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Matthias Kleiner

From an Idea to Knowledge: Making Science Visible

Discussing research often comes down to talking about funding and organisation. It's easy to lose sight of what matters most: the research itself. That is why science promotion also involves showcasing scientific potential and successes to the public.

My editorials often revolve around two things: money and structures, which is not surprising. How research gets funded is as fundamental to researchers, their scientific communities, and their financial backers, as how it is organised. Both issues together significantly define the framework for research and its promotion. And they are among the key indicators of just how advanced a research system is.

These parameters can also be used to track the most recent developments, both good and bad, in Germany's science and research system: on the one hand, there are the Excellence Initiative and billions of euros in investments; on the other hand, there are shrinking core support for universities and the unreasonable ban on cooperation between federal and state governments.

With good reason, we at the DFG are among those who continue to focus on finances and structures: in our many discussions with policymakers, in our joint efforts with other research organisations, but also in our public positions, our press releases, and in our magazine's editorials.

Yet this focus, important though it is, also poses a danger: the more our conversations and thoughts on research and its promotion are dominated by money and organisation, the easier it becomes to lose sight of research itself. The topics, substance and results then fail to receive the attention and ultimately the appreciation they deserve. Such disregard does a double injustice to science and scholarship, selling short the riches of research itself as well as its benefits to society's welfare and future viability. Science and research should not be viewed as part of our financial problems, but instead

be seen as instrumental in solving the challenges of the future.

All those interested in research therefore do well not only to keep in mind and discuss science per se but also to highlight it. This also applies to the DFG. To promote science and scholarship also means to make visible its potential and successes.

And indeed, the DFG is already doing a lot along these lines. Each issue of *german research*, where DFG-funded researchers report on their projects, helps to provide such visibility. And each award of the Gottfried Wilhelm Leibniz Prize shines a light on what makes research and researchers great: the power of an idea, a passion for asking questions, the courage to take risks, the desire to succeed, and a little bit of luck as well.

That's not all: How much science the institutions of the Excellence Initiative have to offer, even though they may have garnered more attention for their structures and money, can be seen online on our video portal www.excellence-initiative.com. With the Communicator Award, we honour researchers who present their work to the media and the public in original and diverse ways. And our recently modularised grant programmes now allow researchers to request public-relations funding for their projects.

But particularly in recent weeks, the Deutsche Forschungsgemeinschaft has helped to make science and research visible and tangible in a different and very special way: by lending its support to several major exhibitions, about which you can read more in this issue.



Illustration: DFG/Ausserhofer

Be it the DFG showcase "Von der Idee zur Erkenntnis" (From an Idea to Knowledge), which presented throughout the month of March ten exemplary projects from the DFG's Individual Grants Programme in the Paul-Löbe-Haus of the Bundestag, and which is now on tour through the German states; or "Brisante Begegnungen" (Encounters of Significance) at the Hamburg Museum of Ethnology, where a Collaborative Research Centre presents its findings on nomads past and present; or "MenschMikrobe", our joint exhibit with the Robert Koch Institute on infection research, which recently arrived in Lübeck and has already attracted more than 70,000 visitors since its launch in 2010 – these are all attempts to present, with scientific as well as visual appeal, the questions research can ask and the answers it can give.

What and how we present science is also being seen and heard by professional-critical stakeholders and observers, which is especially gratifying. The words said by Bundestag president Norbert Lammert and by representative and committee chair Ulla Burchardt at the opening of the exhibition in the Paul-Löbe-Haus were a paean, rarely heard in this form, to science in general and especially to basic research and its social value. And Eckhard Fuhr, chief correspondent of the newspaper

Die Welt, who was asked by *german research* to take a tour of the show as a well-known outside writer, saw on display the "originality and wilfulness" that are so essential to science and the "playful free spirit that animates researchers".

That is precisely what we want to continue to make visible again and again. This is not to downplay the DFG's role as funding agency and organiser of science, a role in which we will continue to face criticism. It does not mean that we are softening our commitment to advocating better financial and structural conditions for research and its funding. Nor are we trying to take credit for the achievements of others. It is the scientists and scholars themselves who come up with ideas and develop them into projects that in turn generate the insights made visible in this way. But they, too, are part of the community which the DFG represents and tirelessly supports.

Matthias Kleiner

Prof. Dr.-Ing. Matthias Kleiner
is President of the DFG.



Christian Holz-Rau, Dennis Guth and Joachim Scheiner

The Secret Life of the Commuter

From home to work: Commuting has become an established part of city life. From a scientific perspective, it's a highly complex phenomenon which is only now being explored.

It's Monday morning in the Ruhr region, and the traffic broadcast is reporting only those tailbacks over five kilometres in length. Mentioning all the smaller ones would take too long. As usual, the regional train from Dortmund to Düsseldorf is extremely overcrowded – and it's late, yet again. Thousands upon thousands of workers are travelling to work from one Ruhr town to another, or are coming in from the Sauerland and Münsterland regions. All of these people are regular commuters. Working close to home and walking or biking to work is, nowadays, nothing to sneer at. Instead, it's something to be envied.

Regular commuting for work has long been a part of everyday life in many areas, not just the Ruhr. Until now, however, it has scarcely been studied, making it the perfect research topic for the transport scientists and spatial planners at the TU Dortmund University.

The subject poses a variety of questions. Why, for example, is commuting considered such a normal part of life nowadays? And how have commuter flows and structures changed since the 1970s? The Dortmund-based project team, which comprises three male researchers and one fe-

male, aims to use data to trace and analyse the changes in commuting. Two of them are commuters themselves, working in Dortmund and living outside the city. One of them has never moved to Dortmund. Travelling from Essen to Dortmund for work has become the norm – and in more conurbations than this one.

One researcher moved to Braunschweig for family reasons – she now commutes long-distance to Dortmund. Internal commuters, regional commuters, long-distance commuters ... the factors affecting them personally and their own experiences provide a solid basis for a research project that involves close cooperation with a parallel project at the ETH Zurich.

One of the key spatial developments affecting Germany's commuter traffic was, for a long time, the suburbanisation of the residential population. Households moved from the major cities to smaller neighbouring communities, into what's known as the "hinterland". Most of the working members of those households kept their jobs, travelling to the city every day. This phenomenon is one that has long been recognised in spatial planning and is also apparent in our analysis.

For some time, however, this suburbanisation seems to have halted. The current buzzword in urban studies is “reurbanisation” – a term which describes the renewed growth of the cities following the urbanisation of the 19th and early 20th centuries.

The long-dominant phenomenon of residential suburbanisation has been followed by the creation of more jobs outside the major cities. Experts describe this as the “urbanisation” of the hinterland, with the term “post-suburbanisation” also being used. This results in the development of “polycentric urban regions” which offer large numbers of jobs in the environs of the major cities.

If the working population of the hinterland were to take these “suburbanised” jobs, this could result in shorter commutes. This hypothesis

of the “decoupling of the hinterland from the city itself” has been proved in several US regions. Shorter journeys to work may also be a result of the trend towards reurbanisation.

How can this hypothesis be tested using the existing data? Firstly, the major cities’ changing outbound and inbound commuter flows can be analysed. The outbound commuter rate describes the percentage of people who work outside the town or city where they live. In other words, they commute outwards. The inbound commuter rate, on the other hand, describes the percentage of people who work in a major city, yet live outside it. These people commute inwards.

If the hinterland is decoupled from its core city, these inbound and

outbound commuter rates should decline over time. Due to the different data bases, these analyses require some additional assumptions and data alignment. They do, however, allow reliable statements about major trends to be made.

Let’s stay with the Ruhr area for the moment, and take a look at the city of Dortmund. In 1970, Dortmund’s outbound commuter rate was just under 9 percent. In 1987 it was around 18 percent; in 1999, it was almost 31 percent, and in 2007 it was more than 35 percent. In the same time period, the inbound commuter rate increased from 14 percent (1970) to 26 percent (1987) and 37 percent (1999) to 43 percent in 2007. More and more Dortmund residents are, therefore, commuting outwards, while at the same time

In a traffic jam on the way to work: In addition to the high volume of traffic, construction sites (like this one on Bonn’s Kennedy Bridge) often prevent commuters from making rapid progress.



