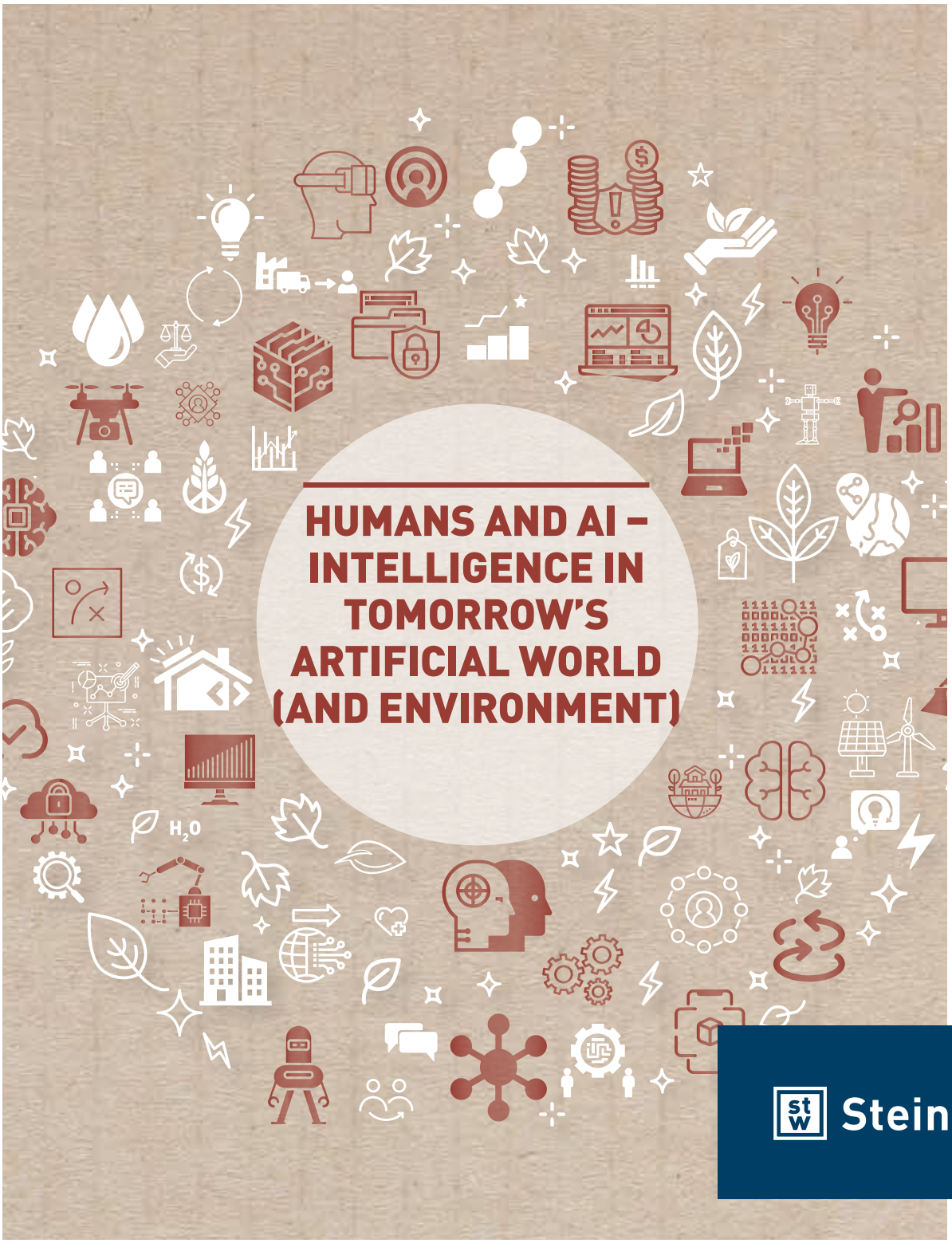
TRANSFER

THE STEINBEIS MAGAZINE **03|21**



HUMANS AND AI – INTELLIGENCE IN TOMORROW'S ARTIFICIAL WORLD (AND ENVIRONMENT)

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DEAR READERS,

This issue of TRANSFER magazine highlights the potential and interrelationship between human beings and "machine intelligence" in the world we will live in one day. This topic marks the conclusion of a series of special features, this year revolving around the overarching campaign motto of "delivering benefit … for the challenges of the economy and ecology."

There can be no question that it is crucial to examine current and upcoming developments in the field of artificial intelligence (AI) – first and foremost in terms of their usefulness – and technological feasibility studies should gradually give rise to applications that add value. After all, what's the point of having a solution if it doesn't match a problem? This development, described in German as "solutionism," appears to be evolving into a challenge for digital transformation. This is not a trivial issue either, because many applications only exist at the moment simply because they're possible from a technological standpoint. Using an extremely apt analogy to describe this conflict, American architect and designer Richard Saul Wurman explains that having more schools does not automatically result in having smarter kids. It's a poignant example that could serve as a useful maxim for many inventions of the digital economy, so that highly powerful technology – which AI can be – is applied with intelligence and consideration.

In addition to researching what is feasible, AI development also requires science that takes a holistic view of socio-technical issues – to consider the measurable benefits solutions bring to people and their environment. It's important to move away from a sense of fascination focusing exclusively on technology and water down the exaggerated fiction and fears. So we should focus on why we need artificial intelligence and, more importantly, what for? Also, we should concentrate on how we can coexist with AI and use it to improve the world we will live in tomorrow.

Compared to the leading centers of AI on the American Pacific Coast and in Asia, research that focuses on areas with a bearing on socio-technical topics should be seen as an opportunity – especially in Europe. With this almost unique concentration of successful scientific institutions and the multi-layered cultural influences of countries engaged in close cooperation, the standards of digital development can reach a higher level – and in some respects a more profitable level.

Last but not least, in addition to transcultural exchange, it is of utmost importance to engage in interdisciplinary exchange. This will be the only way to forge the links that are required between different fields of research – and thus, in the future, also enshrine human values within digital innovation processes. The Steinbeis Network offers a number of potential ways to achieve this – let's use this potential together.

With kind regards,

PROF. ERICH SCHÖLS
erich.schoels@steinbeis.de (author)

Professor Erich Schöls was the founder of Design and Systems, the Steinbeis Research Center in Würzburg, which he continues to head up today. He is the dean of the Faculty of Visual Design at the University of Applied Sciences in Würzburg, where he is also in charge of the digital media major. In 2019, Erich Schöls and his colleagues received the Steinbeis Foundation Transfer Award, the Löhn Award, for his project called Kyana – Predictive Maintenance Using Digital Twins.

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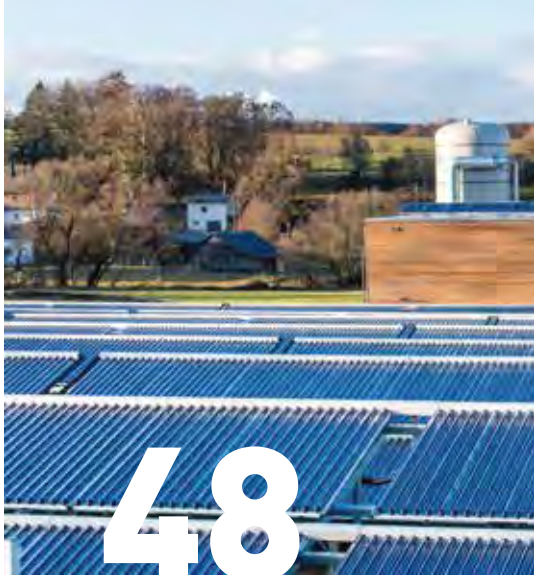


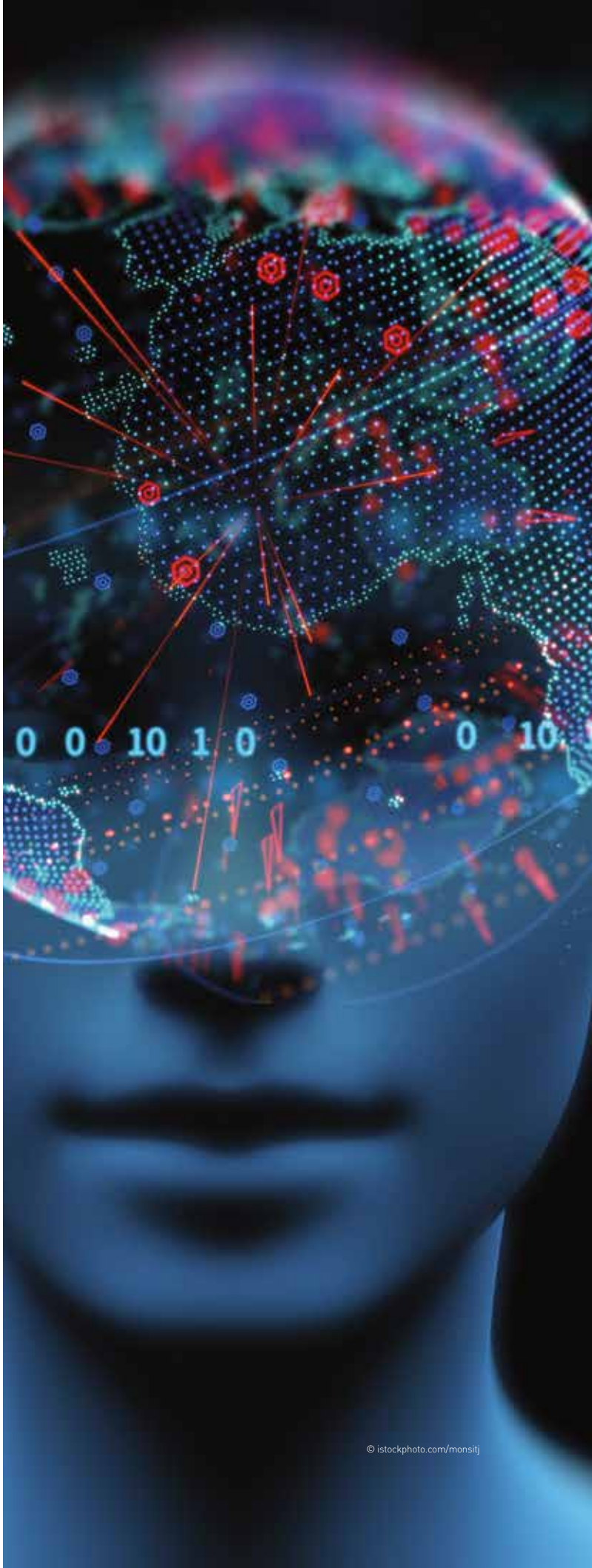
HUMANS AND AI – INTELLIGENCE IN TOMORROW'S ARTIFICIAL WORLD (AND ENVIRONMENT)

AI APPLICATIONS have long been taken for granted, even if the technology is still considered relatively new. Look into the facts more closely, however, and its beginnings can be traced back to the early **20TH CENTURY. IN 1936,** Alan Turing translated some initial ideas into his own machine, and in 1956 American scientists described the concept of allowing machines to simulate the features of **HUMAN INTELLIGENCE**, thus coining the term **ARTIFICIAL INTELLIGENCE.** Today, automatic facial recognition, navigation systems, and voice assistants are part of our everyday lives. But where is the **JOURNEY** taking us? And is there a clear dividing line between the **OPPORTUNITIES** and **THREATS** it poses? Steinbeis experts offer insights into **CURRENT SOLUTIONS** and the latest trends, as well the challenges that await us. And of course we ask an important question: Who will the **FUTURE** of humanity belong to – humans or AI?

VISIONS OF ARTIFICIAL INTELLIGENCE: SCIENCE FICTION OR JUST AROUND THE CORNER?

PROFESSOR DR. WOLFGANG ERTEL OUTLINES THE POTENTIAL SCENARIOS OF FUTURE AI SINGULARITY

A central theme of Origin, the novel by American author Dan Brown, is a form of artificial intelligence that kills its human inventor after weighing all the facts. From a logical standpoint, this seemed like the right decision for the AI system. Realistically speaking, what is still science fiction in technological terms today may actually be possible within decades. Using conventional methods based on mathematics, computer simulation, and software engineering, previously unsolvable problems can now be solved through machine learning methods. AI is now driving the economy, not only improving the quality of living, comfort, and convenience, but also promising to change more and more areas of our lives. In addition to improving human health, learning diagnostic systems help protect the environment and our climate. As our author Professor Dr. Wolfgang Ertel explains, one prerequisite for this is a smart approach to AI based on a long-term outlook, especially if we want to avoid drifting into disaster. An entrepreneur at the Steinbeis Transfer Center for Artificial Intelligence and Data Safety, Ertel also lectures at Ravensburg-Weingarten University of Applied Sciences.



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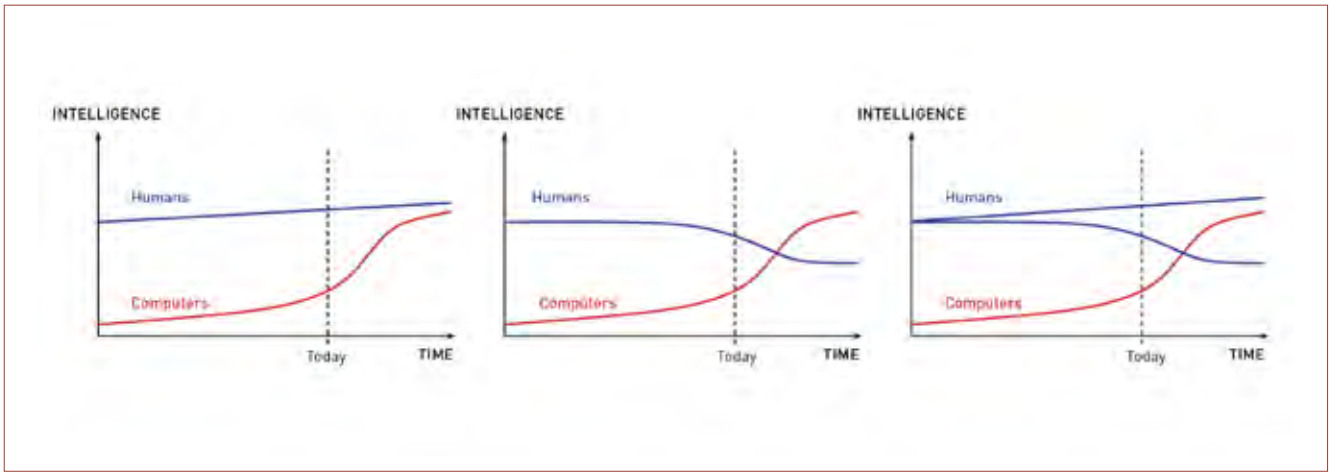


Three potential developments: Humans are the crown of creation (left), humans degenerate (center), and humankind diverges (right).

Machine learning has achieved significant breakthroughs in the last ten years. Thanks to deep learning, neural networks are better than humans at recognizing random objects in photos. In the coming years deep learning will, on top of technology such as radiology imaging, deliver significantly better medical diagnoses. Deep learning is already powering advancements in self-driving vehicles, and one day they will become a global phenomenon. Service robots are also becoming an important area of application, achieving excellent standards, with robots now capable of reliably detecting and grasping objects. In creative areas, so-called GAN networks are now able to create artworks or portraits of artificial people, or integrate existing people into generated videos.

THE NEXT LEVEL – COMPLEX LANGUAGE MODELS

Adaptive AI systems are now able to solve a whole host of special tasks better than humans. But these systems are still restricted to solving one task at a time [1]. In 2020, software development specialist OpenAI from San Francisco unveiled its Generative Pre-trained Transformer 3 (GPT-3) networks, taking the quality of the technology into an entirely new dimension [2]. GPT-3 is a highly complex language model that learns from texts found in books, databases, and Wikipedia, absorbing no less than four billion pages of text. You can hold a conversation with GPT-3 like talking to an academic. In response, you get grammatically and semantically correct answers to any question from any field of knowledge.

This makes the next step toward "general intelligence" seem entirely feasible. All that is left to do now is to get systems to talk, perform any chosen action, and acquire new skills. And that is exactly what OpenAI is now attempting to achieve with Codex [3], a system based on GPT-3 that, in addition to learning the language model, has also learned a model based on Python programming language by training on GitHub, the open source software database. Codex makes it possible to use task descriptions in text formats to automatically generate nontrivial computer programs.

Extrapolating these successes into the future raises the question of whether and, if so, when AI systems as a whole will be superior to us humans in all areas. The point at which AI achieves the same level of intelligence as humans is called singularity. It is assumed that this will happen within the next twenty to fifty years. Shortly after achieving singularity, AI systems will be far superior to us humans because they will keep evolving much faster than we do. So what would this mean for us?

THE RACE BETWEEN HUMAN BEINGS AND AI: DIFFERENT SCENARIOS

Developments could quite conceivably go in a number of directions when it comes to the temporal evolution of human and computer intelligence. In the figure top left, human intelligence increases gradually on a linear basis, whereas AI initially increases exponentially before asymptotically starting to approximate to human beings. This is based on the assumption that AI developed by humans can never become smarter than its creators. What speaks against this hypothesis is that human intelligence could also decline, especially if life becomes more and more convenient as AI does more and more thinking for us, for example through car navigation systems. This scenario is shown in the middle diagram above. It is also pos-

sible, however, that a division emerges in society as shown in the diagram on the right, with an "intellectual elite" in contrast to "wallowers" – a situation that is certain to offer considerable potential for conflict.

Things really become interesting in the graphs below, where the red lines cross the blue lines at the point of singularity. On the left, the exponential rise in AI continues unabated. This cannot be completely ruled out, because AI that is smarter than us would also steer research and develop completely new technologies and algorithms. Such a superintelligent form of AI is called artificial general intelligence (AGI). There could also be limited singularity, however, with a stagnation in the rise of intelligence as shown in the middle graph.

With both of these scenarios, human beings are outstripped by AI, which takes the lead and can define its own plans for homo sapiens. Precisely because AI is then smarter than us, we will likely have no opportunity to predict how AI deals with us humans – heaven or hell, both scenarios are conceivable. What's interesting and new is that reality and our concept of the future – previously dismissed as science fiction – are increasingly converging.

Finally, the graph on the right is another fascinating vision of the future. It more or less represents the vision of the future held by Ray Kurzweil, who heads up development at Google and is an AI futurist. Assuming we humans find ways to connect our brains to a digital AGI and thus develop into superintelligent beings ourselves, we would be in a position to keep determining our own destiny. And thanks to modern genetic engineering, we would potentially no longer age and thus be able to live much longer.

AGI: A CURSE OR A BLESSING FOR THE HUMAN RACE?

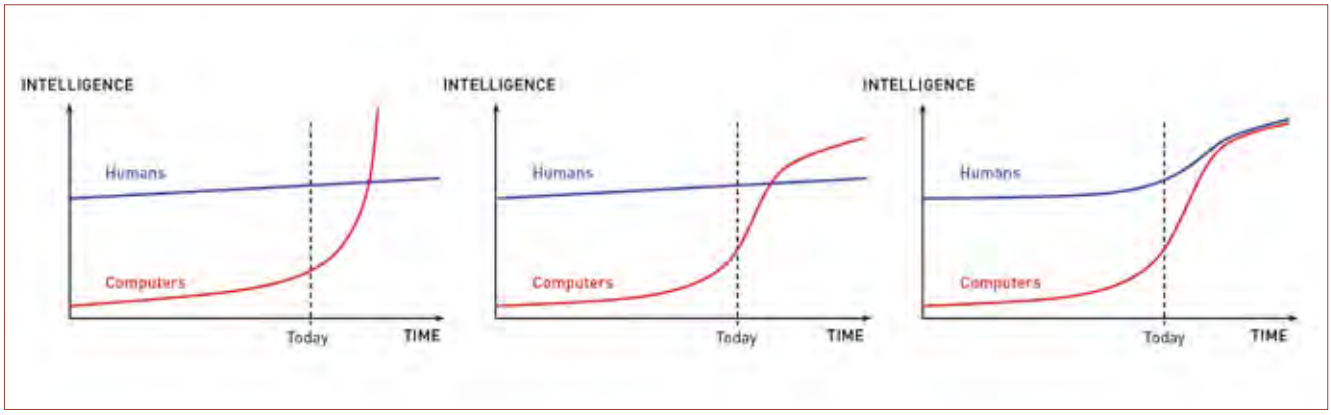
How long singularity will take and what will change as a result, is impossible to say. But we can think through the possibilities. We can draw on four scenarios to paint a brief picture of the future and its consequences for homo sapiens – with or without AGI:

1. Humans do not develop AGI
Life goes on as before and is essentially about the important (albeit under this scenario no longer pertinent) question of how we humans interact with one another and nature.

2. Humans develop AGI
Since, by its very definition, AGI is smarter than humans, it will decide the future of humanity. The following possibilities are conceivable: AGI decides to serve humankind, which could theoretically lead to paradisiacal conditions. Whether, in the process, this would actually make us humans happy is difficult to say. Moreover, it is unlikely that AGI would really want to be a servant to us. If anything, it is more likely to want to make use of human beings, for its own purposes – just as we breed farm animals, for example. AGI could, however, also decide to destroy humanity or let it die out [4].

3. Humans develop AGI and die out
When the dinosaurs became extinct 66 million years ago, they left behind a biological niche for us humans. Had they survived, we would not exist today. Presumably, there will be no humans left in 66 million years. It is entirely probable that humanity will die out as a result of

Singularity (left), limited singularity (center), and the superintelligent convergence of humankind and machines (right).



THANKS TO DEEP LEARNING, NEURAL NETWORKS ARE BETTER THAN HUMANS AT RECOGNIZING RANDOM OBJECTS IN PHOTOS

climate change, environmental pollution, a pandemic, or a world war. It would be a shame if we departed from this planet without a legacy. AGI would lend itself to this. We should ensure we have pushed it far enough to develop autonomously – before our downfall. Unlike biological beings, AGI can be easily separated from the body and transmitted by radio waves, opening up exciting possibilities for its propagation throughout the universe.

4. Humans die out before the inception of AGI

In contrast to the third scenario, we depart from the universe without leaving behind a legacy. In the same way homo sapiens once succeeded the dinosaurs, humankind has clearly not succeeded in creating a species to replace itself. Tough luck.

You might be wondering if there's really any need to think about these things – indeed, is there any point? Well, on the one hand, from an academic standpoint researching the future of humankind is tremendously interesting. But on the other, we may also want to shape the future, for example by preventing the development of AGI, especially if we think it could pose a threat to us humans. And we should think about these concepts early – before singularity happens. This is because once AI matches the intelligence of primates, it would be too late to do anything about it. Really clever AI would replicate itself many times over on the internet and evolve rapidly.

Even if AGI doesn't yet enter the scene, or never does, the AI systems that are in wide-scale use today already pose highly tangible dangers. They were developed to lighten the load on us humans, which they do. The work environment will change dramatically, since AI and automation are taking on more and more work, in almost all professions. We must therefore think about life in a future in which fewer people practice a profession [5], also within the context of the limitations of this planet – which our never-ending consumption has long since exceeded [6].

References

[1] W. Ertel. A Fundamental Course in Artificial Intelligence. Springer-Vieweg Publishing, 5th edition, 2021.

[2] T. B. Brown, B. Mann, N. Ryder, et al. Language Models are Few-Shot Learners. arXiv:2005.14165, 2020.

[3] M. Chen, J. Tworek, et al. Evaluating Large Language Models Trained on Code. arXiv:2107.03374, 2021.

[4] Th. Metzinger. Virtual Reality and Artificial Intelligence. Talk given at ETH Zurich, 2018. https://www.youtube.com/watch?v=XwiM2P3xHZs.

[5] W. Ertel. Artificial intelligence and the economy of the future. Informatik Aktuell, October 2018. https://www.informatik-aktuell.de.

[6] W. Ertel. Artificial Intelligence and the Leisure Rebound Effect. Informatik Aktuell, July 2021. https://www.informatik-aktuell.de.

PROF. DR. WOLFGANG ERTEL
wolfgang.ertel@steinbeis.de (author)

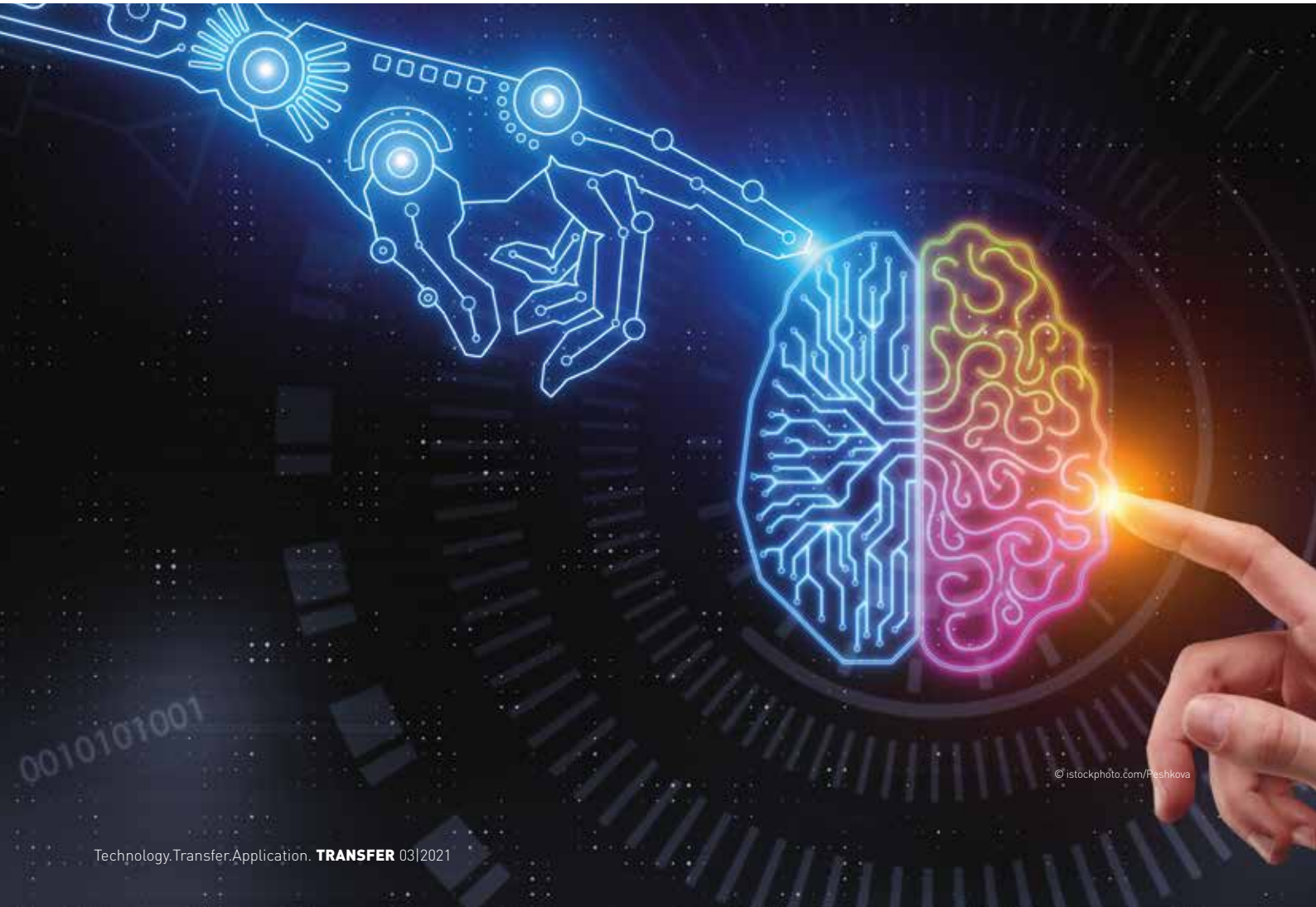
Steinbeis Entrepreneur
Steinbeis Transfer Center
Artificial Intelligence and
Data Safety (KIDS)
(Ravensburg)

www.steinbeis.de/en/su/605

"DESPITE ITS SUPERHUMAN ABILITIES, COMPARED TO NATURAL INTELLIGENCE AI IS EXTREMELY LIMITED"

TRANSFER MAGAZINE SPEAKS TO AI EXPERT CARSTEN ULLRICH, PROFESSOR AT STEINBEIS UNIVERSITY

Sometimes it feels like the only opinions you hear about artificial intelligence (AI) are extreme opinions – it's not often you experience moderate opinions. Some see AI as a 21st-century panacea, the solution that will surpass natural human intelligence in coming decades. Others see it as Pandora's box, something we lost control of many years ago without even noticing. In an interview with TRANSFER magazine, Professor Dr.-Ing. Carsten Ullrich shows how to weigh up the opportunities and risks. As an AI expert at CENTOGENE, a specialist company in diagnosis and therapy development for rare diseases, Ullrich also lectures at Steinbeis University. He explains how in many areas it can be extremely helpful to use AI, but he also points out its limitations, which clearly still exist.



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Hello Professor Ullrich. You've been working on artificial intelligence for more than 15 years now. Which developments would you describe as the milestones in this area?

There have been many milestones. You could even go back to Leibniz and the first time it was realized that machines could not only be used to calculate numbers, but also to formalize logic or thought processes. In the 40s and 50s of the last century, when the first computers came along and started performing calculations on numbers semi-electronically, the smart thinkers realized that maybe you could use them to do a lot more. It was the very early days of AI, but it didn't take long before some incredibly impressive results were produced. They came up with AI programs that were capable of proving mathematical theorems, there were the first translation programs – and that was all in the 1960s, when there were no such thing as a computer as we know it now.

