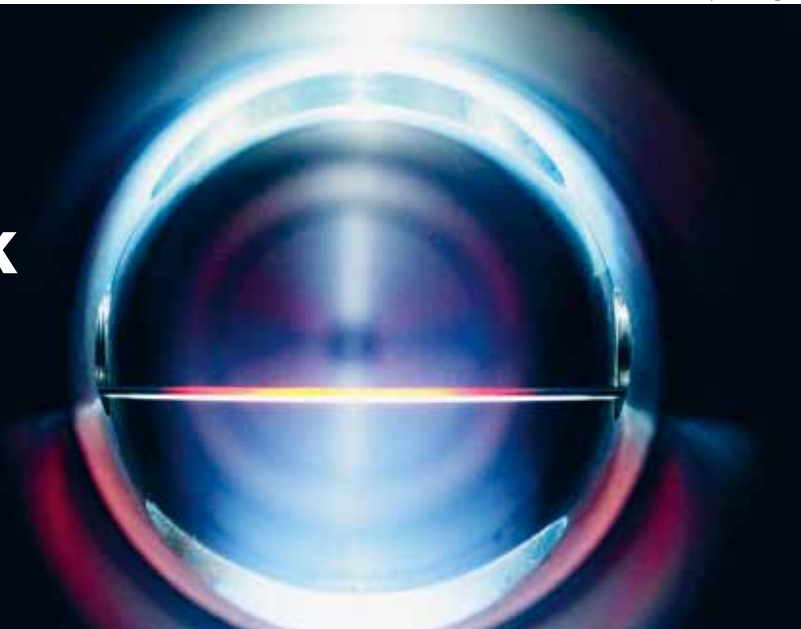
Based on the results of the surveys, researchers at the University of Stuttgart are planning to develop some preliminary designs for the interiors of future vehicle generations, which test subjects in detailed vehicle mock ups will then navigate through Ingolstadt in a virtual reality system. →

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# Building block for the hydrogen economy



Research for the NexPlas project: testing a perovskite hollow fiber in a CO<sub>2</sub> plasma

TEXT: Michael Vogel

**Basic chemical elements can be produced in an elegant plasma process that uses CO<sub>2</sub> exhaust gases and hydrogen.**

Hydrogen is deemed to be the second most important energy carrier in a sustainable energy economy, alongside electricity. Even more than in the road transport sector, Green hydrogen will be needed in such areas as the process industry to produce higher-value basic chemical substances. One of these almost universal basic substances is methanol, which unlike hydrogen, can also be easily distributed via existing infrastructure.

Although we already have established processes for the synthesis of methanol, a consortium coordinated by the University of Stuttgart is currently exploring a novel combined plasma and membrane process for producing methanol in as sustainable a manner as possible. The “NexPlas” project is being funded by the German Federal Ministry of Education and Research (BMBF) and is scheduled to run for three years ending in February 2024. “We are using a microwave generator to ignite a plasma in a CO<sub>2</sub> chamber in order to split the gas into carbon monoxide and oxygen,” Katharina Wiegers explains. Materials scientist Wiegers is a doctoral student at the University of Stuttgart's Institute of Interfacial Process Engineering and Plasma Technology (IGVP). “A membrane is used to separate the oxygen out, after which hydrogen is added to the carbon monoxide.” The carbon monoxide and hydrogen then react to form methanol.

## ANSWERING COMPLEX RESEARCH QUESTIONS

Although this sounds quite simple, it actually requires some extensive material science and process engineering research. What is the best way of adding the CO<sub>2</sub>? What is the ideal form of the plasma to maximize the production of carbon monoxide? What changes must the plasma undergo in order to efficiently separate the oxygen out via the membrane? What is the best way of feeding in the hydrogen? How can the energy be recovered in a way that maximizes efficiency? “We're currently achieving CO<sub>2</sub> efficiencies of up to 40 percent, which is already pretty good,” says Wiegers.

While the IGVP is working on the plasma burner and the general process, TU Darmstadt is responsible for the material development of the membrane. The Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB) in Stuttgart will then use this material to develop the actual membrane, which will consist of hollow fibers. Other project partners include four companies responsible respectively for manufacturing the membrane modules (RTM, Bornheim), electrical microwave generation (Muegge, Reichelsheim), spectroscopic analysis of the processes (Plasus, Mering), and the user perspective (Evonik Operations, Marl).

“Our concept is easily scalable,” says Wiegers. “We can achieve throughput rates of anything from one to several hundred cubic meters per hour, and can also connect the systems in parallel.” →

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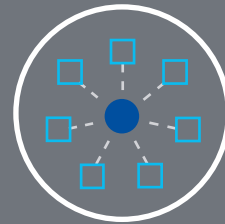
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# PUBLIC ENGAGEMENT IN FIGURES



Public engagement is about actively involving the public in research and strengthening the dialog between science and society. It has become hugely important in recent years and also represents a new direction for the communication of science. This is shown, for example, through the ScienceYears initiative, which is run by the German Federal Ministry of Education and Research (BMBF) and the Wissenschaft im Dialog (Science in Dialog) organization, and most recently through the #FactoryWisskomm think tank, as well as through highly popular science exhibitions, science slams, and a wide range of interactive formats.

The University of Stuttgart was quick to recognize the importance of maintaining an ongoing dialog between science, business, and society. Knowledge and technology transfer is now firmly enshrined as a goal in both the "Intelligent Systems for a Sustainable Society" vision and the university's mission statement.

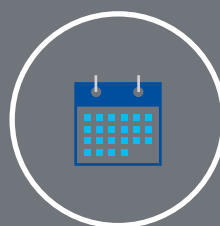
**7** #FactoryWisskomm, a think tank initiated by the BMBF for the German science system, has defined various fields of action for science communication including skills development, recognition and reputation, science communication research, quality, participation, and science journalism in the digital age.



## 2022

The motto for the 2022 Year of Science 2022 is "In demand!". Private citizens and civil society groups are invited to put their questions to political, administrative, and scientific stakeholders with a view to learning from one another.





# 400

The University of Stuttgart's calendar of events for 2021 lists around 400 events including lectures, seminars, round table discussions, exhibitions, and much more besides.



# 2002

The International Center for Cultural and Technological Studies (IZKT), a highly respected pioneering institute for the public understanding of science and public dialog, was founded at the University of Stuttgart in 2002 under the motto "the university's window into the city".



# 133

Since being launched in 2013, many graduates have successfully earned a master's degree in Planning and Participation. The program equips students with concepts and methods to facilitate the effective involvement of the public in planning and decision-making processes.

# 1100

interested citizens per semester on average attend the guest speaker lecture program at the University of Stuttgart. This program, which has no set curriculum, provides the opportunity to participate in lecture series, seminars, and workshops and encourages lifelong learning.



# From plastic to

TEXT: Daniel Völpe

**A hybrid science exhibition is being presented in Stuttgart to explain what porous media are and, above all, how important it is to study them for a wide range of scientific fields.**



**Desktop learning: texts and videos on at recreated workplaces during the exhibition.**

# human hair

Whether it's paper, asphalt, or human bones, countless materials and structures incorporate empty spaces. Researchers from various disciplines at the University of Stuttgart are studying how flow, transport and deformation processes occur in these so-called porous media. They are also presenting their results and the benefits of their work in the "Pretty Porous - Alles Porös" (Pretty Porous - Everything Porous) science exhibition together with the State Academy of Fine Arts Stuttgart (ABK). The physical exhibition took place at the Stuttgart Planetarium in the summer of 2020 but it can still be viewed online.

## **A FIELD OF RESEARCH THAT OFTEN RECEIVES LITTLE PUBLIC ATTENTION**

It is unlikely that many people outside of the scientific community would know what porous media are or anything about the processes that take place within them. This was what prompted Prof. Rainer Helmig, spokesman for the University of Stuttgart's Collaborative Research Center (SFB) 1313 on porous media, to organize the exhibition in collaboration with Prof. Thomas Ertl, who heads the SFB's "Public Relations" project, among other things. →

→ Around 60 researchers from the University of Stuttgart have been collaborating with 35 international partner universities and scientific institutions in the Collaborative Research Center, which is funded by the German Research Foundation (DFG), since 2018 and will continue to do so until at least 2025, in an effort to understand the processes that take place within porous media, as these play an important role in such things as climate models, fuel cells, and tumor growth. The multidisciplinary team is investigating how gases and liquids flow through these permeable materials and what changes occur in the process.

#### DEMONSTRATING THE RANGE AND SIGNIFICANCE OF POROUS MEDIA

As Helmig explains, the purpose of the exhibition is to show the general public “how important and socially relevant research questions in the field of porous media actually are. Almost anything could be porous including various materials, such as rock or plastic, but also the ground beneath our feet, and of course we humans with our porous skin and hair.”

This is what the team wanted to highlight in the exhibition. “First,” as Patrizia Ambrisi, project coordinator for the exhibition explains, “we introduce the basic idea of what porous media are. It is not only a question of permeable materials, but also of human cells and skin, for example, which explains the use of the rather superficial term ‘media’ that encompasses just about everything.” Although the special focus of the Collaborative Research Center is on the fundamental properties of these media, the team exhibited three specific research cases from the fields of biology, technology, and the environment including, for example, osteoporotic vertebrae that had been treated with a cement-like substance to restore their stability. Describing another of the exhibition models, Ambrisi explains that the team “displayed an interactive geothermal model on a large screen, which had been computed and visualized by three researchers from different disciplines. The simulation showed “how the groundwater temperature changes when alternately warm water is withdrawn or cool water is injected back into the subsurface.”