From the country to the city: Major cities act as magnets for commuters, attracting workers from the hinterland.

more and more workers are travelling to Dortmund for work. This cannot be described as a decoupling; instead, it shows an increasing level of interlinking in both directions.

For more general analyses, let’s look at several of Germany’s major cities. For the time frame between 1970 and 1987, we can do this only for the former West German states. In all the major cities, and for all the time periods researched, the inbound commuter rates are higher than the outbound commuter rates. This is not surprising, given that the numerous jobs in the major cities are commuter magnets.

According to the statistics, the cities in the Ruhr region have particularly high inbound and outbound commuter rates. In 2007, the outbound commuter rate was almost 40 percent, with the inbound commuter rate, at 45 percent, scarcely higher. With an inbound commuter rate of 50 percent (two out of four members), our project team is within the average range for the Ruhr area. The Ruhr area has a distinctive feature: the inbound and outbound commuter rates almost balance each other out.

The federal city states, on the other hand, have the lowest outbound commuter rates – in 2007, these were less than 20 percent. The other major cities have outbound commuter rates of approximately 30 percent for 2007. Their significance for inbound commuter traffic is, on the other hand, considerably higher. The highest figure, 65 percent, was achieved by Frankfurt am Main.

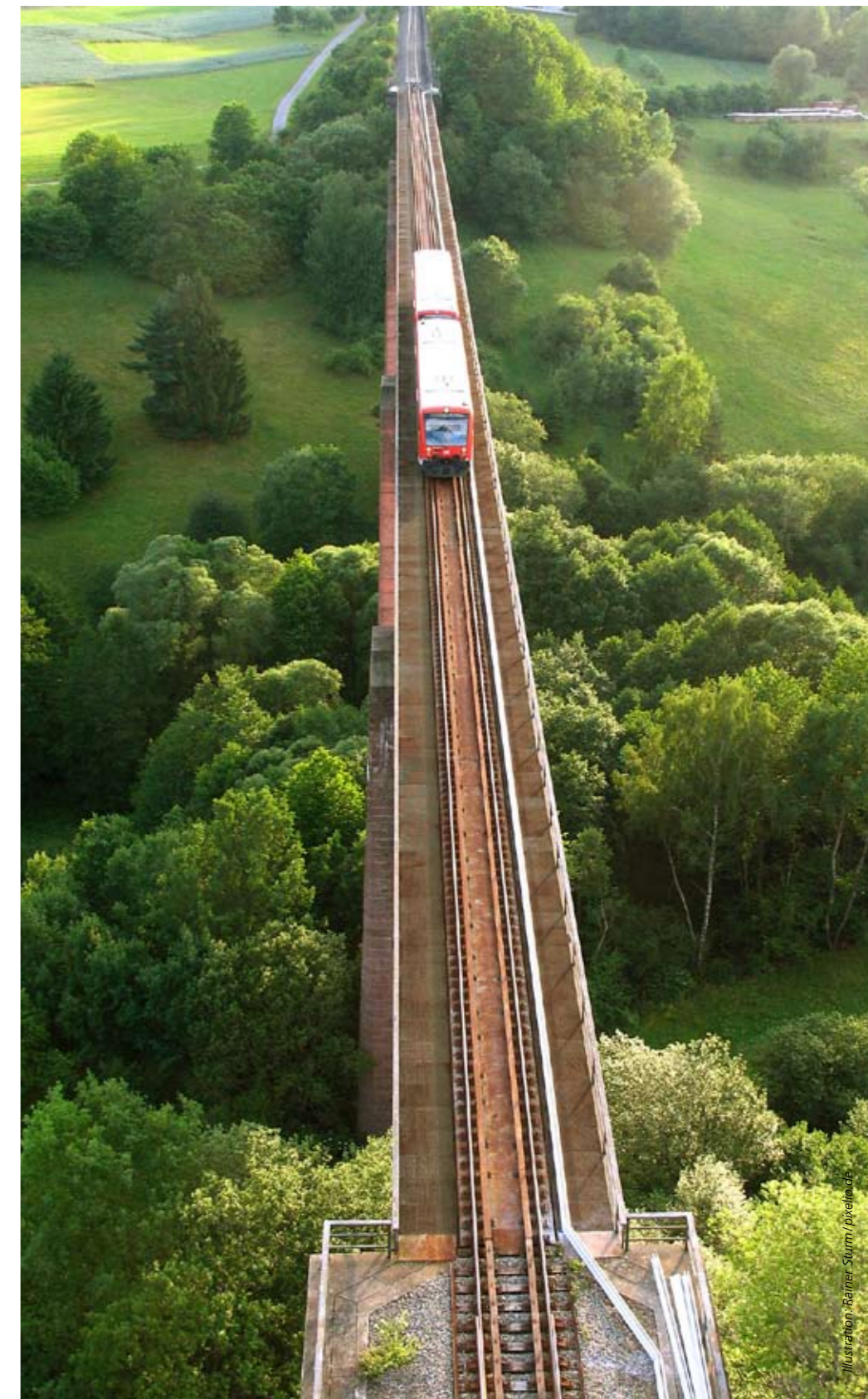




Illustration: sparkie/pixelto.de

When bus and rail operators strike, commuters have difficulty travelling any distance. Job mobility depends on reliable transportation connections.

Over the last 40 years, the inbound and outbound commuter rates have increased in all areas of the old West German states. The “decoupling” of the hinterland has been observed in none of the regions. On the contrary, the number of people living and working in the same city is decreasing everywhere. The era of the greatest increases in commuter numbers does, however, seem to be over. The greatest increases in inbound commuter rates took place mainly between 1970 and 1987, while the greatest increases in outbound commuter rates occurred between 1987 and 1999.

Despite this drop-off, cities have become even more interlinked. This is particularly noticeable in long-distance commuter flows. Let’s take Berlin, for example. Most Berlin residents work, naturally, in their home city. The two biggest outbound commuter flows travel a short distance beyond the city boundary to Potsdam and Schönefeld. The

next most important working destinations for Berlin residents are Hamburg, Frankfurt am Main and Munich. Within eight years, from 1999 to 2007, the commuter flow to Hamburg increased by more than 60 percent from an admittedly low level, while the number of commuters travelling to Frankfurt am Main and Munich have increased by a third. Most of these commuters do not, of course, make the homeward journey every day. Instead, many of them spend periods of time living in two places.

No doubt there is a link between spatial developments like the suburbanisation of residential locations and workplaces and the increase in commuter flows. This is, however, not the most important explanation; let alone the only one. It is clear that the increase in commuter flows is considerably greater than the changes in spatial structures. Even in towns (and periods) in which the number of jobs increased considerably, the number of internal commuters declines. Even the strong increase in long-distance commuting cannot be explained by developments in urban planning alone.

Numerous social trends are contributing to an increase in the number of commuters, both within and across regions. One prerequisite for regional commuting, specifically, is the prevalence of the car. Another factor is the fact that, as people’s professional qualifications increase, it becomes more difficult for them to find an appropriate job close to home. Jobs “just around the corner” are often incompatible with residents’ training and qualifications. This problem is exacerbated by short term employment contracts, which make it scarcely worth moving house. In an increasing number of

households, both partners are employed, and, in most cases, one of them must commute. This is usually the man. Calls from politicians for increased mobility add to this issue, with people’s willingness to commute being taken for granted.

The stronger a person’s career orientation is, the more likely it is that long-distance commuting will come into play, often as a temporary solution. Long-distance commuting, in particular, is supported by improvements to long-distance public transport options (such as Intercity Express trains, federal motorways and low-cost flight connections). These social factors involved in commuting cannot, however, be examined using the existing data. Instead, they serve as a backdrop to understanding a highly complex phenomenon, one which is worthy of further investigation.



