

## Inner Beauty

What happens inside the body when musicians play wind instruments



Craters in the lab: Simulations illustrate what happens when meteorites hit the Earth



Friends on the net: Social networks provide new ways for citizens of Cairo to interact



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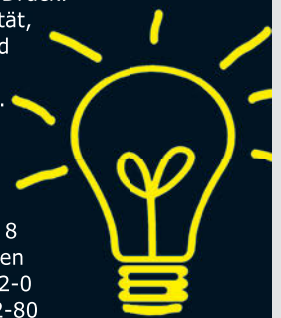
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## Yearly Report 2013: The Numbers Stand for People

The positive development of the University of Freiburg cannot be represented by means of numbers alone, because the numbers stand for people and their achievements. All the same, the university would like to give you an idea of these developments in compact form. The detachable yearly report presents data and facts from the past year (1 Oct. 2012 – 30 Sept. 2013)

The Yearly Report 2013 of the University of Freiburg should be attached to this page. The report is also available on the university website:  
[www.uni-freiburg.de/go/jahresbericht\\_2013](http://www.uni-freiburg.de/go/jahresbericht_2013)

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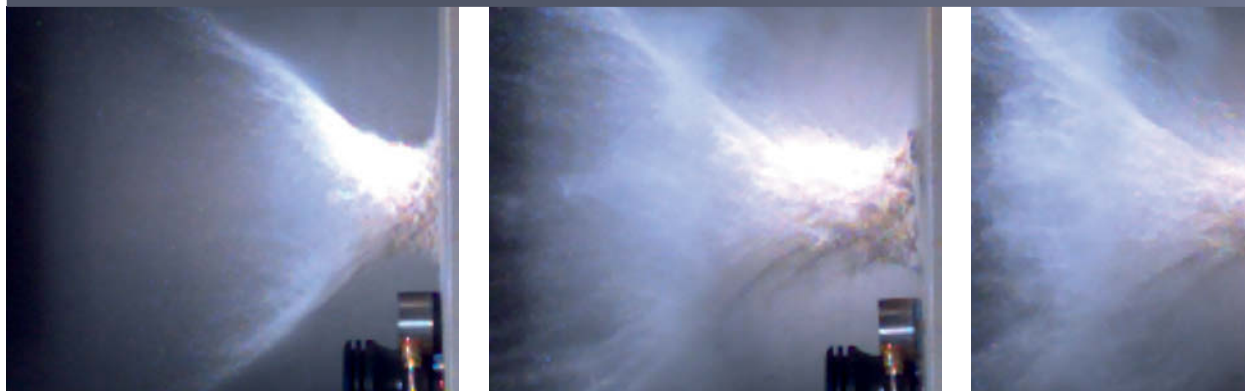
# Geology in Fast Forward

Thomas Kenkmann simulates meteorite impact events in the lab

by Mathilde Bessert-Nettelbeck



© Fraunhofer EMI



Fifteen million years ago in southwestern Germany: A stony meteorite with a diameter of 1.5 kilometers is on a collision course with the Earth. Even before it hits, a shock wave pulverizes the primeval forest. This airburst occurs as the meteorite enters into the Earth's atmosphere. Everything that survives the blast is reduced to ashes by the heat radiating from the point of impact. At the moment the meteorite reaches the Earth's surface, the energy of the impact is transferred to the stone. It breaks, melts, and fumes; a glowing cloud billows up from the ground. The rest of the energy is transferred into motion: The Earth trembles. This shock wave catapults soil and rock from the point of impact into the air. Rocks the size of a house are hurtled as far as 40 kilometers away. A round crater, roughly 4.5 kilometers deep and twelve kilometers wide, takes shape for a brief moment, only to cave in under the influence of gravity. The final crater, the Nördlinger Ries, is only 500 meters deep but has a diameter of 25 kilometers.

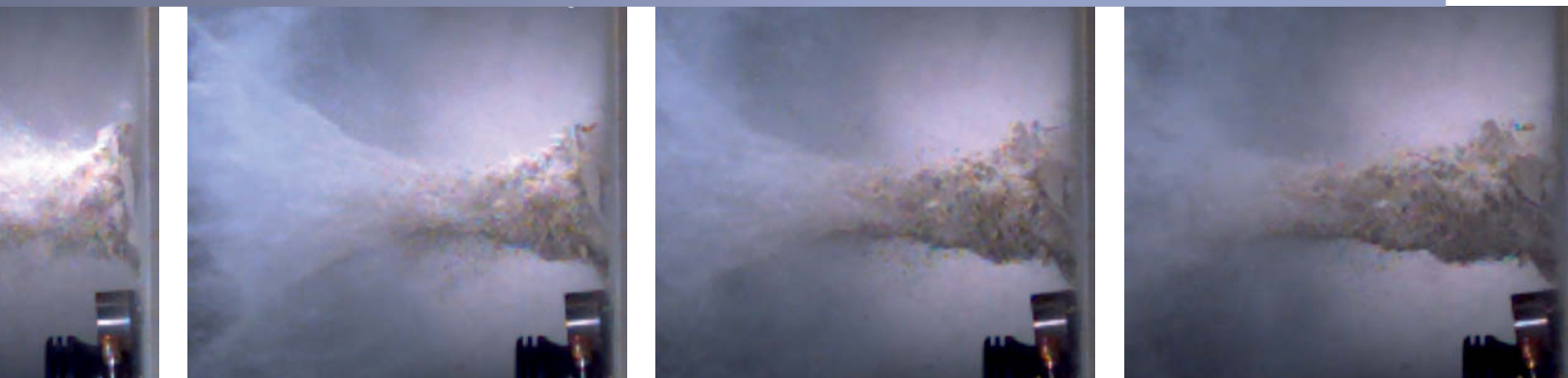
The large circular depression between the Franconian and Swabian Jura was long thought by scientists to be the weathered remains of a volcanic crater. It wasn't until the 1960s that geologists ascertained that the basin-shaped valley was created by the impact of a meteorite. They discovered coesite and stishovite at the site –

high-pressure minerals found only in places where a meteorite has compressed the rock to an extreme extent and left a crater.

Prof. Dr. Thomas Kenkmann from the Institute of Earth and Environmental Sciences of the University of Freiburg wants to understand the process by which craters and high-pressure minerals, also known as impactites, form when a meteorite collides with the Earth. Most geological changes are extremely long, drawn-out processes in which rock is transformed and shifted by various forces, movements in the Earth's crust, and chemical reactions over the course of millions of years. In impact craters this all happens in fast forward. In the case of the Nördlinger Ries, for instance, the impact and the entire process of crater formation lasted approximately 50 seconds. "It's a geology of seconds," says Kenkmann.

In order to reach a better understanding of the process by which such craters are formed, geologists can't wait for something new to drop from the sky. Instead, Kenkmann falls back on a miniature model. He conducts simulations with his research group, "Multidisciplinary Experimental and Modeling Impact Research Network" (MEMIN), funded by the German Research Foundation. The cooperation between scientists of the University of Freiburg and the Fraunhofer Association's

*High-speed film sequences show how a crater is formed: In a laboratory experiment, a small meteorite knocks a cone-shaped cloud of fragments out of the rock. Photos: Fraunhofer EMI*

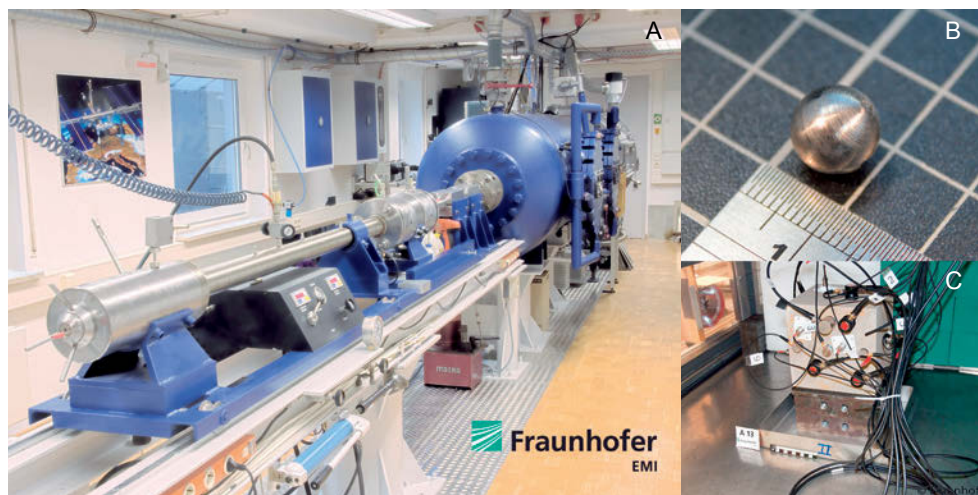


Ernst Mach Institute (EMI) plays a key role in the network: Geologists and geophysicists work together with engineers and physicists to understand precisely what happens when meteorites collide with the Earth – in the cellar and on a small scale.

**“We’re something of a global impact crater taskforce”**

**Hot Iron and Wet Stone**

A two-stage light-gas accelerator in the cellar of the EMI in Freiburg accelerates metal balls to the speed of a meteorite. In a room with a length of approximately 20 meters, the researchers let pieces of real meteorites fly at blocks of stone from the side. The balls are shaped from the Argentinian meteorite Campo del Cielo into 2.5 millimeter-large projectiles. They produce craters measuring roughly five to ten centimeters in sandstone, quartzite, or tuff. The stone blocks are cubes with an edge length of 20 centimeters, representing the Earth’s surface in miniature. In the town of Efringen-Kirchen near Lörrach, the EMI also has a larger accelerator capable of firing balls with a diameter of up to 1.2 centimeters at one cubic meter-large blocks. The researchers also use a simpler testing facility located at the Institute of Earth and Environmental Sciences of the University of Freiburg, at which a small meteorite gun fires at colorful layers of sandstone – this time from above.



*The researchers use the two-stage light-gas accelerator at the Ernst Mach Institute of the Fraunhofer Association (A) to shoot iron balls made from the meteorite Campo del Cielo (B) at blocks of stone (C). A miniature crater is formed. Photos: Fraunhofer EMI*



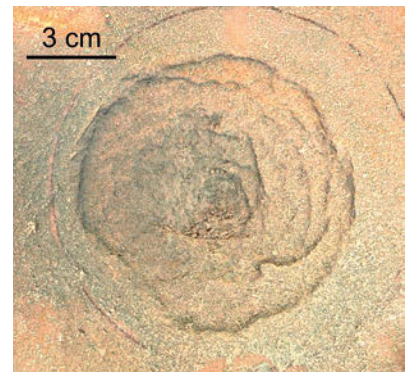
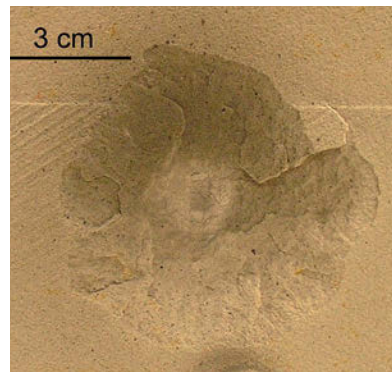
“When the rock contains a lot of water, the effects of a meteorite’s impact are four times as great”

The impact event unfolds much more slowly in the laboratory than in nature. The aim of the experiments is to predict what would happen if the Earth were bombarded from space. The results need to be transferable to real, large-scale impact events. With the help of computer simulations, the researchers first calculate what forces are at work during an impact event on the Earth’s surface and then use the accelerator to test how their calculations match up to reality.

When a meteorite is shot out of the EMI’s light-gas accelerator in Freiburg, it crashes into the rock in the tightly sealed and secured metal chamber at the end of the five meter-long pipe of the accelerator. There is a bang as if someone had struck a table with a hammer. The little crater in the stone block shows cracks and fissures. The scientists capture the miniature impact event on high-speed film at 100,000 images per second. They measure the pressure, temperature, and speed at numerous points in the impact chamber and inside the stone block. Crammed with sensors and cables, the block resembles a little computer made of stone.

#### With Floral Foam and Vaseline

The most interesting thing for Kenkmann now is to examine the tiny shards, drips, and fragments the meteorite has blasted out of the stone block. “A contraption made of floral foam and Vaseline proved to be the best way to catch the fragments blasted out of the rock,” he says. The fragments and the crater are now subjected to a close examination under the microscope: Which fragments were thrown how far, and how fast did



*The properties of the rocks change the effect of the impact: Meteorites leave smaller craters in rocks with lower water content (left) than in those with higher water content (right). Photos: MEMIN*

the blast fling them there? How did the stone change? The blast creates pressures millions of times higher than that of the Earth’s atmosphere, causing the atoms in minerals like quartz crystal to rearrange themselves. This leads to the formation of minerals like stishovite and coesite, even in the crater lab.