Because the porousness of a given media can usually only be seen under a microscope, adults and children alike were also given the opportunity to view various porous media through magnifying devices at an experiment station during the 2020 exhibition at the planetarium. Interested visitors were also taken on a tour of the researchers’ day-to-day routine, whereby everyday infrastructure such as desks, monitors, and a printer were used to convey the content. Visitors were able to view explanatory texts, videos, and graphics at the workstations, or browse a selection of original research papers.

#### FURTHER PRESENTATIONS PLANNED

The exhibition was a collaborative project between the University of Stuttgart’s Collaborative Research Center 1313 and the “Data-Integrated Simulation Science” (SimTech) Cluster of Excellence 2075 with support from the Robert Bosch Stiftung. The State Academy of Fine Arts Stuttgart (ABK) was involved in the concept, design and implementation of the exhibition in collaboration with the Space Sharing Real-World Lab. Commenting on the collaboration with the ABK, Ambrisi says it is necessary to take advantage of the great potential of her city. “Not every city has an art academy of its own.”

In addition to the virtual exhibition, the local exhibition will also be continued at events such as “TryScience” or the “Girls’Day” for schoolchildren, as well as at one of the international InterPore conferences. The team is also planning to work with a school in Stuttgart to develop a porous media program for the curriculum. They are also planning to present other subjects, such as evaporation and salinization, which are the key research areas in the recently approved extension of the Collaborative Research Center until 2025. →

**Rainer Helmig**

**“Almost anything could be porous including various materials, such as rock plastic, but also the ground beneath our feet.”**



**EXHIBITION  
WEBSITE:**  
<https://allesporoes.de/en>

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# PR instead of a white coat



**INTERVIEW:** Bettina Wind

**The astronomer Dr. Dörte Mehlert has been working in the Education and Public Relations Department of the German SOFIA Institute (DSI) at the University of Stuttgart's Institute of Space Systems for 16 years. In the following interview, she talks about how society and science benefit from mutual dialog, the changes that have taken place over time, and why this is her dream job.**



## Dr. Dörte Mehlert

“It is important to make science visible to both the general public and policy makers.”



Unique view: SOFIA can fly with the telescopic door open.

**The dialog between the science community and the public is given a high priority at the German SOFIA Institute (DSI). In what ways does this show?**

**DR. DÖRTE MEHLERT (DM)** One of the special aspects of the DSI is that one and a half staff positions had already been earmarked for educational and public relations work when it was founded back in 2004 and have been funded by the University of Stuttgart ever since. So we've had our own educational and public outreach program right from the outset. In formal terms, the DSI is actually a third-party funded project rather than an institute. I'm not aware of any other third-party funded project in Germany that has its own education and outreach program, let alone one that was launched in 2004.

**How come the DSI is pioneering this approach?**

**DM** It has to do with our flying infrared observatory SOFIA, which is a joint project between NASA and the German Aerospace Center (DLR). On the German side, the University of Stuttgart coordinates the scientific operation of SOFIA on behalf of the DLR. NASA allocates a certain percentage of the project budget to outreach activities for each of its programs, and the DLR has done the same for SOFIA. Apart from that, the founder of the DSI, Professor Hans-Peter Röser, has played a decisive role and has placed great emphasis on public relations from the very start, his personal credo being: “do good, and talk about it.”

**What educational and outreach opportunities does the program offer?**

**DM** It opens up a lot of possibilities for us that couldn't be achieved in other projects. One example of our educational work is the teacher co-flight program in SOFIA, for which all teachers in Germany are eligible to apply. Following a selection process and a preparatory meeting in Stuttgart, the successful applicants spend about a week in the USA, where, they prepare for the co-flight, which is scheduled for the end of their stay there. During the flight, they get to experience first-hand how the scientists work and what kind of things they are observing. The co-flight leaves the teachers with a lasting sense of enthusiasm, which they take back to their schools and, ideally, pass on to their students. Many teachers go on to give public lectures or publish blogs about their co-flight experiences for years afterwards. SOFIA is also now included in educational curricula and textbooks.

**Sounds like a practical and at the same time high-profile way of communicating science.**

**DM** The co-flight program and the accompanying media response always make a gigantic impression. The teachers talk about their experience in very authentic terms and local media in particular, such as regional newspapers, local radio, and TV stations, take a great interest in this. We could never achieve this level of enthusiasm and the associated knowledge transfer through a simple press release. →



**Science Days: schoolchildren learning about SOFIA at an exhibition at the Europa-Park in Rust.**

**Flying Observatory:  
the infrared observatory SOFIA**

Dr. Dörte Mehlert

**“The co-flight  
leaves the  
teachers with  
a lasting sense  
of enthusiasm.”**



**Advanced training  
above the clouds:  
teachers can experi-  
ence science up close  
during a co-flight.**

## SOFIA

SOFIA is the only flying infrared observatory in the world, and is one of the largest bilateral US-German projects in the field of space exploration. It is one of the largest third-party funded projects being carried out at the University of Stuttgart, which coordinates SOFIA's scientific operations in Germany. The Stratospheric Observatory for Infrared Astronomy (SOFIA) is a re-fitted Boeing 747 SP with a 17-tonne telescope on board. Scientists often travel on board the aircraft, for example to observe young stars and planetary systems being formed or to study the Milky Way.

SOFIA is a joint project between the German Space Agency at the German Aerospace Center (DLR) and the National Aeronautics and Space Administration (NASA). The development of this German instrument was financed through funds from the Max Planck Society (MPG), the German Research Foundation (DFG) and the DLR. It was implemented on the initiative of the DLR, which resulted in a resolution by the German federal government and was funded by the German Federal Ministry of Economics and Energy (BMWi), the state of Baden-Württemberg, and the University of Stuttgart.

→ **What other projects or services are on offer?**

**DM** Our infrared experiment kit for schoolchildren, which teachers can use to teach the infrared spectrum in the classroom and explain what we are observing with SOFIA and how it works, is particularly popular. We also have a mobile exhibition about the infrared observatory, which we make available for lectures and trade shows. And, whenever SOFIA visits Germany, we offer tours of the aircraft. Public interest in it was enormous during its last two stops here in 2011 and 2019.

**These are all activities that enrich society as a whole. To what extent does research benefit from public relations work?**

**DM** It is important to make science visible to both the general public and policy makers. Decision makers need to be convinced that continuing to provide funding for a particular piece of research makes sense, so the projects we carry out have to be visible. Competition is fierce these days, which makes it all the more important to attract attention through good public relations work. And taxpayers have a right to see what their money is being spent on and to see for themselves that they are reaping the benefits. After all, they are our advocates. And last but by no means least, the goal of our educational and public relations work is to inspire young people and to recruit the next generation of scientists.

**You have been responsible for education and public relations at DSI since 2006: what appeals to you about this career path on a personal level?**

**DM** During my training as a physicist in Hamburg, I used to imagine my future self standing in a laboratory, wearing a white coat and wire-rimmed spectacles: discouraged by this notion, I realized that I wanted more contact with people. After that I completed a number of internships with newspapers and realized that I enjoyed explaining things. As a doctoral student in Munich, I continued to write articles and give lectures at adult education centers. Organizing an open day at the Munich Observatory in 1996 was something of a highlight for me and I knew then that this was my vocation. Later, when I saw the DSI vacancy announcement, I knew it was the perfect job for me.

**That was 16 years ago, and there have been many changes in your field since then. Is it still the perfect job for you?**

**DM** Yes. The job profile of a public relations professional has changed, of course, but that's what makes it so exciting. The biggest change for me has been brought about by social media, which have totally changed the nature of my work.

**Can you think of an example?**

**DM** When SOFIA landed at Stuttgart Airport in 2011, the role of social media was not particularly relevant for us. This had changed dramatically by the time it landed there again in 2019: the interest and attention it got on social media had grown exponentially. People everywhere were talking about SOFIA, and many were uploading pictures. There is a very large online community of so-called plane spotters, i.e., people who like to observe and photograph airplanes and track their movements. All of this results in numerous positive effects. Interacting with users is often fun, and makes it even easier to motivate them and get them involved. However, erroneous information is sometimes shared as well: if I notice it, I can react and steer people in the right direction. But I often don't notice it, which is something you just have to live with.

Another example that occurred in 2013 involved a weeks-long coordination process for a press release about a SOFIA flight in New Zealand. We had to take three time zones into account to time the press release perfectly: NASA on the West Coast of America, us in Germany, and SOFIA in New Zealand. As soon as SOFIA landed in New Zealand, local plane spotters immediately tweeted the first photos and info, and everyone knew about it. Our colleagues in the USA didn't publish our long-prepared press release for another 19 hours. We have learned from this and have adapted our communication strategy accordingly. →

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## Introducing fusion research in schools

Explaining fusion research:  
Dr. Alf Köhn-Seemann  
delivering a lecture

TEXT: Michael Vogel

**The European fusion research community is attempting to educate the general public about the importance of a fusion reactor through a comprehensive set of educational materials, lectures, and continuing education day events.**

Energy from fusion reactors is one of the great technological promises for mankind: it would solve several of our current energy production problems because it would not come from fossil sources, would always be available in large quantities, would not produce any long-lived radioactive waste, and would not be at risk of running out of control. But so far, fusion reactors have only been a subject of interest to the applied research community: it remains to be seen whether they will one day actually be able to satisfy our thirst for energy in a sustainable and cost-effective manner. “Yet whenever we move closer to its potential commercial use, it will ultimately be (scientific) lay persons who will decide on the necessary investments,” says Alf Köhn-Seemann, a research associate with a doctorate in physics at the University of Stuttgart’s Institute of Interfacial Process Engineering and Plasma Technology (IGVP), one of whose research focuses is on fusion research. The required investment he is talking about would not be mere pocket money; it would cost billions.