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www.vpl.tu-dortmund.de/cms/de/forschung/forschungsprojekte/pendler/index.html

A Demonstration of Solidarity

One year after Fukushima: German-Japanese scientific cooperation shows the way forward



Illustration: DFG Office Japan/Myra Bauer-Schich

Earthquakes, tsunami and meltdown – on 11 March 2011 Japan was hit by a devastating series of tragedies. One year after this three-fold catastrophe, everyday life has returned. However, the job of reconstruction will require years and may cost more than 200 billion euros. 20 million metric tonnes of debris still lie scattered, and it will take 30 to 40 years to clear up Fukushima.

Nobody expected an earthquake of this strength at this location. In places, the tectonic plates shifted up to 50 metres eastwards, and the sea floor rose by up to 5 metres. Many of the mechanisms that caused this remain poorly understood today. The Tohoku earthquake is a call to investigate these fundamental processes in order to comprehend them better.

Consequently, the earthquake region has been the focus of intensive research by joint international projects since March 2011. On 8 March 2012, German and Japanese researchers from MARUM, JAMSTEC and ERI embarked on an expedition to the area of the epicentre in the research ship SONNE.

Using modern submersibles, they are investigating the traces left by the earthquake on the sea floor. The ship has been provided using funds from the BMBF; the DFG is financing the scientific expedition, which is an example of the DFG’s unbureaucratic support for German-Japanese projects “post-Fukushima”.

The expedition builds on existing areas of cooperation and is a contribution to the planned international drilling expedition J-FAST under Japanese leadership as part of the International Ocean Drilling Program (IODP).

In recognition of the significance and opportunities of the SONNE’s activities, DFG Vice President Ferdi Schüth came to Japan to attend the

start of the expedition. The German ambassador Volker Stanzel and head of MARUM Gerold Wefer hosted the reception on the ship while docked in Yokohama. Here, Schüth (in the photo: centre) emphasised: “The journey of the SONNE sends out a message and is an important demonstration of solidarity. The expedition shows the enormous potential of German-Japanese cooperation.”

Japan’s nuclear power stations are currently undergoing stress tests. Consequently, only two of the original 54 reactors are connected to the net at present. The question of power supply is on both the public and the scientific agendas, for example at the “Science and Technology in Society” forum in October 2011 in

Kyoto attended by 800 participants. The DFG President Matthias Kleiner also spoke here on his experiences in the German Ethics Commission and on the switch to renewable sources of energy.

What role should research funding organisations play in crises and what functions can they perform? These questions, like those on the boundaries and responsibilities of research and science, will not go away. The DFG Office Japan in Tokyo remains committed to supporting and promoting German-Japanese cooperation in research on the ground (www.dfg.de/japan/en).

Dr. Iris Wiczorek is head of the DFG Office Japan in Tokyo.

Eckhard Fuhr

RoboBee and Friends

A columnist's view of the DFG exhibition "Von der Idee zur Erkenntnis" – an outsider's insight into the originality and playful spirit of basic research

When zoologist Karl von Frisch published his decades of research on the communicative dance of the honeybee in 1946, it was received by the scientific community with astonished disbelief. Some considered the researcher a fantasist. How could a creature with such a tiny brain be capable of communicating with its fellow creatures through signs and abstract symbols?

In 1973, the same year as the behavioural scientist Konrad Lorenz, Frisch received the Nobel Prize. He devoted his life to studying bees and discovered their secrets through patient observation. Based upon his suspicion that chaos could not pos-

sibly reign inside beehives – after all, any beekeeper knows how effective this collective organism is – he made a revolutionary discovery. His hunch that there must be a bee language was, however, far removed from what people considered common sense. In this respect, those who called him a fantasist were not entirely wrong. But science needs this type of fantasist.

In the Paul-Löbe-Haus of the German Bundestag, in whose conference rooms the representatives (hopefully) battle with passion and sound judgement for the greater good, the DFG's exhibition "Von der Idee zur Erkenntnis" (From an Idea

to Knowledge) provides a stage for ten successors – in both the broader and narrower sense – of maverick scientist Karl von Frisch. The building's long foyer incorporates ten "research islands" – compact, neatly arranged stations which showcase examples of individual projects funded by the DFG. A poster at each station provides information on the underlying concept, the issues involved, and the project's aims. Interactive elements provide insights into the specific research undertaken. Thus, political representatives and visitor groups are invited to consider the types of projects made possible by public research funding in Germany. From



Berlin, the exhibition will tour the German federal states.

The focus is not the larger Collaborative Research Centres and Priority Programmes. Instead, the exhibition showcases what one might call the "grass roots" of science: individual researchers or groups of researchers who take an often risky – and consequently freer – path. The DFG funds 20,000 such individual projects, which make up more than a third of their funding.

Karl von Frisch's direct legacy is the "RoboBee" project. At the Free University of Berlin, neurobiologist Randolf Menzel and computer scientist Raúl Rojas have joined forces to discover how honeybees process the messages of the waggle dance. How do the female worker bees learn the direction and distance of a feeding ground from the messengers? While Frisch discovered that they understand these messages, he did not, however, manage to decode the interplay of the individual factors in bee communication, and the weight afforded to each one. What role is played by smell, sound and body temperature, for example? What is the significance of the patterns followed in the dance? What, then, is the relationship between immediate sensory impressions and the interpretation of signs?

The Berlin-based researchers had the idea of using an artificial bee to communicate with real bees. This would enable them to control the

Left: The bee language is deciphered, step by step: The RoboBee project helps us to understand how honeybees process the messages communicated through the waggle dance. Right: A glimpse into the exhibition at the Paul-Löbe-Haus.

signals they were sending out. They therefore developed a mini robot which can do everything a bee can, including fly, emit scents, generate sounds and vibrations – and do the waggle dance, whose movements are digitally programmed into the robot. The bees understood their artificial counterpart, even when she offered nothing more than the dance. Its symbolic content, therefore, carries the greatest weight in bee communication. It is, in fact, a "language". Proof of this was furnished because researchers pushed the boundaries between life sciences and technology.

It would be impossible to describe all ten of the research projects exhibited here in detail. Based on the bee project, however, it is possible to discern a pattern common to all of them. When one thinks of bees, one immediately thinks of collective intelligence. This is a great misconception. When one studies the videos of dancing bees at the RoboBee Project's "lab bench", it becomes clear that this dance is an extremely intimate process. Individual bees in the seething swarm on the comb become attentive and observe the dancer's movements. It could almost be described as an intensive exchange of ideas.

The bees also fly out individually to search for food. Bee swarms serve an entirely different purpose. That swarm intelligence is not the driving force of scientific discovery is a fact evidenced by every one of the individual projects showcased in this exhibition. Without independent thinking and originality, there would be no innovation.

It is, for example, possible to have original and independent ideas while driving in the rain. One asks oneself whether the diligent back-and-forth motion of the windscreen



wipers could, perhaps, be good for something other than keeping the windscreen clear. Windscreen wiper technology is mechanically mature, cars are ubiquitous – could there potentially be a useful side benefit of

the simple windscreen wiper? This question was posed by hydrologists and GIS experts at the Gottfried Wilhelm Leibniz University of Hannover working to improve the prediction of precipitation quantities.

Being able to expand and aggregate this data would be of tremendous benefit to agriculture and flood protection agencies. The wide-meshed network of fixed measuring stations would need to be expanded by adding a large number of mobile rain sensors. This is where the windscreen wipers come in. Computer simulations have shown that if just one percent of all vehicles were used as mobile measuring stations, the precision of precipitation prognoses could be considerably improved.

Predicting and estimating natural processes is also part of the “MANDY” project, or, to give it its full name, “Modelling gap dynamics, succession, and disturbance regimes of mangrove forests”. This project is being carried out by forestry researchers from the Dresden University of Technology. They are examining how tropical mangrove forests, which have a key ecological function, regenerate after various types of disturbance. For a long time, foresters were concerned with keeping order and peace in the forest. Some time ago, however, a paradigm shift took place, and their focus is currently on disturbances and catastrophes as catalysts of natural processes. It shows that well-intended protection mechanisms are often not entirely expedient. In the reforested mangrove forests of Vietnam, destructive lightning strikes increase the vitality of the forests by generating “healing chaos”.