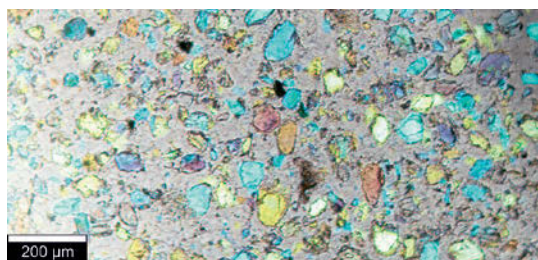
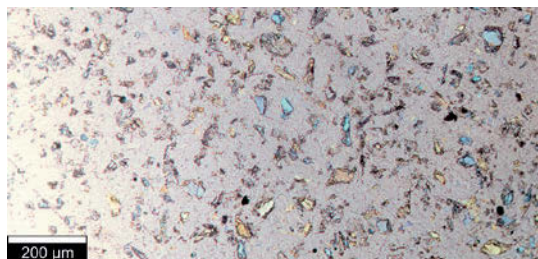
The researchers participating in the MEMIN project have analyzed 24 impact experiments since 2009. They have tested rocks of various thickness and composition. One of the most astounding findings they have made is that the rock’s porosity – the amount of spaces in it allowing air to pass through – has a particularly great influence on the forces set free during the formation of a crater. The air works like an airbag, lowering the pressures released upon impact. In a porous mineral like tuff, for instance, the crater will be smaller and the consequences for the environment less severe than in granite or gneiss. Another major influencing factor is water. “When the rock contains a lot of water, the effects of a meteorite’s impact are four times as great. This was previously unknown,” says Kenkmann.

In the second funding phase, which began in July 2013, the MEMIN project is going into more detail: “We aren’t just interested in looking at how the rocks have become more dense afterwards; we want to be there when it happens. In order to do this, we need strong x-rays.” At the German Electron Synchrotron in Hamburg (DESY), a research center operated by the Helmholtz Association, the scientists can follow the crystals as they change form during impact. A further ambitious research focus in the second funding phase

will be to study the first nanoseconds following impact, in which an enormous amount of heat is generated and plasma is formed. Moreover, the researchers want to try out other rocks, like marble and gneiss.

### Protection from Meteorites

Can the findings help to protect the Earth from meteorite impacts? Like many other scientists, Kenkmann was surprised when a meteorite entered the Earth's atmosphere over Russia on 15 February 2013. Luckily it broke up into thousands of tiny fragments, slowed down by the atmosphere. There was thus no impact crater. The 1500 injuries it caused were due to the atmospheric shock wave created by the meteorite. "Had the rock been only a little bit larger than 15 meters, it would have caused a crater," explains Kenkmann. The city of Chelyabinsk would likely have been completely destroyed. The MEMIN project makes precise calculations like this possible and shows how dangers can be averted: "According to the principle of billiard balls colliding with one another, projectiles can be used to divert celestial objects on a collision course with Earth from their course. The experiments conducted within the context of MEMIN have also yielded initial findings concerning this mechanism," says Dr. Frank Schäfer from the Ernst Mach Institute.



A contraption made of floral foam and Vaseline catches the tiny shards, drips, and fragments blasted out of the rock in the simulations of impact events. A look at the foam under the microscope reveals that more large fragments are caught when there is a lot of water in the rock (below). When the rock is dry, the fragments are smaller and all of roughly the same size. Photos: MEMIN

The experiments help the scientists to understand the history of meteorite impacts on the Earth. One of the largest craters on Earth, with a diameter of 200 kilometers, is the Chicxulub crater in Mexico. The meteorite that created it 65 million years ago triggered global mass extinctions, including dinosaurs. Like at the Nördlinger Ries, scientists have only succeeded in reconstructing the impact event in Chicxulub by analyzing rocks found at the site and making calculations, because it is no longer possible to discern the original form of the crater itself due to erosion.

There are 184 known impact craters on the Earth's surface, and new ones are being discovered every year – also by geologists at the University of Freiburg. "We're something of a global impact crater taskforce," says Kenkmann. When a meteorite hit the ground near Lake Titicaca in South America on 15 September 2007, the researcher flew there with his team to measure the crater and take samples. "You could say it has become a passion." Kenkmann would love to experience a real meteorite impact sometime – from a safe distance and in an uninhabited area. Until then, he'll have to make do with shooting stars.

### Further Reading

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Prof. Dr. Thomas Kenkmann also simulates meteorite impact events in his lab at the University of Freiburg. Visit our research portal [www.surprising-science.de](http://www.surprising-science.de) for a video clip and an article on the research facility: [www.pr.uni-freiburg.de/go/meteoriten](http://www.pr.uni-freiburg.de/go/meteoriten)



**Prof. Dr. Thomas Kenkmann**

has served as professor of general geology and structural geology at the University of Freiburg since 2010 and as assistant dean of the Faculty of Environment and Natural Resources since 2013. After studying geology and paleontology in Cologne, he earned his PhD at the Free University of Berlin in 1997 and completed his habilitation in 2003. He then worked as a scientist and curator at the German Research Center for Geosciences in Potsdam and later at the Museum für Naturkunde in Berlin. From 2007 to 2010 he also served as director of the Center for Ries Crater and Impact Research in Nördlingen. Since 2009 he has headed the research group "Multidisciplinary Experimental and Modeling Impact Research Network," funded by the German Research Foundation. In addition to meteorite craters, his research interests include rockslides and slower deformations of the Earth's crust.

Photo: Thomas Kunz





*Modern communication in the public space:  
Many citizens of Cairo take their smartphone  
with them wherever they go in order to keep  
up with the lives of their friends.*

# True Friends

The ethnologist Kathrin Sharaf is studying how the middle class in Cairo interacts on the internet – and how this has changed in the wake of the Egyptian Revolution of 2011

*by Thomas Goebel*



“True friendship can only exist between people who have sat face to face with each other”

Getting around in the Egyptian capital Cairo, the largest city in North Africa, takes a lot of patience: The distances are great, the streets often congested. Visiting friends from other parts of town takes a lot of planning, time, and energy. Many citizens therefore always carry their smartphone and thus also their social networks with them wherever they go. “The internet, and especially Facebook – ‘al Face’ – is an easy and effective means of keeping in touch with friends and participating in their lives alongside school or work,” says Kathrin Sharaf.

The Freiburg ethnologist is writing a dissertation on the ways in which concepts of friendship in Cairo’s middle class influence internet use – and vice versa. When she began, Sharaf had no idea that the project would also be of such immediate topical interest: Right in the middle of her research, the Egyptian Revolution broke out; her seven-month phase of field research in Cairo began just after the peak of the uprising in 2011. “Then things really boiled over on Facebook, even between friends,” she says.

But who is actually in contact with whom on laptops and smartphones in Cairo? One of the main findings of Sharaf’s dissertation is that friendships maintained over the internet are generally based on acquaintances made outside of the internet. “Contact requests from strangers tend to be frowned upon,” she says. “The basic

principle is that true friendship can only exist between people who have sat face to face with each other.”

#### Connected with Your Own Parents

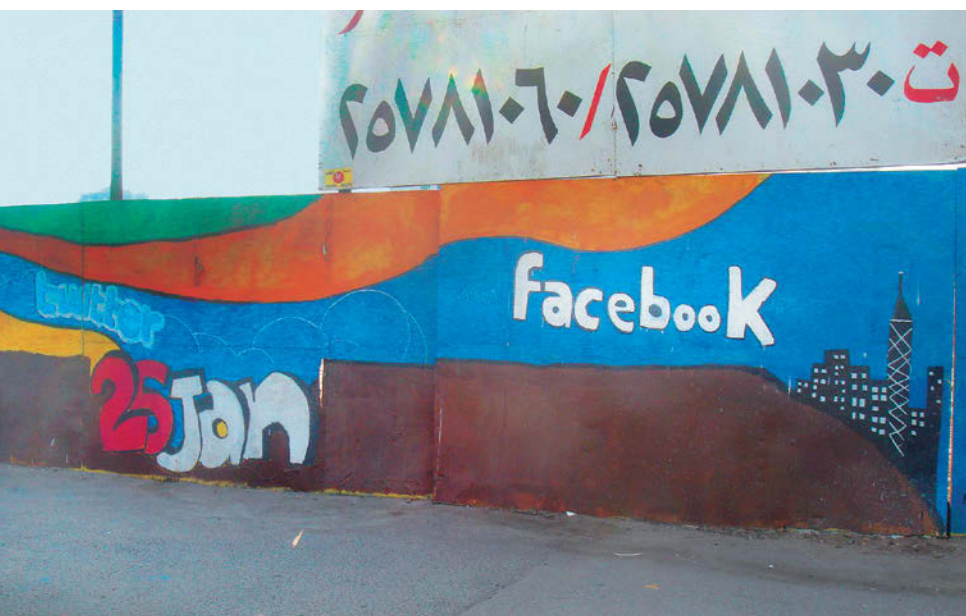
Sharaf speaks of a specific form of caution that is particularly prevalent among young Egyptians. This is due among other things to a fear of ruining one’s reputation, for instance when pictures are shared uncontrollably in social networks. “The Egyptian society is very conservative.” Societal conventions that govern friendships in everyday life are also adhered to on the internet: “For example, you don’t share any photos of girls smoking a water pipe.” Many older Cairenes from the middle class also use social networks. It is not unusual to be friends with one’s own parents on Facebook. “There are also many modern myths, for instance about brothers who are supposedly registered on Facebook under a false name in order to keep watch over their sister.”

Women thus often have two Facebook accounts, says Sharaf: one for a larger group and one for close friends. “It is a special honor to be invited to this friendship account.” These more private accounts are where women share photos from weddings, births, parties, or vacations. Social networks are a place where one’s friends are always present: “I’ve seen it happen that people who haven’t seen each other in a

“There is hardly any basis for friendships that transcend class boundaries – whether online or offline”

long time will research each other on Facebook before a meeting to bring themselves up to date.”

Sharaf came upon the idea for the topic while doing an internship at a women’s rights organization in Cairo in 2007. “I learned from a friend what an important role the internet had played for her relationship.” The web can serve as an “intimate space.” After all, a chat is – as long as one takes the necessary precautions – harder to monitor than a landline telephone conversation in one’s living room. “The internet has given young women in particular, but also men, an enormous amount of freedom.”



*Street art in the Cairo neighborhood Nasr City: Social networks like Facebook and Twitter exerted profound influence on the course of the revolution in Egypt. At the same time, they changed the way friends communicate with each other on the internet. Photo: Kathrin Sharaf*



Up until the Egyptian Revolution, however, most Cairenes used this freedom primarily to maintain friendships – not to engage in political discussions. Although demonstrations were occasionally announced in Facebook groups, says Sharaf, this was less common than it is today. Until around 2010 people were afraid to state their political views even on social media: “But then that suddenly changed.”

At the height of the revolution in late January 2011, the Mubarak government went so far as to block access to the internet and the mobile phone networks for several days to weaken the opposition. “That was a big mistake,” says Sharaf: “After that, even people who hadn’t been politically active before were furious with the regime.” Since social media had become so important for maintaining friendships and planning recreational activities, the internet shutdown also encroached on the daily lives of many apolitical citizens. “Many friends couldn’t communicate with each other any more – because they didn’t have each other’s landline telephone numbers.”

#### **Facebook as an Interactive Newspaper**

It is evident to Sharaf that social networks – Facebook as well as the microblogging service Twitter, which is less widespread but is used by many activists as a source of information – exerted profound influence on the course of the revolution. As a result of her research approach, however, she was able to produce much more evidence of the reverse: The revolution in Egypt changed the way in which friends communicate with each other on Facebook. In some cases, this went so far that circles of friends were broken up entirely: “As soon as the internet was available again, they started arguing,” says Sharaf. People shared information, links to newspaper articles, photos, and political comics.



*Connected: In Cairo, Kathrin Sharaf studied who maintains contact with whom on laptops and smart-phones – and participated in the online networks of friends herself.*

*Photos: Maria Vazquez/Jürgen Piewe (both Fotolia)*

“Facebook metamorphosed from a platform for maintaining friendships to a source of information, like an interactive newspaper.” But at the same time, the connection to friendships always remained present: “After all, the people engaged in the discussion were friends.”

The private character of Facebook use now led to very personal disputes. Oftentimes the bone of contention didn't concern fully developed political positions. A desire for a quick end to the unrest, for instance, might be pitted against a plea for further political changes. Although Sharaf herself did her best to refrain from adopting political positions as an observer in her Facebook groups, she still ended up being “defriended” by several people – because she posted certain articles and comics that she had seen on the profiles of other friends or in online editions of newspapers on her own profile.

Participating in the online networks of friends she studies is part of Sharaf's research strategy: “I was always online; Facebook is the object of my research and part of my method.” The necessary precondition for this was establishing a basis of trust – offline. The ethnologist was already familiar with Cairo from her many visits to the

city. Her father is Egyptian. However, her research stay in 2011 was the first time she had been there for seven months at a time. She established her contacts one by one on location, “according to the snowball principle,” she says. Finding older users was thus difficult at the start, but in time the snowball started rolling: “The older ladies are very well networked.” Besides making online and offline observations and documenting them in a research journal, Sharaf conducted individual and group interviews with a total of 115 people. “Many began of their own accord to talk about the significance of the internet and Facebook when I asked them about friendships.”

