



Cover: LVR/www.alltagskulturen.lvr.de
Documenting everyday life in the Rhineland in the 20th century: This picture from 1940, which depicts a farmer with an enormous pig at a slaughter site, is part of a new multimedia portal.

Digitised Cultural Heritage: An Unvarnished Look at Day-to-Day Life | Change of Presidency: Follow the Needs of the Sciences and Humanities | Synthetic Membranes: Smart Filters | Speech Recognition: Teaching Alexa | Global Theatre History: Behind the Scenes | Organic Catalysis: It's All About Resources | Primates: The Light and Dark Side of Sociality

Change of Presidency
Follow the Needs of the Sciences and Humanities 2
Peter Strohschneider looks back at his seven-year term in office



A Riveting Farewell 4
DFG bids goodbye to outgoing president in Berlin

Engineering Sciences
Matthias Wessling
Smart Filters 6
Synthetic membranes: New possibilities in combination with artificial intelligence



Engineering Sciences
Reinhold Häb-Umbach
Teaching Alexa 12
How speech recognition can improve digital virtual assistants

Humanities and Social Sciences
Nic Leonhardt
Behind the Scenes of Global Theatre History 16
Using unusual sources to trace the international story of an art form



Humanities and Social Sciences
Rembert Unterstell
An Unvarnished Look at Day-to-Day Life 22
A new multimedia portal on everyday cultures in the Rhineland

Natural Sciences
Lutz Ackermann
It's All About Resources 27
The growing potential and benefits of C–H activation



Life Sciences
Peter Kappeler
The Light and Dark Side of Sociality 32
Close bonds in primate groups are important but may pose risks

Follow the Needs of the Sciences and Humanities

Accomplishments, challenges and the unexpected: Peter Strohschneider looks back at his seven-year term as DFG President

german research: Mr. Strohschneider, we're holding this interview in mid-December on the journey from Bonn to Frankfurt as you head to another appointment, this being our only opportunity to meet prior to your leaving office. Would it be fair to say that the life of a DFG president is full right up to the last day on the job?

Peter Strohschneider: It's certainly packed with a rigorous, wide-ranging schedule. The operational flow in this role and in the DFG as such a large organisation has its own imperative, and it doesn't come to a natural halt at the end of a year or a term in office.

With the result that you haven't had the chance to take stock yet?

It's definitely too early for that. I also don't have the necessary distance yet to take stock. But over the last few days there have been some wonderful and touching farewell moments, in the DFG's various committees, at the DFG Head Office, with politicians and other leading figures in society, that bring to mind past events and provide an opportunity for reflection.

What kind of reflection?

This varies considerably depending on whether you're looking at the tasks and challenges associated with this role in the DFG, or the wider

world of research policy in which the DFG operates, or the world at large, in which both are embedded.

Let's start with the DFG: Would it be accurate to say that your participation in the organisation had the highest importance for you, even higher than the DFG's role and activity in the research system and research policy?

Yes, you could say that. The way I understood my role was: "I'm not simply distributing research funding – I'm managing a complex decision-making system." That's what the DFG is, after all, a decision-making system that decides on how to allocate billions of euros of taxpayers' money in a research-driven process based on research project plans and quality assessments. Nurturing and further developing this system always seemed to me a job that was as demanding and necessary as it was fascinating.

To what extent is it necessary?

For organisations of the size, complexity and importance of the DFG, critical self-reflection is an ongoing task that has become and will continue to be increasingly important. And it's closely tied to the responsiveness that is a principle of our funding activity. At the same time, it was obvious that the DFG funding instruments and associ-

ated decision-making processes had achieved a degree of expansion and diversification that I believed could not simply keep on growing. In this respect, the considerable efforts that we've made over previous years in systematisation and standardisation were urgently needed.

Does this put the DFG in a better position now compared to seven years ago?

If you look at our funding portfolio and the decision-making processes, you might indeed draw that conclusion. Given the ever-increasing dynamism of research funding, which is part of the dynamism of the scientific enterprise as a whole, the DFG has hopefully not only maintained but enhanced its functional capability. This is good news for the researchers submitting proposals and also for the organisation itself. But there's an even bigger advantage. An organisation that is modern and adaptable, and is perceived as such, can make its voice heard on issues that not everyone immediately recognises as important and timely.

Something you did above all with your continuous insistence on the value of curiosity-driven research?

Yes, in a diversified system of research funding providers, there



In this section of german research, Peter Strohschneider regularly addressed fundamental issues affecting research funding and science policy. His last interview with the DFG magazine was held in his official car – which, together with his offices in Bonn and Berlin, has been the outgoing President's most-used workplace over the past years.

can and must be places where research is not predetermined by external assumptions of relevance or simple problem-solving chains or by predictable outcomes, but instead driven by the quest for knowledge. The primary location for such research is our universities, and one primary source of their funding is the DFG. In recent years, if anything it has become more important to insist on this for the sake of our society's ability to perform and innovate. But I also saw it as a personal obligation.

This obviously didn't go unnoticed: during your time in office the DFG's funding budget for this type of research rose steadily and will continue to grow in the years ahead ...

... which is extremely satisfying, and which also applies analogously to the non-university research organisations in the German research system. An annual budget increase of three percent for another ten years, as achieved with the fourth Pact for Research and Innovation, and the associated confidence of politicians in a self-organised research community, is currently unique in the world.

You obviously couldn't have imagined this when you first took office, when you commented that the "seven fat years" were possibly over. Seven years on, this turned out to be a misjudgement – or perhaps the result of targeted action, including yours?

This prognosis clearly proved to be wrong – although I would add that

it did have a systematically correct core in that it's unwise to always assume that funding can be boosted indefinitely. But back then it wasn't anticipated that politicians would further increase their financial efforts on behalf of science. Nor did anyone expect, in the case of the Excellence Initiative, despite its importance to the international competitiveness of research at German universities, the kind of ongoing support that then came with the Excellence Strategy. The fact that this happened is first and foremost a success for research policy amidst other political budget priorities. The research community and its organisations also contributed to this success by laying out the value and capabilities of their research in political debates.

But more funding alone doesn't solve all the money problems to which you have repeatedly referred?

No, the asymmetries in funding flows in the German research system still persist, between university and non-university research and between basic and third-party funding – with all the implications this has for researchers as well as for a funding organisation like the DFG.

Enabling the organisation to function more effectively and securing financial growth are challenges you expect to face as DFG president – but you certainly wouldn't expect to be battling anti-science sentiments and populism. Would you ever have anticipated dealing with these kinds of issues, as has been the case over the last two or three years?

No, absolutely not. Who could have predicted the rapid rate at which representative democracy would tumble into crisis around the world, a crisis linked with an aversion to science and a crisis of confidence in it? A development like Brexit was as little anticipated as, say, the purge of Turkish universities, the suppression of academic freedom in Hungary, Trumpism or the arrival of a right-wing reactionary party in the German Bundestag.

Was there a moment when you thought "This is the issue I need to talk about"?

That moment actually came in early summer 2016, shortly before the DFG's annual meeting. I had wanted to give a speech on research policy and funding in Europe. In the last few days of preparations, the UK referendum took place, and it made clear to me that things like the executive technocracy of the European Commission and the populism

of the Brexiteers had recognisable structural traits in common.

Since then you've continually spoken out against populism and anti-science messages with such intensity and spirit that we might wonder whether it was Peter Strohschneider, the President of the DFG, speaking, or Peter Strohschneider, the public intellectual. Why is that?

I don't really see myself as a public intellectual. But personally I feel very provoked by this crisis phenomenon. All my life, I've oriented my relationship to the world and my use of language – with its subjunctives, modal particles and "distance formulations" – as well as my work as a literary scholar towards

mediation as a prerequisite for the modernisation of society. And now we see these populist and autocratic currents in revolt against the impositions of the modern age, with claims to non-mediation and directness. I see this as a threat to our pluralistic society. It's also an attack on the basic principles of liberal democracy and academic freedom. That's why I regarded my role and its visibility as an obligation, and was perhaps also able to use it to raise public awareness of these relationships.

Is that ultimately the type of impact you had on the role?

At the moment, it's beyond the limits of my self-observation to

A Riveting Farewell

DFG bids goodbye to Peter Strohschneider in Berlin

They had met the previous evening at a dinner with members of the academic research community, but Chancellor Angela Merkel wanted to take the opportunity to express her thanks once more. Her video message was shown in the

brilliant blue-illuminated foyer of the Museum for Communication in Berlin, and it was not the only surprise awaiting Peter Strohschneider, who on 16 December received a fitting farewell from more than 200 colleagues and friends in academia,



Illustrations: DFG / Aussenhofer

say whether and how I had an impact on the role of president. But I would be pleased if I was able to demonstrate that reasons are more important than positions of power and authority, and that we mustn't move too hastily from the mode of complexity-increasing analysis to the complexity-reducing mode of decision-making.

These seven years as DFG President are seven years that you could have used differently, especially as an academic. Do you have any regrets about this?

No, not at all. On the contrary, I've always regarded these years, plus the six years I spent on the German Council of Science and Humanities, as an enrichment of my life. They

have opened up new perspectives for me and allowed me to observe academia, politics and society in a way that I could hardly have done as a university professor. So I've been spared any such regret.

Your successor Katja Becker introduced herself with the words: "I'm joining the DFG directly from the research community." Afterwards, the weekly Die Zeit reported that with a president who is an expert in genuinely political issues such as Africa and tropical diseases, the DFG could become a world research foundation. What are your thoughts on such a vision?

It would be a very satisfying vision. But it neglects the fact that scientific inquiry and discovery

have always transcended national borders. However, as a social system, and from an institutional, legal, financial and economic perspective, it remains tied to a high degree to individual states. And at the present time, it seems to me that around the globe these ties are increasing again rather than diminishing.

So what would be your vision for the DFG?

For the DFG to continue carrying out its mandate of supporting academic research in which funding is distributed on the basis of rational decisions that follow the needs of the sciences and humanities, thereby serving to further develop a modern scientific society. This presupposes, of course, that the DFG will continue to be equipped with the resources necessary to best support this endeavour.

And your own plans for the future?

My plans aren't yet firmly fixed. Apart from the need for a little distance once again from non-stop activity. Of course, I'll be continuing to perform certain duties in the research system and I'm looking forward to new opportunities, such as working with the University of Göttingen's Foundation Council. And then, perhaps unsurprisingly, for me writing is part of achieving a little distance and that element of mediation in my relationship with the world. Recently I've had too little time for this, and in the tense relationship between knowledge and power, in which I've now spent so many years, there are numerous topics that could be explored in writing.



politics, the media and society after seven years in office. The round of farewell speeches combined tributes to his successful contributions to research and research funding and to his determined support of academic freedom and independence in an era of populism with memories of personal encounters and appearances. This came as just as much of a surprise to him as the musical background to the event provided

by percussion duo Double-Beats, whose sonically dramatic performance further captivated the audience. Strohschneider expressed his gratitude for the support he received both as president of the DFG and individually throughout different times and circumstances. At the end, the outgoing President was presented with a farewell gift, a volume of selected extracts from his speeches, and given a thundering standing ovation. **fine**

Interview by Marco Finetti

Matthias Wessling

Smart Filters

Synthetic membranes are an essential technology for water treatment and purification. Physical models are now also being combined with artificial intelligence, opening up new possibilities for the provision of safe drinking water.



A bundle of hollow fibre membranes, here ultrafiltration membranes made of polymer.

The pressing challenges of a globalised world and a steadily growing world population are becoming increasingly complex. This is associated with an array of issues and requirements, for example a reconsideration of the consumer needs of our societies, the intelligent exploitation of sustainable resources and a shift from existing value-added chains towards sustainable solutions. One example is the development and use of innovative membrane technologies, an interdisciplinary and forward-looking field of research with significant application potential.

Global population growth is going hand in hand with increasing urbanisation, which among other things demands modern technologies for drinking water treatment and post-treatment. Water scarcity in dry regions is also creating a necessity for new, economically viable concepts for the provision of safe water. Synthetic membranes made of polymers, metals or ceramics are an essential technology for water treatment and purification, laying the foundation for the supply of high-quality drinking water. The use of membranes is considered to be an innovative and resource-

efficient approach and may have the potential to revolutionise the complex water economy. One innovative membrane technology is helping to exploit sustainable sources from urban and industrial waste water, and therefore close the loop in the value-added chain from raw material to tailor-made product.

Taking their inspiration from biological membranes, researchers began to develop the first synthetic membranes to desalinate water and make it suitable for drinking in the mid-20th century. Membranes work in a similar way to filters,

allowing some substances to pass through while holding others back. The substances can be separated at completely different scales of size: while more porous ultrafiltration membranes separate larger particles such as bacteria and viruses, reverse osmosis membranes retain salt ions and allow only water to permeate.

