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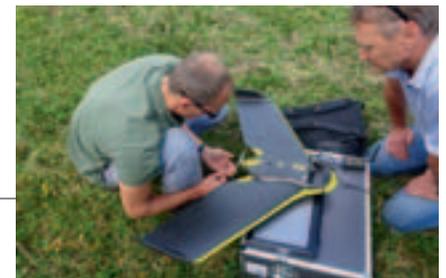
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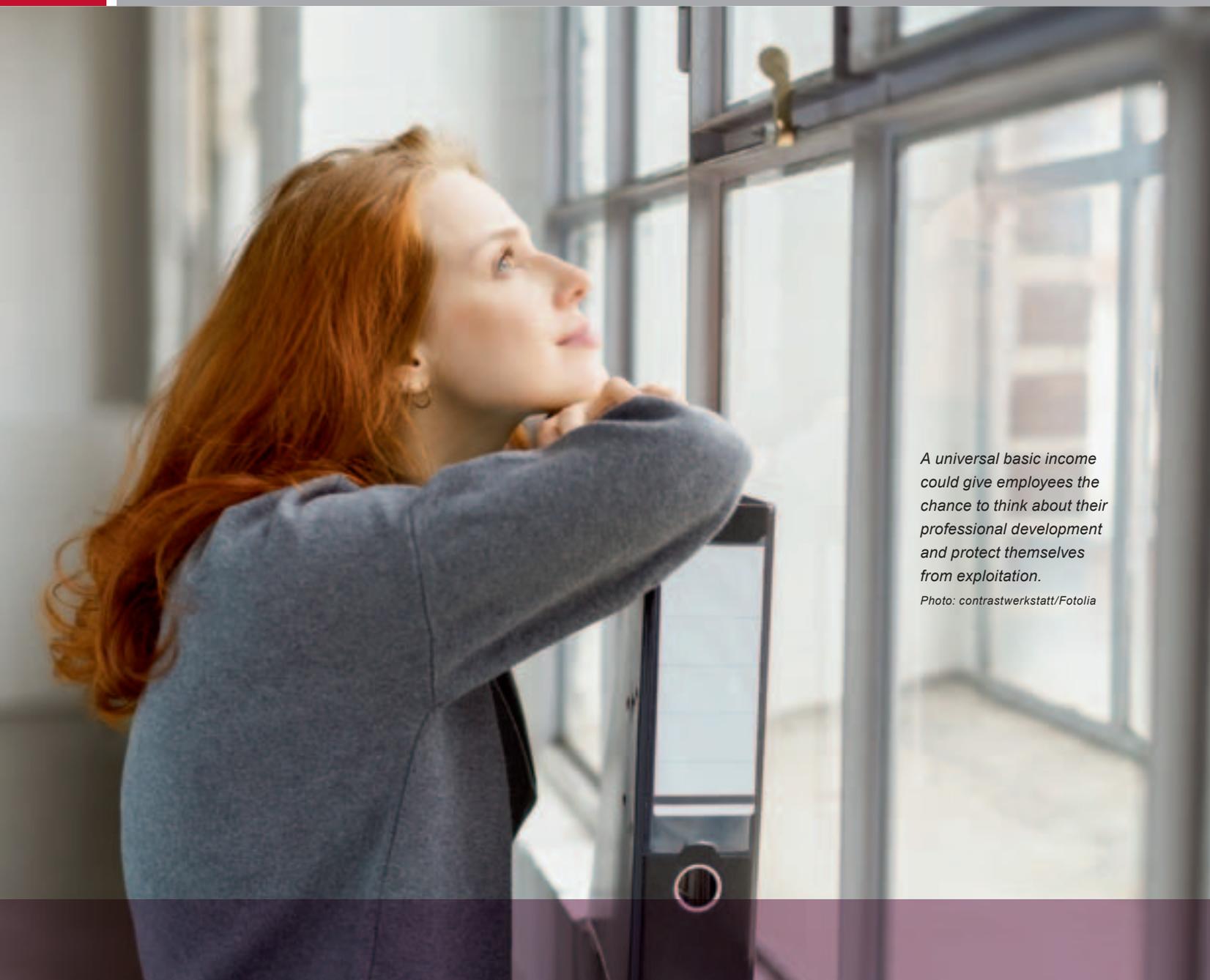
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*A universal basic income could give employees the chance to think about their professional development and protect themselves from exploitation.*

*Photo: contrastwerkstatt/Fotolia*

# A Model for Human Dignity

Karl Justus Bernhard Neumärker's research suggests that a universal basic income would have a chance in Germany

*by Rimma Gerenstein*



What would you do if you didn't have to worry about earning a living?" A roughly 30-year-old man stares fixedly into the camera. The corners of his mouth turn up in a smile: "I'm Micha from Berlin, and that's exactly what I'm trying to find out for myself." Micha, or more precisely Michael Bohmeyer, looks like a typical hipster from Friedrichshain or Kreuzberg, with a trendy distressed t-shirt, turquoise pants, and casually tousled blond hair. Walking down the streets of his neighborhood, lined with blooming trees and well-kept old buildings, he talks about his new life. His plan was originally to rest up and just be lazy, he says, but now he feels a great urge to get up and do things: "I feel free and relaxed, my head is full of business ideas, I do volunteer work, have become a better father, and lead a more healthy lifestyle."

Bohmeyer founded an association called "Mein Grundeinkommen" ("My Basic Income") in 2014 as a means of testing out the "society of tomorrow." The association collects donations on a website. As soon as 12,000 euros are raised, they are raffled off and given away. The recipient gets 12,000 euros for twelve months free from stress and worries. To date, the association has funded 94 basic incomes via crowdfunding and is now collecting for number 95.

### No Questions, No Requirements

Universal basic income (UBI) is only the topic of a private initiative in Germany, but in other European countries it is already being negotiated at the state level: Switzerland held a referendum on the issue in 2016, and Finland began testing several variants of UBI in 2017. The Federal Republic should also take the plunge, argues Prof. Dr. Karl Justus Bernhard Neumärker: "If there's a country that can afford to introduce UBI, it's Germany. Our state has a large amount of assets at its disposal, and our concept of social market economy at least provides us with the right intellectual basis for it."

Neumärker heads the Department of Economic Policy and Theory of Economic Order at the

University of Freiburg. He is regarded as something of a rare bird by colleagues in his field in Germany – topics like "social justice" or "social participation" are not exactly at the top of the list of research interests for economists. "When I predicted ten years ago at a conference that even democracies would soon call for caps on managers' salaries and for the introduction of a minimum wage, I was practically driven out the of the place," he remembers with a laugh.

**“There is evidently not only the argument of efficiency but also that of fairness.”**

Neumärker thinks UBI would have a real chance. Even more, he sees it as a potential solution to future challenges that will bring about sweeping changes in the labor market, such as increasing digitalization and robotization: "It is unrealistic to expect that we will be able to find enough new work for the many people who will lose their jobs. After all, the purpose of developing humanoid robots is to replace human workers, not – as in the first digital wave – to make the work easier for them."

At the moment, Neumärker is conducting studies on the ways in which individuals with a UBI spend their time in comparison to those receiving benefits from state welfare programs like Germany's so-called Hartz IV, on the decoupling of work and payment, and on the UBI as a mechanism for reducing competition-induced forms of discrimination – such as that of women. The results of his research indicate that UBI could serve as a foundation for justice and social peace and guarantee both in the long term. The researcher sees it as a model for human dignity: "It would no longer be possible to exploit people who work in the low-pay sector, for example. If your boss tried to introduce another pay cut, you could just quit and think in peace about how to best continue your professional development." However, Neumärker stresses that this would only work if the UBI were high enough. The

amount currently under discussion in Germany is 1000 euros a month.

### A Veil of Ignorance

The economist refers to his approach as “new ordoliberalism.” This places it in the tradition of the “Freiburg School,” which saw regulatory policy as the precondition for a functioning society. To state the idea in simplified terms, a strong state maintains a constant level of competition in the economy, thus guaranteeing its citizens freedom and stability. Neumärker adds a new component to this theory: social justice. He is interested in questions that have been largely disregarded up to now: What criteria does a society apply in distributing its wealth, what conditions lead political and economic actors to reassess their behavior, and when should something be regarded as fair or unfair?

The “social contract lab” is an experimental laboratory in which Neumärker has test subjects negotiate new social orders. The “lab” consists of a lecture hall, computers for chatting, and a lot

of dividing walls, because anonymity is key. The participants have the task of negotiating the basic rules for society, but they do not know where they will later stand in the order they have established.

“A large majority of the test subjects always allowed themselves to be led behind the veil of this ignorance when questions of social justice were on the table,” reports Neumärker. “They selected models that incorporate a UBI rather than the classical market economy model, in which income level is determined by productivity. There is evidently not only the argument of efficiency but also that of fairness.” In other words, it was important for the test subjects to first ensure that all members of society enjoyed a consistent level of security. Only then were they also prepared to accept low wages.

### Old Model, New Arguments

But what is the price of fairness? In other words, what consequences would it have for the gross domestic product if everyone were provided with a basic income as a gift from birth? This would be a horror scenario for advocates of classical competitive society, who warn that a UBI would lull people into a state of chronic laziness. If one believes the beaming faces on the “Mein Grundeinkommen” website, however, the opposite appears to be the case. The winners of a basic income have been transformed into veritable workhorses: Judy can finally put all her energy into running her ice cream parlor, because she has paid off the loan she took out to open it. Hildegard has realized a lifelong dream and staged a play. Christoph has quit his job at a call center and started studying to become a kindergarten teacher. So what is realistic?

Neumärker is investigating how people with a UBI organize and spend their time. He and a doctoral student are developing a formula that adds new factors to the common work–life model. In its current form, this model only takes account of the time in which an individual works – that is, earns money – and the time in which he or she does not work and is therefore unproductive. There is no place in this binary formula for volunteer work or hobbies. Neumärker is now adding factors like volunteering, leisure, and creativity to the model.



*The increasing digitalization and robotization will bring about sweeping changes in the labor market. Karl Justus Bernhard Neumärker thinks it is unrealistic to believe that it will be possible to find paid jobs for the many laid-off workers.*

*Photo: Nataliya Hora/Fotolia*



*More time to relax? The researchers at the Department of Economic Policy and Theory of Economic Order are studying how people would spend their time if they had a guaranteed basic income. To do so, they are adding new factors to the common work–life model, such as volunteering, leisure, and creativity. Photo: Syda Productions/Fotolia*

“The model could be used to calculate the actual effects a lump payment would have on people’s behavior and the behavior they would exhibit under various conditions.” Although the researcher does not yet have conclusive results, he is convinced that a UBI would motivate people to make different use of their time, that most scarce of all resources. “That’s the theoretical regulatory policy issue underpinning my research: What if it were not just the rich ‘leisure class’ that could afford to work less and enjoy more free time but also, for instance, employees from the low wage sector? That would lead to a real redistribution of free time and enable everyone to participate in social life.”

### Experimentation Is Permitted

The idea of a UBI is not new in Germany: A representative survey conducted by a large German cashback website in 2017 found that 73 percent of all Germans have heard of UBI and 75 percent wish one would be introduced. In addition, German politicians of various leanings have been discussing the idea for decades, and several variants have been suggested by the CDU, the FDP, the Greens, and the Left. “Our constitution already allows for the introduction of a UBI as an element of the welfare state today, and experimentation is also permitted,” Neumärker emphasizes. That’s where he sees the key to success: “We need to test different variants of UBI to determine which model succeeds in becoming accepted. It’s not a matter of taking a gamble, however, but of being realistic and involving the people in the process.”

There is much to learn from the attempts in Switzerland and Finland, because neither of them were particularly successful. The Swiss

wanted too much at once: The state set the UBI at the equivalent of 2,250 euros, and in the referendum it was only possible to vote yes or no. “The sum was too high even for the Swiss. They were afraid it wouldn’t be possible to pay for it in the long run and thus rejected the UBI.” The Finns, on the other hand, were interested above all in lowering the country’s long-term unemployment figures, Neumärker suspects, and therefore provided incomes of 650 euros a month exclusively for unemployed people. However, this approach contradicts the basic idea of UBI. Even so, Finland’s attempt at implementing the concept points the way to the future: “We shouldn’t forget that Finland is already much farther along with digitalization than Germany,” says Neumärker, and the consequences this development will have on the labor market are already visible there. “In the long run, a UBI would give us a means of dealing with them where Hartz IV fails, because in a world in which human workers are being replaced by machines, even the best and fairest initial and further training can only get a few of them off the unemployment rolls.”

[www.pr.uni-freiburg.de/go/grundeinkommen](http://www.pr.uni-freiburg.de/go/grundeinkommen)

### Further Reading

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**Prof. Dr. Karl Justus Bernhard Neumärker** has served as professor of economic policy and theory of economic order at the University of Freiburg since 2004. After completing a degree in economics at the University of Hohenheim, he wrote his doctoral dissertation and habilitation thesis at the University of Bochum. Neumärker’s international professional experience includes stints in Leicester, England; Santa Barbara, USA; Mexico City, Mexico; and Sofia, Bulgaria. His research interests are regulatory policy, constitutional economics and social contract studies, the politics of economic reforms, the economics of social justice, and power and conflict economics.

*Photo: private*

# Who's Afraid of Vampire Flu?

A newly discovered virus in bats is not transmittable to humans

by Jürgen Schickinger

*Bats are regarded as hosts for infectious diseases that can be dangerous for humans.*

*Photo: Juan Cruzado Cortés*



**“Zoonoses are infections that can be transmitted to humans from animals.”**

**B**ats are great,” finds Prof. Dr. Martin Schwemmler. The nocturnal flyers helped the researcher from the Freiburg University Medical Center’s Institute of Virology to achieve a scientific breakthrough, but that’s not the only reason he likes them. In fact, they are bound by a relationship in which both sides benefit: Schwemmler’s research cleared bats of a nasty suspicion. They are not responsible for transmitting a “vampire flu,” contrary to a claim advanced by the German newspaper *Bild*. “Bats carry a number of viruses and can transmit them to humans,” says the virologist. These include rabies, mumps, Ebola, and severe acute respiratory syndrome (SARS). The announcement that American researchers had discovered a new pathogen in bats that is similar to flu viruses therefore caused a great stir. But Schwemmler succeeded where his American colleagues had failed: He and his team managed to produce and study functional bat flu viruses. While it is true that the viruses can infect human cells, says the researcher, “it is extremely unlikely that they could become dangerous for humans.” Now he is investigating H18N11, as the virus is called, for zoonoses.

#### **Tick and Mosquito Bites**

“Zoonoses are infections that can be transmitted to humans from animals,” explains Schwemmler. There are more than 200 known zoonoses. Two that are familiar in Southern Germany are Lyme disease and tick-borne encephalitis (TBE), both of which are transmitted to humans by infected ticks. Others that are common in the tropics include malaria and yellow fever. They are transmitted by mosquito bites. The swine flu, which spread throughout the world in 2009 and 2010, even bears its origin in its name. “The vast majority of the pathogens responsible for human viral diseases

derive originally from animals,” the Freiburg virologist estimates. In pigs and bats, which only seldom bite humans, the infectious contact occurs via excreta, says the expert. Bats, whose viruses he is studying, eat fruit, but they are unhygienic and leave waste matter on it. A human who comes along later and eats the fruit could contract a “vampire flu” – assuming that there is such a thing.