“That’s why I think it’s important that we inform the public about the potential of fusion energy,” Köhn-Seemann explains. He believes that schools are an important →



**A project with global support: the ITER fusion reactor in southern France**

→ starting point, as he explains “the subject has barely been covered in school curricula to date.” The European fusion research community has founded the FuseNet network for this purpose, whose German members include universities and research institutes from Garching, Greifswald, Jülich, and Karlsruhe as well as the IGVP In Stuttgart. “In the FuseNet initiative, we are creating materials that teachers can make free use of in their classes,” says Köhn-Seemann. FuseNet has also been hosting a “European Fusion Teacher Day” for the past two years, which is organized by local FuseNet members in each country. “The first of these only drew 15 participants here in Germany, which then grew to 45 the second time.” The third theme day is scheduled to follow in October 2022.

## **INTERNATIONAL PROJECT FOR THE FUTURE: THE ITER FUSION REACTOR**

Fusion research has currently reached a critical stage. The first test runs on the most expensive project, the ITER research reactor in southern France, are scheduled to begin in 2025. At long last, one might say, as things at the International Thermonuclear Experimental Reactor have not always gone smoothly since construction began there in 2007, and the costs have had to be revised upward several times. It took a change in management to get the mega project back on track.

“Yes, it is taking quite a long time,” Köhn-Seemann confirms, “but what you have to bear in mind is that there are 35 countries involved in the ITER. It really is a global project – the 35 countries involved, which include the EU, China, the UK, India, Japan, Russia, Switzerland, South Korea, and the USA, represent about half of the world’s population. It is expected that another nine years will elapse from initial test runs in 2025 to the first fusion reaction.

“However,” as Köhn-Seemann points out, “research is not only being carried out at ITER, but also at the participating universities and research institutes.” In addition to ITER, there are other fusion plants, albeit much smaller ones, such as those in Germany and the United Kingdom.

## **INFORMING THE PUBLIC ABOUT FUSION RESEARCH**

Deuterium and tritium nuclei will be fused together in a future fusion reactor. Whereas deuterium, or heavy hydrogen, occurs naturally in seawater, tritium, also known as super-heavy hydrogen, has to be produced using nuclear technology aided by lithium and is a radioactive substance albeit with a half-life of just twelve years rather than the tens or even hundreds of thousands of years that characterizes some waste products from today’s nuclear reactors. For the positively charged atomic nuclei to fuse together in the reactor, they need to have high energy levels and be held together by strong, suitably shaped magnetic fields.

“However,” as Köhn-Seemann explains, “FuseNet will only be addressing physics teachers as a first step, because they are our natural multipliers, so to speak. “We do plan to expand the target group considerably.” After all, energy and energy sources are also mentioned in geography lessons, for example. “Later this year, we’re also planning lectures for undergraduates not studying science or engineering,” says the physicist, “with the aim of contributing to a better-informed society overall.” →

Dr. Alf Köhn-Seemann

**“Research is not only being carried out at the ITER, but also at the participating universities and research institutes.”**

**ALF KÖHN-SEEMANN'S BLOG ON FUSION RESEARCH:**  
[www.scilogs.spektrum.de/formbar/author/koehn](http://www.scilogs.spektrum.de/formbar/author/koehn)

**TEACHING MATERIALS FROM FUSENET:**  
[www.fusenet.eu/education/material](http://www.fusenet.eu/education/material)

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# LEARNING FROM THE DISASTER

TEXT: JENS EBER

**The Ahr valley in North Rhine-Westphalia was devastated by a hitherto unimaginable flood disaster in the summer of 2021. Prof. Jörn Birkmann, an urban and regional planner at the University of Stuttgart, is looking at what reconstruction efforts need to focus on and how regions can better protect themselves against such natural disasters.**



Prof. Jörn Birkmann wants to learn some lessons from the flood disaster in the Ahr Valley.

Towns and villages in Rhineland-Palatinate and North Rhine-Westphalia were devastated with unprecedented violence by heavy rain and floods in July 2021. Over 130 people were killed in the Ahr Valley alone, and the economic damage runs into billions. Since then, authorities, companies and sometimes thousands of volunteers have been working to rebuild roads, bridges, and houses.

However, a group of scientific experts is also studying the consequences of the disaster and reconstruction efforts in the Ahr Valley. The group wants to find ways to make the Ahr Valley and other at-risk areas more resilient to extreme events and climate change.

## BETTER PROTECTION AGAINST WEATHER-RELATED EXTREME EVENTS

Prof. Jörn Birkmann, who heads up the University of Stuttgart's Institute of Spatial and Regional Planning (IREUS), is coordinating the group and has already been involved several times with the management of and adaptation to natural hazards. "We may be faced with such events more often in the future even in other regions," says Birkmann, "not least because of climate change." For this reason, the team not only wants to develop a strategy for increased resilience for the Ahr Valley, but also to develop some fundamental principles that other regions can apply to prepare for weather-related extreme events. Not long after the disaster, the German Federal Ministry of Education and Research approached Birkmann and his colleague Prof. Holger Schüttrumpf, head of the RWTH

Aachen University's Institute of Hydraulic Engineering and Water Resources Management, with a view to drawing scientific lessons from the floods as quickly as possible and the expert group, which includes representatives of the Ahrweiler district, the Eifel-Rur Water Association, and researchers from the University of Potsdam, the GFZ German Research Centre for Geosciences, the Helmholtz Centre for Environmental Research, the Technical University of Kaiserslautern, and the Koblenz University of Applied Sciences, started working on it in December. Although the project, whose budget is five million euro, is scheduled to run for three years, Birkmann is well aware that politicians and, above all, the people in the affected region are hoping for initial answers as quickly as possible. "Our goal is to show how to manage land use and infrastructure development throughout the valley to better cope with these types of environmental phenomena and climate change in the future," says Birkmann. →

Swept away by the flood: a building ruin on the banks of the Ahr



→ Initial on-site investigations, he continues, had already clearly shown that the natural disaster was not the sole cause of the immense damage. A share of the blame also falls to the respective authorities, because infrastructure and facilities had been "extremely vulnerable" in some cases, and early warning systems had not been sufficient. "We are interested in understanding which key risk drivers were involved," says Birkmann, because there were obviously many factors at play, including such things as oil-fired heating systems in potential flood areas, which can "float up" and cause severe pollution, and buildings with no means of escape to safer areas, such as higher floors, in the event of an emergency. However, bridges in the Ahr valley also suffered massive damage, because, for example, vehicles and parts of buildings were swept away from campsites and their accumulated kinetic energy wreaked great havoc.

#### CLOSE ATTENTION TO CRITICAL INFRASTRUCTURE

"We want to see whether there is any critical infrastructure that should be relocated or better protected," Birkmann explains. At the same time, the researchers are discussing which roads could potentially be used as emergency waterways for the targeted drainage of water masses. Green spaces in certain locations could also help to drain heavy rains and floods more effectively.

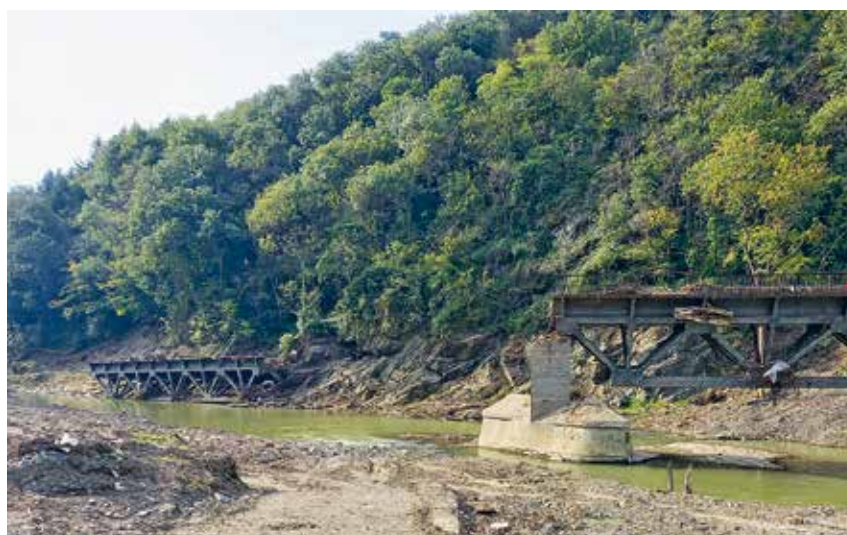
The results of the project will also help to make for safer rural and urban development throughout Germany in the face of climate change. "It's not just about disaster management," says Birkmann, "but also about development issues." One particular current challenge, as Birkmann points out, is the fact that in many cases the 30 billion euro in reconstruction aid is only meant to cover the damage, rather than to fund adaptation and resilience measures.

