Galaxy

Imprint

Scientific editors
Prof. Dr. Volker Trommsdorff (Technische Universität Berlin)
Dr. Wolfgang Merten (Technische Universität Berlin)

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Authors
Frank Brunner (Berlin)
Martina Hinz (Berlin)
Carsten Jasner (Berlin)
Annekatrin Looss (Berlin)
Dr. Wolfgang Merten (Berlin)
Dr. Monika Offenberger (Munich)
Prof. Dr. Volker Trommsdorff (Berlin)
Andrea Walter (Berlin)

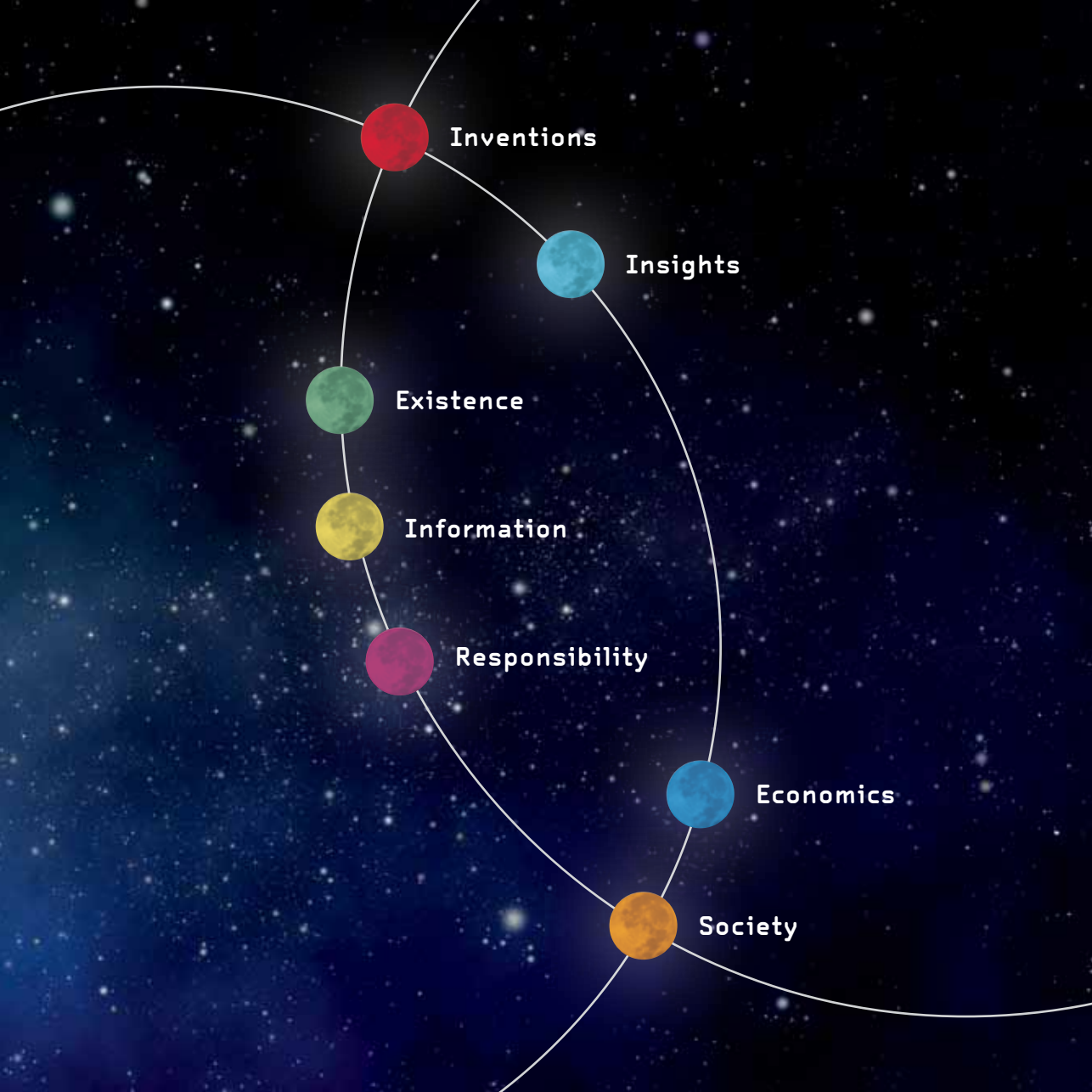
Production
W. Bertelsmann Verlag GmbH und Co. KG (wbv)

Editorial department
Katja Dammann, wbv

Coordination
Stefan Hase-Bergen, German Academic Exchange Service
Dr. Irene Jansen, German Academic Exchange Service
Ulrike Koch, German Rectors' Conference
Dr. Nina Lemmens, German Academic Exchange Service
Marijke Wahlers, German Rectors' Conference

Layout
Marion Schnepf, lok. design division, Bielefeld

Translation
The Brenn-White Group, LLC:
Talia Bloch, Megan Brenn-White, Laura Montgomery


Inventions
Insights
Existence
Information
Responsibility
Economics
Society

Dear reader,

Distinguished by its centuries-long tradition of scientific and scholarly achievement, Germany remains one of the most important centres of research and scholarship in the world today. This publication seeks to offer an overview of some of the research highlights and scientific achievements emerging from German universities, schools of applied sciences, and academies of art and music that have contributed to this success story.

Creative genius flourishes under favourable conditions. By providing an open and stimulating environment and maintaining state-of-the-art facilities, German universities help support their scholars and scientists to develop their creative powers. These settings provide fertile ground for cultivating internationally successful research careers as well as highly regarded research work.

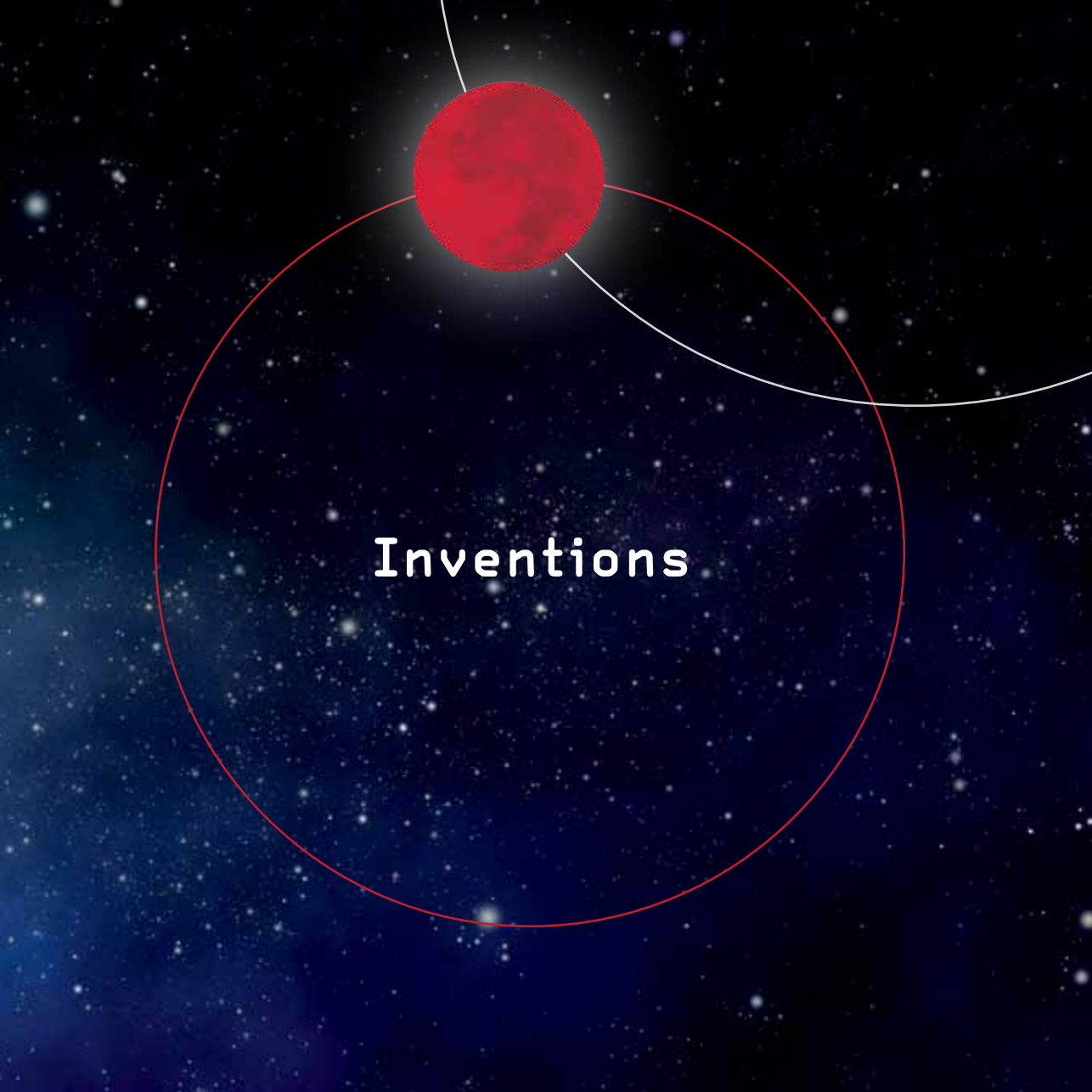
We would like to highlight several of the leading figures and significant achievements that have emerged across various fields at German universities over the past fifty years – each has had an important impact on all of our lives or is certain to influence us in the future. These achievements have significantly enriched the world's store of knowledge, and their effects will be felt for a long time to come.

The following ground-breaking discoveries, inventions, and findings were selected by Professor Volker Trommsdorff and Dr. Wolfgang Merten of the ScienceMarketing department at Technischen Universität Berlin, on behalf of the German Academic Exchange Service (DAAD) and the German Rectors' Conference (HRK). Trommsdorff and Merten selected a representative collection of exemplary work from across all disciplines and from a range of higher education institutions, with an emphasis on more recent achievements. They then collaborated with a team of authors to write up descriptions of the chosen research work.

We hope you enjoy this fascinating material! Should you be interested in learning more about any of the work described here, you can find information for further reading at the end of this publication, or you may visit the links provided after each individual article.

Prof. Dr. Margret Wintermantel
President of the German Academic Exchange Service

Prof. Dr. Horst Hippler
President of the German Rectors' Conference

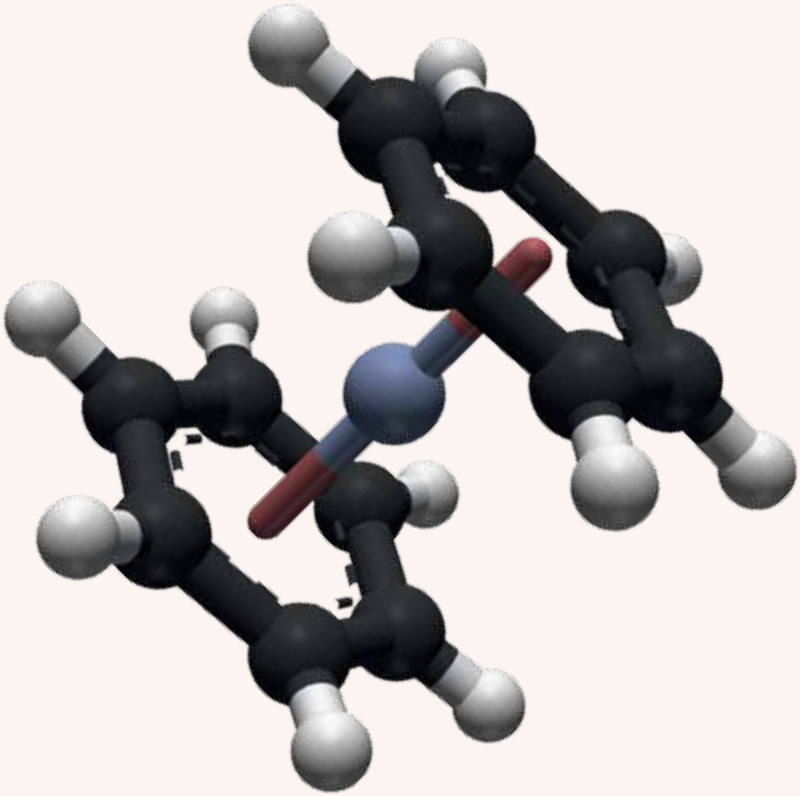

Inventions

Inventors solve problems by finding technical solutions. As early as half a millennium before the advent of the internet era, Johannes Gutenberg caused a paradigm shift in the media world. With the construction of the world's first printing press in Germany, books became a mass-market product. The car, tram, light bulb, television, computer, and the MP-3 audio file format are also products of German ingenuity.

The articles in the following "Inventions" section are not limited to a narrowly defined subset of the engineering sciences, such as those examples we have provided from the fields of materials research, manufacturing technology, and computer electronics. In touching on so many areas in the following pages, it's no accident that many Nobel Prize winners are showcased. There's the chemist Georg Wittig, for example, whose research helped make the production of low-cost pharmaceuticals possible, and the engineer Ernst Ruska, whom we can thank for the development of electron microscopes that allow us to see atoms. And without the physicist Peter Grünberg, super-fast computers would remain in the realm of science fiction.

Excellent support for young scientists will guarantee that "Made in Germany" continues to be the hallmark for outstanding inventions. At present, a completely novel type of aircraft is being developed in Hamburg. In Dresden, researchers are seeking to identify tumour cells more rapidly through the use of nanotechnology. Meanwhile, a team in Stuttgart headed by Nobel Prize winner Klaus von Klitzing is planning the next revolution: the end of the digital age, brought about by quantum technology.

A master of molecules



A sandwich structure for chemists

Impulsive yet pensive, a man of the world who loved his own country, and as ardently devoted to the fine arts as to the natural sciences, Ernst Otto Fischer was a portrait in contrasts. Even as a scientist, he was able to reconcile apparent contradictions. Fischer combined metals and carbon compounds to create complex substances with previously unknown properties. In 1973, his groundbreaking work earned him the Nobel Prize in Chemistry.

Fischer had planned to study art history, but the Second World War derailed his plans. It was then, rather by chance, that he discovered his love of inorganic chemistry. Fischer was especially interested in matter that combined organic elements, such as carbon, with inorganic elements, such as iron or other metals. He wanted to understand how such dissimilar elements could bond, and in the process of studying them, he discovered an unknown molecular composition: the "sandwich structure".

Fischer's pioneering achievements in the field of organometallic chemistry laid the foundation for the synthesis of numerous new substances and many synthetic materials. To this day, Fischer's students continue to expand the field both in academia and in industry.

Test-tube vitamins

A simple way to produce complex natural compounds synthetically

Vitamin D protects infants against rickets; vitamin C strengthens the immune system – in nature, these vital substances occur naturally as complex compounds. Nowadays, it is cheap and easy to produce vitamins synthetically, due primarily to the work of chemist Georg Wittig, who died in 1987. The carbonyl olefination reaction, which he discovered and named, has since become known as the Wittig reaction and has brought the researcher from Heidelberg international fame. In 1979, he was awarded the Nobel Prize for his work.

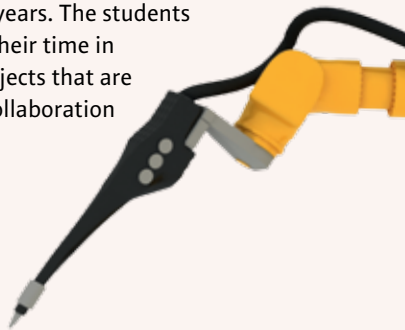
Like all other organic substances, the vitamins our bodies need are made up of a complex scaffold of carbon and hydrogen atoms. The characteristic traits of individual substances are determined by the structure of – and by the groups of other synthetic elements attached to – their scaffolds. If you want to produce a specific compound synthetically, you first have to construct the appropriate scaffold.

The discovery was pure coincidence. "Wittig neither invented nor envisaged this reaction. He discovered it. And that proves once again that important research cannot usually be planned," says Reinhard W. Hoffmann, professor emeritus at Marburg University and former colleague of the Nobel laureate at Heidelberg University. Today, the Wittig reaction is used around the world in the synthetic production of natural substances such as vitamins, hormones, and medicines.

The factory of the future

When are industrial companies successful? When they manufacture goods that are sustainable, cost-effective, and reliable. They must also have production processes that can be adapted quickly to changing conditions. The Graduate School of Excellence advanced Manufacturing Engineering (GSaME) at the University of Stuttgart follows these guiding principles. How can my company survive in turbulent international markets? How can I create more product versions in less time? Which employees are most suitable for the job? GSaME addresses questions like these by taking an interdisciplinary approach that combines theory and practice.

More than 60 doctoral students from production technology, materials engineering, electrical engineering, and business management receive an interdisciplinary education at GSaME and work in teams to conduct research into key topic areas and application-oriented solutions. Each doctoral student is awarded a scholarship lasting up to four years. The students invest more than half their time in working on specific projects that are undertaken partly in collaboration with industry.



A3 | **Technische Universität Berlin, RWTH Aachen University and University of Stuttgart**

www.ptz-berlin.de/geschichte | www.exzellenz.rwth-aachen.de/go/id/sat | www.gsame.uni-stuttgart.de

In Stuttgart, doctoral students are revolutionising production technologies and organisational structures

This means a machine tool manufacturer, for example, gains a direct benefit from being involved in the development of a laser beam that can cut various materials to the same high quality standard. The doctoral students also use a model factory to simulate effective organisational structures and IT systems. Business administration students carry out research into new management models that take social and ecological developments into consideration, as it is now recognised that beliefs and emotions have an influence on employees' performance and customers' purchasing decisions. The institute follows a dual educational system that combines research and training, theory and practice, and management and technology. This concept is considered unique in Europe and is supported by the German Research Foundation and the state of Baden-Württemberg as part of the Excellence Initiative.

Frontier physics

The quantum Hall effect is the basis for completely new computers

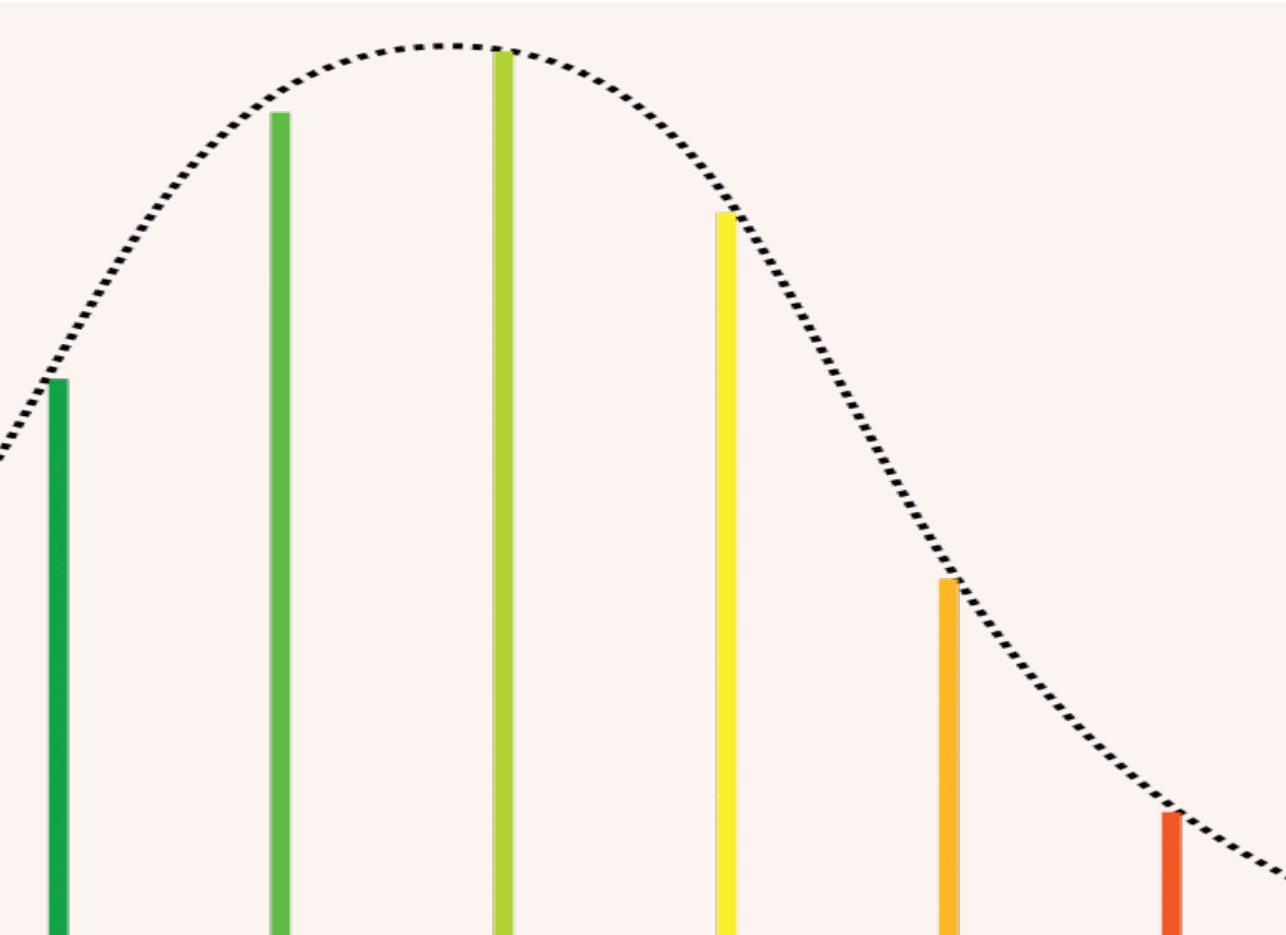
Its findings may start a revolution – albeit not necessarily an immediate one. Time and again, basic research produces results whose importance often only becomes clear several decades later. A good example of this is the quantum Hall effect, discovered by physicist Klaus von Klitzing in February 1980.

When subjected to strong magnetic fields and temperatures close to absolute zero, electrical current does not increase in line with the increasing magnetic field, as is usually the case, but in series of steps. Von Klitzing proved that the levels of resistance measured are integers – and components of a value that represents a natural constant. The von Klitzing constant was thus established as a universal standard for the measurement of electrical conductivity. For this work, the researcher received the Nobel Prize in 1985.

Hall voltage allows researchers to investigate the movement, drift velocity, and concentration of charge carriers in semiconductor materials. Without the quantum Hall effect, modern nanotechnology and the examination of the physical characteristics of semiconductors would hardly be possible. Now it seems that von Klitzing's findings may, through quantum computing, revolutionise computer technology. Whereas conventional computers are based on classical physics – with bits existing in only one of two possible states, 0 or 1, at any one time – the qubits in quantum computing can exist in several states at the same time. With this technology, it could take just seconds to perform calculations which would take even today's fastest computers years to solve.