For a long time, research on synthetic membranes lagged behind that on biological membranes. Synthetic membrane development stagnated and increasingly focused on high-purity water treatment,

for which very dense synthetic reverse osmosis membranes were used. But sustainable drinking water treatment has different requirements from the production of high-purity water. Here, the complete removal of all minerals from the water is more of a drawback of reverse osmosis. There are also new requirements in the food and pharmaceutical industries and the demand for recovery solutions for the valuable substances contained in water.

In the last two decades, a promising solution has been developed in nanofiltration that filters out

only specific salt ions. Nanofiltration membranes lie between reverse osmosis and ultrafiltration membranes on the membrane spectrum and currently they are used mostly in water softening. Softening refers to the removal of bivalent ions such as calcium and magnesium, for example to reduce unwanted limescale. The development of such membranes and the modelling of the underlying transport mechanisms through the membrane, particularly for filtering properties tailored to specific molecules, are the focus of our basic research in Aachen.

The first step towards tailored retention was made possible by the development of layer-by-layer nanofiltration membranes. The layer-by-layer architecture consists of oppositely charged polymer layers applied to a conventional high-porosity ultrafiltration membrane. Applying the material in layers proved to be a practical method of achieving retention of specific components in the water. This manufacturing technique has since been further developed. The new method makes it possible not only to manufacture individual membranes in the lab with a high degree of reproducibility, but also to scale up layer-by-layer nanofiltration membranes from lab scale to industrial scale in a membrane module.

Due to the interaction of charged ions with charged membranes and their charged surfaces, desalination processes based on these selective nanofiltration membranes are still difficult to fully understand. One way of examining them in detail is to use complex physical or mechanistic models. A fundamental model

Reverse osmosis membranes (left) have denser structures which retain salts, for example, while allowing water to pass through. Ultrafiltration membranes (right) only retain larger pollutants such as bacteria and viruses but allow a much higher flow rate.

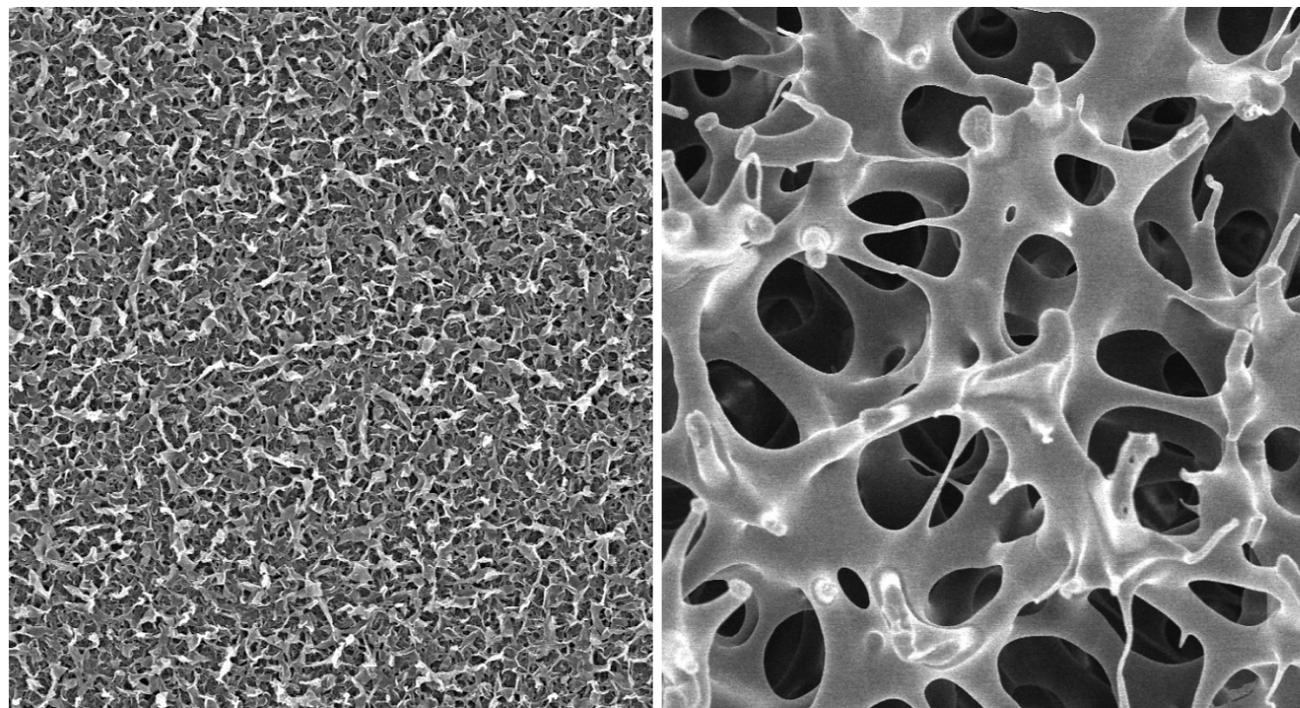
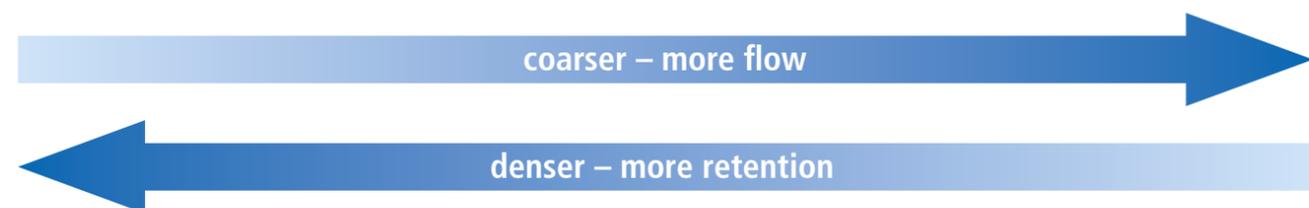


Illustration: Karin Faensen, Deniz Rall



In layer-by-layer nanofiltration membranes, charged polymer layers are applied to an ultrafiltration membrane. This has the advantage that, unlike a reverse osmosis membrane, the membrane can selectively retain salts / ions.

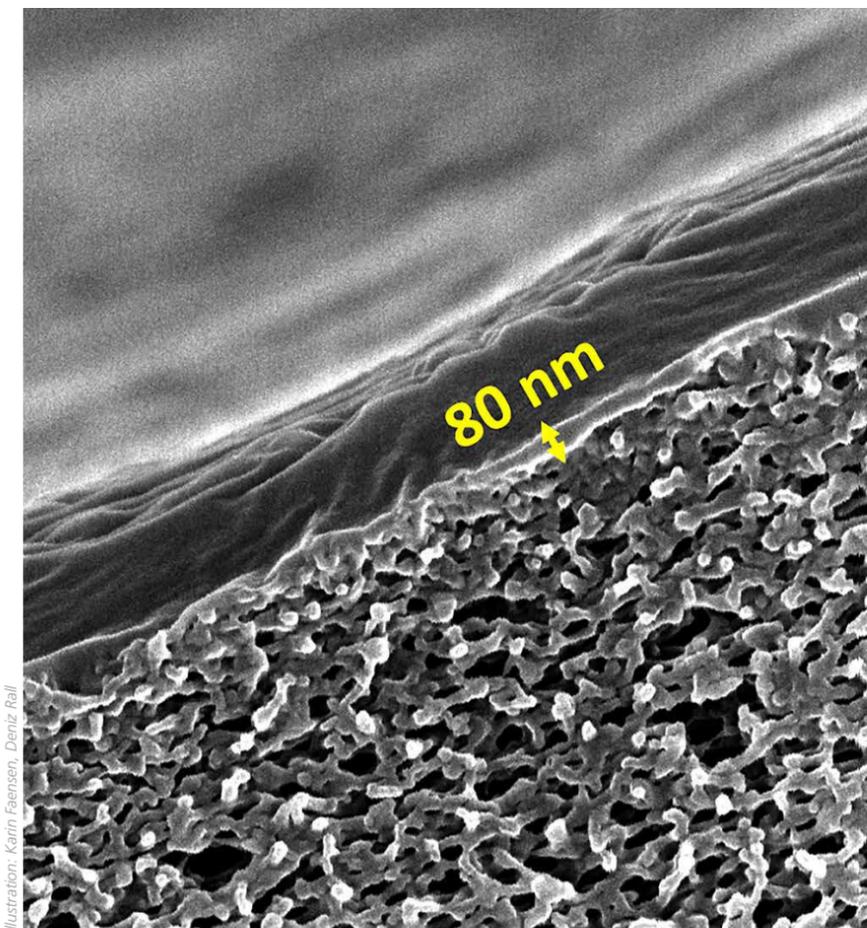


Illustration: Karin Faensen, Deniz Rall

developed by our team, known as pEnPEN, predicts the performance of pressure-driven layer-by-layer nanofiltration membranes. The acronym is a description of ion transport by multilayer geometries consisting of n electrolyte layers (E) with n polyelectrolyte layers, i.e. membranes (PEN), with an applied pressure (p) that drives the separation process. The promising aspect of this model is the fact that it can be applied to any membrane processes for the selective elimination of salt ions.

However, as with many model-based descriptions of membranes using mechanistic models, one crucial challenge remains: it is very difficult to correlate manufacturing of the membrane in the lab with its performance spectrum. For the first time, our team was able to demonstrate that artificial neural networks can provide tailored retention in layer-by-layer nanofiltration membranes and also the possibility of predicting and adjusting defined concentrations of specific components in the water.

To achieve this, the manufacturing and performance of the membrane were linked via an artificial neural network to produce useful correlations between the synthesis protocols of the manufacturing process and the membrane property. This unconventional development method is now being used to plan precisely tailored membranes for a predefined application scenario.

The development of membranes with the aid of artificial intelligence eliminates the need for conventional development

For people in developing countries and worldwide, safe drinking water is essential to survival. New membrane technologies and related research are contributing to the development of better methods for water treatment.



Illustration: epa / Fotoreport

Parallel filtration experiments are useful when characterising a membrane. The retention of substances is recorded under different experimental conditions.

methods that rely on a knowledge-driven process, known as a heuristic technique and involving a series of experiments. These experiments are usually performed in a conventional screening process: a membrane is manufactured on an “educated guess” basis, tested for its separation properties, improved and then tested again. The new data-driven method makes it possible to skip several of these steps thanks to the predictions of the artificial neural network. Since the neural network is trained solely on the basis of empirical correlations, a procedure involving artificial intelligence can be adapted to different material systems.

Combining artificial intelligence with physical models also allows a reliable physical analysis of the membrane’s performance spectrum with the help of neural networks. This gives rise to an interface between the membrane in the lab and its model-based optimisation – a paradigm shift in membrane technology. This method of membrane development will encourage other materials scientists and engineers at water treatment companies and enable them to overcome current limitations in the process design of membrane systems. Artificial neural networks make possible nonintuitive solutions that may remain hidden to view so long as only conventional screening processes with a known membrane system are used. The utilisation and expansion of exist-

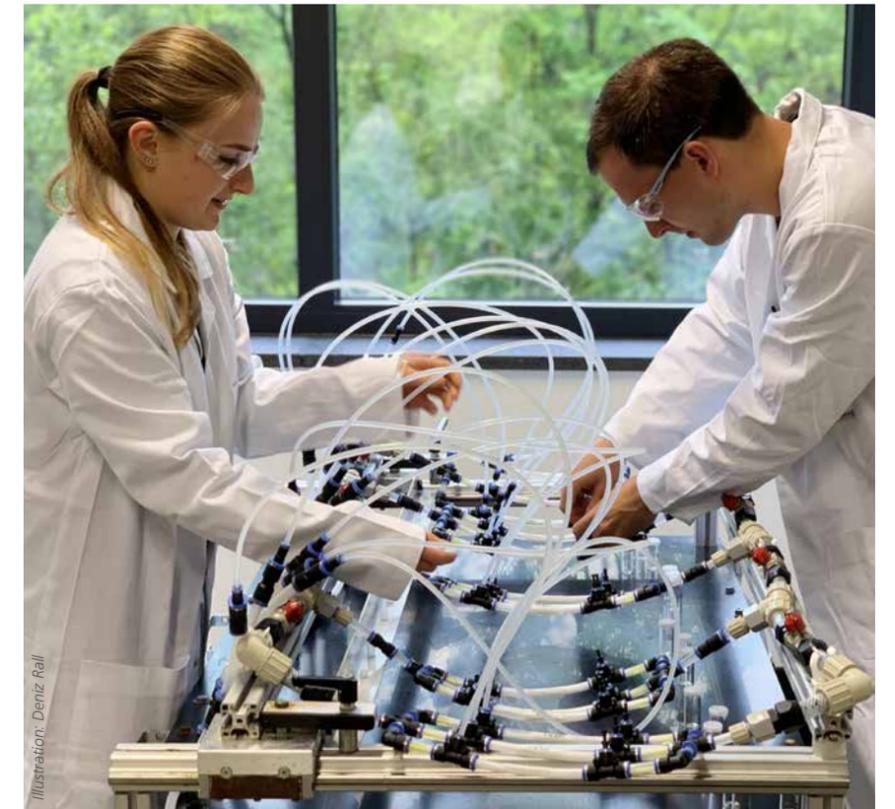


Illustration: Deniz Rall

ing knowledge through multigenerational learning with artificial neural networks will contribute to more efficient design of development processes and planning of membrane systems.