In addition to urban and spatial planners such as Prof. Birkmann, the team also includes modelers who are looking at possible flood scenarios, and sociologists who are focusing on social processes. "This kind of disaster event is always the result of highly contingent factors," says Birkmann. This makes it difficult to make precise predictions, but it is possible to estimate what might happen, for example, in the event of heavy rainfall.

The focus in the Ahr Valley, he adds, is to increase the resilience of the infrastructure during the reconstruction process. Moreover, he says, those people who want to move away from the flood zone after experiencing the disaster will need assistance. Birkmann reports that people are very receptive to the work being done by the researchers. "Policymakers are extremely interested and want to know how it could ever have come to this disaster and what the options and limits are for future preparedness." →

#### Prof. Jörn Birkmann

"We are interested in understanding which key risk drivers were involved."



Even massive steel bridges were destroyed in the disaster.

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## CONCRETE ROADWAY 4.0

Today, 70 percent of passenger and freight traffic goes via the roads, which puts enormous stress on the road surfaces. Concrete has proven to be particularly robust and sustainable, and can also be recycled to a high quality standard at the end of its service life. However, it would be preferable if the replacement cycles of the roadways were even longer, as this would save on resources as well as reduce the number of roadworks and accidents.

A new test stand with a concrete mixing plant at the University of Stuttgart's Materials Testing Institute, which exploits the potential of digitization, is a step in this direction. New concretes, mixing technologies and sensor systems can be tested at the plant, and research can be carried out into a wide range of issues relating to design, materials, and processes on a pilot plant scale and then scaled up to production scale. For example, different concrete mixes can be tested, consistencies controlled, and solidification behavior as well as post-processing steps, such as grinding the road surface (grinding) and cutting grooves (grooving), documented. It is also possible to work out the ideal time to cut into the roadway, which is necessary to avoid any uncontrolled fractures when the road surface is solidifying.

## ULTRA COMPACT BATTERY CHARGER FOR CYCLISTS

Whilst batteries for e-bikes and scooters are becoming increasingly smaller and lighter and the efficiency of the electric drivetrain is improving and the range increasing, the battery chargers have not yet been able to keep pace with these developments. Researchers at the University of Stuttgart's Institute of Robust Power Semiconductor Systems (ILH) and the Institute for Power Electronics and Electrical Drives (ILEA) have recently developed a charger that sets new standards in terms of performance and compactness. The researchers looked for, analyzed and simulated electronic power topologies (arrangements) of the charger circuitry that could best accommodate the wide operating range of bicycle batteries whilst ensuring the most ideally distributed surface temperature possible and simultaneously avoiding electromagnetic interference. Among other things, the new technology relies on gallium nitride (GaN) semiconductors, which offer the promise of high performance in a small package.

# 70%

of passenger and freight traffic still travel by road. An exhaustive search is underway for new concrete mixes to extend the renewal cycle of road surfaces, which are subject to enormous stresses.

Photos: University of Stuttgart/PI 4, Julian Karst, University of Stuttgart/MPA, University of Stuttgart/PI 3, BioMat at ITKE, Masih Imani



#### **ELECTRICALLY SWITCHABLE NANOANTENNAS FOR HOLOGRAPHIC VIDEOS**

Our everyday working lives have been dominated by videoconferencing throughout the Covid-19 pandemic, and it will continue to play an increasingly important role going forward. However, to create the feeling of a real human-to-human interaction, a key technology has been missing until now, namely video holography. Researchers at the University of Stuttgart's physics and chemistry departments have recently introduced a completely new approach to holographic displays based on the use of newly developed electrically switchable metallic nanoantennas that use conductive polymers measuring just a few hundred nanometers each. This technology provides the key building block needed to create moving holograms in real time to facilitate virtual round-table discussions.

To create the feeling of a real human-to-human interaction, a key technology has been missing until now, namely video holography.

#### **QUANTUM COMPUTERS ARE GROWING TOGETHER**

Research into superfast quantum computers is now well advanced, but it is still not possible to interconnect the individual processors. In a paper published in the journal "Nature Materials", an international research team including members of the University of Stuttgart's 3<sup>rd</sup> Institute of Physics has now demonstrated a way of using nanophotonic silicon carbide structures to scale up quantum computers in order to solve the associated problems.

To achieve this, the researchers exploited the so-called silicon defect in silicon carbide, a color center with exceptionally stable optical spin properties. The team uses a very gentle processing method based on a chemical dry etching process to integrate these color centers into nanophotonic waveguides. This enabled them to create structures without affecting the properties of the silicon carbide crystal.



#### **MAXIMUM FLEXIBILITY**

A research pavilion built on the City Center Campus by the "Biomat" group led by Jun.-Prof. Hanaa Dahy as well as students at the University of Stuttgart resembles bamboo, as well as being curved and as light as a feather. The centerpiece of the Biomat Pavilion 2021 is an active bending structure made of natural fibers, which was developed as part of the "LeichtPRO" research project.

The "scaffolding" of the pavilion comprises 'bamboo-like pultruded (drawn) profiles made from natural flax and hemp fibers. These are prefabricated and processed in a bending-active lattice construction into a unique double-curved surface structure which is covered with a stretched membrane. The bending-active structure system made it possible to produce an elastically deformed shape out of a bamboo-like linear profile to create a double-curved shell roughly 10 meters wide and 4 meters high. "We tested this pavilion to the absolute bending and loading limits that the structure can support," Hanaa Dahy explains, "and we found that we can push it extremely far."



# Josy cares

TEXT: BETTINA WIND

**A virtual assistance technology system designed to help older people in their everyday lives. The developers exchange ideas with interested parties in a series of workshops.**



“She” is ticklish, loves to laugh, and drinks regularly: “Josy” is a virtual assistance technology system designed to help older people in their everyday lives. The system was developed by Franziska Braun and her colleagues at the University of Stuttgart's Institute of Human Factors and Technology Management (IAT) and the Fraunhofer Institute for Industrial Engineering (IAO). “Josy acts as a friend that older people like to talk to and include in their daily lives,” Braun explains.

For example, the virtual companion regularly takes a drink, which is something that older people in particular often forget to do. The system can also recognize when someone feels lonely or sad, whereupon it asks: “Would you like to call your relatives, or should we send them a picture of you?” The technology is intended as an aid in preventing loneliness and social isolation.

Josy incorporates an app based on facial recognition technology, whereby the built-in camera scans a face and compares the resulting data with an emotion recognition library. If the corners of the mouth point downwards then the system assumes that person is sad and responds by suggesting something along the lines of looking at a virtual photograph album together. Relatives can select the images beforehand and store them in the app. The fact that Josy can be personalized is important to Braun and her team: “Our aim is to create a personalized solution that can create an emotional connection. Everyone likes it when something comes from the heart.” That's why the researchers also offer sewing instructions for making a cover for Josy, which relatives can use to customize the companion even more. →



**A male or female companion: Josy also recognizes when someone is sad.**

Franziska Braun

**“We programmed Josy to be as simple as possible to use. No one will be able to accidentally delete the Internet or buy anything by mistake.”**

**Personal support: virtual assistance technology should also touch people on an emotional level.**

#### HIGH PERFORMANCE CENTER FOR MASS PERSONALIZATION

Scientists from nine University of Stuttgart Institutes and four Fraunhofer Institutes in Stuttgart are collaborating with future-oriented industrial partners to explore ways of manufacturing customized products for the mass market. The concept of “Mass Personalization” takes account of the individual needs of users right from the product development stage.

#### → THE FOCUS IS ON THE USER PERSPECTIVE

The project is part of the High Performance Center for Mass Personalization (LZMP), where research is focused on a user-centric approach: “We’ve been engaging a lot with our potential users, always listening to what they’re thinking and trying to understand their thought processes.” In the process, we discovered that older people are often worried that they might make mistakes or break something when using digital devices. “That’s why we programmed Josy to be as simple as possible to use,” says Braun: “No one will be able to accidentally delete the Internet or buy anything by mistake.” A code has to be entered in order to access the device settings area, which relatives and friends can use to add photos or change the viewing settings, for example.

Among other things, Braun and her team acquired these insights in a series of online workshops, the aim of which is to present Josy as an assistance solution to interested persons, but a lot of it is also about dialog. The workshops are aimed at a range of very different target groups including managers who are interested in innovative production processes, care facilities that want to learn more about the system, companies that are interested in the product, and, of course, people with elderly relatives.

#### RESEARCH BENEFITS FROM PUBLIC DIALOG

Braun makes a point of ensuring that the training seminars do not resemble a traditional classroom teaching session and is pursuing a community-based approach with the project: “Engaging in dialog with interested parties and the public is hugely important to us,” she explains. “We explicitly invite public participation and plan to incorporate the feedback into our research, which will ultimately benefit us and the project.” For example, the people’s reactions during their initial contact with Josy are extremely revealing. Does a person say “wow!” or do they make some skeptical comment about privacy?