A4 | **Klaus von Klitzing: University of Würzburg, Technische Universität München and University of Stuttgart**
www.ph.tum.de/personen/nobelpreise/klitzing | www.uni-wuerzburg.de/ueber/universitaet/wissenschaftsmeile_roentgenring/die_nobelpreistraeger/klaus_von_klitzing_1985/

A quantum leap in measurement technology



Ultramodern precision instruments from Munich

Light is one of the basic requirements for human life. The investigation of this natural phenomenon, which is based on electromagnetic radiation, has been the subject of research for centuries. An understanding of light led Albert Einstein to his theory of relativity and is the cornerstone of quantum physics. Lasers, atomic clocks, and satellite navigation systems are just some of the many achievements based on light-related discoveries.

One of the pioneers in this field is Theodor Wolfgang Hänsch. In 1998, he and a team of experts developed a new measuring tool – the frequency comb, which allows extremely high-precision measurements of laser beam oscillations. Its spectrum is made up of hundreds of thousands of extremely fine lines of colour. The known frequencies of these lines differ only slightly from one another. These coloured lines divide the visible light spectrum into a precise scale, from red through to violet. The colours are located next to one another like the teeth of a very fine comb. This is the “optical frequency comb”. The frequency of a laser can be measured precisely by observing a beatnote of low frequency with the nearest comb line. The invention represented a quantum leap forward for the precise quantification of time and distance, and Hänsch received the 2005 Nobel Prize in Physics for his work in this area.

Hänsch’s current primary field of research at the Ludwig-Maximilians-University Munich is the high-resolution laser spectroscopy of hydrogen.

Following in the tracks of evolution

Scientists in Berlin use natural phenomena to solve technical problems

What do a Velcro fastener, an aircraft engine, Wikipedia, and a diving fin have in common? All four inventions are based on principles found in nature. While walking his dog one day, the Swiss engineer Georges de Mestral noticed that the seeds of the burdock – a plant species with tiny, flexible hooks – stuck to his dog's coat. Velcro works in exactly the same fashion. A turbo jet engine uses the reverse thrust principle employed by jellyfish, Wikipedia functions according to the swarm intelligence of insects, and a diving fin imitates the webbed feet of frogs.

Numerous examples illustrate how evolution has come up with solutions perfectly adapted to a particular situation that are eminently transferable to technical problems. Bionics is the science of investigating how natural phenomena can be used in the design of technical products. One of the pioneers in this field is Ingo Rechenberg, Professor of Bionics at the Technische Universität Berlin since 1972. The qualified aircraft engineer has developed a wind turbine that copies the principle of flow acceleration on the splayed wingtip of a bird. He has also analysed how penguins "fly" under water, investigated how the outer feathers of the Antarctic Skua are used in braking reverse flow, designed a miniature helicopter that flies like a dragonfly, and travelled to the Sahara to examine a skink lizard that can swim through desert sand with minimal abrasion.

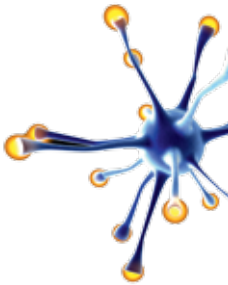
For Rechenberg, bionics is a combination of observing nature closely and discovering new ways to apply the principles that are revealed. That is why students at TU Berlin study subjects from both the biological and technical fields. Rechenberg explains that the aim is for the young scholars to "combine the wonder and astonishment of a child with the pragmatic thinking of an engineer".

Design inspired by Mother Nature

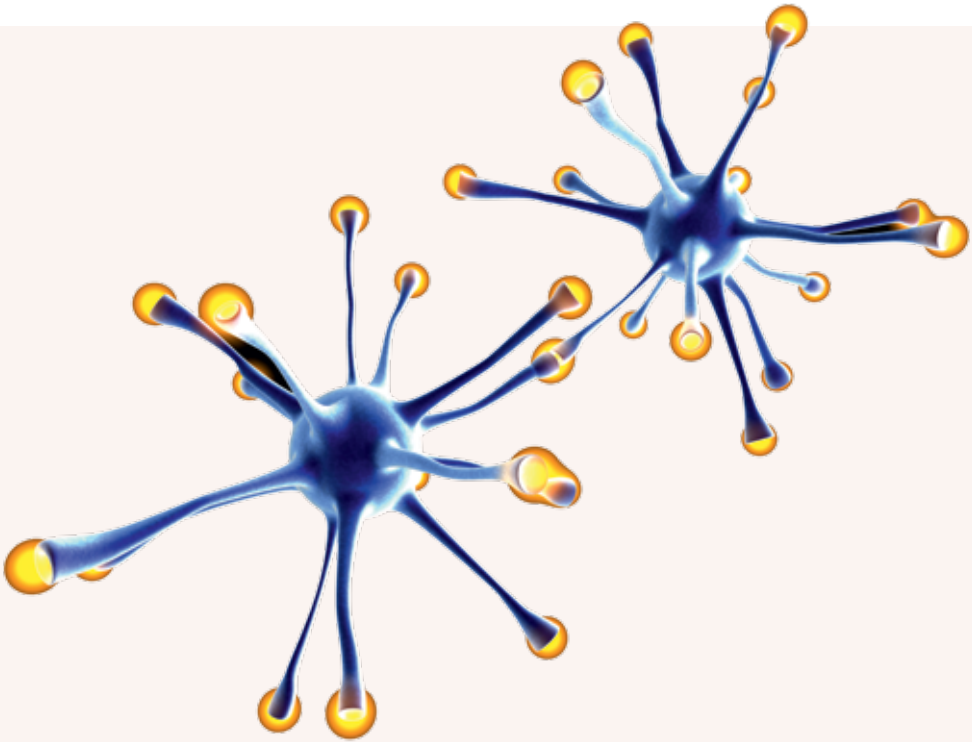
One of engineering's major goals to date has been trying to pack ever more technology into ever smaller spaces. However, this drive toward miniaturisation is limited by the size of the materials being used. Materials scientists at the Technische Universität Dresden's Max Bergmann Center have therefore decided to come at the problem from the opposite direction, taking a bottom-up approach to devising such structures. They are assembling individual atoms and molecules into ever more complex nanostructures.

Nature serves as their model: its principles have been perfected over millions of years, and no human being could devise anything more effective. A team of approximately 100 materials scientists, biologists, chemists, physicists, and electrical engineers are currently trying to replicate the structure of naturally occurring substances, piece by piece. Their findings could revolutionise both medicine and information technology. The functioning of the brain has been one source of inspiration. Neurons and synapses are interconnected in such an ingenious fashion that they themselves determine along which neighbouring neuron to relay a signal. Scientists are trying to replicate this process using nano-switches. When inserted into a computer, these switches would be 50 times smaller than today's transistors and would be able to connect to each other autonomously.

In medicine, molecules could emit electrical signals over nanowires as soon as particular bacteria, viruses, or tumour-cell DNA sequences show up, allowing for much earlier detection of disease than is currently possible. A further innovation under development at the Max Bergmann Center is a range of biomaterials consisting of silicate, collagen, and calcium-phosphate composites that help the body repair and regenerate severely damaged bone and skin tissue.



Scientists in Dresden are copying nanostructures found in nature



Making the smallest particles visible

50 PICOMETER =

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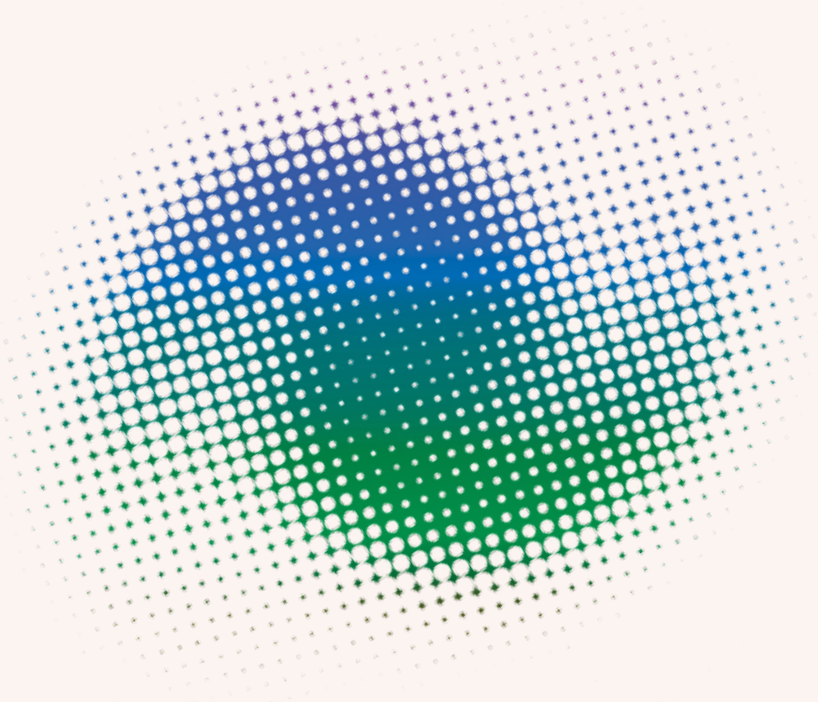
One of the most powerful electron microscopes in the world is housed at Forschungszentrum Jülich

No piece of equipment demonstrates progress in the natural sciences better than the microscope. At the beginning of the 17th century, Galileo Galilei was one of the first people to look into a compound microscope, which he himself had built. Four hundred years later, a high-performance electron microscope, which can even reveal atomic structures, was put into operation. Ernst Ruska, a German electrical engineer, played a crucial role in advancing this development.

A compound microscope can magnify objects up to 1,500 times. This is largely determined by the property of light waves, which are between 0.4 and 0.7 micrometres long. Structures that are smaller in size cannot be detected, however, and moving electrons have much shorter wavelengths than light. In March 1931, Ernst Ruska and Max Knoll succeeded in producing the first electron-optical magnification at the Technische Hochschule Berlin. Ruska received the Nobel Prize in Physics for this work in 1986, two years before his death.

The principle behind this type of magnification is as follows: an electron gun emits a beam that is focused by magnetic coils and transmitted through the specimen. This beam bends depending on the electron density of the individual atoms, and is then captured by an objective lens and projected onto a screen. This development made it possible to look inside cells and crystals. Since the 1990s, ongoing improvements to the technology have been able to correct fuzziness around the edges of the electron beams, known as aberrations. The PICO electron microscope was constructed on the basis of this principle by scientists from Forschungszentrum Jülich and RWTH Aachen University. Researchers and industry partners have been able to make use of the microscope in their work since 2011. The microscope's resolution of up to 50 picometres makes it possible to measure crystallites with a nano-sized diameter.

Expedition into the world of atoms



Physicists are researching the foundations of tomorrow's computer technology

Fast, compact storage media are now indispensable in our information-based society. The capacity of this storage media is no longer calculated in megabytes but in terabytes. Normally, it takes just milliseconds for a computer to launch applications and for files to appear on the monitor. We have Peter Grünberg, primarily, to thank for this speed. The physicist completed his postdoctoral Habilitation thesis at the University of Cologne in 1984 and regularly gave lectures and seminars there as a senior lecturer until 2004. Together with Albert Fert, he discovered the giant magnetoresistance (GMR) effect in 1988, which earned them the Nobel Prize in Physics in 2007.

For decades, electrical charges have been used to process digital information. This technology is reaching its limits. But now, rather than using the charge of electrons, computers can use their intrinsic rotational momentum – or spin – to create a physical effect that may help to increase the storage density of a hard drive, boost data transfer speeds, and reduce energy consumption. The idea is that electrons whir around an atom's nucleus with different spin values. If a nonmagnetic layer is placed between two magnetised blocks, and if the polarisation of one of the blocks is then reversed, then the transmission of electrons with a specific spin value changes – and, therefore, so does the level of electrical conductivity. Today, most hard drive read heads operate using the GMR effect, which Grünberg discovered in 1988.

Since 2011, physicists, computer scientists, and nanotechnologists have been researching the basis of tomorrow's information technology at the Peter Grünberg Institute. The retired physicist, after whom the institute is named, is also involved in the research, which looks at whether the spin of individual electrons can be turned off in order to transmit information as microscopic particles in accordance with quantum mechanical principles.

The universe's fingerprint

A10 | **Rudolf Mößbauer, Technische Universität München**
www.ph.tum.de/personen/nobelpreise/moessbauer

The Mößbauer effect, used for the precise analysis of materials, was discovered over 50 years ago

Mößbauer spectroscopy is used by archaeologists to analyse the composition of ancient ceramics, by biophysicists to examine the behaviour of proteins, and by materials scientists to determine which materials to use in computer storage disks.

In the 1950s, the young physicist Rudolf Mößbauer experimented with gamma rays that were emitted when the atomic nuclei of the precious metal iridium underwent radioactive decay. He beamed the rays at normal iridium and noticed that they were absorbed by the atomic nuclei of the non-radioactive sample. Normally, the emission and absorption of gamma particles generates a so-called recoil effect: the particles lose energy in a manner similar to the effect a swimmer has in pushing back a boat when jumping from it. The particles then no longer have enough energy to stimulate an iridium nucleus.

However, if the iridium atoms are fixed within a crystal lattice (the boat is tied together with many others), the whole lattice (or the boat platform) absorbs the impact. The gamma particles retain their energy and can then be absorbed by other iridium atoms. This is the Mößbauer effect. It allows for precise measurements that reveal how a particular atom is bound. Chemical changes alter absorption behaviour, and every substance exhibits its own unique behaviour, giving it a type of fingerprint. In 1961, at the age of 32, Mößbauer was awarded the Nobel Prize for his discovery. He then went on to set up the Physics Department of the Technische Universität München. He died in September 2011. Most recently, robots on Mars used the Mößbauer effect to establish that water must once have flowed on the red planet.

Flying like a bird

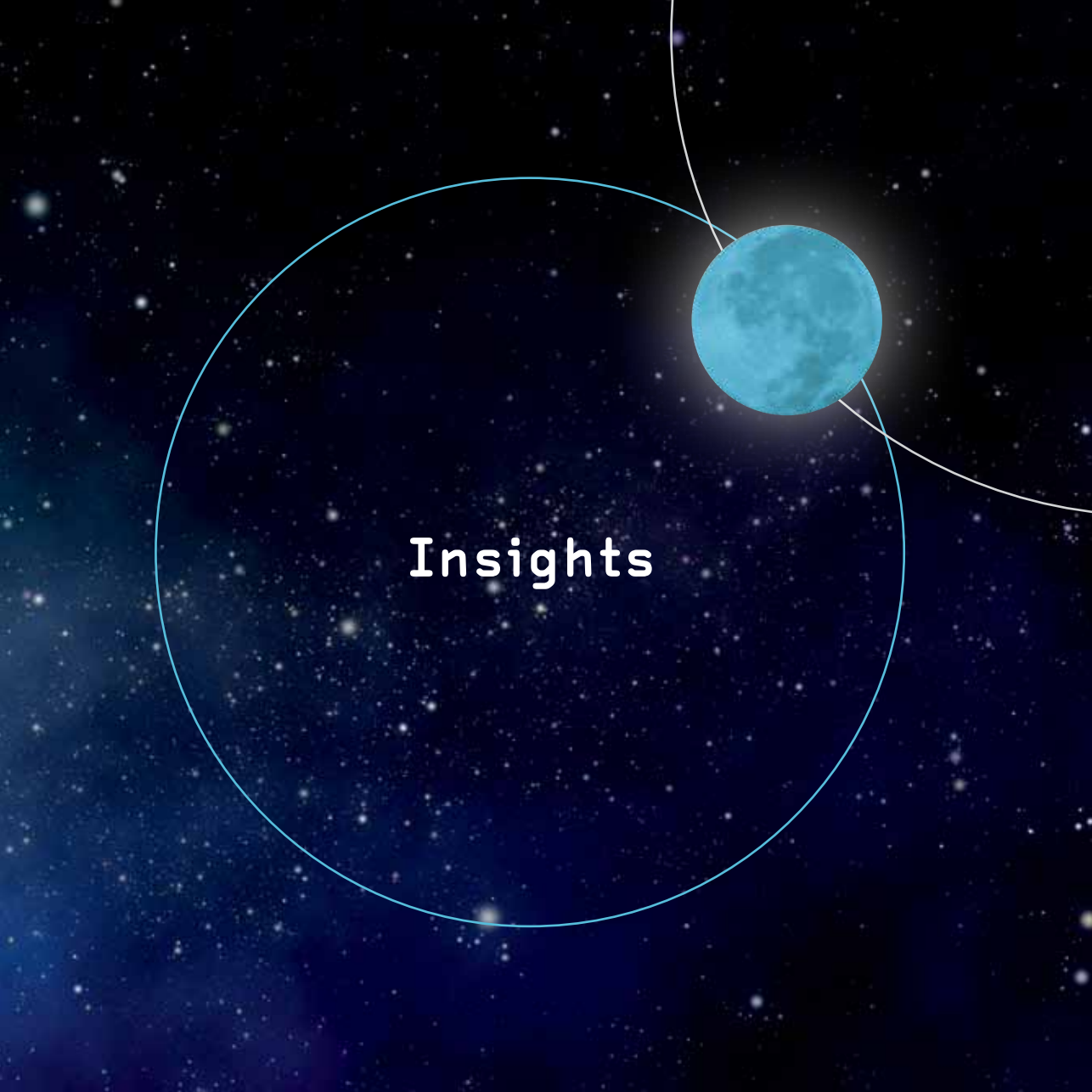
Conventional aircraft construction reached its technological and economic limits with the Airbus A380, the world's largest passenger airliner. Constructing something even bigger, faster, or wider is impossible. But there is an alternative: an extremely flat aircraft called the BWB AC 20.30. It looks like something that has just flown in from another galaxy, but it was built in Hamburg. Young scholars and students at the HAW Hamburg's Department of Automotive and Aeronautical Engineering are carrying out research into a very unusual type of aeroplane.

In the blended-wing-body (BWB) aeroplane, the fuselage and wings are not clearly differentiated parts of the aircraft, but rather blend smoothly into one another. This increases the lift considerably and reduces drag. These aeroplanes copy the aerodynamics of birds and therefore resemble them. They can potentially consume up to a quarter less fuel than conventional aircraft, and refrigerated tanks can be incorporated into the large wings so that hydrogen can be used to power the aircraft.

Innovative aircraft construction has a long tradition in Hamburg. The industry currently employs around 30,000 people. The students of Professor Thomas Netzel have ambitious plans. By the year 2030 at the latest, a prototype of the BWB AC 20.30 is expected to take its maiden flight. Nine hundred passengers may then be able to fly halfway around the world without stopping.

Scientists and students in Hamburg are developing a new type of aeroplane

A11 | Hamburg University of Applied Sciences | www.haw-hamburg.de/fakultaeten-und-departments/ti/forschung-entwicklung/studentische-projekte/projekte-2011/bwb.html


Insights

Historically, the humanities have expanded upon the consequences of advances in the natural sciences. They provide answers to the challenges to which scientific progress gives rise, challenges that manifest themselves in both technology and the life sciences. If natural science research views nature in terms of how it can be used to expand our technical capabilities, the humanities see it as their mission to decode meaningful connections. Some of the challenges posed by the natural sciences are illustrated in the following articles, including the ones presenting Cramer's work on deciphering the language of genes, Jensen's shell model, the research on the architecture of cells, and Meyer's work in the area of evolutionary biology.

The kind of answers the humanities can provide us is illustrated by the findings of the art historian Klaus Bredekamp. He reported that even in the 14th century, at the beginning of the Renaissance, an ancient statue of Venus was destroyed in Siena because it was believed to be responsible for a series of military defeats. Delusional religious distortions continue to exist in modern times as well, demonstrating that the advancement of knowledge is as fragile as the civilising standards in which it is embedded. Indeed, we are driven to learn more about the realities of the world in order to arm ourselves against setbacks. The Historical Dictionary of Philosophy, which was written over the course of two generations, is especially revealing in this regard. This work poses an apparent paradox: slowing down does, in fact, help us to keep pace with progress.

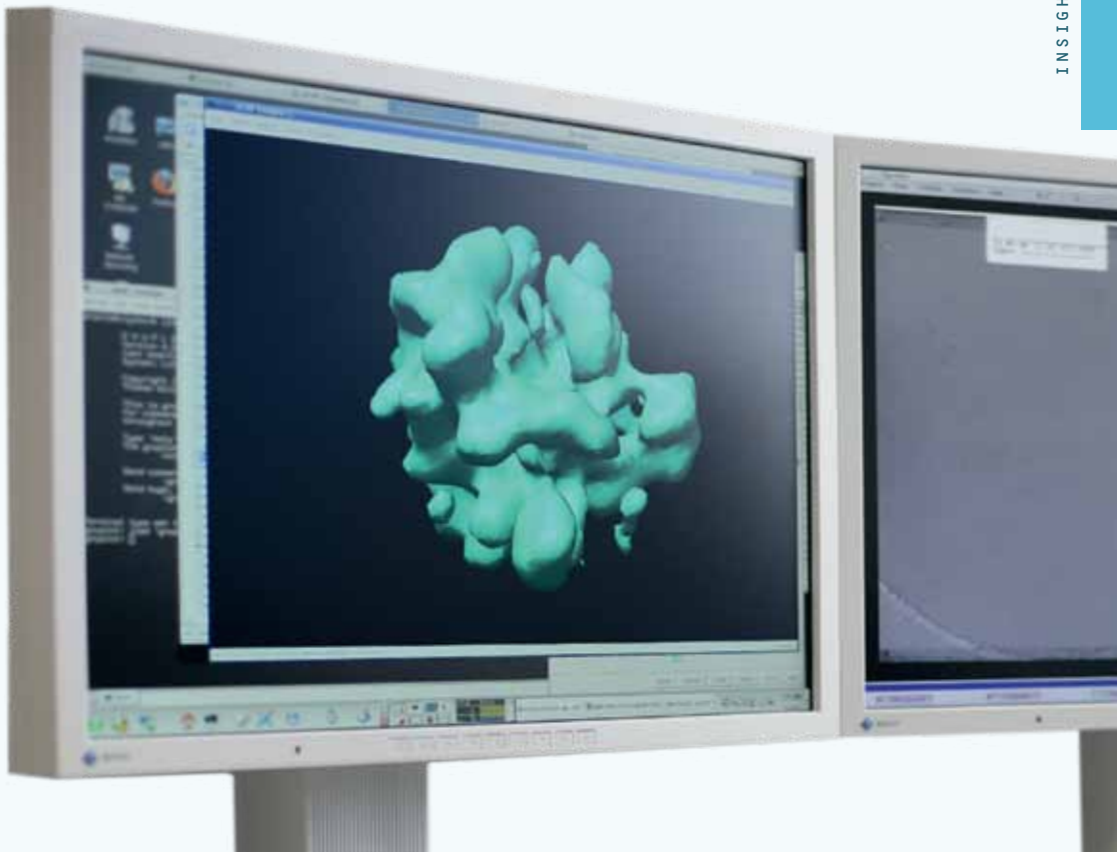
Making genes talk

A human being consists of some 30,000 genes, while simple baking yeast has around 6,000 and 100,000 can be found in cabbage. We've known the genomes of hundreds of organisms for a long time and can even understand the sequence of their building blocks. But this knowledge alone isn't all that helpful, notes Professor Patrick Cramer, a chemist. As Cramer says, "The most exciting question is actually how the cell manages to get to the information that's held in all those genes – and how the cell translates this information into a function that has some sort of effect in the body."