#### **Does the Virus Exist at All?**

Bats are regarded as reservoirs, long-term hosts for infectious diseases that can be dangerous for humans. Experts have succeeded in tracing quite a few different diseases back to bats – but not flu. Schwemmler is concentrating his efforts especially on pathogens of the genus influenza virus A. They are responsible for catastrophic pandemics like the Spanish flu of 1918–1919 and the Hong Kong flu, which raged from 1968 to 1970. Since influenza A viruses often mutate and can exchange genetic material with each other, they change very quickly. It is therefore necessary to develop a new vaccine each flu season. The various strains of the influenza A virus are named according to the types of two proteins present in them, hemagglutinin (H) and neuraminidase (N). The virus that caused the Spanish flu, for instance, was from the H1N1 strain, while that responsible for the Hong Kong flu belonged to the H3N2 strain.

Until 2012 it was believed that all influenza A viruses originated in wild birds. But then researchers from the US Centers for Disease Control and Prevention (CDC) detected the genome of a new virus in bats. Its genome consists of RNA, the same material as in the influenza A virus. It contains eight segments, as is typical of influenza A viruses, it has the right size, and it



*Getting to the source of the disease:  
Scientists are studying infectious bat influenza  
viruses in the lab. Photo: Martin Schwemmler*

includes genes for H and N, namely the variants H18 and N11. “The virus is clearly similar to influenza A viruses but is different,” says Schwemmler. One significant difference is that the bat virus does not bind to sialic acid. This molecule is present on the surface of human cells. It is the docking site for the H protein of influenza A viruses. The pathogens latch onto the cells they infect via sialic acids.

But what does H18 from the flu-like bat virus bind to? To find out, the researchers from CDC attempted to isolate the virus from bat cells – in vain. They attempted to produce it from genetic material in a test tube – in vain. “The scientists were suddenly presented with the question of whether the virus existed at all or was just a phantom,” reports Schwemmler. Without a concrete virus to point to, they were incapable of answering the most important questions: Can humans

**“No one needs to  
be afraid of bats.”**

be infected with H18N11? Does the “vampire flu” described in *Bild* present a real danger? Schwemmler was very interested in answering these questions, and the well-connected virologist also believed he knew an indirect means of obtaining a functional virus.

#### **Artificial Virus Lights Up Green**

Schwemmler had the virus genome sent to him and contacted Dr. Gert Zimmer from the University of Bern. The Swiss virologist had developed a system in which viruses light up green when they infect cells. However, the system was designed to work with another virus, vesicular stomatitis virus (VSV). Schwemmler and Zimmer adapted the system and fit the anchoring protein H18 from the bat virus into VSV. Then they tested their artificial virus VSV-H18 with many cells of different origins. Most of the time it remained dark, but several of the bat cells made it light up a delicate pale green. The cultures with particular cells from dogs shined brightest, but several cultures with human cells also began to glow. This was proof that it is fundamentally possible for humans to be infected.

But can the virus make the jump to humans in nature as well? How great is the danger of this happening? “Only a functioning virus could provide the answer,” says Schwemmler, and so the Freiburg researchers also went about attempting to reconstruct the bat flu virus H18N11 from the available genetic material. They enjoyed a crucial advantage over their American colleagues: H18N11 reproduced rapidly in the dog cells that had been

so easy to infect. Only a few weeks later, the team had succeeded in reconstructing the virus. Schwemmler and Prof. Dr. Martin Beer, director of the Friedrich Löffler Institute in Greifswald, are currently studying H18N11 with ferrets: "They have similar flu symptoms as humans and can also pass on viruses by sneezing." Ferrets thus provide a good picture of how an epidemic would spread among humans. In addition, Schwemmler is testing the probability of such a scenario together with his Freiburg colleague Prof. Peter Staeheli, who has developed a mouse system for determining zoonosis potential.

### The Right Docking Site

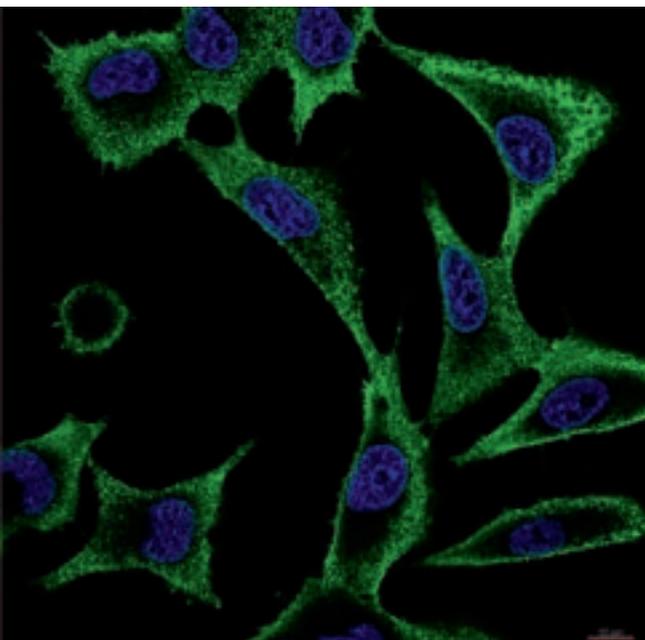
Schwemmler has found out quite a few things about H18N11, for instance that the virus does not exchange any gene sequences with influenza A viruses: "It can't get any worse." But the researcher wants to learn more: Why hasn't it

been possible so far to isolate H18N11 from bat cells? What surface molecule does it bind to on human cells? Does this receptor also play a part in the transmission of other zoonoses? Would it be a worthwhile target for vaccines? "Identifying the docking site would be like hitting the jackpot," says Schwemmler. Time is short: "The newcomer H18N11 is spreading fast in the world of virus research – faster than you can look." Thus, if a feverish "vampire flu" is really catching, it's probably only among the virologists themselves. Schwemmler emphasizes again that the health risk posed by H18N11 is very low. He also comes to the defense of the carriers: "No one needs to be afraid of bats. Just avoid choosing a bat cave as a place to have a picnic."

[www.pr.uni-freiburg.de/go/schwemmler](http://www.pr.uni-freiburg.de/go/schwemmler)

*Human cells infected with influenza viruses (green).  
The blue patches are the nuclei of the infected cells.*

*Image: Martin Schwemmler*



**Prof. Dr. Martin Schwemmler** studied biology at the University of Freiburg and completed his PhD in 1992. His doctoral dissertation focused on cell biology and virology. These were also the areas he concentrated on while conducting research in California, USA, and in Switzerland. He earned his habilitation qualification in molecular virology at the Freiburg University Medical Center in 2000. He returned to the Institute of Virology of the same institution in 2003, where he has since studied Borna disease virus, flu viruses, and zoonoses with a team of ten researchers. Schwemmler sits on the editorial board of several journals and on the board of directors of the Spemann Graduate School of Biology and Medicine (SGBM). *Photo: private*

### Further Reading

Moreira, É. A. / Locher, S. / Kolesnikova, L., et al. (2016): Synthetically derived bat influenza A-like viruses reveal a cell type – but not species-specific tropism. In: *Proceedings of the National Academy of Sciences* 113/45, pp. 12797–12802. doi: 10.1073/pnas.1608821113

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# All at the Same Time

University of Freiburg psychologists are searching for strategies to facilitate multitasking

by Mathilde Bessert-Nettelbeck

She's already on her second cup of coffee and still hasn't written a single line. Lea's research paper waits patiently to be written, buried under a slew of other windows on her virtual desktop, but first she has to check her email and print out a text for this afternoon's seminar. While the printer is working, she does the paperwork for the Erasmus exchange she's applying for and tries at the same time to arrange the next meeting for her study group – her smartphone vibrates constantly, because Fred and Nina can't agree on a time for the meeting. Lea sends a text message: "Should we put it off until tomorrow?" The phone keeps vibrating as she calls up the window with her research paper and begins to type.

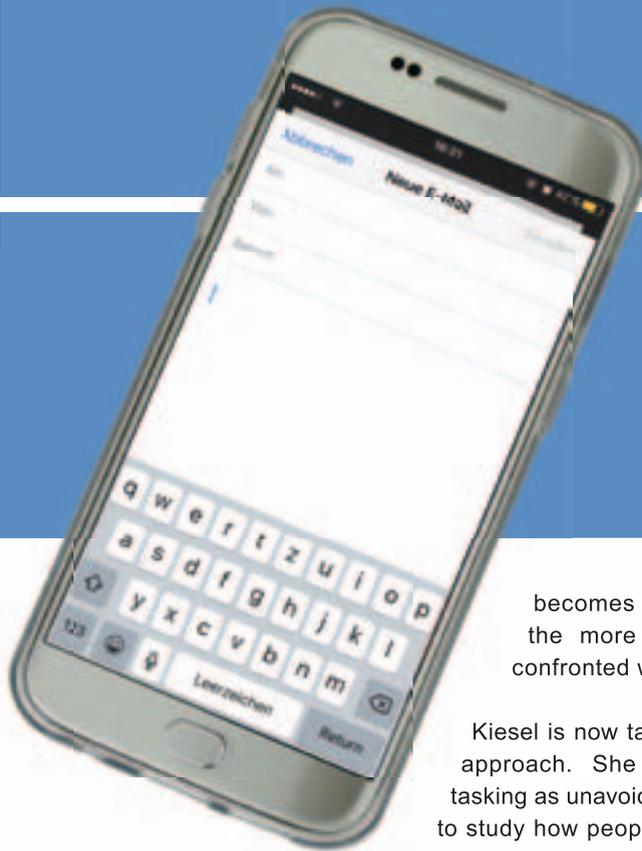
**“Multitasking is ubiquitous.”**

It's difficult to avoid doing a lot of things at once in our day and age, whether in our private lives, for our studies, or at work. "Multitasking is ubiquitous," explains the psychologist Prof. Dr. Andrea Kiesel, who is conducting research on the phenomenon at the University of Freiburg. In the worst case this behavior gives rise to a considerable amount of stress – and in the best case it leads to effective work in an environment in which assembly line-style work is a thing of the past.

"Up to now, psychological research on this issue has focused on the costs people bear in multitasking and how it can be avoided," explains Kiesel, who works at the Department of General Psychology. What psychologists mean by multitasking is not just divided attention – such as when someone talks on the telephone while driving a car – but also situations in which we are interrupted from tasks and continue them later – as in the case of Lea's research paper. Researchers assume that we possess limited cognitive resources that need to be reallocated when we get ready to tackle a new task. This "reconfiguring"

*Emails, telephone calls, jobs: Multitasking has become virtually unavoidable in our daily lives and can lead to stress.*

*Illustration: Svenja Kirsch*



*Telephone, camera, calendar, and much more:  
Smartphones unite all kinds of tools, but they make it more  
difficult to complete several tasks at the same time.*

*Photo: Sandra Meyndt*

becomes more difficult the more tasks we are confronted with at once.

Kiesel is now taking a different approach. She regards multitasking as unavoidable and wants to study how people deal with the cognitive challenge it involves: "Do we find circumstances in which multitasking is easier? Can we train these abilities? These questions have been neglected until now." This has changed since the establishment of a German Research Foundation (DFG) Priority Program on the topic in 2015. Coordinated by Kiesel, the program encompasses 22 research projects at 19 German universities and focuses primarily on integrating aspects from kinesiology and cognitive psychology. "My research group is studying how effective people are when they can determine the sequence of tasks themselves," she explains.

**"We reduce the phenomena to simple tasks."**

Although Kiesel and her research group didn't come to Freiburg until 2015, they have already produced concrete results. The psychologists recruited test subjects – mostly students – to test when people complete simple cognitive tasks on the computer faster: when the sequence of tasks is predetermined or when they can determine the sequence themselves. "We reduce the phenomena to simple tasks in order to draw inferences about complex abilities from everyday life," explains Kiesel.

A small room with a computer is all the researchers need to conduct the experiment. The tasks are easy: identifying even and odd numbers,

classifying vowels and consonants. The experiment begins following a brief practice phase. The test subjects have to complete more than 100 of these tasks. After each task, the ones who are allowed to multitask have four options to choose from. Among other things, they can choose to continue with the task they have begun or switch to another task. Data from 20 to 40 test subjects allow the researchers to identify trends: Multitasking does not really make the test subjects faster, and most of them opt to continue working on a single task. Responses to a questionnaire completed afterwards indicate that study participants find multitasking stressful.

### **Stress Reduction Training**

In another test, Kiesel also found out that people can estimate when switching to another task will save them time. When a task had to be repeated, the researchers made the wait between the repetitions longer each time. Hence, it was best to switch to another task as soon as the wait became longer than the time it took to get started on a new task. The test subjects needed approximately 200 milliseconds for this. "We demonstrate that the test subjects are relatively good at estimating this trade-off," explains Kiesel. "Controlled forms of multitasking can therefore enable us to work more effectively." Among other things, Kiesel would like to study whether people could profit from determining the sequence of tasks themselves and then always completing them in this sequence. Training could also help reduce the stress caused by multitasking: "When the test subjects practice switching between the tasks ten times for an hour, the potential for saving time is huge."

However, a better understanding of multitasking is not just useful for optimizing work routines. The researchers also receive indications on how to improve the operation of technical instruments: "What we see in our experiments is that it is easier for people to switch between tasks when they

need to use different keys for the tasks,” explains Kiesel. This contradicts current technological trends: Developers of smartphones try to unite all kinds of tools in a single device. “Such multi-purpose devices make it more difficult to complete several tasks at the same time – particularly for older people who find multitasking more challenging.” Hence, the research can also help to design technical devices like computers and smartphones that are optimized for the way people work. “Due to advancements in communication technology, we are exposed to more multitasking

now than we were 15 years ago,” says Kiesel. “We need to learn how to deal with this.” Multitasking is often associated with burnout or emotional exhaustion. However, the psychologist warns against making generalizations based on observations of everyday life and being taken in by prejudices. “We want to test observations in reduced experiments and avoid jumping to conclusions.”