#### **A Mix of English and Arabic**

In addition to gender and family norms, another factor that influences friendships on and off the internet is social class: “There is hardly any basis for friendships that transcend class boundaries – whether online or offline.” Members of the middle class typically use a mix of English and Arabic to communicate on the internet. The texts are often typed on an English keyboard with numbers as supporting letters. “This shows that one is educated and also rooted in the Egyptian identity.”

Today people talk more about politics on the social networks, says Sharaf, but friendship-based use and the norms that go with it still forms the main focus. Sharaf has also observed a keen interest in establishing contact with foreigners: “This is active knowledge acquisition,” she says, “and many young Egyptians do it more by engaging in discussions and exchange on the web than by reading long texts.”



**Kathrin Sharaf**

*studied ethnology, psychology, and biological anthropology at the University of Freiburg. In 2010 she completed her magister degree – with a thesis on internet use among young adults in Cairo, Egypt. Afterwards, she began conducting research for her dissertation with the working title Mediated Friendship: Social Relations and the Internet in Cairo. Her supervisor is the Freiburg ethnologist Prof. Dr. Judith Schlehe. Sharaf received funding for her dissertation from the German Research Foundation (DFG) as a member of the research training group “Friends, Patrons, Clients: Practice and Semantics of Friendship and Patronage in Historical, Anthropological, and Cross-Cultural Perspectives.” She is currently also working for the DFG research unit “History in Popular Cultures of Knowledge.”*

*Photo: Thomas Goebel*

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# Diploma for the Cell

Freiburg biologists are studying zebrafish to find the mechanism that triggers embryonic development

*by Martin Jost*

*Lined up like on a pearl necklace: Zebrafish eggs are over one half of a millimeter large and easy to see under the microscope. Photo: Peter Mesenholl*

Pluripotent stem cells are all-rounders. They have the potential to develop into any type of body cell. The hopes that have been pinned on the use of stem cells for medical purposes are gigantic. Among other things, doctors want to use them to improve their understanding of the development of cancer, to replace dead tissue after events such as a heart attack, or to repair nerve fibers after a spinal cord injury. Until 2006, however, scientists could only obtain stem cells by removing them from embryos, a process that entails ethical challenges, particularly for research on humans.

In 2012, the Japanese professor of medicine Shinya Yamanaka received the Nobel Prize in Medicine for his discovery of the technique for converting specialized body cells back into pluripotent cells. The research on so-called induced – artificially reprogrammed – pluripotent stem cells is considered to be the fastest-growing field of research in biology. In creating pluripotent stem cells in accordance with Yamanaka's technique, scientists used viruses to introduce a cocktail of genes to the newly started cell, including the transcription factor Oct-4.

#### Preparing Cells for Graduation

Scientists are not yet certain what causes the specialization of the cell to be erased, changing it back into a stem cell. Prof. Dr. Wolfgang Driever and Dr. Daria Onichtchouk from the Cluster of Excellence BIOSS Centre for Biological Signaling Studies and the Department of Developmental Biology of the University of Freiburg and their team have uncovered a further piece of this complicated puzzle – with the help of the model or-

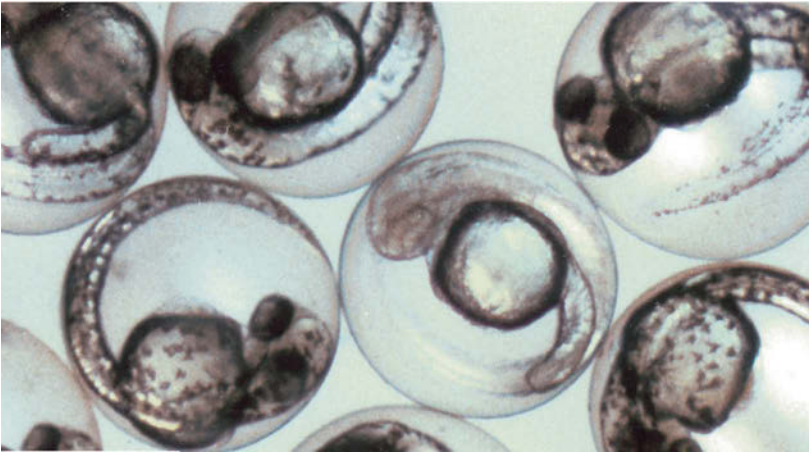
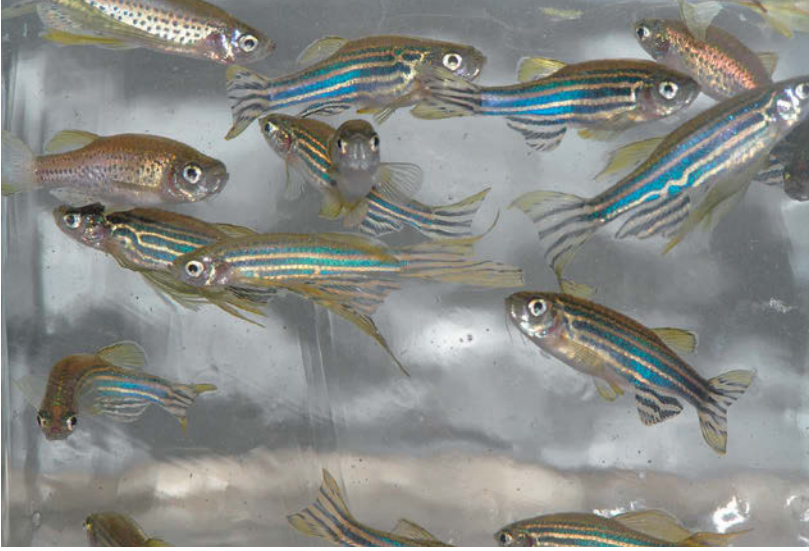
ganism zebrafish. The researchers demonstrate in an article in the journal *Science* that Pou5f1, the counterpart of the gene Oct-4 in zebrafish, serves not only to reprogram a specialized cell and convert it back into a pluripotent stem cell; in addition, Pou5f1 also switches on the embryo's own genes at a very early stage in development. This stage is called the "maternal to zygotic transition."

The zygote is the first cell of a new organism, created through the fusion of an egg with a sperm cell. The development of the zygote is controlled initially by genes given to it by the egg cell. The maternal to zygotic transition is the process by which the maternal genes are separated

**“There is a very brief transitional phase in which the cells have the potential to become anything at all”**

from the embryo's own genes. In humans this occurs after the first cell division in the two-cell stage, while in fish it does not happen until the embryo has reached a size of around 1000 cells. Afterwards, the cells in the embryo are pluripotent for a brief developmental stage.

The way this mechanism functions in the zebrafish is very similar to the way it functions in humans, which points to a common heritage in the distant evolutionary past. “The zebrafish is an ideal model organism,” says Onichtchouk.



The eggs are over one half of a millimeter large and easy to see under the microscope. Scientists can create up to 10,000 eggs in a comparatively short period of time and collect a great variety of molecular data as they develop synchronously. Mammalian zygotes, on the other hand, only complete the transition to the embryonic stage after they have lodged themselves in the uterus – where it is no longer possible to observe them.

“There is a very brief transitional phase in which the cells have the potential to become anything at all,” says Driever. “Extending this moment artificially is like trying to hold a seesaw

**“What happens is not that everything is erased but that, on the contrary, everything is prepared for something new”**

in perfect balance.” At almost exactly the moment when the pluripotent state is reached, the cells are sent gradually onto the path of specialization. The seesaw starts swinging. The cells differentiate roughly into three layers: so-called ectodermal cells, which later become part of the skin or the nervous system; mesodermal cells,

which form blood or muscles; and endodermal cells, which line the digestive tract.

**Making Artificial Stem Cells Stable**

The state of pluripotency is thus not a complete lack of purpose but rather a positive potential for the cell: first the potential to become any kind of cell and a moment later the potential to belong to one of the three basic types of cells that make up an organism. “The image of the transcription factor Pou5f1 as an eraser is not quite correct,” says Driever. “What happens is not that everything is erased but that, on the contrary, everything is prepared for something new.” The maternal to zygotic transition is better described as the cell’s high school graduation. On the one hand, a high school diploma qualifies one to enroll in college and major in the field of one’s choice. On the other hand, the advanced placement courses and electives one took on the way to graduation already represent a rough specialization based on one’s talents and interests. “Our experience has been that the regulation of pluripotency and the activation of the zygote’s own genes are inextricably entwined with each another,” says Driever.

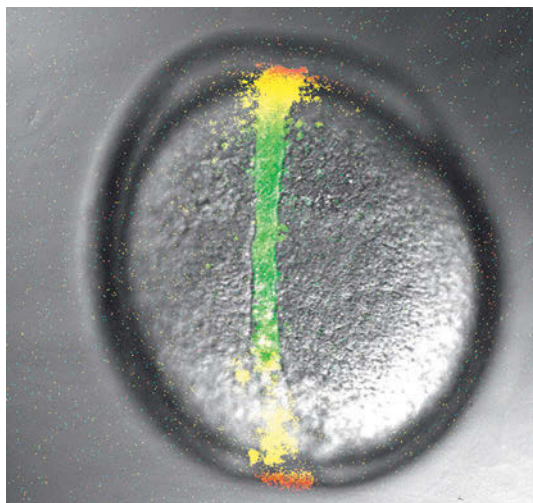
As an example of the way in which Pou5f1 participates in the network of rules governing the

transformation of stem cells into highly specialized zygotic cells, the biologists took a look at mesodermal cells in the zebrafish. Pou5f1 is also involved in switching on several genes that regulate the development of the mesoderm. Further signals determine which cells embark on which developmental path.

Driever understands his group's work as fundamental research. However, the scientists participating in the University of Freiburg's collaborative research center "Control of Cell Motility in Morphogenesis, Cancer Invasion, and Metastasis" also include experts on human biology and tumor research. Research on pluripotency presents an opportunity to breathe new life into cancer research, because cancer stem cells play an important role in tumor growth and metastasis formation. In addition, knowledge of the mechanisms governing the transition from stem cell to tissue cell is instrumental for growing replacement tissue from stem cells.

What are the next steps? "The balance between pluripotency and development will remain the central theme," says Daria Onichtchouk. The network of rules the researchers discovered in the zebrafish will enable them to investigate in detail how stem cells develop into stable specialized cells. Not until it is possible to use artificially created pluripotent stem cells to make stable body cells that do not cause cancer can they be put into medical practice.

Stem cells develop into ectodermal cells, which later become part of the skin or the nervous system; mesodermal cells, which form blood or muscles; or endodermal cells, which line the digestive tract. In this zebrafish embryo, the mesodermal cells are shown in color. Photo: Wolfgang Driever's research group



**Prof. Dr. Wolfgang Driever** studied biochemistry in Tübingen and Munich. He earned his PhD at the Max Planck Institute for Developmental Biology in Tübingen. After a spell as a postdoctoral researcher, he accepted a position in 1990 as assistant professor of genetics at the Harvard Medical School, USA. Since 1996 he has served as professor of developmental biology at the University of Freiburg. From 2001 to 2012 Driever coordinated the collaborative research center "Signaling Mechanisms in Embryogenesis and Organogenesis." He also founded the Center for Systems Biology at the University of Freiburg and served as its director from 2010 to 2012. Driever is a member of the Cluster of Excellence BIOSS Centre for Biological Signalling Studies and conducts research on the model organism zebrafish regarding the regulation of cell behavior in early development and the formation of neuronal networks in the brain. Photo: BIOSS



**Dr. Daria Onichtchouk** studied at the University of Moscow, Russia, and earned her PhD in Heidelberg in 1999. From 1999 to 2001 she was a postdoctoral researcher at the Max Planck Institute for Biophysical Chemistry in Göttingen. She then worked as a senior scientist at DeveloGen AG, a company co-founded by Prof. Dr. Wolfgang Driever. She has been employed by the Institute of Developmental Biology of the University of Freiburg since 2006. Onichtchouk heads the project "Epigenetics of Zebrafish Midblastula Transition" at the Cluster of Excellence BIOSS Centre for Biological Signalling Studies. Her main research interest is control mechanisms in the earliest stages of development in zebrafish. Photo: private

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# Wireless, Not Clueless

Leo Reindl develops wireless sensors that control machines and collect information from the environment

by Anja Biehler

*Small and independent: Miniature power stations harvest solar energy, generating electricity for sensors that transmit data by radio. Photo: Thomas Wendt*





“In a world with limited material and energy resources and environmental burdens, regulation is the only way to achieve an optimal process”

**M**easurement and control technology is like riding a bicycle: Once you succeed in coordinating sight and steering with each other, the process works,” says Prof. Dr. Leo Reindl, head of the Laboratory for Electrical Instrumentation at the Department of Microsystems Engineering of the University of Freiburg. “The better you can get the sensor – the sight – and the actor – the steering – to work together, the more efficiently the system will function.”