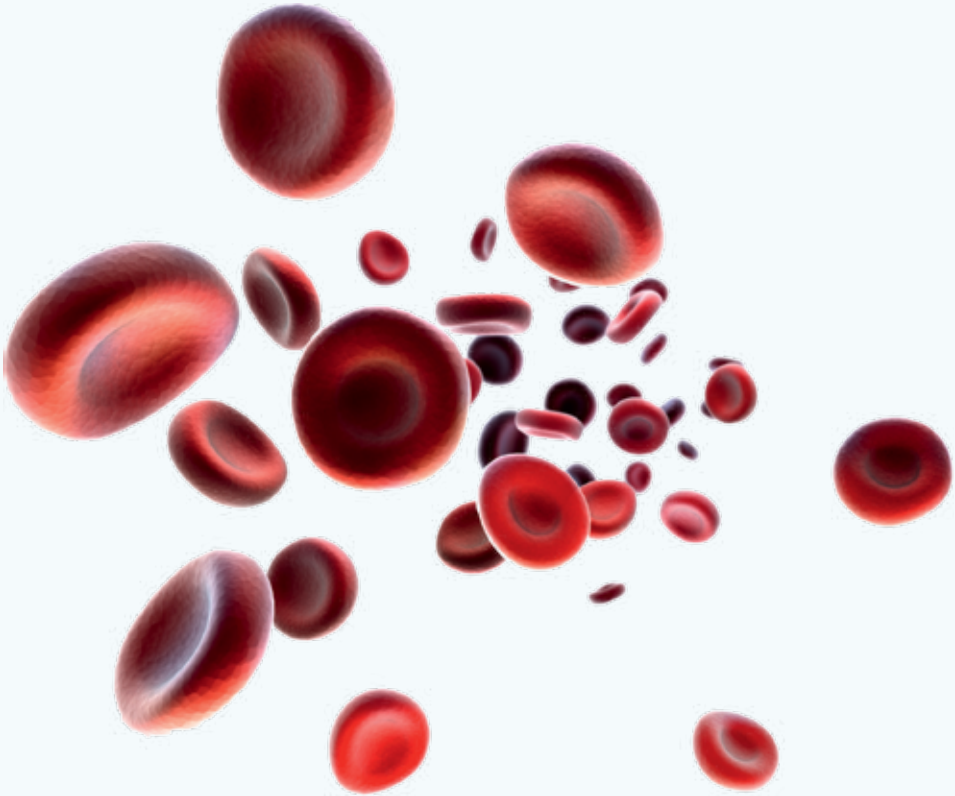
In order to comprehend the cell's decoding mechanism Cramer makes images of its component parts: "X-ray crystallography is able to display the atomic structure of even very large and asymmetrically formed macro-molecules." His team uses special cryo-electron microscopy to capture the three-dimensional structure of the various biomolecules working together in complex synergies to transcribe genetic information. This is how Cramer and his colleagues will eventually reveal the structural design of the entire translation process. Cramer has already prepared a very detailed description of one of the most important molecular translators, RNA polymerase II (Pol II for short). Now he's turning his attention to its elder siblings Pol I and III; of central importance for cell growth, their malfunction may lead to cancer.

Cramer says: "We want to approach the largely unresolved problem of genomic regulation using new techniques, and are focusing on molecular systems biology." The chemist has been honoured for his achievements with numerous awards. After holding positions at Cambridge, Grenoble, and Stanford, this leading researcher moved to the Ludwig-Maximilians-University in Munich, where he has headed the Gene Centre since 2004.

Molecular translators of genetic information



Architects of life's building blocks



B2 | Joachim Spatz, Heidelberg University | www.pci.uni-heidelberg.de

Alter cell structure to conquer serious diseases

Joachim Spatz is a kind of interior designer whose architectural practice focuses on designing tiny spaces in the biological realm. At the Heidelberg University and at the Max Planck Institute for Intelligent Systems (Stuttgart), he deals with human cells and tries to influence the structure of cells, i.e. their architecture. His research has contributed much to the understanding of changes on the cellular level.

Why and how does cancer spread? To find answers to this question, we must delve into the cellular nanocosmos, but without destroying it in the process. Miniscule forces that influence the cellular cytoskeleton and determine its mechanical properties have to be measured. Joachim Spatz is the pioneer in this field and has left his mark on what has been dubbed nanolithography. His team is made up of physicists, chemists, and biologists, and their goal is to build a bridge between nanotechnology and medicine in order to produce better implants and advance cancer research.

Spatz engineers the contact between cells and particular biomolecules. “These molecules consist of chemical substances that reach for the individual cell receptors like hands and can change the position of individual receptors,” notes Spatz. Nerve cells are built differently than bone or blood cells and cell function determines cell structure. This statement also applies the other way round. By altering the structure of cells Spatz causes their biochemical signals to change, thereby activating other genes. This research may be of significant benefit to people suffering from disease or illness. It may one day be possible to change stem cell receptors so that cells become – as needed – skin or heart cells. Immune cells might be able to resist specific infectious germs, or cancer cells might be beaten by the body’s own immune system.

A ray of light in mental darkness

Using high-tech microscopy from Göttingen to observe the brain in action

As you read these words, hundreds of billions of neurons in your brain are working away so that you can perceive, understand, perhaps also learn, and, in the best case scenario, later remember what you have read. All of these processes are actually controlled and executed by molecules. Yet, given the complexity of the human brain, the question of how molecules function within their larger network systems is an almost inexhaustible field of research. The biggest challenge lies in applying the lessons learned in molecular physiology for medical purposes so that in future diseases such as Parkinson's, schizophrenia, or Alzheimer's can be treated more successfully.

This is the ambitious goal pursued by the Cluster of Excellence and DFG Research Center "Nanoscale Microscopy and Molecular Physiology of the Brain (CNMPB)" in Göttingen. Their work involves studying molecular processes and interactions in neuronal cells non-invasively. Such non-invasive observation calls for novel light microscopy (nanoscopy) methods with unprecedented resolution, a focal point for the Cluster. The revolutionary microscopy methods developed in the cluster allow the mapping of molecular processes in living neuronal cells at the scale of the molecules critically involved in our thinking.

B3 | Stefan Hell, Universität Göttingen | www.cmpb.uni-goettingen.de
Cluster of Excellence and DFG Research Center
"Nanoscale Microscopy and Molecular Physiology of the Brain (CNMPB)" | www.cmpb.org

Free dance in the beehive

When Karl von Frisch won the Nobel Prize in 1973 alongside Nikolaas Tinbergen and Konrad Lorenz, he was honoured for his research into hearing and vision in fish and, above all, for his spectacular studies into the behaviour of the Western honeybee. He discovered that bees differentiate between plants through smell, and that their colour perception is similar to a human's. Their compound eyes afford a high level of visual discrimination, allowing them to perceive movements clearly. And viewing small sections of sky is sufficient for them to gather information about both direction and time, as they possess an internal clock with three different synchronisation and timing mechanisms. This allows them to locate and fly to areas where there might be food available.

But how do bees communicate this knowledge to each other? Here von Frisch made his most amazing discovery. The bees use two differently choreographed dances to communicate information: the round dance gives information about the location of food and nearby food sources, and the waggle dance directs fellow bees to objects located further away. The dancing bees waggle forward a short distance across the vertical honeycomb within the hive, and then turn in a semicircle back towards their starting point. The direction of the dance illustrates the direction of the food; the speed of the dance and the number of times it is repeated communicate the distance.

The discoveries made by the biologist have also served to inspire behavioural studies of birds, whales, monkeys, and many other animals.

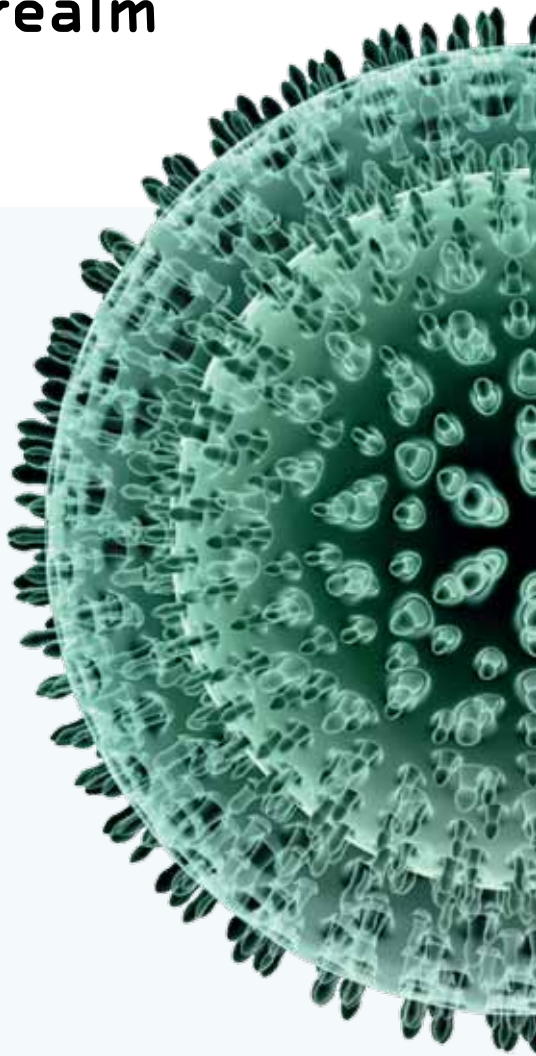
Nobel Laureate Karl von Frisch decoded the language of bees

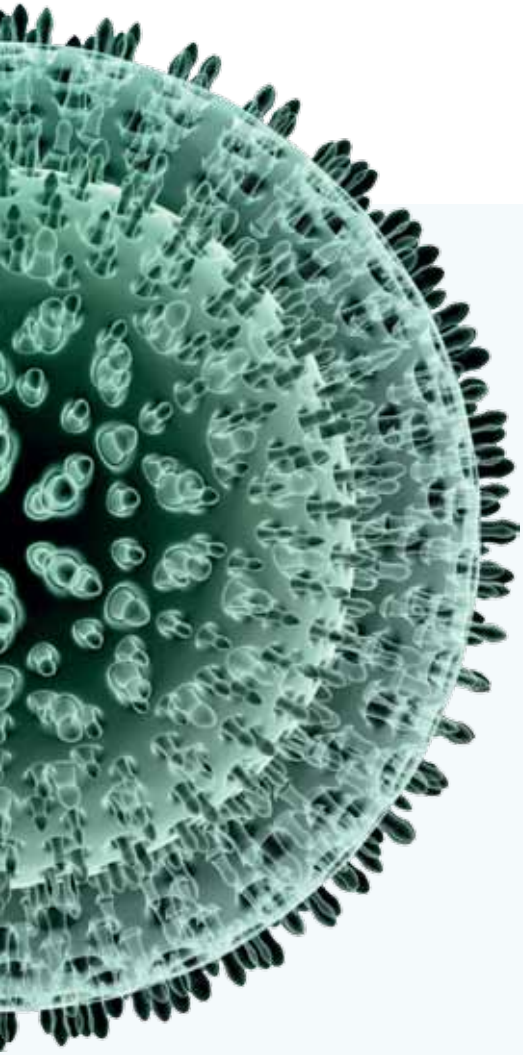
B4 | Karl von Frisch, University of Würzburg

www.biozentrum2.uni-wuerzburg.de | www.bienenforschung.biozentrum.uni-wuerzburg.de/

Translators in the realm of bacteria

The smallest and most versatile organisms on our planet communicate using chemical signals. Microorganisms are everywhere – they colonize flora, fauna, and human beings. Some of them cause diseases, others are essential to our health, and many species safeguard the very basis of our existence by degrading toxins in water and air or by ensuring that soil is fertile. Understanding the language of bacteria may render it possible to alter their properties, for example to prevent diseases. This is precisely the goal researchers at the Jena School for Microbial Communication Graduate School (JSMC) are pursuing.





Researchers decode how microorganisms communicate

Microbiological research has a long tradition in Jena. University and non-university research institutes collaborate on various projects in this field, including the development of new antibiotics, the decontamination of soil, and the production of biomolecules for use in industrial processes.

Early-career researchers, in particular, benefit from this expertise: three International Research Training Groups joined forces to establish the JSMC at the University of Jena in 2006. This umbrella organisation offers approximately 200 doctoral students from all over the world a comprehensive training programme that includes basic research on microbes as well as industrial applications. Collaborative projects abroad, scientific events with international guests and participation at conferences provide the researchers with opportunities to network internationally. After all, communication is essential for both microbes and scientists.

In the universe of languages and literatures

“This too, my dear, is yet another sign that we should get out of here as quickly as possible.”

Transnational literary studies and modern comparative literature at the Peter Szondi-Institute

"When we were brought to Bergen-Belsen and there was no butter, my grandmother turned to her companion and said, 'This too, my dear, is yet another sign that we should get out of here as quickly as possible.' That was all." This anecdote from the life of Peter Szondi – recounted and commented on by Klaus Reichert – is, in its portrayal of a moment of such obvious misjudgement, more appalling than the recollection of the atrocities themselves. As such, it provides insight into the "Szondi Method", a technique that opens our eyes to the significance of the seemingly trivial and the apparently irrelevant.

According to Szondi, the focus should not be on interpretation. He wanted to let a poem speak for itself instead of talking about it, and he insisted that the insights gained from reading a particular poem were unique to the poem and not generally applicable. A major contribution of Szondi was the internationalisation of literary studies in the Federal Republic of Germany. Again and again he addressed the situation of the Jews in Germany, warning of a new anti-Semitism, and reflecting on the social responsibility of the scientist. The names of those who accepted Szondi's invitations to visit the Institute of General and Comparative Literature at the Freie Universität Berlin during his tenure are a testament to his prominence. They include Theodor W. Adorno, Jacques Derrida, Jean Starobinski, and Gershom Scholem.

Today the institute is dubbed Peter Szondi. It is one of the world's leading establishments for the field of comparative literature, and is involved in collaborative research centres and graduate schools supported by the national Excellence Initiative. The Peter Szondi Institute regularly awards visiting professorships to renowned writers and translators. The first of these, in the summer semester of 2005, was Herta Müller, who went on to win the Nobel Prize in literature. Subsequent guests have included Ilja Trojanow, Sibylle Lewitscharoff, and Rainald Goetz.

The aesthetics of the moment

The history of art and images from antiquity to the present

How are Hans-Peter Briegel, who played defence for the West German football team in the 1980s, and Leonardo da Vinci's fresco of the Battle of Anghiari connected? A comparison of a sports photograph from 1982 with this Renaissance painting reveals exactly how. Both images portray extreme circumstances and people at the limits of physical and mental exertion. The similarities in the two scenes depicted, down to the smallest details, are astounding, and both images captivate us with their highly choreographed composition.

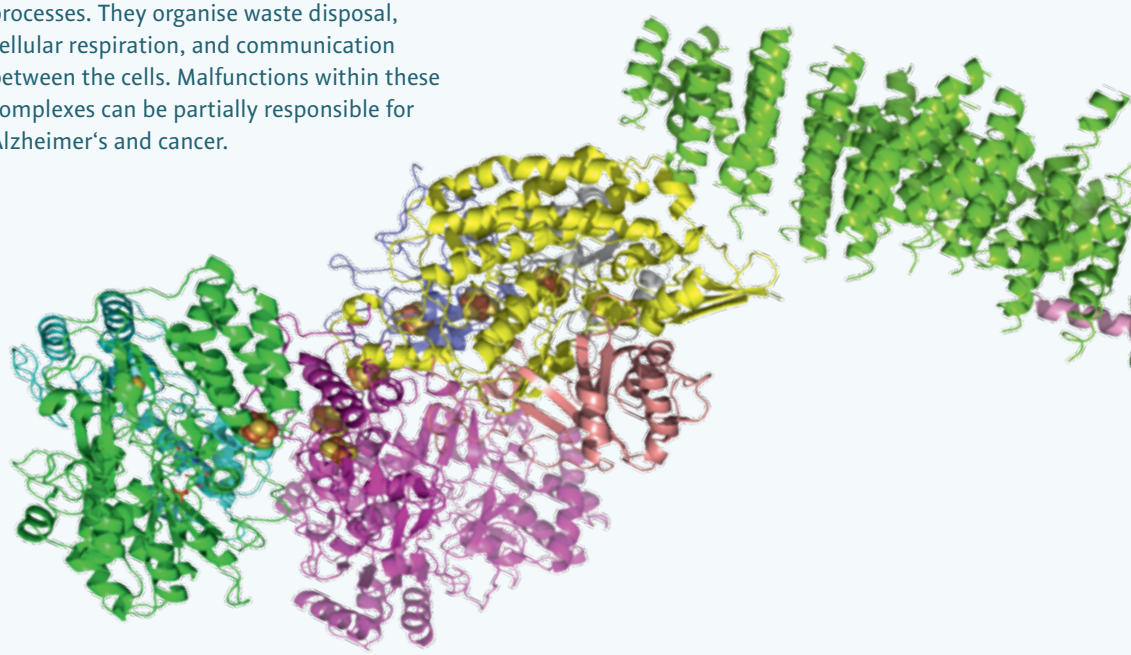
The scholar who first brought this connection to light is one equally well-versed in low and high culture: Horst Bredekamp. He relies on the fact that images are able to express what language cannot: "It serves both word and image to illuminate each other. Language helps us understand images; images help us understand language." This means we can interpret contemporary ball games as metaphorical re-enactments of war scenes from the 16th century. "With every game, everything begins anew; every player is essentially naked, like the artist in front of the canvas."

Not everything can be rationalised, and this is reflected in the fact that there is no way around aesthetic rules, even in football. "All the analyses of a football's path, a player's moves, and all the tactical statistics have done little to influence the game itself." No trainer would advocate that players should drive the ball directly down the middle of the pitch and abandon the more elegant path through the side lines, even if statistics have shown that the former is more successful. Playing the game on the side lines simply looks better. As a professor of art history and one of the most internationally renowned experts in the field, Bredekamp's iconography has helped us to see better – and not just with regards to football.

B7 | **Horst Bredekamp, Humboldt-Universität zu Berlin**
www.kunstgeschichte.hu-berlin.de | www.bildakt-verkoerperung.de

Cell biology research into serious illnesses

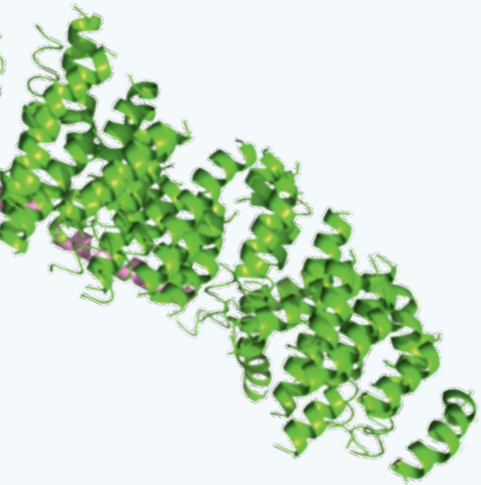
It is not a particularly romantic notion, but the human body is like a gigantic control room. In each cell, bio-machines – so-called macromolecular complexes – control all vital processes. They organise waste disposal, cellular respiration, and communication between the cells. Malfunctions within these complexes can be partially responsible for Alzheimer‘s and cancer.



B8 | Harald Schwalbe, University of Frankfurt | http://www.cef-mc.de/

Research into the cellular causes of cancer and Alzheimer's disease is underway at the Cluster of Excellence "Macromolecular Complexes"

Research into these diseases is central to the work of the Cluster of Excellence "Macromolecular Complexes" (CEF), which was founded in Frankfurt am Main in November 2006. The establishment of this cluster was a collaboration of the University of Frankfurt with the Max Planck Institutes for Biophysics and Brain Research.



The Macromolecular Complexes graduate programme belongs to the Graduate Programme of the Cluster of Excellence Frankfurt (GRACE). The programme trains outstanding scientists who possess – in addition to their scientific knowledge – professional skills such as academic writing, presentation skills and leadership qualities. Great emphasis is placed on the exchange of interdisciplinary knowledge through the collaboration of students from various disciplines, such as biochemistry, electron microscopy, or neuroscience. At the end of the programme, the young scientists prepare projects which serve as the basis for a postdoc. The spokesman for the cluster, Harald Schwalbe, says: "The optimal conditions offered by the cluster have also opened up new opportunities for us to attract young researchers from abroad". Werner Müller-Esterl, President of the University of Frankfurt, feels similarly. He adds: "The CEF has made outstanding contributions in its initial funding period, something which has been further strengthened by the construction of its own research facility."