[www.spp1772.uni-freiburg.de](http://www.spp1772.uni-freiburg.de)



**Prof. Dr. Andrea Kiesel** studied psychology at the University of Würzburg, earning her PhD in 2003. In 2006 she did postdoctoral work at the University of Otago, New Zealand. Back in Würzburg, she completed a habilitation thesis on the topic of unconscious cognition. In 2015 she accepted a post as professor of general psychology at the University of Freiburg and has since also served as coordinator of the German Research Foundation (DFG) Priority Program “Human Performance under Multiple Cognitive Task Requirements: From Basic Mechanisms to Optimized Task Scheduling.” She also conducts research on time perception and traffic psychology issues.  
Photo: Jürgen Gocke



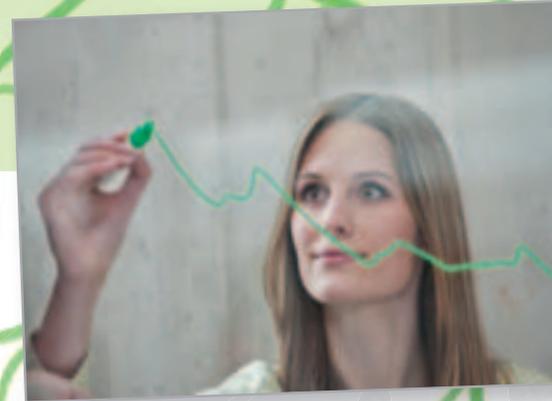
*Tick, tock, tick, tock – get done as much as you can as quickly as possible: Scientific findings indicate that controlled forms of multitasking can allow for more effective work. Photo: booka/Fotolia*

### Further Reading

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The psychology researchers rely on the help of paid test subjects for their experiments. If you are interested in volunteering, please add yourself to the list on the following website: <https://psychologie-freiburg.sona-systems.com>



Special Topic: Sustainability



Photos: dr322, Gina Sanders, piyaset, firstflight, WavebreakmediaMicro, zapp2photo, htpix, Richtsteiger/Fotolia



# An Interdisciplinary Thread

The University of Freiburg has teamed up with regional partner institutions to establish a research focus on sustainability

by *Nicolas Scherger*

Poverty, education, climate change, energy supply, security, infrastructure, gender equality, economic growth, conservation of ecosystems – these are just a few of the topics treated in the sustainability strategy passed by the German federal government in early 2017. Sustainability seems to have become an all-encompassing buzzword. So what can we expect when the University of Freiburg establishes a research focus on sustainability research? “We can’t cover everything,” says Prof. Dr. Gunther Neuhaus, deputy rector and vice president of research at the University of Freiburg, “but we are very well placed to make significant and groundbreaking contributions in several fields.”

What puts the university in a unique position for this task is its broad spectrum of fields and the way they are linked by an interdisciplinary thread. “Freiburg offers a full range of disciplines: from humanities, social sciences, law, and economics to environmental and natural sciences, engineering, and materials science. This enables us to take a systematic approach,” Neuhaus emphasizes. Institutions have been established in which researchers from a variety of fields are conducting joint projects on sustainability issues, both within the university and together with regional partners that contribute additional expertise. (See the profiles on pages 18–19 for examples.)

The research focus is divided into four fields: Technical sustainability research develops new materials and energy systems; biodiversity research studies the significance of biological

diversity in ecosystems and how it can be maintained in the long term; resilience research improves the robustness, adaptability, and learnability of infrastructures and technical systems to keep the damage caused by extreme weather events, industrial accidents, terrorist attacks, and other sources of danger as low as possible; finally, humanities, law, and social science research contributes aspects like governance, acceptance, legal feasibility, ethics, and technological impact assessment. In this issue of *uni'wissen* we present several research projects that address sustainability issues from various perspectives.

In addition, the University of Freiburg has committed itself to following a model of sustainable development. Among other things, we are generating certified green energy from water power and operating photovoltaic systems, we are using environmentally friendly recycled paper in almost all departments, we are Baden-Württemberg's leading university in the area of waste management according to a study by the State Court of Auditors, and we have received the City of Freiburg's ecological traffic award several times – in recognition of the incentives we offer to our students and employees for commuting to the university by public transportation or bicycle. The goal is to be as economical and efficient as possible with all resources and to continue to reduce our ecological footprint.

[www.nachhaltige.uni-freiburg.de](http://www.nachhaltige.uni-freiburg.de)



### Faculty of Environment and Natural Resources

The University of Freiburg's Faculty of Forest and Environmental Sciences and Institute of Earth Sciences merged in 2013 to form the Faculty of Environment and Natural Resources. The researchers study natural processes and the resulting interplay between the environment and society. The main areas of joint research include the sustainable use of natural resources, the conservation of water, soil, air, and biodiversity, means of adapting to global change, and natural dangers and risks.

[www.unr.uni-freiburg.de](http://www.unr.uni-freiburg.de)

### Center for Renewable Energy

Founded in 2008, the Center for Renewable Energy (ZEE) unites all University of Freiburg departments that engage in research, instruction, and continuing education on renewable energy – including photovoltaics, biomass, wind power, and geothermal power, as well as questions involving energy efficiency. The center also collaborates with external partners, particularly on activities involving research and development.

[www.zee.uni-freiburg.de](http://www.zee.uni-freiburg.de)

### Freiburg Center for Interactive Materials and Bioinspired Technologies | Freiburg Materials Research Center

The University of Freiburg opened the Freiburg Center for Interactive Materials and Bioinspired Technologies (FIT) in 2016. The scientists at the center take nature as a model for developing intelligent materials and systems that are capable of things like identifying, reacting to, and learning from changes in the environment, healing themselves, and supplying themselves with energy autonomously. The fundamental research conducted at FIT forms the basis for the work done at the Freiburg Materials Research Center (FMF). The FMF has been engaged in applied research on the electric, magnetic, thermal, chemical, and optical qualities of organic and inorganic materials since 1990.

[www.fit.uni-freiburg.de](http://www.fit.uni-freiburg.de) [www.fmf.uni-freiburg.de](http://www.fmf.uni-freiburg.de)

# “Sustainability Means Conflict”

The German federal government appointed Prof. Dr. Ulrich Schraml from the University of Freiburg's Faculty of Environment and Natural Resources and Baden-Württemberg's State Forest Testing and Research Institute to the German Council on Sustainable Development in late 2016. Nicolas Scherger spoke to him about his experiences as a policy advisor.

**uni'wissen:** Prof. Schraml, why did you decide to participate in the Council on Sustainable Development?

**Ulrich Schraml:** I've always enjoyed advising politicians, in Stuttgart just as at the national level. A major source of my motivation for conducting scientific research is the prospect of receiving feedback – not just from an expert who reviews a journal article but also from political actors who are then, at best, very enthusiastic about letting you know whether they find something good or bad.

**Do scientists have a special responsibility to make a contribution in matters concerning the long-term conservation of nature?**

That is certainly the case. We hear the term “sustainability” a lot, but it often remains vague and inaccessible. Scientists can be a big help in communicating and interpreting what it means. They can translate the term to make it politically accessible in the first place and pinpoint areas where there is a particular need for action.

**How does the council aim to do this?**

Our great chance is that we receive regular institutional access to policymakers, such as members of Bundestag, the German Chancellery, or the federal government. To use the words of our prime minister here in Baden-Württemberg, we are heard as a matter of course – and if our argumentation is sound, our recommendations have a chance of being acted upon.

**What do you see as being the most difficult task?**

The greatest challenge is to better integrate and coordinate the sometimes very good policies of the individual ministries, like agriculture, labor, education, or environment. When the people at the ministries speak more with one another before pressing ahead with their sectoral policies, we've taken one big step forward.



*There are many sustainability issues in which the problem is known but the solution is yet to be found, says Ulrich Schraml.*

*Photo: Klaus Polkowski*

### **But sustainability is something everyone can agree upon, right?**

As long as the concept remains abstract, everybody nods his or her head in approval. However, things get interesting as soon as it becomes concrete, because sustainability means conflict. Environmental, economic, agricultural, and social policymakers need to debate with one another to determine which programs are feasible from the standpoint of sustainability.

### **What aspects are you most interested in bringing to the table?**

The fields I'm most familiar with are environmental policy and land use, with an emphasis on forests. In the past years my team and I have also focused increasingly on social topics, such as health and recreation. These are important and interesting aspects, both for forests and for urban green spaces.

### **Generally speaking, are the social sciences gaining in significance here?**

That is the impression I get, because there are a lot of issues where we know the problem but do not yet have the solution. Take purchasing, for example: A lot of organizations want to follow sustainability goals when purchasing goods like paper, furniture, or automobiles, but the results often fall short of expectations – for instance due to legal barriers, a lack of knowledge, or high costs. Social science research can improve our understanding of where these problems of implementation lie and how we can address them.

[www.ifp.uni-freiburg.de/team/ma-fopof/ulrich-schraml](http://www.ifp.uni-freiburg.de/team/ma-fopof/ulrich-schraml)

### **Sustainability Center Freiburg | Department of Sustainable Systems Engineering**

The University of Freiburg and the city's five Fraunhofer institutes opened the Sustainability Center Freiburg in 2015. Scientists at the center cooperate with industry partners and other external institutions to develop solutions to great challenges like climate change and resource scarcity. The key topics are sustainable materials, energy systems, resilience research and resilient engineering systems, and ecological and social transformation. The engineering core of the center is the Department of Sustainable Systems Engineering (INATECH), also founded in 2015 at the University of Freiburg's Faculty of Engineering..

[www.leistungszentrum-nachhaltigkeit.de](http://www.leistungszentrum-nachhaltigkeit.de)

[www.inatech.uni-freiburg.de](http://www.inatech.uni-freiburg.de)

### **Upper Rhine Cluster for Sustainability Research**

Founded in 2016, the Upper Rhine Cluster for Sustainability Research includes the member universities of "Eucor – The European Campus" in Basel, Freiburg, Karlsruhe, Mulhouse, and Strasbourg, the University of Koblenz and Landau, and other associated partners. The cluster concentrates on the general theme of how to govern sustainable growth, encompassing ecological, social, and economic sustainability. The main focus areas are "Governance," "Energy, Infrastructure, and Social Change," "Transformation Processes and Technologies," "Resource Management," and "Multiculturalism and Multilingualism."

[www.nachhaltigkeit-oberrhein.info](http://www.nachhaltigkeit-oberrhein.info)

### **Upper Rhine Research Alliance**

The Upper Rhine Research Alliance, founded in 2017 by the University of Freiburg, the Karlsruhe Institute of Technology, and the Universities of Applied Sciences in Furtwangen, Karlsruhe, and Offenburg, focuses on the technical foundations of sustainability under the theme "long-term stable and resilient technologies – from the component to the system." The goal is to develop energy-efficient, intelligent, and resilient technical systems for countering global warming and resource scarcity and dealing with their ecological and social consequences.

[www.pr.uni-freiburg.de/go/forschungsallianz](http://www.pr.uni-freiburg.de/go/forschungsallianz)



*What could Freiburg look like in the year 2030?  
The city and the university are participating in a  
competition organized by the German Federal Ministry  
of Education and Research. Photos: Thomas Kunz*

Special Topic: Sustainability

# Freiburg: City of the Future

A project is bringing citizens and researchers together to discuss how to make urban life sustainable

by Petra Völzing

Where questions of the future are concerned, the boundaries between science and society become more permeable. This is evident in the project “Freiburg: City of the Future.” Organized by the German Federal Ministry of Education and Research, the “City of the Future” competition invites municipalities to discuss their ideas of sustainable urban life along with citizens and scientists, and in later phases of the competition also to put them into practice in pilot projects. Freiburg is participating in this competition, which began in 2015. The scientific side is represented by the Sustainability Center Freiburg and the city’s five Fraunhofer institutes. The project “Freiburg: City of the Future” is being organized and coordinated by Michael Pregernig, professor of sustainability governance at the university’s Institute of Environmental Social Sciences and Geography. His contribution consists primarily in treating methodological issues, because the goal of the competition is not just to develop a sustainability concept but also to design new methodologies and put them to the test.

#### An Urban Vision for 2030

The city and university are already well into their work on the project. The first phase, which involved developing an urban vision for Freiburg in the year 2030, lasted nine months and is already completed. Citizens were invited to submit their ideas and projects for a sustainable city on an online tool. Then Pregernig’s team arranged the ideas into the five subject areas integration, energy, mobility, trade and industry, and new communication forms. At the heart of this phase of the competition was the “Dialogue on the Future” in February 2016, a half-day event at which 30 citizens and scientists got together at the university to incorporate the citizens’ ideas for projects into a common vision. “Our task at the institute is to develop methods that enable scientists and citizens to tackle sustainability challenges together. The dialogue event format is one of these methods,” explains Pregernig.

The idea behind it is to give social actors, instead of just scientists, an opportunity to set priorities for research and formulate specific questions. Known as “co-design,” this new principle is becoming increasingly important in sus-



*Shopping at the farmer’s market: One of the topics of the project is how to better promote regional food production in the future.*

tainability research. With an eye to the further course of the competition, the citizens and scientists decided together at the dialogue event which issues to prioritize in their concept. The issues they selected were sustainable energy supply, alternative forms of economy, and regional food production. “It became clear at the event that food production is a matter of particular concern,” says Pregernig, “so we decided to treat it as a discreet topic for the further development of our concept.”

The second phase of the competition is now underway, and Freiburg was one of 20 out of an original 52 cities to make the cut. The goal of this 18-month phase, which began in January 2017, is to develop a strategy for planning and implementing the “vision for 2030” outlined in the first phase. The starting point for this task is to elaborate on the three topics suggested in the dialogue on the future. This involves a lot of steps. “What we are doing now is studying the individual project ideas from a scientific perspective to determine how realistic they are,” for instance the goal of making Freiburg completely self-sufficient with

regard to its food supply. “The goal is unrealistic,” says Pregernig, and this has also been confirmed by the results of a study recently commissioned by the city. However, he does see the sense in investigating the systemic connections. If areas on the Upper Rhine Plain currently dedicated to growing corn for biogas were instead used to produce food, the city could indeed make itself more self-sufficient.

In a project led by Gerhard Stryi-Hipp, the Fraunhofer Institute for Solar Energy Systems (ISE) is testing whether and how it is possible for



*Corn for biogas can help to provide a city more renewable energy, but it takes away space for growing food – making it more difficult to achieve self-sufficiency with regard to food supply. Photo: AVTG/Fotolia*

Freiburg to produce 100 percent of its energy supply from renewable sources. This issue illustrates how difficult it is to develop robust sustainable concepts: If you take away the corn for biogas, you make it that much more difficult to solve the energy problem. To assess this situation in more detail, Uli Siebold's team at the Fraun-

By the end of the second phase of the competition, the researchers hope to have developed a sound concept. The goal in the third phase – presumably starting in mid 2018 – will then be to put the various elements to the test in the form of so-called living labs in the pilot neighborhoods. For Pregernig, the innovative thing about the



**Prof. Dr. Michael Pregernig** studied commercial science with an emphasis on environmental economics and forestry with an emphasis on environmental and resource policy in Vienna, Austria. He completed his PhD in 1999 and his habilitation qualification in environmental and resource policy in 2006, both at the University of Natural Resources and Life Sciences, Vienna. In 2009 he came to the University of Freiburg to serve as interim head of the master's program Environmental Governance (MEG). In March 2016 he was appointed as professor of sustainability governance at the Institute of Social Environmental Sciences and Geography. His research interests include the governance of sustainability processes in politics and society.

Photo: Jürgen Gocke

## “Food production is a matter of particular concern.”

hofer Ernst Mach Institute (EMI) is working on a web-based tool for comparing the sustainability effects of various measures. The tool reveals how various sustainability goals are dependent on each other and allows them to be considered in the development of implementation concepts. At the moment, Pregernig is looking for suitable neighborhoods for pilot projects. “We need places where scientists and citizens can exchange ideas on concrete project ideas and ideally implement them together.” He is also still looking for scientists interested in participating in the project. “However, we already have several researchers on board, for instance environmental scientists, economists, and engineers.”