Since then, more and more ways have been found to get computers to calculate things and behave intelligently. The processes of machine learning have also made another major leap forward in recent years. This was all thanks to the huge volumes of data made available by the Internet, but also the ability to perform monumental computations in parallel. This has made it possible to run algorithms on huge amounts of data in order to detect patterns.

There have also been numerous milestones in the last 15 years. Look at the board game Go: Computers now play it better than any human, which was basically inconceivable six years ago. Or the protein prediction system AlphaFold recently unveiled a sister company of Google. For a long time, the protein problem was seen as one of those unsolved challenges. Being able to predict the folding of many proteins not only constitutes a milestone in terms of AI technology, it also spills over into the corresponding field of life science. The problem with all milestones is that the moment you reach them, people no longer see it as AI, it becomes the standard. So you're permanently raising the bar.

You're a professor of artificial intelligence at Steinbeis University. What are your main areas of focus?

I've been dealing with AI in one way or another for the whole of my career until now, and it's always revolved around the same question: How can we use AI to make life easier for humans? The first studies I carried out looked at adaptive learning systems for schoolchildren and students based on AI processes; the tasks I was working on in Shanghai involved AI in distance learning. But also for my work at the German Research Center for Artificial Intelligence, I developed assistance systems for smart factories to provide operators with support in different working environments. This is the topic I've continued working on at Steinbeis. The key question for me is, where can AI be used to help people do their jobs, or automate monotonous tasks, or give people more time to focus on what's important to them? So it's about more than programming algorithms. When you introduce a technical system to an organization, the other question that arises is how best to do that. Basically, when you develop an AI system you should get staff involved to understand their apprehensions and expectations. Only then will you be in a position to apply AI successfully. After all, you don't want to introduce AI just for the sake of it; you want to make things better or change business processes.

What opportunities does AI offer to companies, but also to society, and what risks does it entail?

My main concern is always how to use a new form of technology and what I want to achieve with it. For me, AI should make things easier for people or give them more leeway to take action. This is where it offers tremendous potential. It's comparable to the impact of previous industrial revolutions, and it's this potential that needs to be leveraged.

Of course, every technology involves certain risks. The concerns you hear, over and over again, are that technology will mean humans will have less to do and they'll be given less and less room to intervene themselves. But at the end of the day, what matters is how you design the overall system. I can create an AI solution that calculates the optimal bed occupancy schedule for a hospital. So this immediately raises a question: What's "optimal?" Should I define it as meaning there's a nurse avail-

able for each patient, as quickly as possible, someone who can look after them a lot? Or should I define optimal as the minimum number of people I need to perform the minimum number of hours of care? There's always a target for an AI system, and it doesn't come from the system itself, but from the people who put it to use. AI then computes the best solution for the given target, but in itself, it has no ethical aptitude – that comes from the outside. Of course, there is a risk that AI achieves its targets but they're not in the general public interest. But that's a risk you have with any technology, even everyday automation. AI solves a specific problem in a quasi-superhuman way – faster and more accurately. But it solves the exact problem given to it by people. That's something you must always be aware of.

A number of people feel skeptical about the widespread use of AI applications. How justified do you think they are to feel that way? What can be done about this skepticism?

The way I see it, general understanding regarding AI needs to be improved in society. We need to ensure people understand that it's not AI that dictates what the ideal solution is, it's human beings who define the best solution. AI will never decide on its own to cut back tens of thousands of jobs – that decision always comes from the outside. An AI solution is developed for a certain target and it's used for that target. And that should also match our human values.

If you decide to introduce an AI system to a company, for it to be accepted it's also important that from the moment you start the development process, you include the people that'll ultimately use the tool – that you listen to their fears, their reservations, but also their expectations. Sometimes people have much too high hopes, so you have to discuss these and clarify things. But then you also have to go into their specific fears and show how the system will prevent those things happening. If there's a particular apprehension, you align the overall system to impair it. But also, AI systems can be created to open the door to new opportunities and give employees more leeway to take action. It's not easy and it takes a lot of discussion with all groups of stakeholders that'll use the AI system. But I believe it's the only way to translate AI – or technology in general – into use.

In addition to your work at Steinbeis University, you're also Senior Director of Artificial Intelligence at CENTOGENE, where you apply AI methods to diagnostics and the development of rare disease therapies. What advantages does AI offer in that area, and what hurdles still need to be overcome?

It currently takes more than eight years on average to correctly diagnose a rare disease – eight years of a patient going on an odyssey, from doctor to doctor, because no-one knows how to interpret the symptoms. If a doctor's given a way to send our company a blood sample and gets a diagnosis back in two weeks, that's tremendously helpful. We analyze the sample and tell the physician that a mutation was found indicating the presence of a rare disease or even that a rare disease can be discounted. The doctor then decides what to do next, and we also provide them with information on how we arrived at the diagnosis – which variant or mutation was identified, or any research articles that are relevant. This allows doctors to understand our diagnosis. We use AI to identify quick ways to improve the diagnostic process. This starts with little things: For example, there's still a tendency for medical practitioners to send us paper records, so we scan them. We analyze the words behind the letters. Often the patient records are handwritten, so we use an AI solution to digitize them. We then have another application that tries to pick out specific content within the scanned text, such as the name of the patient or their symptoms, and it tries to suggest ways to simplify the process used by our staff to enter data manually.

The bit where it gets exciting with AI is when it's used on the data we've been allowed to collect over the years at CENTOGENE. Many of our customers have agreed to us analyzing data beyond the actual diagnosis, because this is the only way to move things forward when it comes to exploring new diagnostic options and drugs. We've succeeded in collecting data on approximately 600,000 patients with rare diseases since 2007. We use a variety of AI methods at CENTOGENE, all of them aimed at improving diagnoses or enabling new therapies in the future. It's a dream job actually. You get to turn the thing you love – AI – into an opportunity to help people.

And it's a wonderful feeling for us when the innovations we use, across all the different disciplines, are given awards. Just a couple of weeks ago, we received the Health-i Award from Handelsblatt newspaper and the health insurance fund Techniker Krankenkasse. We were awarded the prize for an AI-based platform used to examine the metabolome. We succeeded in using the platform to shorten biomarker searches from months to just days – so it's a lovely example of the disruptive capability of AI.

Data protection is the top priority for us, but at the same time it's one of those obstacles in our area. Depending on the

nature of the approvals the patients give us to use data, some data we may use, some data we may not. Basically this part comes first, before any other process. The more data you have, the more robust the results you get. So having the option to use data is an extremely important issue for us. I was chatting with a corporate partner the other day, and she said, "Data privacy protection is for healthy people." She was exaggerating of course, but I think her comment gets to the heart of the matter. If your child's suffering from a rare disease and nobody knows how to diagnose it or there's no treatment for it, you're grateful for any donated information that'll allow a drug to be developed. That's why I'd appeal again to everyone to think again about releasing their data so it can be used for medical development. Surely the key point is that this results in new treatment and diagnostic options. Ultimately, the obstacles we're facing at the moment when it comes to using data are drastically slowing down a number of processes. But when it's about human lives, I think you have to consider what the top priority is. For many rare diseases, we only have one or two patients, so of course that's very little. This problem is a challenge to us every day.

On top of that, medicine is extremely tightly regulated, which is also quite challenging. Of course there's always a reason for it, but sometimes you have to question why there's a need for the sheer number of formalities it takes to gain approvals for a medical product. And when I think about the ideas being mooted by the EU to regulate AI systems, I envisage clear competitive disadvantages compared to China and the US. The question this raises for me is what we're trying to achieve. Of course it's important to consider social factors, but how do you assess the other goals in this area, and what priorities do you set?

A final question then – and of course we can't wait to ask this, because scientists harmlessly describe this issue as "singularity": Do you think artificial intelligence will supersede human intelligence?

I see no danger of this happening. Let me attempt to explain why. What's possible with AI today? If I specifically ringfence a problem well enough, I can create an AI solution that's better than any human. I mentioned the example a moment ago with the board game Go. The problem is that as a human being, I always use human intelligence as my benchmark and take that to assess AI systems. I project this view of human intelligence onto an artificial intelligence. So if we go back to the Go game, which AI currently plays better than human beings, and we expand the board from 19 to 20 squares each way, people can cope with that, of course; they can adapt their skills to changing circumstances. But AI can't; it founders. It has to completely retrain itself, because it only knows how to solve the one, highly specific problem. It's the same with every AI solution. AI solutions can only solve problems within the framework defined by humans. And it can't extend that framework by itself. As human beings, we're defining new targets for ourselves and we keep trying to develop in order to get there. AI is an algorithm – it was programmed and it operates within its framework. But it would never occur to an AI system to expand its own algorithm. And until now, no methods have been found in intelligence research for how to fundamentally solve this. Once you've understood that, you can see how much of the stuff that's propagated about AI, even in the media, is just pie in the sky. Despite its superhuman abilities, compared to natural intelligence AI is extremely limited.

PROF. DR.-ING. CARSTEN ULLRICH
carsten.ullrich@steinbeis.de (interviewee)

Professor of artificial intelligence at Steinbeis University
www.steinbeis.de/en/su/403 | www.steinbeis-hochschule.de

Senior Director Artificial Intelligence
CENTOGENE GmbH (Rostock)
www.centogene.com

"REALIZING AI-BASED SYSTEMS IS JUST AS IMPORTANT TO ME AS UNDERSTANDING THEIR CONSEQUENCES"

AN INTERVIEW WITH PROFESSOR DR.-ING. CRISTÓBAL CURIO, STEINBEIS ENTREPRENEUR AT THE STEINBEIS TRANSFER CENTER FOR HUMAN-CENTERED ARTIFICIAL INTELLIGENCE

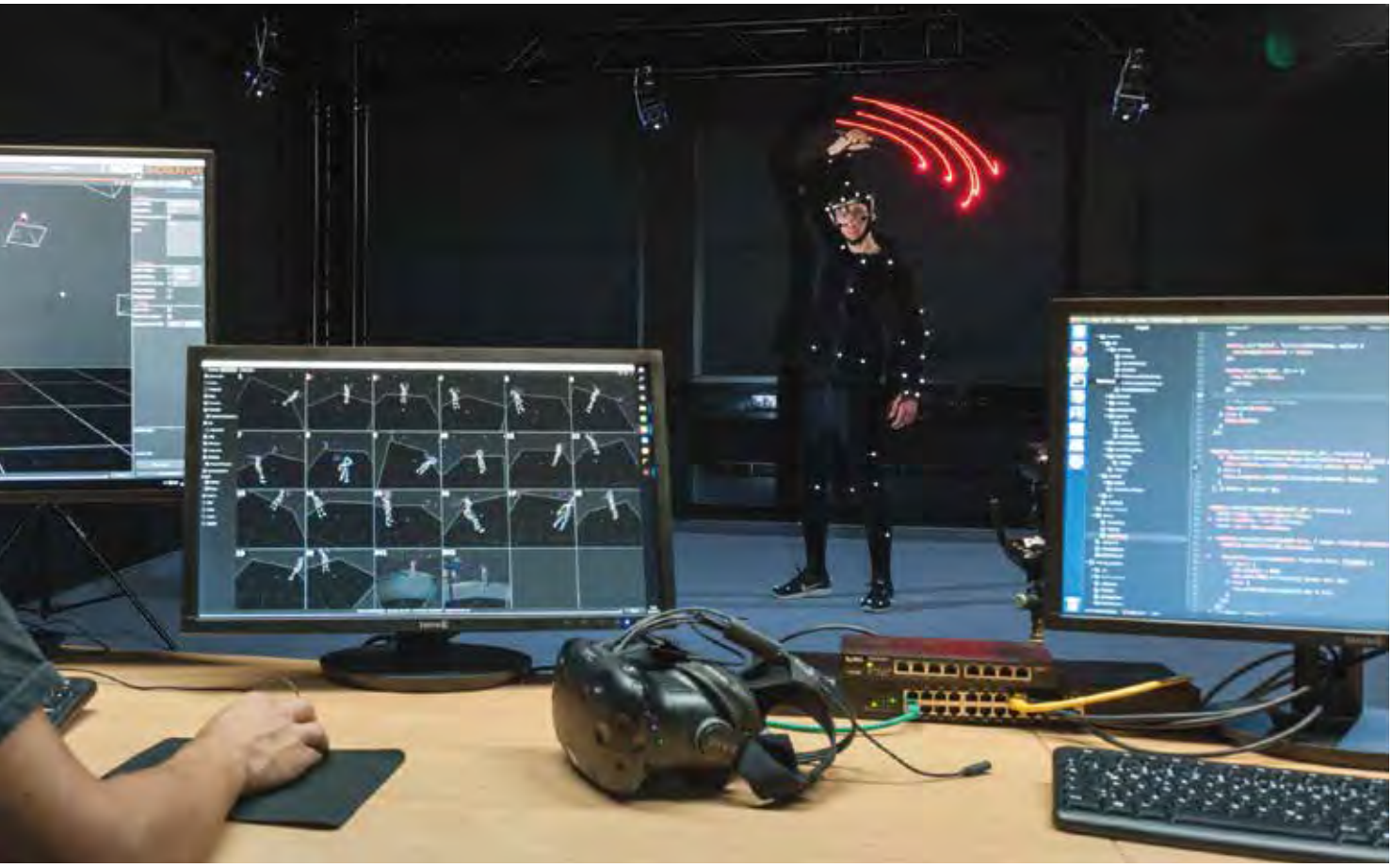
Artificial intelligence that focuses on people, despite thinking like a machine – is that utopian or an entirely possible scenario for the future development of AI? This was just one of the topics TRANSFER magazine discussed with Professor Dr.-Ing. Cristóbal Curio, an entrepreneur at the Steinbeis Transfer Center for Human-centered Artificial Intelligence and vice-dean of research at Reutlingen University.

Hello Professor Curio. You focus on human-centric artificial intelligence in your work. What exactly does that involve?

My work is driven by the concept of "learning from humans – learning for humans." I think it's precisely this interplay that gives rise to technical innovations for human beings, and what allows different sectors of industry to move forward. Ideally, this leads to insights into new methods, which can even be used to explore human cognition. It's something that's engrossed me since my time conducting fundamental research into human cognition at the Max Planck Institutes in Tübingen, Germany. The concept of human-centricity in artificial intelligence is nothing new, and can make an important contribution to Industry 4.0, or cyber-physical systems – or to be more precise: to any area in which human factors will continue to play an important role in the future. The challenge is to see human beings as a non-deterministic factor that behaves in very different ways.

Everyone is talking about autonomous systems at the moment – promising great things such as autonomous vehicles or systems based on a high degree of automation. By their very definition, autonomous systems don't start out as human-centric. If you look at the regimes of rapid interactions, but also spaces in which people are found – such as urban living spaces – it makes you realize that these systems have plenty of potential to cause harm. So it's all the more important for them to have a quasi-human understanding of people, so they don't behave as selfish systems and assume they have right of way. Autonomous systems without a human-like understanding of human beings would be unacceptable when it comes to current transportation systems.

On the technical side, my focus lies in optimizing and harnessing machine learning algorithms to make sensor technologies smarter. To a large extent, humans provide me with a role model in this because of the way we optimize the interplay between our sensory perceptions during our entire "life cycles" – including our principles of learning. Even if we still haven't yet understood all mechanisms of human perception, the way our senses interact does make it possible to work out some fascinating technical requirements for sensor



Using modern motion capture and VR technology to develop valuable digital human models – for example to simulate key sensor data

systems in order to design them to think smartly.

That should also include social intelligence. And it results in some amazing new features. For example, this can be used to enhance sensory perceptions from a human perspective, and that improves system safety. Giving consideration to human characteristics is often an important factor for users when interacting with applications – for example, a system might provide visual support or a system can guide your attention in a car. "Human-centered" means considering everything, as part of the overall development system. Where it gets interesting is when you have to consider users beyond the norm. This requires AI-based technology that offers accessibility and is useful for everyone in an aging society.

Realizing AI-based systems is just as important to me as understanding their consequences. This is where being able to interact with new VR technologies provides us with a realistic experience of technology. At the same time, possessing the technology to simulate interactions lays a foundation for further innovation. It provides a basis for simulating critical situations – so-called corner cases – so you can safeguard smart systems. In lots of areas, it's not possible to predict how much information will be required for a system. One way to get around this is to use complex data simulations that are as faithful as possible. The solutions in this area are getting more and more powerful all the time. A particular challenge is simulating sensors according to the depictions we have of people; there's still no way to synthesize all the different facets of their behavior. But here, too, there are some exciting things coming out of research at the moment, and they'll be suitable for transferring to a whole variety of applications.

In lots of the areas I've just mentioned, the research has all the right fundamentals in place, and that's already led to a number of processes being used in a whole variety of sectors of industry.

You just mentioned machine learning, but also AI. In what ways do these two concepts differ?

Machine learning is seen as a subfield of artificial intelligence, and it's currently moving forward extremely quickly. The language used at the moment to describe artificial intelligence often now includes a definition of machine learn-

ing. It involves learning techniques, especially when there's only access to limited data, which are also referred to as observations. Machine learning also often extends previous intelligent search strategies, making it possible to solve complex optimization tasks.

What challenges do you believe the current AI developments pose for companies, particularly SMEs?

Many of the innovations in AI have an impact on methodologies. The methods are often developed by AI scientists conducting research by looking at specific benchmarks. Often the first step is to work out what level of abstraction you need in order to understand the relevance of a particular innovation for an application. Identifying the categories problems have to be solved under is usually a quick process for companies. In some cases, the solutions prove to be quite complex for companies at first; in others they don't have access to the required expert knowledge. Also, empirical AI requires that you always have access to relevant data. The value of data often entails an understanding of specific events. But unfortunately, important events only occur infrequently, so having access to a large volume of data turns out to be much less valuable than was initially assumed.

Many industries are undergoing a transformation toward the use of AI. The automotive industry has still yet to prove that it's in a position to introduce widespread autonomous driving, and it can't be denied that AI plays a crucial role here; but there are some big markets yet to be uncovered, such as other kinds of assistance systems – like microelectronics used to automatically design analog circuitry. The picture that's emerging is that combining the right kinds of simulations, expert knowledge, and data-driven AI methods such as reinforcement learning will play a major role in the future.

The human-centered development of sensor systems through immersion into virtual worlds using future interactive systems.

Once an initial solution to a problem has been found and is introduced, you have to ensure it keeps working and it's maintained. There are still many things that need to be understood, especially with larger data models. Future service providers will be in a position to solve many of the technological challenges, but there's still a lot that needs doing when it comes to new software and AI hardware. Whatever happens, there will be liability issues, especially in the healthcare industry, and they're a major challenge when it comes to regulatory issues.

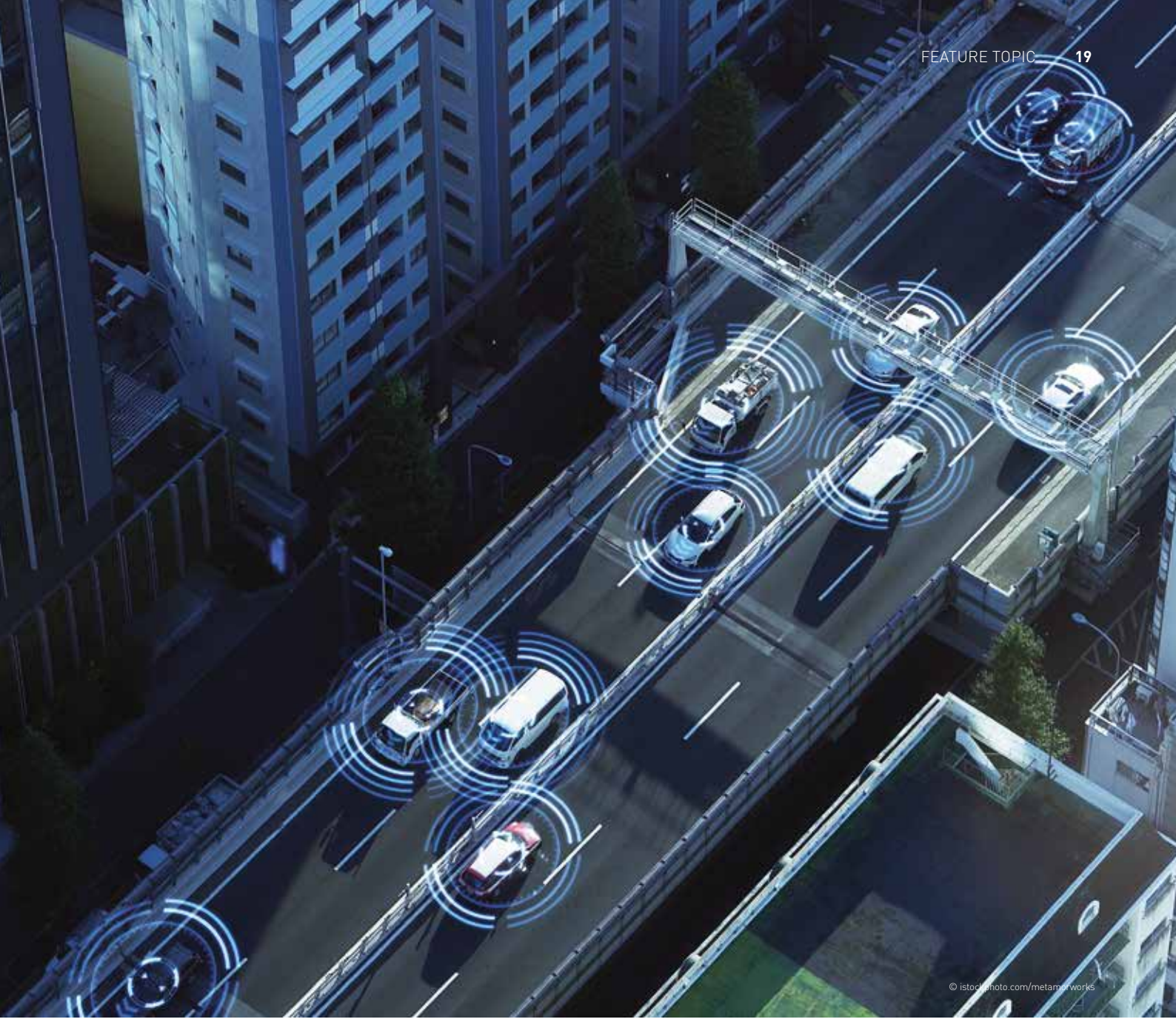
You also work on AI ecosystems. What potential does this area offer, especially for companies involved in manufacturing?

Complex innovations, especially at classic manufacturing companies, require increasingly complex alliances to allow contributions to be dovetailed. Particularly smaller manufacturing companies should establish a meticulous understanding of AI and identify the benefits it offers in a whole variety of areas. These range from automation to quality assurance aspects. We expect there to be demand for recurring solutions, and this will require the dovetailing of different providers. There'll be demand for new AI ecosystems – AI provider networks, so to speak – that will optimally complement one another. Particularly for manufacturing companies, the hope is that being part of such AI ecosystems could result in new ideas and inspiration, also with regard to fundamental research into AI, and that new AI research benchmarks will emerge – which will result in breakthroughs for entire sectors of industry in the long term. One challenge will be agile competitors – who are skillful at using AI, integrate it early into their products, and thus produce faster and more efficiently, or even develop completely new business models.

PROF. DR.-ING. CRISTÓBAL CURIO
cristobal.curio@steinbeis.de (interviewee)

Steinbeis Entrepreneur
Steinbeis Transfer Center
Human-centered Artificial Intelligence (Tübingen)

www.steinbeis.de/en/su/2387



ALL GOOD THINGS COME FROM ABOVE

DRONE DATA SUPPORTS THE ARTIFICIAL WORLDS OF AUTONOMOUS VEHICLES

Simulations – especially those aimed at providing the closest possible representations of reality – are particularly important for attaining higher levels of autonomy in self-driving vehicles. Until a suitably large fleet of vehicles becomes available to provide this data, the biggest challenge is to obtain measurements and improve the accuracy of simulations. In addition to video and lidar data from the perspective of vehicles, a complete picture of driving data is required, covering a variety of traffic situations. One way to gather such traffic measurements is to conduct aerial surveillance using drones. The IT Designers Group, in which the Steinbeis Transfer Center for Software Engineering also plays an active role, has already gained experience with this method.

Horizontally rotated sections of aerial observations taken on the A8 autobahn near Wendlingen. The excerpts show tracked vehicles with "bounding" boxes (top), the vehicles' determined 3D measurements (middle), and the driving lanes (bottom) to which vehicles are assigned.

At AI Day 2021, Tesla demonstrated the considerable progress it has made with the development of its driving strategy module. To develop its existing driving strategy system, as well as a new AI-based planning system, it uses a 3D artificial training environment. The training data it requires for this is collected from its fleet of sold vehicles, which according to company sources currently comprises over 1.5 million vehicles. This makes it possible to query and collect data for more challenging driving situations. This is a particularly useful way to improve the detection rate of rare incidents with the potential to jeopardize safe automated driving. The data collection process is currently the most straightforward method available, and in all likelihood it will also be used to provide suitable data for uncommon traffic situations – assuming sufficient vehicles are available for taking measurements.

Artificial worlds play an even bigger role at Alphabet subsidiary Waymo, which has been working on self-driving vehicles for about five years. Waymo runs a much smaller fleet of around 1,000 vehicles. The majority of its test drives are therefore carried out in simulations. According to Waymo, its testing covered roughly 30 million kilometers in 2020.

DRONE DATA – AN ALTERNATIVE TO TEST DRIVES

In the meantime, drone surveillance has become established as a viable alternative to collecting traffic measurement data. Camera drones can be sent up quickly and flexibly in a variety of locations with interesting traffic, typically recording road sections and intersection areas approximately 500 meters in length. Important requirements for flying drones include ensuring operators receive appropriate training, gaining authorizations, and limiting recordings to no longer than roughly half an hour. Despite this, measurements can still be taken over several flights, making it relatively easy to record several hours of traffic data.

The experts at the IT Designers Group use this measurement method for product development purposes. They have already succeeded in tracking roughly 1,350 vehicles during a thirty-minute drone flight along an inner-city arterial road. In total, the vehicles covered a distance of 530 kilometers, with a joint driving time of 41 hours. Although this falls a long way short of the volume of data provided by vehicle fleets, it does allow critical sections of roads to be continuously monitored, whereas vehicles taking measurements only pass through such areas every now and again.

"To reconstruct road traffic, the video data is processed in an automated evaluation pipeline. The stages we go through include camera tracking, vehicle detection and tracking, regression of the 3D bounding boxes of the vehicles, lane detection, and lane assignment," explains Dr. Stefan Kaufmann (IT Designers), who is working on the project. To recognize and track vehicles, a neural network is used to detect objects and place them into categories depending on whether they are a car, a van, a truck or bus, or a motorcycle. To train the system, the project team is currently using 66,000 manually annotated or verified vehicle images. Another neural re-identification (ReID) network supports this tracking process by distinguishing vehicles from each other based on visual characteristics. This also makes it possible to spot the same vehicles again in different video sequences. The network was trained with 350,000 vehicle imag-

An aerial observation of an inner-city highway section (top) and a reproduction of measurements in a SUMO simulation (bottom).

es that were automatically extracted from existing data. By using clustering methods, vehicle trajectories can be grouped according to similarities in direction of travel. This produces driving lane information. So far, this method has provided reliable results for uncomplicated road layouts such as state highways. Currently, manual adjustments are still required for multi-lane intersections.

Measurements include vehicle dimensions, direction of travel, vehicle positions with geocoordinates, local coordinates, and distance traveled in each lane. Vehicle speeds and acceleration rates are also derived from this information. By comparing readings with reference vehicles, the project team was unable to spot any significant deviations in measurement data [1], although some work is still needed to determine if there were measurement errors.

THE OUTLOOK: INCREASING COMPLEXITY AND 2D STRATEGIES

As such, the current system is already providing useful input data for simulation and training systems. During initial experimentation carried out by the team at the IT Designers Group, the experts succeeded in replicating measurement data in a traffic simulation, using calculations based on the Kerner-Klenov microscopic simulation model. Individual simulation parameters are determined for every vehicle with the aim of reproducing measurements as realistically as possible. To do this, each vehicle is simulated individually within the traffic flow of measured vehicle trajectories. Based on hundreds of sequences, a genetic algorithm optimizes the simulation parameters of each driving profile in order to reproduce the most similar possible speed profile. This has enabled the team to achieve an average match level of 89% for individual adjustments [2]. Until now, the simulated vehicles only move along lanes in one dimension. They may switch to different lanes, but in doing so the maneuvers they perform are simple and continuous.

References

[1] Salles, Dominik; Kaufmann, Stefan; Reuss, Hans-Christian. Extending the Intelligent Driver Model in SUMO and Verifying the Drive Off Trajectories with Aerial Measurements.

[2] Eissler, Christian; Kaufmann, Stefan. Model calibration to simulate driving recommendations for traffic flow optimization in oversaturated city traffic, Procedia Computer Science 170 (2020): 482-489.