Readers should not, however, get the impression that DFG funding is available only for the natural sciences. “Von der Idee zur Erkenntnis” also showcases research from the humanities and social sciences. Art researchers at the Humboldt University of Berlin are focussing on “technical images” and aim to use art



May I Have This Dance ... RoboBee?

A biomimetic bee robot helps research the waggle dance

Project Managers: Prof. Dr. Raúl Rojas, Prof. Dr. Dr. h.c. Rolf Menzel

www.robobee.eu

Welcome Disturbances?

Modelling gap dynamics, succession, and disturbance regimes of mangrove forests (MANDY)

Project Manager: Prof. Dr. rer. nat. Uta Berger
www.forst.tu-dresden.de/SystemsAnalysis

What Do Images Know?

Visual Strategies in Science and Technology
Project Manager: Prof. Dr. Horst Bredekamp
www.kulturtechnik.hu-berlin.de

Counting Against Oil Pollution?

Analysis of oil separation in oil skimmer systems in sea states I + II

Project Manager: Prof. Dr.-Ing. Günther Clauss
www.marsys.tu-berlin.de

Can Windscreen Wipers Prevent Flooding?

Rainfall estimation using moving cars as rain gauges (RainCars)

Project Manager: Prof. Dr.-Ing. Uwe Haberlandt und Prof. Dr.-Ing. habil. Monika Sester
www.ikg.uni-hannover.de/raincars

Saving Lives in 3D?

Quantification of the morphology of human blood vessels using 3-D tomographical image data (QuantVessel)

Project Manager: PD Dr. Karl Rohr
www.bioquant.uni-heidelberg.de/bmcv

Quo vadis, Democracy?

Voting dynamics: A long-term study on change and stability in the electoral process in Germany

Project Managers: Prof. Dr. Hans Rattinger, Prof. Dr. Rüdiger Schmitt-Beck, Prof. Dr. Sigrid Roßteutscher, PD Dr. Bernhard Weßels
www.gles.eu

Does This Picture Have the Right Chemistry?

Pigments through the ages – Artists' colours of the 20th and 21st centuries and options for their minimally destructive analysis and identification

Project Manager: PD Dr. Heike Stege
www.doernerinstitut.de

Capturing Molecules with Guitar Strings?

Nanoelectromechanical Resonators (NEMRES)

Project Managers: Prof. Dr. Jörg P. Kotthaus, Dr. Eva M. Weig
www.nano.physik.uni-muenchen.de

Seeing with our Ears?

Sound localisation in the barn owl in virtual environments

Project Manager: Prof. Dr. Hermann Wagner
www.bio2.rwth-aachen.de

Further Information:
www.dfg.de/idee_erkennnis



At the display entitled “Mit Gitarrensaiten Moleküle fangen?": Ulla Burchardt, Chair, Bundestag Committee on Education, Research and Technology Assessment; Matthias Kleiner, DFG President; Norbert Lammert, Bundestag President; Jörg P. Kotthaus, Project Manager.

history methods to show researchers from all disciplines historical patterns in the way they visualise their results. Chemists and restorers at the Bavarian State Picture Collections' Doerner Institute are investigating the synthetic pigments which have, since the 20th century, increasingly replaced natural dyes and made it more difficult to distinguish between original works and fakes.

In addition to these research projects, which appear specialised only at first glance, researchers are also tackling the big picture: the future of our democracy and the changes in its sovereignty. Election research is usually carried out in the immediate environs of elections. Political scientists from Mannheim, Frankfurt and Berlin are now using empirical surveys and media analyses to examine the German parliamentary elections of 2009, 2013

and 2017. This long-term study is intended to record the extent of political and social change.

In his opening speech at the ceremony in Berlin, DFG President Matthias Kleiner made reference to the fact that, while individual projects receive 35 percent of DFG funding, they remain in the shadows of public perception compared to projects carried out by major research associations, clusters of excellence and graduate schools. Repeatedly, he continues, even in the scientific community, the fear is being voiced that small-scale research is being placed at a disadvantage when it comes to competing with the “research giants” for funding. With the “Von der Idee zur Erkenntnis” exhibition, the DFG aims to “contribute to increasing awareness of the creativity and potential of individual projects”.

We can only hope that the exhibition will, on its tour of Germany, communicate some of that playful and free-spirited character with which the researchers are blessed. It is a truism to state that knowledge is the most important raw material our country possesses. But truisms are also true, and sometimes we need to be reminded of them. “Von der Idee zur Erkenntnis” does this in an impressive manner.



Eckhard Fuhr

is a cultural and social correspondent for the Berlin-based WELT Group.

Rembert Unterstell



Illustration: SFB 586/Uta Schilling

Wanderers in a Settled World

Nomads past and present: The “Brisante Begegnungen” exhibition at Hamburg’s Museum of Ethnology opens windows on a wide variety of lifestyles. This thought-provoking exhibition showcases the findings of a DFG Collaborative Research Centre.

“Where’s your yurt?” asks the shepherd on the steppes. He means “Where is your home?” This temporary home is a living space, family hub and storage area in one. These round tents of Central Asia (picture above, taken in western Mongolia) consist of flexible trellis walls, which can be quickly as-

sembled and disassembled. These are then covered with strips of felt. They provide the nomads with a refuge in the dry and hostile steppe and highland landscapes. For settled people, the nomad’s tent has always served as an expression and symbol for a non-settled life – like that of an animal herder – which

revolves around grazing areas, watering holes and marketplaces.

“Berbers”, “travelling people”, “gypsies”: according to research into the stereotypes, they are all viewed as “strange” and “different” by the townspeople and villagers of Central Europe. Despite romantic – and fictitious – 19th century tales of the free

and proud “gypsy life”, travellers and their extended families are still perceived as “threatening”. Their business practices, which include, for example, peddling goods door-to-door, are considered “dirty”, if not downright criminal. For the majority of society, travelling people are on the fringe. In a cultural history of foreignness, negative opinions of nomadic minorities are widespread. The lunacy and racist mania of the Nazis consolidated this resentment with disastrous results: the Sinti and Romani gypsies were deprived of their rights and deported. More than 20,000 lost their lives in concentration camps.

Nomads past and present are the topic of the “Brisante Begegnungen” (Encounters of Significance) exhibition, which is on display at the Hamburg Museum of Ethnology until 20 May 2012. It aims to open our eyes to a variety of nomadic lifestyles, and looks back on 5,000 years of nomadic civilisation in a panorama which extends from Morocco to Egypt, Syria, Iran, Kazakhstan and Tibet to Siberia and Lapland. Organised by Leipzig ethnologists Professor Annegret Nippa and Dr. Andreea Bretan, it sets out to show “nomads in a settled world”, and thus to illustrate the interrelationships between settled and nomadic societies.

The exhibition is based on eleven years of work by the “Difference and Integration” Collaborative Research Centre at the Universities of Leipzig and Halle-Wittenberg,

Right: Nomadic grazing lands in the Nagqu prefecture of the Tibet Autonomous Region: Motorcycles bring new forms of mobility and take the place of horses and other mounts.

as well as at other, non-university institutions. Here, researchers from 15 disciplines, including ancient history, Islamic and Oriental studies, geography and ethnology, worked together on over 50 projects. At the opening of the Collaborative Research Centre’s concluding exhibition, which was funded by the DFG at a cost of almost a million euros, Annegret Nippa explained the exhibition’s key points: “The displays have also been designed to reflect the nomadic way of thinking. Visitors therefore wander through the building, experiencing the topic in its flexibility and in its fundamental tenet: mobility.” This concept also has the advantage of allowing 400 objects to be displayed. Half of them come from DFG field studies, a quarter are part of the Hamburg Ethnology Museum’s collection, and the rest are on loan from other collections.