The challenges facing existing value-added chains are becoming increasingly complex, and not just in the water economy. The exploitation of sustainable resources also requires a rethink of value creation from raw material to product in an ecological and economic product cycle. Complex, tailored membrane processes based on innovative development methods lay the foundations for new processes. From concepts for the return of CO₂ to the product cycle using electrochemical membrane reactors to the biochemical production of basic chemicals in a biorefinery, over the

next few years the team will seek to further advance the development and application of innovative membrane technologies.



Prof. Dr.-Ing. Matthias Wessling holds the Chair of Chemical Engineering at RWTH Aachen University and belongs to the management team of DWI – Leibniz Institute for Interactive Materials in Aachen. He was awarded the DFG’s Gottfried Wilhelm Leibniz Prize in 2019.

Contact: Rheinisch-Westfälische Technische Hochschule Aachen, Lehrstuhl für Chemische Verfahrenstechnik (CVT), Forckenbeckstraße 51, 52074 Aachen, Germany

www.avt.rwth-aachen.de/go/id/inzr/idx/1



Reinhold Häb-Umbach

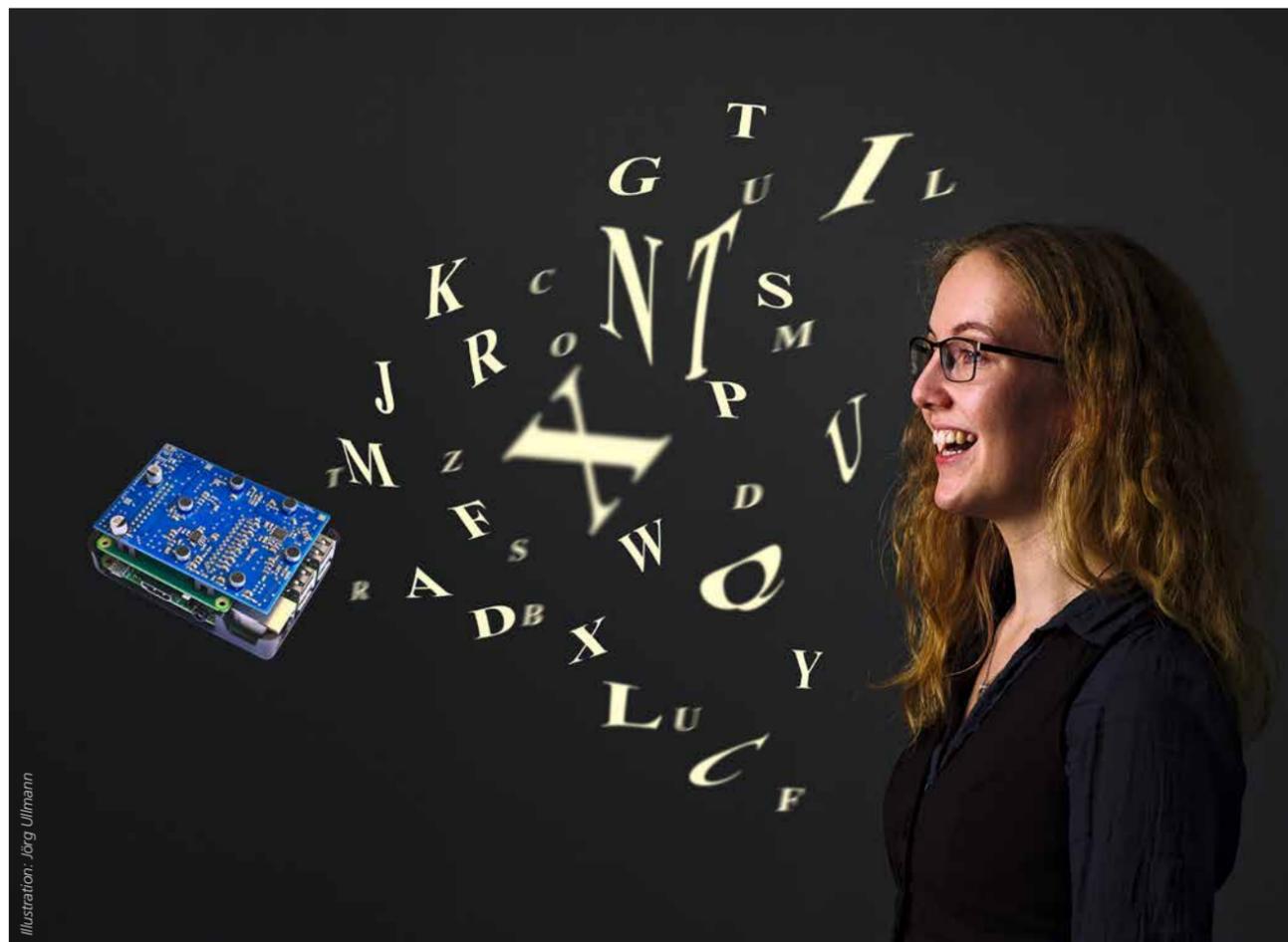


Illustration: Jörg Ullmann

Teaching Alexa

Combining acoustic signal processing with automated learning: Communications engineers are using microphone arrays and deep neural networks to improve speech recognition under difficult conditions. In the long term, these sensor networks could also help to improve digital virtual assistants.

Apple's Siri, Amazon's Alexa and other virtual assistants have become almost ubiquitous. In recent years, digital assistants operated by voice commands have advanced by incredible leaps and bounds. Responding to the spoken word, they will play previously selected music, create a shopping list or answer questions.

There are now tens of thousands of "skills" they can perform, from turning up the heating to lowering the window blinds in a smart home. Apart from a voice command, the only requirement is that the device or application be connected to the Internet or a home network.

None of this would have been possible without a combination

of basic and applied research. Research into speech recognition systems, computer programmes that

Above: Human speech is recorded by a powerful microphone array as a speech signal cloud. Right: An acoustic sensor node consisting of a multichannel microphone array and a minicomputer with radio module.

can convert human speech into a machine-readable form, began in the 1960s. Many early efforts were unsuccessful: although the systems developed could recognise a few dozen words, they could only do so under laboratory conditions with no interference or disturbance. This was partly due to the limited knowledge available in this new field, but also to the limited technical possibilities available to researchers 50 years ago.

Then came a significant development. In the mid-1980s, methods from probability theory and statistics began to be used in automatic speech recognition, dramatically improving recognition performance. The first commercial systems to be capable of recognising continuous text with a virtually unlimited vocabulary were launched on the market in the 1990s. These were specialist systems designed specifically for use in a professional environment, for example to record medical findings.

These systems could only achieve sufficiently satisfactory language processing within a clearly defined application.

It would be another 20 years before the next breakthrough. In the early 2010s, deep neural networks began to be used in speech and language processing. This technology, known as "deep learning", dramatically improved speech recognition. In 2017, for instance, researchers at Microsoft and IBM announced that they had achieved human parity: the computer could recognise language with the same word error rate as a human being.

The concept of artificial neural networks is, at least in principle, very simple, and the learning algorithms used have been known since the mid-1980s. Essentially, the network consists of a sequence of layers. In each layer, input values are multiplied by numbers derived from training data, referred to as weights, and the results are

added together. A nonlinearity is applied to the result, and the resulting variable is passed on to the next layer. The deep networks used today may contain up to several hundred layers.

During the learning or "training" process, the aim is to determine the weights from training data consisting of voice recordings and the corresponding text. If the voice recording is placed at the network input and the text, as the training objective, at the output, the weights are determined such that for a given audio signal at the input, they predict the output as accurately as possible. The network can then transcribe any speech input and convert it into text.

If the underlying algorithms have been known since the 1980s, then why did it take so long to achieve this breakthrough? The key success factors were the significantly greater capabilities of modern computers and the huge amount of speech data available,

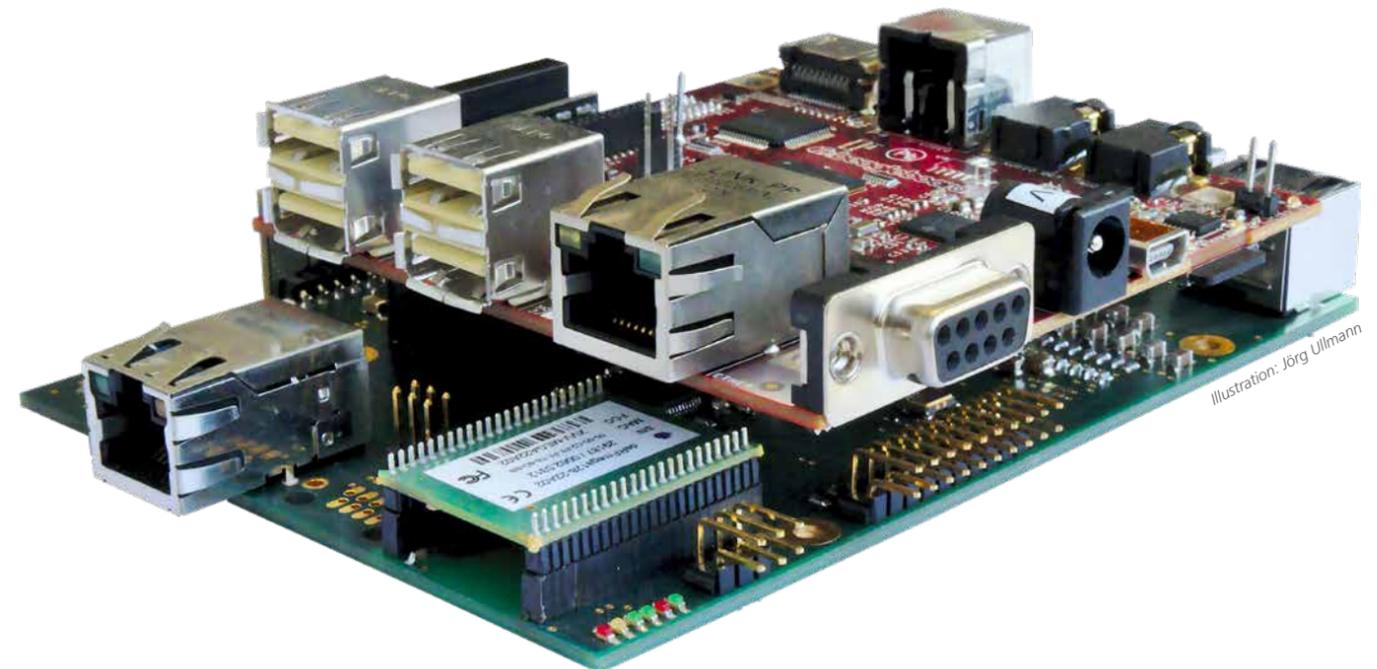


Illustration: Jörg Ullmann

often amounting to more than 1,000 hours of spoken language. This was what made the training of deep networks technically feasible.

The breakthrough in deep neural networks also prompted the development of consumer products, such as the pioneering virtual assistant Siri for Apple iPhones. But there was still a long way to go before Alexa and similar remotely controlled devices appeared in our living rooms, because for applications like these the desired speech recognition was much more difficult – and for two reasons. Firstly, the voice signal can be distorted by room echo and other signal sources in the room (such as side noise from a television). Secondly, operation must be completely voice-

based; using a keyboard or touch-sensitive screen is not an option.

A crucial element in the success of the technology was the use of microphone arrays rather than a single microphone. This allows a “directional beam” to be focused on the target individual’s voice signals, with signals from other directions being suppressed. A single microphone cannot make use of spatial information in this way.

Reliable speech recognition using remote microphones is an area being studied by researchers at the University of Paderborn. With the help of DFG funding, traditional sensor array techniques are being combined with neural networks to improve speech recognition and processing even in

environments with a lot of interference. The success of this approach has been demonstrated by international comparative tests, as well as the fact that it has been adopted by research groups worldwide who are now further developing it.

Perhaps an analogy will make it easier to imagine the regulating effect of signal processing on pattern recognition using neural networks. A neural network for speech recognition needs training data from representative recognition situations. The system is fed with speech data like a shotgun being loaded with shot. We do this in the hope that, in an actual application, the specific recognition situation is there, in other words that when a shot is fired at the target, one piece of shot will score a

hit. The use of signal processing makes the shotgun more accurate, so that you gradually need less and less shots in order to hit the target.

The adroit combination of traditional signal processing and neural networks has advantages over a purely neural network-based solution. It allows previous knowledge to be applied to a problem, requires less training data and computing capacity, and ultimately enables better interpretation of the processing steps compared with the “black box” solution of a neural network. When it comes to improving speech processing, for example removing reverberation from a signal or separating out multiple speakers, this hybrid approach has proved successful.