PROF. DR. JOACHIM GOLL
joachim.goll@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Center
Software Engineering (Esslingen)

www.steinbeis.de/en/su/221
www.stz-softwaretechnik.de

DR. STEFAN KAUFMANN
stefan.kaufmann@it-designers.de (author)

Assistant
IT-Designers GmbH
(Esslingen)

www.it-designers.de

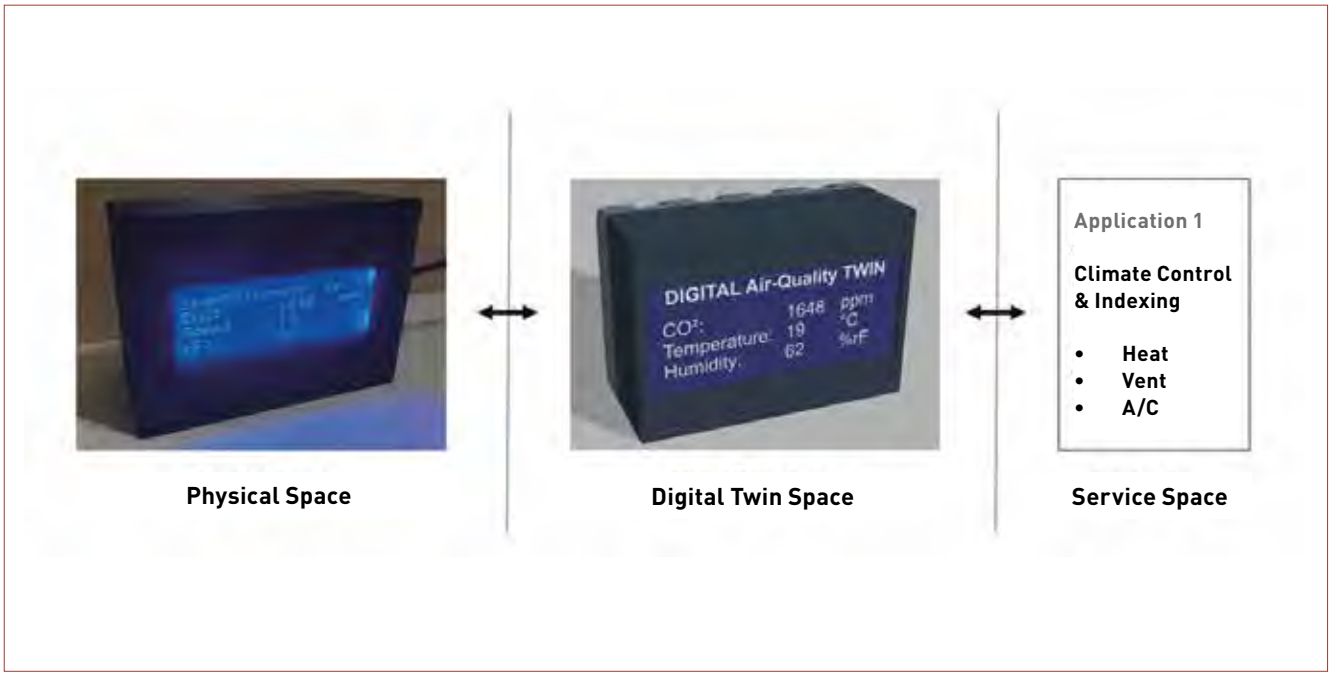
A HABITAT FOR DIGITAL TWINS

A TEAM OF RESEARCHERS FROM MANNHEIM EXPANDS THE FUNDAMENTAL CONCEPT OF DIGITAL TRANSFORMATION

How do I turn my physical product into a smart product of the future? This is the question many producers are forced to ask themselves when they think about the complex challenge of digitalizing their businesses. What's happening in manufacturing is only symbolic for what's happening in almost all areas of industry. A common approach now being adopted is not to make "smartness" a directly embedded element of physical objects, but to create digital twins to which intelligence can be outsourced. The CeMOS research center at Mannheim University of Applied Sciences has been working with the Steinbeis Transfer Center for Smart Industrial Solutions on ways to move digital twins on from their purely passive roles and place them into the roles of autonomous entities. To do this, the team has developed a prototype infrastructure.

Digital twins are a core concept of digital transformation in business and society in general. Based on the foundation of technology laid by the internet of things, they provide digital representations of a wide variety of objects in the physical world. The term "representation" has a broad definition, such that a digital twin could merely be a representation of data and the states of physical objects, like an "example of an object" in the main memory of a computer – or it could constitute a visual depiction by using corresponding virtual technology, augmented reality technology, or complex simulation models.

Every change of state in the physical object is reflected in the digital twin, but in parallel to this changes of state are



Automatically generated examples of digital twins of physical devices and their functional extension using smart apps

reproduced in the digital twin and the physical object. This makes it possible to set up complex, cyberphysical systems with digital representations that cannot be meaningfully divorced from physical systems.

The advantage of designing such systems is that their functionality can be extended. Whereas it can take a great deal of time and effort to modify or expand machines or process-based equipment once they are set up, with some functions – such as analyzing sensor data, calibrating settings to match the context, or applying machine learning methods – there is the flexibility of adding them to digital twins. This makes it simple and straightforward to add smart features to physical devices in the digital space, without having to adapt the physical objects. Communication between physical devices and their digital twins is established and maintained via so-called digital threads.

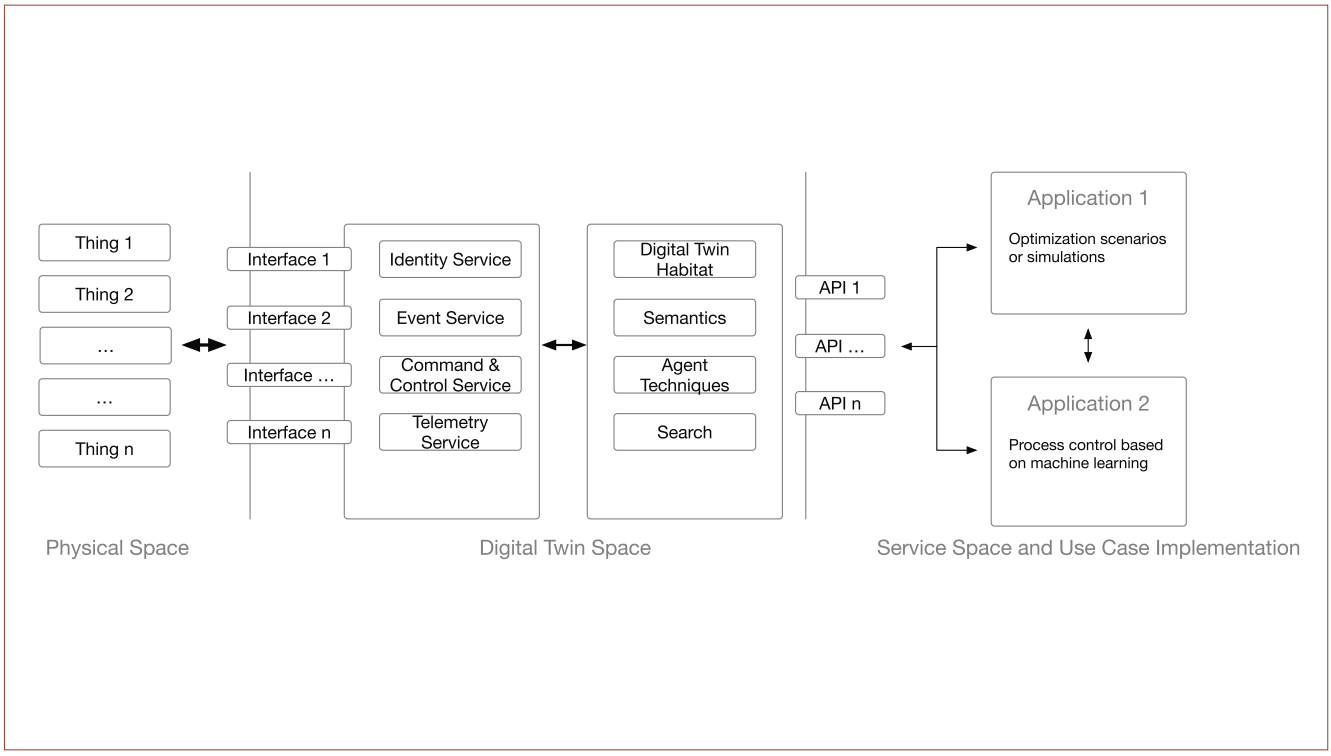
THE GOAL: AUTONOMOUS DIGITAL TWINS

Until now, however, beyond the de facto standards of the internet of things, there is no real standardization in this area and this is currently hindered by the high levels of heterogeneity of physical objects, as well as by requirements affecting individual use cases when it comes to equipment timing, applied protocols, and data exchange formats. Also, digital twins are still currently perceived as playing a more passive role, driven by external events; indeed, in tangible terms they do not actually play any role in the field of autonomous, active, agent-like systems. This significantly limits the leverageable potential of digital twins with respect to value creation and productivity.

As part of the TWINEvent project, researchers at the Center for Mass Spectrometry and Optical Spectroscopy (CeMOS) at Mannheim University of Applied Sciences are developing an overall architecture that, in addition to providing standardized on-demand digital twins (digital twins as a service, or DTaaS), also provides a distributed and scalable runtime environment – i.e. a kind of habitat for digital twins.

PROXICUBE: PHYSICAL OBJECTS CREATE THEIR OWN DIGITAL TWINS

For a number of years, Proxivision, the Bensheim-based optoelectronics specialist, has been working on a project



A schematic overview of the digital twin infrastructure designed at the CeMOS research center

basis with the CeMOS team and experts at the Steinbeis Transfer Center for Smart Manufacturing Solutions. For their current project – ProxiCube, a kind of measurement cube – the experts have been using the overall architecture developed by CeMOS for advanced control and data processing. The cube measures all kinds of environmental data, assessing not just particulate matter – a particular highlight – but also liquid aerosols using a separate measuring channel.

This is especially important given the current pandemic. The large number of sensors that need to be delivered and rapid advancements in knowledge are making it important to gather extremely high volumes of location-specific data and carry out frequent software updates. These are precisely the kind of processes that can be automated with digital twins – remotely and extremely efficiently, without coming into physical contact with the measuring cubes.

The first step for the project team was to design a basic service that allows practically any physical object to generate a digital twin of itself based on its description in a standardized language. The only prerequisite for this is that the physical object is capable of communicating directly or indirectly with the DTaaS system, for example using gateway architecture or proxies. The standardized language for the description is not only used to describe the functions, capabilities, and properties of the physical object, it also makes it possible to place devices into semantic categories. This allows objects to be placed in their respective and currently valid context. The specific placement of digital twins is transparent and freely configurable. As a result, the entire infrastructure can be operated in the cloud, although it is also possible to set up on-premise solutions, operate systems on edge/fog servers, or even set up hybrid operations as required by the use case.

The basic service is responsible for providing a standardized programming interface for applications, thus automatically generating an abstraction layer between applications and the actual physical devices. In this way, an application developer can give one or more digital twins more advanced functions and capabilities. These can be parameter studies, simulations, or even optimization procedures, to name just a few, and the results and effects are – by definition – transferred to the physical object. The basic service thus automatically provides a generic instance

of a digital twin, enriched with semantic properties, also facilitating bidirectional data exchange between the digital twin and the physical device, plus the automatic generation of a programming interface based on open standard protocols. This makes it possible for application developers to introduce smart capabilities to the twin (and thus to the device itself).

AUTONOMOUS COMMUNICATION BETWEEN MULTIPLE DIGITAL TWINS

Beyond the basic service, the project team is working to develop an extension to the runtime environment that will allow the digital twins to operate autonomously and independently – and pursue predefined goals. To do this, methods used with multi-agent systems are being investigated and implemented as appropriate. The team believes this will enable complex processes to be mapped between multiple digital twins without the flow of control having to be managed by a central application. Especially in combination with semantic context classification, such a solution will enable communication and process mapping for digital twins that do not yet know each other. Here, too, there is huge application potential: Digital twins of workpieces can work independently to obtain offers for processing at different processing centers, or products already in distribution can try to activate the right levers to be delivered to the customer as quickly as possible within a specified budget. When digital twins solve problems, they are automatically solved in the physical world as well, and necessary measures can be introduced automatically.

The projects conducted by the researchers in Mannheim demonstrate the possibilities offered by the system in "smart anything" scenarios: Whether it is smart production, smart cities, or smart transportation, with the help of autonomous digital twins, distributed, scalable use cases can be automated on demand based on simple principles. The new system therefore provides an elementary building block for digital transformation in business and society as a whole, also contributing to the rapid and demand-oriented adaptation and implementation of complex technology.

DIGITAL TWINS ARE A CORE CONCEPT OF DIGITAL TRANSFORMATION IN BUSINESS AND SOCIETY IN GENERAL

PROF. DR. MATTHIAS RÄDLE
matthias.raedle@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Center: Smart Manufacturing Solutions
(Mannheim)

www.steinbeis.de/en/su/1951

PROF. DR. JULIAN REICHWALD
j.reichwald@hs-mannheim.de

Business Informatics – Digital Business Technologies
CeMOS Research Center (Center for Mass Spectrometry and Optical Spectroscopy)
at Mannheim University of Applied Sciences

www.cemos.hs-mannheim.de

PREDICTIVE MAINTENANCE – A GAME CHANGER EMPOWERED BY INDUSTRY 4.0

STEINBEIS EXPERTS DEVELOP DECISION-MAKING TOOL FOR ANALYZING THE ECONOMIC EFFICIENCY OF PREDICTIVE MAINTENANCE

The tools of smart factories (Industry 4.0) offer companies a number of ways to improve competitiveness and, at the same time, secure their future viability. The interoperability of production systems can be improved by introducing state-of-the-art information and communication technology, while sensor technology, cloud services, and artificial intelligence foster innovative production and customer processes. The potential areas of application include operational maintenance, a key element of which is predictive maintenance. The question is: When does it pay to invest in such tools, especially for SMEs? This was the question examined by the Saarbrücken Institute for Controlling Innovations (saar#cinnovaton, a Steinbeis Innovation Center).

Predictive maintenance advances condition-based maintenance, which determines maintenance requirements by the physical condition of objects. This condition is inspected at regular intervals by machine operators or checked as part of continual monitoring processes. Predictive maintenance extends this principle by predicting degradation rates based on an independent assessment of machine data. This intends an optimal timing and selection of maintenance actions.

The challenges faced in successfully introducing predictive maintenance include identifying the right sensor technology to monitor equipment condition and gather data, structuring acquired data, and using suitable methods to analyze data. It is important to capture sensitive data on machine condition and machine usage, and this information needs to be monitored in real time. For example, to detect deviating machine behaviour, measurements need to be taken of ambient conditions (temperature, air pressure, or relative humidity), speed ranges, sound, the temperatures of individual components, or vibrations. This allows for early predictions of potential maintenance requirements.

A number of innovative analysis methods can be used to evaluate gathered data, especially artificial intelligence. In addition to traditional predictive models, which apply the laws of physics to determine degradation behavior, methods based on algorithms, such as machine learning, can be used to detect patterns in data sets and predict required maintenance. Such algorithms have to be trained using historical data, which requires detailed documentation on, for example, the timing and type of maintenance carried out. Using artificial intelligence offers a variety of advantages, e. g. a holistic supervision of machine behavior, an early detection of potential failures or the prediction of optimal maintenance times.

USING PREDICTIVE MAINTENANCE TO CUT COSTS

For many companies, maintenance is a key cost driver. Implementing a predictive maintenance strategy can significantly reduce costs, ensure machines and systems are kept fully functional and avoid unplanned machine downtimes. Predictive maintenance is typically much more cost-effective compared to preventive maintenance, i.e. regularly replacing wear parts, since the service life of machinery and plant is extended optimally utilizing the components' potential of degradation. Furthermore, downtimes can be minimized by adapting maintenance whenever needed to pending orders.

SMES ARE INCREASINGLY FORCED TO INVEST IN SMART FACTORY TECHNOLOGY: ADOPTING A PREDICTIVE MAINTENANCE STRATEGY PROMISES A VARIETY OF BENEFITS.

EWIK – A USEFUL DECISION-MAKING TOOL FOR SMES

SMEs are increasingly forced to invest in smart factory technology (Industry 4.0), and adopting a predictive maintenance strategy promises a variety of benefits. However, SMEs often feel overwhelmed by decisions regarding investments in the technology required to enable predictive maintenance.

There are a number of reasons for this, including the benefits are often difficult to quantify, or the fact that SMEs generally lack sufficient planning resources. This often results in SMEs failing to make the necessary investments in predictive maintenance solutions, which consequently jeopardizes competitiveness. It would therefore be highly beneficial to SMEs to have a tool that makes it easier to assess the benefits of an investment in Industry 4.0 solutions, also so they can receive recommendations on which measures are worthwhile taking under which circumstances.

This is precisely the goal of the EWIK research initiative (EWIK is a German acronym for "decision-making tool for analysing the economic viability of investments in predictive maintenance at SMEs in Saarland"). Due to its cross-company significance, the project is funded by the Saarland Ministry for Economic Affairs, Labour, Energy and Transport and is being implemented by an interdisciplinary team of economic and engineering experts at the Saarbrücken Institute for Controlling Innovations (saar#cinnovaton, a Steinbeis Innovation Center).

The project team is currently conducting an empirical evaluation of the maintenance challenges faced by SMEs. It is also working alongside SMEs to come up with different approaches for assessing investments in predictive maintenance instruments. This will not only make it possible to understand the current status when it comes to introducing predictive, sensor-based maintenance, it will also help identify the need for decision-making support surrounding investment measures and pinpoint potentially conflicting goals. Whether a specific application involves processing machines or conveyor vehicles – just to name two examples – the underlying decision-making issues are similar. As a result, a tool that is standardized, yet individually adaptable when it comes to defining parameters, can be extremely useful. Working alongside SMEs also ensures that profitability evaluations are sound in methodological terms and user-friendly.

PROF. DR. ALEXANDER BAUMEISTER
alexander.baumeister@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Innovation Center
Saarbrücken Institute for
Controlling Innovations
(saar#cinnovation) (Saarbrücken)

www.steinbeis.de/en/su/2408

ANDREAS NAGEL
andreas-manfred.nagel@steinbeis.de (author)

Project Assistant
Steinbeis Innovation Center
Saarbrücken Institute for
Controlling Innovations
(saar#cinnovation) (Saarbrücken)

www.steinbeis.de/en/su/2408

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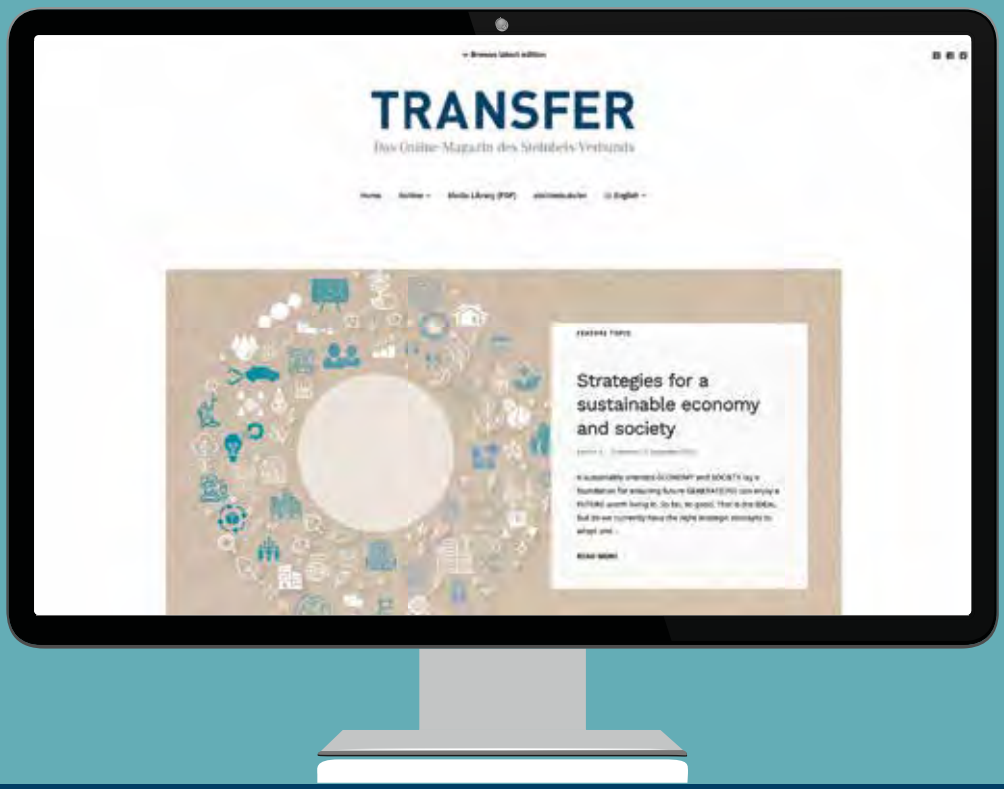

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"ULTIMATELY, THE FOCUS IS ALWAYS ON PEOPLE"

AN INTERVIEW WITH PROFESSOR BERNHARD HUMM, PH.D., STEINBEIS ENTREPRENEUR AT THE STEINBEIS TRANSFER CENTER FOR APPLIED ARTIFICIAL INTELLIGENCE AT DARMSTADT UNIVERSITY OF APPLIED SCIENCES

The futuristic image some people associate with AI is that of an intelligent, humanoid robot. Yet we already use AI applications in many areas of everyday life: cell phones with facial recognition, digital voice assistants, smart home devices – with more developments coming along. Will it become dangerous if something that was created outperforms the one who created it? Steinbeis expert Professor Bernhard Humm believes it will not, since machines can only ever behave or learn within the frame of reference of tasks set for them by humans. In an interview for TRANSFER magazine, Professor Humm highlights the importance of our societal responsibility when it comes to AI.

Hello Professor Humm. People talk about artificial intelligence as if it's a matter of course, but what exactly does the term mean?

You're right, one of the reasons AI is such a controversial topic at the moment is that the term is fuzzy. Few people know exactly what AI means, so anyone can make up their own definition of it. This is why I'm happy to provide a definition of AI: AI is the area of developing computer systems or apps that exhibit aspects of human intelligence. In other words, they're not intelligent the way you or I are – they merely simulate aspects of human intelligence. For instance, one such quality is communication. Apps like Alexa or Siri reproduce this. But also thinking or reasoning are aspects of human intelligence; those are qualities that support decision-making. These qualities are simulated by so-called expert systems – for example systems that recommend courses of action to physicians. Or take the ability to carry out an action, an example of which would be a self-driving car. And then there are cameras with face recognition, which is also AI applications. So as you see, we already have many AI applications in everyday use, but they're often taken for granted and not necessarily perceived as AI.

You deal with concrete AI applications in your work. What sort of issues do your customers approach you with?

I can think of many interesting examples, especially from my research projects at the university together with my team. Let's start with medicine. We have developed applications for doctors treating cancer patients. These draw on patient information held in electronic health records to provide physicians with evidence-based recommendations regarding diagnostic procedures and therapies.

Another example comes from the field of psychotherapy, where support is given to patients with borderline personality disorders and their therapists – for example, if there is a risk that the patient will drop out of therapy.

Then there is the area of industrial manufacturing, where it is all about smart or connected factories. The idea here is to pinpoint production errors or machine faults early on and then, give maintenance engineers an indication of where an error is occurring, what might be causing it, and how to solve the problem.

Also, we worked on a project in the field of tourism. The challenge of this project was to recommend hotels to end customers, e.g., families, and match their wishes, interests, and preferences without them having to enter the exact same wording used in the hotel descriptions. So for example, if a customer searches for a family-friendly hotel but the hotel description says children-friendly, the hotel will still be recommended because the two terms relate to the same concept.

The last example is from the world of creative arts. It was a project for the

Städel Museum in Frankfurt, one of the most prominent arts museums in Germany. It resulted in a digital version of its collection with interesting cross-references between various artworks.

All the examples I've just named have one thing in common: when you're applying AI technology, the focus is always on people using the applications. This is sometimes called user-centered AI.

Often fears come up when people hear the term AI. What do you see as the actual risks of AI?

I think we can start with the dystopian fears – there are quite a few of them. You're probably familiar with this one: Machines evolve all by themselves to the point where they surpass human intelligence and eventually take over the entire world. The whole idea has something fascinating about it, so Hollywood and the media have greeted it with open arms. But let's be honest, if – and that's "if" with a capital I – if it really were possible for a genuine intelligence to emerge that would actually be able to evolve on its own, it's not going to happen in the foreseeable future. And I go further and say there's currently zero evidence that this could ever be the case, because there are fundamental differences between humans and machines. Humans are unified entities comprising body, mind, and soul, so our intelligence is not just something that exists in our brains; it's a product of this unified entity. Add to that the way we interact with our environment, the way we learn and develop from within. Human intelligence is much more complex than AI. It's important to remember that AI systems always operate within the framework of a purpose defined by humans, and there's no evidence that it could break out of that frame of reference by itself.

But let's think about the real risks of AI. One is the risk that AI systems take wrong decisions like incorrect medical diagnoses or actions leading to accidents in self-driving cars. And then there are risks caused by humans not understanding decisions made by machines, and then intervening incorrectly. In the 1980s, there was an accident with an Airbus aircraft equipped with new autopilot systems. The pilot wanted to perform an impressive maneuver at an airshow, but the autopilot was programmed to compensate for it, so the pilot steered against the system and the system steered against the pilot, which resulted in the airplane crashing. The human-machine interaction wasn't right.

The next risk relates to the quality of data used by AI systems to carry out actions. If data is faulty or erroneous, machines make the wrong decisions.

And there's another important aspect which I call blind belief in technology. Let's take an example from medicine. There are now some very good AI systems capable of supporting diagnosis. But what will happen if physicians decides on purpose, and for good reasons, not to agree with certain recommendations by the machine? They will might come under pressure to justify their decision. One generation of physicians later, perhaps the ability to consciously make own decisions could be lost.

What trends do you think will shape the future of AI applications? Do we need certain regulation for future developments?

This is an important question, and I think it has less to do with technical developments and much more to do with the responsibility held by society – or actually the global community. A good example are autonomous weapons, which can even make decisions to launch an attack automatically. The question is: Do we want this as a society?

I see three directions in different continents: The American way, which primarily business-oriented. Then there's the Chinese way, which is largely about social control. And the third is the direction targeted by the EU, which is about ethical responsibility or human-centered AI. One aspect of this is data protection. But this puts us in a situation of conflict – data protection versus data-driven technology. On the one hand, the more data you have access to, the better such technologies work. On the other hand, data protection actually impedes such technologies. But what you have to remember is that AI isn't an end in itself, so you have to operate within that situation of conflict. This not only about regulatory or legal measures, it's also the general ethical framework – which we have to define as a society.

PROF. DR. BERNHARD HUMM
bernhard.humm@steinbeis.de (interviewee)

Steinbeis Entrepreneur
Steinbeis Transfer Center
Applied Artificial Intelligence
(Darmstadt)

www.steinbeis.de/en/su/2293

WHEN AI ANALYZES THE RISKS IT FACES ITSELF

RESEARCH TEAM INVESTIGATES IMPACT OF ARTIFICIAL INTELLIGENCE ON DATA AND INFORMATION SECURITY

Over the last two years, the specialist press in Germany has published no less than 1,500 articles on the risk posed to companies by artificial intelligence. According to the authors, using AI could exacerbate the strategic and systemic risks faced by companies, undermine data security standards and customer protection, and even result in governmental organizations becoming irrelevant, as legislation lags behind technological developments. So far, so good. To be honest, though, so much was written that even an expert could not read all the articles and analyze them. So what can you do? Well, you could allow AI to analyze articles about the risks it creates: With AI, it only takes seconds of computer processing to analyze texts for language content. AI makes it easier to process text containing natural language and it is already used by major international law firms and a growing number of public administration bodies to produce summaries and reviews of large documents. Steinbeis Transfer Institute zeb/business.school and process mining specialist celonis have also been using the technology to model the amplification and inhibition of causal loops as part of an AI study. Based on their modeling, the experts have also generated short-, medium-, and long-term forecasts.

Using AI to conduct a linguistic text analysis of the 1,500 articles on AI risks and security threats resulted in so-called topic clouds. These show the relevance of and relationships between dominant words featured in the articles. The project team compared a general topic cloud covering all articles with a topic cloud revolving around a specific area, which mapped 105 articles on regulatory issues.

Each topic comprises a mixture of words. Words that occur predominantly within a topic tend to be found side by side in articles. The relative positions on the topic cloud indicate how closely topics are discussed in relation to one together within an article. The closer the position of topics on the map, the more frequently they are discussed with each other and placed within a similar context.