One of the results that came out of the public dialog was that people view the hand-sewn covers as a very positive thing. All interested parties also liked the fact that Josy reacts when touched, exclaiming, for example: “Hey, quit tickling me.” Open desiderata include, for example, that Josy’s facial feature recognition capabilities should be even better. Going forward, Braun and her team plan to continue offering workshops and seeking dialog with the public, whereby the focus will always be on people’s wishes and needs. →

**Josy’s developer, Franziska Braun, is working on the development of virtual companions.**

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# Designing the “most public room”



TEXT: Jutta Witte

**Prof. Martina Baum and her team at the University of Stuttgart's Urban Planning Institute are using the “Daily” project to show how the research by design approach can be applied in everyday life.**

**Research by Design –  
Design for a “Daily” space  
in Bad Cannstatt, Stuttgart**

For architect and urban planner Prof. Martina Baum, designing and creating is not just an artistic and creative act, but also an excellent research approach for finding solutions to complex societal challenges, whereby her favored approach is the research by design method. This is an established approach in the planning and design disciplines, which combines research, theory, and practice in a continuous interplay and requires a spirit of open mindedness and reflection. “This is highly relevant in architecture and urban planning,” says Baum: “Our professional culture has always involved going beyond the study of the past and analysis of the present to design for the future.”

Unlike traditional research approaches, which are often linear, research by design is open-ended and iterative. It is open-ended because one begins with a holistic view of complex social issues such as participation, climate change, and digitization, and only then considers how one's own discipline could make a practical contribution to addressing these issues. It is an iterative process, because it involves reflection after each step, taking a deeper look at the original problem complex, adapting the potential solution, or, in case of doubt, discarding it altogether. →



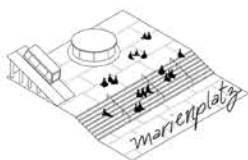
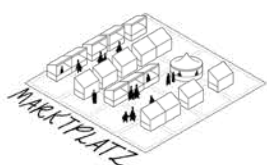
Prof. Martina Baum

**“If you think of the entire district as a house, the ‘Daily’ would be the most public room.”**



# Daily

Learning from the concept of public spaces.



→ Typical steps in the research by design approach include observation, evaluation, modeling, and testing, and finally, reviewing, adapting, discarding, or deriving new questions and tasks. “It’s not about finding the one single right answer,” Baum explains: Our aim is to highlight potential approaches and to experiment in a creative and reflexive process.” What at first sounds very abstract is taking shape in concrete initiatives such as the “Daily” project.

## CREATING A PUBLIC AND DEMOCRATIC SPACE

The concept for this research project, which was initiated by the Urban Planning Institute and funded by the City of Stuttgart and the International Building Exhibition 2027 (IBA'27), emerged when Baum and her team began to take an in-depth look at the multicultural and multi-ethnic society of Western Europe. The researchers concluded that, whilst this heterogeneity offers great potential for greater diversity, it is overwhelmingly perceived as a source of fragmentation and as a threat, so they asked themselves: “How could architecture and urban design help to harness these potentials?”

Having collected the data and weighted the relevant aspects, the team came up with the concept of a new “public and democratic place” and scoured the world for references for the structural design, organization, and funding of such a project. They then met with political and administrative representatives from the City of Stuttgart, the state capital of Baden-Württemberg, to discuss what form such a place could take and where it could be located.

The concept of a “radically public and inclusive building” equipped with various infrastructures emerged – a public service for the city’s residents, combined with an open invitation to fill it with their own activities. Like the public fora of classical antiquity, this space will belong to everyone. A “team of enablers” will provide operational support. The initiators have dubbed the space “Daily” because they hope it will become a part of people’s everyday lives. “If you think of the entire district as a house, the “Daily” would be the most public room,” says Baum, summing up the concept.

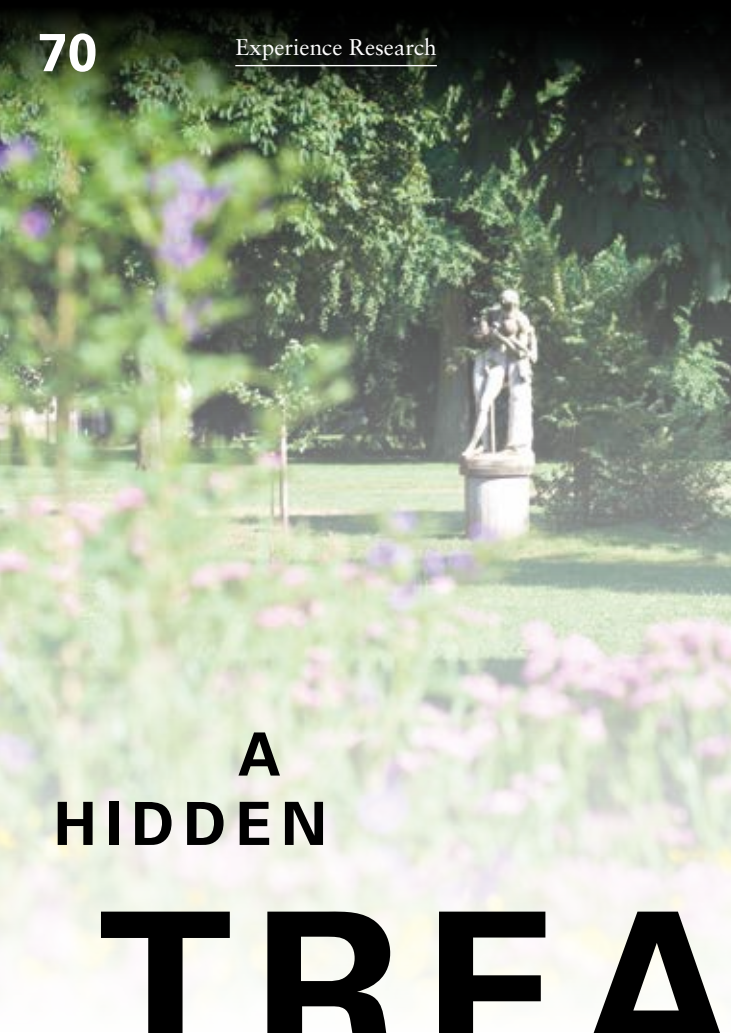
## STUDENTS DESIGN THEIR OWN CONCEPTS

To test it in an actual space, the authorities selected Wilhelmsplatz in Bad Cannstatt, Stuttgart’s oldest, most densely populated, and most multi-cultural urban district, where the project was met with lively interest. 25 master’s and bachelor’s students at the Institute of Urban Planning and Design each produced their own designs based on the “Daily” concept. The result was a variety of design strategies for new buildings or for the redesign of existing buildings, such as a vacant multi-story car park or the Schwaben-Bräu-Passage, an ensemble of buildings close to the train station in the Bad Cannstatt district, which is as steeped in history as it is in need of renovation. “Working with students over several semesters,” Baum explains, “is helping us to test the concept both spatially and at different scales, and to refine it, as well as to produce images and use them to initiate discussions.”

The project will be presented and discussed with the public at the Stuttgart Stadtpalais in June 2022. Having identified the issue and developed the concept and draft designs, this dialog with the public represents another important building block in the research by design process. Although the project participants cannot be sure that the “Daily” forum will ever really become a reality, they have not only stimulated interest within the City of Stuttgart, but also within the international research community, who are now engaged in further discussions about the concept of an inclusive building. →

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## A HIDDEN

# TREASURE

Prof. Klaus Jan Philipp

**“What we are motivated to do ... is to reignite the debate around the Stadtgarten and to get things moving again.”**

TEXT: CARINA LINDIG

**The Stadtgarten (park), which is situated on the University of Stuttgart’s premises is a little gem, but its potential is not yet being fully exploited. A team at the Institute of Architectural History is planning a new initiative to change that.**

It's a typical day at the Stadtgarten right next to the University of Stuttgart: a student is gingerly making her way across a slackline; a chap is sitting on a park bench enjoying his lunch break; a pensioner is walking her dog across the lawn. In the midst of the urban hustle and bustle, the park is a place to relax and is a popular meeting place, especially for students. At the same time, it is a bit of a hidden treasure, because it is cut off from the surrounding city precincts by a number of multi-lane roads. And there are hardly any direct access points, despite the fact that it is only a ten-minute walk to Schlossplatz in the city center as well as to the main railway station. That might explain why the slackline course is popular with younger people, but many other things, such as the playground and sports facilities, are little used.

Prof. Klaus Jan Philipp and Lena Engelfried from the University of Stuttgart's Institute of Architectural History are hoping to change that. At the beginning of 2021, they founded the “Quartier Stadtgarten” initiative to kick-start the urban development in the area surrounding the Stadtgarten, which has been the subject of controversial discussions in the city council for many years. The park was originally established for the first Württemberg Garden Exhibition in 1870, and was redesigned between 1973 and 1975 after having been largely destroyed during the Second World War.

### INITIATING A DISCUSSION ABOUT THE STADTGARTEN PARK

Now, almost 50 years later, the team wants to encourage new approaches with their initiative. “People are clearly interested, but no one wants to pay the money,” Philipp explains. →



→ As a first step, he and Lena Engelfried wrote to all residents adjacent to the Stadtgarten, such as the hospital, various ministries, restaurants, and universities. One of the first things that the team did was to write a letter to the Lord Mayor of Stuttgart, Frank Nopper, in which they outlined their ideas for the future of the Stadtgarten. Since then, they have been in talks with numerous other people who are employed by the municipal authorities.

The idea of the initiative is to improve the Stadtgarten in time for the International Building Exhibition 2027 which will be held in the urban district of Stuttgart (IBA'27). "In the meantime, it will not be possible to build any new structures or make any major planning changes to the garden," says Philipp. However, he does want people to at least see some difference by 2027. "What we are motivated to do," says Engelfried, "is to reignite the debate around the Stadtgarten and to get things moving again. As well as connecting residents, this initiative will also ramp up the pressure to highlight the relevance of the issue. United, we will have a louder voice."