The quantity and variety of the exhibits, which include a few written works, are surprising. Researchers and exhibitors had to deal with the difficulty of obtaining objects and nomads’ inconspicuousness. Whether camel-riding Bedouins in the Sahara or nomads herding Yak (a type of domesticated grunting ox) on the Tibetan high plains, nomadic cultures are almost completely non-literate. Since ancient times, non-nomads have written about them from their settled viewpoints and with differing goals. Their original traces have, however, been literally lost on the steppes and in the desert sands.

The exhibition contains four sections: “Exchange and Trade”, “Leadership and Control”, “Nature and Animals – Work and Product”, and “Difference and Integration”. Nomadic societies arise where uncultivable deserts, steppe landscapes and



Illustration: SFB 586/Andreas Grieschke

high karst plains permit only a peripatetic existence. Nomads (literally: “people who move with herds”) live with and from their livestock, with goats, sheep and yaks providing the basic materials for food, clothing and trade. (Wild) horses and camels serve as pack and riding animals, ensuring the nomads’ mobility. It is no surprise that the stirrup was invented by the Turkic peoples.

Since ancient times, trade and change have created the traditional interface between the nomadic and settled worlds. In the marketplaces and caravanserais, the nomads bartered with wool products, milk products and meat for grain, sugar and tea, as well as metal and wooden items. They also offered goods which bore testimony to their specialist knowledge (handed down through oral traditions) and their familiarity with regional flora and fauna. These included, for example, the finely curled karakul fleece of the Persian lamb for coats and hats, marmot fat to protect against cold,

Masters of a sustainable economy (top): Nomads learned early on how to dye wool using natural substances. Everything is used (below): Half a reindeer skull becomes a salt container; a reindeer’s stomach is used to store dried milk.



or Armenian healing earth for skin conditions. Even more specialised are “healing” tortoise dung or the resin of white vermouth. The displays place items that seem exotic at first glance in an everyday context. Rather than attempting to sensationalise the adventurous aspects of nomadic life, the exhibition focusses on everyday life for the nomad. This is one of its strengths.

It is, however, also a weakness. While the exhibition does cover the nomads’ attitudes to power structures and their boundaries, to changes in leadership and control, it focusses mainly on their coexistence and cooperation with these concepts, describing their conflicts with them only as a side note. Such meetings really would have been “charged encounters”. In her guided tour, Andreea Bretan likes to talk of “similarities in the differences”. This includes the (possibly unique) second-century custom of giving nomads in the Roman province of North Africa Roman citizenship rights. This is borne out by the



“Tabula Banasitana”, a bronze tablet found in Banasa, Morocco, which contains three emperor’s letters on the matter to the province’s governor. Integration through citizenship! Drawing a contemporary parallel, a naturalisation certificate from today and German citizenship rights are displayed beside the historical documents in a display of socio-political finger-pointing. Conflict and confrontation, and, in particular, warlike skirmishes – the Bedouin wars spring to mind – take a back seat. Andreea Bretan emphasises “the high potential for peaceful coexistence”. In the eye of the beholder, however, “possibility” can trump “reality”.

The exhibition traces the route taken by the centre’s work. A corner of the first exhibition room contains a world map showing all the places

and regions examined. A display case describes the sources of the research: finds from grave sites, documents from archives, an exemplary field studies notebook, and empirical data records. This high and wide multidisciplinary umbrella also enables researchers to discover new nomadic settings and phenomena.

One multimedia station, for example, showcases Romani palaces. These have been found increasingly in Eastern Europe since the 1990s, most notably in Romanian suburbs and villages. These “castellos” have no running water, heating, cellars or garages. They are designed not for living in, but to demonstrate the wealth and pride of their builders, and are used only on feast days. The façades – and particularly the cupolas – are crucially important for the family involved: the more ornate, higher and more artistically ornamented they are, the more prestigious. The concept of settlement is given form as a fantasy.

The Romani, too, are masters of mobile life. The exhibition supports the concept that nomadic communities represent a separate and independent way of living, rather than the remnants of an archaic precursor to settlement. “For millennia, nomads have been part and parcel of civilisation in the Old World dry belt which extends from Morocco in the west to northern China in the east,” explains Arabist and Islamic scholar Professor Stefan Leder, the first coordinator of the Collaborative Research Centre. In the modern world, nomadic cultures – which have long since adopted the mobile phone, motorbike and campervan – are a current, if repressed, way of life. In a culture shaped by urbanisation, the nomadic lifestyle receives little support: metaphori-



A vacant “gypsy palace” in the village of Huedin, in the district of Cluj, Romania. The Romani mainly work as “service nomads”, travelling from job to job instead of from pasture to pasture. They work as gutter makers, tin-platers and smiths.

cal slurs like “renter nomads”, job nomads and “relationship nomads” speak for themselves.

But what can we learn from nomadic lifestyles? If we perceive the nomad as “a vanguard of globalisation” as the Leipzig-based SFB coordinator Professor Jörg Gertel, an expert on the economy and social geography of the Near East, does, it becomes clear that mobility and flexibility can overcome hostile living conditions and existential uncertainties, that scarce resources can be creatively used and that people can live sustainably in harmony with nature and the environment.

The “Brisante Begegnungen” exhibition presents visitors – of which there have, so far, been more than 25,000 – with a new and multifaceted image of the nomadic lifestyle. It also shows that “refining” this image requires intensive

research. The alphabet of nomadism is one in which it is worth becoming literate.

Dr. Rembert Unterstell is Publishing Executive Editor of *german research*.

“Brisante Begegnungen” will be on display at the Hamburg Museum of Ethnology until 20 May 2012. Since February, it has been expanded to include the special exhibition “Wahlverwandtschaften. Imaginationen des Nomadischen in der Gegenwartskunst” (Elective Affinities. Portrayals of Nomadic Life in Contemporary Art).

www.voelkerkundemuseum.com/306-0-Brisante-Begegnungen-Nomadinnen-in-einer-sesshaften-Welt.html



A companion volume to the exhibition is available. The “Kleines abc des Nomadismus” (Nomadic Primer) by Annegret Nippa is published by the Verlag Museum für Völkerkunde, Hamburg 2012, ISBN: 978-3-9812566-5-9.



Illustration: Herder Institute

Wolfgang Kreft

Reborn from the Spirit of Europe

Moving map: The first volume of the historical-topographical atlas of Silesian towns looks at the border town of Görlitz/Zgorzelec. The project is intended to create a basis for comparative city research.

At the intersection of Upper Lusatia, Lower Silesia and North Bohemia, in what is today the Euroregion Nysa-Nisa-Neisse, European vision is becoming reality. Although, as is widely known, the twin city of Görlitz/Zgorzelec was not named the 2010 European Capital of Culture, its goal remains to build bridges across space and time – based on facts and topography.

Görlitz/Zgorzelec's European vision has its roots in the city's history. Since its forcible division in 1945, the political events of 1989/90, and its proclamation as a City of Europe in 1998, the town on the Lusatian Neisse has striven to achieve a new local and regional identity. Although traces of its long-ago Bohemian, Brandenburg and Hungarian rulers are still part of its history, this city on the Via Regia was an Electoral Saxonian provincial town for over 180 years until the Congress of Vienna in 1815. It was then Prussian (as part of Lower Silesia) until 1945.

In particular, the two most recent – and still very much alive – centuries see Görlitz becoming a model town in many respects, beginning with its integration into the Prussian province of Silesia in 1815. In

1833, Görlitz was granted Prussian city status, and subsequently experienced a sustained boom.

The economic basis for Görlitz's rapid urban development in the 19th century was created by the textile industry, as well as by plant and railroad construction. In 1847, the town was connected to the Prussian and Saxonian railway networks. By 1869, the Görlitzer Maschinenbau-Anstalt, which was founded at the same time, already employed almost 600 people. It later became one of the German Reich's leading wagon construction companies, and it still exists today.

Between 1825 and 1871, the population increased fourfold, from 10,700 to 42,200. It had doubled again by 1905, to 84,700. This rapid population increase led to dramatic urban development, a process lent impetus by the removal of the city walls, which began in 1848. According to contemporary reports, the development plans of around 1848 and 1866/71, which were modelled on major cities like Paris, Berlin and Vienna, enabled Görlitz to become Germany's most charming provincial town during the last third of the 19th century.