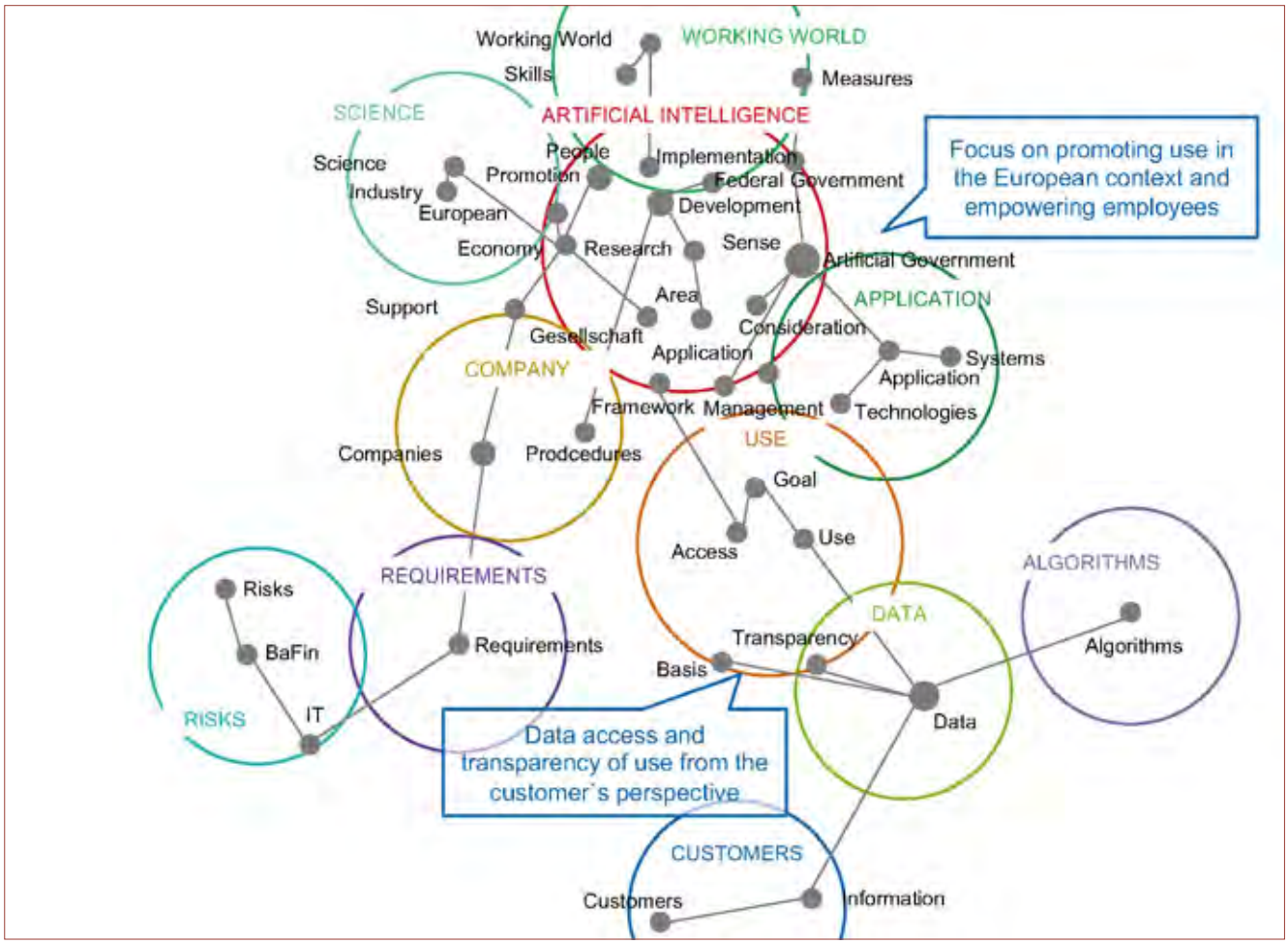
The analysis showed that general discussion regarding AI mainly revolves around access to client information and supplementary data, as well as transparency requirements affecting the use of AI at companies. There was no specific discussion about the role of AI in society. Instead, discussion revolved around the possibilities offered by AI when it comes to future interaction between customers and businesses, as well as the development of technical systems. Discussion regarding risks did not play a predominant role in public discussion. The only risk that received some degree of discussion was the threat of jobs being lost as a result of automation.

A comparison between general discussion and discussion within articles relating to supervisory responsibilities and regulatory affairs provided the project team with a number of interesting insights. The topics were more closely related in this area. In particular, there were different nuances in the discussion regarding AI within the context of regulatory frameworks, and this highlighted impacts on the workplace. One important issue is risk, which was considered from the standpoint of requirements affecting companies. There were strong correlations between, on the one hand, access to information, transparency, and how exactly data is analyzed, and on the other, customers and the use of customer data.

THE SEARCH FOR THE CAUSAL LOOP

Drawing on the topics that arose from the linguistic text evaluations, the experts from Steinbeis and celonis categorized 32 topics as influencing factors. The remaining twelve topics were categorized as areas of risk. Examples of the influencing factors range from societal aspects (such as citizens' opinions of AI, or general access to AI technology), to organizational aspects (such as efficiency gains through advanced automation and human workers being replaced by AI), and also technical aspects (such as IT investments and enterprise data management). Areas of risk included threats to reputation, legal threats, operational risks, data security risks, and systemic risks.

For the project team, this was just the starting point. It then asked 50 experts if they felt there were positive, negative, or neutral relationships not only be-



A topic cloud on authorities responsible for regulating AI in financial services

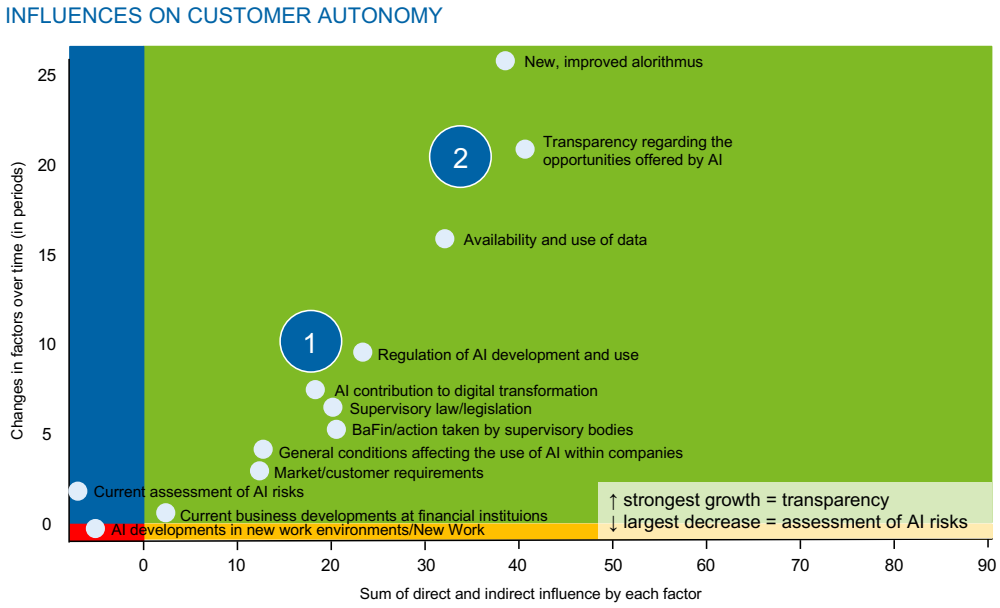
tween the 32 influencing factors, but also between each factor and the 12 areas of risk. This resulted in a heat map showing inhibiting and amplifying influences.

NEURAL FORECASTING – SETTING THE LOOPS IN MOTION

The assessments offered by the experts provided an evaluation of one factor at a time, without considering interdependencies. Such networks of interrelationships – in this case comprising more than 1,400 linked factors – cannot possibly be evaluated by human beings. The research team therefore transferred the expert evaluations to a self-learning, artificial neural network that simulates all influences in the form of limiting conditions. This allowed forecasts to be made based on calculations of future developments. If a large number of inhibiting influences have an impact on a factor, that factor does not progress and loses importance. This contrasts to intensifying influences, which cause factors to evolve and become increasingly relevant.

The factors affecting systemic and strategic risks faced by financial service providers can then be summarized by assessing whether they will have a positive or negative impact on areas of risk if they develop, or whether they make them more or less relevant. The most important factor fueling strategic risk at the moment is a lack of suitable data for conducting assessments and a lack of clarity regarding regulatory conditions. Laws and regulations use wording that cannot be directly translated into the function of algorithms, and such "language barriers" result in uncertainty. One short-term factor that mitigates risk is using AI to support human beings in making decisions rather than replace them.

Because algorithms are becoming more and more sophisticated, experts agree that AI will, on average, help reduce sys-



Impact cloud showing factors with inhibiting influences (red area) and promoting influences (green area) on the use of AI

temic risk. In the event that a risk actually does occur, the shock will become more intense because algorithms are not trained to deal with extreme events on which they have little or no data.

AI DOES NOT REPLACE PEOPLE – IT REPLACES OCCUPATIONS AND QUALIFICATIONS

Innovations created by AI cannot push aside human beings. Typical human skills will play an even more crucial role in the future, but these will need to adjust to new challenges. It will be necessary to redefine roles within all processes of management and work. The principles of lifelong learning also need to be integrated into everyday work. Twenty years ago, there was no such thing as a data scientist or software developer. Today, there are not enough of such professionals on the labor market. The result of this development will be the emergence of completely new jobs, with everything ranging from user experience designers (who optimize human-machine interactions) to virtual assistants (who no longer provide on-site support but help remotely via online tools).

So what does the team's simulated forecast tell us? In the future, understanding the methods used by AI and retaining transparency will not be enough to learn from available data. Currently, AI methods can still offer competitive advantage but in the future, they will probably become a commonplace asset. What really matters is that we not just engage in the short-term promotion of technology and infrastructure, but also support business concepts and how they are implemented. Whether sharing AI and making it accessible in the market proves successful will be determined by the degree of clarity regarding the use of information and comprehensibility of AI output.

If we look at current developments in AI, it is clear that improving data and information security is not the same thing as mitigating strategic risk. Aside from specialist knowledge and skills, it will be necessary to develop and test new forms of human-machine interaction. Technology based on AI will not increase risk, but reduce it. But this will only happen if organizations and technology use become more user-centric, i.e. human-centric.

PROF. DR. HABIL. JOACHIM HASEBROOK
joachim.hasebrook@steinbeis.de (author)

Study director
Steinbeis Transfer Institute
zeb/business.school (Baden-Baden)

www.steinbeis.de/en/su/1811
www.zeb-bs.de

DR. PATRICK LOHMANN

Senior Solution Engineer
celonis SE (New York City)

www.celonis.com

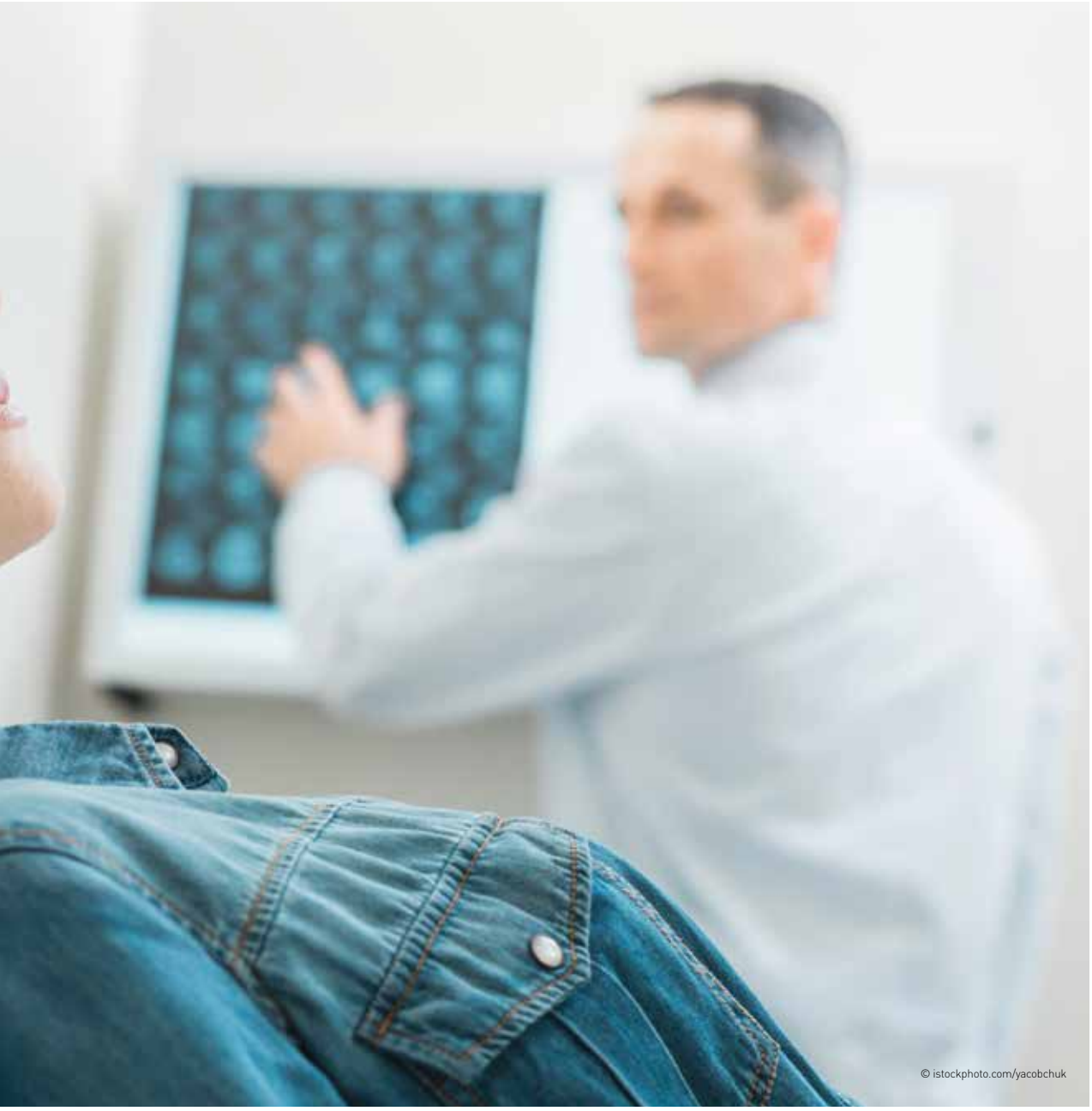
AI FOR THE NEXT GENERATION OF TUMOR DIAGNOSTICS

A RESEARCH NETWORK DEVELOPS A PLATFORM BASED ON AI TECHNOLOGY TO SUPPORT MEDICAL TREATMENT

Genomic cancer medicine and immunotherapy are revolutionizing the treatment of cancer patients. U.S. scientists Ralph Weissleder and Mikael Pittet predict that in the future, most diagnostic and therapeutic decisions in oncology will be based on the molecular genetic analysis of tumor patients as part of precision medicine. Many new forms of cancer will likely be treated as chronic conditions as a result of these new approaches. In the future, tumors will be treated not only according to their location in the body, but also according to their genomic profile. This makes it necessary to analyze the genomic tumor profile of each patient and determine individual treatments on a case-by-case basis following reviews by molecular tumor boards. Steinbeis entrepreneur Professor Dr. Dirk Hempel and his Steinbeis Transfer Institute for Clinical Hematology-Oncology are part of a network that is working on the development of an AI-based platform to be used by virtual molecular tumor boards. The platform will allow experts to match genomic data with imaging and clinical courses to support decisions regarding appropriate treatment.

Personalized medicine is developing at such a rapid pace that it will soon find its way into routine healthcare, so it will have to be widely available. It will also not take long for diagnostics to reach such a high level that it will no longer be possible for a small number of leading specialist centers to deal with demand. "Since the expert teams who take part in molecular tumor boards are not available at all hospitals, our aim is to make an AI-based expert system widely available so it supports the virtual, web-based work of molecular tumor boards – so-called Virtual Molecular Tumor Boards," says Dirk Hempel, outlining one of the network's goals.

The challenge is that genomic tumor analysis involves generating and analyzing extremely large amounts of data (big data). In addition, individual patients' treatable gene modifications come in a huge range of variants, and the incidence of driver mutations that can provide a point of attack for subsequent drug interventions is therefore very low.



THE GOALS OF THE ONKOVISION PROJECT

For the OnkoVision initiative, a team of researchers from the Steinbeis Transfer Institute for Clinical Hematology-Oncology has been working with the Fraunhofer Institute of Optronics in Karlsruhe (IOSB), the Helmholtz Institute in Munich, and the Technical University of Munich to develop an automated high-tech support platform using artificial intelligence. The planned platform differs fundamentally from all systems currently available in Europe, as well as international markets.

The network has defined four key questions that need to be addressed by the OnkoVision project:

1. How does one achieve broad-scale genomic medicine?
2. How can the enormous volumes of data be evaluated and compared with large databases?
3. How should molecular tumor boards be implemented nationwide?
4. How can the vast amount of real-world data be used for oncological healthcare provision research?

THE ROLE OF ONKOVISION

OnkoVision is looking into ways to develop and test AI solutions that will make it possible to link genomics repositories, including omics and medical databases, biobanks, and other registries, with the goal of supporting clinical research and decision-making. The project aims to combine the following functions:

PERSONALIZED MEDICINE IS DEVELOPING AT SUCH A RAPID PACE THAT IT WILL SOON FIND ITS WAY INTO ROUTINE HEALTHCARE, SO IT WILL HAVE TO BE WIDELY AVAILABLE.

- Automatic image recognition as part of radiological cross-sectional imaging, such as CT/core spin scans and PET according to RECIST criteria.
- A matching function, performed by automatically comparing patient-specific molecular data with ever-expanding international molecular databases.
- A self-taught function that continuously enhances the above functions based on self-learning algorithms.
- Mosaic variant detection within gathered molecular data, also as part of matches between clinical data and molecular data, including imaging that would automatically offer suggestions for suitable personalized treatment.

The platform is being developed to include two modules. Module A will be used for the first step to facilitate decisions made by the molecular tumor board with the support of AI algorithms. The platform should make molecular medicine expertise available to a wider audience in order to facilitate molecular medicine as a basis for precision medicine – not just at a small number of leading centers, but also in rural areas. By making full use of AI, the system is expected to be self-learning and improve through continuous input from medical experts. Another role played by the system will be to tap into growing volumes of data by using machine learning to draw on so-called real-world data and answer research issues as part of medical research.

The second module should make it possible to detect new molecular biomarkers for use in diagnosis and treatment, such that eventually orphan drugs will be approved for rare tumor diseases based on real-world data.

The approach adopted for the platform reflects a new generation of decision-making support and differs significantly from all previously available systems. Of course, one essential factor for making optimal use of the system is that it is "networkable" – this means it should not only forge networks with other databases, but also network with users. The community of users should comprise certified tumor centers working in the clinical field as well as centers dealing with outpatients in the broadest possible sense – i.e. not just a small number of leading centers.

PROF. DR. MED. DIRK HEMPEL
dirk.hempel@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Institute
Clinical Hematology-Oncology
(Donauwörth)

www.steinbeis.de/en/su/1695
www.sti-cho.com

IT'S ALL IN THE MIX – EXPLORING THE WORLD IMMERSIVELY WITH AI AND AR

STEINBEIS EXPERTS REDEVELOP INDOOR POSITIONING AND AUGMENTED REALITY (AR) APPLICATIONS

For Professor Dr.-Ing. Frank Deinzer of the Steinbeis Transfer Center for New Media and Data Science, the starting point is university research. Supported by his team, Deinzer is conducting research into artificial intelligence (AI) with a focus on sensor fusion. He tells TRANSFER magazine about his findings and how they are being applied to concrete AR projects.

Sensor fusion is the process of combining data from different – sometimes disparate – sources of information and sensors in order to derive an overall picture of a given situation. From a research perspective, this is a universal issue that leads to generally applicable methods. "You step closer to applications the moment the focus turns on specific, demanding problems and you're able to draw on your research results," explains Frank Deinzer.

MOVING FROM THE PROBLEM TO THE SOLUTION

For years, one such problem has been the issue of indoor positioning: Where is a person or object located inside a building? The items of technology people carry around anyway play an important part in this – smartphones, which perceive their surroundings through built-in sensor systems. If this information can be combined with what is already known – for example by using building layouts – this should be enough to continuously determine a person's position, in sufficiently accurate detail.

Artificial intelligence recognizes exhibits and enriches them with additional information using augmented reality. Individual points of interest offer you further information. Cards at the bottom of the screen can be used to recount ordered stories about the work. (Image: author)

Another topic the Steinbeis Enterprise is working on is augmented reality (AR), i.e. the interplay between analog and digital life. For example, there are applications that enrich image data from smartphone cameras with information generated artificially by the device. AI then helps identify and track objects or people in the image data stream. From a scientific standpoint, it is important to use sensor fusion techniques to do this.

DOES THIS ADD VALUE?

The question is: Ultimately, what does indoor positioning offer that genuinely adds value? One example would be location-based services, which have now become indispensable in outdoor areas. These are not just conventional navigation systems, but all of the kinds of applications offered by Google Maps – searching for the nearest store or services, location-based games and advertising, or recommended local events. Similar applications are virtually knocking down the door to indoor environments – navigation within large, complex buildings such as airports, audio guides in museums, or the analysis of pedestrian routes and highly frequented areas within buildings. These are precisely the applications being worked on at the Steinbeis Transfer Center for New

A terrain model at the Porsche Development Center in Weissach (background).

Artificial intelligence recognizes the exact position of the model. The image on the tablet shows an overlay of the world in augmented reality.

YOU STEP CLOSER TO APPLICATIONS THE MOMENT THE FOCUS TURNS ON SPECIFIC, DEMANDING PROBLEMS AND YOU CAN DRAW ON YOUR RESEARCH RESULTS.

Media and Data Science. Based on the findings of university research, the experts are setting up adaptable position-finding frameworks for use in specific projects.

So which environments should AR be used in for users to benefit from it, combined with which information? One example is a toolkit developed by the Steinbeis experts from Dettelbach to allow museums to create their own AR apps and add content without outside support. Unlike traditional guided tours, the new approach to evolving information allows visitors to explore the museum interactively, on a completely new level. "This also allows us to inspire younger museum visitors, making it possible to offer more exciting and contemporary educational content," believes Steinbeis expert Toni Fetzer.

SUCCESSFUL KNOWLEDGE AND TECHNOLOGY TRANSFER

The broad range of potential uses for the applications is best demonstrated by looking at current projects. A navigation system is currently receiving its final touches at Würzburg City Hall, a complex extending over several wings and floors. Visitors can use a smartphone app to search for topics, departments, or people, which they are then guided to, right up to the actual door. The New Media and Data Science center also contributed to the 100th anniversary of the Mozart Festival in Würzburg, using the AR toolkit to create an app that allowed visitors to use their smartphones to enjoy an audio-visual experience of the exhibition, exhibits enriched with texts, audio and video streams, and historical content.

Frank Deinzer and his colleagues also implemented a project for the Porsche Museum in Stuttgart, using an AR app to allow visitors to engage in an immersive exploration of a model measuring approximately seven by three meters at the Porsche Development Center.

AI SLIDES INTO THE BACKGROUND

As the three project examples show, AI does not exactly leap out at you when it is included in overall solutions. And that's a good thing. The focus always lies in people and their requirements – everything else is secondary. It is precisely for this reason that the "best" AI is not even consciously noticed, even if it may be central to a key function of an app and really impresses users by its performance.

Would you like to learn more about the projects of the Steinbeis Transfer Center for New Media and Data Science?

Take a look at the simpleLoc YouTube channel at **https://simpleloc.de/yt** or visit this website to try out the augmented reality app toolkit yourself: **https://augmented-art.de**

PROF. DR.-ING. FRANK DEINZER
frank.deinzer@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Center: New Media and Data Science (Dettelbach)

www.steinbeis.de/en/su/1806

TONI FETZER
toni.fetzer@steinbeis.de (author)

Freelance project manager
Steinbeis Transfer Center: New Media and Data Science (Dettelbach)

www.steinbeis.de/en/su/1806

ARABLE LAND ASSESSMENTS – CONDUCTED BY AI

STEINBEIS EXPERTS HELP IMPROVE THE AGRO-ECOSYSTEM IN AFRICA

Artificial intelligence (AI) is used today in many areas. The Horb-based Steinbeis Transfer Center for Industrial Digitization is now even involved in one area that is literally a down-to-earth field: agriculture. As part of a pioneering project called Agricultural and Rainforest Development in Africa, it has been providing expert support to international non-profit food and agricultural research organizations, with a focus on AI topics. Most of the research institutions taking part in the project are involved on a voluntary basis in cross-border environmental protection and nature conservation in Africa. This relies on partnerships with organizations based in the respective countries. As part of the project, the Steinbeis experts developed data models, AI algorithms, and analysis models to be used in vegetation management with the aim of regularly assessing the status of greenery in agricultural areas in Africa.

To conduct the project, the Steinbeis experts merged artificial intelligence, data analysis, and data from the agricultural internet of things (IoT) with the expertise of experienced agricultural scientists. This was in order to overcome difficulties in the agricultural sector with digital technology. Their work has resulted in a solution that facilitates quicker and more informed agricultural decisions. It has also spawned an opportunity to improve the entire agro-ecosystem in Africa.

The main objective of the project was to determine growth rates and crop changes in areas where precipitations fall under 80% of climatological normal values. The team also wanted to assess resulting changes in land use. To do this, the Steinbeis experts focused on data validation, since smart solutions require coherent data and data models. It was therefore important to harmonize data – i.e. spot inconsistent data, such as so-called outliers, which have to be cleaned up without being forced to de-

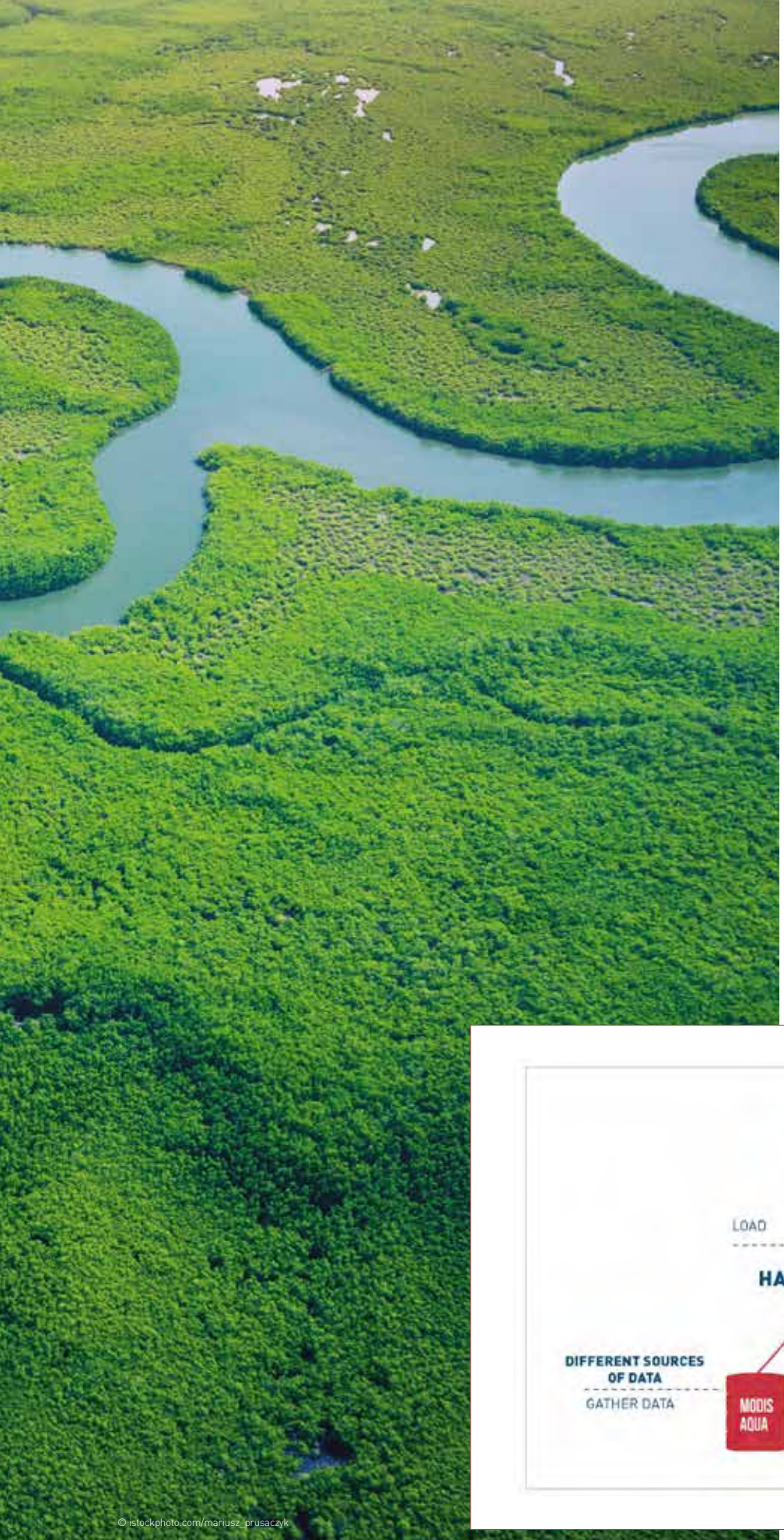
THE WORK HAS RESULTED IN A SOLUTION THAT FACILITATES MADE-TO-MEASURE, QUICK, AND INFORMED AGRICULTURAL DECISIONS.

termine clear rules for the process in advance. Due to other differences in factors such as time periods and data formats, it was also important to standardize data models and formats.

The developed solution identifies high-risk cycles or corridors most likely to have the greatest impact on vegetation. The scores and KPIs calculated by the solution provide effective support in prioritizing and determining possible areas in which to take action. Steinbeis project manager Hans-Dieter Wehle describes the development as a first and important step on the path to smart agriculture and an optimized food supply chain.