“city of the future” format is not just the content of the projects themselves but also the new methodological approaches – like the dialogue on the future or the role of the knowledge broker, both of which will be continued in the third phase.

[www.zukunftsstadt.freiburg.de](http://www.zukunftsstadt.freiburg.de)

### Research in Pilot Neighborhoods

A second dialogue event that will bring together citizens and scientists is planned for July 2017. The goal is to formulate concrete research projects. “The first dialogue was devoted to collecting ideas for topics; in July we will be putting these ideas in concrete terms and working out the details,” Pregernig explains. After the event, the researchers will define and implement small-scale specialized research projects and then invite the citizens to participate in the research work according to the principle of citizen science. “A project like this might, for example, consist in testing out alternative forms of sustainable food supply in a neighborhood.” Citizens could participate in the data collection by conducting surveys on eating habits or “(self-)experiments on consumption.” Dörte Peters from the Institute of Environmental Social Sciences and Geography will help with the implementation of these projects – as a so-called knowledge broker, whose job will be to coordinate the work between the citizens and scientists and provide organizational support.

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# Airborne Data Collectors

Remote sensing enables scientists to collect information on the environment and make more accurate assessments of geo-risks

by *Katrin Albaum*

Torrents of water surge through the streets and spill into buildings. The townspeople hadn't expected such severe flooding. They had been warned that the river that flows through the town would rise after a heavy rainfall, but no one could have foreseen the precise extent of the catastrophe. The firefighters just barely managed to reach the buildings with their emergency vehicles to evacuate everyone, but now they're stuck, because the street they used to reach the buildings

development of the flood and its magnitude in this fictitious scenario.

**“The photosynthetic activity tells us whether a plant is under stress.”**

has suddenly flooded as well. The people are stranded. A helicopter is called in, but it takes a long time for it to show up, and it has to make several trips to evacuate everyone. If the rescue workers had known how quickly the flood would spread, they would have used a helicopter right away instead of ground vehicles. Precise information on flow rate, an elevation profile of the surroundings, and other environmental data would have enabled the town to predict the

The forest scientist Barbara Koch, professor of remote sensing and landscape information systems at the University of Freiburg, and the members of her research group aim to prevent such events from happening or reduce the dangers they pose. In their project at the Sustainability Center Freiburg and the city's five Fraunhofer institutes, MulDiScan, they are developing technical tools for collecting environmental data that will make it possible to more accurately assess geo-risks like floods and to take suitable measures to combat them. “The term ‘geo-risks’ includes all dangers that are neither caused by humans nor set off by biological processes,” explains Koch. Landslides, avalanches, and volcanic eruptions also fall in this category. “Among other things, we are working with the Fraunhofer Institute for Physical Measurement Techniques on sensor systems on unmanned airborne platforms that can collect environmental information.” What this involves in particular is remote sensing: “Remote sensing is a method we can use to obtain information about some-



*View of a forested area from an unmanned airborne platform: Freiburg researchers are developing a system that collects data on features like tree structure and photosynthetic activity.*

*Photos: Andreas Fritz*



*The unmanned flight platform covers a large area in a short time and is equipped with a sensor that either uses available sunlight or generates electromagnetic energy itself.*

thing without coming into physical contact with the object of investigation.”

### **Great Danger from Small Insects**

Besides geo-risks, Koch and her assistants are also measuring and analyzing bio-risks, which can appear, for example, when trees become infested with pests. The team is studying ways to identify such biotic damage caused by living organisms early on. The goal is to prevent pests and diseases from spreading further in the forest, thus limiting their negative effects on the environment. “Wood is a renewable resource, so the management of our forests is also important for sustainability. As a part of the nutrient cycle in ecosystems, wood decomposes and forms the basis for the growth of new plants.”

Certain insects present a great danger to many trees. One example is the bark beetle, which breeds in the spring and summer. Several generations can develop when the weather is warm and dry and spread to further nearby trees. In this way, the bark beetle can quickly infest a large area under the right conditions. “Commer-



*Researchers at the Department of Remote Sensing and Landscape Information Systems are teaming up with the Fraunhofer Institute for Physical Measurement Techniques to develop sensor systems that can be attached to unmanned airborne platforms.*

*Photo: Markus Quinten*



*Bark beetles pose a major threat to trees. The traces of the beetle are visible after the tree has been infested for a certain time.*

*Photo: Friedberg/Fotolia*

cial forests bordering on a national park are at a particular risk," explains Koch. In protected forests the bark beetle can breed and spread unchecked because these areas are designated as free from human intervention. "There is thus a buffer zone around the parks in which the bark beetles are observed especially closely." The goal is to prevent the beetles from making the jump to the commercial forests. "Here remote sensing methods serve to support monitoring on the ground."

The traces of a bark beetle infestation become visible in the crowns of affected trees after a certain time. The needles change, turning a pale yellow. At this point the pests have already used the tree as a breeding ground for a long time. If a tree is infested by bark beetles, the owner of the forest is required to chop it and all other surrounding trees down. Only in this way

**“We use sensors to measure the emitted light energy.”**

can the pests be prevented from spreading unchecked. "It would be more advantageous if we had a means of identifying which trees are infested before external changes are visible and the beetles have multiplied and spread to other trees," says Koch. "We are therefore working on methods for identifying an infestation at a very early stage." In this case less trees would need

to be chopped down, reducing the economic damage.

### Identifying Plant Stress

The unmanned airborne platforms with sensor systems developed in the project cover a large area in a short period of time. If a plant is under stress, it causes a change in the chlorophyll absorption of their leaves, and they reflect more radiation in certain wavelength ranges, indicating a reduced photosynthetic activity. This is the first source of information on the state of a plant's health, says Koch. "We use sensors to measure the emitted light energy, which is directly connected with the photosynthetic activity and thus with the vitality of the plant." However, it is not possible to see everything from above. "The photosynthetic activity tells us whether a plant is under stress, one possible cause of which is a bark beetle infestation." Determining whether the stress is being caused by beetles or some other factor involves sending a person to examine the tree on location. In the case of certain tree species, however, it is highly likely that the bark beetle is indeed responsible – two of the most common bark beetle species in Germany are partial to spruce. "Our sensors are designed to identify critical areas that can then be checked individually. In this way, forest owners do not have to monitor their entire plot and can take the necessary measures to prevent the infestation from spreading to other trees more quickly.

There are passive and active sensor systems: Passive systems use the available sunlight, while active systems generate electromagnetic energy themselves, send it toward the ground, and measure the reflected radiation. "One difficulty is designing the sensors to be small and light enough to be fixed on unmanned airborne platforms." This is where the scientists at the Fraunhofer Institute for Physical Measurement Techniques come in: They are responsible for developing and improving the sensor systems. Koch and her team, for instance, provide information on the relevant wavelengths, test the sensor systems, and process the data from the studies. Airborne systems are already good at identifying severely damaged trees whose leaves exhibit distinct changes and moderately damaged trees that also show visible changes. "Our goal is to identify the reduced photosynthetic activity before the changes are visible."

## Encouraging Biodiversity

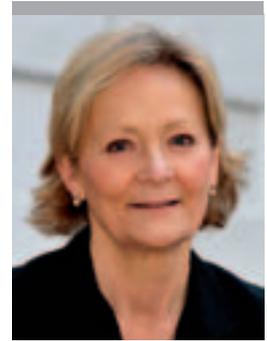
The researchers at the Department of Remote Sensing and Landscape Information Systems are also working on methods for collecting data on a forest's structural diversity with unmanned airborne platforms. Structural diversity is closely connected to biodiversity. For example, large, old trees often have a pronounced crown with many branches and small structures that provide niches for insects and birds. "Such features therefore also have a positive effect on biodiversity."

Once these structures have been identified, it is possible to take action to conserve or even encourage them. In addition, the technology can also be transferred to numerous other areas of application, emphasizes Koch. For example, they could be used in the future to inspect crevices and analyze the risk of rock falls or to check man-made structures like bridges for cracks.

[www.leistungszentrum-nachhaltigkeit.de/pilotprojekte/muldiscan](http://www.leistungszentrum-nachhaltigkeit.de/pilotprojekte/muldiscan)



Spotting damage from the sky: The sensor system identifies the trees that are infested with beetles. Forest owners can chop down these trees quickly to protect other nearby trees. Photo: Teja Kattenborn



**Prof. Dr. Barbara Koch** has served as professor of remote sensing and landscape information systems at the University of Freiburg's Faculty of Environment and Natural Resources since 1994. She studied forest science at the Ludwig Maximilian University of Munich from 1977 to 1982. She worked as a research assistant at the same institution from 1982 to 1994, earning her PhD in 1988. Koch also spent a time conducting research at the Jet Propulsion Laboratory in California, USA. In 2005 she founded the Steinbeis research center "FeLis," which makes scientific findings from her field available to industry research and development departments. Her research interests are remote sensing, geomatics, and spatial modeling. Photo: Thomas Kunz

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# Maintaining Structural Diversity

Examples from Germany and Brazil demonstrate the impact of the logging industry on biodiversity

by Sarah Schwarzkopf

*Special living space:  
Hollow tree trunks are an  
important habitat for many  
forest types. However, trees  
with these structures are rare  
in intensively used forests.*

*Photos: Jürgen Bausch*

Growing interest in the bioeconomy has also led to an increased demand for wood. As a renewable resource, wood can serve in the long term as an alternative to some fossil resources in the economic cycle. However, an increased use of forests endangers their biodiversity. Species-rich forests perform important services for humans and are often more resistant to external disturbances – they are better at withstanding climate change, for instance. Ecosystems with high biological diversity also fulfill their functions more effectively. For example, a larger amount of animal species can kill off more pests, and forests with high diversity fix more carbon, thus making a major contribution to climate protection. “Forests are the last natural terrestrial ecosystems. They provide much more biodiversity than agricultural systems. We have a great responsibility to conserve their species and processes,” says the forest scientist Jürgen Bauhus, professor of silviculture at the University of Freiburg's Faculty of Environment and Natural Resources.

#### Index for Structural Diversity

Bauhus studies how mixed forests contribute to the maintenance of forest functions and what influence forestry can have on the forest structure. He is interested in how intensively humans can use forests without causing a substantial reduction in their biological diversity. Since it is difficult to measure biodiversity directly – for instance to identify hundreds of fungus and beetle species in a particular patch of forest –, Bauhus focuses on structural diversity. It determines whether the forest is capable of fulfilling one of its most important functions: providing a habitat for a variety of animal and plant species. Mixed forests with trees of various ages are particularly rich in structural features. The trees there are not all the same but vary in size from very large to very small. Fallen dead trees provide a home for many species, and the differences in crown height also increase structural diversity. Bauhus thus takes the structure of a forest as an indicator for its biodiversity.

One of the tools his research group uses to study how intensively forests can be used without endangering their biological diversity is the Bundeswaldinventur, a national forest inventory conducted every ten years in Germany. It includes data on features like the species and di-

mensions of individual trees and the amount of woody debris from approximately 60,000 forested areas in Germany. However, up to now it was not possible to use this inventory to make direct inferences concerning changes in the biodiversity of the forests. Bauhus's doctoral candidate Felix Storch therefore used the individual measurements to compile an index that reveals the

“Forests are the last natural terrestrial ecosystems.”

structural diversity of the forests – and thus also the habitat they provide. The higher a forest's score on the index, the more diverse is its structure. Now, with each new edition of the inventory, it will be possible to track how this diversity changes in the course of time.

Storch took the volume of the harvested wood from trees chopped down since the last inventory and the change in the structural index as a basis for calculating the impact intensity of use had on the structural diversity of the forest. His results demonstrate that the available habitat initially increases when only small amounts of wood are harvested and is only reduced in the



*Species-rich stands like this near-natural and structurally rich beech-fir forest in the Black Forest perform important services for humans.*



*The natural regeneration of beech forests involves an extensive use of individual old-growth trees. The conservation of habitat trees, i.e., trees that provide a habitat for other organisms, and woody debris leads to an increase in structural diversity. Photos: Jürgen Bauhus*

*Shelterwood cutting is a traditional form of forest management. Individual trees are chopped down, leading to a permanent high forest that can be used intensively while at the same providing space for many different tree species.*

case of more intensive use. There is thus a threshold value, above which the wood harvest has a negative influence on structural diversity. Limiting forest use to this level enables a sustainable cultivation of the forest with regard to biodiversity. “This allows us to determine for the first time ever what level of use intensity will likely have a positive effect on biodiversity, or at least not a negative effect,” reports Storch. Bauhus and his research group are conducting two studies to demonstrate the relevance of this threshold value – one in the forests of Baden-Württemberg, and the other in the Brazilian rainforest.

**“This long-term study in the tropical rainforest is practically one of a kind.”**

Germany is one of the European Union’s most densely forested countries. The average forest in Baden-Württemberg yields a volume of almost 380 cubic meters of wood per hectare – a record amount. With the help of the inventory data from this state, Bauhus and Storch have demonstrated that the threshold values for a reduction in structural diversity differ depending on the type of forest. In a beech forest, for example, it is advisable to harvest somewhat less wood than can grow back in the same period of time, while in a spruce forest one can harvest nearly twice as much as what grows back. Bauhus stresses that the threshold values are not fixed limits but merely an indication of where one should reduce use intensity or could potentially increase it:

While deciduous forests tend to be less tolerant of intensive use, it is possible to harvest large amounts of wood from coniferous forests and then convert them into mixed forests.

#### **Sustainable Rainforests**

As an example of how widely threshold values can differ from region to region, Bauhus and his assistant Dr. Angela de Avila are conducting studies in Brazilian rainforests. They contain 200 to 300 tree species – compared to only half a dozen or less in German forests. Since many of the tree species in rainforests are not usable, foresters chop down just five to ten selected trees per hectare and leave the rest standing. It is only since the second half of the 20th century that attempts are being made to make sustainable use of the rainforests. However, there is a lack of experience with regard to the issue of how much time rainforests need to recover from the interventions and whether this depends on the intensity of use.

De Avila and Bauhus analyzed an experiment that has been running for over 30 years – including eight inventories to date. “This long-term study in the tropical rainforest is practically one of a kind. They greatly increased the level of use intensity to test out how the forest would recover over time,” explains de Avila. She calculated a threshold value for the Brazilian forests: In a selective wood harvest, one can use approximately 20 percent of the wood supply. If one takes away more, the composition of tree species and the carbon stock of the forests does not recover



A tree of the species *Manilkara huberi* in the Amazon rainforest in Brazil – it is one of the economically useful species in the rainforest and is valued for the hardness of its wood and its resistance to decay.

within the next 30 years. This is also true of the economically interesting trees: They only grow again if one limits the intensity of use – otherwise it is mainly the non-usable trees that multiply. The legally permitted use intensity in Brazil now lies below the threshold calculated in the study. “According to our analyses, a sustainable use of these forests is possible if one obeys the law there,” concludes Bauhus.