The expansion which took place during the Gründerzeit extended initially from the railway station, which was located to the southwest of the town, and gradually shifted the town's functional centre to an axis between the Old Town and the station. Until the turn of the century, it encroached upon the district to the south of the railway station while, after 1990, it incorporated more of the districts east of the Lusatian Neisse. Closed perimeter blocks were a very typical construction feature, and these were later built partly in the ornate Art Nouveau style.

It was during that period that Görlitz's favourable municipal infrastructure earned the town its reputation as a "pensionopolis" – a

Mecca for retired people. The town's amenities included numerous green areas, good connections to Dresden, Breslau and Berlin, and proximity to attractive excursion destinations in the neighbouring mountainous regions of the Zittau Mountains and Krkonoše to the south.

After the First World War, the town's population growth slowed, and it was not until 1934 that it re-attained its highest pre-war level of 94,600. The amalgamation of other communities caused the town's area to grow to 30.5 square kilometres. This area was distributed equally east and west of the Lusatian Neisse. The major part of the building activity in the period between the wars focussed on the area east of the river, which had approximately 8,800 in-

habitants in 1939. It was characterised by the construction of cooperative housing and garden-city-style residential areas. Also in 1938, the renovation of the Old Town began.

As Görlitz was spared the bombardments of the Second World War, the town's historic sector has been preserved almost in its entirety. The Neisse bridges were blown up, however, which severely affected the town's transport infrastructure. The division of the city in 1945 had far-reaching consequences for the city's internal structures. The Polish municipal authorities governing Zgorzelec were faced with the difficult task of creating an independent town, with all its attendant functions, from what was previously the Neißevorstadt suburb. In the end,

Town atlas online: Historical maps and aerial photographs illustrate Görlitz's growth phases and development.



The Lusatian Neisse Viaduct, completed in 1847, was one of Silesia's largest rail bridges.

the two towns developed very differently, with their planning axes running either side of the Lusatian Neisse, from north to south.

In the period between the town's division and its reunification, it faced additional challenges. Due to its strong population growth, these began with residential restructuring. This was followed by initiatives to deal with the Old Town's cultural legacy, which had been neglected by town planners for decades and was, in some cases, literally falling apart.

By the mid-1980s, three major new residential areas had been created in Görlitz. A competition held in 1976 "as a sign of friendship" between the people of the GDR and the People's Republic of Poland and aimed at remodelling the Gründerzeit-era city centre in the socialist modern style, was, however, not pursued further. Instead, Zgorzelec's garden city, which had not been completed before the war, was expanded and a series of

multi-storey residential buildings was added. In the 1980s, builders in Zgorzelec's new sector, opposite the Old Town, began using the industrial panel-construction method, whereas the existing old buildings in the Neißevorstadt suburb initially remained uncategorised by urban planners. During this period, the population of both towns rose, over several years, to its highest level to date at just under 116,000.

In 1991, the town was accepted into the Arbeitsgemeinschaft historischer Städte (Working Group of Historic Towns). Görlitz became a model for historic town centre renovation and is once more considered one of Germany's most beautiful towns. The town's Gründerzeit-era expansion is now a protected monument. It is flanked by an integrated town development concept which will be further stepped up as part of the current "Stadt 2030 – Gemeinsames Leitbild der Europastadt Görlitz/Zgorzelec" project (City 2030

– A Joint Approach to the Görlitz/Zgorzelec City of Europe).

The model city of Görlitz has an eventful history. The first volume of a new historical and topographical atlas of Silesian towns, which was published in the summer of 2010, provides a balanced view of Görlitz/Zgorzelec. The aim of the research project, which began in 2008, is to document the development of thirty-four selected towns in the historic region of Silesia and the structural changes which took place there between the 19th and 21st centuries. This period covers both the Prussian province of Silesia and the Austrian dukedom of Silesia as defined in the 19th century. The project will both document the town's development and place it in a geographical context. It covers the beginning of the Industrial Age in Silesia and continues via the expansion of the town during the Gründerzeit era and the development of its modern transport infrastructure, right through to the creation of residential areas in the period between the two World Wars.

The period after 1945 is examined primarily in terms of the different forms of redevelopment and the changing functions of the areas cited, including the towns' current transformations. Using the historic region of Silesia, therefore, the project team has produced a work of reference for use in comparative urban research in Europe. This work will also appeal to those studying the history of town planning and contributes to the current discussion on general principles. In addition, the team's transnational examination of the city's development after 1945 is groundbreaking.

The research results are communicated by 29 authors from Poland,



A bird's-eye view of Görlitz: The historic boundaries of the city's crowded Old Town are still visible.

the Czech Republic and Germany. Their contributions to the stories of the towns studied cover issues pertaining to the settlement, transport and economic geography of each town and its hinterland. In addition to written sources, their work is based on a series of (partly unique) maps and aerial photographs. These have been scaled to 1:25,000 and date from key years around 1830, 1900, 1940, 1975 and 2000. They are taken from the map collections belonging to the Herder Institute in Marburg and the cooperation partners involved.

The maps and aerial photographs selected clarify the changes in the town's landscape over the past two centuries and enable researchers and practical users to make insightful comparisons of past and present land use, including its consequences. Evaluated vertical aerial photographs from 1944/45

are particularly valuable resources. In many cases, these provide the last documentary evidence of undisturbed historical cityscapes.

In addition to the publication of the bilingual atlases, a multimedia version of the volumes has been published online. This has been done with an eye to the additional evaluation options offered since 2009, which include the ability to continually update the material. This medium speaks to a wider audience, one which prefers to have maps, images and text information displayed simultaneously and interactively on-screen. The animated urban development maps are particularly noteworthy.

Current discussions of the town's future are focussed on reviving the European city model, taking into account local historical developments. This model includes a defined layout with a relatively high

structural density, a networked system of public spaces, and a spatial hierarchy with a built-up centre. In this sense, the European city is an expression in stone of its particular history. This must be preserved and, where necessary, restored – a challenge which few towns in Central Europe are tackling as thoroughly as Görlitz/Zgorzelec.



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DFG Exhibition "General Plan East" in Poland

Travelling exhibit, opened in Warsaw, to tour Polish cities / German and Polish partners encourage dialogue

When the DFG first presented its exhibition "Wissenschaft – Planung – Vertreibung: Der Generalplan Ost der Nationalsozialisten" (Research – Planning – Expulsion: The National Socialists' General Plan East) to the public in 2006, it was the organisation's most visible attempt to date to come to terms with its own involvement with the Nazi regime.

Since 2000, historians Isabel Heinemann, Willi Oberkrome, Sabine Schleiermacher and Patrick Wagner, part of an independent group contracted by the DFG to research the history of the funding organisation from 1920 to 1970, have been working to reconstruct the plan with which agricultural scientist Konrad Meyer both advanced and substantiated the "Ger-

manisation of the Eastern Territories" in 1942. Over a period of 25 years, five million Germans were to have colonised annexed Poland and the western part of the Soviet Union. In return, millions of Slavic inhabitants of these regions would have been enslaved, expelled and murdered. The DFG provided considerable funding for the development of this plan.

The exhibition on the General Plan East has been displayed in more than 20 German cities since 2006, primarily in universities, but also at the concentration camp memorials at Bergen-Belsen and Mittelbau-Dora.

From April to October this year, the story of the General Plan East can be viewed in the country which would have been most affected by its

deplorable consequences: Poland. At the invitation of and in close cooperation with the Polish Academy of Sciences (PAN), as well as the Polish Institute of National Remembrance (IPN), the DFG will hold the exhibition in Warsaw, Lublin, Wrocław, Poznań and Gdańsk.