Developers see great potential in regulation – that is, the coordination between sensor and actor – for making daily life easier, protecting the environment, saving energy, and making work routines safer. “In a world with limited material and energy resources and environmental burdens, regulation is the only way to achieve an optimal process. We need sensors and computers for these regulators that we can embed into the process.” Driving a car, for example, has become much safer thanks to the integration of roughly 100 regulators for airbags, autonomous cruise control and lane departure warning systems, blind spot monitors, and braking assistants. According to the German automobile club ADAC, the number of deaths due to automobile accidents has sunk continuously since 1970, despite the fact that traffic density has increased in the same period.

But the field of research Reindl is focusing on is more complex: He is studying how processes can be regulated optimally even when sensor

and actor are not connected by a cable. Under normal circumstances, the cable maintains the flow of information between sensor and actor and also provides the energy the actor needs to control the system. However, oftentimes it is either too expensive or simply impossible to link the two elements by cable, because they are in motion or are located too far apart from each other. This is the case, for instance, when one needs to determine the current position of a robot in a building, obtain information on the state of precision workpieces being transported on a conveyor belt, measure the temperature of a high-tension power line or the pressure in an automobile tire, or take measurements inside of a living organism. In addition, cables are inconvenient when one is monitoring the structural integrity of bridges or buildings or analyzing soil composition for agriculture. In these cases, it is necessary to use sensors that transmit data by radio. This presents new challenges for the system, especially with regard to ensuring a sufficient supply of energy.

#### **Harvesting Energy from the Environment**

When the cable is missing, so is the power. There are two ways to solve this problem: attaching a battery or enabling the system to harvest energy directly from the environment with the help of a miniature power station. Promising candidates are light energy, thermal energy, vibrational energy, and the electromagnetic radiation present everywhere on Earth. In order to devel-



*Monitoring modules individually: The wake up technology developed by SmartExergy WMS, a spin-off of the University of Freiburg, enhances the performance and safety of photovoltaic systems. Photo: Michel Angelo/Fotolia*

op self-sufficient systems, scientists in Reindl's laboratory are studying solar cells that generate enough power for the sensors even in low-light areas such as forests or inside buildings. In addition, they are developing miniature generators that produce energy out of the variation in temperature between day and night. However, the amount of energy it is possible to glean from such sources is low and subject to great fluctuation, making the methods very expensive.

Batteries, on the other hand, have the disadvantage that they only have a limited energy supply and need to be changed regularly. The less energy radio transmission processes need, the longer the life of the batteries. Reindl has developed a sleep-wake up technology for wireless sensor networks that requires 10,000 times less energy for transmission than comparable standard systems: It needs a mere 10 microwatts of power – a radio receiver powered by a standard round cell battery equipped with this technology achieves a lifespan of roughly seven years.

#### **A Baby Monitor for Photovoltaic Systems**

The wake up strategy is the technological foundation of SmartExergy WMS, a start-up founded by Dr. Tolgay Ungan, one of Reindl's former PhD students, and the businessman Patrick Steindl with support from the entrepreneurial office of the University of Freiburg and an EXIST entrepreneurial grant from the German Federal Ministry of Economics and Technology. The EXIST Program provides funding for spinoffs derived from innovative tech-oriented research projects at universities with good economic prospects. SmartExergy WMS delivers monitoring technologies that make the operation of photovoltaic systems more efficient, safer, and easier to service. The university spinoff has received

several awards: After winning the Freiburg Innovation Prize and an award at the entrepreneurial competition "start2grow" in 2012, the company won a CyberOne High-Tech Award and, most recently, the Baden-Württemberg Environmental Technology Prize in the category instrumentation and control engineering in 2013.

**“Everywhere where the safety of a structure is in doubt but needs to be guaranteed, we can use radio sensors to obtain information about its current state”**

Standard monitoring systems work according to the principle of comparison: The system measures the performance of the strings, which consist of up to 20 solar modules, and compares the actual performance to the target performance. Only when these two values deviate from each other to a certain extent do the operators search for and analyze the errors on location. By contrast, the wake up technology developed by SmartExergy WMS works like a baby monitor: Each and every photovoltaic module is monitored by a wireless sensor. When the performance of a module drops, the sensor sets off an alarm and corrects the error immediately. The time gained by the precise localization and analysis of the reason for the error makes photovoltaic systems much more efficient, since even minor influences like dirt on the modules can have a major impact on their output.

The technology developed by SmartExergy WMS also provides a solution to the string problem that often plagues photovoltaic systems, in which a single defective module or a module that



At the bridge over the Neckar in Weitingen in the rural district of Freudenstadt, Leo Reindl is developing a network of self-sufficient radio sensor nodes to monitor the state of the bridge. A master node sends the data to a server to be analyzed and visualized.

Photo: Karl Gotsch

receives no sun reduces the performance of the entire system. The technology detects this dip in performance and shuts down the module responsible for it automatically, allowing all of the other modules to continue functioning optimally. In addition, the targeted shutting down of defective modules makes it easier to service the modules and increases the safety of the system in the case of lightning or fires: When the entire system is shut down centrally, the technology short-circuits each of the modules, thus removing all electric tension remaining in them after the system is shut down. Firefighters can extinguish the fires and be certain that there is no electricity flowing through the system.

### Radio Saves Lives

Wireless communication and regulation is a field of research with great potential for applications in industry – not just because it can make systems safer and more efficient, but also because it can show where something is currently located. For the localization of objects, Reindl is developing radio systems that optimize the flow of materials and goods in industrial production. In addition, this technology can also save lives: In collaboration with the university, Reindl has developed a system that can determine the precise location of a mobile phone – for instance after an earthquake. Since more than 70 percent of all persons buried during an earthquake are carrying a phone with them, rescue teams can find out where to look for them. However, the localization disrupts the normal operation of a mobile telecommunications network and can therefore only be used in the event of a catastrophe.

Reindl is extending this research to develop systems that can prevent impending disasters in run-down structures. In many places in Germany the public infrastructure is in disrepair, but the government does not have enough money to fix

it. Should a bridge be closed? Can a dam still withstand the pressure being put on it? “Everywhere where the safety of a structure is in doubt but needs to be guaranteed, we can use radio sensors to obtain information about its current state. This allows us to determine whether the structure can continue to be used or not,” says Reindl, who is conducting research on sensors for monitoring bridges in collaboration with the German Federal Road Research Institute. The sensors can measure a variety of variables: the slightest movement by means of GPS, microcracks, temperature, or moisture – depending on what is relevant for the continued serviceability of the structure in question. The sensors send out a warning signal when the danger becomes too great, thus allowing civil engineers to keep the structures in use for as long as possible before replacing them. Thanks to the measurements taken by the wireless radio sensors, decision-makers are now no longer clueless when it comes to ensuring public infrastructure remains safe.

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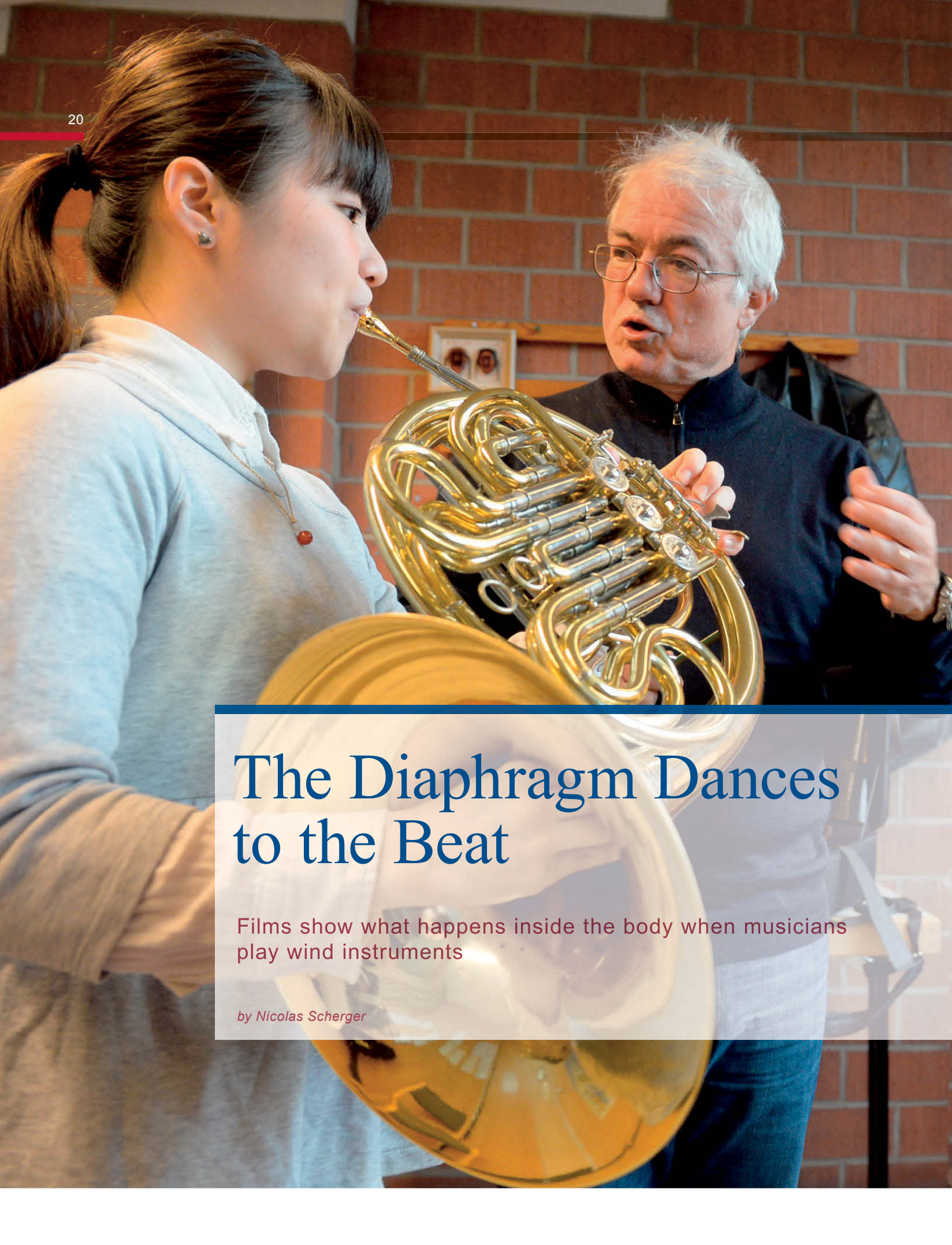
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**Prof. Dr. Leo Reindl**

studied technical physics at the Technical University of Munich. After graduation, he established a research unit on radio sensor technology at Siemens AG while completing his PhD at the Vienna University of Technology, Austria. In 1999 he accepted a professorship at the Technical University of Clausthal. Since 2003 he has served as a professor at the Department of Microsystems Engineering of the University of Freiburg, where he conducts interdisciplinary research with industrial applications. In particular, his research interests include energy conversion in micro-generators, energy-efficient radio sensor networks for monitoring critical infrastructure, the localization of robots, and technology for locating buried persons. He has participated in the development of 35 patents and is the author or coauthor of more than 150 scientific publications.

Photo: private



# The Diaphragm Dances to the Beat

Films show what happens inside the body when musicians play wind instruments

*by Nicolas Scherger*

*Understand, apply, improve: The educational video clips are suitable for use in the music classroom. Bruno Schneider, French horn professor at the Freiburg University of Music, came up with the idea for the project.*

*Photo: Patrick Seeger*

**B**reathe in. The vocal cords in the horn player's larynx are wide open. They allow air to enter his body. The player's diaphragm, previously bent in like two bowls turned upside down, has now flattened. It lowers, pushing down with it his liver, stomach, and other abdominal organs. His breast widens, and air flows into his lungs. His tongue moves upward and suddenly shoots forward. His vocal cords almost close, leaving only a small crack. Breathe out. His upper lip beats rapidly against his lower lip on the mouthpiece. The first note rings out. His abdominal and chest muscles contract. His vocal cords slowly rise, letting the air escape steadily out of his lungs. When the horn player hits the next notes, he uses his tongue to interrupt the flow of air by beating it again against the back of his front teeth. Until the air is gone. Breathe in – and start over again.