### Debate on the Bioeconomy

The guidelines for forest use in Germany are set in accordance with the condition, wood growth, and desired functions of the forest. “The principle is to not take away more than can grow back in the long term,” explains Bauhus. The amount taken away has even been much less in the past decades. Whether this should remain so is a contentious issue, because bioeconomy initiatives want to use the forests more intensively in the future. The research conducted by Bauhus and his group is making an important contribution to this debate. “We can show on the basis of the structural index what levels of use intensity are possible in particular forests without causing a large-scale reduction in biodiversity,” he summarizes. If it is not possible to remain under the threshold value, it is necessary to compensate for the higher level of use: Conserving habitat trees and adding woody debris present alternative means of creating a diverse habitat and therefore maintaining biodiversity.

[www.waldbau.uni-freiburg.de](http://www.waldbau.uni-freiburg.de)

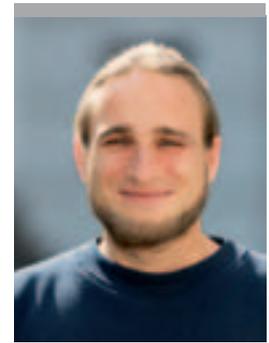


**Prof. Dr. Jürgen Bauhus** studied forest science at the Universities of Freiburg; Vienna, Austria; and Göttingen. He earned his PhD in Göttingen in 1994 with a dissertation on the nutrient cycle in beech forests. He then researched and taught in Montreal, Canada, and Canberra, Australia. In 2003 Bauhus was appointed as professor of silviculture at the University of Freiburg's Faculty of Environment and Natural Resources. His research focuses on the interplay between the structure and function of forest ecosystems as well as their silvicultural control.

Photos: Jürgen Gocke



**Dr. Angela de Avila** completed a diplom degree in forest engineering at the Federal University of Santa Maria, Brazil. She then went on to specialize in environmental education at the same institution, earning her master's in forest science in 2010. After teaching for two years at the University of West Santa Catarina in Xanxerê, Brazil, she came to the University of Freiburg as a research assistant under Prof. Bauhus. She earned her PhD in January 2017. Her dissertation explores how the tropical rainforest regenerates within 30 years after a wood harvest.



**Felix Storch** earned his diplom degree in forest science at the University of Freiburg in 2009. He then worked for three years at the Baden-Württemberg Forest Testing and Research Institute, where he collected and analyzed data for the German forest inventory. Since 2014 he has been working on his doctorate at the University of Freiburg under Prof. Bauhus. His dissertation investigates the impact of use intensity on biodiversity in the forests of Baden-Württemberg.

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# Switched On

The project SusLight is developing better LEDs and therefore addressing the issue of sustainable lighting

*by Alexander Ochs*

Special Topic: Sustainability

*The metropolitan area of Atlanta, USA, seen from space:  
Around one-fifth of the electricity generated worldwide is  
used for lighting, and the amount continues to increase.  
The demand for sustainable lighting is correspondingly great.*

*Source: NASA Image and Video Library*



The light emitted by large cities like New York, Moscow, and Tokyo at night rivals that of the moon, as satellite images from the US space agency NASA reveal. While some parts of the earth are shrouded almost entirely in darkness, the densely populated regions appear bathed in a bright light. Around one-fifth of the electricity generated worldwide is used for lighting today, and the amount continues to increase. The demand for sustainable lighting is correspondingly great.

One of the most important technologies in this context is the light-emitting diode, LED for short. A pilot project at the Sustainability Center Freiburg has set itself the task of improving LEDs and making them more efficient. The university's side of the project involving technical aspects, which goes by the title "SusLight – Sustainable LED Lighting" and is part of the "Energy Systems" research focus at the center, is headed by Prof. Dr. Yiannos Manoli, holder of the Fritz Hüttinger Chair of Microelectronics at the University of Freiburg's Department of Microsystems Engineering (IMTEK).

**“We want to integrate microelectronic circuits into the lamps to improve their efficiency even more.”**

The European Commission implemented a ban on incandescent light bulbs in 2009, paving the way for more modern lighting technologies. One of the most well known of these, the compact fluorescent lamp, is not regarded as a satisfactory replacement. Its many limitations include a relatively short lifespan, an unnatural rendering of colors, and a delay before reaching full brightness – plus it is poisonous because it contains mercury. As a result, researchers are now focusing on the white LED, invented in 1995 with support from Fraunhofer Institute for Applied Solid State Physics (IAF) in Freiburg.

White LEDs are optoelectronic semiconductor components capable of converting electrical energy directly into light. To be used in conventional lamp sockets, however, they need to be retrofitted with a driver circuit that converts the alternating current from the 230 volt wall socket to direct current. The method currently in favor is silicon MOSFET technology; MOSFET stands for metal-

oxide–semiconductor field-effect transistor. For the SusLight project, Prof. Dr. Joachim Wagner, Dr. Michael Kunzer, and the latter's team at the Fraunhofer IAF are conducting research on gallium nitride components for the driver electronics as well as on the assembly and circuitry of the entire LED lamp. Manoli says of their work so far: "In comparison to the commercial models of the same size, our LED lamp yields twice as much light output."

**“Cold white light keeps us awake during the day; warm white light helps us fall asleep better in the evening.”**

Another objective is to improve the functioning of the LEDs. The scientists want to equip the lamps with sensors to make them controllable. For example, the color temperature of the white light could be adjusted so that it appears warm white like the light from a conventional light bulb or cold white like daylight.

That is important, because our innate sense of time, our "internal clock," is influenced by the color temperature of the light in our environment: "Cold white light keeps us awake during the day; warm white light helps us fall asleep better in the evening," says Manoli. The scientists want to control the intensity and thus also the brightness of the light by dimming. Moreover, they are developing an integrated motion sensor, for instance so that the lamp only switches on when a person is actually nearby.

"Efficient architectures" is the term Manoli uses to refer to what he and his team are working on developing. The process

involves running computer simulations of circuit configurations that consume less electricity but also require less components. The most promising models are then constructed, measured, and evaluated in the lab.

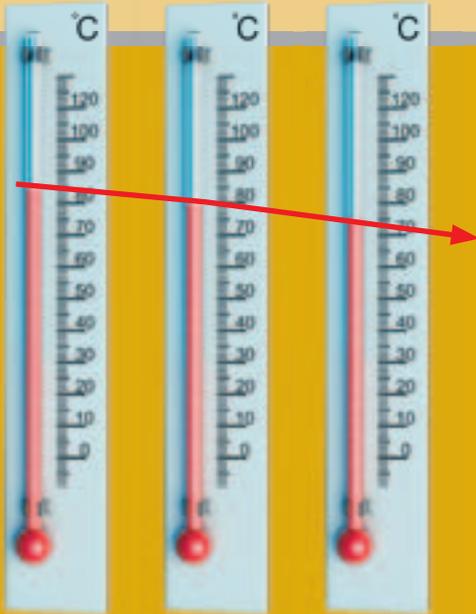
Another means of optimizing LED lamps is to replace components with others made of different materials. One of the weak points in current LED lamps or retrofits is the electrolytic capacitors built into them, which are used for temporary energy storage. They are more affordable and can store more energy per volume than other types of capacitors, but they are much less durable than the LEDs and therefore shorten the lifespan of the lamp as a whole. "We have developed a concept that does without electrolytic capacitors and have applied for a patent, and we believe that it could drastically increase the lifespan of LEDs." And that's not all: "We want to integrate microelectronic circuits into the lamps to improve their efficiency even more, and above all to make them smaller."

Even though LEDs are already far more efficient than incandescent light bulbs, the scientists participating in the SusLight project are conducting research on ways to reduce performance losses in the driver electronics and in the LEDs even further. The goal is to allow as little heat energy as possible to escape and to reduce the lamp's operating temperature – currently around 80 degrees Celsius – to increase the lifespan of the components. That's reason enough to search for ways and means to carry off the heat, to "reduce the heat dissipation in the lamp," as Manoli terms it: "We've already managed to get the losses in the driver electronics down to under 10 percent."



*This light bulb is based on a highly-efficient LED module developed by researchers in the SusLight project. It has a color temperature in the cold white region.*

*Photo: Jürgen Gocke*



The project team at SusLight is working on further reducing performance losses in the driver electronics and in the LEDs. The goal is to allow as little heat energy as possible to escape and to reduce the lamp's operating temperature – currently around 80 degrees Celsius – to increase the lifespan of the components. Photo: 3dmavr/Fotolia

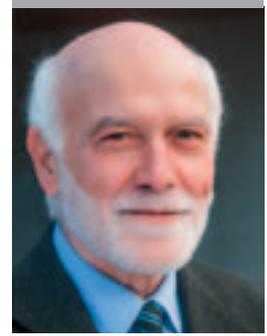
If everything goes off according to plan, a prototype will be completed by 2018. The overarching goal of the SusLight project is to encourage the more widespread adoption of LED lighting and to more fully exploit the energy-saving potential of the technology. The longer the new lamps can be made to last, the less of them will have to be disposed of in the future – and when they do need to be thrown away, they will contain less pollutants. This is another of the many sustainability issues addressed in the project.

Another feature of the project, which is receiving funding from the State of Baden-Württemberg, is that the researchers have managed to bring on board a host of partners from various institutions and a wide range of disciplines, including Hahn-Schickard, an institute for applied research with facilities in Villingen-Schwenningen and other locations. Besides tackling the technological challenges of LEDs, the project partners are also investigating economic and behavioral aspects of the technology. The idea is to motivate consumers to use energy-efficient and long-lasting lamps and thus adopt sustainable practices – without making them feel like they are being told

what to do. For example, a team of economists from the University of Freiburg is studying the barriers to market entry faced by manufacturers of LED lamps. They are taking a look at the public perception and acceptance of LED lighting and investigating the support for sustainable consumption among consumers as well as the issue of how the government can encourage sustainable consumption and production.

At the end of the day, even the best high-tech lighting will have little impact if the consumer does not buy it – preferring instead to hoard old-style light bulbs in the basement. Even though the price of LEDs is falling very rapidly, they are still relatively expensive to make. And yet the efficiency of LEDs is sensational compared to that of traditional incandescent light bulbs: While the latter manage a meager efficiency level of just five percent, white LEDs can now achieve up to 65 percent, depending on the quality of color rendering and temperature. The project partners therefore still see great potential in the further spread of LEDs – especially when one considers that around one-fifth of the electrical energy generated worldwide today is used for lighting. This figure could rise in the future, for obvious reasons, says Manoli: “The population is growing, there are more single-person households, the living space per person is increasing, and the issue of security in public spaces also calls for more lighting.”

[www.leistungszentrum-nachhaltigkeit.de/pilotprojekte/suslight](http://www.leistungszentrum-nachhaltigkeit.de/pilotprojekte/suslight)



*Prof. Dr. Yiannos Manoli studied in the USA on a Fulbright scholarship, completing a bachelor's in physics and mathematics and a master's in electrical engineering and computer science. In 1987 he earned his PhD at the University of Duisburg. His research in the 1980s and 1990s focused on the development of analog/digital MOS and CMOS circuits. This work led to numerous patents, scientific publications, and awards for his research and teaching. Since 2001 Manoli has held the Fritz Hüttinger Chair of Microelectronics at the University of Freiburg's Department of Microsystems Engineering (IMTEK). His current research interests include mixed analog/digital integrated circuits and the design of circuit concepts and system solutions with especially low power consumption.*

*Photo: Klaus Polkowski*

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# Authority and Democratic Education

West Germany experienced dynamic educational change in the 1950s and 1960s – in contrast to France

by Thomas Goebel

*School was supposed to educate the Germans to become democrats after the Second World War and thus help them to overcome “authoritarian traditions” that had ultimately also paved the way for National Socialism. Photo: ADDICTIVE STOCK/Fotolia*



In 1967, the Frankfurt school student Karin Storch held a graduation speech that attracted nationwide attention. Its title was “Teaching Disobedience as a Responsibility of a Democratic School.” The young woman criticized the fact that German schools too often taught authoritarian behavior and educated the students to be loyal and subservient, even though autonomy, critical thinking, and disobedience are necessary virtues for the life and health of a democratic society.

Some people saw the speech as a provocation, but the reactions from the public and from state institutions were not all negative. On the contrary, organs like the conservative Protestant weekly *Christ und Welt* published the text, and the political education department of the City of Cologne school board reprinted the speech to make it available to students and teachers. In 1968 Karin Storch received the Theodor Heuss Medal. “The speech sounds like a rebellion against the authorities,” says University of Freiburg historian Dr. Sonja Levsen, “but in 1967 the authorities already supported most of what this speech calls for.”

### Rapidly Growing Criticism

Sonja Levsen studied the relationship between authority and democracy in the post war era in her habilitation thesis, which she completed in September 2016. According to its subtitle, the thesis is a cultural history of educational change in West Germany and France. “It is striking that the term ‘authoritarian’ often appears in historical accounts of the 1950s and 1960s,” says Levsen. According to this widely-held view, the young Federal Republic of Germany was – in contrast to countries like France or Great Britain – marked to a large extent by “authoritarian traditions,” by hierarchical thinking and Prussian subservience, attributes that had ultimately also paved the way for National Socialism.

In her study, Levsen comes to the contrasting conclusion that it was not a particularly marked authoritarianism that made the young Federal Republic different from France – but rapidly

growing criticism of authoritarianism. The historian speaks of an “unusually pronounced feeling of discontent with forms of authority aimed at obedience and subordination.” Hardly anyone spoke of a contrast between authority and democracy in 1950s and 1960s France, says Levsen. In Germany, on the other hand, this view had a very strong impact as an explanation for National Socialism, especially in the education sector.

“The Americans as well as the British asked themselves at the end of the war what was wrong with the Germans.”

And yet this interpretation was first put forward by the allied occupying powers: “The Americans as well as the British asked themselves at the end of the war what was wrong with the Germans,” says Levsen. In an attempt to find an answer, they fell back on the old image of the Germans as obedient subjects. In the course of the so-called re-education of the Germans as democrats, the Americans placed great emphasis on the school culture: They encouraged discussions in class, saw to it that student councils were introduced, and supported the establishment of critical student newspapers.

“The Germans gradually began to adopt this image themselves,” says Levsen. In the immediate aftermath of the war it had still been common to interpret National Socialism as a break with traditional forms of authority, but gradually the belief became accepted that the Germans needed to break away from their authoritarian traditions to become real democrats, particularly in education. This interpretation became “a driving force in the educational change” – because it appeared especially compelling against the backdrop of National Socialism.

“For example, many ministries of education – even some in states governed by the conservative Christian Democratic Union – began in the second half of the 1950s to support critical student newspapers,” says Levsen. Active students were invited to participate, and there were government grants. From the 1960s on, more and more ministries began forbidding school principals from censoring the newspapers, “with the argument: ‘We’ve had that already.’” Levsen estimates that almost 1000 student newspapers existed in mid 1960s Germany, compared to perhaps 20 or 30 in France – and even these were “underground” newspapers, established without official recognition and support.