The vocabulary of world history

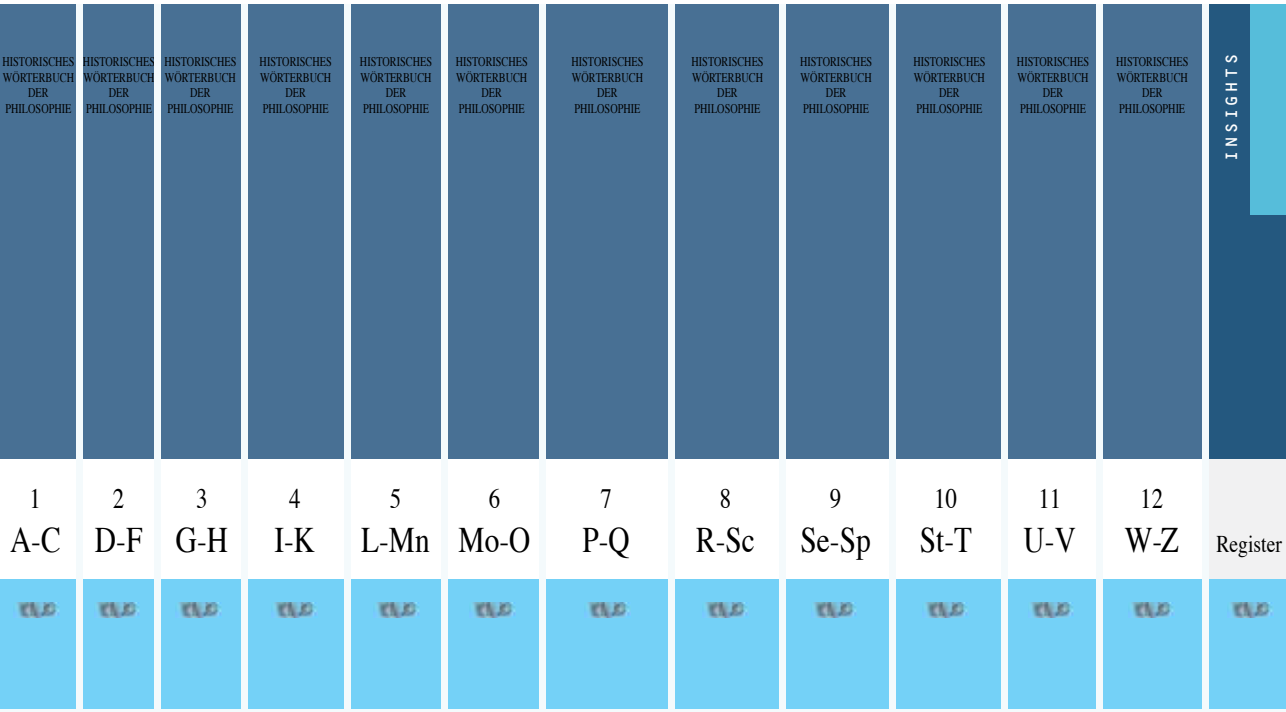
It is a sign of great confidence to begin a "cosmic" undertaking such as the Historical Dictionary of Philosophy. It requires perseverance, secure financial resources, and the intrinsic motivation of the scholarly community.

The work was published from 1971 to 2005 under the editorship of Joachim Ritter (†), Karlfried Gründer, and Gottfried Gabriel. The 12th and final volume was completed by the editor Gabriel of the University of Jena in 2007. The figures are impressive: 6,000 articles on 3,670 philosophical terms by 1,500 authors, all of them subject-matter experts.

The work was conducted under the auspices of the Academy of Sciences, Humanities, and Literature in Mainz, and was funded by the Federal Ministry of Education and Research and the State of Berlin. It remains a blessing to be able to revert back to a book that outlines the definitive concepts of Western thought and of Jewish, Arabic, and Far Eastern philosophy and describes how each evolved over time.

Thousands of anonymous wiki authors will presumably make use of the digital version of the dictionary to provide additions and updates that may prove necessary over the years. Ritter would be pleased that the torch has been passed on in this unconventional, but very contemporary, manner.

The Historical Dictionary of Philosophy is one of the grandest academic projects



What holds the world together

B10 | **Johannes Hans Daniel Jensen, Heidelberg University**

www.uni-heidelberg.de/nobellaureates | www.physik.uni-heidelberg.de/index/en

Magic numbers stabilise the nucleus of an atom

Have you heard of the “Atomium”, built in Brussels for Expo ’58, the Brussels World’s Fair? It depicts the atomic shell model, which expands on Bohr’s liquid droplet model of 1913. It was a long 42 years later before Johannes Hans Daniel Jensen and Maria Goeppert-Mayer were able to establish the shell model of the atomic nucleus.

Now it became clear that atoms with the “magic numbers” (2, 8, 20, 28, 50, 82, and 126) of protons or neutrons in their nuclei are very stable and occur frequently. But from where does this stability come? Jensen explained it in 1948 with spin-orbit coupling, the interaction between an electron’s spin and its orbital angular momentum. If the shells in the atomic nucleus are full, the atom’s spin-orbit coupling is stable. It was this finding that first allowed scientists to explain various atomic properties, such as the mirror symmetries and torques, of many stable and radioactive nuclei.

Later, Jensen and Goeppert-Mayer collaborated to explain the properties of lighter atoms, and they published these findings in 1955 in the book “Elementary Theory of Nuclear Shell Structure”. In 1963, they were awarded the Nobel Prize in Physics for their findings, along with Eugene Wigner. Heidelberg University, where Jensen worked from 1949 until his retirement in 1969 belongs to this day to the most prestigious research institutions in atomic physics. Students can complete an international master’s program here, and in addition there is also a graduate school for fundamental physics. In 2008, on the hundred-year anniversary of Jensen’s birth, the first annual J. Hans D. Jensen Prize for outstanding theoretical physicists was awarded. Among other things, the prize funds a visiting professorship for internationally recognised scientists at Heidelberg University.

Observing and understanding evolution

How do new species evolve? Since the days of Charles Darwin biologists have sought to understand how new species evolve. Axel Meyer, professor at the University of Konstanz, is among those contemporary evolutionary biologists who are retracing Darwin's footsteps with modern molecular methods. Meyer, a zoologist by training, has chosen as his subject the cichlids of East Africa's Great Lakes and Nicaragua's crater lakes. "These fish are a prime example of the imaginativeness of evolution," Meyer observes. "In Lake Victoria alone 500 different species have evolved in less than 100,000 years." In the crater lakes of Nicaragua there are species of cichlids that are found only in a single crater lake, which is less than 2,000 years old.

B11 | **Axel Meyer, University of Konstanz**

www.evolutionsbiologie.uni-konstanz.de/index.php?section=10 | www.broadinstitute.org/models/tilapia

How the genome controls the diverse shapes and colours of cichlid fishes

For all these species to survive, they must adapt. “There are one-of-a-kind eating specialists that only crack snails,” Meyer explains, “while others pick out the eyes of bigger fish or eat their scales. Some of the cichlids in Lake Malawi and Lake Tanganyika are similarly specialised.” For this reason it was thought that all the snail-cracking cichlids from the Great Lakes region were closely related. However, genetic testing showed that the different varieties within each lake come from just one common ancestor. In other words, they are more closely related to each other than to similar cichlids in neighbouring lakes, showing that these astonishing adjustments originated independently on multiple occasions.

Physical characteristics are therefore not a reliable indication of the evolutionary relationships between living beings – so Meyer’s conclusion, adding, “Evolution repeats itself, and in so doing follows evolutionary biological and genetic laws that depend on ecological factors.” It is this connection between evolutionary biology and genetics that the biologist from Konstanz is now tracking down using the latest methods of genome research. For instance, his team is part of an international consortium seeking to learn more about the cichlid genome. “We are also looking for genes that determine the shape of the lips and teeth of the fish or influence their social behaviour,” adds Meyer. Even standard methods are useful, such as classic breeding experiments with different species of cichlids, hundreds of which Meyer keeps in his aquaria. Fresh supplies of test subjects are sourced during diving trips in the African and Nicaraguan lakes, because, as Meyer notes, “To understand the fish, I need to observe them in their natural habitat.”

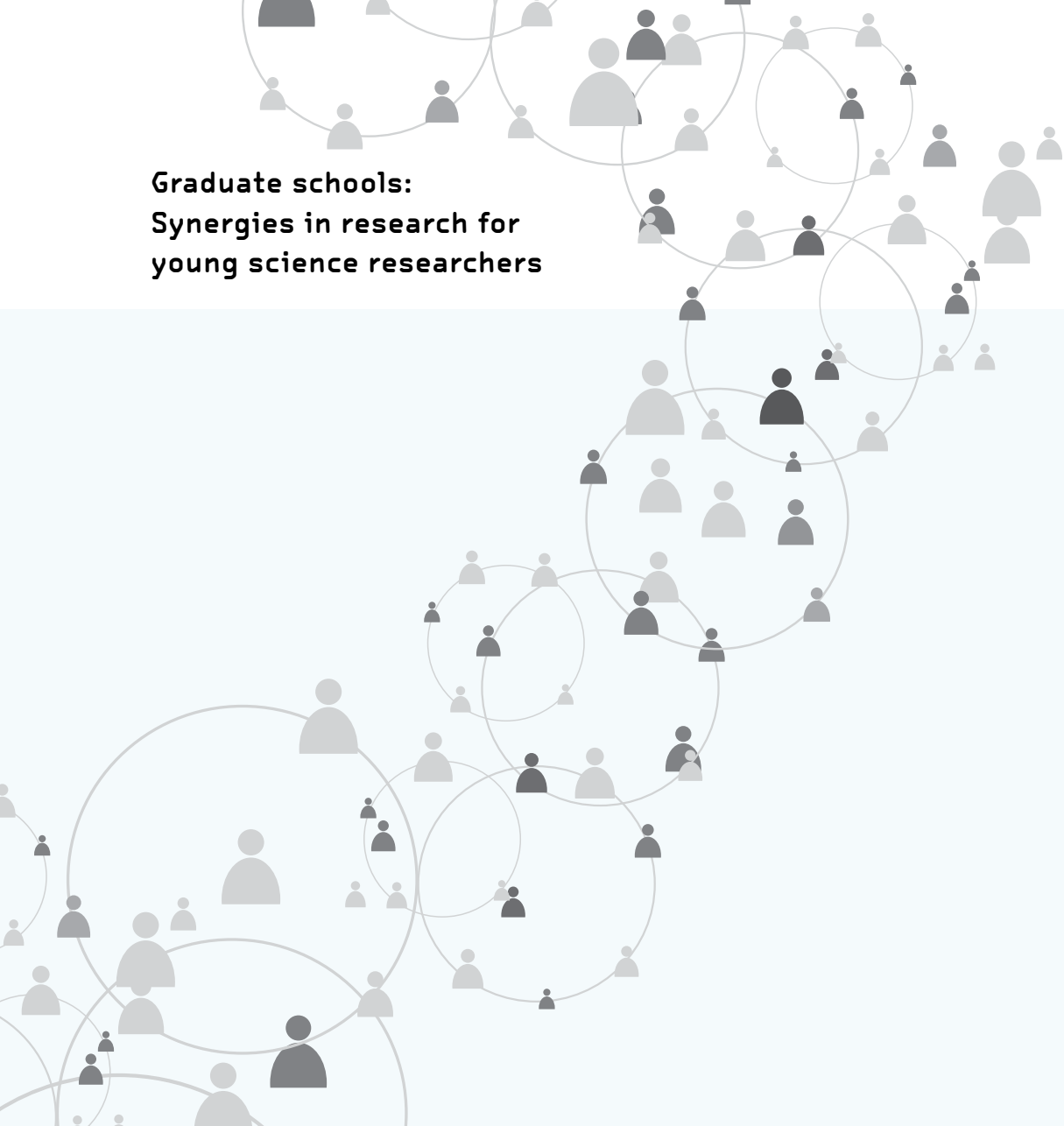
Excellent cooperation

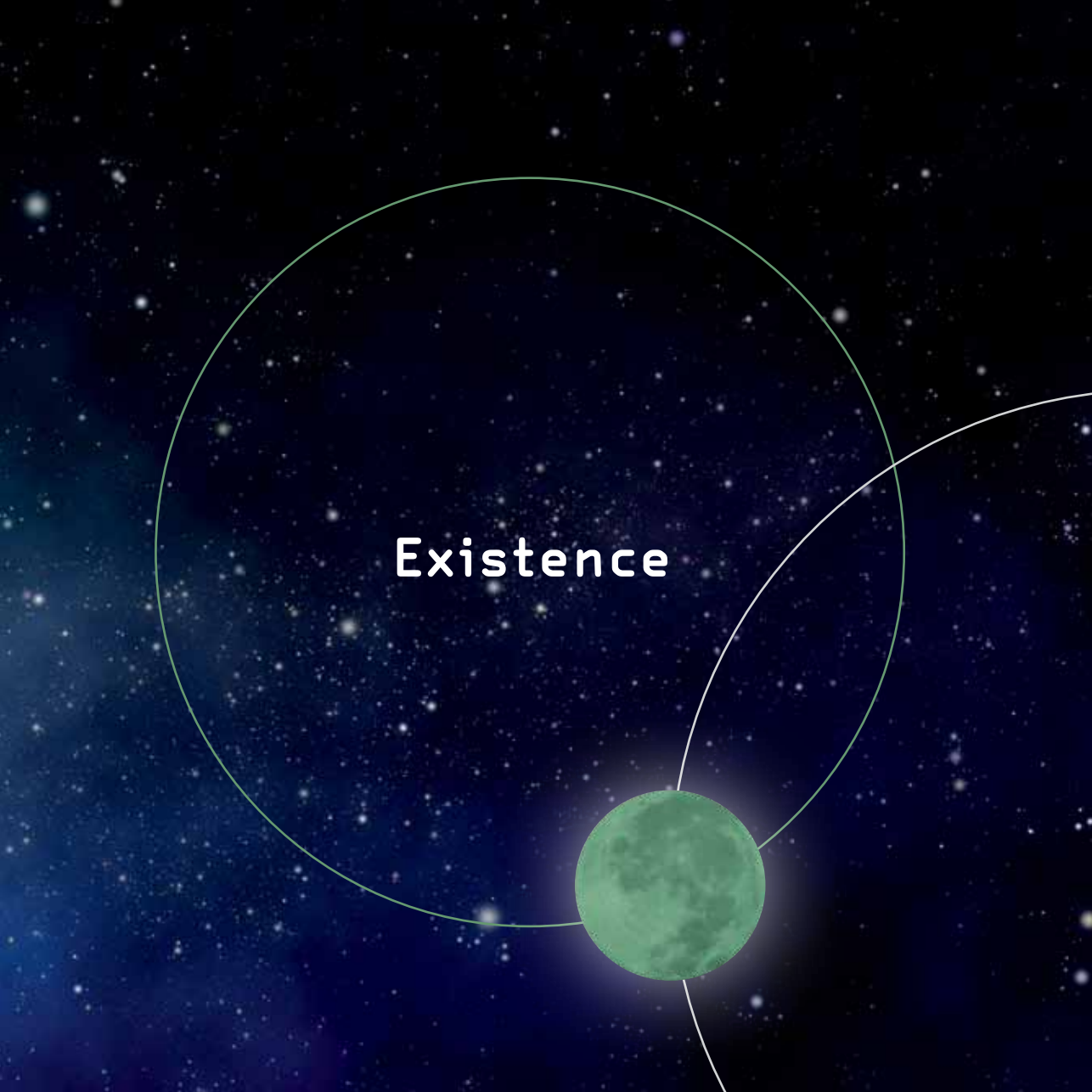
"Strength in numbers" was a slogan that summed up the student protests of 1968. It meant that the revolution would only be brought about by concerted action. And what is basic research, if not an attempt at a (knowledge) revolution? Cutting-edge research is increasingly being conducted in clusters and schools.

This research encompasses examining high mass stars that refract light like a lens, terahertz rays that can test substances or recognise tumours, and many other important topics. The Bonn-Cologne Graduate School of Physics and Astronomy (BCGS), for example, is a collaboration between the universities of Bonn and Cologne to conduct cutting-edge research in theoretical physics. Recently, it has wrestled with how to understand the formation and structure of the world in its entirety.

The Graduate School of Systemic Neurosciences (GSN) is an institute at the Ludwig-Maximilians-University Munich that encompasses the neurosciences, psychology, electrical engineering, and theoretical biophysics, enabling an integrated approach to research into highly complex brain processes. Every year, each of these graduate schools accepts 25–30 outstanding national and international bachelor's and master's degree holders from various disciplines to enter its doctoral programme. High-calibre bachelor's graduates can complete their PhD degrees within four years in the PhD fast-track programme. The best are also awarded generous fellowships. Since 2007, both graduate schools have received funding from the Excellence Initiative of the German Research Foundation.

Graduate schools: Synergies in research for young science researchers




Existence

The examples of research showcased in this section share the objective of improving our existence, whether through expanding medical treatment options, reducing the impact of diseases, or developing and improving diagnostic methods.

Feodor Lynen's discoveries on diabetes have helped to combat a veritable epidemic. Zur Hausen's finding that cervical cancer is caused by viruses has facilitated prevention through targeted immunisation programmes. Advances in minimally invasive surgery have led to improved success rates and faster recoveries for patients. Renewable cartilage has allowed patients who had previously been impaired in their movements, despite undergoing complicated operations, to live symptom-free lives. Researchers in Aachen are developing a retinal implant that offers blind people a certain degree of vision, and in Cologne, researchers are exploring the use of carbon monoxide to heal wounds.

Humans are more than mere matter, however. Through hermeneutics, a methodology for holistic understanding and interpretation, philosophers in Freiburg are using psychological insights to complete our knowledge of the physical underpinnings for our existence.

A ray of hope for the blind

A retinal implant from Aachen helps people regain partial sight

First colours and contrasts fade, then the field of vision begins to shrink. Finally the world turns to night – forever. This inexorable loss of sight can be the result of a genetic disorder named retinitis pigmentosa. More than three million people worldwide suffer from this incurable condition, which destroys light-sensitive retinal cells, although the neurons in the retina remain partially intact. This is where electrical engineer Wilfried Mokwa's completely novel visual prosthesis comes into play.

High-tech wireless glasses with a built-in camera record the image data and send it wirelessly to a chip placed inside the retina. The chip then transmits the received signals via electrodes to the nerve cells, stimulating the remaining healthy nerves. As a result, contours in one's surroundings become more clearly visible. The feasibility of this concept has been proven using a simple visual prosthesis of 25 electrodes developed by Mokwa. Six completely blind patients allowed the prototype to be implanted for a four-week trial period – and those patients were able to recognise wirelessly transmitted test signals as bright spots.

Ongoing research on the retina implant focuses on refining the coupling of the electrodes with the nerve cells. "This can only succeed once we know more about the spatial structure of the degenerated retina. If photoreceptors die off as a result of progressive retinitis, then the interconnected nerve cells begin the process of rewiring. We want to capture this neural restructuring, so that we can tailor the design of our system accordingly," Mokwa explains. Biologists from the Forschungszentrum Jülich and doctors from the university hospitals in Aachen and Essen are supporting this research.

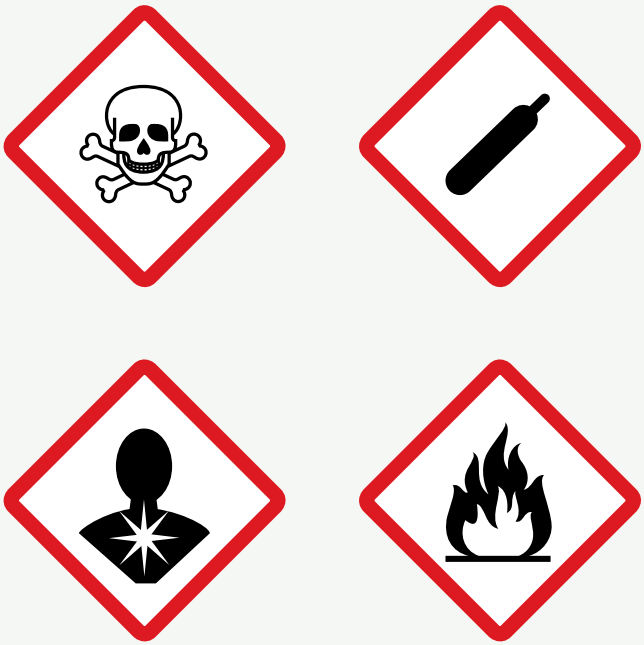
A poison that heals

Pinch your finger, and you will see it immediately: a fleck of black-and-blue. Soon it turns green, then yellow, and eventually it disappears. Heme oxygenase plays a role in all of these stages; this naturally occurring enzyme breaks down blood in the damaged tissue while simultaneously releasing a beneficial gas. That gas is carbon monoxide (CO), and it prevents the affected cells from dying.

This colourless and odourless gas is more commonly known for its lethal effects. When inhaled, it enters the bloodstream and obstructs the supply of oxygen, resulting in suffocation, but the danger is in the dosage size. Applied in small amounts in the right places, carbon monoxide can have healing powers. It can act as an anti-inflammatory and a vasodilator, and it helps stimulate circulation.

Hans-Günther Schmalz of the Institute of Organic Chemistry at the University of Cologne explains: "Unfortunately, our systems are only able to produce the necessary amounts of carbon monoxide in the same place where haemoglobin is broken down: the red blood cells." The chemist is certain that other cells and tissues could also benefit from the healing power of this molecule. Thus, his goal is to introduce the gas into the body without poisoning it. Elaborating on the concept, Schmalz said, "We've engineered molecules that contain iron, which can form bonds with carbon monoxide that are initially stable. Only when they reach a cell, where the bonds are broken down by enzymes, do they release the carbon monoxide." The new molecules offer a range of possibilities for therapeutic applications. Currently, kidney specialists are testing carbon monoxide's capacity to protect organs intended for transplant, while dermatologists are examining its healing effect on burns.

Chemists want to treat illnesses with carbon monoxide



The Methuselah method

Using adult stem cells to prevent age-related disorders

Brain cells and internal organs age and either gradually or suddenly cease to function as in the case with Alzheimer's disease or coronary malfunctions. The human body contains its own so-called adult stem cells (AS). Adult stem cells contribute to the preservation and regeneration of our tissue and organs throughout our lives. However, adult stem cells show signs of age and eventually lose their functionality, leading to decreased organ function in old age.