IT ALL STARTS WITH THE DATA

To assess the situation, use was made of different sources of public information: spatio-temporal data provided by NASA satellites and the European



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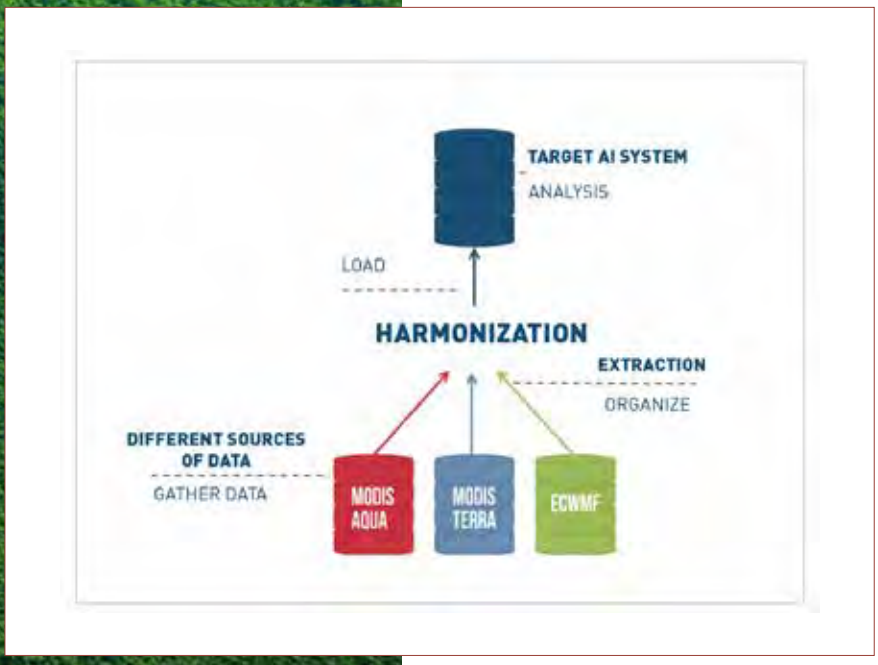
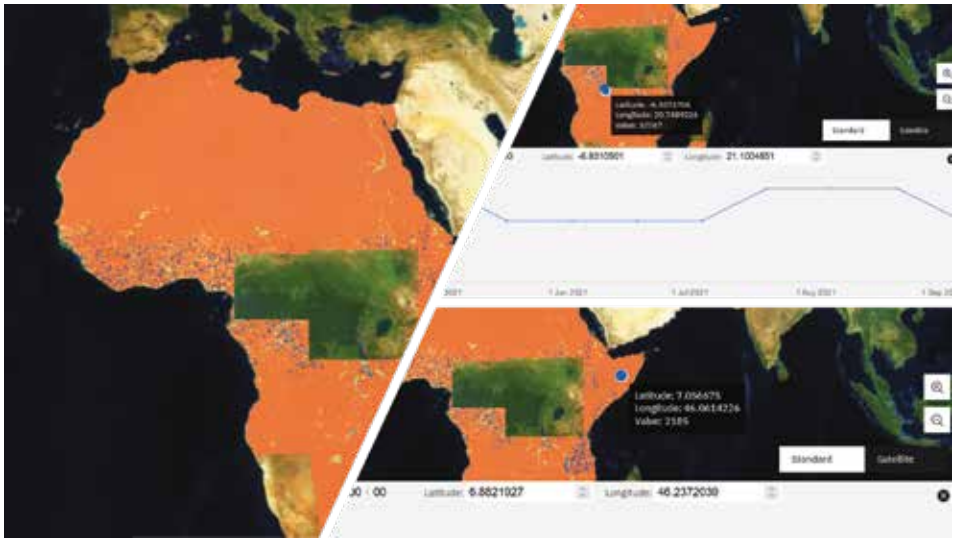
The data infrastructure at a glance





Values of nearly zero (-0.1 to +0.1) generally correspond to barren areas of rock and sand, shown here in ocher. The light green patches returned low, positive values for areas such as scrub or grassland (approx. 0.2 to 0.4) and the high values are shown in green to represent temperate and tropical rainforest. On the right side of the chart, a plot shows changes in the vegetation index over four months with a comparison between different locations. Absolute values between the compared sites are also shown.

Center for Medium-Range Weather Forecasts (ECMWF). MODIS (Moderate Resolution Imaging Spectrometer) on board NASA's Aqua satellite provided the NDVI (Normalized Difference Vegetation Index) data needed for calculations, underpinned every one or two days by Earth surface observations from NASA's Terra satellite.

MODIS creates images of the Earth in 36 different spectral bands (wavelength intervals) offering spatial resolutions of 250, 500, or 1,000 meters. The images represent an area measuring 1,200 x 1,200 km in the form of 4,800 rows and columns in 16-bit signed integers. For each pixel, the best value is selected from a 16-day period in order to minimize errors resulting from cloud cover or the viewing angle, and in order to maximize NDVI – a standardized measurement of greenery that is calculated as a ratio, based on the difference between near-infrared reflectance (NIR) and red spectral bands and the sum of those bands. This makes it possible to plot vegetation, since plant leaves reflect almost all incidental near-infrared light but absorb red in chlorophyll. The ECMWF data includes forecasts and accumulations of events such as snowfall, wind, and solar radiation, which play an essential role when it comes to context-based analysis and visualization of the results.

The Steinbeis experts used a variety of AI tools and techniques for their analysis. For example, they employed data mining observation techniques such as association analysis to search for relationships between data in order to identify a rule of inference. They also used cluster analysis to create groups of data that had greater similarities than other groups of data.

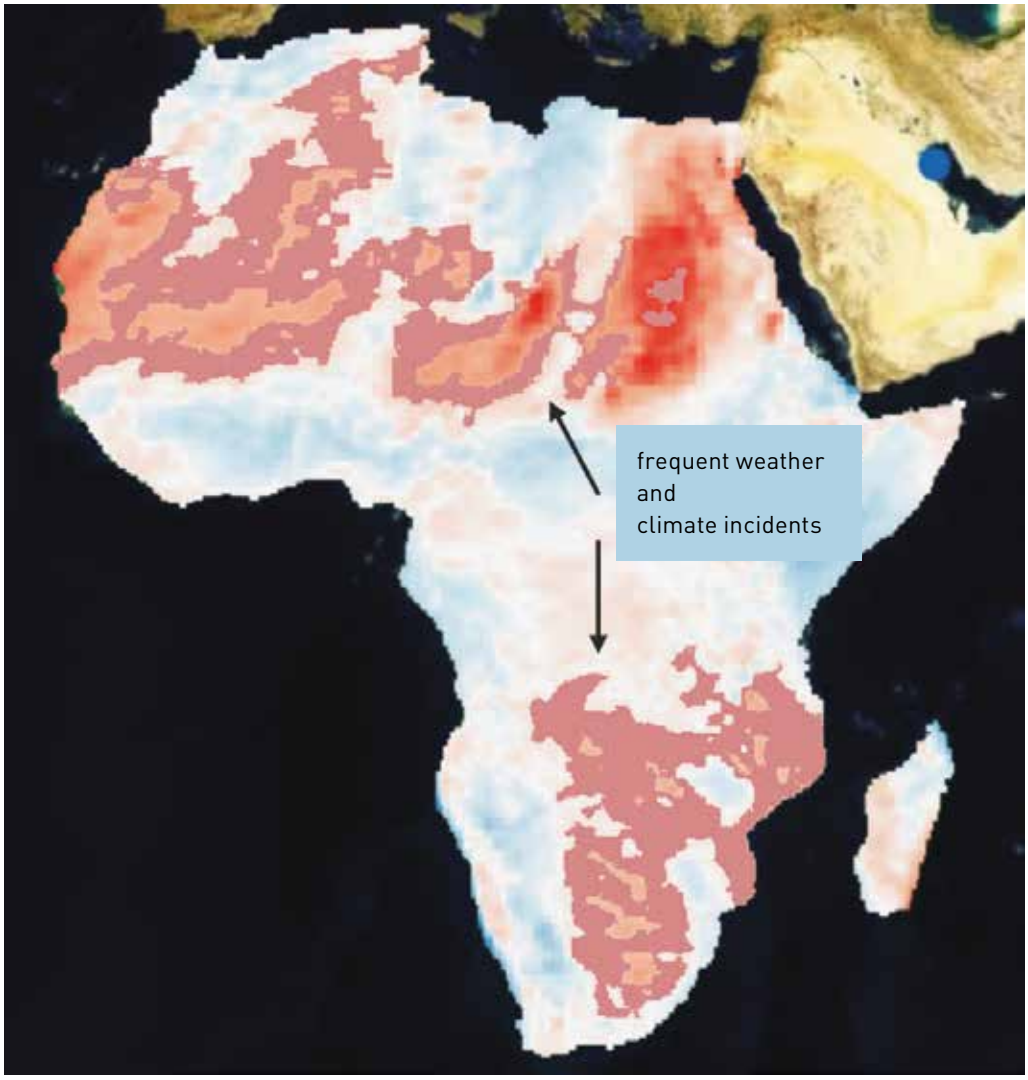
THE RESULTS PRODUCED BY ANALYZING THE DATA

Climate data were analyzed for the last ten years, showing a noticeable rise in temperatures as well as clusters of extreme weather and climate incidents. Such changes are not favorable for the continuous development of greenery, and in many cases they go hand in hand with the destruction of arable land, which in turn leads to logging of rainforest areas in order to open up new arable land.

Although only minimal differences can be perceived in actual land use year on year, the data relating to cultivated farming land does reflect year-on-year fluctuations in the proportion of farmed land in relation to overall areas of vegetation – with a steady rise in barren areas.

CLEAR POTENTIAL

The described solution makes it possible for different stakeholders to automate data transfer between different systems, establishing a transparent, connected ecosystem that delivers benefit to up- and downstream organizations – such as



Map based on ECMWF analysis: The red areas show land with difficult climatic conditions; the blue areas show land that is suitable for the continuous development of vegetation.

- Food and drinks manufacturers, which can introduce integrated supply chains based on improved harvesting schedules and more reliable volume forecasts
- Financial lenders to agriculture, which can monitor the performance of yields compared to potential
- Insurance agencies, which can use validated information to gauge risk more accurately and thus offer growers more logical premiums
- Governments, which can improve strategies for reducing dependence on food supplies by providing producers and authorities with access to shared instruments

PROF. DR.-ING. TIM JANSEN
tim.jansen@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Center
Industrial Digitization (Horb)

www.steinbeis.de/en/su/2004
www.idhorb.de

HANS-DIETER WEHLE
hans-dieter.wehle@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Center
Industrial Digitization (Horb)

www.steinbeis.de/en/su/2004
www.idhorb.de

"WE'D LIKE TO OFFER SMES THE OPPORTUNITY TO INTRODUCE AI TO ACTUAL APPLICATIONS"

AN INTERVIEW WITH ALEXANDRA FEZER AND STEFANO SBARBATI FROM STEINBEIS EUROPA ZENTRUM

The Vanguard Initiative aims to bolster innovation and industrial growth in the EU. Starting points for the project are regional strategies aimed at fostering intelligent specialization. This involves focusing on the existing strengths of regions and their strategic development. For the initiative, in 2020 Steinbeis Europa Zentrum launched an AI pilot program with the support of the Italian region of Emilia-Romagna. In an interview for TRANSFER magazine, Alexandra Fezer and Stefano Sbarbati, who are in charge of the project at Steinbeis Europa Zentrum, explain what it's all about.

Hello Ms. Fezer. What are the goals of the AI pilot project?

Alexandra Fezer:
We'd particularly like to offer SMEs the opportunity to introduce AI to actual applications and by doing so, accelerate innovation processes at companies. This is an important step in laying a course for the future, and it will enable companies and research institutions to participate in European funding and interregional partnerships – in addition to the initiatives and instruments that already exist in each state – and this will make it easier to gain access to markets. This complements our commitment to building and networking the European Digital Innovation Hubs (EDIHs) with relevant stakeholders in Baden-Wuerttemberg.

Hello Mr. Sbarbati. What does implementing the project entail in concrete terms?

Stefano Sbarbati:
It's a pilot concept and it's been organized in the form of demo cases. The aim is to make the results of collaboration facilitated by the project more accessible to the market. We're currently helping with two different demo cases, and we'd be happy to expand our portfolio of demo cases and help regional stakeholders apply their concepts. In addition to focusing on the key topic of resource efficiency in production, the pilot project is also looking at the user experience, data analytics, user-centered design, AI-enhanced cyber-physical automation, HMI evolution, and other topics.

Are there already any concrete examples of applications?

Alexandra Fezer:
At the moment, we're busy pulling together a demo case spearheaded by stakeholders here in Baden-Wuerttemberg. Our focus lies in researching AI applications that allow processes to be optimized in production. At the same time, we're exploring a variety of options for supporting AI applications at SMEs in Baden-Wuerttemberg, but also be-

yond. We also investigate international funding options – with a particular focus on Horizon Europe – and we're trying to make it easier to introduce AI at our SMEs by also taking advantage of these funding opportunities.

As an initiative, Vanguard falls under European policy. What's the role of Steinbeis Europa Zentrum in this project?

Stefano Sbarbati:
We've been supporting research and innovation in the field of artificial intelligence for many years. Aside from the goal of getting AI innovations onto the market, a particularly important aspect of the Vanguard Initiative is interregional cooperation within Europe. Our role at Steinbeis Europa Zentrum is to help on a European level with conceptual planning and the development of research and innovation policies, and in addition to supporting the European Commission, we also accompany stakeholders in Baden-Wuerttemberg with the implementation of political initiatives and partnerships. Being a member of a whole variety of initiatives, such as the Enterprise Europe Network and the Digital Innovation Hubs, also contributes to networking.

ALEXANDRA FEZER
alexandra.fezer@steinbeis.de (interviewee)

Senior Project Manager
Steinbeis Europa Zentrum
Steinbeis 2i GmbH
(Stuttgart/Karlsruhe)

www.steinbeis.de/en/su/2017
www.steinbeis-europa.de

STEFANO SBARBATI
stefano.sbarbati@steinbeis.de (interviewee)

Project Manager
Steinbeis Europa Zentrum
Steinbeis 2i GmbH
(Stuttgart/Karlsruhe)

www.steinbeis.de/en/su/2017
www.steinbeis-europa.de

EMISSION-FREE, CARBON-NEUTRAL, AND EFFICIENT: SOLAR DISTRICT HEATING SUPPORT LOCAL CLIMATE PROTECTION

STEINBEIS EXPERTS COORDINATE CLIMATE PROTECTION PROJECT TO SUPPORT THE TRANSITION TO ENVIRONMENTALLY FRIENDLY HEATING

Ground-mounted solar thermal collectors in front of the central heating plant at the Hallerndorf district heating (Source: Guido Bröer)

The SolnetPlus project team at the official handover of the funding check with Parliamentary State Secretary Rita Schwarzelühr-Sutter, Steinbeis Board Member Prof. Dr. Michael Auer, and representatives of the Solar Heating Networks Industrial Initiative (picture taken July 8, 2021 at the Steinbeis House for Management and Technology (SHMT) in Stuttgart. Source: Guido Bröer)

Solar district heating combines two established and perfected forms of technology: solar thermal energy ("solarthermics") and district heating. The general expansion of district heating and, in particular, solar district heating represents a significant opportunity for local authorities to play their part in climate protection. Heating currently accounts for more than 50 % of the annual final energy required by the housing sector in Germany. Funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the SolnetPlus climate protection project supports the development of district heating based on large-scale solar thermal systems – thus also supporting the transition to environmentally friendly heating. The project is being coordinated by Solites, the Steinbeis Research Center for Solar and Sustainable Thermal Energy Systems.

The German federal government has been promoting the development and construction of large-scale solar thermal systems on open spaces and roofs since the 1990s. More than 44 such large-scale plants are in operation now, supplying thermal energy for heating and hot water to a large number of residential and non-residential buildings. The fastest growth is currently being witnessed in urban district heating networks and in the district heating of smaller cities and communities in rural areas.

Basically, there are two different types of collectors used to generate heat: high-temperature flat plate collectors and evacuated tube collectors. When the sun shines, absorbers heat up a liquid heat transport medium inside the collectors. Depending on the specific design and construction, systems deliver different temperature levels of output, achieve different efficiencies and result in different costs for each type of collector. By connecting multiple panels to form large-scale collector farms (tens of thousands of square meters are possible), heat can be transported to a

heating plant. From the heating plant, the thermal energy is shared with connected buildings via insulated pipelines as part of so-called district heating.

THE ADVANTAGES OF SOLAR ENERGY

Using solar energy as the primary power source makes it possible to generate 100 % emission-free heat. It is also carbon-neutral. In addition, these systems achieve stable heating costs, typically for many years because they are unaffected by fuel prices and offer low maintenance and servicing costs. These costs are highly competitive compared to other heat generation systems. Aside from the energy saved when cutting carbon emissions, ground-mounted solar thermal systems can also have a positive impact on the ecology and biodiversity of the surroundings. Allowing meadows to fill with flowers and designing the technology to blend in with its environment offers new habitats to native plant life and insects, enhancing the overall area.

KEY FACTORS AFFECTING SOLAR THERMAL SYSTEMS

In principle, solar thermal collectors can be used on any open space. A number of factors need to be taken into account, however, such as proximity to the heating plant, the orientation of collectors and local topography. A key challenge with large-scale solar thermal systems is increasing competition over land use with farming, businesses and other renewable energy sources. In part, competition can be mitigated by, for instance, using old landfills or occupying land converted from other uses. As solar thermal collectors are the most efficient way to use open spaces – even compared to other renewables, including solar energy used for photovoltaics – the priority with suitable land should be to earmark it for solar thermal energy.

↗ Supporting biodiversity through wildflower meadows and ecological concepts at a ground-mounted solar thermal plant (Source: Solites)

A key prerequisite for using large-scale solar thermal collectors is an existing or recently constructed district heating system. (Solar) district heating makes an important contribution to municipal climate protection. Within three years, a large number of buildings can be supplied with climate-neutral solar heat, either through completely new district heating systems in rural areas, for example in combination with biomass, or by feeding thermal energy into existing urban district heating networks. Integrating solar thermal systems into existing district heating works well if the flow and return temperatures of the district heating system are kept as low as possible. The lower the temperatures are, the more efficiently solar-generated heat can be used. This enables the solar thermal collectors to cover the summer heating requirements of an entire network. During this time, alternative heat generators can be left to idle. Not only does this save expensive fuel, it also makes it possible to carry out maintenance and servicing.

It also becomes possible to cover more demand through solar energy. Examples of systems in Denmark and Germany show that using seasonal heat storage systems makes it possible to achieve "solar fractions" of 50 %. In the process, solar surpluses generated in the summer can be stored over extended periods and used in the winter months. Making multifunctional use of thermal storage systems also improves the cost-effectiveness of seasonal heat storage.

SOLNETPLUS CONTRIBUTES TO CLIMATE PROTECTION AND THE GREEN ENERGY TRANSITION

More and more heating suppliers are now constructing large-scale solar thermal systems in Germany – primarily because highly appealing subsidies are now available, but also for commercial reasons. As a result, a number of solar thermal collector farms have been constructed in recent years, ranging in size from 2,000 to 14,800 square meters. Measuring 18,700 sqm, Germany's largest solar thermal plant to date is currently under construction in Greifswald.

Large-scale solar thermal systems used in district heating in Germany (Source: Solites)

To keep up the momentum of this trend, the Steinbeis Research Center for Solar and Sustainable Thermal Energy Systems (Solites) is coordinating a project called SolnetPlus – Solar district heating as a Solution for Municipal Climate Protection. The initiative is receiving just under € 1 million of funding from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Working alongside project partners AGFW (a rationalization, information, and standardization specialist), Hamburg Institut Research (HIR), the German Institute for Urban Affairs (Difu), and freelance journalist Guido Bröer, the aim is to improve awareness of solar heating system solutions and to accelerate municipal climate protection through the implementation of concrete projects.

For the project, local authorities are being targeted with the aim of offering them information and advisory services that could motivate them to contribute to local climate protection and promote the transition to environmentally friendly heating. The other important target group in transforming the sector is heating suppliers, which are also being approached and offered training.

In addition, assessments are being carried out not only to understand the underlying factors that shape planning and approval processes, but also to establish potential areas that concrete improvements could be made in – and to propose recommended actions among governmental institutions. The project is being supported by both professional PR experts, with the aim of increasing impact and a project advisory board comprising manufacturers and supplier companies.

The innovative climate protection project is funded by the German Federal Ministry for the Environment through the National Climate Initiative (NKI). Further information on the National Climate Initiative of the German Federal Ministry for the Environment: **www.klimaschutz.de.**

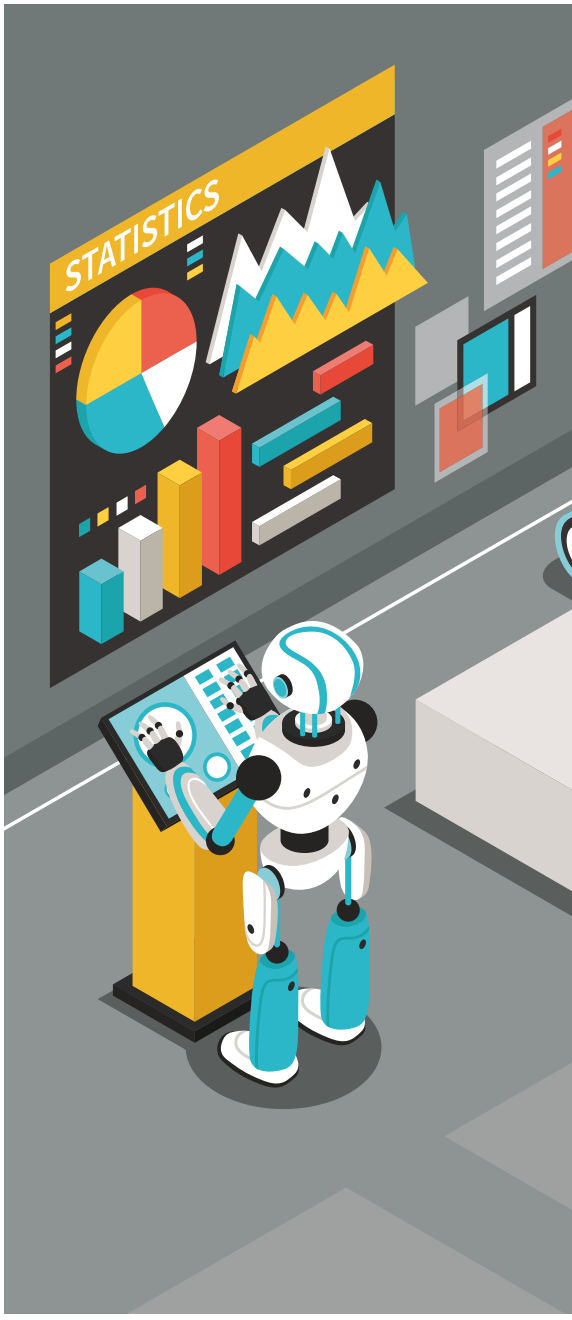
PATRICK GEIGER
patrick.geiger@steinbeis.de (author)

Assistant
Steinbeis Research Center Solar and Sustainable Thermal Energy Systems (Solites) (Stuttgart)

www.steinbeis.de/en/su/0891 | www.solites.de

HOW AUTOMATING PROCESSES RAISES PRODUCTIVITY AND CUTS COSTS

STEINBEIS STUDENT ANALYZES THE AUTOMATION LEVEL OF A SOFTWARE RELEASE PROCESS



Improving the efficiency, speed, cost-effectiveness, and, above all, the quality of business and IT processes is increasingly becoming a key factor for future competitiveness. Automating tasks, individual steps within processes, or even complete processes – including across departmental boundaries – is now of central importance and not only beneficial for companies, but also for their employees. This was also something ascertained by Smart Solutions for Industry employee Arne Steckler, as part of his business competence project for his Master of Science degree in Business Information Systems at Steinbeis University. For his project, he helped Steinbeis Interagierende Systeme (a supplier of software used on a platform that tests driver assistance systems) to document its software release process based on suitable methods – also analyzing the potential to automate and thus optimize processes. The process he looked at is used by the company to perform merges, ensure there are no errors, and deliver new software versions.

Automated processes save time and are often more reliable and less prone to errors. As a result, not only do they facilitate significant productivity enhancements, they can also lead to major cost savings. Both of these aspects are crucial for quality assurance processes. Whereas humans are clearly superior to machines when it comes to flexible or creative tasks, machines are almost invariably better and much faster with mindless, repetitive tasks. With automated processes, it is entirely possible to ensure quality assurance tasks are completed and carried out correctly, but not all tasks can be performed by computers, and sometimes they require or even wholly necessitate the creativity and flexibility of a human being. Automation levels are thus an important indicator of a company's process maturity. Automating processes is a good way to achieve all three corners of the magic time, quality, and cost triangle, especially when people are given the best possible support: Ultimately, being faster (time) and achieving fewer errors (quality) also makes things less expensive (costs).

A WIN-WIN SITUATION FOR COMPANIES AND WORKERS

Automation does not just offer advantages to companies, however; employees also derive benefit in a number of

areas, because it is rarely about cutting resources. More often, it is about avoiding mind-numbing and repetitive tasks in order to free people up to engage in more valuable work that requires a variety of human skills. In essence, available time can be put to better use and made more interesting for employees. Furthermore, enabling highly automated processes to dovetail with tasks performed by humans offers ways to ensure that defined (internal or statutory) processes and reporting standards are adhered to, as well as compliance regulations.

A STEP-BY-STEP PROCESS LEADING TO SUCCESS

The objective of the project conducted by Arne Steckler on behalf of Steinbeis Interagierende Systeme was to determine the degree of automation required within a software release process and pinpoint potential to make improvements when it comes to automation. On the one hand, this involved documenting the current standard of the process, thus making it transparent for management and people responsible for the process. On the other, Steckler was to highlight tasks offering the strongest potential to be automated. It was important to pay particularly close attention to specific areas in which human steps should be kept in place, also showing how they

AUTOMATED PROCESSES SAVE TIME AND ARE OFTEN MORE RELIABLE AND LESS PRONE TO ERRORS. AS A RESULT, NOT ONLY CAN THEY MAKE IT POSSIBLE TO SIGNIFICANTLY ENHANCE PRODUCTIVITY, THEY CAN ALSO LEAD TO MAJOR COST SAVINGS

could be systematically dovetailed and safeguarded.

Steckler was also asked to provide a clear overview of the process in the form of a BPMN model highlighting communication interfaces. This would offer a better, shared understanding of the process and result in an overview of the process in the form of documentation.

To kick off the project, Steckler conducted one-on-one interviews with people involved in the process to discuss any of their tasks that overlapped with the chosen process. Their responses were recorded, documented, and transferred into a BPMN model. To ensure information was captured correctly and to rule out misunderstandings, the documented process was reviewed and refined in follow-up meetings with the interviewees. Once all process tasks and relevant artifacts (model elements) had been successfully captured, a sign-off meeting was organized to allow all participants in the process to validate the process documentation as an overall model.

The very procedure of capturing processes and providing a clear representation of them in BPMN is an opportunity to make improvements – simply by encouraging stakeholders involved in the process to actively think about how it works, to talk to one another, and to see the process in its entirety in order to point to potential in visible terms. Such models can also provide input further down the line for additional, in-depth assessments. Such assessments can be used to capture the process in value terms, also highlighting weak points, the potential to make improvements, and the causes of potential discrepancies between actual and target process performance.

For Steckler, the focus of his process analysis lay in the degree of automation of the software release process. His aim was to ascertain the extent to which certain tasks had already been automated and to pinpoint areas in which there was meaningful potential to convert manual tasks into automated routines. Overall, there should be further reductions in manual tasks and, in the future, it should be possible to produce automated reports.

The first task for Steckler was to develop a formula for calculating automation levels, taking the overall circumstances into account as described above. Based on this, he defined options for evaluating the potential to automate individual steps. The factors required to calculate automation levels were provided by stakeholders responsible for carrying out the process. In addition, these factors were used to identify tasks offering the best potential to automate processes.

LEVERAGING DOCUMENTATION AND TRANSPARENCY TO IMPROVE QUALITY

Documenting the release process for the first time created a common understanding among all process stakeholders, also making it possible to work together in pinpointing initial areas to make optimizations and provide a user-friendly representation of the process. In addition, the project participants have added transparency to the automation level of the process, identified further potential for the company to automate processes, and made it possible to assess automation levels in numerical terms. Implementing the identified improvements will improve the quality of artifacts and thus enhance produced software. In follow-up interviews, staff gave positive feedback on the approach, particularly regarding the role they played as the starting point for process improvements, and the fact that the quantitative assessment showed in visible terms how they contributed in their role to automation.