When the DFG, PAN and IPN opened the exhibition at IPN's educational centre in Warsaw on 17 April, everyone agreed that this is a special project for all involved. Twenty years ago the DFG would not have thought of designing such an exhibition, let alone bringing it to Poland, acknowledged Matthias Kleiner. The DFG President expressed the wish – and the hope – that this exhibition "will provide an impetus for coming to terms with this particularly difficult chapter in German-Polish relations and enable it to be jointly discussed". The Polish Academy of Sciences feels that the exhibition makes it clear that "Germans and Poles now share common values". The Institute of National Remembrance is convinced that it "will have a positive effect on Polish-German relations".

The exhibition's patrons are Bundestag President Professor Norbert Lammert and his Polish colleague, Marshall of the Sejm Eva Kopacz. Petra Pau, one of the vice presidents of the Bundestag, travelled to Poland for the opening where she met her Polish Counterpart, Vice-Sejm marshal Eugeniusz Grzeszczak. At the beginning of April, Warsaw also played host to an international scientific conference which places the General Plan East in the wider context of forced migration and of "Social Engineering in the 20th Century".

www.dfg.de/dfg_magazin/wissenschaft_oeffentlichkeit/ausstellungen_veranstaltungen/generalplan_ost/index.html

Polish rural inhabitants being driven from their villages – one of numerous pictorial documents from the "General Plan East" exhibition, which is now on display in Poland.



Illustration: Bundesarchiv, Koblenz



Illustration: SFB/TR 8

Julia Gantenberg, Kerstin Schill and Christoph Zetsche

Exploring Virtual Worlds in a Computerised Hamster Wheel

A new experimental platform called "VirtuSphere" is helping scientists to understand how we perceive and process spatial information. Their findings will help scientists to develop the next generation of assistive devices and robotic systems.

Finding our way through a house or apartment is something that comes naturally to healthy people. We can identify our location, distinguish between the living room and the bedroom, and get from the kitchen to the bathroom with ease. Healthy individuals generally have strong spatial cognition abilities and are able to recognise the position of various objects within a given space. Moreover, they can explore and learn to "navigate" a seemingly endless series of new environments.

This remarkable cognitive ability – the perception of spatial environments and their representation in the human brain – is highly interesting from a basic research perspective. Improving our knowledge of how humans perceive and interact with spatial environments would enable researchers to develop new technical systems – such as robotic systems capable of assisting disabled or elderly persons in their households.

In order to learn more about how we navigate in spatial environments,

Spatial cognition in a virtual space: researchers are using VirtuSphere to study fundamental spatial orientation.

and which movements and senses we employ in the process, a group of researchers has been studying how humans navigate in virtual environments. The advantage of using computer-simulated environments lies in their configurability. However, in previous studies test subjects were usually unable to physically move in spatial environments, and experiments were limited to the observation of their visual perception. From the comfort of a chair, test subjects navigated computer-simulated environments on a monitor using a joystick or keyboard.

The VirtuSphere will add a new dimension to research in this area and could deliver new findings. As an ideal experimental platform for the systematic study of human spatial perception, reasoning and action, the VirtuSphere looks like an oversized, spheroid hamster wheel for humans. Nearly three metres high, the sphere is mounted on rollers which allow it to rotate freely in any direction according to the user's steps, enabling researchers to create experiments in which test subjects can move around in a virtual world by actually walking. A special head-mounted display (HMD) worn by the test subject tracks their motions

and displays images of a dynamic virtual environment. The sphere itself is also equipped with an array of sensors that track the user's motions inside the sphere and transmit data to the researchers' computer displays.

The VirtuSphere enables researchers to study the movements of the test subject's legs, head and body in conjunction with their visual perception of the virtual environment. The experience of movement within this virtual environment is not restricted to the visual level; instead test subjects must actually perform the corresponding motion to move forward or turn corners. Researchers are keen to understand how the interplay of body motion and visual perception, also known as sensorimotor coupling, affects the processing of spatial information.

Until now, a predominant scientific hypothesis was that humans record spatial information in a cognitive map. In other words, according to this hypothesis the human brain integrates spatial information into a metric representation of an environment, similar to a geographic map. However, there are signs that the humans do not rely on a map-like representation



Left: Data generated by the VirtuSphere is transmitted to the researcher's monitor. Right: The research findings will help in the development of robots with cognitive abilities similar to humans. The robot in this image is equipped with a spatial cognition system.

and there are no noticeable bridges or tunnels. According to the physical laws that hold sway in our real world, these two corridors should intersect at some point. And yet they never meet in this man-made virtual world.

If the human mind did generate a map of its surroundings, this environment would defy its ability to do so. In other words: as the brain attempts to generate a map of this impossible environment, test subjects should become aware of this spatial discrepancy as it is simply impossible to create a map of this particular virtual world without distorting the information on a massive scale.

of environments with which we are already sufficiently familiar, and the VirtuSphere is being used to test this hypothesis in a special experiment.

In order to refute the hypothesis of "the map in the mind", researchers are sending test subjects into par-

adoxical virtual worlds that could not exist in our physical world. One of these worlds, for example, consists of a circular passageway. Two other corridors branch off from this circuit and dissect the centre of the ring. The corridors in this virtual world are open to the skies above

Researchers have built virtual worlds to help them understand how the human brain processes spatial data.



Illustrations: SFB/TR 8

This raises a number of fundamental questions: do test subjects notice that this environment is anomalous? And how do they cope, for instance, when asked to perform spatial tasks such as identifying the shortest route between a given destination and a starting point?

The preliminary findings of these studies show that instead of noticing this anomaly, test subjects move around within this spatial environment as if nothing was amiss. Oblivious to the missing intersection, test subjects are able to solve the tasks presented to them without any problem whatsoever. Confronted with an anomalous virtual environment, the test subjects were anything but perplexed, and were able to navigate this physically impossible world with ease. The question is: how?

The current hypothesis is that a sensorimotor representation of the environment generated by the brain is behind these amazing feats of spatial orientation. To put it another way: our brain creates a representation of the spatial envi-

ronment based on the actions we perform within this space together with incoming sensory data. In its most basic form, this sensorimotor representation would consist of elements such as: "If I walk forwards and turn right at the corner, I will see the church tower ahead of me." This representation of our surroundings is generated by combining data provided through our various actions with sensory input, i.e. visual, aural, haptic and olfactory input, together with information about the manner and direction of our movement. This information forms the basic units of the spatial representation.

The findings from these experiments show that the brains of the test subjects did not refer to a cognitive map in performing these tasks. However, these findings do not detract from the fact that we are obviously capable of generating maps of our surroundings and use these to retain and pass on spatial information. The question remains, however, as to whether this ability is rooted primarily in our spatial cognitive abilities or in something altogether different. The alternative – sensorimotor representation – clearly requires further investigation and researchers have planned a series of further experiments utilising the VirtuSphere platform.

Research into the cognitive processing of spatial information in humans is particularly important as findings in this area will provide valuable insights for the development of suitable technical assistance systems. Next generation robotic systems will be equipped with a dynamic orientation system similar to that used by humans. Researchers hope that these systems

will be able to interact with their spatial environments in a more human-like manner, and operate using the same type of spatial intelligence.

A robotic head has already been developed that uses movements to guide its spatial orientation. Its programme is based, among other things, on insights gained through the observation of human behaviour. Equipped with arms and legs, this robot might one day be used to assist elderly or disabled persons in everyday life. This development would enable the use of robots in a whole range of settings.



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Foto: Johnen / Montage: Poganiatz

Hermann Wagner and Laura Hausmann

Perfectly Matched

Seeing, hearing, navigating – when it comes to adapting to a habitat, the barn owl is a model animal. Learning from nature with these nocturnal birds not only leads to new fundamental discoveries, it might also bring innovative technical applications closer to reality.

Barn owls (*Tyto alba*) are familiar to most people only from nature films. Few have seen the shy, nocturnal creatures in forests or fields. And yet, owls evoke huge fascination in human beings and provide material for all sorts of legends. Owls are a symbol of wisdom to some. With the Latin genus name *Athene*, the bird is often depicted in illustrations alongside its divine namesake. To others, owls are the prophets of doom. Why? The tawny owl performs its courtship display in February with the loud call “kuwitt, kuwitt”. To some Germans, this resembles the sound of the words “kommt mit, kommt mit!” (“come along, come along”), and as it is heard towards the end of winter, at a time when the mortality rate is highest, it is interpreted as a death call.