**Studying out in the fresh air: the park is especially popular with students.**

## STUDENTS ARE DEVELOPING IDEAS FOR THE NEW DESIGN

Alongside the "Quartier Stadtgarten" initiative, Engelfried and Johannes Nöldeke of the Institute for Social Sciences are offering a work placement semester in the interdisciplinary Public Planning and Participation master's program, which will not only support the initiative but will also give students some hands-on work experience. "The Stadtgarten is ideal for public participation because it involves an ongoing planning process with a public interest dimension," says Nöldeke, "and it's also right on our doorstep, on the Stadtmitte Campus. "It's important to me to give students a chance to take ownership, make an impact, and ultimately to experience a sense of personal growth in the process."

Students analyzed the initial situation and developed ideas for participation procedures in the winter semester of 2021/2022. One group, for example, is campaigning to make part of the Breitscheidstraße parking lot, which is near the university, car-free for a day, which they then want to repurpose as a multi-generational meeting point.

They are also planning to set up various benches made of pallets, each of which include a QR code, which will give people access to a number of surveys to find out how Stuttgart residents envision the Stadtgarten in the future. They will also be setting up a kind of living room with a sofa, bookshelves, and a ping-pong table in which each piece of furniture will symbolize one of the garden's functions, such as relaxation, movement, and gastronomy, where visitors will be able to contribute their own ideas for each area. Another group plans to spray chalk footprints on the ground to highlight the networking potential of the park. The results of the seminar will eventually be presented during the City of Stuttgart's Science Festival, and may potentially provide a further impetus to revitalize the historic Stadtgarten. →

**This historic recreational space directly adjacent to the university is now almost completely cut off from the surrounding city neighborhoods by multi-lane roads.**



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# Flax rather than cement



TEXT: MIRIAM HOFFMEYER

**Researchers are using modern technology and plant materials for more sustainable construction. One example of this is the livMatS pavilion in Freiburg, with which a team from the University of Stuttgart is also involved.**

**Aesthetically pleasing and sustainable: A team from clusters of excellence at the universities of Stuttgart and Freiburg worked on the livMatS pavilion.**





**Light and airy: an image of the braided flax fiber mesh.**



Conventional construction technologies are extremely damaging to the environment. Studies have shown that eight percent of global greenhouse gas emissions are attributable to cement production alone. The global construction industry's demand for sand and gravel has tripled over the past 20 years, and according to United Nations estimates, it is still increasing at an annual rate of 5.5 percent. Entire beaches have already been dredged so that the sand could be used to produce concrete. “As it stands today,” says Prof. Achim Menges of the University of Stuttgart's Institute for Computational Design (ICD), “conventional building approaches, which involve a trade-off between the ease of construction and a significant increase in the amount of materials required, no longer seem viable for the future. There is an urgent need for new approaches.”

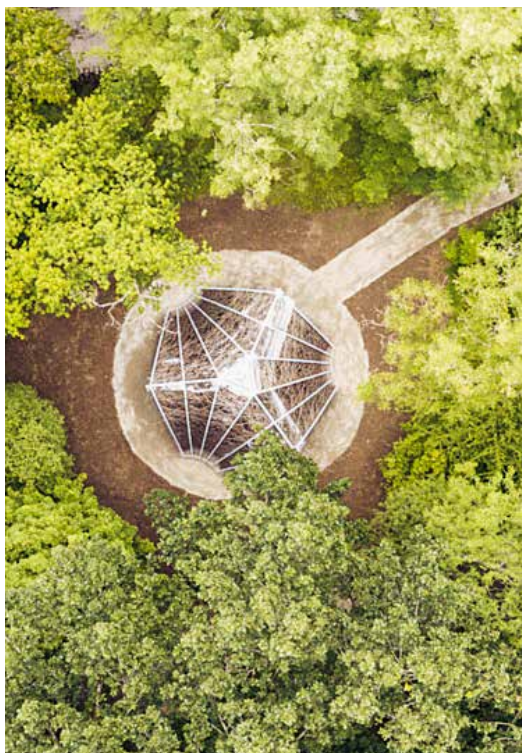
#### **DIGITAL TECHNOLOGY AND PLANT-BASED MATERIALS FOR SUSTAINABLE CONSTRUCTION**

The livMatS pavilion in the University of Freiburg's Botanical Garden has been showcasing potential sustainable alternatives since July 2021. This seemingly flimsy building was constructed from plant-based materials with the help of the latest digital technologies. As civil engineer Marta Gil Pérez of the University of Stuttgart's Institute of Building Structures and Structural Design (ITKE) explains, “The livMatS pavilion is the first building whose load-bearing structure is made entirely of robotically wound flax fibers, a natural, renewable, biodegradable and regionally available material.” Whereas trees have to grow for decades before they can be harvested for timber, flax is harvested every year. Fibers from this ancient cultivated plant have been used to make textiles in Europe for thousands of years.

The pavilion is the result of a collaboration between an interdisciplinary team from the ITECH master's program at the Integrative Computational Design and Construction for Architecture (IntCDC) cluster of excellence in Stuttgart and biologists from the University of Freiburg's Living, Adaptive and Energy-autonomous Material Systems (livMatS) cluster of excellence. The inspiration for the structural elements came from plant structures, namely the net-like bundles of wood fibers that give the saguaro cactus and the side shoots of the prickly pear cactus a very high degree of stability. “The pavilion is also a visible symbol of our very successful collaboration with the livMatS cluster of excellence,” says Gil Pérez. Despite being designed to withstand full snow and wind loads in compliance with building regulations, the pavilion, which covers a total area of 46 square meters, weighs just 1.5 tons.

#### **LEARNING FROM NATURE FOR ARCHITECTURE**

Researchers at the University of Stuttgart have been looking into how to transfer biological principles to architecture in order to build more efficiently and conserve resources for more than a decade. “Using digitally controlled robotic manufacturing, we can layer fibers exactly as needed to support loads whilst minimizing the use of materials,” explains Prof. Dr. Jan Knippers of the ITKE. Load-bearing components are produced using a coreless winding process developed at the ICD and ITKE, in which a robot places bundles of fibers on a winding frame with a high degree of precision. The component is shaped by the interaction of the fibers within the frame, and there is no waste or offcuts. →



Unique wickerwork: various views of the pavilion in the Botanical Garden in Freiburg

Marta Gil Pérez

**"It took a lot of experimentation just to get an initial understanding of the material properties."**



**High tech meets nature:** The flax fibers are manufactured using state-of-the-art robot-assisted technologies.





Until quite recently, research into the use of fiber-reinforced composite construction elements has been focused on the use of synthetically produced materials such as carbon and glass fibers. The livMatS pavilion was the first structure in which organic fibers were used. The new material posed something of a challenge for the interdisciplinary development team. “From the planning stage to production, we had to overcome numerous obstacles,” Gil Pérez explains: “It took a lot of experimentation just to get an initial understanding of the material properties.” Whereas continuous glass and carbon fibers are homogeneous, vegetable fibers are variable. This meant that both the computer-based design process and the robotic manufacturing workflows and machine control systems had to be adapted to the new material.

#### TAKING BOTH ECOLOGICAL AND AESTHETIC ASPECTS INTO ACCOUNT

According to architect and course coordinator Katja Rinderspacher, who led the project together with Gil Pérez, students at ITECH were particularly enthusiastic about the planning and construction of the livMatS pavilion. The goal of the master's program, she explains, is to prepare students from a variety of disciplines for the technological and planning advances that are taking place in the construction industry: “Our students are taught to rethink design and construction and to take an integrative approach based on the use of digital technologies. Right from the outset, all ITECH projects take material, structural and production aspects into account, as well as ecological and aesthetic considerations.” The pavilion showcases how these co-design approaches can be combined with robotic manufacturing techniques to create unique architecture, as Rinderspacher explains: “Not only did the holistic approach from initial project concept to computer-based design, digital planning, and fabrication help us to minimize the use of materials, but it also resulted in a distinctive spatial impression.”

Once the design had been completed, the data was transferred to industrial partner FibR GmbH Stuttgart, who manufactured the 15 flax fiber elements. The pavilion, which stands in the University of Freiburg's Botanical Garden, is currently being used as an event venue and serves to illustrate the potential of bio-inspired construction and natural building materials. Among other things, researchers from the livMatS Cluster of Excellence will be presenting their research there in guided tours or workshops.

#### FURTHER RESEARCH INTO THE USE OF PLANT FIBERS IN CONSTRUCTION

The pavilion was covered with a waterproof skin made of polycarbonate to weatherproof it. The plan is for it to remain at the Botanical Garden for at least five years, during which time it will be regularly tested to determine how well the natural fiber components are able to withstand the environmental effects, especially UV radiation. Researchers at the Cluster of Excellence also plan to continue their research into the use of plant fibers in construction in their laboratories. One of the things they are planning to study is whether it would be possible to replace the petroleum-based epoxy resins used to treat the flax fibers used in the pavilion with organic materials. They also want to study the material properties of hemp, which is another crop native to Europe, whose fibers could be used for sustainable construction.