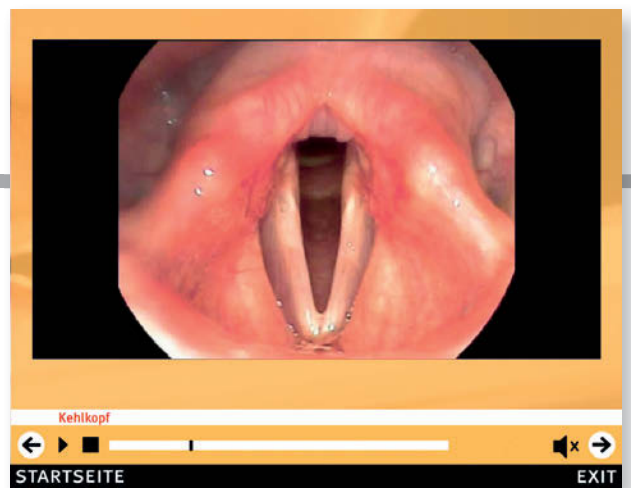
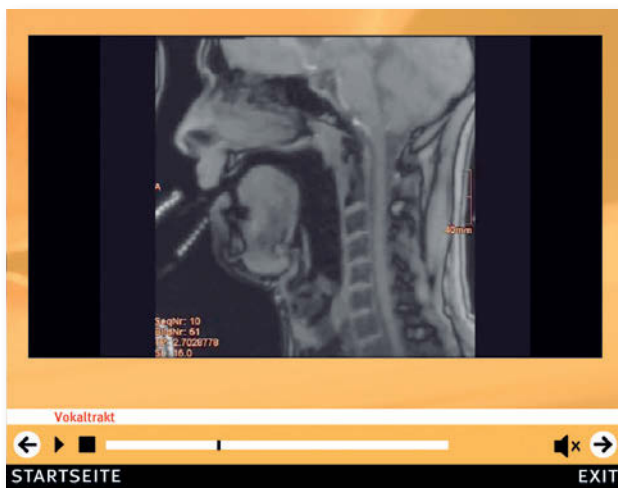
When pianists, string players, or drummers want to improve their playing motions, they observe the movements of their hands and fingers while practicing or look at them in a mirror. This is not an option for horn players, because the most important movements they make take place inside of the body: in the oral cavity, the larynx, and the chest area. However, for the first time ever they can now watch films that capture these internal movements in detail – thanks to the research of Prof. Dr. Claudia Spahn and Prof. Dr. Bernhard Richter, the dual directors of the Freiburg Institute of Music Medicine (FIM), a joint institution of the University of Freiburg and the Freiburg University of Music. With the help of a research team including senior physician Prof. Dr. Matthias Echternach from the FIM, the medical student and professional horn player Matthias Pöppe, and further partners, they have documented their findings meticulously on a DVD with over 130 video clips. “The goal is to

generate new ideas for the methodology of wind instrument playing,” says Spahn. The publication was preceded by years of work in which the research team and the professional musicians participating in the project treaded new methodological paths.

#### **With a Plastic Mouthpiece and a Garden Hose**

The horn player lies down on his back and puts on headphones equipped with a microphone. Bernhard Richter gives him a garden hose. Attached to one end of it is a plastic mouthpiece, to the other a cardboard funnel – the instrument the musician plays with cannot have any metal parts: The patient disappears inside the tube of an MRI scanner. The scanner creates a strong magnetic field that excites tissue containing water molecules in the body and uses this energy to take up to eight images per second of the inside of the musician's body. For this purpose, a smaller magnetic coil is placed around his head, and later a larger coil is placed around his torso. Initially, individual notes sound out from the tube, then entire scales, and finally an entire horn concerto by Wolfgang Amadeus Mozart. Back outside, Richter inserts an endoscope through the musician's nose and into his throat in order to film the larynx while he is playing. However, the movements of the musician's vocal cords are too rapid to be captured by the human eye. The doctor thus uses a high-speed camera that can take up to 4,000 images per second and a stroboscope that illuminates the larynx intermittently with a flash of light. The slower speed of the flashes in comparison to the vibrations of the vocal cords creates a slow motion effect. Finally, the two methods are used again when the researchers film the musician's lips from the outside through a sawed-off mouthpiece.

**“The goal is to generate new ideas for the methodology of wind instrument playing”**



Oral cavity and throat, larynx, chest area (from left): Video clips illustrate what happens in the key parts of the body when wind instrumentalists employ basic techniques of sound production and articulation. Source: Helbling Verlag

“These experimental conditions might be somewhat artificial, but they are realistic enough to allow us to draw conclusions about normal playing practice,” says Richter. All of the key movements are captured on film: The larynx at the upper end of the windpipe allows the air the musician breathes in to enter into the lungs, the vocal cords participate in the tone control. The vocal tract, the space between the lips and the larynx, influences the pressure and speed of the air, controlled above all by the shape and position of the tongue. The respiratory system in the chest provides the air and thus the energy. In the case of brass instruments, the lips are also important, because they create the sound. The scientists demonstrate all of this not only with the French horn, but also with the trumpet, clarinet, oboe, recorder, and flute. “We instructed the musicians to use the basic techniques for sound creation one after the other,” reports Spahn. For example, they played short and long, high and low, soft and loud, and staccato and legato notes. The films illustrate clearly what happens in the vocal tract, the larynx, and the respiratory system when musicians create these notes. The researchers produced around 20 video clips for each instrument from inside the body.

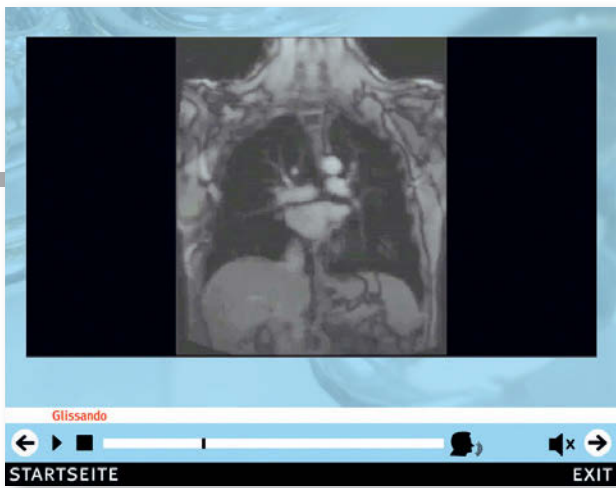
The films made with the help of the MRI scanner show a two-dimensional view, those recorded through the head mostly from the side, those through the chest from the front. The soft parts of the body are displayed in grayscale. The films recorded with the endoscope are in color and leave a spatial impression. “Much of what the films show is transferable to other instruments,” says Richter. For example, the technique of double-tonguing always works the same way – players of wind instruments can play notes in more rapid succession when they thrust their tongue forward against their teeth and upwards against the roof of their mouth by turns. But there are also differences. Trumpet players, for instance, raise their tongue sharply to make notes higher, making the space between it and the roof of their mouth narrower but the space in the throat wider. The air flows faster, the pressure is higher. In the case of the clarinet, by contrast, the same technique is used to make lower notes. The peculiarity of the oboe, a high-pressure instrument, is that the player often has to breathe out superfluous air at the end of a musical phrase before breathing in fresh air. And with the recorder, the way to brighten or darken a tone is by shaping one’s vocal tract as one would when pronouncing an A, E, I, O, or U.

### Raised Tongue, High Note

These findings are not entirely new to musicians and researchers. There have already been several attempts to capture the movements inside the mouths of wind players. However, the new films made by the Freiburg research team are of much higher quality thanks to the modern methods used to make them. The films have particularly great potential for use in the classroom. In addition to the clips on the six instruments, the researchers also made films using color computer animations that illustrate basic principles of anatomy – such as the parts the larynx is made up of and where the diaphragm is located. These clips also explain the



Brass instrument without brass: The research team built their own instruments like this metal-free French horn to use for the films they took of brass instrumentalists in an MRI scanner. Photo: FIM



methods the researchers used to record the films inside the body. Despite the educational nature of the films, however, Spahn stresses that the point is not to show people the right or wrong way to play: "There are various schools and techniques, and everyone has his or her own physical preconditions. But we take the example of excellent soloists to show how it can be done." What Spahn finds most remarkable about the movements of the professional musicians is the precision and economy in the interplay between breathing, the larynx, and the vocal tract. They hardly make any unnecessary movements at all: "The better the musicians are, the less they do."

**“The better the musicians  
are, the less they do”**

There were also several surprising findings – such as how radically the tongue can change its shape. This is particularly pronounced when a clarinet player glides from the highest to the deepest notes: The tongue can contract until it is remarkably compact and then expand to fill almost the entire oral cavity. Also previously unknown was how important the vocal cords are for playing vibrato, which wind instrumentalists do mainly by moving their diaphragm. Images like this, says Spahn, are fascinating and beautiful: "It is astounding how well these complex processes work, and there are wonderful parallels to the music inside our bodies – for example the way the diaphragm dances to the beat."



**Prof. Dr. Claudia Spahn** has served as co-director of the Freiburg Institute of Music Medicine (FIM) along with Prof. Dr. Bernhard Richter since the institute's founding in 2005. She studied medicine at the Universities of Freiburg, Paris, and Chur as well as recorder and piano at the Freiburg University of Music. After completing her doctorate in medicine and training as a specialist in psychotherapeutic medicine, she earned her habilitation qualification in Freiburg in 2004. At the FIM she primarily treats instrumentalists with physical and psychological problems. Her research and teaching focuses on prevention for musicians, performance anxiety in singers and instrumentalists, and the analysis of body methods as well as motion in playing musical instruments. Photos: FIM



**Prof. Dr. Bernhard Richter** has served as co-director of the Freiburg Institute of Music Medicine (FIM) along with Prof. Dr. Claudia Spahn since the institute's founding in 2005. He studied medicine at the Universities of Freiburg, Basel, and Dublin as well as singing at the Freiburg University of Music. After completing his doctorate in medicine and training as an ear, nose, and throat and voice specialist, he earned his habilitation qualification in Freiburg in 2002. At the FIM he primarily treats singers and voice patients. His research and teaching focuses on the opera stage as a place of work, the methods of high-speed glottography and dynamic magnetic resonance imaging for the study of voice physiology, voice development in singers throughout life, and ear protection for orchestral musicians.

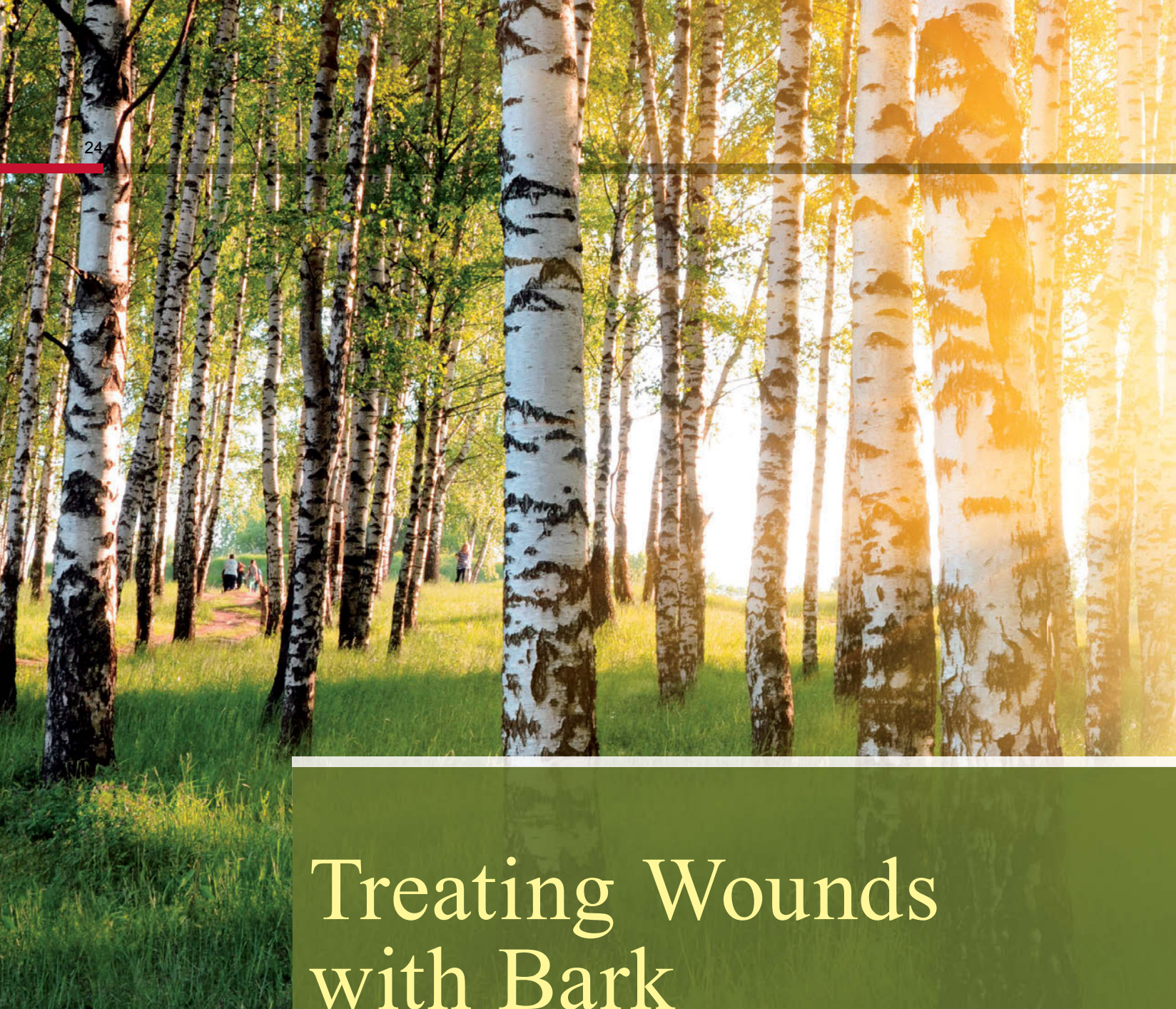
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Visit our research portal [www.surprising-science.de](http://www.surprising-science.de) to learn more about the technology employed by Prof. Dr. Claudia Spahn and Prof. Dr. Bernhard Richter. Sample video clips from the DVD *Das Blasinstrumentenspiel* are available for viewing at [www.pr.uni-freiburg.de/go/musikerimscanner](http://www.pr.uni-freiburg.de/go/musikerimscanner).