What does the future hold for virtual assistants? It is already not unusual to find more than one smart speaker in a home. Since smartphones have at least one microphone, and many other devices are now also equipped with one (for example TV remote controls), the obvious question is whether these distributed microphones could collaborate to achieve much better signal detection than a single device positioned somewhere in the room. There is a very good chance that one microphone will be located somewhere near the person speaking.

It is scenarios like these that interest the DFG Research Unit “Acoustic Sensor Networks”, where researchers from Paderborn University, Ruhr-Universität Bochum and Friedrich-Alexander-Universität Erlangen-Nürnberg investigate communication, signal processing and pattern recognition aspects in networks of distributed microphones. Other large-scale ap-



How can a smartphone be given even more functionality? Improving speech recognition amid background noise is one possible starting point.

plications outside the home include the acoustic monitoring of noise control regulations and wildlife reserves. The protection of privacy is another very important issue in this regard and has led to the concept of “privacy by design”. In line with this principle, again with the help of neural networks, the detected signal is compressed such that it can only be used for the intended purpose (for example the recognition of bird song or calls).

So, are virtual assistants or “smart speakers” actually intelligent? No – as philosopher John Searle’s thought experiment of the Chinese room demonstrates. Imagine a sealed room in which a person who does not understand Chinese is given questions written in Chinese and is required to answer them, also in Chinese, with the help of instructions in his or her native language. A piece of paper with a question written in Chinese is passed into the room through a slot. The person searches for the symbols on

the paper in a large table and, under each entry in the table, finds the symbols to be given as the answer. Based on the results, people outside the room conclude that the person in the room understands Chinese, even though this is not the case. Algorithms or competent devices in themselves are not intelligent, but they can be “intelligently” used and exploited.



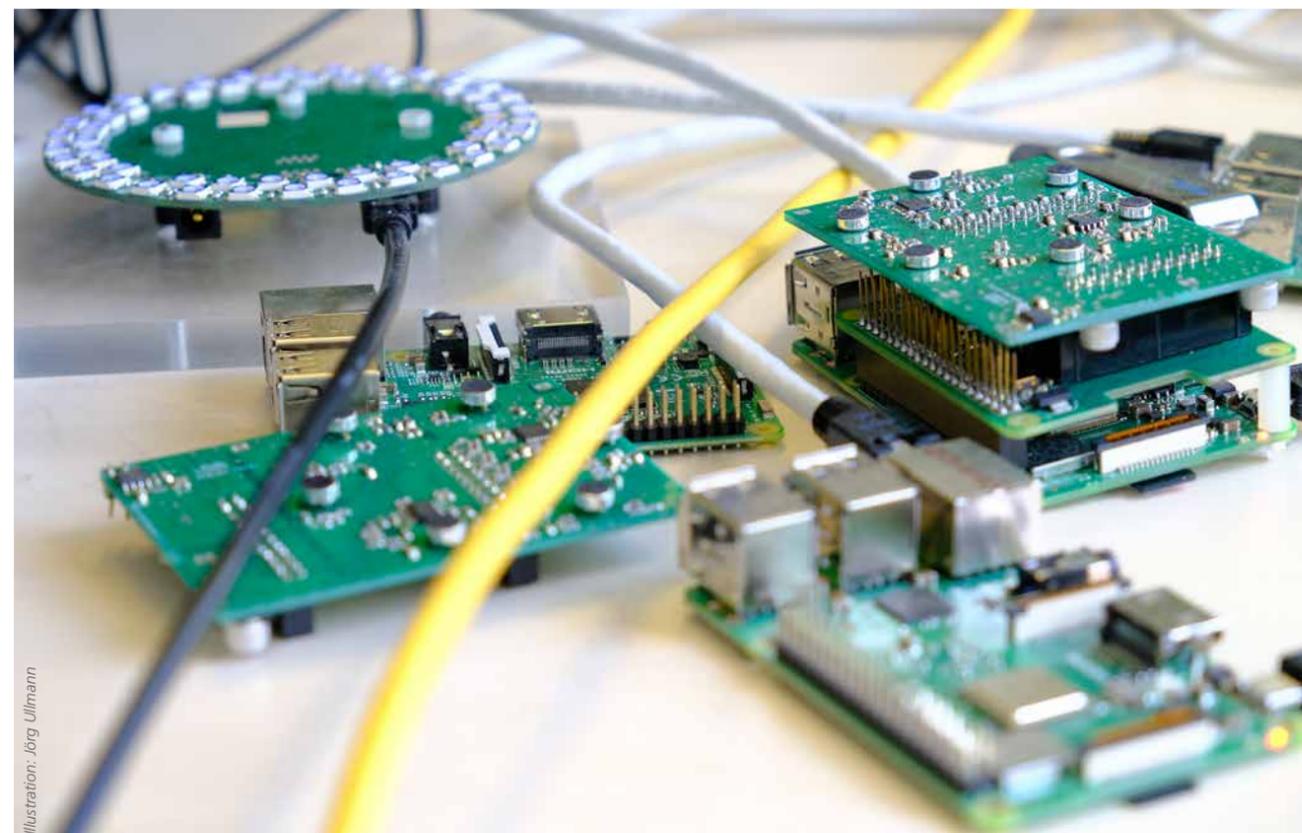
Prof. Dr. Reinhold Häb-Umbach holds the Chair of Communications Engineering at the University of Paderborn and is the spokesperson for the DFG Research Unit “Acoustic Sensor Networks”.

Contact: Universität Paderborn, Fakultät für Elektrotechnik, Informatik und Mathematik (EIM), Institut für Elektrotechnik und Informationstechnik, Warburger Straße 100, 33098 Paderborn, Germany

www.uni-paderborn.de/asn



A communications engineering lab set-up with which researchers are testing a newly developed multichannel microphone array.



Nic Leonhardt



Behind the Scenes of Global Theatre History

How do you research and recount the global history of theatre? A Reinhart Koselleck project in Munich used unusual sources such as passport applications and passenger lists to trace the international story of an ephemeral art form.

Our age has changed the very notion of travel. What was once a dreaded ordeal has become a pleasure. Only once modern advancements had achieved their remarkable and unprecedented progress, once it became possible to travel from one country to another with ease and rapidity, did we learn to enjoy the pleasures of travelling. Nowadays, cities and countries seem to have drawn closer to one another [...].”

Travel. Across wide oceans. Across borders. Encountering what is new and strange. The brief and lyrical quotation above might almost be recent, but in fact it comes from an article in the *Berliner Illustrierte Zeitung* published in 1912, under the heading “Pleasure Cruises by Sea”. It seems almost prophetic of the modern enthusiasm for cruises.

Although we take it for granted today, in 1900 this form of travel was just beginning to take off in a

big way. This article may reflect a luxury for the rich, but it also testifies to a degree of mobility already being taken for granted in the years leading up to the First World War. This new mobility was made possible by “unprecedented progress”, travel by motor-car, train and ship, and the apparent shrinking of the world due to modern technologies and media such as the telegraph, press agencies and a huge variety of newspapers. All of this has been the subject of extensive critical research in recent years in the context of global or transnational history as well as interdisciplinary transcultural studies. A Reinhart Koselleck project entitled “Global Theatre Histories”, funded by the DFG between 2010 and 2016, engages with this very discourse.

Global Theatre Histories addresses the feasible-sounding yet laborious task of illuminating theatre in the context of early phases of globalisation and transnational transfer, cultural and cultural-industrial networks and infrastructures. But linking theatre with sea voyages? With mobility? Seeing theatre history as the history of global networking? Isn't theatre tied to a specific location, fixed

The famous Royal Opera House in Mumbai. Built from 1908 to 1912 by theatre impresario Maurice E. Bandmann and J. F. Karaka, restored from 2008 to 2016. Research done by the project team informed the restoration process.

venues, and locally and culturally specific audiences, you might ask? The simple but ambiguous answer is “Yes and no”.

Books on theatre history provide only an occasional glimpse of the global mobility of the art form. It is well known that famous artists such as the French actress Sarah Bernhardt and the Canadian dancer Maud Allan went on tour. It is also known that plays by Norwegian dramatist Henrik Ibsen were quickly translated and performed in many different countries, and that Viennese operettas caused a sensation on Broadway for years. But apart from occasional glimpses like these, studying the background

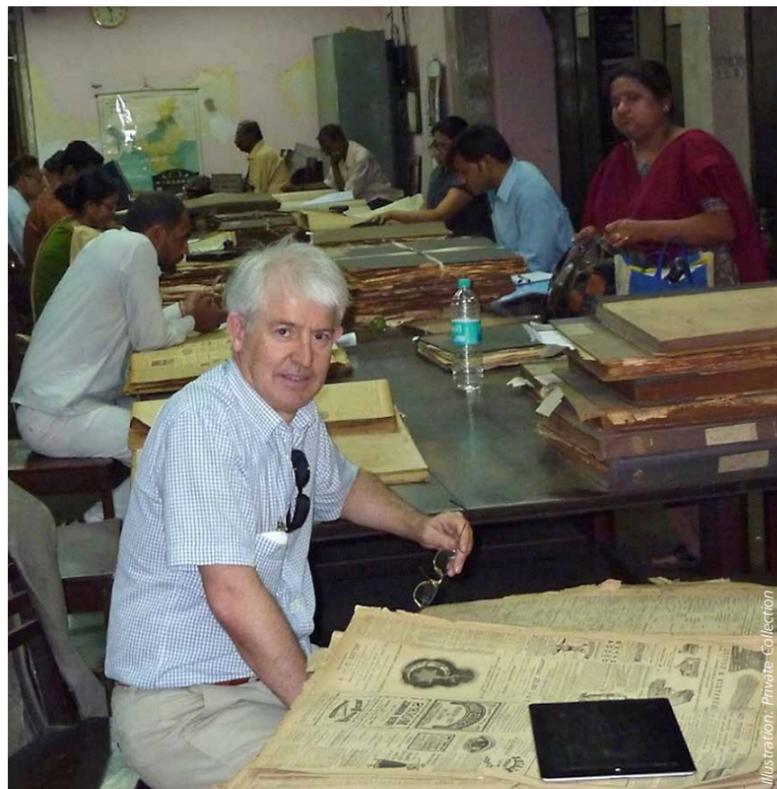
to these tours and above all their infrastructure has so far played no more than a marginal role in theatre studies.

Global Theatre Histories was therefore breaking new ground. The project identified and followed traces of the history of theatre that transcend a national or local historiography, examining exchange, mobility, touring artists and their agents, and the circulation of productions, aesthetic ideas, dance, artistry and musical theatre. Although international tours by theatre practitioners were already part of the theatrical business prior to the 19th century, it was in the late 19th and early 20th centuries that they reached their height.

Right: The theatre business was quick to adopt new technologies and means of communication. Cover of the *Artistic Telegrams Schlüssel* dating from 1889 (Austrian National Library, Theatre Museum)

The global mobility of theatre increased continuously over the course of the 19th century. But how do you study it? The questions pile up: What role has theatre played in the context of the dynamics of globalisation since around 1860? What transnational links and networks arose through theatrical exchange and what motivated this exchange? Were the motivations political? Economic? Aesthetic? To what extent

Left: Project leader Christopher Balme at the National Newspaper Library in Kolkata. Studying the history of theatre in its global context requires the examination of many different sources. Right: Passport application of theatre broker Richard Pitrot dating from 1909.



 A scan of a United States of America passport application form from 1909. The form is filled out for Richard Pitrot, a citizen of Austria. It includes fields for name, date of birth, date of arrival, and a sworn statement of intent to reside in the United States. The form is signed by the applicant and a consular official, George E. Morrow.

DESCRIPTION OF APPLICANT	
Age, 37 years	Month, <i>October</i>
Stature, 5' 7" inches, Eng.	Color, <i>Gray</i>
Forehead, <i>High</i>	Hair, <i>Dark</i>
Eyes, <i>Blue</i>	Complexion, <i>Dark</i>
Nose, <i>Straight</i>	Face, <i>Round</i>

 A vintage advertisement for 'Artistic Telegrams Schlüssel' (Theat.-S.). The design features a large, stylized key graphic. The text is in German and includes:

- NATIONALBIBLIOTHEK IN WIEN
- 623464-A
- THEAT.-S.
- 100 bis 200% Ersparniss an Zeit und Geld.
- Preis 1 Gulden österr. Währ.
- Preis 1 Mark 60 Pf.
- Uebersetzungsrecht in allen Sprachen vorbehalten. (Oesterreich-Ungarn, Deutsches Reich).
- Zum internationalen Verkehr zwischen Directoren, Artisten, Agenten und allen Interessenten der Variété- u. Specialitäten-Theater des Continents.

did theatre influence the institutional and aesthetic processes of modernisation in non-western regions? What is the relationship between mobility, theatre and the law? And what role has theatrical entertainment played in the development of transnational audiences, for example in cities such as Buenos Aires, Kolkata, Singapore and Shanghai?