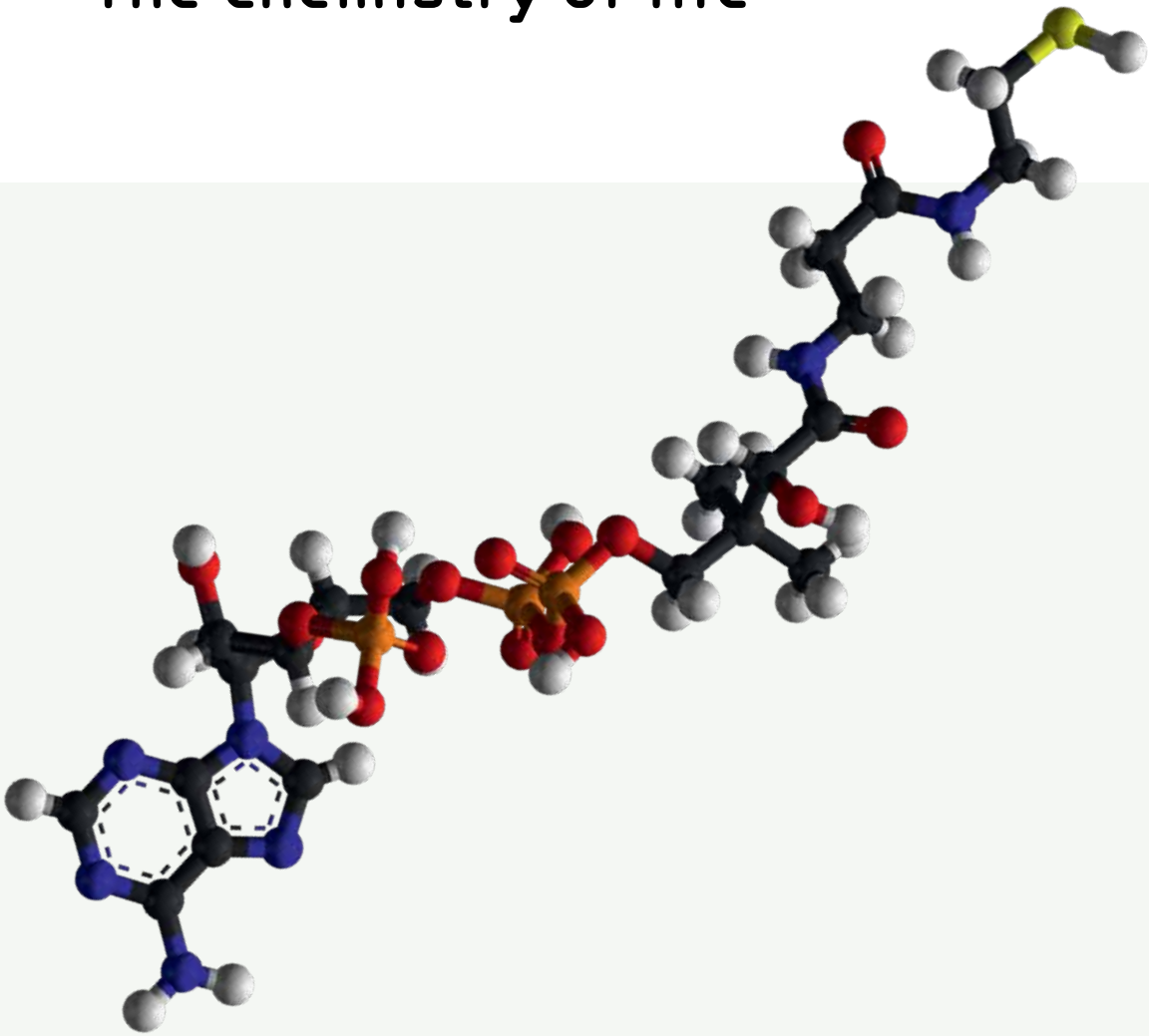
The research group led by Karl Lenhard Rudolph at the University of Ulm wants to understand the mechanisms that lead to this loss of function in AS. Pharmacologically viable substances, able to support cellular regeneration, could be developed as a result of the findings. Adult stem cells have a great advantage as they are found in almost all organs and can, unlike normal cells, reproduce and renew themselves. Unlike embryonic stem cell implantation, there is no need for risky cell transplant operations.

Rudolph has just scored a first coup: he has discovered that a specific signal molecule restricts the functioning of adult stem cells as they age. His team has developed several drugs that seek to keep this molecule in check. Rudolph states, "Now we want to see whether we really can prolong the functioning of different types of stem cells in this way. Failing that, we could develop medicines for diseases which are caused by an organ's limited regenerative capacity." As we face the challenge of aging populations, the importance of this research is continuously increasing. In recognition of his work, the doctor has been granted the renowned Leibniz Prize.

C3 | **Karl Lenhard Rudolph, University of Ulm**

www.uni-ulm.de/home2/presse/aktuelles-thema/stammzellenalterung-06122008.html

The chemistry of life



Nobel laureate Feodor Lynen investigated biochemical processes in humans

Diabetes, heart attacks, and strokes are so widespread globally that they could be referred to as the epidemics of the 21st century. Their causes are rooted in metabolic processes. Understanding these diseases, and others like them, has been a major focus of research since the middle of the 20th century. At that time, biochemists from all over the world were studying metabolic processes. One of these processes involved activating acetic acid in such a way that made it possible to track changes going on within the body.

In 1951, Feodor Lynen's experiments at the Ludwig-Maximilians-University Munich led to a breakthrough in this area. He managed to isolate activated acetic acid from yeast cells. This "acetyl coenzyme A" is involved in many metabolic processes. Its discovery started with Lynen's hunch that acetate residues could be bound together using sulphur. He confirmed this through experiments and proved the existence of acetyl coenzyme A. The report of his research findings was comprised of just one single, highly controversial page. He became an internationally renowned researcher practically overnight. His discovery laid the foundations for clinical research into lipid metabolic disorders such as the origin of diabetes mellitus and arteriosclerosis.

Lynen felt it was appropriate when he was awarded the Nobel Prize in 1964 (alongside Konrad Emil Bloch). He certainly tried everything in his power to sway his luck. He never had the intention of founding a school, yet that is exactly what happened. Many of his students became professors at universities and Max Planck Institutes. The "Lynen School" very soon had campuses all over the world.

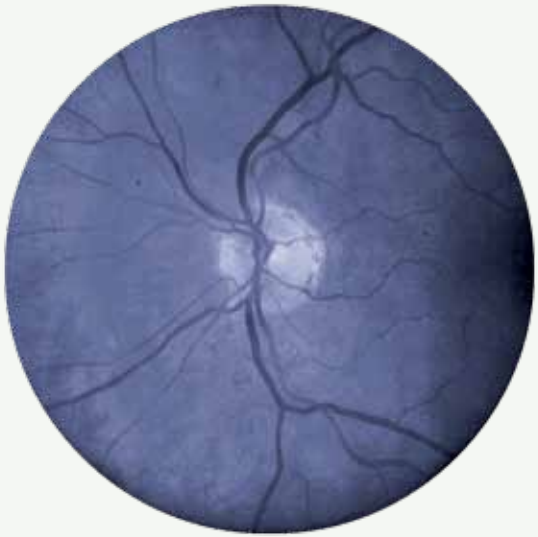
Early diagnosis and treatment at a glance

Until now, a diagnosis of Alzheimer's disease has signified a lost battle against time. The illness may have been developing over the course of two decades before it actually manifests itself; the brain can compensate for the loss of cells for a long time before the first signs are noticed. By this time, a third of the brain's cells may have been destroyed, and, at this stage, the disease can no longer be halted. For each individual – and for their friends and relatives – the diagnosis represents a catastrophe. This is set to change. The department of Translational Brain Research at the German Center for Neurodegenerative Diseases (DZNE) in Munich is working on new diagnostic and therapeutic procedures.

Neuropathologist Jochen Herms and his team are on a promising path toward early detection of the disease. In the future, a glance into a patient's eye or nose could make all the difference. Herms' theory is that abnormalities found in the retinas or the olfactory epithelium of Alzheimer's sufferers display abnormalities that then can be used to infer corresponding processes within the brain. This can be done long before the typical symptoms of Alzheimer's manifest themselves. Using mice that have been genetically modified to have Alzheimer's disease, researchers are simultaneously examining the pathology of the retina, the olfactory epithelium and cortex in vivo as the disease progresses. The aim is to enable doctors to start treating the disease before irreversible damage occurs – so that a diagnosis does not necessarily preclude all hope of a recovery.

This research is accompanied by studies conducted at the Clemens Schöpf Institute of the Technische Universität Darmstadt to identify fluorophores that make abnormalities in the retina or the olfactory epithelium observable through the use of laser scanning and other optical devices. Optics companies such as Carl Zeiss Jena and Karl Storz AG are currently developing such equipment.

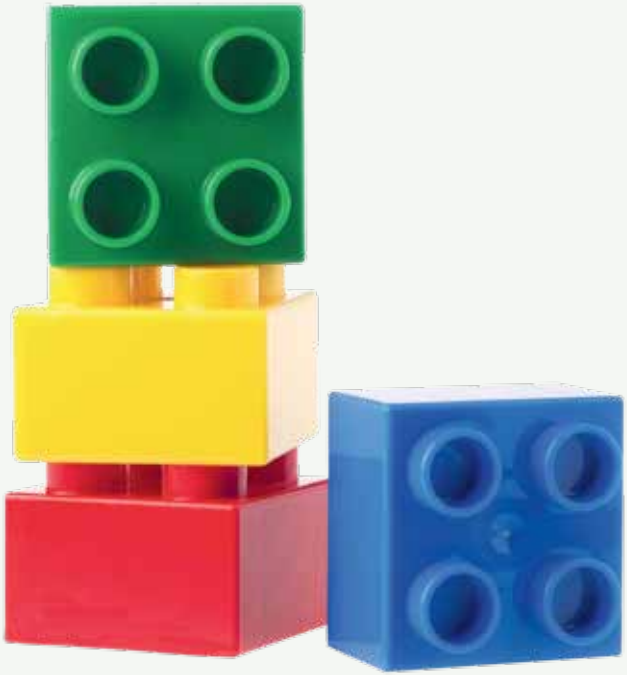
The development of new optical diagnostic methods for the early detection of Alzheimer's



C5 | Jochen Herms, Ludwig-Maximilians-University Munich

www.dzne.de/standorte/muenchen/forschergruppen/herms.html | www.neuropathologie.med.uni-muenchen.de

Tracking life



C6 | Michael Reth, University of Freiburg | www.bioss.uni-freiburg.de/cms/index.php

Using a new method to analyse biological signals

How do living cells work? Where do they get their energy from, when do they divide, and why do some mutate and become cancer cells? If you are looking for answers to these questions, you need to study biological signals, as they regulate all vital processes within and between cells. “Many diseases such as cancer or rheumatism occur due to misdirected signalling processes. A better understanding of the correlations could revolutionise medical diagnostics and therapy,” Michael Reth says. The biologist is the spokesperson and founder of the BIOSS Centre for Biological Signalling Studies, one of the Clusters of Excellence at the University of Freiburg, whose motto is “Moving from analysis towards synthesis.”

Biological signalling structures are highly complex. To investigate them, the Freiburg-based scientists are utilising a new kind of research strategy: instead of just analysing every component within a process, they are concentrating on the most crucial ones in order to create simplified model systems. Furthermore, they are developing artificial molecules with which they are able to manipulate and uncover signalling paths in a targeted way. This approach originated in the field of synthetic biology, a new branch of the life sciences. The University of Freiburg was the first to have a professorship in this discipline, supplemented by an assistant professorship of synthetic biology and signalling processes. “This combination of subjects is unique in the world and the ideal opportunity to define the essential characteristics of a signal process,” emphasizes Reth.

Numerous biologists, chemists, and computer scientists who now work within the Cluster of Excellence came to Freiburg from Asia, the United States, and other European countries. The centre’s BIOSS junior professorships and the Spemann Graduate School of Biology and Medicine help to attract young scientists.

Bold new remedies

Cartilage damage in the knee is a common injury, as the knee must carry the weight of the entire body. It has to endure extreme stress during sporting activities, and may be submitted to constant stress as if a person is overweight. The knee joint is covered by firm but flexible cartilage tissue. If this cartilage is ever damaged through an accident, competitive sport, or even simple wear and tear, it can no longer protect the joint – it wears out.

Michael Sittinger and his colleagues at the Charité have been attempting to find a cure using special attractants. These are inserted into the knee to "lure" healthy cells from the bone marrow into the surrounding cartilage, and from there to the exact location of the injury. To this end, a kind of nest, into which the healthy cells can settle, is constructed in the laboratory. This nest consists of numerous small, artificial fibres and looks rather like a ball of wool. Its structure serves to stabilise the cells and causes them to grow in all directions and ultimately fix into place.

An additional attractant is used to ensure that healthy cells will later make their way into the "ball of wool". Like bees to nectar, it is meant to draw intact stem cells from the bone marrow to the cartilage. There, the stem cells are instructed to create cartilage cells, so that in the end, the entire ball will be filled with them. The ball is then surgically implanted in the knee. Because the nest structure of the ball is made of degradable fibres, it dissolves completely within a few months. The cartilage adheres to the knee joint, the injury is cured, and the knee can once again withstand stress. Athletes, overweight individuals, and health insurance companies are following this research work with great interest.

Doctors stimulate the growth of cartilage in the knee

C7 | Michael Sittinger, Jochen Ringe, Charité Berlin | bcrt.charite.de/index.php?id=101

Understanding and interpretation

. . . in the awareness of one's own limits and through the recognition of the other in his unfamiliarity

Hans-Georg Gadamer | Sein, das verstanden werden kann, ist Sprache

Hermeneutics of Hans-Georg Gadamer

Hans-Georg Gadamer is regarded as one of the leading figures in philosophical hermeneutics. A student of Husserl and Heidegger, Gadamer argued in his major work "Truth and Method" (published in 1960) that, in principle, hermeneutics can apply to ethical and aesthetic questions and issues in any area of life. According to Gadamer, numerous forms of knowledge and behaviour can themselves be described as acts of understanding and interpretation, a view which exerted a strong influence on literary hermeneutics and on the arts and humanities.

Gadamer engaged in intense debates with Jürgen Habermas and Karl-Otto Apel, examining whether the acceptance of a truth arrived at through consensus was not in fact naive, due to the fact that it may underestimate power structures that are not made apparent through dialogue. This debate was a rare example of academic opponents taking the arguments of their critics seriously and using them productively to further develop their own theories. Gadamer's influence on Habermas's concept of discourse free from constraint or coercion is unmistakeable. Today, Gadamer's influence is still seen in the writings of the philosophy of scepticism and in the work of his students.

It was Odo Marquard, a representative of philosophical scepticism in the tradition of Gadamer, who put it so aptly: "The philosophers of history, in various ways, have only changed the world – what matters is sparing it; the way to spare it that brings about the most change, however, is through interpretation."

A vaccination against cancer

Viruses as the trigger for cervical cancer

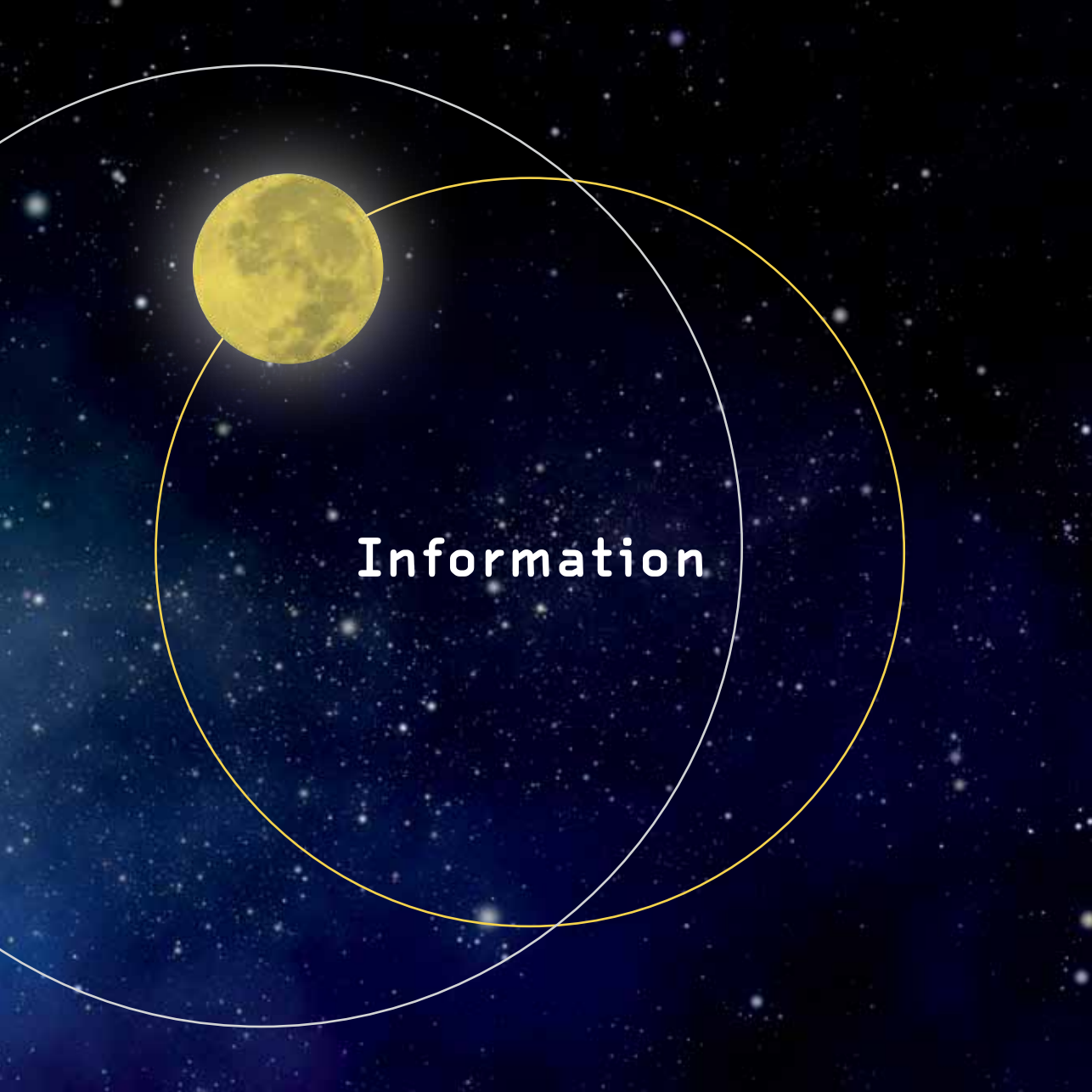
Cervical cancer is recognised to be the second most common malignant tumour in women worldwide. It was the physician and biologist Harald zur Hausen who discovered how malignant cell growth, and consequently cervical cancer, comes about.

Harald zur Hausen focused his research on the role that viral infections play in the development of cancer. Previously, medical opinion had excluded the possibility that viruses could trigger the onset of cancer. By 1974, zur Hausen had published a hypothesis claiming that the human papillomavirus (HPV) could contribute to the development of cervical cancer. In the early 1980s, he and his team at the University of Freiburg succeeded in substantiating this hypothesis when they were able to isolate HPV types 16 and 18 in cervical cancer tissue. This discovery opened new perspectives for prevention and treatment.

In 2006, a usable vaccine was developed from the surface proteins of the virus particles allowing young women to protect themselves against life-threatening growths. For this accomplishment, zur Hausen was honoured in 2008 with the Nobel Prize for Medicine. Today zur Hausen believes that viruses and other pathogens can cause various malignant tumours: “Infectious events probably play a much bigger role in carcinogenesis than previously thought,” says the doctor. From 1983 to 2003, he headed the German Cancer Research Center in Heidelberg and “encourages young researchers to pursue this track further.”

C9 | **Harald zur Hausen, University of Freiburg**

www.nobelprize.org/nobel_prizes/medicine/laureates/2008/hausen.html


Information

Information has come to be regarded as the most important resource for value creation and quality of life. It is therefore essential to understand information and utilise it efficiently and effectively. The first aspect of information to consider is how it is created: facts can be turned into data through investigation, data can be turned into information through understanding knowledge can be produced by integrating information into existing structures, and adding up-to-date information to knowledge by intelligently linking means and ends can produce action. A second aspect of information is its usage as a resource – how it is transmitted and disseminated. This encompasses data collection, storage, and transfer, as well as the exchange of knowledge through communication. A third aspect is the rational, efficient, and ethically responsible use of information.

This section is only able to cover some of these topics as representative examples of research conducted at universities in Germany. How the brain makes decisions, and which stimuli are processed in order to do so, is being investigated by neurobiologists and philosophers at the Berlin School of Mind and Brain. In Bremen, neuroscientists are enquiring into whether human free will is simply an illusion. Four of the articles focus on the use of new techniques to collect, transport, disseminate, and protect data – accuracy, speed, and security come into play here. Other articles address innovative applications of information, for example, in analytical chemistry, brain surgery, business process optimisation, and intercultural communications. German universities are often global leaders in this type of research.

Common spirit

"Complex questions about the way the human brain works can no longer be answered by just one academic discipline," says Michael Pauen, from the Department of Philosophy at the Humboldt-Universität zu Berlin. He and the neurologist Arno Villringer, director of the Max Planck Institute for Human Cognitive and Brain Sciences and professor at the Charité Berlin, are the academic directors of the Berlin School of Mind and Brain.

The joint appointment symbolises the idea behind this graduate school, which is dedicated to research at the interface between mind and brain. It is committed to the very biggest questions: What is consciousness? Who is it doing the thinking? Is it just the sum of our neurons and how they interconnect inside our brain? Or is there something else behind it, beyond the boundaries of neuroscience? Must we give up the belief that we can think and act for ourselves?

Students at the Berlin School of Mind and Brain receive a well-founded education in neuroanatomy and imaging, as well as in philosophy and linguistics. They are supervised by two professors – one from the mind sciences and one from the brain sciences – to ensure their interdisciplinary PhD project is successful. "That exists nowhere else in the world," Villringer emphasis. A total of 60 researchers are involved, including philosophers, psychologists, linguists, biologists, and physicians. The six main areas of research are decision-making, perception, language, neuroplasticity and ontogenetic brain development, brain disorders and mental dysfunction, and social cognition.

Philosophers and neurobiologists are investigating our brain

A question of will?

A new look at old questions

Certain questions occupied Gerhard Roth, professor at the Brain Research Institute of the University of Bremen, even as a schoolboy. What is the mind? Where does perception originate? Why is man conscious of himself? He sought answers as a student of philosophy in Münster and Rome. “It was there that I learned everything about what intelligent people from Plato to Kant and Hegel thought – but no one could tell me who was right,” recalls Roth.

So Roth made his way to other disciplines. He was particularly influenced by the work of biologist Bernhard Rensch and psychologist Wolfgang Metzger. Rensch had investigated whether chimpanzees were capable of planned behaviour, while Metzger, a leading Gestalt psychologist, showed how our perception of the world is defined by our senses. Roth was unable to pursue these intellectual approaches further in the Faculty of Philosophy, so he began to study zoology in addition to philosophy. He earned doctorates in both subjects and now encourages young scientists to take an interdisciplinary approach to their work.

Roth explores the existence of free will. “Psychologists and neurobiologists are agreed that all human activity is driven by conscious or unconscious motives,” he says – recognising, of course, how this contradicts the idea of free will as postulated by Immanuel Kant. In terms of everyday life, Roth refers to the words of Scottish philosopher David Hume: a person feels free if he is able to do what he wants. That said, the Bremen scientist realises that findings from brain research present a dilemma for the criminal justice system. Legal systems are still predicated on Kant’s concept of free will, and it forms the basis for establishing the criminal liability of an offender. But neurobiological findings demand at least a re-examination of this premise. Roth thus observes that “more and more legal professionals question whether the concept of criminal liability remains a valid principle”.