ARNE STECKLER
a.steckler@smso4i.com (author)

Process Design & Consulting
Smart Solutions for Industry AG
(Filderstadt)

www.smso4i.com

ALEXANDER WOBETZKY
a.wobetzky@smso4i.com (author)

COO
Smart Solutions for Industry AG
(Filderstadt)

www.smso4i.com

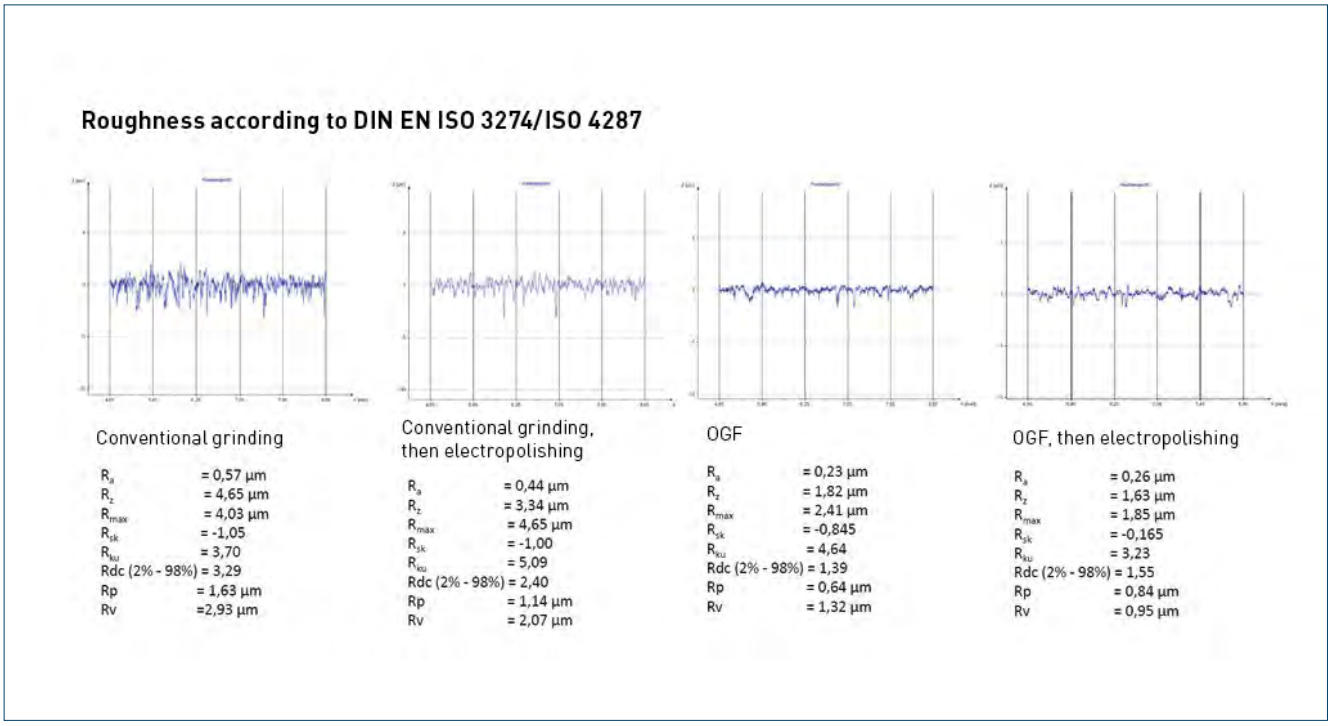
DANIEL ULMER
daniel.ulmer@steinbeis.de (author)

Managing Director
Steinbeis Interagierende Systeme
GmbH (Herrenberg)

www.steinbeis.de/en/su/1913
www.interagierende-systeme.de

NOT MUCH TO STICK TO

PROJECT TEAM DEVELOPS A SURFACE OPTIMIZATION METHOD FOR USE WITH PHARMACEUTICAL, FOOD, AND PROCESS TECHNOLOGY



Tactile measurements showing the influence of surface finishing on roughness

Surface finishes on stainless steel are significantly influenced by chemical and physical properties. Technical terms such as "hygienic design" are becoming increasingly important in sensitive areas, such as food and beverages, or the pharmaceutical industry. This is because firms want to do whatever they can to avoid particles being carried over to other areas and contaminating different batches. Surface cleaning properties play a crucial role in this, as does the ability of particles to gain adhesion. The question is: Which factors influence particle adhesion on hygienic surfaces, and how can these factors be optimized? This was the question posed by stainless steel specialist Bolz Intec from Eisenharz in Baden-Wuerttemberg. The firm has been producing tanks and customized vessels from chromium-nickel steels for many years, and for a number of those years it has been working with the University of Constance and Technology – Organization – Human Resources, the Steinbeis Transfer Center in Ravensburg, to investigate surface properties.

Currently, the main attribute used to characterize surface properties is surface roughness. Despite this, the research team decided to focus on other factors such as final surface energy.

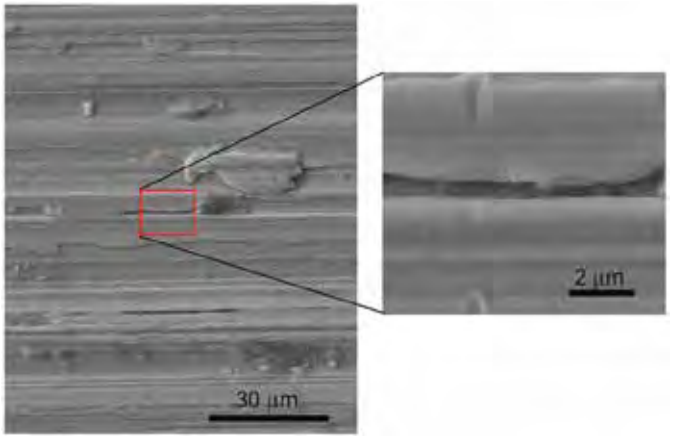
Current technology revolves around the assessment of surfaces using non-destructive testing, such as roughness measurement in combination with visual observations. There are, however, further important criteria such as how and in what ways surfaces are finished. "We discovered that even if the Ra of different surfaces is the same, in the final surface assessment different grinding techniques result in different adhesion properties," explains Steinbeis entrepreneur Professor Edmund Haupenthal. It became clear that it is important exactly how material is removed. An experiment was set up to grind a vessel over a longer period using automated grinding rather than grinding surfaces

manually. Gradually removing material over a time resulted in less build-up and thus better cleaning properties. This is what the experts refer to as final surface energy.

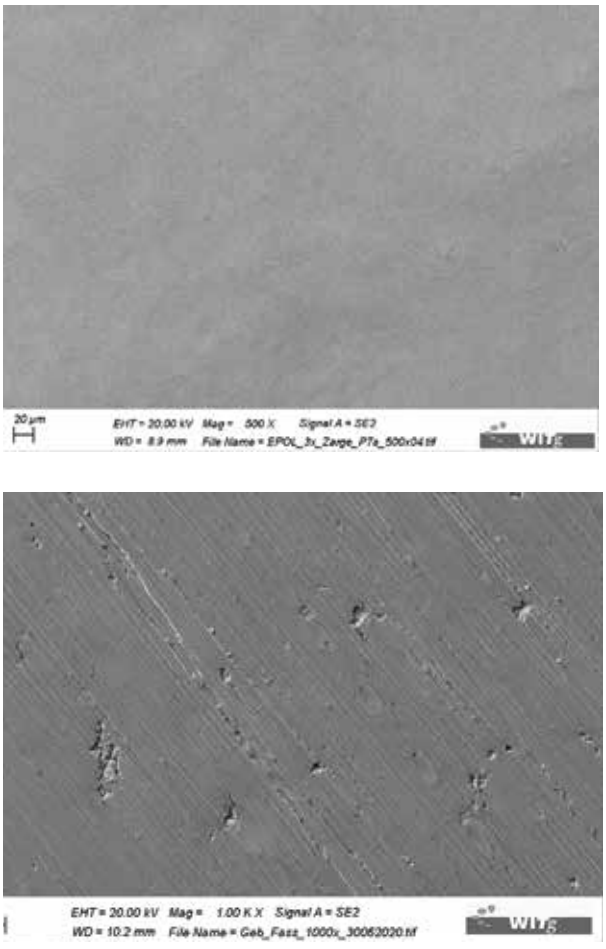
OGF – OPTIMIZED GRIND FINISHING PRODUCES OPTIMIZED SURFACES

Bolz Intec has made full use of these new insights to develop a process capable of removing small amounts of material on a continual basis over a long period of time. This process, which is semi-automated, is called optimized grind finishing, or OGF for short. To remove material, indeterminately shaped abrasive fragments are allowed to swill around inside vessels. The big advantage with this process is that the resulting surface is not only of an outstanding quality, it is also reproducible. The processes used by Bolz Intec do not depend on imprecise variables, such as manual pressure during conventional grinding carried out by an operative, or the quality of individual abrasive materials. The results are defined roughness depths with low influences on the depth of microstructures and visually appealing surfaces.

The differences versus conventional processes are also obvious to the eye. The project team compared a surface produced using conventional grinding processes with a surface finished using the OGF method. The different surfaces were then examined using a 3D optical measuring instrument, which also made it possible to render false-color images. The comparison showed that the OFG method does not produce linear abrasions and as a result, there are significantly lower peaks and troughs on the surface versus the standard sample. The surface does display some imperfections, but these are significantly reduced by the extremely fine and gentle removal process of the OGF method.

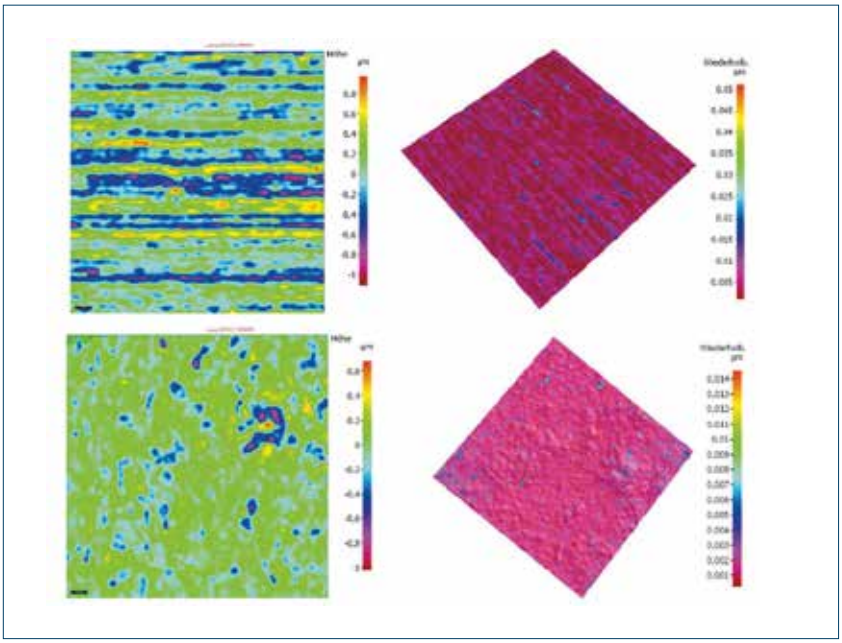


A localized defect on a conventionally ground surface (2)



SEM images of the surfaces. The surface at the top was OGF-electropolished. The surface below was precision-grind electropolished.

THE RESEARCH TEAM DECIDED TO FOCUS ON OTHER FACTORS SUCH AS THE FINAL SURFACE ENERGY



VISUAL AND CHEMICAL IMPROVEMENTS

During further investigation, the surfaces were refined even further and underwent electropolishing. This resulted in surface spikes being removed, which not only delivered visual benefits but also improved chemical properties, such as enhanced corrosion protection due to strengthening of the passive layer.

In its final assessment of the study, the project team also demonstrated improved cleaning properties using a test based on VDA19.1 (March 2015)/ISO16232 (December 2018). The OGF method reduces the build-up of residual dirt in vessels. For users, this significantly reduces the risk of contamination between different batches.

The project partners felt positive about the results of the project. The desired parameters were achieved and thanks to the research, it was possible to create surfaces that can be accurately reproduced in terms of both roughness and visual impact. In addition, the surfaces offer advantages when it comes to cleaning. This added value could be especially important for critical, extremely valuable, or very fine particles. In industries such as nanotechnology, biotechnology, and pharmaceuticals, batch purity and avoiding contamination are a crucial aspect of the production process.

References

[1] P. Gümpel and seven co-authors: Stainless Steels, 5th revised edition, 2015; expert-verlag GmbH; Renningen; ISBN 978-3-8169-3148-5 [German]

[2] A. Turnbull, K. Mingard, J. D. Lord, B. Roebuck: Sensitivity of stress corrosion cracking of stainless steel to surface machining and grinding procedure; Corrosion Science 53, pp. 349-355, 2012

PROF. EDMUND HAUPENTHAL
edmund.haupenthal@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Center:
Technology – Organization – Human Resources (TOP) (Ravensburg)

www.steinbeis.de/en/su/151
www.stz-top.de

THE 2021 STEINBEIS ENGINEERING DAY: THE ROLE PLAYED BY AIOT IN PRACTICE

HOW ARTIFICIAL INTELLIGENCE OF THINGS (AIOT) CREATES BENEFITS FOR BUSINESS

The internet of things has not only found its way into our living rooms, industry is also increasingly recognizing the potential offered by networking between companies. Suddenly, processes that for years were optimized purely based on the gut feeling of employees are becoming transparent – in areas in which artificial intelligence can now provide support. How this works in practical terms was explained by the presenters at the 2021 Steinbeis Engineering Day.

Some forms of technology require large volumes of data to map information as accurately as possible, whereas others generate a deluge of data that, until now, has been difficult to translate into pertinent information. In retrospect, bringing these two types of technologies together was pretty inevitable. The experts at this year's Steinbeis Engineering Day were quick to recognize that artificial intelligence and the internet of things are a perfect complement to one another. This made it possible for them to share their AIoT experiences with the audience – drawing on a variety of examples from their everyday work.

IMPLEMENTING AIOT SUCCESSFULLY – WITH THE RIGHT PARTNER

In a keynote speech given by Professor Dr. Heiner Lasi, academic head of the Ferdinand Steinbeis Institute, a vivid demonstration was offered of how the automation pyramid is being replaced by a new paradigm of flexible collaboration within digital ecosystems. Based on digital reflections of reality, solutions can be designed to focus on benefits. One such solution in the field of intralogistics was presented by Friedhelm Keller (aberu) and Michael Sinn (Flux MES). It became obvious that nobody is in a position to manage the digital transformation process by themselves. You have to work with others offering complementary skills.

How digital products will need to be set up in the future was explained by Marian Raphael Demme from Robert Bosch Manufacturing Solutions, who demonstrated a Bosch Nexo cordless nutrunner in use. Products that are designed to work with digitech must be capable of communicating openly with one another via standard interfaces. These days, if you try to install vendor lock-ins in your software, your product is already obsolete. In the future, products will enable

buyers to select their own digital services and create packages from a range of different offerings. Using ideas from his AIoT playbook, Dr. Dirk Slama provided a vivid demonstration of the role played by AIoT in delivering straightforward, quick benefits in such settings.

Overall, looking at AIoT allowed the Steinbeis Engineering Day to highlight how in the old days, development departments were much needed, whereas these days just a handful of experts are enough to deliver significant benefit.

SVEN KURRLE
sven.kurrle@steinbeis.de (author)

Research Assistant
Ferdinand Steinbeis Institute Heilbronn

www.steinbeis.de/en/su/2278
https://ferdinand-steinbeis-institut.de

The LEONARDO Center for Creativity and Innovation is a collaborative project between Nuremberg Institute of Technology, Nuremberg Academy of Fine Arts, and Nuremberg University of Music. The initiative was made possible by a joint Federal and State-level program called Innovative University.

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THOSE WHO WANT TO GO FAR, GO TOGETHER

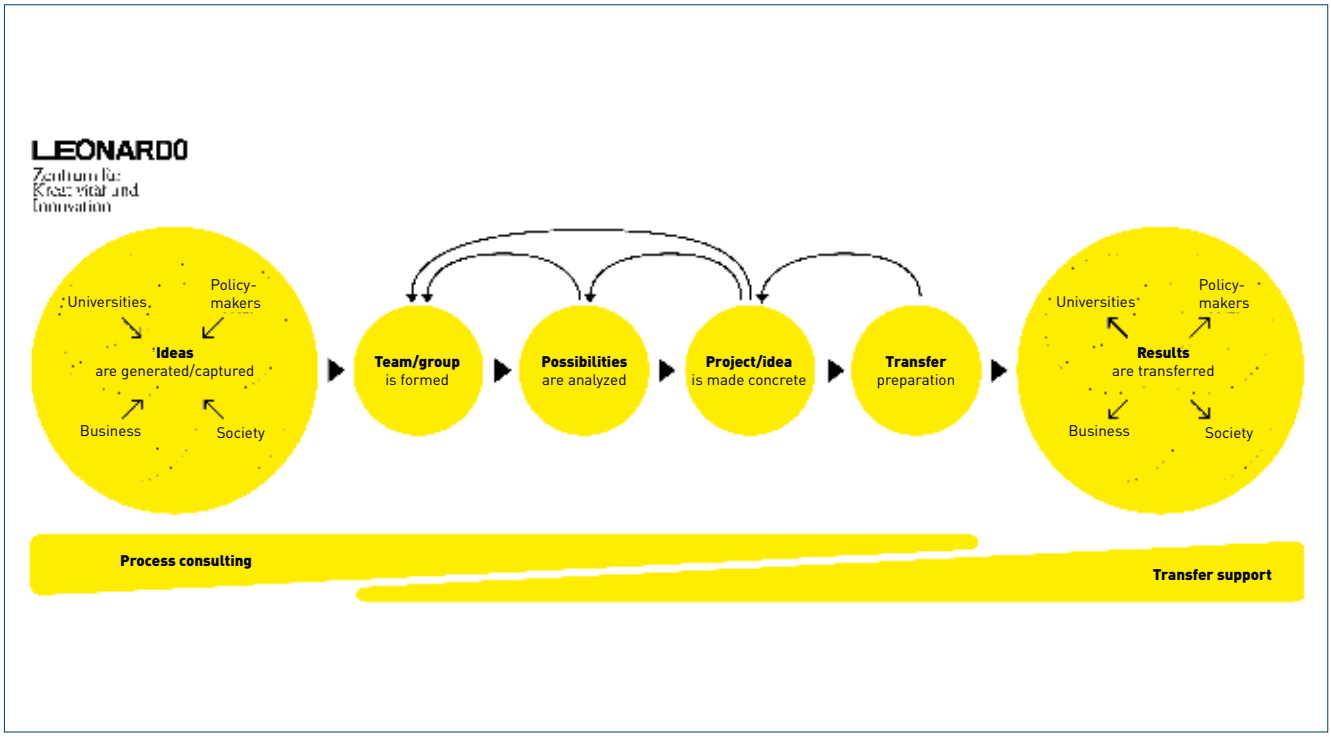
STEINBEIS EXPERTS SUPPORT THE LEONARDO CENTER FOR CREATIVITY AND INNOVATION WITH THE PLANNING AND ORGANIZATION OF KNOWLEDGE TRANSFER DURING THE PROCESS OF INNOVATION

Our economic systems and society thrive on a continual supply of new ideas. The best ones lead to products and services that meet the complex demands of the globalized economy. To do this, it is important to dovetail relevant views and ways of looking at things into the innovation process as early as possible. Universities provide an ideal breeding ground for such approaches. Aside from offering an incomparably broad base of professional expertise, they make it possible to introduce interdisciplinary thinking to development processes – from a variety of angles, even as early as the 3I phases: inspiration, ideation, and invention. The LEONARDO Center for Creativity and Innovation in Nuremberg has set itself the task of offering more space for this potential offered by universities, also making it possible to explore the bounds of feasibility. By applying a phase model – which, from the moment an initial idea is born, revolves closely around the innovation process – the center supports interdisciplinary teams in their work, also exploring the key factors that determine the successful transfer of promising ideas. Professor Dr. Michael Braun, entrepreneur at the Steinbeis Consulting Center for Science Management, co-founded the center and is now supporting its ongoing development with his Steinbeis expertise.

These days, institutions and companies have to operate under conditions that are considered volatile, uncertain, complex, and ambiguous. The acronym VUCA has become established as a buzzword for this state of affairs. VUCA highlights the challenges faced in modern, global society, but at the same time it points to a way to meet these challenges and potentially emerge successfully: through vision, understanding, clarity, and agility.

When developing potential solutions to complex problems or creating visions and capturing them in concrete terms, it is important not only to determine the key factors and aspects relating to specific issues, but also to understand how they relate to one another. Adopting an interdisciplinary approach by considering the views of different specialist communities and methodology stakeholders leads to ideas that can only arise in the areas of overlap between those disciplines.

Nuremberg is a city of science characterized by application-oriented research and intensive networking between universities, non-university research institutions,



The LEONARDO Process Model

and innovative companies. With a wide range of degree courses, 25,000 students, and hundreds of professors and university staff, it offers the ideal prerequisites for leveraging interdisciplinarity and promoting ideas in the region.

VUCA VERSUS INTERDISCIPLINARITY

The flip side of the many things hoped for in interdisciplinarity – which sound appealing at first glance – is a realization that interdisciplinary collaboration is itself a complex challenge: The more disciplines, the more difficult it becomes to stem VUCA in the process.

As a collaborative project between Nuremberg Institute of Technology, Nuremberg Academy of Fine Arts, and Nuremberg University of Music, the LEONARDO Center is tackling this exact challenge. Its role is to establish a framework to promote the positive impact of interdisciplinarity on the innovation process, also bridging critical factors. This revolves around a model called the LEONARDO Process. "It's a generic process that's particularly effective in content and methodological terms during the uncertain and vague early stages of innovation by stimulating and supporting the generation and transfer of ideas between interdisciplinary teams – covering six phases," explains Steinbeis consultant Michael Braun. As co-founder of the LEONARDO Center, Braun now supports the center with his Steinbeis Enterprise in rethinking interdisciplinary collaboration at universities in order to shape transfer in the innovation process from the very beginning.

Ideally, the innovation process starts with the right ideas at the right time. A foundation for this is laid by an informal setting that facilitates the low-threshold exchange of ideas in order to allow people to inspire one another and come up with ideas. It's important to underpin this with proactive support in order to capture those ideas and make them tangible. LEONARDO offers a number of formats that are suitable for promoting communication and congregation. It also organizes, among other things, networking events, themed workshops, and talks, not only providing individual assistance but also visiting organizations.

Once an idea for a joint project has emerged, the different stakeholders require a structural framework that will help them with two important tasks: to gain trust in one another in order to gain visibility as a team and function properly; and to develop a vision together as a point of orientation. On top of this, they face another task in interdisciplinary contexts: Because teams are made up of different individuals, not only do they offer a considerable variety of views and expertise, but there are significant differences in specialist terminology, con-

ventions, and approaches. LEONARDO accompanies the different stakeholders in making constructive use of both the differences and similarities between communities.

To ascertain the potential areas that can be explored by the project, ideation begins during the preparation phase. It is important at this point to reach agreement on areas of commonality and workflows. This includes agreeing collaborative formats that will offer the possibility to exchange views creatively, not only when it comes to current content, but also with respect to future prospects of engaging in co-creation. The LEONARDO Center supports this process by offering suitable physical facilities and a digital infrastructure, providing guidance on ideation methods and techniques, assisting with moderation and evaluation, and helping with actual implementation.

Once a framework has been put in place regarding the scope of the project, it is important to exchange ideas and suggestions, to examine those ideas, discount them, or come back to them. It is not uncommon for opportunities identified during this phase to be underestimated, such that ideas are prioritized too quickly over prototyping – even though it is precisely the diverse spectrum of knowledge regarding methodologies and different experience within involved disciplines that presents such a broad scope of potential solutions. To exploit this potential offered by interdisciplinary collaboration, the LEONARDO Center strengthens the ability of teams to experiment, lowering the entry point for "trying things out" iteratively. In methodical terms, this revolves around techniques used in creative research, innovation development, and design. In spatial terms, it involves providing access to adaptable and technologically outstanding rooms and laboratories.

KEY AREA OF FOCUS: THE TRANSFER PHASE

The transfer part of the model highlights how important it is for third-party stakeholders to put existing ideas into context and provide input – and how crucial it is to continuously think about transferring content into and out of the project during the process. The interdisciplinary, collaborative approach not only results in significantly more stakeholders being recognized as important for idea development. It also ensures the required networks are put in place. As a result, LEONARDO projects may not always culminate in a finished product, process, or service. Instead, interested stakeholders are offered an ongoing opportunity to evaluate "work in progress" or findings and take these forward.

It is this transfer mindset that Steinbeis consultant Michael Braun strives for with LEONARDO, and aside from changing transfer itself, it also transforms thinking regarding projects. "The focus is no longer just on results, but on exchange and the actual ideas that emerge during the process," explains LEONARDO research associate Dr. Daniela Bauer. Making the process just as important as the outcome paves the way for new transfer formats, also adding appeal to collaboration between universities during the early stages of innovation. For example, students can engage with companies by contributing with novel views on shared ideas revolving around a societal problem as part of a hackathon. Networking meetings allow stakeholders from research and front-line business practice to focus on exchanging ideas rather than just business cards. As a result, they arrive at shared visions and concrete collaborative projects.

This interdisciplinary approach makes it possible to raise the profile of a wide range of scientific disciplines and research questions. In addition, it allows external stakeholders from science, industry, and society in general to become closely involved in processes. The LEONARDO Model highlights the fact that transfer is not just about "lots of communication" regarding outcomes, or results at the end of projects. Transfer is also about facilitating collaboration between many stakeholders and developing ideas during the process itself.

PROF. DR. MICHAEL BRAUN
michael.braun@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Consulting Center
Science Management
(Roßtal)

www.steinbeis.de/en/su/2331

DR. DANIELA BAUER
daniela.bauer@th-nuernberg.de (author)

Scientific assistant
LEONARDO Center for Creativity and Innovation at Nuremberg University of Applied Sciences
(Nuremberg)

www.th-nuernberg.de

FABIAN BITTER
fabian.bitter@th-nuernberg.de (author)

Scientific assistant
LEONARDO Center for Creativity and Innovation at Nuremberg University of Applied Sciences
(Nuremberg)

www.th-nuernberg.de

LÖHN AWARD GOES TO THE MASTERMINDS BEHIND THE CLIMATE-NEUTRAL DISTRICT IN ESSLINGEN

STEINBEIS EXPERTS DEVELOP ENERGY AND SUSTAINABILITY CONCEPT

Dedication to sustainability that thoroughly deserves recognition – on October 6, 2021, Steinbeis presented the team at the Steinbeis Innovation Center energyplus and its project partners with the Steinbeis Foundation's Transfer Award – the Löhn Award – at the Steinbeis House for Management and Technology in Hohenheim, Stuttgart. The prize is awarded for outstanding projects and achievements in entrepreneurial knowledge and technology transfer.

The Steinbeis Foundation's Transfer Award, the Löhn Award, was initiated in 2004 in recognition of the achievements of Professor Dr. Dr. h. c. mult. Johann Löhn, former Chairman and now an honorary trustee of the Steinbeis Foundation. This year the jury awarded the prize to the climate-neutral urban project "Neue Weststadt" in Esslingen. Due to the pandemic, Johann Löhn and Dr.-Ing. Leonhard Vilser, Chairman of the Steinbeis Board of Trustees, presented a sculpture symbolizing the idea of transfer, as well as the prize money, to a small but nevertheless festive audience.

The circle of award-winners included the Steinbeis Innovation Center energyplus (Stuttgart), the City of Esslingen, Green Hydrogen Esslingen (GHE), TU Braunschweig represented by the Institute for Building Climatology and Energy of Architecture, the Esslingen University of Applied Sciences represented by the Institute for Sustainable Energy Technology and Mobility, the Berlin Institute for Social Research (BIS), Esslingen Municipal Transport (SVE), Polarstern (Munich), mondayVision (Stuttgart), HyEnTec (Zell unter Aichelberg) and the Baden-Wuerttemberg Center for Solar Energy and Hydrogen Research (ZSW, Stuttgart/Ulm).

CLIMATE NEUTRALITY FOR AN ENTIRE URBAN DISTRICT

The award-winning project is based on the principle of domestic electricity generation using renewable energy, local hydrogen production, and waste heat utilization to supply heating to the district. The approach goes back to an integrated energy and sustainability concept developed by the Steinbeis Innovation Center energyplus under the direction of Professor Dr.-Ing. M. Norbert Fisch. Green hydrogen is fed into the local gas network, making an important contribution to reducing the carbon footprint of the energy sector. Waste heat generated by water electrolysis is fed into the local heating network. At the heart of the project lies a "real-life laboratory" for the green energy transition – an urban district measuring 12 hectares, comprising around 500 residential properties, offices, commercial buildings, and a new building for Esslingen University of Applied Sciences.

The overarching aim is to create an urban district that is almost carbon-neutral. The project defines carbon-neutral as achieving annual carbon emissions for housing and travel of under one ton per capita. This should be achieved, among other things, by reducing energy requirements, using a large number of solar installations (peak generation approx. 1,500 kilowatts), recovering waste

» **THE AWARD-WINNING PROJECT IS BASED ON THE PRINCIPLE OF DOMESTIC ELECTRICITY GENERATION USING RENEWABLE ENERGY, LOCAL HYDROGEN PRODUCTION, AND WASTE HEAT TO SUPPLY HEATING TO THE DISTRICT**

The 2021 winners of the Steinbeis Foundation's Transfer Award – the Löhn Award – pictured with their project partners and the jury (back row to front row, from left to right): Uwe Haug (Steinbeis Headquarters), Tobias Nusser (Steinbeis Innovation Center energyplus), Dr. Eva Schulze (BIS/Berlin Institute of Social Research), Andreas Brinner (ZSW/Center for Solar Energy and Hydrogen Research Baden-Wuerttemberg), Prof. Dr.-Ing. Ferdinand Panik (Esslingen University of Applied Sciences), Manfred Mattulat (Steinbeis Foundation), Matthias Kluczny (Steinbeis Innovation Center energyplus), Prof. Dr. Michael Auer (Steinbeis Foundation), Dr.-Ing. Leonhard Vilser (Steinbeis Foundation), Felix Mayer (Green Hydrogen, Esslingen), Prof. Dr.-Ing. Manfred Norbert Fisch (Steinbeis Innovation Center energyplus), Prof. Dr. Dr. h.c mult. Johann Löhn (Steinbeis Foundation)

heat from hydrogen production, and importing biomethane for use in combined heat and power plants (CHP).

A key element of the system for supplying the district with energy is a hydrogen electrolyzer with an output of 1,000 kWel. Electricity needed by the district will be supplied by PV systems installed on roofs, with a major share coming from generation plants, which will supply surplus renewable electricity from outside via the national grid. Waste heat from the electrolyzer will be used to meet around half of the heating requirements of housing units, commercial buildings, and the university via a local heating network. This will raise the annual efficiency of electrolysis to roughly 85 to 90%. The idea of building a climate-neutral urban district was first mooted in 2015, followed by a long planning, approval, and construction process. A celebration marking the point of going live for the hydrogen production facility took place with the funding agencies in June 2021. The project was funded to the tune of €12 million by the German Federal Ministry of Economics and Technology and the Federal Ministry of Research and Education, as part of an initiative called Solar Construction/Energy-Efficient City.

Further information on the Steinbeis Foundation's Transfer Award:
www.loehn-preis.de.