# Treating Wounds with Bark

The pharmaceutical researcher Irmgard Merfort is studying how a natural substance accelerates the healing of wounds

*by Katrin Albaum*





**“An inflammation is nothing other than a defensive reaction of the body and is an integral part of the healing process”**

*Medicines that grow in the forest:  
The healing properties of the birch  
have been appreciated for centuries.  
Photo: jordano/Fotolia*

The skin is the human body's first line of defense and its uppermost protective barrier. As an unbroken layer, it prevents bacteria and other pathogens from penetrating through to deeper layers and doing damage there. As soon as the skin is damaged, the body initiates a program to repair it with perfectly coordinated steps. Sometimes this process takes a long time, or the wound doesn't heal at all and becomes chronic. Natural substances extracted from the birch tree have served for centuries as a traditional means of getting wounds to close more quickly. As early as the Middle Ages, the scholar and abbess Hildegard of Bingen recommended using birch bark and other parts of the tree to treat wounds, pimples, and other aches and pains. Prof. Dr. Irmgard Merfort from the Institute of Pharmaceutical Sciences of the University of Freiburg and her research team put these methods to the test to determine whether they are actually useful. "Our aim was to find the scientific basis for this centuries-old tradition," says Merfort. Together with several cooperation partners,

the team investigated how birch bark extract and the substances it contains take effect on the molecular level during the various phases of wound healing.

In a clinical study on patients who had sustained second-degree burns, a cream with birch bark extract sped up the healing process. In another study, doctors treated two damaged patches of skin directly adjacent to one another differently, and here as well the skin treated with natural substances from the birch showed their rapid therapeutic effects. The extract the team used is obtained from the outer, white layer of the tree, a waste product of the timber industry. Its effect is based among other things on the chemical substances betulin, lupeol, betulinic acid, erythrodiol, and oleanolic acid. "The main component is betulin at 87 percent. The other substances are present in lower concentrations. Only around three percent of the extract consists of substances we are not familiar with," explains Merfort. In all of their studies, the



*From bark to powder: Birch bark extract is produced from the external, white layer of the trunk. Photos: Armin Scheffler*

## “It was an exciting and interesting project that enabled us to strengthen traditional plant remedies”

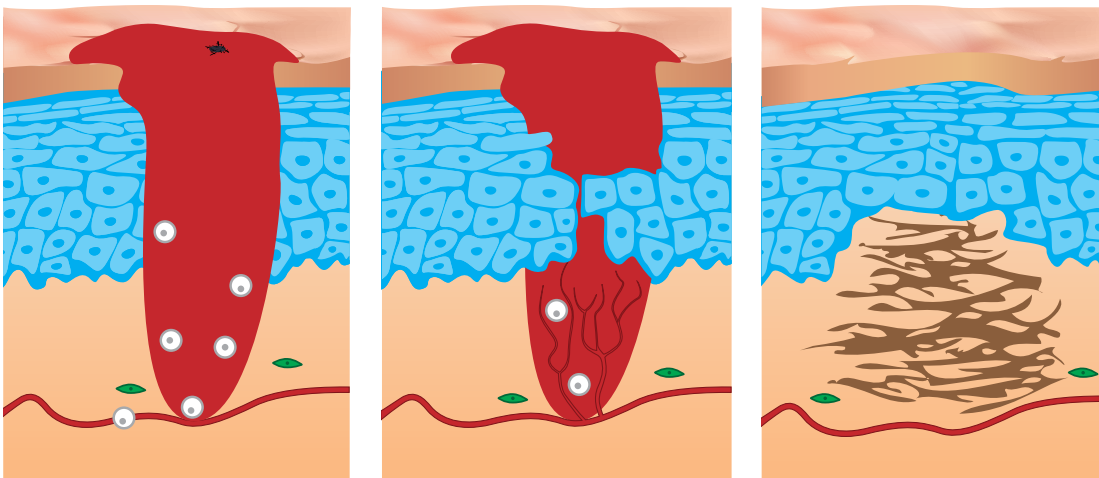
scientists compared the effects of the entire birch bark extract with those of the isolated pure substances.

### Detective Work on the Molecular Level

Merfort and her team determined that the natural substance already takes effect in the first phase of wound healing. When skin cells are damaged, they release certain mediators. These are substances that lead to a temporary inflammation of the body and is an integral part of the healing process,” explains Merfort. The mediators include messengers like chemokines: They attract phagocytes, which remove foreign bacteria and dead tissue. Several tests the Freiburg pharmaceutical researchers conducted demonstrated that the birch bark extract does in fact increase the amount of mediators. Betulin, the main substance of the extract, is primarily responsible for the reaction. The scientists performed these experiments on keratinocytes, the most common cell type in the outermost layer of skin. Dermatologists at the University of Hamburg also tested the natural substance on a pig’s ear, since the skin of this animal is physiologically very similar to that of humans, and confirmed the findings.

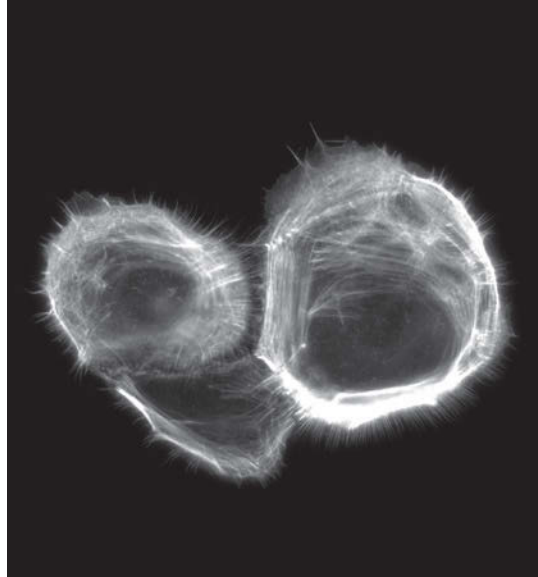
After demonstrating that the birch bark extract temporarily increases the amount of inflammatory mediators, the pharmaceutical researchers set out to find out what happens on the molecular level. They went about it like detectives in search of clues. Since the amount of messengers present is linked directly to the lifespan of the messenger ribonucleic acid (mRNA), they investigated whether the substance from the birch increases the half-life of mRNA. In order for the blueprint of a protein to be read by the genome, a gene first has to be translated into a strand of mRNA. The more mRNA a gene has and the longer it remains stable, the more of the protein it can produce. For example, the half-life of the mRNA of the messenger COX-2 tripled when the scientists added the birch extract to the cells. Again, betulin was responsible for the bulk of this reaction.

The pharmaceutical researchers eventually found the molecular initiator of the reaction: the enzyme p38 MAPK. The birch substance activates p38 MAPK, and the enzyme ensures that the mRNA remains stable longer. In order to be completely sure of this, the researchers added a p38 inhibitor to the human skin cells they had treated. This reduced the half-life again, proving that the enzyme is indeed the main reason why the birch bark extract works in the first phase of



*Healing a wound, step by step: The human skin is composed primarily of keratinocytes (blue) and fibroblasts (green). In the first phase, the damaged cells release inflammatory mediators to attract scavenger cells (white) like granulocytes, phagocytes, and macrophages, which remove foreign bacteria (gray) and dead tissue. In the second phase, macrophages secrete growth factors, allowing the skin cells to proliferate, migrate into the wound, and close it. By the end of the third phase, the remodeling, the skin has restructured itself. The macrophages die off, and scar tissue forms (brown).*

*Illustration: Tamara Klaas*



*The birch substance exerts influence on the cytoskeleton and causes more stress fibers, filopodia, and lamellipodia to form on its surface. They help the cells to migrate – and thus close wounds – more quickly. Photo: Irmgard Merfort*

wound healing. In addition, the scientists identified several other proteins that play a role in these processes.

### Cells Migrate Faster with Birch Bark Extract

In the second phase of wound healing, the cells need to multiply in the skin and close the gap created by the wound. In collaboration with a research group from the Institute of Molecular Medicine and Cell Research at the University of Freiburg, Merfort and her team conducted a test with a small dish full of human skin cells. The scientists inflicted an artificial wound on the keratinocytes by tearing into the cell layer. They then observed the wound under the microscope for 24 hours to determine how quickly it closed with and without the birch bark extract. The result: The cells migrated into the artificial wound and closed it more quickly with the extract. But how can this be explained? “When the cell begins to migrate, it changes its shape,” explains Merfort. The cell receives its shape from its skeleton, which consists of the structural protein actin. It moves by contracting its so-called stress fibers, part of the cytoskeleton composed of actin, and pushing itself forward. In addition, various types of fibers form at the front and the back of the cell and help it seek contact with other cells. The substances tested by the scientists exert influence on the actin cytoskeleton: “Even extremely low concentrations of birch bark extract or the isolated components betulin and lupeol cause the cell to form

more stress fibers. This explains why the keratinocytes migrate into the wound more quickly.”

Merfort and her colleagues then teamed up with a research group at the Institute of Experimental and Clinical Pharmacology and Toxicology of the University of Freiburg to find the protein behind the effect they had observed. The researchers ascertained that the birch substance and its components betulin and lupeol increase the concentrations of several proteins involved in the restructuring of the actin cytoskeleton. This is particularly true of the protein RhoA, which plays an important role in the formation of the stress fibers. “We thus succeeded in explaining the therapeutic effect of birch bark extract on the molecular level. It was an exciting and interesting project that enabled us to strengthen traditional plant remedies,” says Merfort, delighted at the findings. In a follow-up project, the pharmaceutical researcher wants to study how the substances from the birch take effect in wounds on diabetic patients.



*Prof. Dr. Irmgard Merfort studied pharmacy at the University of Münster and earned her doctorate and habilitation qualification at the Institute of Pharmaceutical Biology of the University of Düsseldorf. She has served as professor for pharmaceutical biology and biotechnology at the Institute of Pharmaceutical Sciences of the University of Freiburg since 1995. She conducts research on agents with an anti-inflammatory, anti-tumor, or wound-healing effect. These agents come from medicinal plants of Europe as well as Central and South America. In the EU-funded project Biocombust, she is studying the biological effects of particles created during the process of burning biomass. She has authored more than 140 publications, is co-editor of the journal *Planta Medica*, and is a member of the advisory board of the *Journal of Ethnopharmacology*. Photo: private*

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*Soft forms, hard sword: The 85-meter-high statue "The Motherland Calls" in the southern Russian city Volgograd symbolizes a country that unites female tenderness and male toughness.  
Photo: art\_zzz/Fotolia*

# Mother Russia

How nation and gender are connected  
and why Eastern and Western Europe  
have trouble understanding each other

*by Rimma Gerenstein*



**M**ary, Mother of God, drive Putin away!" The voices sound devout, almost like in Christian choral music. Then the bass kicks in, the women jump around, play air guitar, and bang their heads to the beat on the stage. On this day in February the stage is the alter of the Russian Orthodox cathedral in Moscow. The members of the Russian band Pussy Riot call upon their fellow citizens to join them in a "punk prayer" in the house of worship. The performance lasts just under a minute. Nadezhda Tolokonnikova, Maria Alyokhina, and Yekaterina Samutsevich pay dearly for it. Half a year later, in August 2012, a court in Moscow convicts the musicians and sentences them to two years in a penal colony – for "hooliganism, motivated by religious hatred."

The worldwide protest is not long in coming: The Russian government has shown methods worthy of a dictatorship, it is said, and has dealt a severe blow to the freedom of artistic expression. German politicians accuse Russian Prime Minister Vladimir Putin of imposing "draconian sentences" on the musicians. It is claimed that he has misused the judiciary to silence critics. The musicians indeed put in a daring performance, say the Freiburg Slavic studies scholars Prof. Dr. Elisabeth Cheauré and Dr. Regine Nohejl, but the conflict followed a typical pattern. East and West showed a lack of understanding for each other, and there was no willingness to consider the cultural context of the other side: "Imagine if something like this happened in St. Peter's Basilica. I doubt the West would maintain such a liberal attitude toward artistic freedom if this were the case," says Cheauré.