From the scientist’s perspective, the barn owl is a highly interesting model animal and a gold mine for new discoveries. As a night-time hunter, this species has developed a number of specialisations which are very exciting both from the point of view of basic research and in terms of “natural applications”. In this article we will look at some of these adaptations, or evolutionary inventions.

Firstly: evolution is an optimisation process. Only those species adapted to a specific ecological niche

can expect to survive in the long term. As part of this process, through mutation and selection, evolution finds solutions that are continually surprising not only to biologists, but also to engineers. Particularly good solutions are found in the case of animals that are specialised in specific tasks. And it is therefore useful to study such “specialists”.

Anyone who has observed a barn owl killing its prey has to marvel at its precision. It is so effective at hunting that, while breeding, it returns to the nest every 10 to 15 minutes with a mouse which it has caught within its roughly five square kilometres of territory. This is a job it must perform up to 25 times per night. No human being would man-

and many people therefore sense an affinity to this creature. The birds can in fact be tamed by hand-rearing. This makes the birds very trusting towards humans, which we see in their playful disposition. From a scientific point of view, the frontally placed eyes allow the birds to see the world (just like humans) with sharp depth perception, facilitated by the overlapping fields of vision of the two eyes. Since the spatial depth perception arises from the slightly different image information arriving at the two eyes, this is known as “stereo vision”.

The stereo information comes about from the fact that the eyes are laterally separated in the head. The scene is therefore projected on



Illustration & montage: Bachmann

Left: A barn owl in a lattice of sound localisation coordinates. Above: The wing has a toothed structure on its leading edge, which is presumed to be used for noise suppression.

age that – even if he or she were not afraid of mice.

With its forward facing eyes and its facial ruff, the barn owl appears to us as if it has human features, a face even. This has a bonding effect

slightly different retinal positions of the left eye compared with the retinal position of the right eye. These spatial displacements of the images contain information about the distance relative to the point on



The barn owl has an astounding sense of hearing. The facial ruff collects sounds and acts like an amplifier.

For hunting in twilight, the barn owl mainly uses its highly specialised hearing. The ruff collects sounds in a similar way to a parabolic dish, and acts as an amplifier. This allows the bird to hear sounds that are ten times quieter than the quietest sounds perceptible to humans. A crucial role in this is played by the outer ring of ruff feathers, which is made of a dense border of stiff, sound-reflecting feathers. The interior of the ruff, by contrast, consists of finely barbed auricular feathers (from the Latin *auris* = ear), which due to their structure are “transparent” to sound and relay it to the ears with virtually no attenuation. Work has therefore begun on simulating the ruff, to obtain clues which may help in improving the spatial resolution of directional microphones, for example.

which the gaze is currently fixed. Anyone can experience this when they look at pictures formed using the “magic eye” principle. In these images, such displacements of the image are hidden. When the brain manages to correctly associate the dots, a 3-D effect is produced.

We constructed similar images for experiments with barn owls and were able to show that the birds possess a depth perception system similar to that of humans. As a result of this work we discovered a new analysis principle. This can be implemented – following nature’s example – in so-called mobile agents. Researchers in Göttingen have succeeded in transferring this principle to a video image analysis algorithm.

Just like its eyes, the ears of the bird are also laterally separated on the head. The sound from a sound source arrives at the ear facing away from the sound later than it does at the other ear facing towards the sound. Analogous to the spatial displacements found in vision, this results in propagation-time differences between the ears. Differences in loudness occur between the ears because the head reduces the loudness of sounds at the ear facing away from the sound. These interaural time differences and loudness differences are greater the further away the sound source is from the direction in which the head is facing. Due to its fairly small head, the barn owl should actually be able to localise sound sources less

accurately than humans. But that is not the case.

On the horizontal plane, humans and the barn owl localise sound sources approximately equally well, whereas on the vertical plane the barn owl actually achieves a higher accuracy than a human being. This is due to another special feature: the ear flaps of the barn owl are not arranged symmetrically on a horizontal plane, but the left ear flap is higher than the right, and faces downwards while the right one faces upwards. The ruff and the aural asymmetry interact to produce differences in loudness due to changes in the position of a sound source not only on the horizontal plane, but also on the vertical plane. While humans use differences in both interaural time and level to determine the horizontal angle, the owl uses the interaural time differences to determine the horizontal angle, and level differences to determine the vertical.

If the barn owl with such a small head achieves equally good or even better localisation accuracy than a human being, then it must be better able to evaluate the directional information contained in the sound. The brain of the barn owl is highly specialised for processing acoustic signals. Its hearing organ is greatly enlarged in comparison to other birds. It is in the hearing organ where the arrival time of a



Illustrations: van der Willigen



Illustration: Hausmann

signal is analysed. However, there is a significant problem here. The tiny time differences which the sound requires to travel the distance between the ears are only a few hundred millionths of a second, and are in fact too small to be detectable by unspecialised nerve cells.

We suppose that further specialisations in the form of the molecules which generate the neural signals, and the interaction of many sensory and nerve cells, are what make such a precise temporal resolution possible. A deeper understanding of the optimisation at the cellular level is of particular interest, because it may

Elegant and noiseless – a barn owl coming in to land. Below: A bird wearing stereo glasses, taken in various positions. The visual depth system of the birds is highly effective.

prove useful in improving cochlear implants and hearing aids. We are working on sound-localising “autonomous agents”, for example, based on the kinds of computational operations that also take place in the brain of the owl.

While hunting, the sensitive auditory system would be of no use to the barn owl if the sounds of a potential prey were drowned out by the noise of its own flight. In fact, the barn owl’s flight is almost silent. But how does the owl avoid flight noise? In order to answer this question, biologists and aerodynamicists have joined forces. The aim of this research is not only to decipher the mechanism used by the owl, but, in the long term, perhaps also to exploit it for designing noise-reducing aeroplane wings. This is another area where specific adaptations in the plumage and wing shape play their part. The comparatively large wings are elliptical in shape, and due to their super-fine elongated barbules, the individual feathers form a velvety surface. All this ensures good lift even at lower flight speeds, while at the same time reducing air turbulence which could cause noise.

The long list of special characteristics of the owl currently being studied includes another somewhat unusual one. Like most bird species, barn owls have a preen gland which is situated on top of the base of the tail, the rump. The gland produces an oily secretion which the bird typically spreads over its feathers with its bill when preening, to pro-

tect them against water. Given their high body temperature of almost 40 degrees (which, incidentally, is the reason for the birds’ low susceptibility to most bacterial infections), this is crucial to their survival as ingressive moisture would inevitably lead to massive heat loss. The secretion produced by the preen gland contains fatty acids which are also suitable for use as lubricants. This gave rise to the idea of expressing the genetic sequence of these fatty acids in plants, cultivating them in a field and then extracting the oils. In the future, then, there may be a lubricant for sale that is derived from owls.

All these examples show not only why we find a graceful creature like the owl so beautiful and attractive, but also why the bird can serve as an extremely fascinating animal model in basic research. After some 50 years of research on and with the barn owl, a good many secrets have now been revealed, while others still wait for solutions and answers. This is a source of motivation to us in our research.



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The Deutsche Forschungsgemeinschaft

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Illustration: DFG/Wibben

“Exhibition this way”: The sign leading to the “MenschMikrobe” (Humans and Microbes) exhibition – elegantly mounted on the aesthetically austere pebble-dashed wall of a German university building – could also be an invitation to this issue of *german research*. In addition to the customary main articles penned by DFG-funded researchers, as well as all the latest news on funding policies, programmes and prizes, this issue of our magazine also features multiple exhibitions. These are either organised or supported by the DFG and showcase scientific material, topics and discoveries. Their success is exemplified by the “MenschMikrobe” exhibition, an interactive display on infection research organised jointly with the Robert Koch Institute, which has already attracted well over 70,000 visitors.

Impressum

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