A magnet for particle physicists

D3 | Wolfgang Paul, University of Bonn | www.pi.uni-bonn.de/aktuelles/wolfgang-paul-vorlesungen
www.pi.uni-bonn.de/aktuelles/wolfgang-paul-vorlesungen/wolfgang-paul-biographie

To this day, the University of Bonn still benefits from the work of Nobel Prize winner Wolfgang Paul

In order to analyse unknown substances, ions (electrically charged particles) can be used to make their characteristics visible. But first, those ions need to be "trapped". A "Paul trap" can be used to capture, store, and subsequently release the ions. To do this, it is necessary to know their magnetic moment. Depending on the type of interacting fields, the ions can be trapped in isolated groups or all together in a quadrupole field.

The physicist Wolfgang Paul was a pioneer in the field of particle physics and mass spectrometry. As director of the Physics Institute of the University of Bonn, he and Helmut Steinwedel developed the quadrupole mass filter in 1953.

George Stafford further developed the ion trap to create the Paul trap in 1983, whereupon the technology was adopted in the analytical chemistry field. This invention went on to play an important role in the development of the quantum computer, but is mainly used for analysing substances in ion trap mass spectrometers. In 1989, the invention of the ion trap earned Paul the Nobel Prize in Physics, an honour he shared with Norman Foster Ramsey and Hans Georg Dehmelt. He also received numerous national and international awards. Paul donated half of his Nobel Prize money to establish a foundation for the promotion of international relations in science, which allows for outstanding physicists to be invited to Bonn.

Computer programme is the key to success

Complex and dynamically interrelated processes are constantly at play in businesses. These information, communication, planning, control, and monitoring processes ultimately represent added value. Often, however, they are not clearly organised, have been implemented in an ad hoc manner, or are the result of historical developments. They are difficult to understand and generally not coordinated in the most effective way. It is a long-held dream within business economics to one day be able to perfectly design systems that tend to be chaotic – what Otto Schnutenhaus once defined as the "maximum overall safeguarding of interactions".

Turning that dream into a fundamental and universally applied reality was the lifelong research aim of August-Wilhelm Scheer. He became famous as the designer of the Architecture of Integrated Information Systems, or ARIS. Now the basis of many of today's software products, the ARIS model facilitates the analysis, control, and optimisation of business processes. It was developed at the Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) at the Saarland University. In order to transfer his principle of business-process modelling into real-world settings, he founded the company IDS Scheer (Integrated Data-Processing Systems) in 1984. It rapidly conquered the markets, becoming a world leader within just a few years. IDS, once listed on the German stock exchange, was acquired by Software AG in 2010.

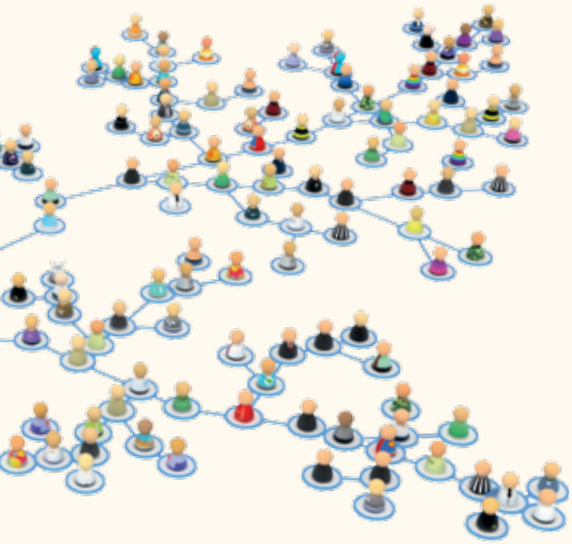
Scheer was named "Entrepreneur of the Year" and was awarded the Philip Morris Research Prize, the German Federal Cross of Merit 1st Class, and many other honours.

Software facilitates control of business processes

In the privacy of the World Wide Web

When tens of thousands of protestors in Egypt, Tunisia, and Syria took to the streets in 2011 they made use of technology that had been developed almost 2,000 kilometres away, in the German city of Darmstadt. There, Thorsten Strufe is a junior professor at the Technische Universität and says, "We are developing software here with which people can communicate anonymously on the internet." People living in authoritarian states, who fear repression from governments or other organisations, have used tools like these to exchange personal information safely.

Programming of a secure social network



Strufe is Chair of the P2P Networks Group at the TU Darmstadt. He and his team are working on a particularly exciting subject: he is seeking to establish a genuinely secure online social network. In terms of security, there are two disadvantages to systems like Facebook. First, confidential data is stored on a small number of networked servers. Whoever manages to crack the system can easily access sensitive data about millions of people. Second, the administrators of social networks often collect enormous amounts of information about their members, enabling them to broadcast private interests, contacts, and preferences.

This is why the Darmstadt scientists are pinning their hopes for privacy on decentralised networks. Such networks allow data to be shared between several computers according to the peer-to-peer principle. Each user profile is encrypted only on the user's own computer and the profiles of his or her friends are stored. This approach allows each individual to decide how much of her or his private information to disclose. The early version of this system was developed as "Safebook" by the researchers; improved versions of the system are now in use.

Surfing the information superhighway safely and quickly

Computer scientists are designing the internet of the future

Imagine the kind of chaos that would ensue on our motorways if drivers were unable to see the length of their route or their destination. This sort of confusion often reigns on the internet. Individual packets of information have no control over which road they take along the information superhighway. This means that users in Hamburg might download data from Beijing that would have also been obtainable from somewhere near their own city. As millions of people surf the World Wide Web, make telephone calls, and upload photos to social networks, the internet becomes ever more congested.

That is why Anja Feldmann, head of the Intelligent Networks and Management of Distributed Systems department at the Technische Universität Berlin, is developing the internet of the future. The computer scientist's research involves analysing how many people access which sort of content and when, in order to anticipate bottlenecks in the system. One of her ideas is to divide the internet into different areas, each of which would meet different requirements in terms of security and speed. Users would like to remain anonymous when surfing, for example, but precise identification is necessary for online banking.

The system is being tested on the TU campus in Berlin-Charlottenburg. There are 46 transmitters on almost all of the rooftops, creating the biggest experimental platform for transmission networks in the world. Feldmann's research findings have already made the internet faster and safer. In 2011, she received the German Research Foundation's Leibniz Prize and €2.5 million in prize money for her work in the field.

The end of language barriers

An electronic super-translator

In Alexander Waibel's vision, international conferences in the future will look like this: participants will each be speaking in their own language but will, nevertheless, be able to understand each other – without an interpreter. The simultaneous translation will be provided by language software that not only knows the meaning of words but also recognises contextual meaning and translates idioms from one language into several others.

Waibel is a professor of computer science at the Karlsruhe Institute of Technology and at Carnegie Mellon University in Pittsburgh, USA. He also heads the International Center for Advanced Communication Technologies (interACT). Together with his interACT team – which includes scientists from Germany, the United States, Italy, Japan, and Hong Kong – he is working towards a world without linguistic confusion, interpreters, or inadequate translations. Their focus is a programme that uses statistics rather than linguistic rules. The software uses correct translations to calculate the frequency with which words and phrases in one language correlate with the parallel sentence in another. The software does this very efficiently by simultaneously searching through the internet, thereby utilising a virtually infinite number of texts. "After just three years of using this method, our system was better than any that had been fed language rules over a period of 20 years," says Waibel.

Simultaneous translation of live speeches, presentations, and lectures is already possible. Currently, the researchers are working on a total of 15 languages. The European Parliament has also shown interest in the program. In a demonstration of the translation system at the Parliament, the software was used to translate Waibel's speech into Spanish while human translators translated it into a further 23 languages. Waibel expects that machine translation of all 200 economically critical languages will be possible in 10 years' time. Thanks to language software, it will then be possible for all people to read the entire content of the internet. Waibel is convinced that "language barriers will fall."

How human are machines?

Investigating and developing artificial intelligence across disciplines

Machines that are able to think, or even feel, have always excited the imagination and are a fixture in most science fiction films. Global research on issues relating to artificial intelligence is similarly fascinating. One of the leading institutions in this area is the Center of Excellence Cognitive Interaction Technology (CITEC), established at Bielefeld University as part of the Excellence Initiative in 2007.

Scientists at CITEC focus on four research areas which each examine key functions of cognitive interactive systems: motion intelligence; attentive systems; situated communication; memory and learning. CITEC comprises around 40 research groups from the fields of computer science, biology, linguistics, mathematics, psychology, and sports science.

For Helge Ritter, CITEC coordinator and head of the neuroinformatics research group, it is this interdisciplinary approach that particularly distinguishes CITEC. “This focus has enabled us to develop a strong position internationally while also becoming one of the leading institutions working on improving the interface between humans and technology,” says Ritter.

One of CITEC’s core components is the Graduate School Cognitive Interaction Technology, which prepares 50 research fellows for academic careers. The Center also has a Virtual Faculty, consisting of renowned scientists from many different countries who hold research seminars, workshops, and conferences in Bielefeld.

Signposts throughout the brain

Computer scientists are developing navigational software for neurosurgical procedures

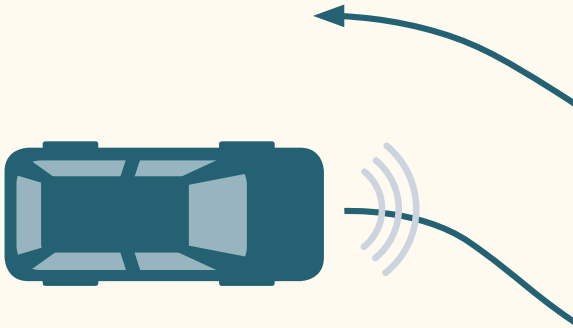
Incurable symptoms of Parkinson's disease, extreme types of movement disorders, headaches, and depression can all be eased by deep electrical brain stimulation. A brain pacemaker is implanted into the chest of the patient. From there, cables running under the skin direct carefully controlled electrical impulses through electrodes into diseased areas of the brain. This targeted stimulation is said to enable affected neurons to regain their original functionality.

The success of the operation depends on the correct placement of the electrodes. "We have developed computer-aided procedures to provide all the data required before and during open-brain surgery," says Peter Gemmar from the Institute for Innovative Informatics Applications at Trier University of Applied Sciences. These procedures allow for improved planning and safer execution of neurosurgical operations.

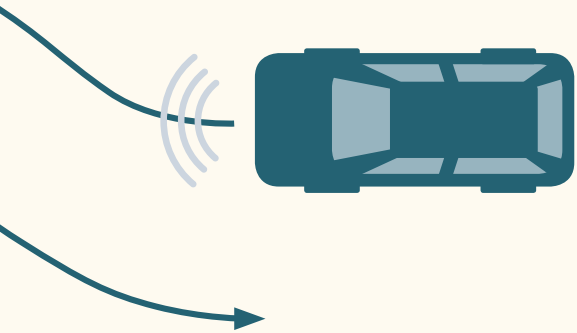
The software even analyses the nuclear magnetic resonance images. Gemmar's studies show that evaluating image data automatically is more efficient than a doctor's evaluation. "Our programme allows us to capture the individual characteristics of a patient's brain, which means we can assess the risks of different operations more accurately and suggest the best way to proceed through the brain," explains the computer scientist. Gemmar's software is also very useful during the operation. Once the surgeon has directed the tip of the electrode to the approximate target area, the ideal final position must be identified. In order to do so, the activity of the surrounding nervous tissue is directly recorded using specially developed measuring electrodes. The computer programme evaluates the recorded signal patterns more quickly than any scientist. Patients will soon be able to benefit from the software developed in Trier when it becomes part of an operation planning system.

Traffic controllers in outer space prevent collisions

A driver steers a car around a bend, but a traffic jam has built up immediately ahead. Perhaps the driver reacts a little too slowly and crashes. In future, this situation might have a better outcome: satellites 22,000 kilometres overhead can track the position of the car, while a computer in the car compares the data with the course of the road and radar sensors register obstructions. At the same time, radio contact with nearby vehicles enables the exchange of information about routes and speed. In an emergency, electronic assistants brake automatically or execute an evasive manoeuvre, even before the driver recognises the danger.



A satellite-based safety system for cars and trains



Dirk Abel firmly believes that “collisions can be avoided using satellite technology and car-to-car communication”. The head of the Institute of Automatic Control at RWTH Aachen University is working with his staff to develop a revolutionary vehicle concept. It is based on the Galileo satellite navigation system planned by the European Union. Abels aims to link location positioning information received from space to car steering and braking systems. In addition to intelligent vehicles, the Aachen team are also working on shunting robots that can move railway carriages on their own or apply brakes to trains.

Galileo is expected to be operational in 2018, but car and train manufacturers can already test their models under real-world conditions. Traffic situations are reconstructed on two road and rail track courses. Scientists have mounted the same satellite technology that will be used in space on poles surrounding these sites. It is even possible to simulate the movement of the satellites in orbit.

Excellence in many dimensions

"Try to explain to an extraterrestrial what music is, using only words. You could explain that it consists of vibrations which are produced by strings, for example, and amplified by a resonating body, and that these vibrations are perceived by means of sensory organs. Yet what does that really say about music? This is how difficult it is to convey what Hirzebruch has done for mathematics."

Don B. Zagier, Director of the Max Planck Institute for Mathematics in Bonn

Internationality stimulates top-level mathematical research

The University of Bonn is one of the most important centres of mathematical research and teaching. Its reputation is inextricably linked with the work of Friedrich Hirzebruch (1927–2012). Considered to be one of the most important German mathematicians of the 20th century, Hirzebruch worked on algebraic geometry, topology, number theory, and singularity theory. His signature theorem, the Riemann-Roch-Hirzebruch theorem, established his international reputation.

Hirzebruch strongly promoted the international networking of German mathematics after the Second World War. In 1957, he founded the international "Mathematics Workshop" (Mathematische Arbeitstagung). Hirzebruch set up a collaborative research centre for theoretical mathematics in 1969, which in 1980 developed into the Max Planck Institute for Mathematics (MPIM), headed by Hirzebruch until 1995.

In 2006, the Hausdorff Centre for Mathematics was established as part of the Excellence Initiative. It operates under the joint auspices of four of the university's mathematical institutes, the MPIM, and the Institute for Economics and Social Sciences. The Centre also includes two graduate schools: the Bonn International Graduate School in Mathematics and the International Max Planck Research School for Moduli Spaces (IMPRS). Born in 1927, Hirzebruch received numerous prestigious awards and prizes for his contributions to mathematics, and gave lectures and provide support to junior researchers he had supervised until his death in 2012.

Bundled information

At the Karlsruhe Institute of Technology (KIT), there was a flash of light. It lasted only a second, but it was a flash of lightning for science: in this second, 26 terabits of data, equivalent to 700 DVDs, were encoded onto a single laser and transmitted.

Advances in information and communications technology happen very fast, but keeping pace with rapidly growing volumes of data traffic remains a challenge. But German scientists are proving that it doesn't have to be this way. New options are emerging as a result of the most recent KIT experiment and other innovations in high-speed communications, according to Jürg Leuthold, head of the Institute of Photonics and Quantum Electronics and the Institute of Microstructure Technology at KIT. The KIT researchers encoded data on a single laser beam and transmitted them over a distance of 50 kilometres. After reaching its destination, the data was decoded. This was a world record in data transmission in 2011. Just one year later, the researchers at KIT have encoded 32 terabits per second on a laser beam and have sent them across 220 kilometres.

In order to achieve what was deemed a fantasy only a few years ago, the scientists employed the orthogonal frequency division multiplexing (OFDM) scheme. OFDM is new to optical communications but it has long been used in mobile communications. The challenge when using it in optical communications is the leap in speed. Optical signals typically operate at a speed 1,000 times faster than mobile communication channels and thus the processing has to be sped up accordingly. To execute the experiment, the KIT team has been supported by companies and scientists from all over Europe. The record is particularly exciting for virtual reality applications, cloud computing, and future 3-D television – and any area which requires huge bandwidths for optical transmission channels.

Large amounts of data are transmitted using laser technology

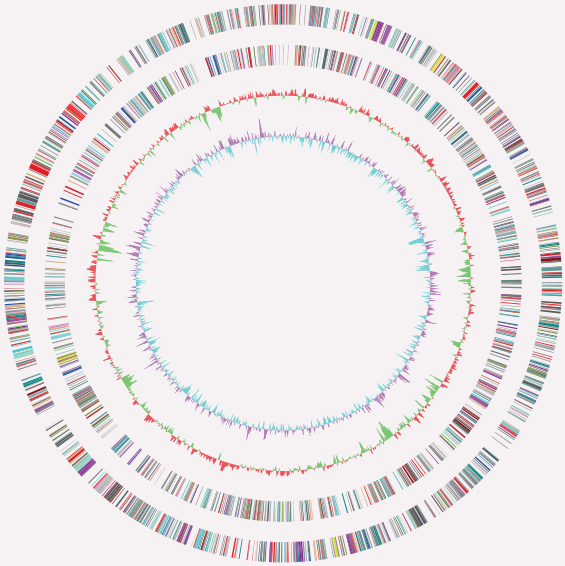

Responsibility

Our world has undergone profound changes. All around the globe, goods are being traded on a tremendous scale, high-tech factories are springing up in former developing countries, and the living standards in previously poor parts of the world are approaching those of industrialised nations. As welcome as this process may be for many people, it also demonstrates how destructive the effects of unbridled growth can be on the climate, soil, rivers, and oceans.

German researchers are working with partners from all over the world to combine the benefits of globalisation with sustainable development. Physicists from Kassel are working with British companies to build tidal power plants that will convert natural energy from tidal currents into electricity. Wastewater technicians from the Technische Universität Darmstadt are constructing factories that can enable growing cities to recycle wastewater and generate energy from sewage sludge. Legal specialists from Berlin are advising colleagues in Vietnam on how to transition successfully to a modern constitutional state.

Despite all the opportunities, many people are reacting with uncertainty to the new challenges. Sociologists Ortwin Renn and Ulrich Beck analyse how societal risks are perceived, exploring whether these risks can be measured and assessed. The researchers are looking for strategies to overcome fear of progress and the ‘tyranny of experts’. Their aim is to find a balance between security and speculation, competition and cooperation. Research must take on this responsibility, for the sake of both the environment and the growing global population.

When microbes hit the gas



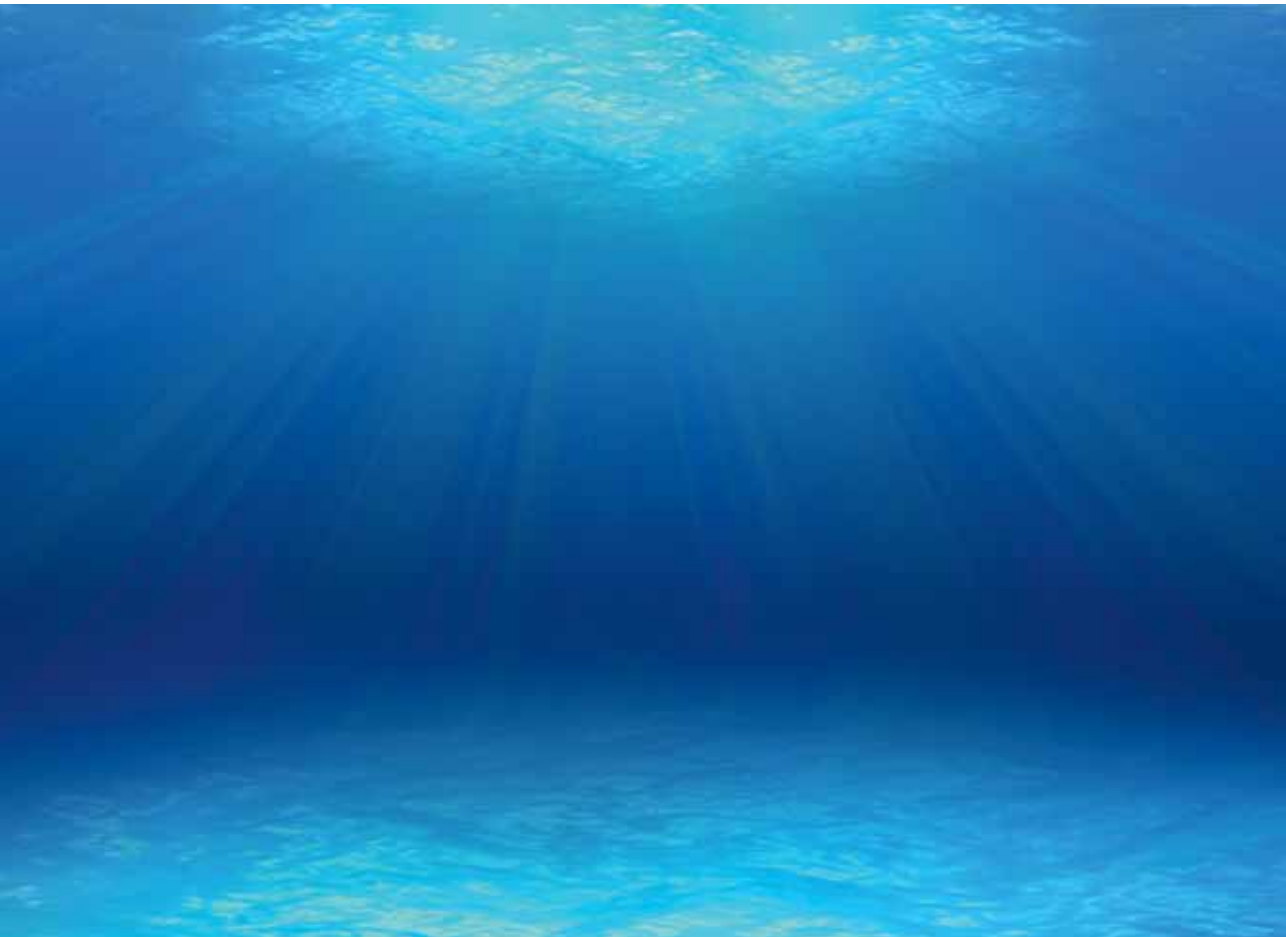
Microorganisms produce methane for power generation

Professor Alfred Pühler sits in his laboratory at Bielefeld University. Glancing into his light microscope, the microbiologist assesses his latest catch: microorganisms from a nearby biogas plant. There, the tiny creatures ferment maize plants, releasing methane. This gas is used for power and heat generation in a combined heat and power plant attached to the biogas facility. Pühler wants to know which microbes contribute the most to the fermentation process: “If we know who the key players are, then we can inoculate biogas plants with them in a targeted manner in the future, thus optimising power plant operations”.

Finding these players is no simple task. A biogas plant contains several hundred different microorganisms. Only a portion of these microorganisms is involved in methane production, to a greater or lesser extent. In order to track down the most important gas producers, the Bielefeld biologists first essentially capture the genetic material of the entire microbe community in one go. This approach is called metagenomic analysis. The complete DNA is then isolated and split into tiny fragments, each of which, in the final stage, is dissected into its basic components and analysed or “sequenced”. Pühler stresses that, “the real work lies in the evaluation of huge amounts of data by experienced bioinformaticians.”