In a project funded by the German Research Foundation, the two researchers traced the development of national identities in Russia – from the 18th century, when the country was still a classical empire in the pre-modern sense, to the series of revolutions in 1917, which attempted to usher in a new political order, and finally to the present, in which photos show a half-naked prime minister petting a tiger cub. Among other things, the Slavacists combed through literary works, magazines, political speeches and programs, films and television series, travel literature, and advertisements. The symbols that express the country's political identity have changed in the course of the past 300 years, but one thing has remained the same: "Nation and gender are always intertwined," explains Nohejl.

"We are interested in how these representations develop and change. And how they breed misunderstandings and barriers between Russia and the West."

### Similar but Different

Misunderstandings and barriers: These are evidently key terms in the relationship between Russia and Western European countries like Germany and France as well as the USA. The Western perception of Russia is a contradiction in itself, say the researchers. On the one hand, there is a sentimental longing – admiration for the great Slavic soul, the soft Mother Russia. On the other hand, Western newspapers characterize Russia as a bear, as a predator that will devour the civilized world. How do these two images go together? "The game with gender metaphors begins as early as the 18th and 19th century," says Nohejl. It runs parallel to two other developments during this time: Great Britain, France, and Germany colonize Asia and Africa – the ideal of the "noble savage," a primitive man untainted by civilization, creeps into the theories of Enlightenment thinkers in Europe.

**"Imagine if something like this happened in St. Peter's Basilica. I doubt the West would maintain such a liberal attitude toward artistic freedom if this were the case"**

A model of the sexes gaining currency at the same time in Western Europe magnifies the differences between men and women, with qualities like unpredictability, irrationality, and a lust for destruction being ascribed to the latter. Against this backdrop, Russia comes to be seen as "different and exotic, but at the same time not so different from the West," says Cheauré. She sees the same principle at work in the market for mail-order brides today: German men dream of the beautiful Olga or Natalia – the woman who has a foreign appeal "but is yet tame enough that she does not pose a threat to German culture," stresses Nohejl.

Speaking of untamed: The French diplomat Louis-Philippe de Ségur writes in the 18th century that the inhabitants of St. Petersburg reminded him of “semi-barbarian human beings.” The question the Slavacists are really interested in answering, however, is how Russian women and men responded to these stereotypes. At first they are outraged, because they see themselves as a Christian nation on an equal footing with the West, not as its colony. But in the 19th century this changes. The emergent intelligentsia reinterprets the Western image of Russians and gives Russian identity a new shape. The writer and music theorist Vladimir Odoyevsky and the novelist Fyodor Dostoyevsky both condemn Western Europe for lapsing into a blind fetishism of reason. They and others go as far as to claim that only Russia can save the “rotten West” from collapsing under the weight of its own ideas.

The victory over Napoleon plays an important role in this sudden change of identity, explain the Slavacists: Russia defeats the power-hungry French military in 1812. “The supposedly underdeveloped nation that lags behind France and Germany advances to the status of Europe’s savior,” says Nohejl. Strengthened by this newfound self-confidence, the Russians no longer find it difficult to accept the long described and extolled cliché of the Slavic soul. On the contrary, it forms the foundation of the Russians’ newly attained sense of superiority. After all, the emotional and mystical are precisely the qualities the West lacks.

### **Macho and Mother Figure**

In 1813, Tsar Alexander I announces an architectural competition: A monumental church is to be built in Moscow in proud memory of the vic-

*Pussy Riot power: The musicians’ performance in the Cathedral of Christ the Savior in Moscow was an attack on the principles of the Russian state model.*

*Illustration: Svenja Kirsch*



tory over Napoleon. 200 years later, Pussy Riot chooses exactly this spot to protest against Putin. Roughly 80 years earlier, the Soviets had torn down the church; they wanted to build a skyscraper to the glory of the revolution, but they failed and instead built an outdoor swimming pool on the site. Not until the 1990s did citizens start an initiative and begin collecting donations for the reconstruction of the church. "This spot plays an unbelievably important role for Russia," underlines Cheauré. "What the cathedral symbolizes is not just the country's newfound self-confidence in Europe but also the new age, a synthesis between the orthodoxy and the state."

## “The supposedly underdeveloped nation that lags behind France and Germany advances to the status of Europe’s savior”

The researchers found this dimension lacking in Western coverage of the Pussy Riot scandal. "The sentence is of course far too severe, but we would have liked to have seen more reflection on the part of Western media and politicians." After all, the performance was a fundamental attack on the age-old principles of the Russian state model – the unity of God, leader, and people. Putin also plays with familiar imagery: When the prime minister sits on a horse with a muscle-bound chest, holds up a hunting rifle, shows endangered cranes the way south on an ultralight hang glider, or presses a fluffy puppy to his cheek, he is putting himself on display as aggressive machine and nature boy, as macho and mother figure at the same time. "The impression these images leave on us is of Putin as a caricature of the West," says Nohejl. "But they also reflect a traditional understanding of power. Putin is just playing with certain stereotypical images that Western Europeans also recognize."



**Prof. Dr. Elisabeth Cheauré** studied German studies, philosophy, and Slavic studies in Austria and Russia. In 1977 she received her PhD from the University of Graz. In 1986 she submitted her habilitation thesis on stories about artists in Russian realism to the same institution. Since 1990 she has served as professor of Slavic philology at the University of Freiburg. In the course of her career, Cheauré has taught as a visiting lecturer in Russia, Bulgaria, Spain, and Switzerland. She is currently coordinating the project "Napoleon, Borodino, and the Patriotic War: On Popularization within the Context of the Search for a National Identity in Russia," which is receiving funding from the German Research Foundation. Her research interests include gender studies, identity and alterity, cultural transfer, and cultures of leisure. Photo: Marie-Elisabeth Weiher



**Dr. Regine Nohejl** studied Slavic studies, Eastern European history, and sociology at the Universities of Freiburg and Tübingen as well as in Russia and the Czech Republic. From 1985 to 1997 she served as a lecturer at the Department of Slavic Studies of the University of Tübingen. In 1998 she accepted a position as a lecturer for literary studies and Eastern Slavic studies at the University of Freiburg, where she completed her dissertation on discourses of identity and alterity in Russia in 2007. Since 2011 Nohejl has collaborated on the project "Napoleon, Borodino, and the Patriotic War: On Popularization within the Context of the Search for a National Identity in Russia." Her research interests include gender studies, identity and alterity, and Russian cultural and intellectual history from the 18th century to the present. Photo: Viktoria Gräser

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# From Tree to Product

Freiburg forest scientists are developing a method for tailoring wood surfaces to customers' needs

by Isabell Wiedle

*What counts is what's inside: Forest scientists use computed tomography to create x-rays of logs in order to visualize characteristics like the form, size, and position of the knots. Photo: FVA Baden-Württemberg*







*Flawless or with knots?  
In a survey, the scientists  
asked customers to rate  
floor patterns made of  
spruce wood  
Photos: Chair of Forest  
Utilization*

People walk on it, sit on it, and build with it: wood. Whether for the floor or for furniture, wood is a popular and versatile natural product for interior design. In order to get the best out of wood, Prof. Dr. Gero Becker, professor of forest utilization at the University of Freiburg, and other researchers initiated the project "What Makes Wood So Attractive? Transforming Customers' Emotions into Material Characteristics." It began in 2011, will run until 2014, and is receiving funding from the Baden-Württemberg Foundation within the context of the program "International Top Research II."

"Up to now, the market has developed its product range and set prices in accordance with the idea that only timber with a flawless surface can be categorized as 'premium' wood," says Becker. Logs with knots, unevenly spaced growth rings, or various kinds of discolorations are generally regarded as being of inferior quality and thus command a lower price. However, pilot studies conducted in Sweden indicate that there are also customers who prefer surfaces with variations in color and grain and are by no means only interested in premium wood. Becker and his team are drawing on these studies in their project: "Our goal is to increase the profitability of high-grade

wood by finding out what customers want and taking their preferences into account when cutting logs into timber at the sawmill."

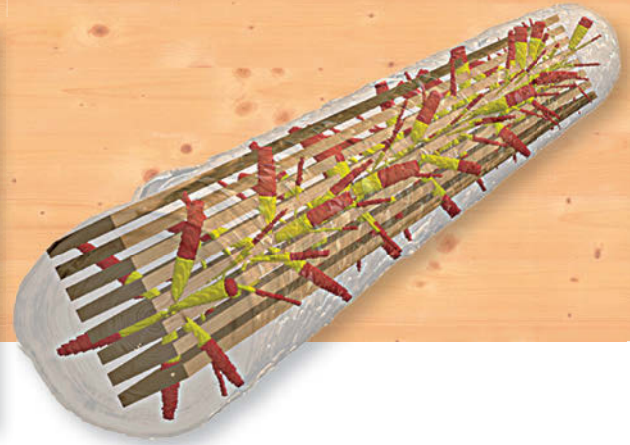
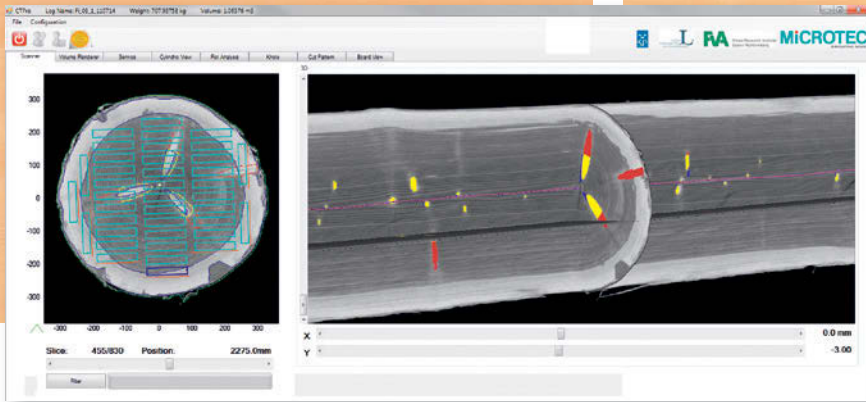
In order to achieve this, Becker has engaged researchers from several different disciplines and departments for the project. The main task Becker and his research assistant Andreas Manuel from the Institute of Forest Utilization and Work Science are working on is to determine what customers want and to translate these preferences into measurable characteristics. They received support from Dr. Rainer Leonhart from the Institute of Psychology of the University of Freiburg in designing and conducting the survey. The results of the survey were passed on to Dr. Franka Brüchert and Lorenz Breinig from the Forest Testing and Research Institute of Baden-Württemberg (FVA) in Freiburg: They are developing methods to saw logs in such a way that the resulting timber meets the aesthetic demands of the customers. Also participating in the project are the wood research institute SP Trä and the Wood Science and Engineering Institute of the Luleå Tekniska Universitet in Skellefteå, Sweden.

The starting point of the project was 58 Norway spruces from the Black Forest. The team

**"Up to now, the market has developed its product range and set prices in accordance with the idea that only timber with a flawless surface can be categorized as 'premium' wood"**



The two- and three-dimensional illustrations show where in the log the knots are located (marked red and yellow). The researchers use this information to determine how floorboards (illustration on left, light blue lines) need to be cut to meet customer preferences. Illustrations: FVA Baden-Württemberg



saw this species of conifer as the ideal object of research for their project due to its straight growth and the fact that it covers 60 percent of the demand for timber in Germany. A regional sawmill cut the spruce logs into floorboards, which the researchers then sorted into 15 groups on the basis of their surface characteristics. Some of the boards were flawless, some of them had small, dark knots, others light, large knots, and still others had striking growth ring patterns. On the basis of this characterization, members of Becker's team at the Institute of Forest Utilization fashioned two-meter square floor patterns in their woodworking shop, which they then used as material for their survey of test subjects at trade fairs and on the internet. Becker and Manuel found it interesting which floor was the most and which the least well liked. "In order to convert these subjective opinions into objectively measurable parameters, we took the idea from the Swedish study of using pairs of terms to describe the optical qualities of the wood: calming – disquieting, symmetrical – asymmetrical, lifeless – lively, and so on," says Manuel. "We then asked the test subjects which words they associated with the floor patterns." The forest scientists found out that, for example, some customers prefer floor patterns with a lot of small knots, because they find them lively, while others find the same patterns to be disquieting.

At this point in the project, the scientists from the FVA come into the picture in order to ensure that the logs can be sawed to create the wood

surface the customers want. They take x-rays of the logs by means of computed tomography (CT) to capture inner characteristics of the wood, such as the form, size, and location of the knots. This involves sliding an x-ray source equipped with detectors along the entire longitudinal axis of the log over the course of approximately 20 minutes. The result is a three-dimensional CT image of the inner structure of the log. The researchers can then use this model to create a computer simulation that indicates the precise way in which the log needs to be cut to achieve an end product with a lot of small knots or only a few large knots. This makes it possible to create timber with a surface that meets customer preferences.