*Student protests in Freiburg: In Germany the movement of 1968 served more to intensify developments that had already been in evidence since the mid 1950s, whereas in France the revolt constituted an actual break.*

*Source: Freiburg University Archive*

The historian paints a similar picture of the way political education was treated in the two countries: Experts funded by the German government came to evening lectures and discussions with the leaders – still known at the time as “Führer” – of youth organizations, and when swastikas were painted on a synagogue in Cologne in 1959,

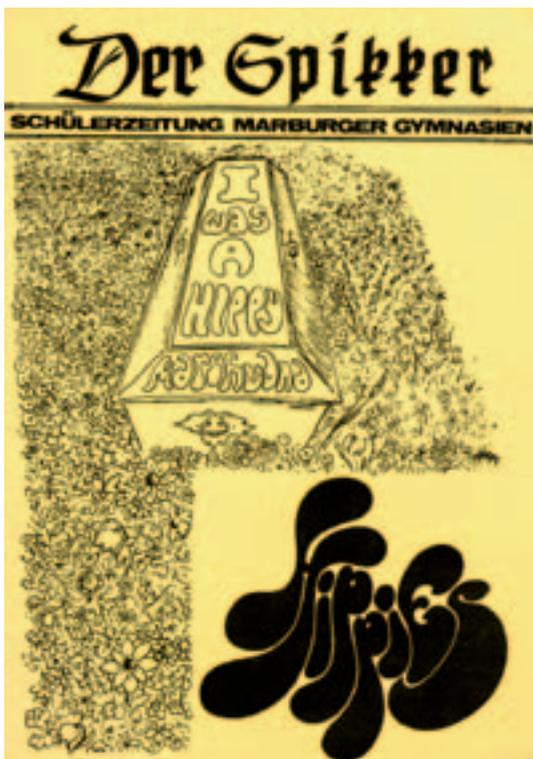
there were immediately calls for more political information at schools. When copycats committed a similar offence shortly afterwards in Paris, the reaction was completely different. Levsen tells of a school principal’s letter prohibiting all political discussion in class, because if the topic were to become a part of school life it could lead to unrest and dissent among the student body.

Levsen stresses that her intention was not to “paint a rosy picture and sum things up in black and white terms” in her book. There were of course many teachers in the early years of the Federal Republic who refused to speak about National Socialism, or principals who banned student newspapers on account of harmless articles. The historian’s intention was rather to identify general patterns of interpretation in the debates and point out their concrete potency. She did her research in the archives of German and French school administrations, as well as in magazines for parents, publications of teachers’ associations, educational treatises, informational material for youth leaders from youth organizations, and student newspapers.

### Radicalized Debates

Levsen examined the treatment of authority relations in four selected fields: school culture, political education, stance on corporal punishment, and sex education. Her findings bring to light subtle differences: “Beatings were indeed much more prevalent in German elementary schools than in French schools,” she says. There had already been criticism of this in the early 1950s, “but the change didn’t really gain momentum until the argument of the past came into play and until psychologists began arguing in the 1960s that if we beat the children they would become new Eichmanns, Nazis ready to obey orders.”

Debates on sex education followed a similar trend, with some aspects becoming even more radicalized in the 1970s: “There was a theory that it was not enough to merely provide children information but that one also needed to awaken their desire, because only so would they develop into truly liberated adults who would not become fascists.” In a follow-up project, Levsen wants to study how this very German argumentation influenced the philosophical debates of the time, also at the international level.



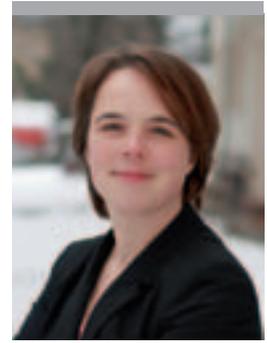
Almost 1000 student newspapers existed in mid 1960s Germany, like the Schüler Digest in Lahr (above) or Der Spikker in Marburg – by contrast, there were only few such publications in France at this time.

Sources: Stadtarchiv Lahr, <https://www.mls-ehemalige.de/der-spikker>

As a result of these differences in dealing with authoritarian structures, the protests of 1968 had a different meaning in Germany than in France: “The schools in Germany were already far more open at the time.” The revolt in France thus constituted an actual break, whereas the movement of 1968 in Germany served more to intensify developments that had already been in evidence since the mid 1950s.

“I naturally also asked myself why the discussion on authority in Germany was so effective in bringing on educational change,” says Levsen. The point of reference was more the collective, society in general, than the individual: “Schools did not fund student newspapers to help the students develop their personalities or express their interests – but to make them into good democrats.” Consequently, the debate should be understood primarily as a means by which society attempted to dissociate itself from its National Socialist past. It was a rather lazy way of doing so, however, “because it evoked the old image of Germans who couldn’t help but obey on account of their education as obedient subjects.”

[www.pr.uni-freiburg.de/go/levsen](http://www.pr.uni-freiburg.de/go/levsen)



**Dr. Sonja Levsen**

is deputy holder of the Chair in Modern and Contemporary Western European History at the University of Freiburg. She studied history, political science, and German studies in Tübingen; Cambridge, England; and Munich and earned her PhD with a comparative study of the consequences of World War I on the mentalities and political attitudes of German and English students, for which she received the Dr. Leopold Lucas Prize for Junior Researchers. Levsen then worked as a research assistant at the University of Freiburg and a junior fellow at the Freiburg Institute for Advanced Studies (FRIAS). She completed her habilitation thesis in 2016 with the help of a Dilthey Fellowship from the Volkswagen Foundation. Her research interests include the history of Western Europe in the 19th and 20th centuries and cultural historical approaches.

Photo: private

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*Starting gun: The brain gives the command, and the muscles execute it – but it is not yet known how this process works in detail.*

*Photo: Valeriy Velikov/Fotolia*



# From Idea to Movement

Scientists are using a special blend of methods to investigate previously unknown neural mechanisms of motor control

*by Stephanie Heyl*

**R**eady, set, go! Many precious milliseconds pass by in the interval between the starting shot and the point at which a 100-meter sprinter starts running – time in which a whole lot happens in the sprinter’s brain. Innumerable nerve cells need to communicate successfully with one another to get the right muscles to flex at just the right time.

The human brain is plastic and therefore changeable. We are thus capable of learning motor skills throughout our lives. Hurlers and dancers, for example, learn to seemingly effortlessly control and coordinate all the muscles of the central nervous system, consisting of the brain and the spinal cord. Evolution has driven the formation of increasingly complex structures in our brains, and the control processes have shifted more and more to an area of the cerebral cortex known as the neocortex. Our control over our fingers and hands as well as our speech organ in particular has become much more refined. Scientists refer to this as cortical takeover: Much of what was once executed autonomously in the spinal cord independent of willpower is now controlled consciously in the cerebral cortex. Primates and humans can exert influence on their environment deliberately and purposefully thanks to this highly developed structure with direct connections to the spinal cord.

### **Passing on Orders**

It is not yet known exactly how an action is controlled in the brain. Junior professor Dr. Christian Leukel, sports scientist and neurophysiologist at the University of Freiburg’s Institute of Sports Science and Physical Education, would like to find out. “We do not yet have a precise conception of where and how the initial plan to execute a movement in the brain begins,” he says. Various brain areas are responsible for motor actions. The deep layers of the primary motor cortex, a part of the cerebral cortex, harbor the pyramidal cells. Some of these cells reach all the way into the spinal cord with long threadlike projections called axons, where they pass on the orders for each movement to the spinal motor

neurons – nerve cells that then use their own axons to activate the skeletal muscles.

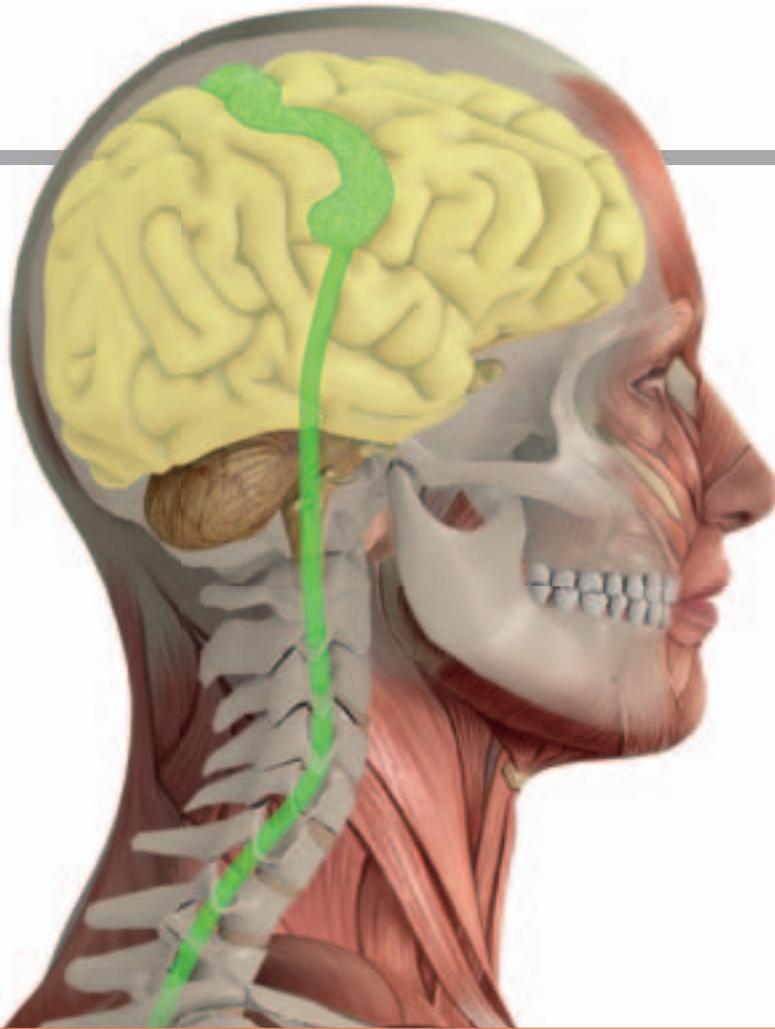
Leukel has devised a special blend of methods to obtain detailed information on the activity of the pyramidal cells and investigate previously unknown neural mechanisms of motor control. He and his team are employing a combination of electrophysiological stimulation and detection techniques. By stimulating the cells, the scientists can determine how nerve cells react to stimuli and thus control their activity.

## **“It’s all about timing.”**

In one experiment, healthy young volunteers sit on a measurement chair and are asked to flex their leg muscles when they hear a signal. The scientists can measure the cell activity in the brain and muscles simultaneously via electroencephalography (EEG) and electromyography (EMG). To stimulate the nerve cells in the brain, they use a method known as transcranial magnetic stimulation (TMS), in which a coil of copper wires is placed on the test subject’s head precisely above the primary motor cortex. The coil generates an electromagnetic field below the skull cap that stimulates cells in the primary motor cortex. “When we stimulate the right parts of the brain, we hit all possible cells at once, including the pyramidal cells, whose activity we want to measure,” says the scientist.

### **Direct Connection to the Spinal Cord**

The primary motor cortex has more pyramidal cells that reach down into the spinal cord than any other connection between the neocortex and the skeletal muscles. “The information there can be transported very quickly to the spinal cord and to the muscles,” explains Leukel. These connections are especially well developed in humans, and some of them run directly to the spinal cord without being influenced by other nerve branches. “The information that the brain



*Executing a simple movement involves complex structures: A part of the cerebral cortex (marked yellow) contains the so-called pyramidal cells. Some of these cells have long projections called axons that reach into the spinal cord, where they pass on the commands to nerve cells that then use their own axons to activate the skeletal muscles. Illustration: Oliver Wrobel*

sends via these connections can not be changed until it reaches the spinal motor neurons, and it is therefore also what activates the muscles.” Leukel’s team wants to stimulate precisely those cells that reach the motor neurons without any further influences. To do so, the researchers use an ingenious trick: “It’s all about timing – that’s the secret ingredient that gives us a unique possibility to apply our methods to observe a subpopulation of cells in the primary motor cortex with great precision.”

**“Training of particular motions is a reduction of variability.”**

To this end, the researchers apply electric stimulation along the leg parallel to the transcranial magnetic stimulation of the brain. These nerves also reach into the spinal cord and activate the motor neurons via a reflex. The two stimuli arrive at the spinal cord simultaneously, and this

can again be measured. This is only possible because the scientists know precisely how much time the information coming from the primary motor cortex needs on the fastest pyramidal pathway. “We wait for the point at which the two stimuli collide at the spinal cord. The collision leads to a change in our measurement signal, allowing us to determine the activity of our pyramidal cell population. This is a rather complex undertaking, but it is the only way to enable isolated and detailed observation of nerve cell activity in the human brain,” Leukel concludes. The key lies in precisely coordinating the stimuli. “Since our stimulation methods and recording devices are much faster than what the nervous system itself is capable of, we are able to image the activity at a high temporal resolution.”

#### **Excitatory and Inhibitory Forces**

But how is the interaction that produces the actual movement organized? When the pyramidal cells are stimulated in the primary motor cortex, excitatory and inhibitory forces are always active

parallel to one another shortly before a movement is executed. Then, according to Leukel's model, the forces cancel each other out, and nothing happens in the cell. If the inhibitory forces suddenly cease and only the excitatory forces remain, movement occurs. The cell in the primary motor cortex then passes on information. The sports scientists have already detected this inhibition. Now Leukel wants to know how the inhibition that influences the pyramidal cells is controlled. He suspects that this excitation is determined not just by the primary motor cortex but also by other structures of the cerebrum.

To what extent are humans capable of learning motor abilities, and how can the process be influenced? Leukel has tools for obtaining precise details on neural mechanisms and exerting influence on the activity of nerve cells. Scientists assume that the increase in cell activity in a person

at the beginning of a movement is not always the same but that the nervous system always produces a range of variation. "At the moment when we wish to precisely time a movement, however, this variation is poor," says Leukel. If the variation can be reduced, the timing becomes better. That is learning. "Training of particular motions is a reduction of variability," says the sports scientist. "A more detailed knowledge of neural mechanisms would allow us to better assess neural variability under pathological conditions and even to foster plasticity. If there is a change in the balance between excitation and inhibition, for example in patients with stroke or Parkinson's disease, we could possibly adjust the control system with our stimulation methods to enable an improved movement."

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#### **Juniorprofessor**

#### **Dr. Christian Leukel**

*studied sports science in Freiburg and earned his PhD in 2010. During stays in Copenhagen, Denmark, and in Zurich and Fribourg, Switzerland, he gained additional qualifications in clinical neurophysiology, focusing particularly on the application of neurophysiological methods in fundamental research on movement and sports.*

*Since 2014 he has served as a junior professor in neuroscience and sports at the University of Freiburg's Institute of Sports Science and Physical Education and as an associate member of the Bernstein Center Freiburg (BCF) and the Freiburg Institute for Advanced Studies (FRIAS).*

*Freiburg sports scientists stimulate nerve cells in the brain of a test subject and follow the activity on a computer screen.*

*Photos: Michael Veit*



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# Digitalized Dialects

A team at the Department of English is pioneering research-based learning approaches with the linguistic database FREDDIE

by Anita Ruffer



When many Germans hear the name Freddy, they think of a television detective from Cologne on the popular crime series *Tatort*. However, FREDDIE is also the name of a linguistic database developed at the University of Freiburg's Department of English that is currently poised to expand into the great wide world of the internet and open up entirely new avenues for research-based learning – and not just for students of English linguistics.