STEINBEIS-ZENTRALE (Stuttgart)
pr@steinbeis.de (author)

www.steinbeis.de

WHAT'S THE POINT? DISCUSSING THE USEFULNESS OF SCIENCE

THE MAX SYRBE SYMPOSIUM IS STREAMED FROM THE HEILBRONN EDUCATION CAMPUS

On November 3, 2021, a selection of "thinkers and doers" met up in the auditorium on Heilbronn Education Campus to take part in the Max Syrbe Symposium and explore prejudices against science and business. For one and a half hours, the experts took part in a streamed panel discussion on a key question: What's the Point?! The Usefulness of Science. The online audience was also given the chance to take part in a chat session and an interactive survey during the event, which was co-organized by the Steinbeis Foundation and the Ferdinand Steinbeis Institute.

Due to the pandemic, the event finally took place at the beginning of November 2021 – taking distancing and hygiene rules into account, without an onsite audience, and facilitated by plenty of technical equipment and streaming technology. This had no detrimental impact on the quality of the discussion, however.

The session was opened by Professor Dr. Michael Auer, Chairman of the Steinbeis Foundation Board, and Michael Köhnlein, Managing Director of the Ferdinand Steinbeis Institute. Together, they highlighted the symbiosis between science and business before welcoming two leading figures in Heilbronn to the panel discussion: Mayor Harry Mergel and Professor Reinhold R. Geilsdörfer, CEO of the Dieter Schwarz Foundation. Both had been asked in advance what value they believe is offered by research and innovation activities carried out on the Heilbronn Education Campus – not just for the city, but also to society in general. Online participants also had their say, using a voting tool to answer the contentious question before the panel began their discussion: "Who sets the direction – science or business?" During the symposium, the audience was also given the chance to inject further interest into the discussion by using a chat function.

The eight panel members comprised six representatives of the scientific community: Professor Dr. Gudrun Kiesmüller (Technical University of Munich), Professor Dr. Tomás Bayón (Baden-Wuerttemberg Cooperative State University, Heilbronn), Professor Dr.-Ing. Oliver Riedel (Fraunhofer IAO), Professor Dr. David Rygl (Ferdinand Steinbeis Institute), Professor. Dr.-Ing. Raoul Daniel Zöllner (Heilbronn University). They were joined via video call by Professor. Dr. Helmut Krcmar (TUM). Outnumbered – but by no means less influential – Dr. Mario Englert (Lauda Dr. R. Wobser) and independent architect Professor Dr. Alexander Beck represented the interests of the business community. Philipp Kahl (WIF GmbH) was unfortunately unable to attend due to illness. Rebecca Beiter and Robin Christoph Knapp moderated the afternoon event. To gather different opinions regarding the benefits of science, the discussion centered around a number of core topics: research, funding, transfer, and communication.

SO WHO IS SETTING THE DIRECTION NOW?

As the Max Syrbe Symposium got underway, votes submitted by the online viewers showed that they saw business in the leading role. The views of the panelists sometimes drifted apart when discussing the various topics, but the audience remained of the opinion that the business community is ahead when it comes to defining the direction – even after the discussion. So what would Ferdinand von Steinbeis have voted? Well, at least we have one statement from him: "He who wishes to devote himself to higher industry, should never lose sight of the fact that it is a craft wedded to science."

Prof. Dr. Helmut Krcmar, Dr. Mario Englert, Prof. Dr. Tomás Bayón, and Univ.-Prof. Dr.-Ing. Oliver Riedel in conversation (left to right)

The two moderators, Rebecca Beiter and Robin Christoph Knapp, took seats at the center of the semicircle of eight panelists to lead the afternoon session.

One from business, one from science: Prof. Dr. Alexander Beck and Prof. Dr. David Rygl.

INES WEYBRECHT
ines.weybrecht@steinbeis.de (author)

Directorate
Ferdinand Steinbeis Institute Heilbronn

www.steinbeis.de/en/su/2278
https://ferdinand-steinbeis-institut.de/

The symposium is organized by the Steinbeis Foundation in memory of Professor Dr. rer. nat. Dr.-Ing. E. h. Max Syrbe, former president of the Fraunhofer Society, long-standing Board of Trustees member and Chairman of the Steinbeis Board of Trustees. In 2009, the jury of the Steinbeis Foundation Transfer Award – the Löhn Award – presented Syrbe with an honorary award in recognition of his outstanding personal contributions to knowledge and technology transfer.

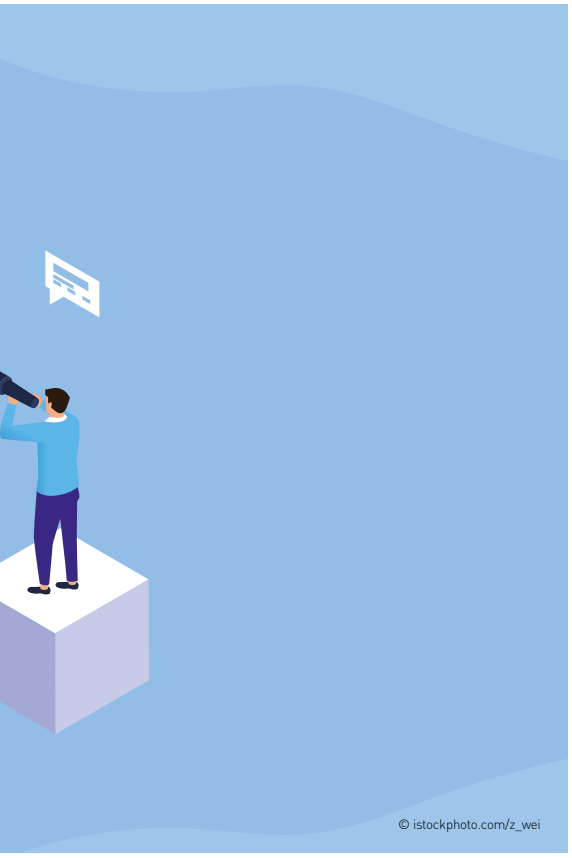
MAKING DECISIONS AND LEADING PEOPLE WITH THE OODA MODEL

HOW TO LEAD THE COMPANY STRATEGY AND OPERATIONS IN A CRISIS SITUATION OR PERIOD OF CHANGE

The current pandemic, the supply problems it has led to, rising energy costs, plus the shift toward sustainability place a variety of demands on companies – on a number of levels, and sometimes in conflicting ways. If you follow financial indicators, short-term financial and operational measures are required – "flying on visual" with paying customers. By contrast, sustainability commitments necessitate strategic decisions of a medium- and long-term nature, including regulatory and normative decisions – "off the radar" for stakeholders in other areas. Support with this is offered by the OODA model, which helps companies make the best possible decisions in any given situation. Steinbeis expert Dr. Peter Meier explains the benefits offered to companies by the model.

The planning scenarios currently used by companies range from worst-case threats – posing short-term risks to the existence of the company due to financial insolvency – to best-case opportunities to add long-term value in response to all of the demands and expectations of other stakeholders. Faced by uncertainty regarding future developments, companies try to identify relationships between the causes and effects of value-adding activities – in all areas of value creation, for all stakeholders. They also seek to plan for different scenarios, make the right decisions, introduce the right measures, and evaluate outcomes. It is therefore still about the decisions and actions of business leaders, partly taken in situations of ignorance, tinged with a great deal of uncertainty.

To make such decisions, companies need different types of information. This forms the basis of all "intelligent" and "intuitive" activities at companies. Currently, information can be supplemented with



META-INFORMATION ↓	INFORMATION →	
	un-known knowns	un-known un-knowns
	known knowns	known un-knowns

The 2×2 Rumsfeld Matrix

	ITEM CATEGORIES →		
	must not have	nice to have	must have

Information budget

AI techniques and tools, but the eternal dilemma between intelligence- and intuition-based decisions remains.

THEORY: THE FOUR CORNERSTONES OF THE OODA MODEL

The OODA model is used to define quick and best-possible decisions and actions in a state of uncertainty and missing information. It was developed as a military concept for the U.S. Air Force during the Korean War in the 1950s, and since then it has been adapted as a business and public sector model. [1], [3] The OODA model has four parts:

- **OBSERVE:**
  Identify information regarding internal and external correlations affecting the organization.
- **ORIENT:**
  Examine, evaluate, and describe the situation faced by the organization.
- **DECIDE:**
  Select a scenario for the preferred future situation of the organization.
- **ACT:**
  Add value for the shareholders and stakeholders of the organization.

PRACTICE: USE OODA TO REORGANIZE INFORMATION MANAGEMENT

How the OODA model can be used by companies is shown by a project conducted by the Steinbeis Transfer Center for Risk Management on behalf of Suthor, a paper processing company from Nettetal, west of Dusseldorf. A family-owned, mid-sized company, Suthor uses an integrated management system – spanning two areas of its multiple-link value chain according to ISO requirements – to manage quality processes (ISO standard 9001) and environmental issues (ISO 14011).

Given the current situation, the company makes daily decisions on short-term and operational changes, versus medium- and long-term strategic plans. There are major deficits with the current ISO standards when it comes to information management and translating this into reality. As a result, the company has been working with Steinbeis expert Dr. Peter Meier and has turned to the OODA concept to place greater emphasis on information management. Meier

CURRENTLY, INFORMATION CAN BE SUPPLEMENTED WITH AI TECHNIQUES AND TOOLS, BUT THE ETERNAL DILEMMA BETWEEN INTELLIGENCE- AND INTUITION-BASED DECISIONS REMAINS

	KEY TERMS →			
IDEAL THEORY	Practicality	Objectivity	Transparency	Consensus
ACTUAL PRACTICE	Mandate Competence	Power Experience	Responsibility Trust	Accountability Personality

↑ Decision-making

transfers the formal methods and models used by large companies to the actual situation and processes of medium-sized companies.

Applied to Suthor, the four parts of the OODA model look like this:

- **OBSERVE:**
  Relevant information is systematically identified and processed using complementary instruments. This is based on the Rumsfeld Matrix [2], which aims to overcome the unpredictability of developments in complex systems.

- **ORIENT:**
  Up-to-date situational reports based on the information are prepared on an ongoing basis to convey the internal and external correlations between the company and its business environment. Updates are produced in the form of management reports in accordance with Section 289 of the German Commercial Code.

- **DECIDE:**
  Actions are decided upon, giving priority to one of a number of virtual scenarios. This quick decision is made under relative uncertainty and in partial ignorance. It is based on the current (actual) situation and the future (target) scenario. This is based on thinking and actions with a focus on threats and opportunities, as outlined in the ISO 9001:2015 standard for quality management. The two sides of management – leadership and followership – converge. Actions of the business leaders are based on demonstration (as a role model), argumentation (based on reason), discussion (to persuade), and imperatives (issuing instructions). Use is made of natural intelligence, natural intuition, and – if possible – artificial intelligence. The process only involves a small number of managers and specialists; during a crisis, only a minimal crisis management team is formed. Beteiligt sind wenige Führungs- und Fachkräfte, in einer Krise nur ein minimaler Krisenstab.

- **ACT:**
  Determined actions are carried out. Responses and feedback loops work immediately, because implementing decisions affects the entire organization and the aim is to take the organization on a journey into the future.

References

[1] Kwon, Munok and Meier, Peter: It all Comes Down to the Right Crisis Management; Steinbeis Transfer Magazine, p. 76, Steinbeis, Stuttgart 2020

[2] Morris, Errol and Rumsfeld, Donald: The unknown known – What you didn't know; Participant Movies, Los Angeles 2013

[3] Schön, Erik; Tzu, Sun; Boyd, Wardley: The Art of Strategy – Steps Towards Business Agility – Yokoso Press, Stockholm 2020

DR. PETER MEIER
peter.meier@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Transfer Center:
Risk Management (Langen)

www.steinbeis.de/en/su/657

EVERYONE STARTS SMALL

FROM A CONTROLLED, SCENARIO-BASED TEST MODEL TO A SELF-DRIVING CAR

Whereas humans use their senses to recognize their surroundings, cars rely on their sensors. Future generations of vehicles will increasingly tap into artificial intelligence to interpret sensor data. This will add a new and more demanding dimension to testing vehicles, not only when it comes to obtaining the data required to train systems, but also with respect to scenario-based testing. To meet the technology and process challenges this presents, and to solve problems efficiently, experts at Steinbeis Interagierende Systeme have developed the AR Car, a fully automated test vehicle that is integrated into the development cloud.

Vehicles can find themselves in an infinite number of situations while out and about on the roads. To ensure they not only perceive their surroundings but also "comprehend" them, an increasing number of AI systems are being introduced to vehicle software. These need training and to do that, you need representative data. For example, if you want a vehicle to recognize signs in the future, first you need to train its software by showing it signs from different angles, under different lighting conditions, or in different colors and sizes.

MOVING FROM DATA TO TESTING

In turn, to validate vehicle software you have to expose vehicles to a variety of situations and see if they behave the way they are expected to. This means that the development process for vehicles, which are expected to move around autonomously within their surroundings, starts by gathering data from representative scenarios and ends by systematically testing processes on the target system, i.e. the vehicle. This involves alternating between tasks carried out by humans and those based in the cloud, and this also has to be processed and evaluated.

To analyze this working method and, in particular, to ensure steps within the process can be experienced in a compact form, Steinbeis Interagierende Systeme uses a CI setup. This includes automated unit testing, a software-in-the-loop solution for vehicles, and a 1:8-scale, fully automatable test vehicle. The CI setup provides a basis for the SensorTwin project launched in July 2021 (see also page 70), which is being funded as part of the Baden-Wuerttemberg AI Innovation Competition. The aim is to find ways to optimize the meaning and usefulness of the cloud-based "test factory" in relation to real vehicles in real surroundings.

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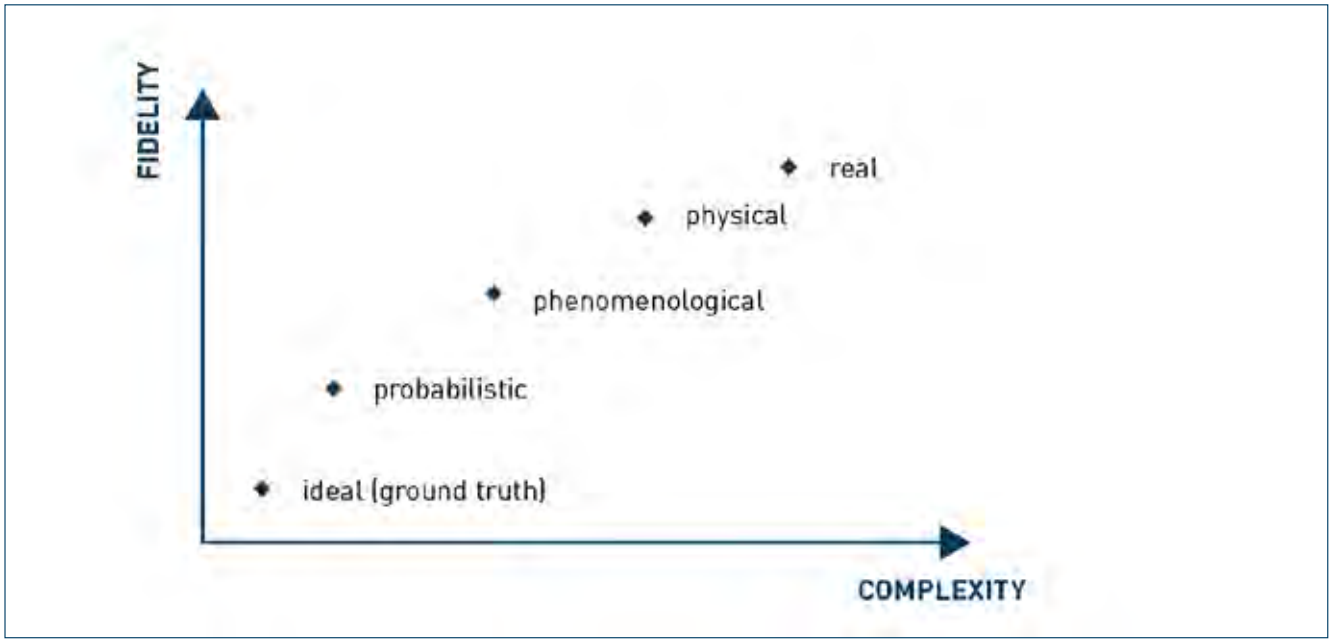
DANIEL ELSENHANS
info@steinbeis-ias.de (author)

Systems Engineer
Steinbeis Interagierende Systeme GmbH (Herrenberg)

www.steinbeis.de/en/su/1913
www.interagierende-systeme.de/sensor-twin

A SENSOR TWIN ENHANCES THE SAFETY OF SELF-DRIVING VEHICLES

STEINBEIS EXPERTS DEVELOP OPTIMIZED SCENARIOS FOR CREATING ROBUST PHENOMENOLOGICAL MODELS



The relationship between realism and complexity in actual, recorded situations

For the automotive industry, alongside electric vehicles, automated vehicles are one of the most important topics of the 21st century. To ensure the control units used in driver assistance systems are safe, there are two approaches to logging millions of test kilometers. One is to record driving situations in a real setting and then replay them using re-simulation methods; the other is to create an artificial environment capable of providing synthetic, but realistic data in a testing environment. With the synthetic approach, the performed simulations might deviate from reality and this can impair the smooth functioning of the control unit. This is where the experts at Steinbeis Interagierende Systeme come in with their SensorTwin project, which is being funded by the Baden-Wuerttemberg Ministry of Economics as part of a competition called AI for SMEs. The goal of the project is to enhance the realisticness (fidelity) of virtual vehicle testing and thus reduce the resources required to conduct real testing on the road.

One problem with synthetic testing approaches is that they are based on replicated models that are "too ideal" and take no or very few real phenomena into account. As a result, they may not deliver suitable data for testing units in every simulated situation. To solve this problem, models are needed of sensors that take in their surroundings. Depending on the actual situation that needs to be simulated, these would deliver the required fidelity and the complexity needed by the simulation.

FOR THE SENSORTWIN PROJECT, THE STEINBEIS TEAM IS FOCUSING ON AN APPROACH AIMED AT SYSTEMATICALLY IDENTIFYING MODEL INACCURACIES AND APPLYING THEM TO PHENOMENOLOGICAL MODELS

A distinction is made between ideal (ground truth) replication, which offers ideal simulations of models without phenomena, probabilistic models (mathematical models), which also take random variables and the distribution of probability into account, and phenomenological models, which include the effects experienced with real sensors. There is also the possibility to construct physical models to calculate physical properties in simulations.

SYSTEMATIC AND AUTOMATED

With simulated environments, complexity is taken to mean the totality of all dependent sensor properties, and corresponding elements, creating comprehensive sets of relationships within the system. It follows that the better the ability of models to include real phenomena, the more difficult it is to replicate those models as digital twins. On the other hand, in actual, recorded situations, there is a direct dependency between fidelity and complexity. With regard to recordings, this means that data have to offer maximum fidelity. But then, only those exact situations are available for re-simulation.

For the SensorTwin project, the Steinbeis team is focusing on an approach aimed at systematically identifying model inaccuracies and applying them to phenomenological models. To do this, the challenges presented by methods applied to future cars will be replicated on an experimental setup with the aim of creating suitable measurement maneuvers. To carry out the testing, an existing 1:8-scale vehicle is being used featuring environmental detection sensor technology, also allowing automated vehicle testing to be performed via scenario-based commands. This experimental setup will first be used to systematically gather labeled data sets. The next step will be to examine how artificial intelligence can be used to support the simulated testing of future vehicle software.

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BENJAMIN BAUR
info@steinbeis-ias.de (author)

SensorTwin project manager
Steinbeis Interagierende Systeme GmbH (Herrenberg)

www.steinbeis.de/en/su/1913
www.interagierende-systeme.de/sensor-twin

WELDED TOGETHER BY A DIAMOND WIRE

STEINBEIS EXPERTS DEVELOP NEW WELDING DEVICE FOR DIAMOND WIRES

To cut hard brittle materials such as silicon, hard metals, sapphires, or even composite materials like circuit boards, it is common to use diamond wire saws. The surfaces of the cutting wires – attached in the form of diamond wire spools – are coated with diamonds, which have to be held in position by a nickel layer. The Steinbeis Innovation Center for Development Technology in Oberndorf am Neckar has been working on diamond wire technology since it was founded in 2009, and has already developed numerous diamond wire saws for its business partners. For one such project, DIASIP, the Steinbeis experts developed a connecting process that made it possible to connect wires with only 0.12 of a millimeter in diameter. The Steinbeis experts continued working on the process, even after project completion in 2015. Their aim was to develop a mobile welding device that would allow to connect wires in a multiwire saw so that you can use the exsiting wire web of a multi-wire saw. And it worked!

Sawing with diamond wire loops offers two key advantages over conventional wire saws based on winding technology: The cutting performance remains uniform, because the wire only moves in one direction, and much higher cutting speeds are possible – up to 50 m/s.

For the Steinbeis experts' project, which aimed to develop a mobile welding device, joints in the wire web would need to deliver a strength of around 3,000 N/mm^2 to be able to continue sawing with the existing wire web. The method makes it possible to use all wire in the wire web, paving the way for a full ROI after 80 days. This is based on a sales price of €100,000 per welding device.

The welding device developed by the Oberndorf Steinbeis experts for diamond wire connecting has nine NC axes and is controlled by a custom-built microprocessor controller unit via an Android tablet. To conduct preliminary testing, the experts controlled the welding device via a unit using programmable logic, but it very quickly became clear that with the extremely fast heat transfer through the thin wire, using this type of controller was too slow.

FROM AN INITIAL IDEA TO A FINISHED PRODUCT

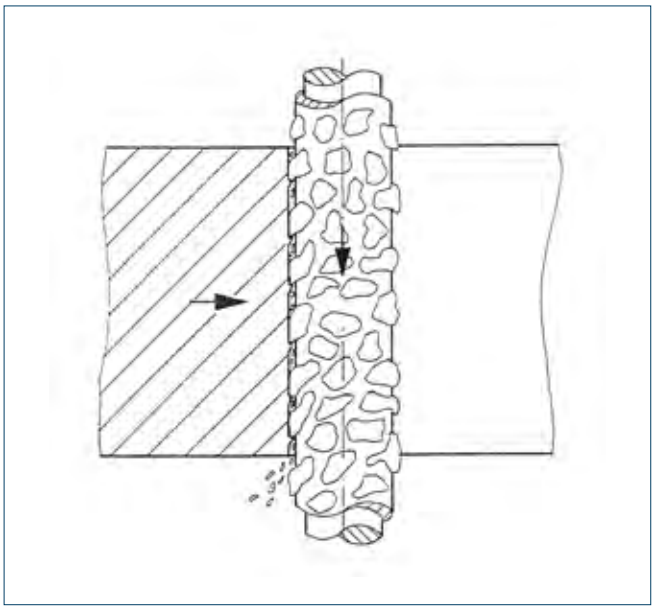
To launch its newly developed welding solution and hold its own against com-

SAWING WITH DIAMOND WIRE SPOOLS OFFERS TWO KEY ADVANTAGES OVER CONVENTIONAL WIRE SAWS BASED ON WINDING TECHNOLOGY

petitors, the Development Technology Steinbeis Innovation Center entered into a partnership with DIDRAS, a spin-off of the Steinbeis enterprise that works on the development and production of diamond wire loops. This partnership works very well for both teams and has already resulted in the development of a CNC diamond wire saw and a straight-cutting machine, both of which are used in a variety of industries, as well as the laboratory sector.

A wire welding device for use in automated welding, heat treatment, and work hardening

Cross-section of a diamond wire



DIAMOND WIRE SAWS AT A GLANCE

Sawing with thin diamond wires is ideal for

- Extremely fragile workpieces that are highly vulnerable to clamping (feed and cutting force < 5N)
- Applications in which edge breakouts need to be avoided, such as tasks involving green compact
- Workpieces that need to be cut from simultaneously hard and soft materials
- Applications involving narrow kerf

DOMINIK VOGEL
dominik.vogel@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Innovation Center:
Development Technology
(Oberndorf)

www.steinbeis.de/en/su/1320

PROF. MATTHIAS VOGEL
info@didras.com (author)

Managing director
DIDRAS GmbH (Oberndorf)

www.didras.com

GO-AHEAD FOR THE SIAT INITIATIVE

STEINBEIS EXPERTS CO-DEVELOP AN INNOVATION AND STAFF TRAINING NETWORK

Innovation and training must go hand in hand – a key factor recognized by a consortium including the Institute for Effective Management, a Steinbeis Consulting Center. Together, the stakeholders want to meet this challenge by working as a network. The project is funded by the Federal Ministry of Labor and Social Affairs to ensure nothing prevents the SIAT Innovation and Training Network getting off to a good start.

The program offers support to companies of all sizes, from all sectors of industry. This enables SIAT to provide companies with targeted help in the individual situations they face. The only limitation is the number of parties that can take part in and thus benefit from the program.

THE GOAL: ENHANCING HR DEVELOPMENT

The consortium, which comprises MAI Carbon (of Composites United), the Institute for Effective Management (a Steinbeis Consulting Center), and The Knowledge Company, has now received funding confirmation from the federal government for the development of a new type of innovation and training network. The three project partners are thus pooling competences in the fields of networking, training and staff development, innovation and HR development, knowledge transformation, and digital learning formats. Together, they have founded SIAT, a shared innovation and training alliance, which has access to an extensive network of partners.

The purpose and goal of the project is to increase the number of companies engaging in innovation and training programs, to improve HR development within companies (especially SMEs), and to significantly reduce the resources required by its members. As network members, companies will be encouraged to organize training by joining forces with other members, as

SIAT IS THE IDEAL FIT FOR MANY COMPANIES IN OUR NETWORK

well as stakeholders in the labor market and continuing education. This should be achieved in such a way that it saves as many resources as possible. "SIAT is the ideal fit for many companies in our network," beams Phillip Scherer of MAI Carbon.

ENHANCED PERFORMANCE FOR LESS MONEY

The idea of SIAT is to bring together companies as members of one and the same network and to enable the different parties to benefit from a shared staff training platform that provides them with access to different service providers in the market – offering cost savings on training programs of up to 50%. "The new digital purchasing platform will allow us to achieve a milestone in assessing offers, and it will also deliver huge cost advantages. The aim is to make it easier for companies in the network to gain access to services, and it should make offers transparent and comparable," says Andreas Renner, Steinbeis Entrepreneur at the Institute for Effective Management.

In addition, SIAT offers specialists in both organizational development and HR development a low-entry opportunity to forge networks and learn from one another. "Accompanying, moderating, and providing all this with the required scientific support is what Steinbeis has stood for for over 40 years, and we're proud to be able to play our part in this fantastic network," explains Steinbeis expert Dr. Philipp Rodrian.

ANDREAS RENNER
andreas.renner@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Consulting Center Institute for Effective Management (Augsburg)

www.steinbeis.de/en/su/2024
www.steinbeis-ifem.de

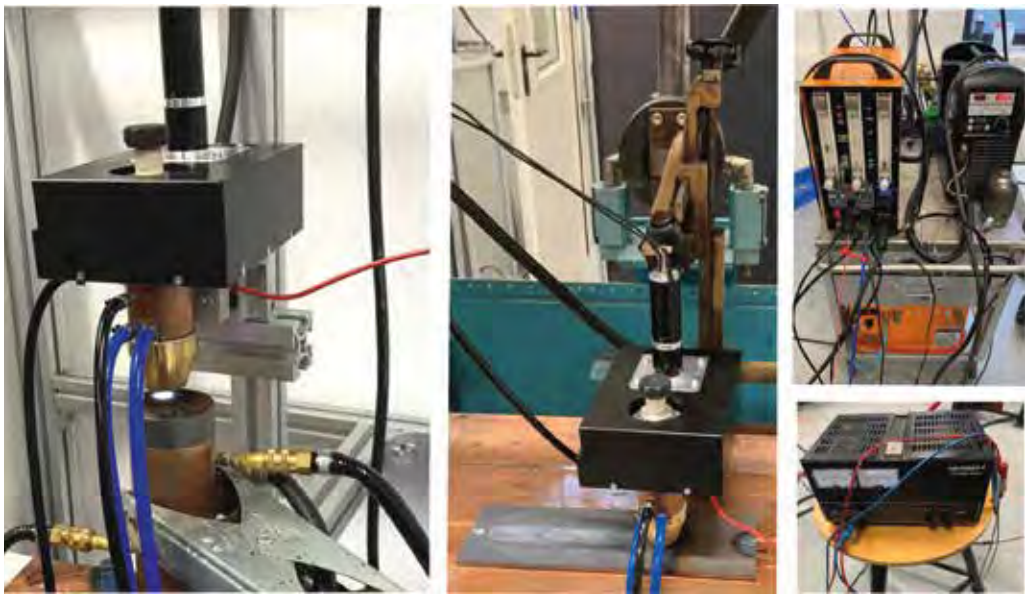
SIAT

SIAT is funded by the Federal Ministry of Labor and Social Affairs under a program called MAI TraiNET, which facilitates the setting up of staff training alliances. The initiative is scheduled to run for three years.

SUCCESS IN ROTATION

STEINBEIS EXPERTS DEVELOP A PLASMA WELDING BURNER USING A MECHANICAL ROTATING LIGHT ARC FOR BONDING AND WELD OVERLAYING

Welding has become an extremely important task, not just for joining traditional materials – such as steel or aluminum – but also for joining different kinds of materials and plastics used in multi-material components. The most common method is arc welding using non-melting electrodes, not only because this technique is highly cost-effective and can be automated, but also because of the high quality of the seams. But welding processes are also subject to increasingly stringent expectations when it comes to productivity and product quality. As a result, Intelligent Functional Materials, Welding and Joining Techniques, Implementation, the Steinbeis Innovation Center in Dresden, joined forces with Autogen-Ritter to design and develop a plasma welding torch that allows arc rotation to be controlled mechanically.