Examining the global history of theatre seems a very ambitious

task. Hence from the outset the project relied on a broad, interdisciplinary team of researchers and a continually expanding international network of partners with the necessary linguistic and specialist skills. The core team led by Christopher Balme in Munich consisted of three doctoral researchers and one postdoctoral researcher as well as associate (early career) researchers. By way of example, Anirban Ghosh inves-

tigated circus arts in colonial India in his project "The Tropic Trapeze". In her monograph "Theater über Ozeane. Vermittler transatlantischen Austauschs (1880–1925)", Nic Leonhardt traced the work of international theatre agents and brokers. MeLê Yamomo dedicated his dissertation project to "Sound-ing Modernities: Music and Theatre in Manila and the Asia-Pacific, 1869–1946". And Gero Tögl undertook a new reading of the international impact of Richard Wagner in his project "The Bayreuth Enterprise: 1848–1914". Finally, project leader Christopher Balme focused on theatrical manager Maurice E. Bandmann, who built up a global theatre circuit around the turn of the century.

To understand how theatre migrates, how artists and productions get from A to B, and by what or whom they are driven, you are obliged to consult an extremely varied range of sources. The source materials range from newspaper articles and visual sources to passport applications, passenger lists, telegrams, contracts, telephone directories, census records, order slips, bills, cheques for artists', agents' and authors' fees, and court records. Obviously this work could not be undertaken without access to other disciplines and their methods, an enhanced sensitivity to the peculiarities of archives and provenance, multi-lingual skills and collaboration.

"Nowadays, cities and countries seem to have drawn closer to one another, such is the rapidity with which they can be reached," noted the 1912 article quoted at the beginning. By contrast, studying the contexts

Since 2015 it has been possible to learn about global theatre history in a massive open online course (MOOC).

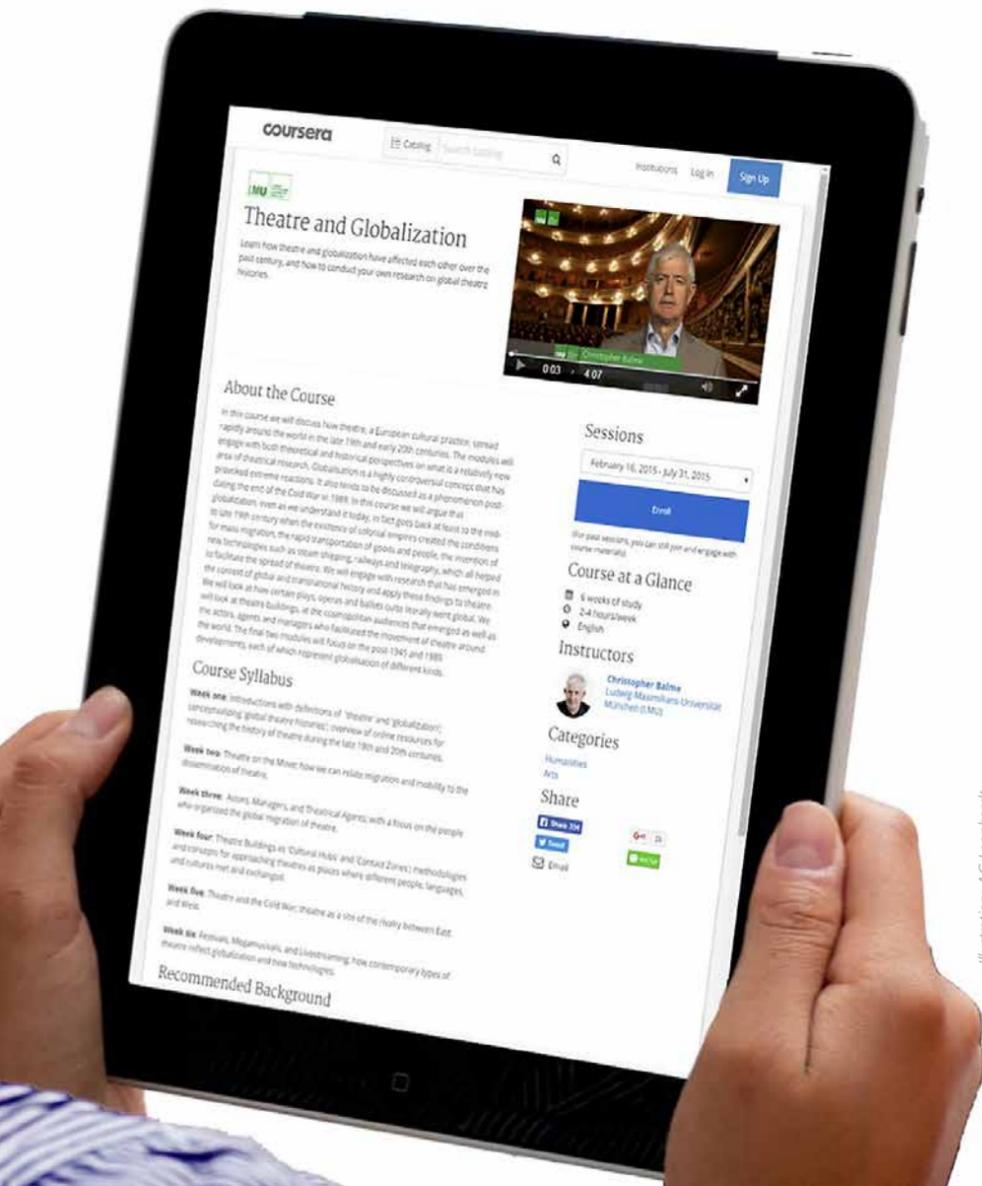
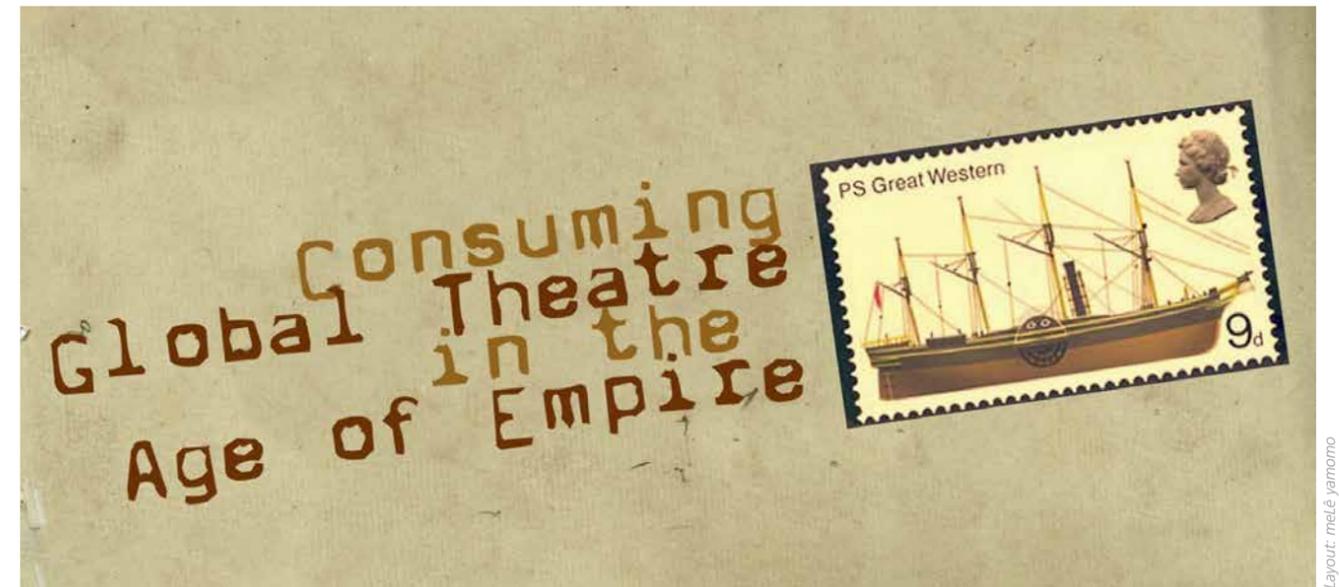


Illustration: AG Leonhardt



Layout: melê yamomo

Detail from the programme of a working session of the Global Theatre History project in Montreal, 2011.

of this supposed shrinking of the globe ex post demands no small investment of time. Over the last decade, more and more historical materials have been digitised and made publicly available – an enormous aid to this type of research. Digitised versions of newspapers and journals, which regularly reported on theatre all over the world, allow us to follow on the heels of Sarah Bernhardt as she crosses the oceans. The historical study of an art form regarded as "ephemeral" is always hard work; looking through the lens of global history does not reduce the work involved, but expands our understanding and enables us to revise and rewrite previous versions of the history of theatre and other cultural practices.

Numerous publications have arisen from the project in the form of monographs, essays, magazine articles, a science cast and an online brochure. A digital mapping tool named Theatrescapes helps us to visualise theatre as a global

phenomenon in the period under investigation and to understand exchange processes, connections and (possibly) asymmetries in the dissemination of theatre, both temporal and spatial. Global Theatre Histories has also been gradually integrated into teaching, with seminars and lectures on the topic, followed in 2015 by the launch of a massive open online course (MOOC) on "Theatre and Globalization", delivered via the international learning platform Coursera.org.

Theatre and sea voyages. Theatre and mobility. Theatre history as the history of global networking. There are still more questions to be asked. The avenues opened up by the project have not all been explored yet; if anything they would seem to be setting the pace for a long-term continuation of the approaches and methods it has developed, to unravel the history of performing arts not just in the period studied within this

project, but beyond. With this in mind, a competence centre has been established at LMU Munich, the Centre for Global Theatre History within the Institute of Theatre Studies, to continue the work begun by this project.



Illustration: Peter von Felbert

PD Dr. Nic Leonhardt was Associate Director of the Global Theatre History project at LMU Munich; the project was led by Munich-based theatre studies scholar Prof. Dr. Christopher Balme.

Contact: Institut für Theaterwissenschaft, Ludwig-Maximilians-Universität München, Georgenstr. 11, 80799 München, Germany

www.gth.theaterwissenschaft.uni-muenchen.de

<https://gth.hypotheses.org>

www.coursera.org/learn/global-theatre



Rembert Unterstell

An Unvarnished Look at Day-to-Day Life

Cultural heritage in the cloud: A multimedia portal is bringing together documents and objects relating to life, home and work in the Rhineland in the 20th century. It's a fascinating example of the possibilities and challenges of digitisation.

There used to be more tinsel," lamented German comedian Loriot, in what has become a well-known phrase from a 1978 Christmas sketch. His character may have hankered for the "good old days", but perhaps it would be more accurate to think of the past as simply being different? There was a time when many people still lived in the countryside and German culture was greatly influenced by a rural way of life. "Provincial" life and livelihoods seem as natural a picture as the proverbial apple trees in the back yard. But as any local or regional historian will tell you, it would be a mistake to assume life was idyllic.

Rural life was often associated with hardship and austerity, close to nature but with more than its fair share of hard graft at home, on the farm and in the workshop. People's lives were subject to the whims of seasonal weather, not to mention pests and the difficulties of selling their products. Working life and

family life were still governed by age-old patterns, yet the world was also changing. The dreams and aspirations of those today who yearn to return to a more rural lifestyle perhaps fail to acknowledge the hardships of daily life that existed until well into the 20th century.

For researchers and history enthusiasts who want to consult original sources and form a picture of the past in all its nuanced complexity, there is now a new resource: the Digital Portal for Everyday Cultures in the Rhineland. This searchable portal contains documents and information about rural life and its transformation. As part of a pilot

project, ethnographers, historians, museum staff and documentation specialists from Rhineland's regional authority, Landschaftsverband Rheinland (LVR), developed a thematically focused "Rhineland Portal", which concentrates on "Rural Transformation 1900–2000".

The DFG project, completed in the summer of 2018, was carried out by experts in cultural studies from LVR's Institute of Ethnography and Regional History (ILR) in Bonn and its two open-air museums in Mechernich-Kommern (Eifel) and Lindlar (Bergisches Land). The partners' shared goal was to bring together items relating to both intan-

Left: Farmer and butcher in one: The pig has been led to the slaughter site and tied with a rope. Picture ca. 1940 from the municipality of Alpen (Niederrhein). Right: Cultural anthropologist Dagmar Hänel holding a glass negative from the extensive photographic collections of Bonn's Institute of Ethnography and Regional History.



gible culture, in other words archive materials, and material culture, i.e. museum objects. The project came about as the result of a DFG call for indexing and digitisation projects. But bringing together such an eclectic range of materials, which in some cases were not even inventoried, came with a host of challenges. But we're getting ahead of ourselves.

The project began six years ago, when all three institutions were tackling the (still ongoing) challenge of digitising their extensive collections and making them available on an open-access basis. The problem was deciding where to start and where to stop. The Bonn institute alone holds between 500,000 and 600,000 photographs of the people and culture of the Rhineland, an immense volume of written documents and research materials (such as old ethnographic surveys in the form of questionnaires), and a unique collection of around 300 ethnographic documentary films.