FREDDIE (Freiburg English Dialect Database for Instruction and E-Learning) is based on an earlier database called the Freiburg Corpus of English Dialects (FRED). Just as not everybody in Germany speaks such a clean standard German as people in Hanover do, not everybody in Great Britain speaks a pure Oxford English like the Queen does, the variety of English generally taught in Germans schools. Just like in Germany, the dialects in Great Britain can differ in grammar or pronunciation from county to county and from town to town. A team of researchers led by Prof. Dr. Bernd Kortmann at the University of Freiburg's Department of Eng-

lish decided in the late 1990s to examine these differences in detail and began systematically collecting data on English dialects. In the course of countless trips, the team collected data in the form of transcripts and original interviews: Men and women, most of them over 60, shared stories from their lives with the researchers. The material could therefore also be of interest to historians.

## From FRED to FREDDIE

What Bernd Kortmann and his data collectors were interested in, however, was not primarily the content of the stories but “how the people said things.” The FRED corpus consists of 300 hours of audio recordings encompassing a total of 2.5 million words from 372 interviews conducted in 163 towns in England, Scotland, and Wales. The collection is the largest of its kind and is a veritable treasure trove for corpus linguistics:



The linguistic database FREDDIE includes examples of dialect from the British counties of Yorkshire, Lancashire, Kent, and Cornwall, among others.

Photos: Davorana/Fotolia; Collage: Kathrin Jachmann

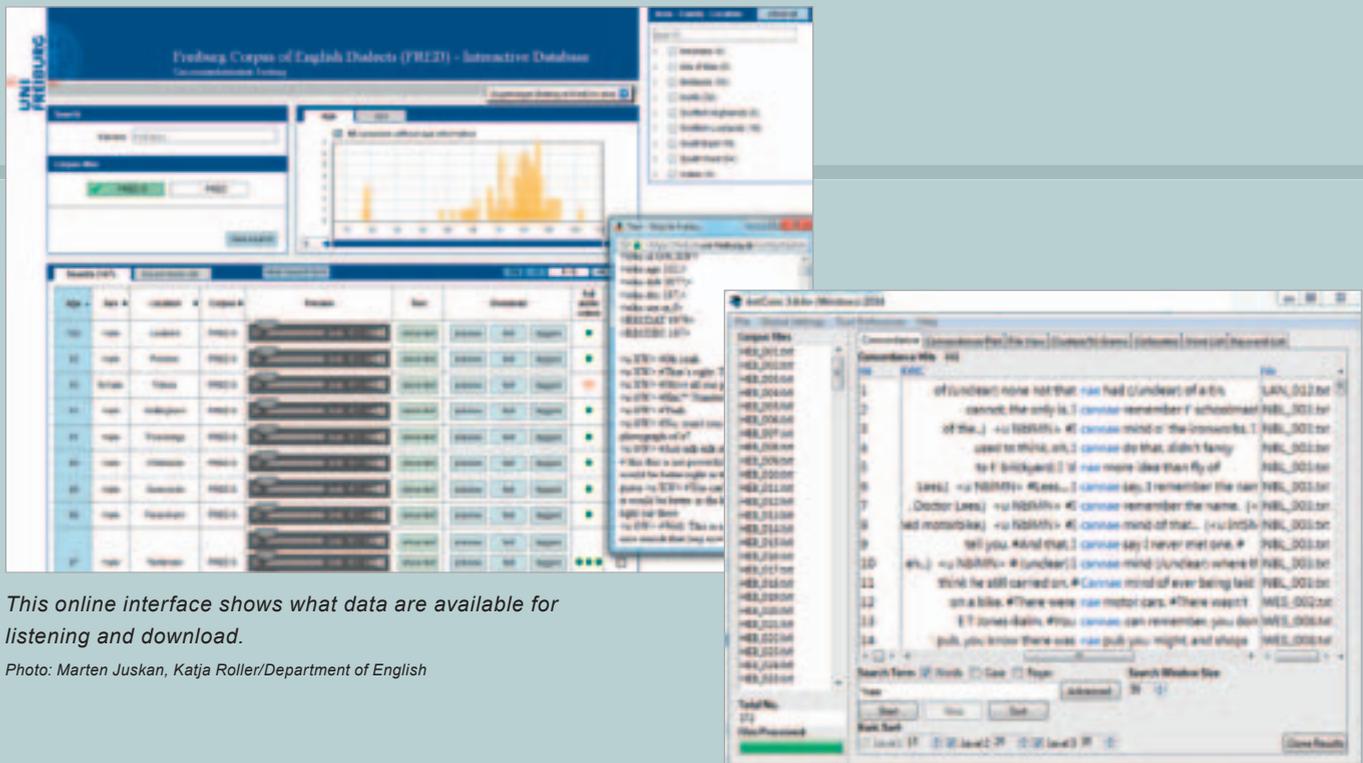
Researchers addressing differences in pronunciation can make use of the audio files, and those interested in grammatical features can draw upon the transcriptions. FRED was created between 2000 and 2005 in two projects funded by the German Research Foundation (DFG), both of them headed by Kortmann.

The remarkable thing about the database is not just the educational and scientific potential. After all, Kortmann and his team would never have been able to unleash this potential if it hadn't been for the rapid technological developments of the past decades. The interviews were originally transported back to Freiburg on audio cassettes and minidisks. They were later all digitalized, and the data edited on the computer. Around three years ago, the team began making them available online for researchers around the world. This involves a lot of hard work: The issue of who owns

copyright to all text and audio files needs to be settled and the data have to be anonymized.

How did FRED become FREDDIE? The collection of interviews alone might be referred to as the raw material – the important thing here too is what one does with it. Bernd Kortmann and his research assistants Dr. Katja Roller and Marten Juskan came up with a whole host of ideas on how FRED could be developed further into the multimedia teaching and learning platform FREDDIE. In 2016 they received an Instructional Development Award (IDA) worth 70,000 euros for their concept from the University of Freiburg. “We are going to edit the data for use by people at different competency levels,” explains Kortmann, possibly even secondary school students.

Katja Roller has already tested out the possibilities of FREDDIE with her students in an



This online interface shows what data are available for listening and download.

Photo: Marten Juskan, Katja Roller/Department of English

With the help of a professional program for linguistic text analysis, students found out that the negation “nae” – as in “He does nae like it”) is common in Scotland but is not used in the South of England.

Photo: Marten Juskan, Katja Roller/Department of English; Source: Laurence Anthony, [www.laurenceanthony.net/software.html](http://www.laurenceanthony.net/software.html)

undergraduate seminar: The students learned to conduct interviews and use a computer program to transcribe them. They saw how a linguistic corpus is set up. They analyzed which regions various words come from – finding out, for instance, that the negation “nae” (as in “He does nae like it”) is common in Scotland but is not used in the South of England. They carried out statistical studies and learned a new programming language for creating charts and diagrams. “Like in a scientific process,” explains Katja Roller, “they selected data, edited and analyzed them, and visualized the results.”

**“We are going to edit the data for use by people at different competency levels.”**

Damaris Stein, one of the participants in the seminar, found it “pretty cool that you can access so many audio files from so many different regions. It’s really funny to compare the various accents.” Without FREDDIE, the 21-year-old undergraduate might have had to conduct hundreds of interviews herself to discover the differences between the dialects. For her term paper she worked with FRED-S, a subcorpus containing around a million words taken from transcribed

interviews conducted in various regions. The subcorpus was recently made available on the Freiburg University Library’s “Freidok” server. The library – as well as the university’s IT Services Department – has been very active in supporting the linguistic pioneers at the Department of English. The library employees write programs, put the data online, and make suggestions about how it can be used. “We spurred each other on,” Kortmann raves of the collaboration.

### Freely Available Elements

Marten Juskan, for example, is working on combining text and audio files. So far it is only possible to make rough classifications, but “we’re going to refine things until it’s possible to look at each individual sound.” He hopes that this monumental project will one day benefit researchers around the world – and of course teachers as well: The Instructional Development Award winners aim to develop general instructional materials and concepts for the FREDDIE platform – like those Katja Roller has already tested out in her seminar – and also make them suitable for independent study. Statistics and corpus analysis programs will be provided on the internet as tools. In addition to these freely available elements, the team is planning password-protected areas in which teachers can post tests

or wikis for particular courses. A simple homepage will include general instructions on using the platform as well as links to the individual elements.

Hence, the platform under development at the Department of English is quite a marvel – and it is not just dialectologists who stand to benefit: It can be used by everyone who works with it to learn basic scientific methods that “can be transferred to other areas of linguistics,” as Kortmann assures. Perhaps the platform will even end up providing practical applications in forensic linguistics: If a perpetrator leaves characteristic “sound prints” instead of footprints, for example, FREDDIE might even turn out to be a useful crime-fighting tool for the other Freddy, the television detective.

<http://fred.ub.uni-freiburg.de>  
[www.freidok.uni-freiburg.de/proj/1](http://www.freidok.uni-freiburg.de/proj/1)



The researchers collected a total of 300 hours of audio material in 163 towns in England, Scotland, and Wales.

Illustration: olive1976/Fotolia, Kathrin Jachmann



**Prof. Dr. Bernd Kortmann** has served as professor of English language and linguistics at the University of Freiburg since 1995. After studying English and history at the University of Trier and the British Universities of Lancaster and Oxford, he completed his PhD at the University of Hanover in 1989 and his habilitation qualification at the Free University of Berlin in 1994. At the University of Freiburg, he is the founder and chairman of the board of the Language Teaching Centre (SLI) and has been executive director and director of humanities at the Freiburg Institute for Advanced Studies (FRIAS) since 2013. His main research interest is the grammar of non-standard English usage around the world.

Photos: Jürgen Gocke



**Dr. Katja Roller** completed an elementary school teaching program with a major in English at the University of Bamberg and the Swansea University in Wales. From 2012 to 2014 she received a doctoral scholarship at the University of Freiburg as a member of the research training group (GRK) “Frequency Effects in Language,” and in 2013 she also served as an adjunct lecturer in English linguistics at the University of Bamberg. From 2014 to 2017 she was a research assistant in the aforementioned research training group and at the Department of English of the University of Freiburg. She finished her PhD in English linguistics in 2016. She is currently completing the student teaching requirement for elementary school teaching qualification in Baden-Württemberg.



**Marten Juskan** studied English and Romance studies at the Universities of Freiburg; Grenoble, France; and Surrey, England. He was an adjunct lecturer at Freiburg’s Department of English from 2014 to 2015 and has since served as a research assistant. His primary research interests are socio-phonetics, language perception, and the interplay between peculiar dialect features, identity issues, and language change.

### Further Reading

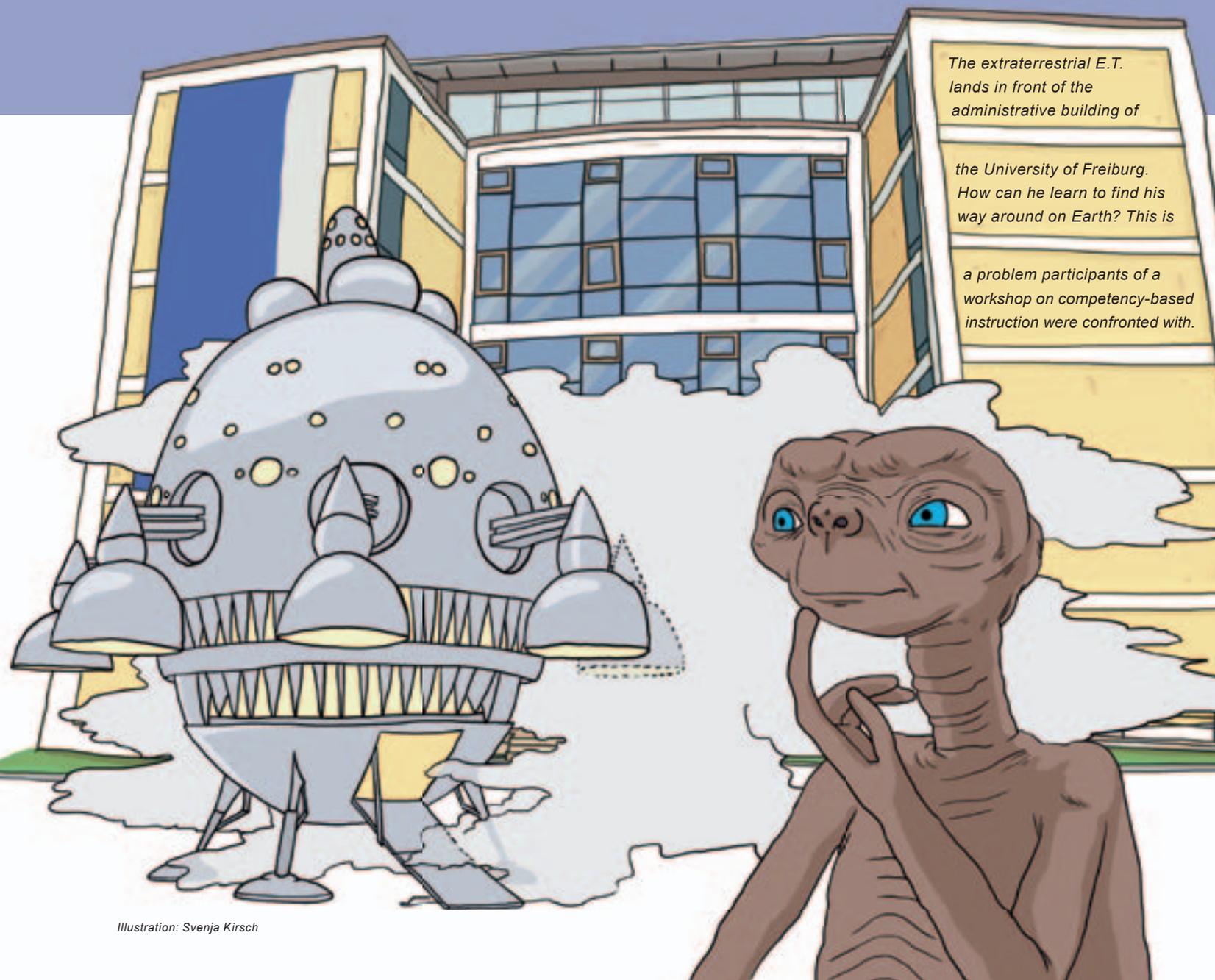
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# Learning Good Teaching

Educational scientists are using an educational research model to improve teacher education

by Stephanie Streif



The extraterrestrial E.T. lands in front of the administrative building of

the University of Freiburg. How can he learn to find his way around on Earth? This is

a problem participants of a workshop on competency-based instruction were confronted with.