The team discovered that the most important methane producer is a microbe of the genus Methanoculleus. The expertise required for its identification and the necessary equipment were provided by the Center for Biotechnology (CeBiTec) at Bielefeld University. An international graduate programme at CeBiTec also gives junior researchers the opportunity to carry out genetic analyses of genomes and metagenomes – not only of microorganisms, but also of all other living things, such as plants and animals.

Oceans of energy



Generating clean energy off the coast of Northern Ireland

Hot water rises in an electric kettle because its density is lower. The world's oceans are also in a state of constant movement. This is due to differences in temperature, differing salt content, and high and low tides. Why shouldn't the ocean's kinetic energy be used to generate electricity?

The first ocean current turbine was put into use for research purposes in the Irish Sea in 2003. It works like a wind turbine, only the 16-metre rotor blades are underwater. In contrast to wind turbines, energy supply can be easily predicted. We know what the tidal currents are, but it is difficult to predict how much wind there will be at a given time. Ocean current turbines are more efficient than wind or solar power. In full-scale production, power costs are estimated to be 5 to 10 cents per kilowatt hour.

SeaFlow, a German-British research project, is led by Jochen Bard, head of the Institute for Ocean Energy at the Institute of Wind Energy and Energy Systems Technology (IWES) at the University of Kassel. It was sponsored by the European Commission, the Federal Ministry for the Environment, and the British Department for Trade and Industry. Bard has been working on Project SeaGen, the successor to SeaFlow, since 2005. The aim is to produce commercially viable plants. The current research plant alone generates approximately 1.2 megawatts of electricity for 1,500 households. In Europe 12,500 megawatts of electricity are generated by ocean turbines each year.

E2 | **Jochen Bard, University of Kassel | www.iset.uni-kassel.de**
www.iwes.fraunhofer.de/de/projekte/projekte01.html

The risk assessor

How safe is safe enough? Even individuals find it difficult to answer this question in relation to their average day. How much more complicated is it, then, for a society as a whole to come to an agreement on which natural, technical, or financial risks it is willing to accept? Ortwin Renn, professor of technological and environmental sociology at the University of Stuttgart, is developing tools to aid in the assessment of such risks. His main aim is to create "a balance between risks, benefits, and uncertainties".

The biggest problem lies in the fact that neither experts nor lay people make rational judgements. A person with arachnophobia, for example, approaches the eight-legged creatures in a different way than would an interested zoologist. An engineer working in a nuclear plant feels less threatened by the possibility of a major nuclear incident than do large sectors of the population. While one side confidently claims that everything is under control, the other side's rejection is based on emotion and speculation. Ultimately, both groups are prejudiced. How can they engage, nevertheless, in a constructive discussion about risk?

An important question, as risks lurk everywhere: in spoilt food, chemicals, natural disasters, terrorism, and gene technology. Renn is trying to describe the diverse problems and phenomena in a way that is comprehensible to everyone. On the one hand, he is employing a classic method: the probability of an incident and the extent of the damage caused by that incident are multiplied in order to calculate precautionary limits for acceptable risk. At the same time, he is taking account of the potential of delayed and long-term effects, the linking of a number of causes, the faster spreading of effects in a globalised world, and the impact of threats on the psyche and on the social and cultural environment of humans. Independence and clear analysis are fundamental to the evaluation of problems. "Risk policy," according to Renn, "must protect itself from the dictatorship of experts as well as from populism, and has to balance the responsibility of the citizen and the state."

Social behaviour toward risk and decision-making

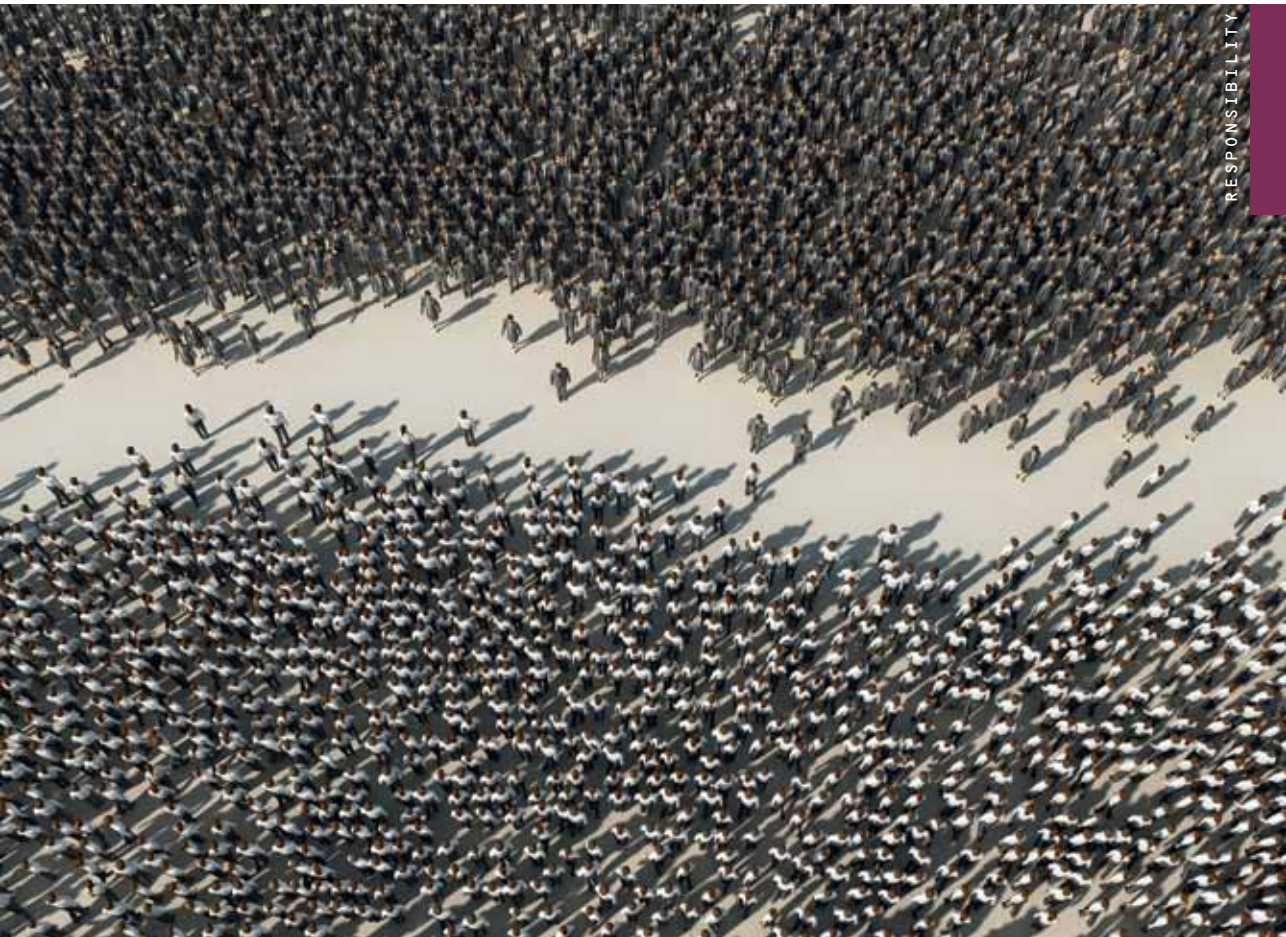
The grande dame of German sociology

Renate Mayntz moulded half a century of sociological research. Her research areas became important points of reference, be it macro theory, the analysis of political control mechanisms, comparative policy research, the organisational and administrative sciences, or the sociology of technology. Mayntz advised politicians long before it was fashionable to be a political advisor, and she set out clear rules: "One should present one's knowledge, and politicians must decide." Her understatement of her own influence reveals itself here; in practice, her advisory capacity encompassed more than just presenting academically sound arguments.

Mayntz worked in the Study Commission for Public Service Law Reform, belonged to the German Education Council, and was involved in the sensitive task of transforming the GDR Academy of Sciences into the Berlin-Brandenburg Academy. She founded the Max Planck Institute for the Study of Societies, and from then on concentrated her research on globalisation and governance issues. Mayntz has had emeritus status since 1997 and has been working all the while on the major problems of our time. In 2009, she created a network of international academics in order to research the regulation of financial markets. At the time she was part of a group that studied the structures of illegal markets. How do criminal organisations arrange the sale of counterfeit goods or the illegal disposal of toxic waste? What is the connection to the legal economy? Answers to these and other questions are found once the relevant projects are complete.

Can there be any question of the productivity of our emeritus professors? Long may they remain with us! In 2010, Mayntz received the North Rhine-Westphalia Innovation Award for her life's work.

Outstanding analyses at the Max Planck Institute for the Study of Societies



RESPONSIBILITY

Bringing German law to Vietnam

Legal knowledge transfer for the purpose of reforming the legal system

Core portions of several foreign legal systems – including those of China, Turkey, and Hungary – have been influenced by or based on German law. One such process of adoption has been taking place in Vietnam since 2010, with academic assistance from German universities, the Friedrich Ebert Foundation and the German Academic Exchange Service.

German experts facilitate knowledge transfer in the areas of contract, civil, and labour law, intellectual property, as well as administrative and constitutional law. One aspect of their work is the establishment of a Centre for German and European Law at Hanoi University. Jürgen Keßler, professor for European and international corporate law at the HTW Berlin – University of Applied Sciences, is coordinating the exchange. "We cooperate closely with the government and universities in Vietnam," he explains. At the moment the focus is on standards pertaining to constitutional reform and the formulation of new corporate and insolvency laws that will enable economic cooperation. As part of this exchange the scholars have organised a number of workshops in which judges, administrators, and legal scholars from Germany present to professors, judges, and ministry employees from Vietnam. The German experts also give lectures to students; several early-career researchers receive scholarships and can enrol at German universities.

What is the reason for this change? Under the leadership of the Communist Party the country wants to participate in globalisation. This also benefits Germany. "Economic cooperation is strengthened through legal harmonisation," says Keßler. These efforts, part of the German/Vietnamese legal dialogue, are connected to the hope that Vietnam develops into a constitutional state. "The early experiences are very encouraging, because Vietnam is interested in taking advantage of learnings from Germany."

City car in the fast lane

Bigger, heavier, faster. For decades, these were the keywords for the automotive industry. It is now clear, however, that due to the world's limited resources we are driving ourselves into a dead end. At the instigation of the federal government, 2020 should see one million emission-free cars on Germany's roads.

So far, the high price of these cars has slowed the advent of eco-friendly mobility. RWTH Aachen University, along with 80 medium-sized companies, has formed a team, led by Professor Achim Kampker, to develop the StreetScooter electric vehicle. Excluding batteries, the car should cost about 5,000 euros. The first target market will be rental car fleets, taxi companies, and distribution firms – who can choose from vehicles with one, two, or three batteries, each with a range of 45 kilometres.

This range is generally sufficient for normal driving as the vast majority of car trips are usually shorter than ten kilometres. "Our goal is to develop a reliable and safe vehicle for city use," states Kampker, the holder of Aachen's Chair of Production Management. In order for the StreetScooter to maintain its low price tag, every component's production costs are factored into the design from the very beginning. In addition, the development won't take place in a specific physical location but instead will all happen in virtual space. All project-related data is collected and managed on a central online platform. The city cars are built from multiple combinable modules, something which also saves on costs.

Engineers develop an affordable and environmentally friendly electric car

On the risk of success

The discourse on the consequences of globalisation

We've faced a major nuclear accident, the global financial crisis, and terror attacks, hurricanes, and tsunamis. Ulrich Beck's theory on the "world risk society" has been proven correct by recent disasters: no one thought them possible, and they are beyond anything we ever expected, rendering all preventative strategies and recovery mechanisms obsolete. They have shaken modern society to the core, and they signal the end of an era when society assumed that comprehensive insurance was enough to keep us safe.

For decades now, Beck, professor of sociology at Ludwig-Maximilians-University in Munich, has influenced sociology research with his consideration of the consequences of globalisation and technological progress. His books on the risk society have been translated into 35 languages, and the term has become a catchphrase in Germany and many other countries. It is specifically as a consequence of its successes, according to Beck, that modern society faces the threat of failure. The same technological advancement upon which the growth and prosperity of the industrial society are based is feeding into an increasing fear of societal collapse. Whereas experiments in the past would have been conducted in a lab or in restricted field scenarios, nowadays the whole world seems to serve as the test bed for experimentation. Whether nuclear plants, genetically modified organisms, nanotechnology – if any of these experiments went wrong, the consequences would have a global impact, would be irreversible, and would impact future generations.

The distinctive traits of this "second modernity", as Beck calls the current era of globalisation, are the lack of limitations in terms of risk and the search by the individual for lost security. Beck recommends turning our backs on the "mathematical morality" of expert opinions, which seek to identify the level of a certain risk by calculating the probability of its occurrence. Instead, we should be using man's fear of collapse in a positive way: as an opportunity for international cooperation and a "cosmopolitan turn" in the social sciences.

Water:
Elixir of life for millions

E8 | Peter Cornel, Technische Universität Darmstadt

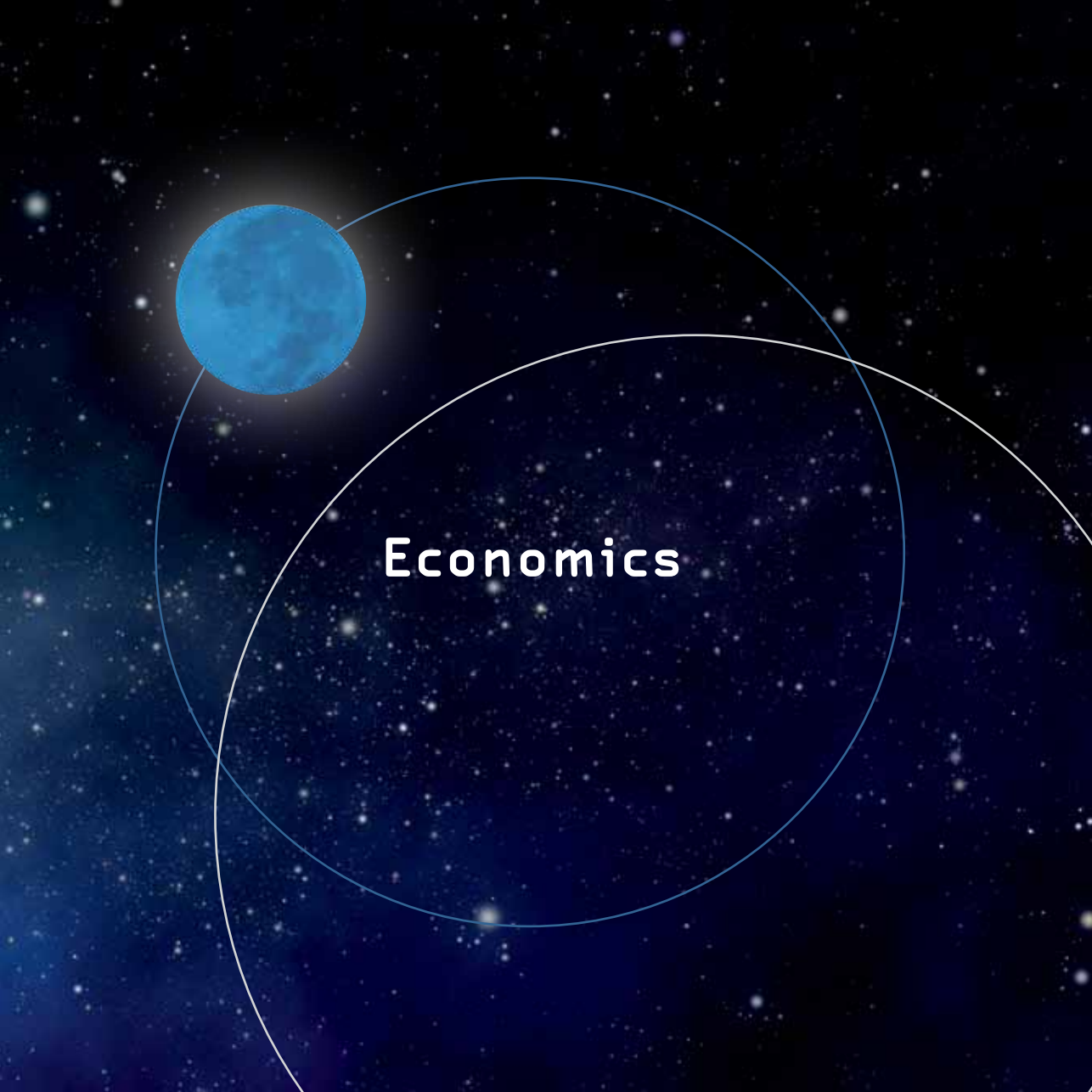
semizentral.de/en | www.iwar.bauing.tu-darmstadt.de/abwasser

Engineers develop self-sufficient waste infrastructure for megacities

With a population of seven million, Hanoi has no sewage treatment plant. Wastewater is collected in septic tanks under buildings, which are supposed to be emptied when full. But because many people in Hanoi cannot afford to do this, most septic tanks run over uncontrollably. The untreated wastewater flows into the rivers and canals, polluting the earth and threatening the city's water supply.

Similar problems exist in many of the world's megacities. In emerging and developing countries, cities are growing faster than their infrastructure systems. Large, centralised conventional solutions take far too long to implement, while decentralised solutions are expensive and difficult to monitor. The solution lies in a semi-centralised approach: compact, professionally operated facilities that handle parts of the city. At the Institute for Sewage Technology (IWAR) at Technische Universität Darmstadt, Peter Cornel has been developing the idea of systems connecting 20,000 to 50,000 inhabitants, which takes a holistic view of critical infrastructure for water supply, sanitation, and waste. This creates synergistic effects that save money and increase the system's efficiency. Enclosed buildings that are the size of a parking garage and located within the city, are a venue for wastewater treatment, water treatment, waste treatment, and energy production. Short distances minimise the transportation and energy costs – and the semi-centralised supply and waste disposal centre is an integral part of the city.

At IWAR, interdisciplinary research teams of wastewater and process engineers, environmental scientists, urban planners, and surveyors are currently conducting research focusing on Vietnam and China. Darmstadt has worked with the Hanoi University of Civil Engineering to develop a concept for improving Hanoi's environmental conditions. German know-how is also needed in the Chinese port city of Qingdao, which by 2014 will be the site of the first semi-centralised water supply and waste disposal centre.


Economics

"It's the economy, stupid." The basic message of this catchphrase from the 1992 Bill Clinton campaign has lost none of its relevance today. If the economy is functioning and growing, the people will be doing well – politicians and policymakers know this. Economic prosperity is a prerequisite for achieving many other societal goals.

Researchers in Germany are working to maintain and improve of our living standards and environments. Engineers are researching intelligent power grids, logistics experts are optimising the flow of goods, and chemists are developing biodegradable plastics, amid many other advances.

The economic sciences are called on to support decisions made by governments, organisations, and businesses. To be able to do this, they need to understand how market players behave as they do and what influences them. What type of framework should the state put in place in order to attain economic goals such as stability, progress, growth, and employment? How much regulation do markets need? How should entrepreneurs invest and strategize to obtain competitive advantage, revenues, and longevity? How can consumers be protected against manipulation? These questions must often take into account the highly complex behaviours that shape human interactions. Science investigates highly complex human behaviours to find the answers.

New approaches to economics would like to understand buyers and sellers, and the effects of constraints and incentives, as well as be able to explain and predict how people will act. In macroeconomics, the current focus is on analysing and simulating market activity; in microeconomics, the trend is to work with findings from psychology. Crises such as insolvencies, state bankruptcies, and collapsing financial markets bring problem areas to the fore. Economic research is in high demand among policymakers and managers alike.

People at the centre

Why do readers pay for the “pay what you want” newspapers found in unattended displays at underground stations? Why do we split up prize money according to the principle of “live and let live” and not according to might and right? To put it simply, people behave like social beings. Contrary to belief, they do not act exclusively in their own economic interests, only pursuing clear goals with all the information at hand and motivated entirely by self-interest.

Behavioural economics examines the limits of our rationality. Axel Ockenfels is Germany’s most prominent and internationally renowned scholar in this field and is also an advocate of a science that investigates real economic behaviour. His work calls into question the theory of the pursuit of pure self-interest and provides experimental proof of socially responsible behaviour, such as the phenomenon of economic fairness.

Such propositions form the basis for behavioural economics, which draws on findings from psychology and neuroscience in order to better understand how perceptions and decisions are formed, and which incentives underpin particular decisions. Ockenfels also observed the practical applications of economic policy from this perspective, such as online auctions, regulation of the electricity market, and the minimum wage hypothesis for solving unemployment. His work helps build bridges between abstract, sterile theory and the highly complex reality of the markets. The bounded rationality of our behaviour can be explained, predicted, and influenced. He was awarded the prestigious Leibniz Prize by the German Research Foundation in 2005.

Axel Ockenfels represents modern economics

Yoghurt pots on the compost heap

Economical production of biodegradable plastics

Plastics are everywhere: in mobile phones, in toys, in cars, and in nearly all forms of packaging. They are easy to process and incredibly durable, but therein lies the problem: sooner or later, plastics end up in the rubbish bin. About one tenth of all plastic refuse ultimately finds its way into the ocean. The volume of waste now amounts to millions of tons and is growing rapidly. Moreover, large amounts of petroleum are used to manufacture these products. It's been clear for a long time already that we cannot go on like this!

At Technische Universität München, Bernhard Rieger and his team together with an industry partner worked out an ingenious solution: they developed a synthesis for the polymer PHB, which decomposes within a few weeks of being put on the compost heap. The material can be equipped with specific properties, such as elasticity and transparency. It is cost-effective to produce and can compete with conventional plastics in terms of quality. Best of all, PHB is catalytically produced from carbon monoxide and propylene oxide. Carbon monoxide can easily be synthesized out of water and carbon, and the process requires only half as much petroleum as the production of polypropylene.

With this widely applicable and sustainable technology, the Munich-based research team has become a world leader in its field. In 2006, in recognition of his work, Rieger and his partner Gerrit Luinstra, from the chemical company BASF, shared the German Philip Morris Foundation's research prize.

Decoding, expanding, and utilising genetic diversity

Collaborative research into animal and plant breeding

For centuries, animal and plant breeding has been the key to producing healthy food in adequate quantities. Breeding methods play a prominent role in today's agriculture. Highly productive plant varieties can help produce larger increases in yield than modern farming technologies or the increased use of fertilisers. "If we want to get even more out of breeding, we need to pool expertise from all the different fields within the life sciences," explains Chris-Carolin Schön, agricultural scientist at the Technische Universität München.