The museums of Rhineland life – one of which, the popular museum

in Kommern, is among the largest open-air museums in Europe – have both collected tens of thousands of objects large and small, from fish platters and reaper-binders to a complete schoolhouse. All pertain to a common cultural space, the Rhine Province, which existed from 1822 until 1945 and covered large areas of the modern federal states of North Rhine-Westphalia, Rhineland-Palatinate and Saarland.

For this 'historical Rhineland', the project team wanted to link paper documents from the archives and the three-dimensional objects from the museum stores. Dr. Eckhard Bolenz, the long-serving director of ILR, sums up the very pragmatic initial considerations: "Digitisation and a long-term database strategy are important to indexing these enormous collections of material."

Project manager Dr. Dagmar Hänel, a cultural anthropologist, took a different perspective. Her approach draws on the bestselling book "A History of the World in 100 Objects" by Neil McGregor. This approach and idea are readily transfer-

Right: Artefacts with a vivid story to tell about rural life in the Rhineland: A straw basket with a fez-like head covering (centre top), weaving shuttles (right, second from top), making wire in a home workshop (right, third from top), a picture postcard with "Greetings from Drachenfels" (bottom right) and a reaper-binder with power take-off manufactured by Fahr (bottom left).

able: why not create a virtual gallery of Rhineland culture through carefully chosen artefacts?

This is of course set against the background of the widespread conviction, unquestioned among digital natives, that if you can't find it on the Internet, it probably doesn't or can't exist. It was an approach that clearly benefited the ethnographically oriented project, which was funded for five years and is reckoned to have produced 12,500 data records. These are gradually being added to the German Digital Library ("Culture and Knowledge Online"), making them available in Germany's largest nationwide portal for digital cultural material. In this way, the source-supported story of everyday life in the Rhineland becomes part of the larger narrative of Germany's cultural past.

Considering the bigger picture by studying the smaller detail, minutely examining representative source material to identify larger cultural patterns, is an established method in the ethnographer's or cultural anthropologist's toolkit. The starting point for the project was the cottage industry of narrow fabric weaving. "It's a very relevant topic of research," says

Left: The purpose of the online portal, which is accessible to both scholars and the public, is "education and research on everyday cultures in the Rhineland".



All illustrations: Landschaftsverband Rheinland (LVR) / www.alltagskulturen.lvr.de

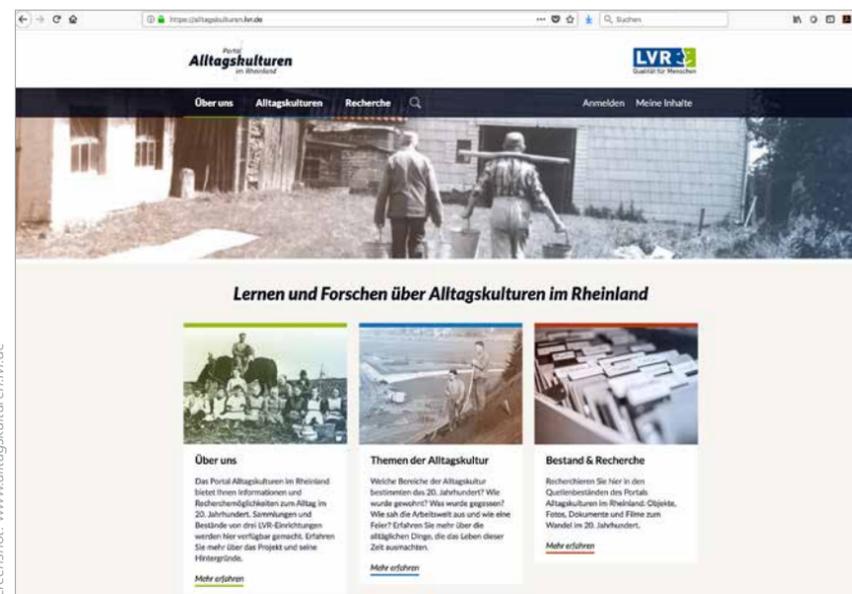
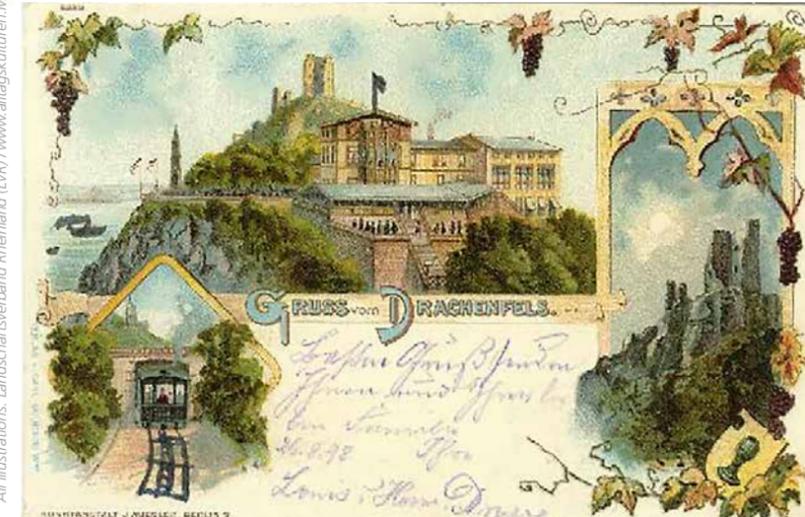




Illustration: T. Pflaßmann / LVR

Hänel as she shows me around the photo, film and document collections of the institute in Bonn.

The photos in the wooden archive boxes provide a window on the past. Around 1900, the Bergisches Land region saw the beginnings of a textile industry that would become world-famous for its Barmer Artikel – tapes and cords made in the town of Barmen. Hänel explains that weavers working at home manufactured tapes and edgings for the production of clothing, linen goods and corsetry, including bindings, straps, tapes for the waistbands and hems of trousers, curtain heading tapes, elastic tapes, braces, technical products such as heavy-duty straps, and even cigar bands and ribbons for gift-wrapping. Even an incomplete list of articles shows clearly that at the turn of the last century, a diverse range of goods was already being manufactured for specific purposes.

All three LVR institutes hold relevant sources for this aspect of the region's heritage, from photos and objects, such as shuttles and bobbins, to a weaver's house (which visitors can explore at the open-air museum in Lindlar) and documentary film

footage. Currently, 149 objects, 25 documents and 23 photos are accessible via the online portal, with many more in the pipeline – each with an explanatory data sheet including a technical description, useful contextual information and a permalink to the object. There are also articles on specific topics (for example the division of labour in cottage weaving), which, unlike encyclopaedia entries, are credited to the author, making contributions of this kind citable.

After the pilot phase came the all-important technical nitty-gritty, explains Bolenz. The work mainly related to the software and database technology, and the fact that DFG-funded digitisation projects aim for reusable standards and workflows in the digitisation environment with a view to maintaining high quality and long-term usability. The same goal was pursued by the Everyday Cultures project, which recorded objects and written materials for the future portal with FAUST, a widely used documentation solution, and used the MediaFiler software to process photo collections, film and audio documents. Unfortunately, the use of two different solutions meant

that significant unexpected problems cropped up in relation to data compatibility and networking.

Hänel says that this was “the biggest and most time-consuming challenge in the project”. In trying to find solutions, the project team perhaps benefited from the fact that they were working on a pilot project not only in ethnography, but also for LVR. For its cultural funding, this organisation pursues a “Digital Agenda 2020”. The end result was a new technical architecture, using the software digiCULT.web, which enables integrated data gathering in line with modern documentation standards. Experts regard it as being future-proof and reusable.

“Everyday Cultures in the Rhineland” is an example of a regionally oriented online portal that benefits from the vivid insights into everyday lives offered by ethnographic studies. As to how the transition from project to product goes, we will have to wait and see. But there is good reason to suppose that the foundations have been laid, in terms of both thematic content and technology, to continue growing the initiative using a modular approach.

One particular feature – often called for, less often delivered – seems to have been achieved already. As well as being open to scholars, the portal is also accessible to members of the public, whether people researching their home region, local journalists, teachers or museum visitors. For those who are fascinated by regional history and appreciate the rich diversity of regional cultures, here is treasure waiting to be discovered.

Dr. Rembert Unterstell

is Publishing Executive Editor of *german research*.

www.alltagskulturen.lvr.de



Lutz Ackermann

It's All About Resources

Organic catalysis: The activation of ubiquitous but unreactive carbon-hydrogen bonds has emerged as an environmentally friendly alternative to traditional techniques of molecular synthesis. This strategy can be used to minimise toxic by-products and develop new functional materials, which may also be beneficial in applications such as polymer synthesis and drug development, among others.

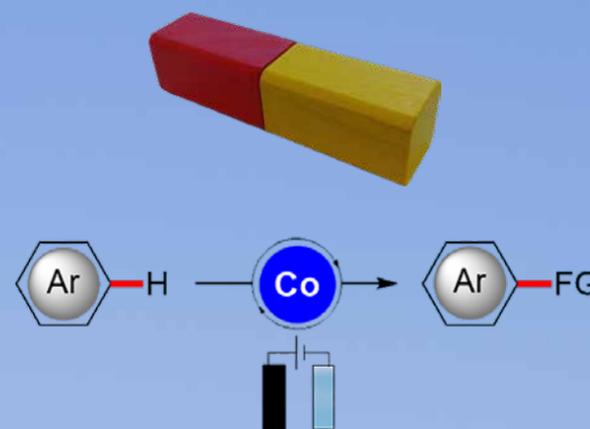


Illustration: Shutterstock, Montage: Hering

From laundry powder to decaffeinated coffee, from smartphones to anti-cancer drugs, chemistry plays an essential role in our everyday lives. Despite – or perhaps because of – its fundamental importance, modern chemistry does not define itself primarily in terms of its productive relationships with its sister disciplines of physics, biology and medicine. The tool of molecular synthesis, in particular, is key to success in the assembly and synthesis of polymers, plant protection agents and numerous pharmaceuticals. Chemical synthesis has likewise paved the way for organic light-emitting diodes (OLEDs) and is laying the foundations for keeping a steadily growing world population healthy and well nourished.

The essential role and importance of chemistry is also reflected in the fact that it is the only discipline in the natural sciences to serve one of the biggest sectors of industry, namely the chemical and pharmaceutical industries. But in spite of its central position and remarkable achievements, chemistry does not always have a positive public image. On the contrary, its image has suffered setbacks as a result of major, unfortunate chemical accidents in the last century.

While such incidents, it is to be hoped, now belong to the past, the efficiency of chemical synthesis still has potential for improvement. In particular, the production of undesired, often toxic by-products can still have a significant environmental impact. To make

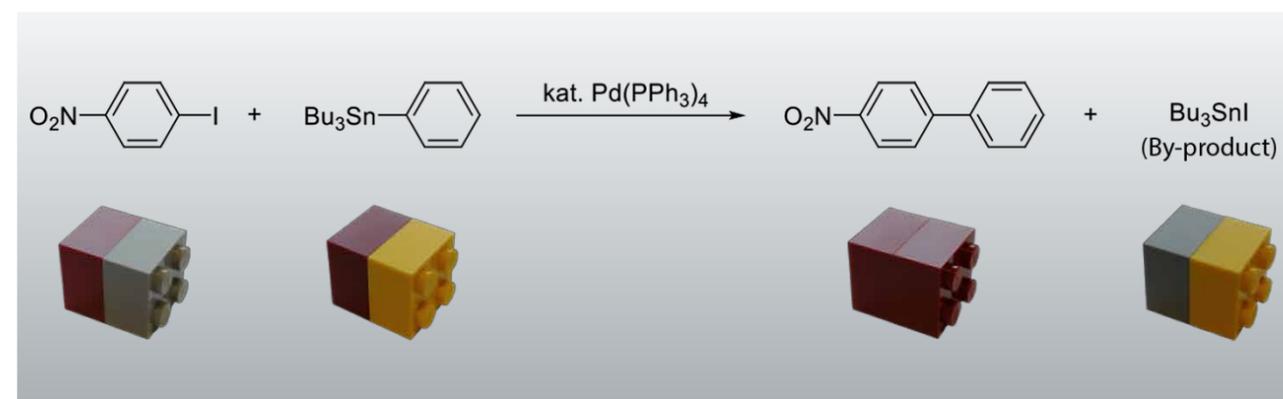
chemistry more sustainable, the aim must be to avoid this as much as possible.