### Only Attractive Products

The CT scanner the team used for the project is now being developed into an industrial scanner that will only need a maximum of 20 seconds to x-ray the logs. This would allow sawmills to improve the cutting area on their own. In the long term, the researchers hope that this technology will lead to a situation in which only attractive products reach the market and poorly selling product lines can be avoided. The final results of the project are not yet certain. The scientists are currently analyzing the survey to determine which surfaces customers like best. It has already become clear that the wood does not have to be flawless to be appealing: "A small but significant percentage of the customers prefer

“A small but significant percentage of the customers prefer boards that have previously been sorted into the third class due to their large knot structures”

boards that have previously been sorted into the third class due to their large knot structures and that are therefore usually built into walls where they are not visible,” says Becker. Whether the forests can provide enough wood that corresponds to the customers’ preferences remains to be seen.

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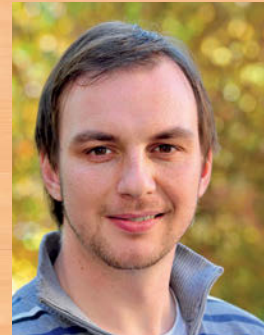
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Follow this link to participate in the study on the attractiveness of wood: [www.uni-freiburg.de/go/umfrage\\_holz](http://www.uni-freiburg.de/go/umfrage_holz)



**Prof. Dr. Gero Becker** studied forest science and economics in Hannoversch Münden, Göttingen, and Freiburg. In 1974 he earned his PhD at the University of Freiburg, in 1980 his habilitation qualification. Afterwards, Becker accepted a professorship at the Faculty of Forest Science at the University of Freiburg. In 1987 he moved to the University of Göttingen, but in 1995 he returned to Freiburg, where he took over as director of the Institute of Forest Utilization and Work Science, which was renamed the Chair for Forest Utilization in 2013. Becker conducts research on problems at the point of intersection between silvicultural production and the use and processing of wood and other forest products as well as on the sustainable use of biomass for energy purposes.



**Andreas Manuel** studied forest science with an additional emphasis on industrial environmental management at the Faculty of Environment and Natural Resources of the University of Freiburg. He has participated in the research project “What Makes Wood So Attractive?” for two years and is writing his dissertation on this topic. Photos: Thomas Kunz



# The Rich Lay Bombs Too

Günther Schulze and Krisztina Kis-Katos are investigating the economic causes of terrorism

by Verena Adt

*Poverty is not the cause of terrorism – the Freiburg economists can back up this claim with statistics.*

*Photo: Mopic/Fotolia*

Is poverty a breeding ground for terrorism? Ulrike Meinhof, guiding intellectual force of the Red Army Fraction (RAF), didn't exactly come from the gutter, and the emblematic Al-Qaeda leader Osama Bin Laden hailed from a rich family in Saudi Arabia. All the same, former US president George W. Bush was convinced of this hypothesis: When he announced the "War on Terror" after the attacks on 11 September 2001, he didn't just send troops to Iraq but also nearly doubled funding for the United States Agency for International Development (USAID). The assumption behind this stance is that those who fear for their economic survival will be more susceptible to extremist agitation and thus more likely to be willing to place their own life on the line in a terrorist attack than those who don't have to worry about where their next meal is coming from. Accordingly, there will be less terrorism in a country whose citizens are financially stable.

## Well Off, Well Educated

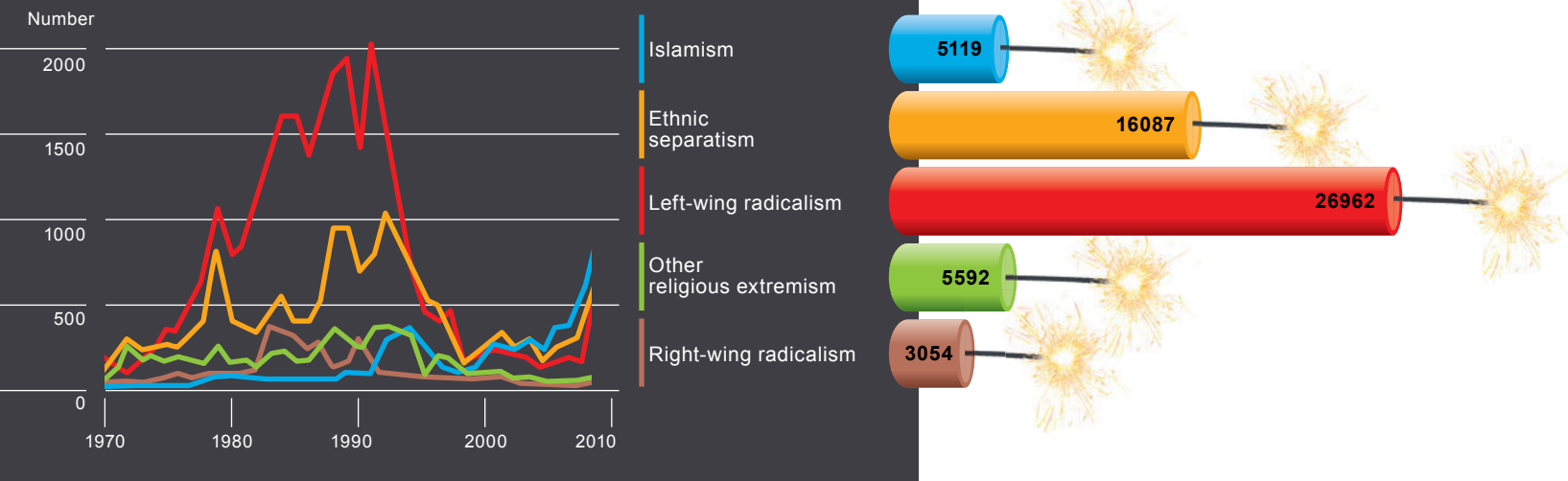
Prof. Dr. Günther Schulze and Dr. Krisztina Kis-Katos from the Institute of Economic Research of the University of Freiburg cannot confirm this simple-sounding theory. Schulze, head of the Department of International Economic

Policy, and his research assistant Kis-Katos have been conducting research on the causes of terrorism from an economic standpoint for the past several years. They have not been able to find a causal relationship between terrorism and economic living conditions in their empirical studies. "There is not more terrorism in poor countries than in rich ones," says Kis-Katos. On the contrary: The number of terrorist acts increases with per capita income. In a joint study, the two researchers found out that most terrorists do not come from impoverished countries. This finding is consistent with the results of empirical studies indicating that terrorists are better off and better educated than the majority of their compatriots.

The team drew its findings from the Global Terrorism Database, according to Schulze "the most comprehensive database to be compiled on this topic to date." It lists more than 104,000 "terrorist incidents" from 1970 to the present – including international attacks as well as the much more common acts committed by terrorists in their native country and aimed at their fellow citizens. Although international terrorist acts like the series of attacks on 11 September 2001 in the USA attract a lot of attention from the media, Schulze and Kis-Katos stress that around 85

Total number of attacks by organized terrorist groups with an ideological background (1970–2008)

Source: Global Terrorism Database



*The economists identified categories of terrorism along ideological lines.*

*The numbers of terrorist attacks in the various categories vary widely.*

*Illustration: qu-int*

percent of all terrorist acts are purely domestic affairs. “Most of the victims are not in the West, but in countries like Iraq, Afghanistan, and Pakistan.”

### Countries with Fragile Authority Are Susceptible

So if poverty isn't what motivates people to join terrorist organizations, what does? Schulze and Kis-Katos have found out that it is above all nations with fragile authority that provide a “terror-friendly” environment. “The countries that are most susceptible to terrorism,” explains Kis-Katos, “are those that are weak due to political instability, those that are in a transitional phase like the former member states of the Soviet Union, or those in which there is no state authority, like Afghanistan or Iraq.” Democratic and semi-democratic states fall victim to terrorism more often than strictly autocratic ones, presumably due to the fact that “the protection of personality rights has greater priority” in the former, explains Kis-Katos. This limits the options available to the state for intervening against potential terrorists. Radical autocracies like North Korea have the lowest risk of terrorism – when one discounts state terror, as Schulze and Kis-Katos do for the purposes of their project. Schulze warns that the reverse is

not necessarily true: More democracy does not automatically lead to an increase in terror.

Although the Freiburg researchers do not see a causal relationship between poverty and terror, there are indications that terrorist organizations can profit from economic difficulties. In a case study, Kis-Katos, Schulze, and the latter's former graduate student Ahmet Turgut discovered that the recruiting rates of the Kurdish workers' party PKK, classified by the German government as a terrorist organization, rises and falls parallel to the national unemployment rate in Turkey. It is also evident that terrorist strongholds work like magnets and attract significantly higher numbers of recruits regardless of the economic situation. The “terror periphery,” on the other hand, is much more susceptible to “terrorist economic cycles.” The authors analyzed hundreds of obituaries of killed combatants published by the PKK in their case study. They found out that economic circumstances in, for example, the Kurdish city of Diyarbakir have next to no impact on the decision to join the PKK, whereas young men from villages on the edge of the Kurdish territory are more likely to join the organization in times of high unemployment.

Their research on the causes of terrorism has also prompted Schulze and Kis-Katos to exam-

“There is not more terrorism in poor countries than in rich ones”

ine the diverse forms of violence that are typically subsumed under the term. “There is no such thing as terrorism as such,” says Schulze. The economist stresses that terrorism is a strategy, not an ideology, and terrorism motivated by different reasons will thus not necessarily have the same background. Left-wing terrorism, for example, occurs more often in countries with high income disparity, but this is not true of religiously motivated terrorism. Ethnically polarized societies are, for their part, more prone to separatist terrorism but not to other forms of terrorism. The forms of terrorism common to various countries also differ along the lines of variables like political stability, democracy, standard of living, and degree of urbanization.

### Developing Strategies against Terrorism

In collaboration with the former student Helge Liebert, Schulze and Kis-Katos identified four categories of terrorism: terrorism from left-wing extremist groups that aim to establish a socialist or communist social order – such as the German Red Army Fraction or the Maoist “Shining Path” organization in Peru; right-wing extremist terrorism aiming to achieve racial or national dominance – the series of murders committed by the “National Socialist Underground” under review by the German judiciary is a current example; ethnic separatist groups fighting for political power or to gain independence like the Basque ETA in Spain; and religious terrorist groups, including not only numerous radical Islamist groups in the Near East and parts of Africa but also Hindu, Christian, and Sikh terrorist groups. Each of these ideologically categorized types of terrorism has its own pattern.

Schulze and Kis-Katos hope the findings of their research project will help politicians to develop effective strategies against terrorism. The causes and forms of terrorism have already been studied many times from a sociological and political perspective, but the idea of studying them from an economic perspective is relatively new. “Our methodology is perhaps somewhat more abstract and quantitative,” says Schulze, “but economics is a methodically well-grounded social science that engages in systematic study of the reality of the world we live in. Ultimately, what it’s about is always human fate.”



Most victims of terrorism are currently in countries like Iraq, Afghanistan, and Pakistan. Photos: Miro Novak/Fotolia



**Dr. Krisztina Kis-Katos** studied economics at the University of Szeged, Hungary, and international economic relations at the University of Constance. In 2010, she earned her PhD at the University of Freiburg with a study on globalization and child labor. She has since conducted research at the Department of International Economic Policy at the Institute of Economic Research, primarily on topics in political economics, economic development, and conflict economics. Her research is grounded on quantitative micro-empirical data analyses.

Photo: private



**Prof. Dr. Günther Schulze** studied economics at the University of Hamburg, earned his PhD at the University of Constance in 1995, and completed his habilitation at the same institution five years later. Since 2002 he has served as professor of economics at the Faculty of Economics and Behavioral Sciences of the University of Freiburg, where he is also head of the Department of International Economic Policy. In addition, he is an adjunct professor at the Australian National University in Canberra. His research interests include political economics, developmental economics, and the economic analysis of terrorism. He is an expert on Southeast Asia and is a member of the Southeast Asian Studies Group at the University of Freiburg, which receives funding from the German Federal Ministry of Education and Research. Photo: Thomas Kurz

### Further Reading

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Kis-Katos, K./Liebert, H./Schulze, G. (2011): On the origin of domestic and international terrorism. In: *European Journal of Political Economy* 27/1, pp. 17–36. [www.pr.uni-freiburg.de/go/origin-of-terrorism](http://www.pr.uni-freiburg.de/go/origin-of-terrorism)

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## Masthead

uni'wissen, the research magazine of the University of Freiburg, is published twice a year.

### Publisher

Albert-Ludwigs-Universität Freiburg,  
Rector Prof. Dr. h.c. Hans-Jochen Schiewer

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### Print Run

10.000 Exemplare

### English Translation

Dr. David Heyde

### Photos

Unless otherwise indicated, property of the university.  
Cover photo: Mario Schmidt  
Cover illustration: Helbling Verlag, Montage: qu-int

### Conception, Design, Production

**qu-int.** | marken | medien | kommunikation  
Alter Zollhof, Freiburg  
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Fax +49 (0)761/28288-66  
E-Mail [uni-publikationen@qu-int.com](mailto:uni-publikationen@qu-int.com)

### Printing and Production

Hofmann Druck, Emmendingen

### Distribution

Office of Public Relations

### Yearly Subscription Price

6,- euros  
uni'wissen is available free of charge  
for students and employees of the university.

ISSN 2194-8054

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