Imagine E.T.'s spaceship lands right next to the Administrative building of the University of Freiburg. Smoke rises, lights flash. The door of the spaceship opens with a low hum. Out shuffles the diminutive extraterrestrial. Once he has reached the end of the long gangway, he stops and looks around – rolling his eyes, waiting cautiously. But this time it's not like it was in Steven Spielberg's film: E.T. does not just want to return home. He wants to explore the world and become a world traveler. This is not something he can do without external support. After all, E.T. is not from this world. He doesn't speak any German or English, and he has no idea how to get around, because he isn't familiar with cars or bicycles and doesn't know how to read a map.

How might one go about preparing E.T. for a world tour? This is the tricky task ten University of Freiburg teachers were confronted with at an introductory workshop on competency-based instruction – taught by Prof. Dr. Jeroen van Merriënboer, a Dutch educational researcher who developed the four-component instructional design model, or 4C/ID for short. This model is becoming increasingly important in the training of future teachers at the University of Freiburg. Why? It offers teachers guidelines for planning and designing lessons that foster the acquisition and long-term retention of knowledge and abilities. Rather than flooding learners with theoretical content, it encourages them to learn actively in a learning environment that is tailored to their needs.

But let's go back to E.T. for a moment: He's still standing in front of the administrative building and doesn't know what to do next. The workshop participants recommended teaching him German as quickly as possible. In addition, he needs to be explained how to read maps. Otherwise he won't even be able to find his way from the administrative building to the train station.

Christiane Klein from the University of Freiburg's Center for Teaching and Learning was one of the participants in the workshop. The educational scientist clearly remembers the sudden insight

she experienced when Merriënboer suggested not teaching E.T. the theoretical background necessary for traveling but helping him to actually travel himself. It would be enough for starters, found Merriënboer, to simply accompany him on his way to the train station and teach him the three or four words necessary to ask someone the way.

Klein is a project member of the Freiburg Advanced Center for Education (FACE), a cooperation network organized jointly by the University of Freiburg and the Freiburg University of Education.

**“The model is perfect for teacher education and professional development.”**

Its purpose is to improve teacher education in Freiburg, in particular with regard to coherence and professional orientation. Improving coherence means combining the academic, pedagogical, theoretical, and practical components of teacher education in a meaningful way and improving the coordination between the various training elements. Improving professional orientation, on the other hand, involves modeling these elements more closely after real situations from school life in an effort to align teacher education programs more closely with the teaching profession. Klein hopes 4C/ID can help to achieve both goals. “The model is perfect for teacher education and professional development,” she explains. “It guides the learning process by providing concrete learning tasks the teachers will later encounter again in the classroom.” Studies have long since provided evidence for the efficiency of 4C/ID-based courses.

4C/ID consists of four components: first, authentic and whole learning tasks; second, supportive information; third, procedural information; and fourth, part-task practice. Hence, if E.T. doesn't want to get stuck in Freiburg forever he'll need a learning environment that supports him in

becoming a globetrotter. More specifically, what he'll need is, first, walks through town; second, a map; third, knowledge on how to navigate through town by foot; and fourth, a whole lot of training in things like passing zebra crossings. Dr. Jessica Kreutz from the Department of Political Science and History at the Freiburg University of Educa-

**“The learning goals need to be arranged in steps, broken up into their individual elements, reviewed, and put together again.”**

tion knows from experience what it means to design a history seminar in accordance with the 4C/ID model. “Instruction in the field of history is no longer just about presenting dates and facts but about teaching the students the necessary know-how,” she says.

What does this involve? Field-specific knowledge is only one side of the coin, says Kreutz. “To become good teachers, students of history also need methodological, diagnostic, analytical, conceptual, and self-reflective competencies to foster an awareness for history in their classes.” As suggested by the 4C/ID model, Kreutz linked the learning content in her seminar “Competency Models and Competency Development in History Instruction” to concrete exercises. This resulted in learning tasks composed of field-specific, pedagogical, and theoretical parts, such as the following: “Design a source-based instructional sequence on a selected historical topic including a complex task description and an explanation of the underlying theory.” This learning task was already quite complex, says Kreutz. “At the beginning of the seminar, the tasks were much simpler.” This is also a part of the model: To avoid making excessive demands on the students, the teacher should begin by providing them more support and less complex learning tasks. At some point the progress becomes apparent, and the students continue learning alone or in small groups. “The learning goals need to be arranged in steps, broken up into their individual elements, reviewed, and put together again,” explains Kreutz. “In this way, you don't lose sight of the big picture with 4C/ID.”

#### Teachers Become Moderators

The idea is that when the students work with the material in this manner, they can still recall and apply what they have learned even years later. The model also appears to foster autonomous learning. Kreutz put a lot of time into preparing her seminar. The role she took on during class meetings was then more that of a moderator. The students did most of the work, and they appreciated the opportunity: In a short evaluation during the last class meeting, 75 percent of them stated that they had felt “more active” than in other courses. In addition, 87.5 percent found the authentic and whole learning tasks “very appropriate” and another 12.5 percent “appropriate.” One course participant noted on her questionnaire that the theoretical knowledge remained longer in her memory because she was able to apply it in practice and learn it step by step. Moreover, wrote another participant, the tasks were oriented closely toward his future working life at school: “That shows the point of it all.”

Authentische und ganzheitliche  
Lernaufgaben  
Beispiel: Spaziergänge durch  
die Stadt

Unterstützende  
Informationen  
Beispiel: ein Stadtplan

Prozedurale  
Informationen  
Beispiel: das Wissen, wie man  
sich zu Fuß durch die Stadt bewegt

Üben von  
Teilaufgaben  
Beispiel: Überqueren  
von Zebra Streifen

The four-component instructional design model, 4C/ID for short, incorporates active learning and fosters the acquisition and long-term retention of knowledge and abilities. Photo: robynmac/Fotolia



*In the future, training content in teacher education programs will be aligned even more closely with real classroom situations.*

*Photo: Oksana Kuzmina/Fotolia*

Christiane Klein and Jessica Kreutz believe that the individual components of teacher education should no longer be treated separately. Some seminars are focused on teaching and learning theories, others on field-specific knowledge, and still others are on pedagogical know-how. In everyday working life, however, teachers need to call upon their field-specific, subject-based pedagogical, and theoretical knowledge spontaneously and often also simultaneously to act in a professional way. According to the two educational scientists, 4C/ID can help to bring these three disciplines together. It is also thanks to the interdisciplinary team at FACE that the model can be used to integrate different academic disciplines. FACE is devoted to practice-based instruction and offers higher education teaching and learning courses designed to help teachers develop professional working strategies as defined by 4C/ID – as well as one-on-one advising, workshops, opportunities for exchange among colleagues, and a wealth of online material. The goal is to meet the complex demands of good instruction. School students will presumably give their seal of approval – and so would E.T., should he one day really decide to become a world traveler.

[www.face-freiburg.de](http://www.face-freiburg.de)



**Christiane Klein** began by studying pharmacy at the University of Freiburg, switching to educational science in 2009. In 2012 she earned her bachelor's degree in education and in 2015 a master's in educational science. Klein then served as a research assistant at the Department of Educational Science. She is currently developing competency-based instructional models and teaching teachers how to use them at the Center for Teaching and Learning.

*Photos: Thomas Kunz*



**Dr. Jessica Kreutz** studied Latin, history, educational science, and German as a foreign language in Greifswald. She earned her PhD in medieval and modern Latin philology in Göttingen. She then worked as a student teacher at the State Seminar for Teaching and Teacher Education in Freiburg. Since 2015 Kreutz has held the post of research assistant in the Department of History and History Teaching at the Freiburg University of Education, where she is engaged among other things with the "Quality Offensive in Teacher Education," a joint project initiated by the German Federal Ministry of Education and Research.

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Field test: 150 students completed the online training course "ELIS."

Photo: Sandra Meyndt



# Ending the Illusion of Understanding

How the online training platform "ELIS" teaches learning strategies and helps students to apply them

by Sonja Seidel

"ELIS" is the name of the cartoon figure that guides students through the University of Freiburg's new online training course. The acronym stands for "Erfolgreich Lernen im Studium" ("learn successfully in a course of study").

Illustrations: Steffen Weyreter/  
University of Freiburg

Lisa is new at the university. The 18-year-old is studying psychology and will be taking her first exam in two weeks. Her desk is cluttered with piles of books. Lisa sorts, underlines, and draws diagrams; she needs to work through hundreds of pages of literature. Time is short, her pulse races – Lisa has only made it through half of the reading material, and she doesn't know how she'll be able to remember the many terms. She begins to doubt whether she'll be able to pass the exam at all. She always had good grades in school, but now she's wondering whether the university is really the right place for her.

The University of Freiburg is now offering a new online training platform designed to help beginning students like Lisa: "ELIS" – "Erfolgreich Lernen im Studium" ("learn successfully in a course of study") – teaches students learning strategies and then helps them to integrate them into their daily lives. "Initially, students are completely overwhelmed with the amount of material they are required to learn," reports Prof. Dr. Alexander Renkl from the University of Freiburg's Institute of Psychology. That's the reason why Renkl and his assistants Jasmin Leber and Timo Endres developed the platform. The idea for it

was born in a practical context: “Our department was always asked to say something about learning strategies in the first week of an introductory lecture at the Institute of Psychology. We complied with this request, but always in the knowledge that you can’t teach anything that leads to substantial effects in the learners in this time. That gave us the idea of developing an online training platform,” explains Renkl.

The platform received the University of Freiburg’s Instructional Development Award (IDA) in 2015. The psychologists used the 70,000 euros in funding from the award to refine the platform in the lab and then test it on around 150 psychology students in an initial application phase in the 2016/2017 winter semester. In contrast to the commercially available self-help literature on the topic, ELIS helps students to apply learning strategies in their daily lives. “This is the first systematic online learning strategy training platform ever, and it is even connected to the authentic learning situation,” emphasizes Leber.

### The Platform Accounts for Prior Knowledge

A cartoon figure, also named ELIS, guides users through the three modules on various learning strategies. The strategies are illustrated in videos, texts, and diagrams. “We were inspired in developing it by so-called MOOCs, massive open online courses, which enable individual learning,” explains Endres. In contrast to MOOCs, however, the use of the tool is not bound to a particular date and time. Hence, the users control their learning on their own. They choose when to start each module and review the material in several consecutive learning phases. And what’s more, ELIS adapts itself to fit the users’ prior knowledge.

When Lisa uses the learning platform, she thus first takes a test in which she has to rate several statements on her learning strategies and study scenarios from daily life. What does she do when she can no longer concentrate and is behind schedule? Does she take a twenty-minute nap, or does she change her learning environment? What tactic helps her when she’s under a lot of pressure? Should she start by skimming through a text for a seminar meeting to

grasp its basic structure or is it better read it several times through? After Lisa has rated the various statements, the program calculates what she knows about learning strategies in the background and then presents her with tasks tailored to her prior knowledge in the three learning modules.

**„Initially, students are completely overwhelmed with the amount of material.“**

Lisa decides to begin with the module on resource-oriented learning strategies. They help to improve the learning environment, organize the learning process, and develop motivation. One of the things Lisa learns in this module is that she can lengthen her concentration span actively by progressively increasing the time she spends concentrating on a task. In the module on cognitive learning strategies, Lisa learns how to reduce the complexity of the learning material. The tool suggests that she should organize the technical terms using visual representations like mind maps or concept maps. This is something she already knows from school. Students do not learn without any strategies at all, of that Renkl is certain: “Most students learn in the course of time very well to organize the material. They make diagrams and underline important terms. But our training makes them better at these things too.”

The metacognitive learning strategies covered in the third module serve to ensure that learning goals are actually reached. “Students often succumb to illusions of understanding. They do not monitor their understanding but rather think that if they have already heard something once, they can do it. The tool is designed to make them more critical,” says Renkl. One advisable method is to compare learning goals and knowledge progress, for instance with learning protocols: The students ask themselves key questions to test for themselves how much they already know about a topic. This works best directly after a study session, when the material is still fresh in the student’s mind, and then again several days later.



*ELIS is satisfied. The learning strategies are grouped into various modules and are designed among other things to help students to plan and control their learning processes.*

The strategies presented on the online training platform focus particularly on knowledge retrieval. “Most students learn by reading a text, reading it again, and then reading the summary. However, merely reading a text again is not a very effective way to learn something by heart – that’s what our research indicates,” explains Endres. It is much more effective to begin by calling back to mind what one has read. Psychologists refer to this as the testing effect or retrieval-based learning. “This links the knowledge to prior knowledge in the brain and consolidates it. The retrieval trains the brain for the concrete exam situation, as it were,” adds Renkl. The tool communicates this principle on an individual basis: The system tests Lisa’s newly acquired knowledge about learning strategies between the learning phases by again asking her questions from the initial test: Have her responses changed? Has she internalized the techniques?



Illustration:  
Steffen Weyreter/  
University of Freiburg

In the second part, the program helps Lisa to come up with concrete situations for applying and practicing the learning strategies. This involves formulating so-called implementation intentions, which follow an “if–then” pattern: If Lisa has finished reading a chapter in a textbook, for example, then she will apply learning strategy A. Since Lisa has set these intentions beforehand with the help of the training platform, it’s easier for her to actually apply the learning strategies in daily life.

The online training platform ELIS has been available to all students at the Institute of Psychology since February 2017. “It currently serves a dual function. We are now at the point where we can already offer it to the students as a fully functional tool, but we’re still testing in the background whether everything works right and whether we can improve any of the content,” says Jasmin Leber. “In the long term we envision that it might also be used at other faculties.”

[www.elis.vm.uni-freiburg.de](http://www.elis.vm.uni-freiburg.de)



**Prof. Dr. Alexander Renkl** studied psychology at RWTH Aachen University and at the University of Marburg. In 1991 he earned his doctorate in psychology at the University of Heidelberg, and in 1997 his habilitation qualification at the Ludwig Maximilian University of Munich. After a stint as an educational psychology professor at the Schwäbisch Gmünd University of Education, he accepted a chair in educational psychology and developmental psychology at the University of Freiburg. His research focuses on example-based learning, self-explanations and instructional explanations, learning from multiple representations (multimedia learning), learning by writing/journal writing, and the pedagogical and psychological knowledge of teachers.



**Tino Endres** studied psychology at the University of Innsbruck, Austria, and at the University of Freiburg. Since 2014 he has worked as a research assistant at the University of Freiburg Institute of Psychology while writing a doctoral dissertation on learning through memory retrieval and the mechanisms of the testing effect. In addition, he has served since 2016 as an editorial assistant for the journal *Unterrichtswissenschaft*.



**Jasmin Leber** first studied to become a secondary school teacher in English and Spanish at the University of Freiburg and then went on to study childhood development and education at the Freiburg University of Education. In 2012 she returned to the University of Freiburg to complete her master’s in educational science. She has served since 2013 as a research assistant at the University of Freiburg Institute of Psychology and is currently writing a doctoral dissertation on learning with adaptive and adaptable multimedia systems. In 2014 Leber received the Johannes Wildt Junior Researchers’ Award for research on higher education teaching and learning from the *Deutsche Gesellschaft für Hochschuldidaktik (dghd)*.

Photos: Thomas Kunz

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## Masthead

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