This can be illustrated with the help of a recent example. There is a particularly effective method for the modern production of organic molecules, known as palladium-catalysed cross-coupling. Here, a soluble palladium complex selectively couples two organic molecules in a process which is used to synthesise plant protection agents, OLEDs and pharmaceuticals, among others. The selectivity, and thus the efficacy, of these cross-couplings is ensured by the presence of two complementary functional groups in the two substrates. This approach can be envisaged in terms of molecular LEGO bricks (see diagram 1 opposite),

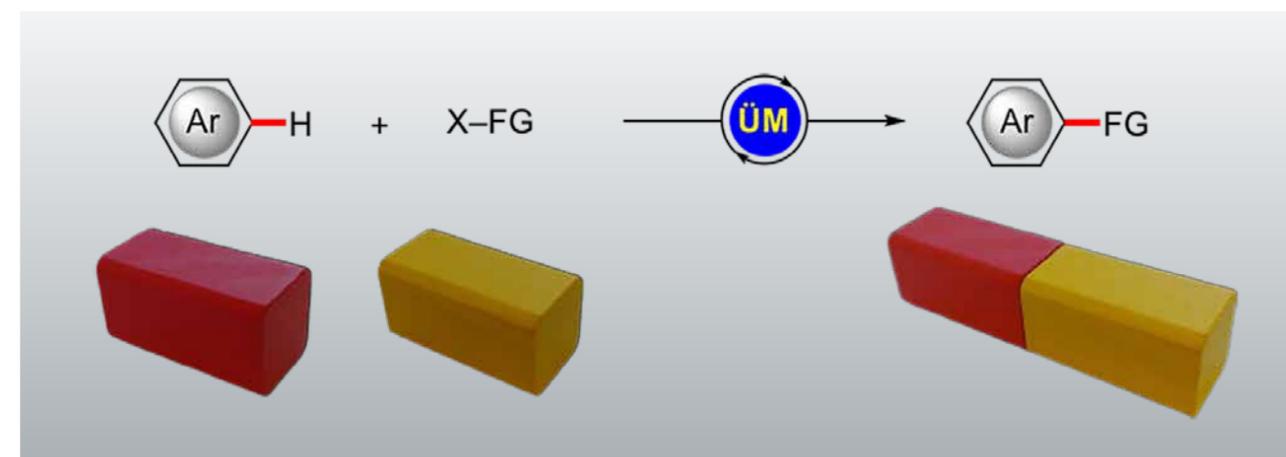
Palladium-catalysed cross-couplings offer considerable potential for chemical synthesis.



Illustration: AG Ackermann



Above: Palladium-catalysed cross-couplings can produce functional materials and bioactive compounds, but at the same time yield unwanted, often toxic by-products (diagram 1). C–H activation makes the production process more environmentally friendly. Below: Electrocatalytic C–H activation can make sustainable use of alternative energy sources, such as wind power (diagram 2).



Models: AG Ackermann

where the functional groups are the studs and tubes on the individual bricks.

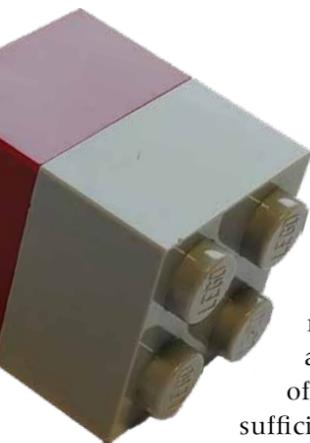
Cross-coupling chemistry has led to major advances in the molecular architecture of functional materials and bioactive substances. So it comes as no surprise that the pioneering research in this important field was recognised with the 2010 Nobel Prize in Chemistry for Richard Heck, Akira Suzuki and Ei-ichi Negishi. But despite this indisputable progress, the “pre-functionalised starting materials”, that is the individual LEGO bricks, first need to be prepared by means

of complex, multi-step synthesis pathways. Additionally, within the actual cross-couplings, unwanted and sometimes toxic by-products are generated in an amount that is proportional to the product itself. This has the disadvantage that these by-products need to be disposed of on an industrial scale, which is a costly undertaking.

In addition, each synthesis operation produces large amounts of toxic organic solvents, which, in the event of any doubt, often have to be incinerated at the end of the process. As a more environmentally benign alternative, our team is aiming to avoid multi-step syn-

thesis and the use of prefunctionalised substrates (the LEGO bricks). Our strategy is based on the direct transformation of ubiquitous carbon-hydrogen (C–H) bonds (see diagram 2 above).

This strategy has the advantage that C–H bonds already occur in readily accessible organic molecules, and not just in crude oil and natural gas. However, since these C–H bonds are extremely unreactive, special metal compounds are needed to convert or “activate” them. Complexes including transition metals play an especially important role in this regard, as they can cleave even stable C–H bonds.

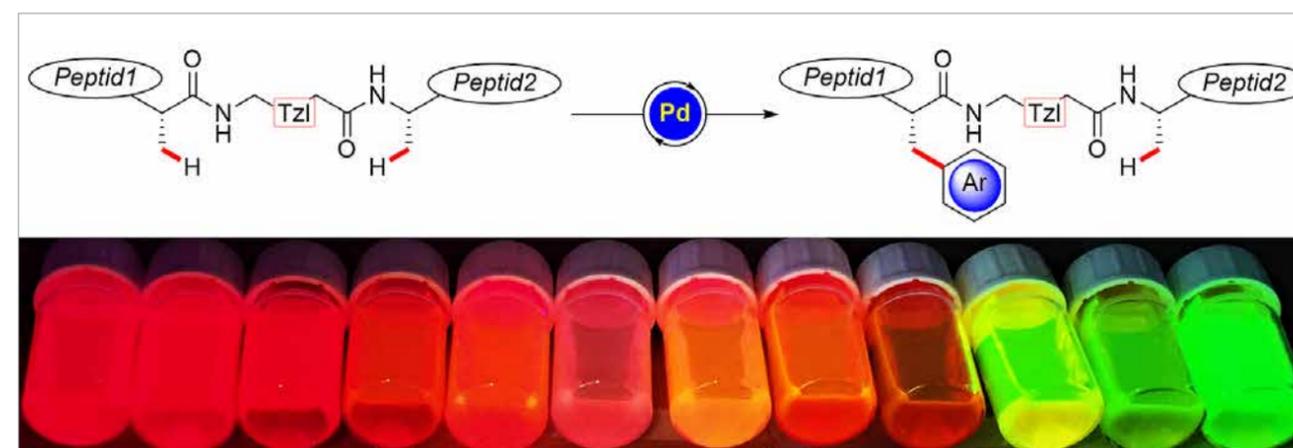


But this benefit presents a problem of its own, because the organic molecules of interest have too many C–H bonds of a similar strength, often resulting in insufficient selectivities. To return to the LEGO brick metaphor, it's like trying to link bricks together without the studs and tubes – rather like trying to join simple wooden blocks together. In a children's playroom this is very difficult to achieve, but in chemistry we can do it by using compounds of certain transition metals. These complexes can activate C–H bonds even in small amounts – that is, they react as catalysts.

In this way, it was possible to control the so-called position selectivity on a wide range of molecules with the aid of new ruthenium catalysts. The robustness of this C–H activation strategy is demonstrated by the fact that it is possible in the presence of atmospheric oxygen or water. This is particularly noteworthy, because the organometallic compounds thus formed normally react preferentially with oxygen and water.

Overall, C–H activation significantly improves not only the environmental footprint of synthesis, but also its cost efficiency. As a consequence, C–H activation has attracted considerable interest from practitioners in the chemical and pharmaceutical industries, where it is already being used in an industrial environment.

But the possible applications of this C–H activation strategy are not limited to environmentally friendly large-scale production. Indeed, C–H activation also offers significant potential for developing entirely new compounds. Thus far, C–H activation has largely been achieved by means of precious transition metal compounds based on palladium, iridium, rhodium or ruthenium. Unfortunately, these valuable metals occur very rarely in nature. So during the past few years, we have been developing customised catalysts of base metals for C–H activation. Nickel and cobalt complexes have proved to be instrumental in this approach. The sustainability of this strategy was further improved by using less expensive and less toxic copper, manganese and iron catalysts.



C–H activation can be used for selective fluorescence labelling of biopolymers.

These Earth-abundant metals are even present in essential enzymes in the human body. The repertoire of modern sustainable chemistry has also been enhanced by resource-conserving “green chemistry”.

Until recently, the activation of unreactive C–H bonds required harsh reaction conditions, such as very high reaction temperatures or the use of toxic metals as oxidising agents. To overcome these constraints, the use of alternative forms of energy has emerged as a promising approach. For instance, our team has successfully used visible light for copper-catalysed C–H functionalisations. Now, these challenging reactions can be achieved even at ambient temperature. In a complementary approach, electricity can also be used. Here, we devised oxidative C–H transformations with user-friendly cobalt catalysts to replace environmentally harmful metal oxidants with electrical energy. In the future, this approach will exploit wind and solar power, making chemistry even greener.

To further enhance the environmental credentials of C–H activation, attention has also been turned to renewable raw materials. For instance, it has been shown that biomass-derived renewable solvents can be used for C–H activation. These can be obtained from lignin, a renewable source of biomass. Likewise, methods to recover and recycle the catalyst are also being developed. Specifically, this has been achieved with the use of solid, insoluble catalysts. These so-called heterogeneous catalysts can now be reused for C–H activation, further improving the sustainability of the strategy.

In summary, C–H activation has emerged as a more environmentally friendly alternative to traditional molecular synthesis. By minimising the formation of unwanted toxic by-products, it can significantly improve the sustainability of molecular synthesis. The methods developed are inspiring research groups worldwide

but are also of key importance in industrial applications, from polymer synthesis to drug development. These factors illustrate the enormous potential of resource-economical C–H activation to advance the development of environmentally friendly or “green” chemistry.

Future research into these and other aspects of C–H activation in the Ackermann team will be funded by the DFG Gottfried Wilhelm Leibniz Prize.



Prof. Dr. Lutz Ackermann lectures in Organic Chemistry at the University of Göttingen.

Contact: Georg-August-Universität Göttingen, Institut für Organische und Biomolekulare Chemie, Tammannstraße 2, 37077 Göttingen, Germany

In 2017, Prof. Dr. Ackermann was awarded the DFG's Gottfried Wilhelm Leibniz Prize.

www.ackermann.chemie.uni-goettingen.de



Team meeting: Lutz Ackermann discusses study results with colleagues in the lab.



Peter Kappeler

The Light and Dark Side of Sociality

Lemurs, macaques and chimpanzees all live in complex societies that influence the health of group members. Close bonds can reduce social stress but they also increase the risk of parasitism and sexually transmitted diseases.

Do you have a tight social network, or is your social life limited to social media? This question is more important than you might think. Regular personal interaction with other people is beneficial for your health and ultimately your life

expectancy. For a good 30 years, it has been known that people who are more socially integrated have a reduced risk of disease and mortality. A patient's socioeconomic status – including factors such as income, occupation and wealth – also allows

accurate predictions about the risk of developing certain diseases or dying at a certain age.

Comparisons across numerous studies have shown that the effects of friendship and social support may be so strong that they can

A young baboon's chances of survival are higher the better its mother is integrated in the social community.



Illustration: Elizabeth Archie

compensate for the damage caused by smoking 15 cigarettes a day. In other words, the impact of social factors on health can be enormous. But why should that be the case? So far, clinical studies have been unable to provide the answer, but comparative research on wild non-human primates is beginning to shed light on this question from an evolutionary and functional-physiological perspective.

Humans and most non-human primates live in stable groups. Members of a group interact with each other, giving rise to patterns of social relationships characterised by varying degrees of competition and cooperation. Primatologists can observe and document exactly who interacts with whom, how often, and in what way. This provides a crucial advantage over human studies, which tend to rely on self-reporting and indirect measures of social integration. Since a great deal of information on the health of wild animals can now be gathered non-invasively, for example by analysing their droppings, and some studies of wild primate populations have been ongoing for decades, it is possible to combine information on social factors with data on health and demography. This enables researchers to study the links between sociality and health under ecologically realistic conditions.

Long-term studies on baboons have shown that adult females who spend time with an above-average number of other females over the years and who frequently groom one another live longer than less well socially integrated females. Socially better integrated females also benefit from reduced mortality of their offspring. Social integration therefore increases individual



Illustration: Lennart Pyritz

Long-term field studies of red-fronted lemurs in Madagascar combine observation of social behaviour with the physiological investigation of faecal and urine samples.

fitness, a correlation that has also been demonstrated in other primate species and for other parameters (number of offspring or survival rate of females). But why should such connections between sociality and health exist, and how are they mediated?

From an evolutionary perspective, living in groups has many advantages – especially in terms of reducing the risk of predation. However, group living also has its drawbacks. Competition for food

and reproductive partners usually leads to inequalities between group members, often resulting in greater stress among subordinate individuals. Stress is in fact an ingenious adaptation that provides the body with additional energy and restores its physiological balance when faced with social or ecological challenges. However, if this response fails to eliminate the triggering factors, prolonged stress has a range of harmful effects, for example on the immune system and cognitive performance.