The researchers are convinced of the potential of digital construction based on the use of natural fiber-reinforced composites for a more environmentally friendly construction industry. In the future, according to Marta Gil Pérez, the load-bearing elements of even large buildings could be made of the same material as the livMatS pavilion: “The potential of flax fibers is enormous.” →



**Unique funnel shapes: building with flax fibers requires a completely new design approach in the planning stage.**

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# J u m p s t a r t i n g c h a n g e





TEXT: DANIEL VÖLPEL

**One of the goals of the “Stuttgart Change Labs” funding program is to implement projects in collaboration with various initiatives and non-governmental organizations, rather than just planning them in the abstract. This approach, which is based on the “learning by building” principle, was modeled on the e1nszue1ns platform of the University of Stuttgart’s Faculty of Architecture and Urban Planning.**

How do the Indonesians construct buildings from bamboo and what can students of architecture learn from this? An international group of professional architects and students traveled to the island of Sumba in 2019 to answer these questions as part of the “Bamboo Route” project, which was organized by the Peruvian “Construye Identidad” initiative. Their goal is to transfer inherited knowledge about sustainable building forms using locally available materials to urban architects.

Melanie Nogales of the “Construye Identidad” initiative, a native Peruvian, who has since completed her master's degree in Integrated Urbanism and Sustainable Design at the University of Stuttgart, was among the participants. “We wanted to bring students together with a village community in Weelewo on the island of Sumba,” she says: “The people in this community have a wealth of knowledge about using local materials for construction, and know how to treat nature respectfully at the same time.”

#### CONCRETE IMPROVEMENTS THROUGH SOCIAL DESIGN

Another participant in the “Bamboo Route” project was Leolo Laubinger, a student at the University of Stuttgart. “We wanted the locals to teach us their construction methods because they were the real experts,” he says. Social design is an architectural term that refers to the process of planning with the future users and their needs in mind right from the start, and when it is the planners themselves, who implement their own plans. In this specific case, a bamboo rain collector, which the team helped the locals to build, obviates the need for tedious treks down to the nearest water source in the valley. The so-called “Bamboo Route Bootcamp”, which is a week of online seminars with experts from Indonesia, Peru and Stuttgart, was created in 2020 because the pandemic made it impossible to continue the project in its original form.

#### COLLABORATION BETWEEN SCIENCE AND SOCIETY

Both projects were funded by the “Stuttgart Change Labs” program, which was set up by the University of Stuttgart with the support of the Baden-Württemberg Ministry of Science. As Prof. Markus Allmann, head of the University of Stuttgart's Institute of Conception of Space and Principles of Design (IRGE), explains: “The purpose of the ‘Stuttgart Change Labs’ program is to promote research-based and interdisciplinary teaching in a sustainable manner, to foster collaboration between science and society, to promote innovative →

Leolo Laubinger

**“We wanted the locals to teach us their construction methods because they were the real experts.”**

→ student projects with community partners, and to support student involvement. He and the Vice Rector for Teaching and Continuing Education, Prof. Frank Gießelmann, share responsibility for the “Stuttgart Change Labs”, where, for example,

students can get advice on how to approach and implement their projects or attend workshops. The coordination office also puts them in touch with external partners, such as non-governmental organizations, and provides them with financial support for which purpose a budget of 10,000 euro is made available each year. “Of course,” says Laubinger, “the financial support helped pay for the experts, travel expenses, and work materials. However, the second important thing was having the name ‘Stuttgart Change Labs’ behind us, which made it easier to find collaboration partners.”

“The idea,” as Špela Setzen, overall coordinator of the Stuttgart Change Labs, explains, “is to initiate projects that serve a meaningful purpose rather than just being about self-development.” There should always be a need, he continues, and it is about core life issues such as poverty and the climate and the projects should be sponsored by local stakeholders. “We only support non-profit projects. It is important for projects to be seen as →



Learning from one another Among other things, the “Stuttgart Change Labs” program is aimed at stimulating dialog.

Prof. Markus Allmann

**“We think this has created a good foundation that will be able to help all stakeholders plan and implement effective projects.”**

Building with bamboo: architectural students are learning unfamiliar technologies in Indonesia.



Špela Setzen

**“The idea is to initiate projects that serve a meaningful purpose rather than just being about self-development.”**

→ collaborative endeavors,” Setzen continues. To meet this requirement, projects must be adapted to suit local social structures, cultures, materials, traditions, and resources.

“The students have received several awards from different institutions for their enormous commitment, their sustainable solutions, and their exemplary participatory construction approaches,” as IRGE director Allmann is pleased to point out. For example, he adds, one project was exhibited in the “Experience in Action” exhibition at the Technical University of Munich's Architekturmuseum, where it was cited as being exemplary for its transdisciplinary approach.

#### **LEARNING AND TEACHING PLATFORM FOR ARCHITECTURE AND URBAN PLANNING**

The Stuttgart Change Labs concept was modeled on the Faculty of Architecture and Urban Planning's e1nszue1ns platform. “During their studies, architectural students draw up a lot of plans for all kinds of imaginary clients,” says Setzen. “Many felt the need to do something themselves, to experience how it feels not only to plan a project, but also implement it.” The idea is to bundle these experiences for future students on a platform, where organizational matters, such as fundraising, can also be handled. Since being launched in 2015, the e1nszue1ns team has provided start-up funding for about 20 projects. “Whereas the purpose of the e1nszue1ns platform in the start-up phase was to pool practical knowledge,” Allmann explains, “the aim in the current stabilization phase is to develop it into a learning and teaching platform and to incorporate methodological evaluation to a greater extent.”

The desire to draw up an initial balance sheet also emerged around the time of the five-year anniversary. A multidisciplinary team from the fields of sociology, urban planning, and law reviewed all e1nszue1ns projects and conducted 19 interviews with various stakeholders and the findings flowed into the 130-page “Learning by building” orientation guide. “The top five values identified for the various projects were: motivation, commitment, a willingness to learn, responsibility, and open mindedness,” Setzen reports. “We think this has created a good foundation that will be able to help all stakeholders plan and implement effective projects,” says Allmann. Going forward, we should be placing even more emphasis on involving all relevant social stakeholders and on closer collaboration with the other disciplines.” This project experience, he adds, also increases academic achievement and prepares students for their professional lives.

#### **PROJECTS ALSO INFLUENCE CAREER CHOICES**

There is every chance that there will be further stages on the “Bamboo Route” because the university has established the “Stuttgart Change Labs” on a permanent basis. “The boot camp was very successful and everyone involved was extremely enthusiastic,” says Nogales. For example, one of the participants is currently working as an architect in Bali. This fits with Setzen's experience with the projects. Almost all e1nszue1ns students, he says, have been shaped by it in their choice of career and subsequent approach to work. “Many of them,” Setzen reports, “now work for companies, whose focus is very much on citizen participation and user friendliness.” “Some even support similar projects in their spare time.” →

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# Improving teacher training in South Africa

TEXT: MICHAEL VOGEL

**South African vocational school teachers are learning about new technologies and teaching approaches for the digital era in a bilateral training program. The University of Stuttgart's Department of Vocational Education (BPT), which focuses on the didactics of technology, is responsible for the didactic and pedagogical-psychological aspects.**

It's fair to describe Tony Lynch as a man, who is always on the go: he spent over two decades working as a process engineer at Mercedes-Benz in South Africa, before taking on a new role with a South African supplier, but was made redundant after just a short time in the course of a downsizing exercise. But Lynch soon found a way to help himself and just a few months later he took up a position as a vocational instructor at TVET College in Buffalo City, which encompasses several campuses, where he has been teaching electrical engineering since 2008. Whilst still working full-time, he managed to take a degree in pedagogy, write a book on electrical engineering education, and contribute to the national curriculum for the relevant field. "A few years ago," says Lynch, "our campus manager pointed me to the TRAINME project and suggested that I take part. It was the right decision."

## A CONTINUING EDUCATION PROJECT WITH MULTIPLE PARTNERS

The TRAINME project was a bilateral research and development program, which ran from 2018 to 2021 and was funded by the German Federal Ministry of Education and Research (BMBF), the purpose of which was to provide continuing education courses for vocational school teachers in South Africa. The project partners included the Department of Vocational Education focused on Teaching Technology (BPT) at the University of Stuttgart's Institute of Educational Science (IfE), the Inter-company training center in Eastern Bavaria (ÜBZO), and the South African Department of Higher Education and Training (DHET). "In the context of the project," says Prof. Bernd Zinn, Executive Director of the IfE, "the ÜBZO was responsible for subject-related professionalization, →







The University of Stuttgart is supporting an advanced training program for dual education in South Africa.

Tony Lynch teaches electrical engineering and participated in the TRAINME Project.



Tony Lynch

**“Now I'm also training the trainers.”**

Participants in one of the TRAINME program courses



One of the participant in the project, which is funded by the German Federal Ministry of Education and Research

→ whilst our own focus was on subject-didactic and pedagogical-psychological professionalization.” The project was undertaken in the context of Germany's efforts to internationalize vocational training and vocational teacher training in line with the dual system established here: learning and teaching through a close integration of theory and practice.

The background situation in South Africa is different, as Gerda Magnus, Senior Director of Programs and Curriculum Innovation in the Vocational Education and Training Department at South Africa's DHET, explains: “We want to make vocational education more popular. School leavers in our country can begin an apprenticeship at the age of 16, but that tends to be the exception. Instead,” she continues, “many stay on in school through twelfth grade instead, but many fail to graduate.” And a university place is not guaranteed even with a school-leaving degree. “So, vocational training would be an excellent alternative for a lot more young people,” says Magnus.