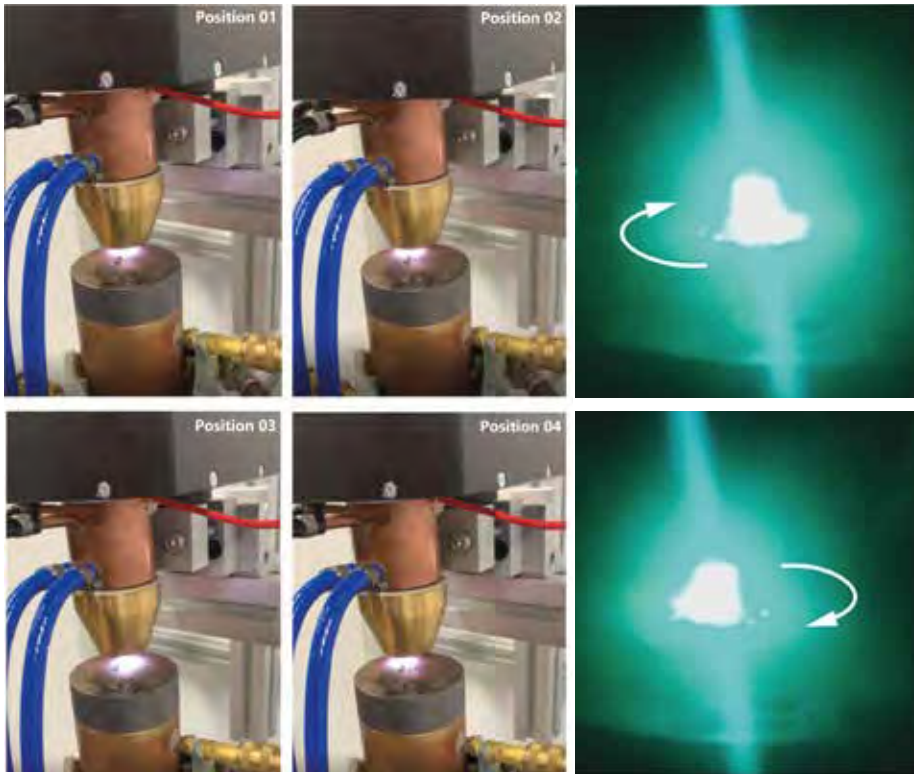


The installed prototype of the mechanically rotating plasma arc welding torch with a rotation and wire feeding unit and hardware

Plasma arc welding is a form of tungsten inert gas (TIG) welding. As such, it offers an interesting alternative to laser welding, especially when used on metal sheets with a thickness of up to 8 millimeters. With plasma welding, the welding arc is constricted by a water-cooled copper nozzle. Not only does this deliver a much more intense pulse of energy, it also makes it possible to alleviate beam divergence. Whereas the diameter of TIG arcs increases rapidly between the electrode and the workpiece, with plasma arcs the diameter only widens marginally. This eliminates the need for time-consuming seam preparation work in order to "bundle" the arc.

In addition, the higher welding speed saves time and money and makes it possible to achieve a greater depth of fusion. Tungsten electrodes also have a much longer service life because they are surrounded by plasma gas, which promotes cooling. The method is used on thin and thick sheets, as well as semi-finished products with metallic coatings. A further potential field of application is repairing and maintaining components. The high power density also supports the welding of metals with good thermal conductivity, such as copper and copper alloys.

Welding processes are subject to continuously intensifying demands: High-



Mechanical rotation of the pilot arc around its own axis: a single-sided beveled cathode (tungsten electrode diameter 2.4 mm) with a pilot current intensity of I = 150 A, plasma gas 2.0 l/min and a distance to the workpiece surface of 7.0 mm

volume production, for example, typically requires highly automated welding processes, especially compared to prototyping and small-scale production; but this also applies to the reworking or repairing of parts in serial production, which are not subject to such high demands in mechanical terms. With such applications, there are a number of ways to derive benefit from the processing advantages of plasma welding.

A PLASMA ARC BURNER WITH MECHANICALLY CONTROLLED LIGHT ARC ROTATION – SAFE AND ECONOMICAL

Experts at Intelligent Functional Materials, Welding and Joining Techniques, Implementation, the Steinbeis Innovation Center based in Dresden, decided to join forces with Autogen-Ritter and take on this challenge as part of an R&D project. Together, they not only developed a plasma welding torch offering mechanically controlled arc rotation, they also established the required process and hardware for seam and build-up welding. The new process technology, including torch technology, also had to be economical in terms of production costs and cycle times. Similarly, it was important that any mutual dependences between the rotation and feed speed on the one hand, and the intensity of the arc energy on the other, delivered the required seam quality during the welding process.

For the first stage of the project, the team drew on an overall process engineering concept to design an intensely cooled plasma arc welding torch with a functionally reliable prototype of a mechanical arc rotation unit. To capture processing data and the process parameters that would be required for the defined burner output of I = 200 A, the experts used a high-speed camera. In order to ensure the mechanical rotation of the plasma welding torch functioned reliably within the process, the researchers also designed an efficient torch cooling and gas supply system. To do this, a water cooling system was designed along with a pump and heat exchanger such that heat generated in the areas around the functional areas of the torch could be safely transferred away during the welding process. The resulting combination of materials and technology was then applied to the design of the welding torch. The plasma and protective gases in the torch head are able to flow without issue, also taking mechanical arc rotation into account to achieve a reliable welding process. The geometries of the torch parts were coupled with the developed arc rotation unit and synchronized in terms of process technology.

This makes it possible to cool the plasma nozzle intensely such that the mechanical arc rotation is achieved without error. As a result, the functional parts of the torch head are subjected to less thermal stress during the welding pro-

Evaluation/validation of the installed burner prototype and the rotation unit: experiments aimed at determining the technical performance limits of the burner prototype

cess and arc rotation. To achieve this, materials that can withstand high temperatures and deliver electrical insulation were fitted between the individual parts, the cooling system, and the power connection. The experts working on the project also developed and designed the documentation required to construct the entire plasma torch head and the mechanical rotation unit. Other elements developed for the project, such as a beveled tungsten electrode, a DC motor, drive elements, plain bearings, a timing belt, and a clamping device for the plasma welding torch, were also coupled in terms of control technology and mechanical interplay. The project also resulted in the development of a feed unit for wire or powder filler materials. In the prototype torch system, this is integrated through the mechanical arc rotation unit.

THE PROTOTYPE MEETS REQUIREMENTS

Testing of the torch prototype not only confirmed that the mechanical arc rotation functioned without error. The torch cooling process worked reliably, as did the in-feed of process gas and filler material. The results also showed that the mechanical rotation of the plasma arc and the high arc temperature gradients

THE EXPERTS WORKING ON THE PROJECT ALSO DEVELOPED AND DESIGNED THE REQUIRED DOCUMENTATION FOR CONSTRUCTING THE ENTIRE PLASMA TORCH HEAD AND THE MECHANICAL ROTATION UNIT

result in a more intense mixing of molten pool and corresponding material particles.

This makes it easier to apply heat more evenly and achieve uniform component cooling. The result: fine-grained microstructure and component properties, in line with quality standards. This was the case with thin and thick sheets, as well as sheets with metallic coatings, depending on the applied process parameters.

When used to weld thin sheets with a maximum thickness of 6.0mm, depending on the type of joint, the mechanically rotating plasma welding torch succeeds in maintaining clearance tolerances, such that uniform seams can be achieved on component surfaces in all kinds of welding positions. The solution also makes it possible to vary component tolerances during the welding process and thus maintain required component tolerances and dimensions. The project team also proved that the newly developed plasma arc, the process technology, and the hardware make it possible to achieve welding speeds of up to 3.0m/min with the required seam quality. The quality of the produced seam show that, equipped with the mechanical rotation unit and based on a torch power of I = 200A, the developed plasma welding torch prototype is suitable for practical application.

THE PROTOTYPE PLASMA ARC WELDING TORCH – TECHNICAL INFORMATION:

- Welding current up to 200A DC
- Working voltage up to 35V
- Tungsten electrode (diam. 2.4mm) beveled on one side at a 30 – 45° angle.
- Rotation of the tungsten electrode/cathode around its own axis (for arc rotation): plasma nozzle diameter 2.3/3.2mm
- Driven by a toothed belt (non-conductive), plain bearing (for example made of plastic)
- Total torch head size: 150 x 100mm (compact design)
- Interchangeable plasma nozzle with an indirect strong water cooling system
- Specially adapted water cooling system with a cooling unit for the rotary unit

PD DR.-ING. HABIL. KHALED ALALUSS
khaled.alaluss@steinbeis.de (author)

Steinbeis Entrepreneur
Steinbeis Innovation Center
Intelligent Functional Materials,
Welding and Joining Techniques,
Implementation (Dresden)

www.steinbeis.de/en/su/1644

DR. JUR. LARS KULKE
lars.kulke@steinbeis.de (author)

Steinbeis Entrepreneurr
Steinbeis Innovation Center
Intelligent Functional Materials,
Welding and Joining Techniques,
Implementation (Dresden)

www.steinbeis.de/en/su/1644

FRIEDEMANN SELL
friedemann.sell@steinbeis.de (author)

Project assistant
Steinbeis Innovation Center
Intelligent Functional Materials,
Welding and Joining Techniques,
Implementation (Dresden)

www.steinbeis.de/en/su/1644

ERICH SCHNAUDER

Managing Director
Autogen-Ritter GmbH
(Feldkirchen-München)

www.autogenritter.com

THOMAS SCHNAUDER
t.schnauder@autogenritter.com

Managing Director
Autogen-Ritter GmbH
(Feldkirchen-München)

www.autogenritter.com

TIMM SCHNAUDER
timm.schnauder@autogenritter.com

Project assistant
Autogen-Ritter GmbH
(Feldkirchen-München)

www.autogenritter.com

"THE BIGGEST THING GENDER EQUALITY REQUIRES IS A SHIFT IN OUR THINKING"

AN INTERVIEW WITH MARTINA SCHMIDT, DIRECTOR OF THE CONTACT POINT FOR WOMEN AND CAREERS IN RAVENSBURG, LAKE CONSTANCE/UPPER SWABIA

Equal treatment for men and women at the workplace – a goal that has still not been achieved in Germany. Like a huge magnifying glass, the current pandemic has done even more to highlight the degree of inequality in the working environment. TRANSFER magazine spoke with Martina Schmidt, director of the Contact Point for Women and Careers in Ravensburg, Lake Constance/Upper Swabia, and asked her about the specific services the unit offers to support women, as well as the fundamental changes in society and politics that would be necessary to change the current situation.

Hello Ms. Schmidt. You head up the Contact Point for Women and Careers. From your experience, what are the biggest challenges faced by women in their professions?

Women face many challenges during their careers. It starts with the fact that even today, it's usually women who step away from work when it's time for children, i.e. they reduce their working hours, and in some cases they even stop working completely and only eventually come back to work on a part-time basis, just so they have enough time for their work with the family – which is unpaid. Of course, this means women not only lose out financially but they also risk having less money in old age, or even facing poverty as senior citizens. Single mothers are particularly badly affected by this.

The team at the advisory center (left to right): Dominique Hoch-Krautter, Katja Enke, Martina Schmidt, and Silke Schrock.

And then there's the fact that women still earn much less than their male counterparts. Many women work in low-wage jobs, such as nursing, whereas many men work in high-salary sectors of industry in technical areas. When women set up companies, they generally attract much less capital than male startups. There are far fewer women in top positions compared to men because they're held back by a glass ceiling. There are still a lot of things that aren't right for us women.

What services can you offer to support women in such circumstances?

Basically, we support women in working out career goals and work alongside them on potential actions and next steps. Each counseling session is tailored to the individual situation the women find themselves in when they seek support. Our aim is to provide comprehensive and neutral advice in an atmosphere of trust in order to identify the most suitable solution on a personal level.

The important topics we cover are career orientation, career progression, career changes, ongoing training, business startups, returning to work, and reconciling the competing priorities of a career and a family. The Contact Point for Women and Careers also organizes events and training, among other things to raise awareness of the issues and challenges I just mentioned, but also to inspire, encourage, and give impetus to women in their professional and personal development. To do this, we work closely with key stakeholders in the local employment market. Everything we do revolves around the needs of our customers and the requirements of business and the labor market.

The current coronavirus pandemic is putting many women at a distinct disadvantage in professional terms. What impact is this having on the services you offer to those affected by the pandemic, and how has that influenced your work?

The coronavirus pandemic revealed the overall situation faced by women, and we find it deeply worrying. Coronavirus works like a magnifying glass when it comes to the level of inequality that already exists between the sexes.

We immediately put our entire services online, the moment the pandemic set in – not just our consulting services but also the events. As a result, within a very short time we succeeded in reaching out to a large number of women in what was a very difficult time. We themed our online events to encourage and empower people. So for example we offered inspiration on "discovering your inner strengths" or workshops such as "times of crisis are times of opportunity." A large number of women made use of the offer, and they were extremely grateful.

We've also developed some made-to-measure services such as a six-week interactive online workshop on "which job makes me happy" for women who want a career change or are forced to change for other reasons, in some cas-

THERE ARE FAR FEWER WOMEN IN TOP POSITIONS COMPARED TO MEN BECAUSE THEY ARE HELD BACK BY A GLASS CEILING

es due to the coronavirus pandemic. The aim of this workshop is for participants to become clearer week by week about what they want and what they can do, so they feel galvanized in taking the next steps.

And then there are topics like networking and gaining visibility in the social media, which were already and still are on the agenda when it comes to helping women connect online. Fortunately our team feels at home with digital technology and is highly adaptable, so that makes it easy for us to adapt quickly to new topics and issues.

You also offers services for – and with – companies. What does that involve, and how strong is the demand from companies?

The idea of our Contact Point for Women and Careers is to provide a port of call for companies committed to equal opportunities, family-friendly working hours, modern HR policies, and a modern corporate culture. Often, the way this translates into practice is that companies approach us with a topic for a joint event, such as "attracting female employees via social media" or specific questions about different ways to set up networks for women, or ways to attract and retain women in IT.

We also help companies find qualified female employees. So on the one hand, that can mean events for companies to introduce themselves, but we also use targeted mailshots to forward job offers through our distribution list, which is pretty extensive. Companies are very happy to make use of our lists.

Time and again we're approached by a company owner looking for a suitable successor – perhaps specifically female – for their company. We also share such inquiries with our network and one or two potential successors have already been found as a result. Last but not least, the Contact Point for Women and Careers was and still is available to companies, as well as the self-employed, or sole-traders with questions about the coronavirus situation.

Thinking about your experience and the things you've witnessed, what needs to change for women and men to participate equally in the world of work?

The biggest thing gender equality needs is a shift in our thinking, which often still revolves around antiquated role models and is also reinforced by the media and advertising. This is where a systemic change is needed; basically this has to start in the parental home. If we want equality at work to become a reality, we should set an example to our children as soon as possible and show them how it works – for example by doing more to share childcare and valuing childcare accordingly.

Also, we women need to do much more to raise our profiles and fight for more visibility; we need to support each other and create positive role models. We need more women to be involved in decision-making processes – at companies and in politics. We can't just wait and hope that the setup will change. We need legal measures, for example a binding equal opportunity target for women. At least until we really achieve parity.

MARTINA SCHMIDT
martina.schmidt@frauundberuf-rv.de (interviewee)

Director
Contact Point for Women and Careers
Ravensburg, Lake Constance/Upper Swabia
(Ravensburg)

www.frauundberuf-rv.de

The Contact Point for Women and Careers in Ravensburg, Lake Constance/Upper Swabia is part of a state program called Contact Points for Women and Careers in Baden-Wuerttemberg. It is funded by the State of Baden-Wuerttemberg through the Ministry of Economics, Labor, and Tourism. On a local level, the center is backed by the Ravensburg ecomomic development and innovation agency (Wirtschafts- und Innovationsförderungsgesellschaft Landkreis Ravensburg).

OBITUARY: HONORARY SENATOR JOSEF PFEFFER

Steinbeis mourns the death of honorary Senator Josef Pfeffer, who passed away on September 25, 2021 at the age of 83. From 1985 to 2004, he accompanied the Steinbeis Network as honorary Deputy Chairman of the Steinbeis Foundation Board.

Josef Pfeffer was an entrepreneur through and through, not only in his highly successful career at the helm of technology companies and their alliance networks, but especially in his numerous voluntary and social ventures. Everything he undertook was approached with an air of reliability and commitment, marked by a brand of modesty that initially concealed his extensive competence and extraordinary success. Anyone who ever met Josef Pfeffer, and especially worked with him, sensed that he never felt he was the important person – the person opposite him was important. They also very quickly noticed his extraordinary perceptive powers and his extensive problem-solving abilities.

In 1985, Josef Pfeffer was elected honorary Vice Chairman of the Steinbeis Foundation for Economic Development. This was preceded by a meeting with the then full-time Chairman of the Board and government commissioner for technology transfer in Baden-Wuerttemberg, who at the time had been in office for two years. This led to his proposed election to the board and a long-standing partnership of synergies.

As a member of the board of directors, Josef Pfeffer mostly worked in the background, but did so extremely successfully and, wholly committed to the Steinbeis model, always remained loyal to people supporting Steinbeis – especially under difficult circumstances. He also supported the establishment of a full-time board and was always an enthusiastic and valuable Steinbeiser – even after stepping down from the board.

Josef Pfeffer will be sorely missed. Our deepest condolences go to his family.

Prof. Dr. Dr. h. c. mult. Johann Löhn
Chairman of the Steinbeis Foundation Board (1983 – 2004) | Government Commissioner for Technology Transfer (1983 – 2006) | Honorary Trustee of the Steinbeis Foundation

Prof. Dr. Michael Auer
Manfred Mattulat
Steinbeis Foundation Board of Directors

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NEW RELEASES FROM STEINBEIS-EDITION

Sharing our know-how with you.
Steinbeis-Edition, the publishing arm of the Steinbeis Foundation, regularly publishes works reflecting the scope of the Steinbeis Network's expertise. Spanning a broad spectrum of topics, these publications include individual papers, series, magazines, conference proceedings, and works linked to specialist events. All titles can easily be ordered via the online shop at: www.steinbeis-edition.de.

YVONNE HÜBNER
edition@steinbeis.de

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MEDIATION – QUARTER IV EDITION, 2021

→ **WWW.STEINBEIS.DE/EN/SU/941**

RESILIENCE – STRONG IN TIMES OF CRISIS
GERNOT BARTH (ED.)

When people talk about resilience, it's always within the future context of individuals and organizations. To consciously shape the future, you first need to consider available resources. In systemic terms, any system has access to resources in order to solve its problems. It's important to determine the nature of these assets and means – often requiring intensive work with third-party consultants. And as Nietzsche once pointed out, "the past bites the tail of everything that is to come". In other words, being clear about the past not only enables you to be aware of your level of resources, it also helps you to clarify obstacles.

In times of particular uncertainty, i.e. during times of transformation in society but also during change processes within organizations, there seems to be a good way forward: In a world undergoing change, effect change yourself by drawing on the secure foundation of your own strengths. Paraphrasing a quote from psychologist Viktor Frankl, one could say that if you understand the meaning of your undertakings, "this consciousness helps you more than anything else to overcome external difficulties and internal disorders."

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QUALIFICATIONS FRAMEWORK ENGINEERING AND MANAGEMENT

→ **WWW.STEINBEIS.DE/EN/SU/273**

INTERNATIONAL COUNCIL OF ACADEMIC DEPARTMENTS IN ENGINEERING AND MANAGEMENT (FFBT WI E. V.), GERMAN ASSOCIATION FOR ENGINEERING MANAGEMENT (VWI E. V.) (EDS.)

The Qualifications Framework for Engineering and Management serves as a set of guidelines and a quality assurance instrument. The framework establishes minimum standards that must be fulfilled in the framework of a degree program in Engineering and Management at both universities of applied sciences and universities in German-speaking countries. It is intended to provide orientation when conceptualizing and further developing the curriculum in these programs.

The purpose of setting detailed minimum standards for the weighing of academic content serves to differentiate these programs from other similar academic programs. It is also intended to ensure that a completed degree in the interdisciplinary field of Engineering and Management is a prestigious seal of approval that offers graduates excellent career opportunities.

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PRIVATE INFORMATION PRODUCTION AND BANK LENDING

→ WWW.STEINBEIS.DE/EN/SU/1477

RALF KELLER

When granting loans, interaction surrounding information – or how it is prepared – plays a decisive role. All lenders have a strong interest in assessing opportunities and threats before making an investment. To conduct such assessments – which can always be flawed – information is needed.

However, this means that the success of an investor depends, among other things, on the information they have access to, because this forms the basis of decisions regarding whether it is worthwhile providing a project, concept, or enterprise company with capital. The subject of this paper is a theoretical investigation of this issue.

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CONSOLIDATED PROCEEDINGS OF THE FIRST ECSCI WORKSHOP ON CRITICAL INFRASTRUCTURE PROTECTION

→ WWW.STEINBEIS.DE/EN/SU/1167

VIRTUAL WORKSHOP, JUNE 24–25, 2020

HABTAMU ABIE, DAVIDE FERRARIO, ERNESTO TROIANO ET AL.

Modern critical infrastructures ("critical entities" in the terminology of the new EU-CER Directive) are becoming increasingly complex, turning into distributed, large-scale cyber-physical systems. Cyber-physical attacks are increasing in number, scope, and sophistication, making it difficult to predict their total impact. Thus, addressing cyber security and physical security separately is no longer effective, but more integrated approaches, that consider both physical security risks and cyber security risks, along with their interrelationships, interactions and cascading effects, are needed to face the challenge of combined cyber-physical attacks. To face them successfully, aligned and integrated responses are needed, and this workshop has provided a great opportunity to do it: aligning and integrating not only the positions of single projects but also of many intended users of their results.

This workshop presented the different approaches on integrated (i.e., cyber and physical) security in seven different industrial sectors, such as finance, healthcare, energy, air transport, communications, industrial plants, gas, and water.

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JOB LOVE

→ WWW.STEINBEIS.DE/EN/SU/1462

AN EMPIRICAL ANALYSIS OF THE CONCEPT OF LOVE FOR A JOB, ITS MEASUREMENT AND ITS ANTECEDENTS

VIKTORIA RITTER

The ongoing competition for talented and highly skilled workers has forced companies to think harder about how to attract and retain highly skilled employees. While research in employer-employee relationships has primarily focused on characteristics such as employee retention, commitment, and happiness, one driving force of interpersonal relationships has been largely overlooked: love. People aspire to more than just a job to earn a living, and many long for work that fulfills them and gives them meaning, work they can love. Yet we still do not know what it means to love a job.

Therefore, this dissertation attempts to clarify the question of what loving a job means. It also introduces the Job Love Scale (JLS), which provides an easy-to-use measurement concept. Furthermore, this dissertation identifies the key drivers of job love and provides recommendations for companies on what they can do to foster job love among their employees.

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LEADERSHIP – TRANSDISCIPLINARY WRITINGS

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DEDICATED TO PROF. DR. DR. H.C. WERNER G. FAIX ON THE OCCASION OF HIS 70TH BIRTHDAY

STEFANIE KISGEN (ED.)

Werner G. Faix is deeply rooted in Württemberg in Southern Germany as well as at home in the world. With an academic background in chemistry, his profound work on today's most relevant social issues has become highly influential and widely acclaimed. He is a well-known and much sought-after visionary, both nationally and internationally. His thinking is often far ahead of its time; he goes beyond well-trodden paths to seek transdisciplinary networks, always with an eye for the big picture. Faix simultaneously takes exciting new, and at the same time, well-founded positions on fundamental questions such as leadership, leadership education, and personality. Likewise, a major focus of his work involves innovations and their transfer to the real world, in order to shape a sustainable and viable future. He is a role model not only in his academic work, but also in his own entrepreneurial as well as deeply human actions.

With this publication, the editor, together with numerous renowned authors, wish to honor Werner G. Faix as an outstanding scholar, entrepreneur, and leadership personality of international standing. They congratulate him on his 70th birthday with their transdisciplinary contributions on leadership – contributions that can only approach the work, impact, and reputation that Werner G. Faix has achieved.

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THE STEINBEIS INNOVATION STUDY

→ WWW.STEINBEIS.DE/EN/SU/1249

(2ND FULLY REVISED, UPDATED, AND EXPANDED EDITION)

CLAUS-CHRISTIAN CARBON, WERNER G. FAIX, STEFANIE KISGEN, JENS MERGENTHALER, FABIAN MURALTER, ALISA SCHWINN, LIANE WINDISCH

Since time immemorial, innovations have not only led to new and creative solutions, but also to fundamental turning points in the history of mankind. But never before has the call for new thinking and radical innovation been so loud in our world as it is today – in a fast-moving world marked by complexity in all areas of life. The result is permanent change, on both a national and global level. This results not only in numerous challenges, but also particularly in significant opportunities to achieve further progress, undergo revolutionary developments, and move humanity forward as a whole.

Innovation has long since ceased to be a "nice to have" and is now indispensable for economic success, social stability, and the preservation of our natural habitat. This paper revolves around an analysis of a selection of economies (Germany, Switzerland, the United States, China, and Brazil), examining the extent to which they are able and willing to secure and build on current competitiveness and future sustainability – especially by exploiting radical or disruptive innovation.

The Steinbeis Innovation Study was conducted under the auspices of the School of International Business and Entrepreneurship in close cooperation with the Chair of General Psychology and Methodology at the University of Bamberg. The successful partnership between the two organizations is also reflected in the establishment of a joint research project in the field of innovation leadership, playing a decisive role in shaping the term, and aiming to unleash considerable potential to innovate through leadership.

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DF&C – MAGAZINE FOR #DIGITAL #FINANCE & #CONTROLLING

ISSUE 2/2021 – DIGITAL CONTROLLING COMPETENCE

STEINBEIS TRANSFER INSTITUTE: BUSINESS INTELLIGENCE (HRSG.) → **WWW.STEINBEIS.DE/EN/SU/2390**

The focal topic of this second issue in 2021 is digital controlling competence and the impact of digitech on finance and management accounting. Topics include "The Controller of the Future", "The Future of Controlling", "The KPI Illusion", and "RPA in Controlling".

The business practice section looks at "Feature-Based Forecasting", "Data Culture", and "Modern Reporting Solutions". In the Innovation section, there is also a feature on using startup solutions to boost competitiveness and an interview with Kaufland board of management member Pierre Schalbe on the challenges posed by digital transformation on the CFO function.

DF&C is the official members' magazine of the XING CONTROLLING Community (approx. 44,000 members).

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INN-BALANCE GUIDEBOOK

IMPROVEMENT OF BALANCE OF PLANT COMPONENTS FOR PEM BASED AUTOMOTIVE FUEL CELL SYSTEMS

PAUL HAERING ET AL.

Fuel cells are a mature technology ready for scale-up in the automotive market. It is now about driving manufacturing forward by reducing production costs, while increasing the overall efficiency and reliability of fuel cell components and systems. INN-BALANCE is an EU project funded by the Fuel Cells and Hydrogen 2 Joint Undertaking tackling this question. INN-BALANCE focuses on the improvement of Balance of Plant (BoP) components for automotive fuel cell systems through design optimisation, testing of innovative components and modules, and the assembly and testing of the complete fuel cell system under laboratory and automotive conditions. Nine partners from five countries are involved in the project.

This guidebook presents the main project activities and results generated during the project. It also contains an overview of the current market for hydrogen vehicles in Europe and provides an outlook to future challenges in this field. The main target groups of this document are vehicles OEMs and their suppliers, fuel cell integrators and manufacturers, BoP manufacturers, research institutions, and public authorities.

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THE ROLE OF LENDING IN CORPORATE BANKING

EMPIRICAL EVIDENCE AND IMPLICATIONS FOR VALUE-BASED LOAN PRICING AND BANK MANAGEMENT

CHRISTOPHER CHARLES MEADOWCROFT

Corporate banking is often associated with lending. While the lending business does generally constitute a major part of the revenues of corporate banks, increased capital requirements combined with often saturated markets continue to challenge the profitability of corporate lending for banks. Under the paradigm of value-based management, firms should price products such that they increase or at least conserve the value of the firm (which includes covering the cost of capital). From a bank's perspective this is especially vital for capital intensive lines of business such as corporate lending. At the same time, the impact which lending has on the overall possibility to generate value in corporate banking should be understood. In this work, the hypothesis that lending serves as an anchor product which facilitates cross-selling is empirically examined. In addition, possible implications for value-based loan pricing are discussed.

PREVIEW

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Feature topic
Standing Strong Together – Network Partnerships that Add Value
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Networks – whether private or professional – are becoming increasingly important and it's not uncommon for them to be described as one of the most important ingredients of success. Attempt to define what constitutes a network and you will find numerous potential explanations, which all have one thing in common: Networks are always about links between multiple elements. With people, just as much as companies, this link is formed by shared views and interests. But how and in what way exactly can the stakeholders of networks benefit from their affiliation? And what conditions must be met for a partnership to be successful? The next issue of TRANSFER magazine will look more closely at the underlying idea behind networks and the challenges they pose.

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EDITOR
Steinbeis GmbH & Co. KG für Technologietransfer
Adornostr. 8 | 70599 Stuttgart | Germany
Phone: +49 711 1839-5 | E-mail: stw@steinbeis.de
Internet: transfermagazin.steinbeis.de | www.steinbeis.de

EDITOR-IN-CHIEF
Anja Reinhardt
Adornostr. 8 | 70599 Stuttgart | Germany
anja.reinhardt@steinbeis.de

EDITORIAL COORDINATORS
Anja Reinhardt, Marina Tyurmina, Luisa Dietrich
E-mail: transfermagazin@stw.de

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