This creates a dilemma for the organism. How can the available energy be allocated between essential bodily maintenance functions, growth and reproduction? Because individuals are exposed to stress factors in different ways and cope with their effects differently, variations arise in the health of individuals, and ultimately in how successfully they reproduce and how long they live.

So the question is how social interactions, such as mutual groom-

ing in primates, attenuate the stress response. There are two different effects to be considered here. Firstly, positive physiological effects may be direct. In a previously stressed macaque, the heart rate – a measure of agitation – is reduced more quickly through grooming than without social support, and in baboons, Barbary macaques and chimpanzees, the mere presence of a close partner can attenuate a stress response. In chimpanzees,

social support or grooming with a good friend increases the secretion of oxytocin, the “cuddle hormone” or “bonding hormone”, strengthening social bonds and also buffering the intensity of future stress responses.

At the level of behaviour, the sum total of interactions over time acts as a social buffer. The effectiveness of this buffer seems to depend on various factors, such as the balance, duration and quantity of social relationships, as well as an individual’s status within the social network of its group. For example, very close social relationships can help individuals to defend or even improve their social rank with the support of their partners, which for females is usually associated with better access to food. The shared defence of resources has a similar effect. Male macaques benefit from having several good friends because it makes them less prone to stress and the higher social position it gives them provides more opportunities to father offspring. The more group members an individual has around them, the lower their risk of falling prey to predators. Finally, socially better integrated individuals have more potential partners with whom to huddle when temperatures drop, which saves energy.

So, if close social relationships have such important short- and long-term benefits, why don’t all individuals have as many as possible or the same number of them? Firstly, there are factors that limit the number of possible interaction partners and best friends. As well as the size and composition of the group in terms of age, sex and relatedness, these include the time

Eyes and ears open: Observing sifakas in the dry forest of Madagascar.

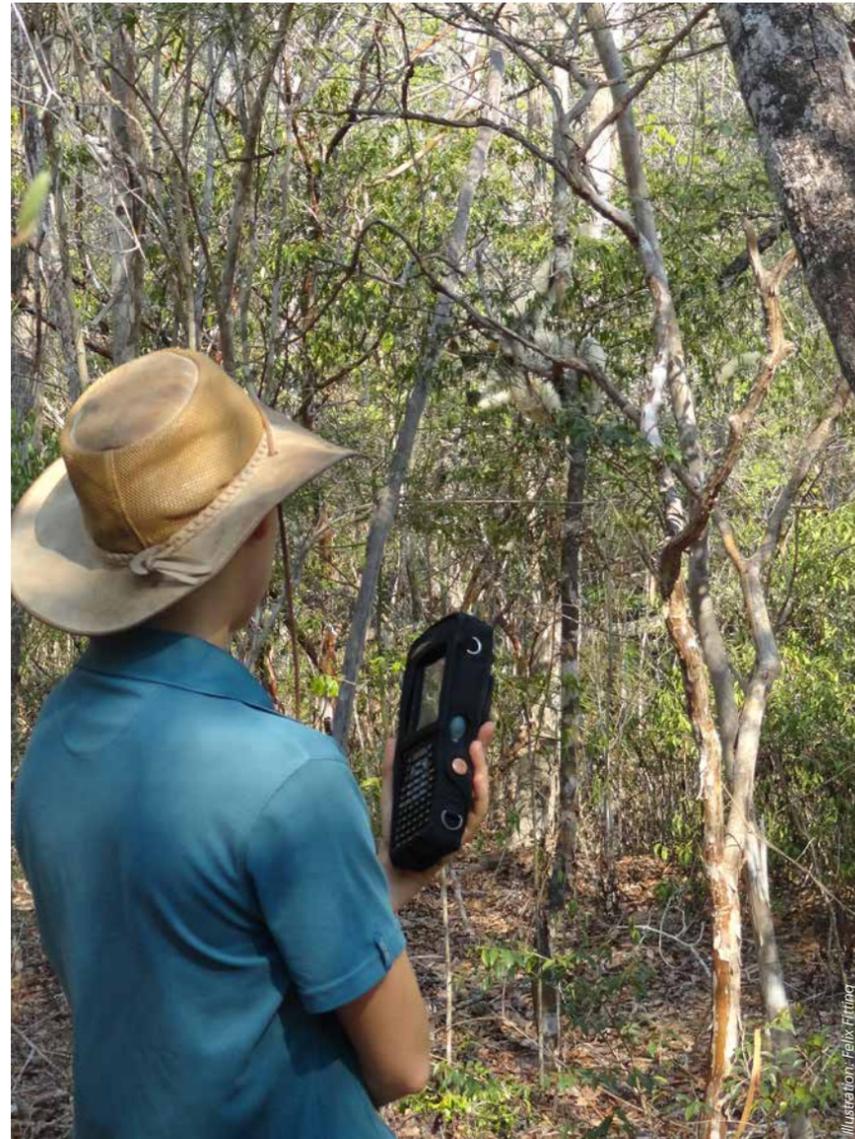


Illustration: Felix Fritting

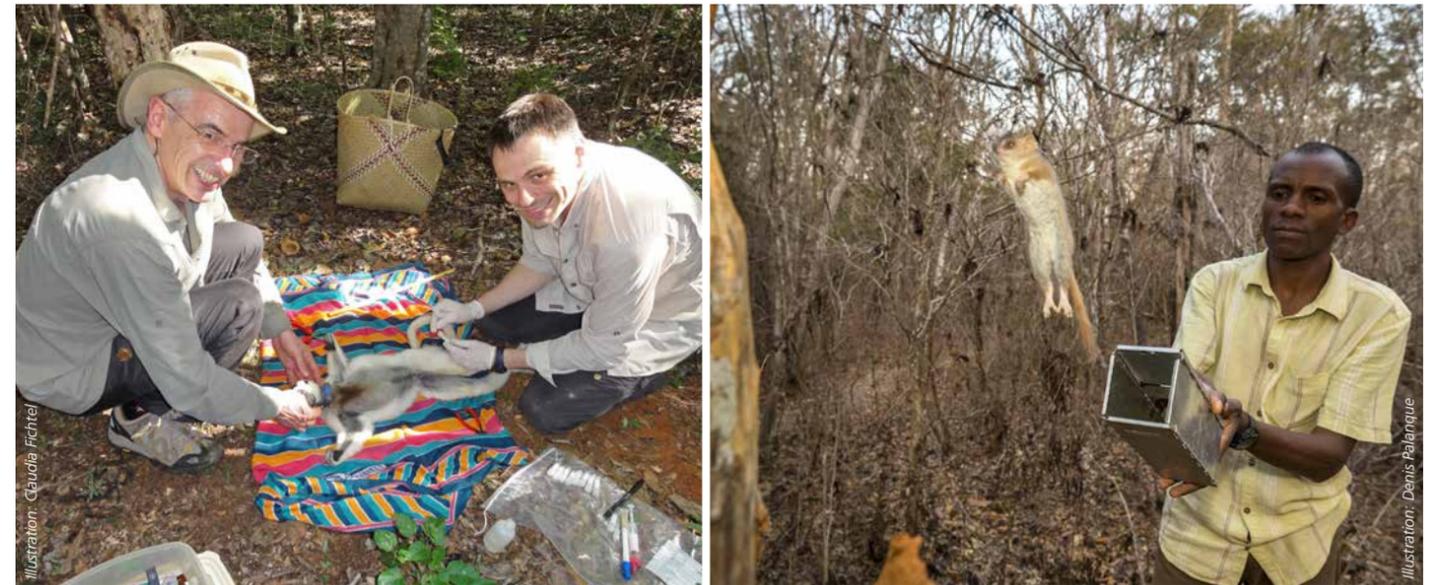


Illustration: Claude Fichtel

Illustration: Denis Ramanque

Left: Wild animal vet Fabian Leendertz (right) and project leader Peter Kappeler collect parasite and blood samples from a sedated sifaka. Right: Leaping back to freedom from the live trap used for smaller primates such as mouse lemurs.

left for social interaction after the daily search for food and shelter. Differences in cognitive ability between species may also play a role, as an animal requires a certain amount of neural capacity to process highly complex interactions with numerous group members over a period of years. Finally, social interactions are also associated with certain risks, perhaps the most costly being the direct transmission of parasites.

Members of a group of primates belong to the same species and are genetically closely related, which means they are vulnerable to the same parasites. Many viruses, bacteria, protozoans, worms and lice, which live off the energy of their host, are transmitted between individuals by more or less direct contact. This means that compared with solitary species, animals living in groups are at a higher risk of picking up such parasites by living in close proximity to others of the same species or through direct body contact.

When neighbouring groups come into contact with one another, parasites can also spread from group to group through an entire population. Sexually transmitted diseases are among the most common risks caused by these pathogens. They reveal the associated dilemma: no sex means no danger of infection, but it also means no reproductive success. The risk of the social transmission of parasites therefore demands a careful assessment of the benefits and costs of social interactions.

Recent studies demonstrate that there is one aspect that has been neglected in previous analysis of pros and cons: social contact also transmits beneficial microorganisms. Current research is focusing on the bacteria in the intestinal tract, as this gut flora supports the host’s immune defence and can keep pathogenic bacteria in check. The first studies on wild primates have revealed that members of the same group have a gut flora composition more similar to each

other than to members of other groups. This suggests that social contact also plays an important role with respect to the transmission of beneficial microorganisms. These and other details of the complex relationship between sociality and health are currently being investigated by the members of a DFG Research Unit carrying out comparative research on wild lemurs, macaques and chimpanzees.



Prof. Dr. Peter Kappeler

holds a joint professorship at the University of Göttingen and the German Primate Center – Leibniz Institute for Primate Research. He studies primate behaviour in Madagascar.

Contact: Deutsches Primatenzentrum, Kellnerweg 4, 37077 Göttingen, Germany

www.sohapi.de



The Deutsche Forschungsgemeinschaft

The Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) is the largest research funding organisation and the central self-governing organisation for research in Germany. Its mission, as defined in its statutes, is to promote “all branches of science and the humanities”.

With an annual budget of around €3.4 billion, the DFG funds and coordinates approximately 33,000 research projects in its various programmes. These projects are carried out by both individual researchers and groups of researchers based at universities and non-university research institutions. The focus in all disciplines is on basic research.

Researchers at universities and research institutions in Germany are eligible to apply for DFG funding. Research proposals are evaluated by reviewers in line with the criteria of scientific quality and originality, and then assessed by review boards, which are elected for a four-year period by the German research community.

For more information, visit www.dfg.de/en

The DFG places special emphasis on early career support, gender equality and scientific relations with other countries. It also funds and initiates measures to develop and expand scientific library services, data centres and the use of major instrumentation in research. Another of the DFG's core tasks is to advise parliaments and public interest institutions on scientific matters. Together with the German Council of Science and Humanities, the DFG is also responsible for implementing the Excellence Strategy to promote top-level research at German universities.

The DFG currently has 97 member organisations, primarily comprised of universities, non-university research organisations such as the Max Planck Society, the Leibniz Association and the Fraunhofer-Gesellschaft, the Helmholtz Association of German Research Centres, and academies of sciences and humanities. The majority of the DFG's budget is provided by the federal and state governments, and it also receives funds from the Stifterverband.

german research is published by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)

Publisher: WILEY-VCH Verlag GmbH & Co. KGaA, P.O. Box 10 11 61, 69541 Weinheim, Germany

For the annual subscription rate please refer to the Wiley Online Library:

<http://olabout.wiley.com/WileyCDA/Section/id-404508.html>

Address of editorial staff: DFG, Press and Public Relations, Kennedyallee 40, 53175 Bonn, Germany
redaktionforschung@dfg.de; www.dfg.de

Editor-in-chief: Marco Finetti (responsible for content)

Publishing Executive Editor: Dr. Rembert Unterstell

Copy Editors: Stephanie Henseler, Inken Kiupel, Lisa Exey

Translation: oneword GmbH, Böblingen

Printed by: Bonner Universitäts-Buchdruckerei (BUB)

Printed on Inapa Oxygen silk, coated, 100% recycled, FSC certified paper with a semi-matt surface

ISSN 0172-1518



Double start to the new year: On 13 January the DFG launched *DFG2020 – Because Research Matters*, a nationwide campaign celebrating research in Germany. *DFG2020* highlights how science-driven research funding by the DFG contributes to advancing knowledge and innovation for an informed, open society. In the evening, the DFG held its traditional New Year's reception, which welcomed more than 400 guests from science and academia, politics and society. The events in Berlin also marked the beginning of a new presidency. On 1 January Professor Dr. Katja Becker, a biochemist and medical scientist, took up her new office as president of the DFG. In the top image, she is shown in front of the *DFG2020* exhibition bus, which will be touring Germany throughout the year with a performance company, showcasing academic research and engaging in and promoting dialogue with the general public. In her new year's address, President Becker emphasised the importance of cooperation and communication within and outside science and academia. Only by engaging in dialogue – and recognising that research matters – can global challenges such as climate change, digitisation and scarcity of resources best be met.