In South Africa, there are currently three different routes that this three-year training can take: exclusively theoretical at a vocational school, theory and practice at a vocational school, or classroom instruction in a vocational school combined with practical phases in various companies. “The latter is the rarest form, which is why we want to expand that path,” Magnus explains. “To do so, advanced training for teachers is important because their backgrounds are often widely different.” →

→ The participants in the TRAINME project were drawn from the 50 vocational schools in the country that offer training in the fields of electrical engineering, electronics and mechanics, whereby a total of 20 teachers participated in the project. “They really enjoyed it and felt that they learned a lot,” says Magnus. The DHET selected so-called master trainers from among the participants, one of whom is Tony Lynch. “Now I’m also training the trainers,” he says happily.

### AN APPETITE FOR REFORM

At the start of the TRAINME project, the BPT team from Stuttgart analyzed the situation in South Africa by looking at the current education policy and curricula, conducting interviews and discussions with focus groups, and carrying out a survey involving 300 vocational school teachers. “This revealed an appetite for the type of reforms that will ultimately lead to a stronger dual education system,” says Zinn. “We were also able to define a set of minimum requirements for the teacher qualifications, but one-fifth of the cohort were unable to meet them.” It was also found that there is room for improvement in terms of equipping vocational schools with the latest technologies used in manufacturing companies. “The bottom line,” says Zinn, summing up, “was that this situation resulted in marked disparities in teachers’ teaching skills.

Training for the South African project participants was provided in the form of a mixture of e-learning and face-to-face events. “Unfortunately,” says Stefanie Holler, a doctoral student in the BPT who worked as a research assistant on the project, “we were forced to greatly reduce the attendance component due to the Covid-19 pandemic.” The teaching staff used a platform provided by the ÜBZO training center for the e-learning component. “An initial teaching phase, which also served as a pilot run for us, ended in November 2019,” Holler explains. “An evaluation and certain amount of optimization were then followed by the second teaching phase.” The trainees participated in the project whilst still continuing their own teaching activities.

### GERDA MAGNUS

“We want to make vocational education more popular.”



Gerda Magnus is responsible for vocational training programs in South Africa.

### DIGITIZATION TO BE THE FOCUS OF THE PROJECT GOING FORWARD

The project partners now want to consolidate and significantly expand what has been achieved in a follow-up project known as TRAINME2, which began in October 2021 and is again scheduled to run for three years. “In terms of content and the didactic objectives, the focus is on increasing the use of ITC in education and on dealing with the heterogeneity of students,” says Zinn. “We also want to involve local companies to a greater extent.” The same quality requirements that apply to German dual training apply here, particularly with respect to sustainability, digitization, law and safety, as formulated by the German Federal Institute for Vocational Education and Training (BIBB).

The TRAINME2 project is divided into four phases. To begin with, the project participants will design needs-oriented training modules in collaboration with the relevant South African authorities responsible for the formal standards of vocational education and training. “In a second phase,” Zinn explains, “we plan to test these modules in the tried-and-tested mix of classroom training and e-learning with a group of teachers who already took part in the previous project.” This will be followed by a third phase in which the project partners will continue to train the master trainers in order to disseminate the contents of the TRAINME2 program. A group of new project participants will then work through the educational modules under the supervision of the master trainers. And finally, the fourth phase will focus on evaluation, knowledge transfer, and public relations. “Our goal is to produce a comprehensive transcription of all teaching and learning content and make it freely available in a number of files under a Creative Commons license,” says Zinn. As in the previous project, a textbook and a teacher’s guide will be available for each module. →

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Gettyimages/Klaus Vedfelt



DR. SIEGFRIED REUSCH

# THE BLUE TRAILBLAZER



TEXT: Andrea Mayer-Grenu

PHOTOS: Uli Regenscheit

**The first comprehensible philosophy journal in German: this was the aspiration of Dr. Siegfried Reusch when he and other alumni of the universities of Stuttgart and Ulm founded the journal *der blaue reiter* (The Blue Rider) in 1995, making him one of the pioneers in public engagement.**

Does sustainability always call for self-restraint? Are revolutions the engine of culture? And is there any such thing as certain knowledge? These are some of the fundamental ethical questions that *der blaue reiter* (the blue rider) addresses. “These are the questions we want to put to society at large and show what philosophy can do,” Reusch explains. Philosophy is all about thinking about the fundamentals and asking questions rather than taking anything for granted. The articles, on the other hand, do not necessarily provide answers. “We want to point out what is conceivable. People have to come up with their own answers,” says Reusch.

The first issue of the magazine in 1995 asked the fundamental question: “What is philosophy?” There are no clear answers to this either. In his editorial, Prof. Günther Bien, under whom Reusch completed his doctorate, describes philosophy as the “... path to wisdom through the narrow gate of science ...”. By contrast, the philosopher Dr. Otto-Peter Obermeier sees philosophy as “... failure in a more or less skillful manner ...” and thus as the cornerstone of a successful life. In so saying, he came quite close to the magazine's logo, which is a silhouette of Don Quixote, whose fight against the windmills may be seen as a metaphor for failure. This struggle is also reflected in title of the journal, *der blaue reiter* (the blue rider): It ties in with the eponymous artists' almanac published by Wassily Kandinsky and Franz Marc, in which the color blue symbolizes the spiritual aspect and the rider the combative one.

## THE IVORY TOWER IS ALSO IMPORTANT

These struggles are also reflected in the balancing act between the use of specialist jargon and comprehensibility for a readership that is largely made up of academics, but not necessarily philosophers. “Comprehensibility is relative,” says Reusch. That is why, he adds, technical terms, sometimes even Latin, are still needed even in a generally →



“We want to point out what is conceivable. People have to come up with their own answers.”



## DR. SIEGFRIED REUSCH

studied chemistry at the University of Ulm and philosophy at the University of Stuttgart. He has been editor-in-chief and co-publisher of *the philosophy journal der blaue reiter* (the blue rider) as well as director of the eponymous publishing house since 1995. Reusch, who has also published and authored several books, organized the first philosophical cafés in Stuttgart and has initiated numerous other philosophical events.

→ understandable article in order to describe things with precision. “It's no use railing against the much-cited ivory tower,” says Reusch, “it's definitely important. However,” he says in the same breath: “scientists do need to stick their heads above the parapet every now and then and show the public what they are up to. The public has a right to know what's going on in expensively funded universities and research institutions.” However, knowledge transfer should not be a one way process. “Both sides are slightly reserved when it comes to contact. Science and society must enter into a dialog,” says Reusch. His most “philosophical” interview was with star chef Vincent Klink.

Feedback from the general public to the scientific community – or, as Reusch casually puts it, “the connection to real life” – also benefits science, he says. It broadens one's view of one's own subject area, as was seen, for example, in the research into nuclear power, which initially had a strong technical focus. “Whereas many researchers may have felt that people's fears about nuclear power were irrational, they have greatly advanced the safety aspects of reactor research in response to these.” A similar situation can be observed today, he continues, for example, in the discourse surrounding the sequestration of CO<sub>2</sub>, in which the public are asking whether this technology is also earthquake-proof. “We need critical discourse with no reservations,” Reusch sums up.

### BRINGING TOGETHER THE NATURAL SCIENCES AND THE HUMANITIES

An interdisciplinary approach is indispensable in order to shape this discourse. The relationship between the natural sciences and philosophy was already addressed in the first edition of *der blaue reiter* (the blue rider). To this day, the editorial team has been put together on a deliberately interdisciplinary basis. Dr. Klaus Erlach, for example, is a mechanical engineer and holds a doctorate in philosophy, Rüdiger Vaas combines biology and philosophy, and Dr. Elke Uhl heads the University of Stuttgart's International Center for Cultural and Technological Studies.

Reusch himself also epitomizes the connection between the two disciplines in his own life: Born in Freiburg, he originally studied chemistry in Ulm and, after obtaining his degree, went on to study philosophy at the University of Stuttgart, where he received his doctorate in 2004. Asked how that fits together, he says: “Chemistry and philosophy are simply two different ways of describing the world, but they are inseparable and ideally complement each other to give a more rounded view of the world.” This requires openness to the views of researchers who work in other disciplines such as those, which natural sciences graduate Reusch learned from the teaching staff at the University of Stuttgart. “I'm extremely grateful for this,” he says, and appeals to practitioners of both the humanities and the natural sciences to listen to one another and to seek a dialog – “as difficult as this may be in practice”.

Universities could and should put structures in place to foster a successful discourse between the various disciplines, he continues. For example, it would make sense to co-opt philosophy professors in the science faculties and to allocate a few semester hours per week for networking as part of the curricula. “The University of Stuttgart was quick to recognize this, which it did, for example, by establishing the IZKT. Provided the university continues steadfastly along this path, it will create a genuine sense of esteem.” The result, according to the philosopher, alluding to the University of Stuttgart's stated vision, “will not only be intelligent systems for a sustainable society, but also systems that will be embraced by society.” →

Dr. Siegfried Reusch

**“Both sides are slightly reserved when it comes to contact. Science and society must enter into dialog.”**



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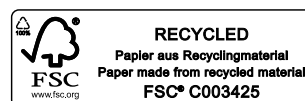
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