The research network SYNBREED (Synergistic Plant and Animal Breeding) brings together plant and animal breeders with molecular biologists, bioinformaticians, and medical scientists. The interdisciplinary make-up of the group is intended to identify synergies and help generate new ideas and approaches. It focuses on utilising the natural diversity of economically significant species including maize, chicken, and cattle – foodstuffs that have great economic importance. Of particular interest are properties that contribute to the health, fertility, and productivity of these species. This is also the key problem: complex markers such as maize yield or milk production in cows depend on a mix of numerous genetic factors.

Schön exemplifies: "This is why it's no longer enough to look for individual genes. Nowadays, we are simultaneously examining thousands of genetic factors within one genome and subsequently determining which combination exerts the greatest influence on complex traits such as egg production in chickens." Advancements in innovative genome research benefit all members of the network, which includes the Technische Universität München, Universität Göttingen, University of Hohenheim, and Kiel University as well as four non-university research institutions and two partners from industry. Part of the programme is a structured doctoral training course, which includes a graduate programme, summer schools, and research grants.

The science of advertising

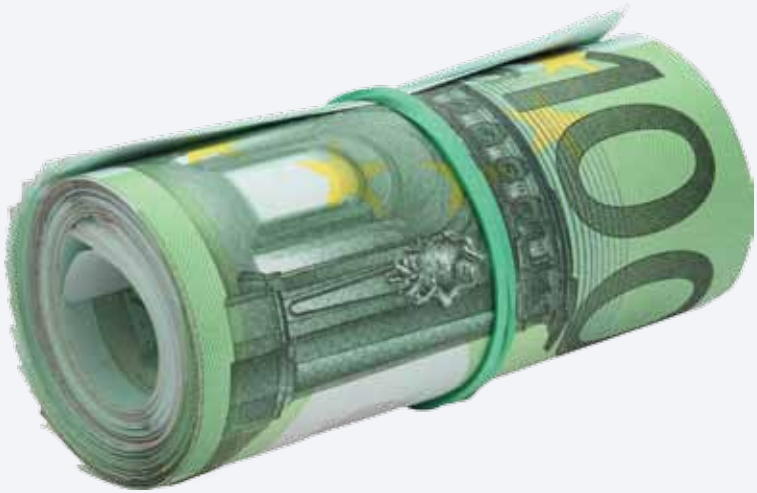
During blind taste tests, consumers are unable to distinguish premium beer brands from other brands, and they express different taste preferences than when they are able to see the labels. Beck's has manoeuvred itself into a competitive spot with a green sailing ship and Flensburger with the distinctive "pop" that comes with opening its swing-top bottle. Shoppers pay significantly more for brand names than for unknown products of equal quality. These and innumerable other examples of the effects of marketing make it clear that the consumer is anything but a rational homo economicus.

Starting in 1970, Saarbrücken-based professor Werner Kroeber-Riel took the outdated, descriptive marketing teaching methods of the time and made them into a modern science. He was the first to replace assumptions with empirical research, claiming that successful marketing needed to understand the psychology of human behaviour and how it influences target customers. Consumer behaviour may not be especially rational, but it obeys certain "psycho-logical" principles. These principles have been empirically researched using interdisciplinary theories.

The Institute for Consumer Research and Behavioral Science (IKV) that Kroeber-Riel founded has continued to develop the theory of consumer behaviour since 1969. Today, it comprises fifteen departments and hundreds of scientists. Using the group's empirical methodology, companies can adapt their products to meet real yet subjective needs instead of leaving product design solely to the engineers. It helps ensure that the tremendous investments made in advertising and branding are used effectively to influence consumers in a targeted way. Their findings also help competition law and consumer protection regulations in identifying illegal and ethically questionable methods of manipulation in order to protect consumers.

Marketing + psychology = consumer research

The Myth of Homo Economicus



F5 | Reinhard Selten, Freie Universität Berlin, Bielefeld University, University of Bonn
www.bonneconlab.uni-bonn.de/team/selten.reinhard

Experimental economics is causing a paradigm shift

He thinks at lightning speed, sums up all the possibilities without overlooking a single one, and invariably selects the very best option. The notion of the rationally acting individual, homo economicus, is one of the great modern myths. „Experimental economics has clearly demonstrated that this model is completely unrealistic," states Reinhard Selten. Selten, an economics professor, is considered a pioneer of experimental economics. In 1994, he was recognised for his contributions to game theory when he became the first German to win the Nobel Prize in Economics.

Selten taught in Berkeley, Berlin, and Bielefeld before moving to Bonn in 1984, where he founded the BonnEconLab, Europe's first laboratory for experimental economics. As part of this research discipline, special experimental sessions are conducted in which subjects make real decisions linked to actual monetary incentives. The empirical data collected provide a comprehensive behavioural analysis of economic activity. This methodology has long been standard within economic research. The institute also works closely with the university's Department of Economics and is involved in its bachelor's, master's and doctoral programmes.

To date, Selten has issued numerous publications and supervised young researchers; he leads several projects at the BonnEconLab as well as the "Rationality in the Light of Experimental Economics" work group at the North Rhine-Westphalian Academy of Sciences and Arts. Through this long-term project, which has been running since 2006, researchers are developing an experimentally based theory of economic behaviour. Their ambitious goal is, in Selten's words, "to determine how economic decisions are actually made."

Controlled emotions

F6 | Dietrich Dörner, University of Bamberg

www.uni-bamberg.de/psychologie/theoretische-psychologie/forschung/downloads

www.uni-bamberg.de/psychologie/theoretische-psychologie/

Complex problem-solving is a rare, invaluable, and teachable skill

Peter Löscher, CEO of Siemens, earns an annual salary of around €9m. It is not unusual for directors of large companies to earn top-level salaries, given their unique ability to consistently make complex decisions and implement them successfully. Complexity means variety (multiple factors at play) plus dynamism (constantly changing variables). Running a company is a highly complex task. It frequently involves making momentous decisions in difficult situations that will affect both short- and long-term goals – some of which may even conflict – and whose long-term repercussions or knock-on effects are hard to predict. Few individuals possess the skills to be a successful manager, and so those who do are highly compensated.

Experiments carried out by psychologist and cognitive scientist Dietrich Dörner demonstrate how even competent and motivated decision-makers have difficulty dealing with complexity. In one experiment, participants were told to take on the role of mayor and solve various problems in the fictional town of Lohhausen using all available means and resources. The majority of test subjects failed the task, as solving one problem resulted in the creation of another, or short term success subsequently turned into disaster in the long term. Most people were able to solve a particular problem, but could not assess the impact of their decisions on the complex web of associated issues or how these decisions would play out further down the line. Nevertheless, managers proved to be better decision-makers than students.

Dörner has studied the psychology of managing complexity, and has pinpointed and made us aware of our alarming deficiencies in this area. On the basis of his research findings, he has formulated psychological explanations and developed methods in accordance with the saying “forewarned is forearmed” that aid in teaching the skills necessary for complex decision-making. Dörner’s findings have enormous potential applications, and his influence extends far beyond the field of psychology. In 1986, the German Research Foundation awarded him the prestigious Leibniz Prize for his work.

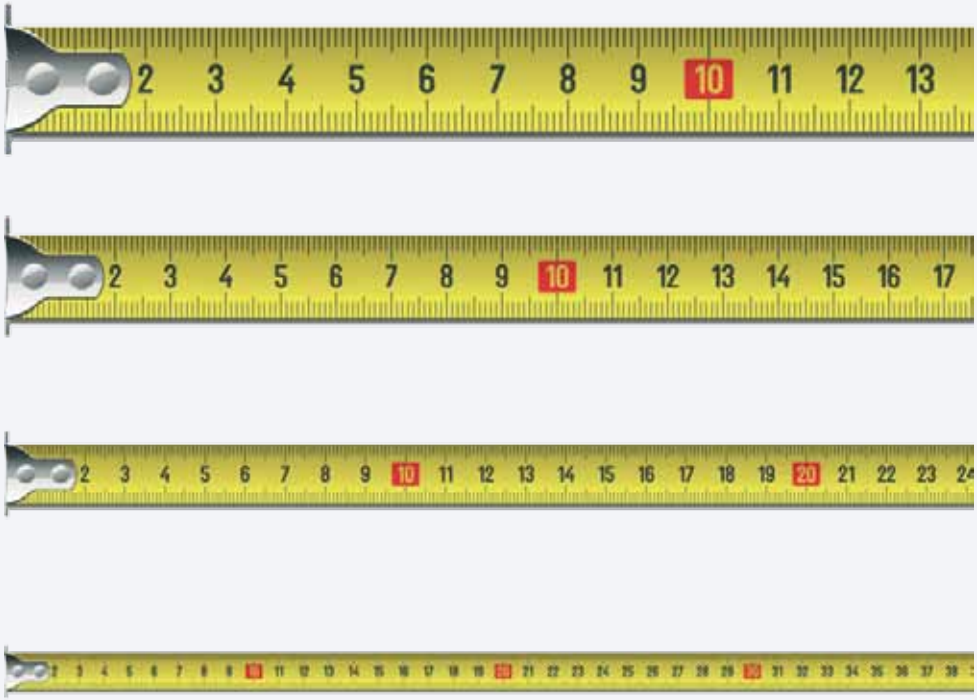
Everything is relative

People are constantly making comparisons. But why? With what? How? And above all, how does making comparisons influence our decisions? Internationally renowned social psychologist Thomas Mussweiler is seeking answers to these questions. With the aid of experimental studies, he has designed a comprehensive model to explain comparison processes. His team also includes neuroscientists and economists.

Mussweiler says: "We make comparisons because we need to make efficient use of our limited cognitive resources". If we were to consider all relevant information when making a judgment, we would be hopelessly overwhelmed. So we use heuristics, which are techniques for simplification. These include rules of thumb, prejudices, stereotypes, and comparisons.

In particular, Mussweiler's analysis of the "anchoring effect" has received widespread attention. This phenomenon describes how people make use of reference points – so-called "anchors" – when making assessments, and how these anchors influence their judgment. Mussweiler has conducted empirical research into the anchoring effect as the basis for economic decisions, and it has become clear how this effect influences the outcomes of negotiations. The opening offer serves as the anchor. The higher this offer is, the higher the price paid will be. Furthermore, he was able to demonstrate that completely irrelevant reference points influence a decision – even one made by an expert. When buying shares, professional investors are guided as much by the anchoring effect as are private investors.

Social psychologists investigate comparison processes



The Biology of Success

F8 | Felix von Cube, Heidelberg University | www.von-cube.de

Felix von Cube's theory of „passion for performance"

How do people learn? What makes them want to work? What is the secret of success? The educationalist Felix von Cube has answered these questions from a logical and empirical standpoint by incorporating findings from cybernetics and behavioural biology into pedagogy. Today his theories extend beyond the traditional academic environment and are influencing management training for leaders.

Von Cube, born in 1927 and Professor of Didactics at the universities of Berlin, Bonn, and Heidelberg, developed his "cybernetic info-theoretical didactics" in the 1970s. This approach views education and learning as a schematically modelled process. Within this process, information, educators, and learners function as part of a closed loop system that can be controlled by certain levers. Von Cube established his "biology of success" theory, based on this idea of a system of pedagogical rules. It holds that humans are compulsive beings, and can be spurred to exceptional performance by internal and external stimuli. "Passion for performance," according to von Cube, "kicks in when flow is experienced, and social recognition and interpersonal bonding occur." Von Cube is referring here to the work of psychologist Mihály Csíkszentmihályi, who was the first to describe the special form of experience known as flow: People experiencing flow work effortlessly, creatively, without stress, and unfettered by their own and others' expectations of success. According to von Cube, flow is activated by our curiosity instinct and functions as a "safety mechanism". It prompts people to make the unknown familiar, and to transform uncertainty into certainty.

In other words, if a company wants to motivate its employees to perform at a high level, it must ensure that its employees can follow their instincts while working. This means providing employees with new problems to solve, making sure they experience feelings of belonging and being valued while participating in group projects, and recognising accomplishments through promotions, bonuses, and praise.

Simulating the future

Innovative technologies for virtual reality

How should a doctor decide where to place electrodes to restore muscle function in a paraplegic? Trial and error? It's the oldest method for finding the best solution to a problem. In the case of complex and delicate systems, trial and error is ruled out as it may take too long and cause damage.

Simulation, however, has made virtual testing a possibility. Systems are reproduced as computer models and the effects of the measures being considered are calculated mathematically. Using the virtual model, multiple experiments can be rapidly conducted, all without affecting the real system. Simulations have become indispensable in almost all areas of life and research, including in the development of new medicines, production planning, weather forecasting, and traffic regulation.

Germany has become a leader in simulation technologies research. At the forefront of this research is the University of Stuttgart's Cluster of Excellence "Simulation Technology" (SimTech) with the affiliated Graduate School. SimTech has been funded by the German Research Foundation since 2007. The 85 projects currently under investigation cover a wide range of topics. For example, one SimTech research group studies the simulation of skeletal muscles and parts of the human musculoskeletal system. Special simulation models enable researchers to examine how muscles respond to external stimuli. The results indicate where electrodes must be placed in order to reactivate damaged muscles using electrical stimulation. In other projects, computer modelling is used to design virtual prototypes, trial the construction of factories, and analyse the effects of gases that are harmful to the environment.

Automated freight crates

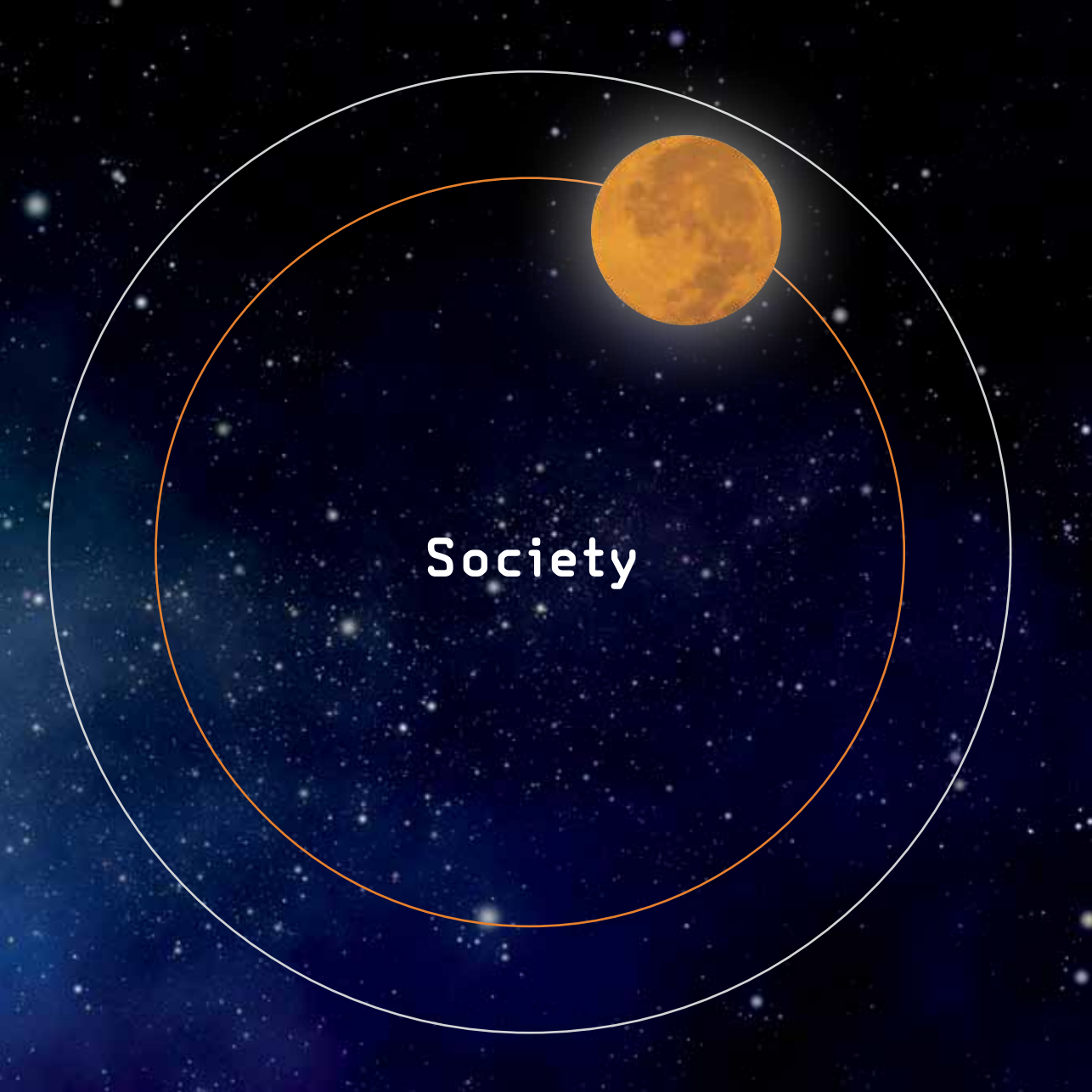
Warehouse operatives of the future will no longer be required to haul crates. Instead, they will monitor software that controls automated transportation vehicles. In Dortmund, work has already begun on turning this vision of the future into reality with the largest-ever trial utilising artificial intelligence in logistics. Driverless shuttles transport goods to pre-specified places within the research hall.

The shuttles move directly to their destinations without following a fixed route, which means they cut down on the distance they cover and save time. “Our aim is to organise logistical processes and systems so they use only 75 per cent of current resources,” says Michael ten Hompel. The 53-year-old professor holds the chair of Materials Handling and Warehousing at TU Dortmund University and heads both the Fraunhofer Institute for Material Flow and Logistics and the EffizienzCluster LogistikRuhr.

The EffizienzCluster LogistikRuhr is made up of organisations and institutions from science and industry and was selected as a leading-edge cluster by the Federal Ministry of Education and Research in 2010. “For logistics to be a hot research topic is really something new,” says ten Hompel. And it is well overdue, as climate change and the increasing shortage of natural resources have long demanded a rethink of processes and systems in the sector. At the same time, logistical requirements are rapidly growing as a result of globalisation. The objective of the Cluster is to develop innovative products and patents and ensure they are ready to be brought to market. This calls for the combined skills of around 120 companies. Dozens of collaborative projects have been initiated with industry partners and with the Fraunhofer Institute. In addition to the automated shuttles, a number of innovations have emerged as a result of the joint projects, including smart crates that move autonomously throughout the warehouse. In 2013, the logistics campus was officially opened in Dortmund. It offers new professorships and posts for scientists and scholars and is expected to be extended in the coming years.

Artificial intelligence for transporting goods

F10 | Michael ten Hompel, TU Dortmund University and partner networks
www.logistikruhr.de | www.flw.mb.tu-dortmund.de | www.iml.fraunhofer.de


Society

„Civilization is in the process of being formed," wrote the renowned sociologist Norbert Elias. The German-Jewish scholar studied how societies have changed in Western Europe since the Middle Ages – and thus also how the personality of the individual has changed as well. His approach is very timely. Anyone who wants to understand what motivates people must analyse how they live together. If you want to help shape the future of civilization, you should know where our cultures have come from.

That's why researchers in Berlin, Bielefeld, Essen, Heidelberg, and Frankfurt are asking what rules and values are followed by people in different societies. With their many historical upheavals, the Germans offer a rich source of research material – whether we study the sensitive souls of the romantic era, the supporters of a murderous Nazi state, or the outraged Wutbürger demanding more democracy.

Through interdisciplinary cooperation, historians, sociologists, anthropologists, archaeologists, and philosophers are researching language as the driving force of culture; defining architecture as a stone-based metaphor for a culture's mentality; identifying cultural and historical influences from Asia; and answering the question of how knowledge is actually created, i.e. what engages a society's curiosity and thus defines our collective consciousness.

Contemporary issues are also in focus. How do we respond to discrimination against women, unregulated financial markets, and the crisis of confidence in politics? Renowned professors are designing models for more equal opportunities, new forms of democratic participation, and a more equitable coexistence.

Tradition and modernity in the "Frankfurt School"

Frankfurt is not just the centre of the German financial sector. Founded in 1923, the city's Institute for Social Research (IfS) is an internationally prominent institution of humanities research and teaching. Inspired by Friedrich Hegel, Karl Marx, and Sigmund Freud, IfS scholars including Max Horkheimer, Theodor Adorno, Erich Fromm, and Herbert Marcuse developed critical theory, a comprehensive analysis of bourgeois society better known as the "Frankfurt School", and served as the driving force in the anti-authoritarian student movement of the 1960s.

As a social philosopher, Jürgen Habermas shaped the image of the "Frankfurt School". However, he declined a request to become the head of the IfS, opting instead to teach sociology seminars. Although he retired in 1994, Habermas still comments on current political and social issues. In his major 1981 work, "The Theory of Communicative Action", Habermas examined, among other topics, the role of language as a fundamental resource for the advancement of a society.

The Institute has changed over time, but has remained true to the principle that social science research must seek a critical understanding of society and provide the theoretical impetus for its emancipatory development. This premise is also subscribed to by social philosopher Professor Axel Honneth, the current head of the IfS: "Although our institution is still regarded as the centre of the Frankfurt School's intellectual legacy, the theoretical and empirical work here is now also greatly influenced by other traditions and only makes occasional reference to the founding authors." According to Honneth, "Social criticism must in its form and function learn from the times and should not blindly adhere to its original form."

Critical social analysis at the Institute for Social Research

G1 | Jürgen Habermas, University of Frankfurt and Axel Honneth, Institute for Social Research at the University of Frankfurt | www.ifs.uni-frankfurt.de

Why we know what we do

How new scientific findings change society

It is said that we live in a knowledge-based society. But who possesses all the knowledge? And what consequences does this have for us? Sociologist Peter Weingart is looking for answers by analysing the current situation with a critical eye. It was important to understand how certain knowledge is acquired today because „a sharp wind of political and economic greed is blowing" through academia. Weingart, born in 1941, was responsible for fostering the field of research into scientific development, in Germany. It was his initiative that established Bielefeld University's Institute of Science and Technology Studies (IWT), which he led from 1993 until he was given emeritus status in 2009.

Weingart and his colleagues research the development of science since the mid-20th Century. This involved the dissolving of the boundaries between basic research and applied industrial research. Such a policy has strengthened scientific expertise and in turn led to the solution of complex problems.

These convergences are analysed on an interdisciplinary basis. Sociologists, philosophers and historians research scientific changes, as well as their resulting ethical challenges and social consequences. Peter Weingart's work has profoundly influenced the sociology of science, and he remains active as a researcher to this day. Currently, he is mainly concerned with the interface between science, media, politics, and business.

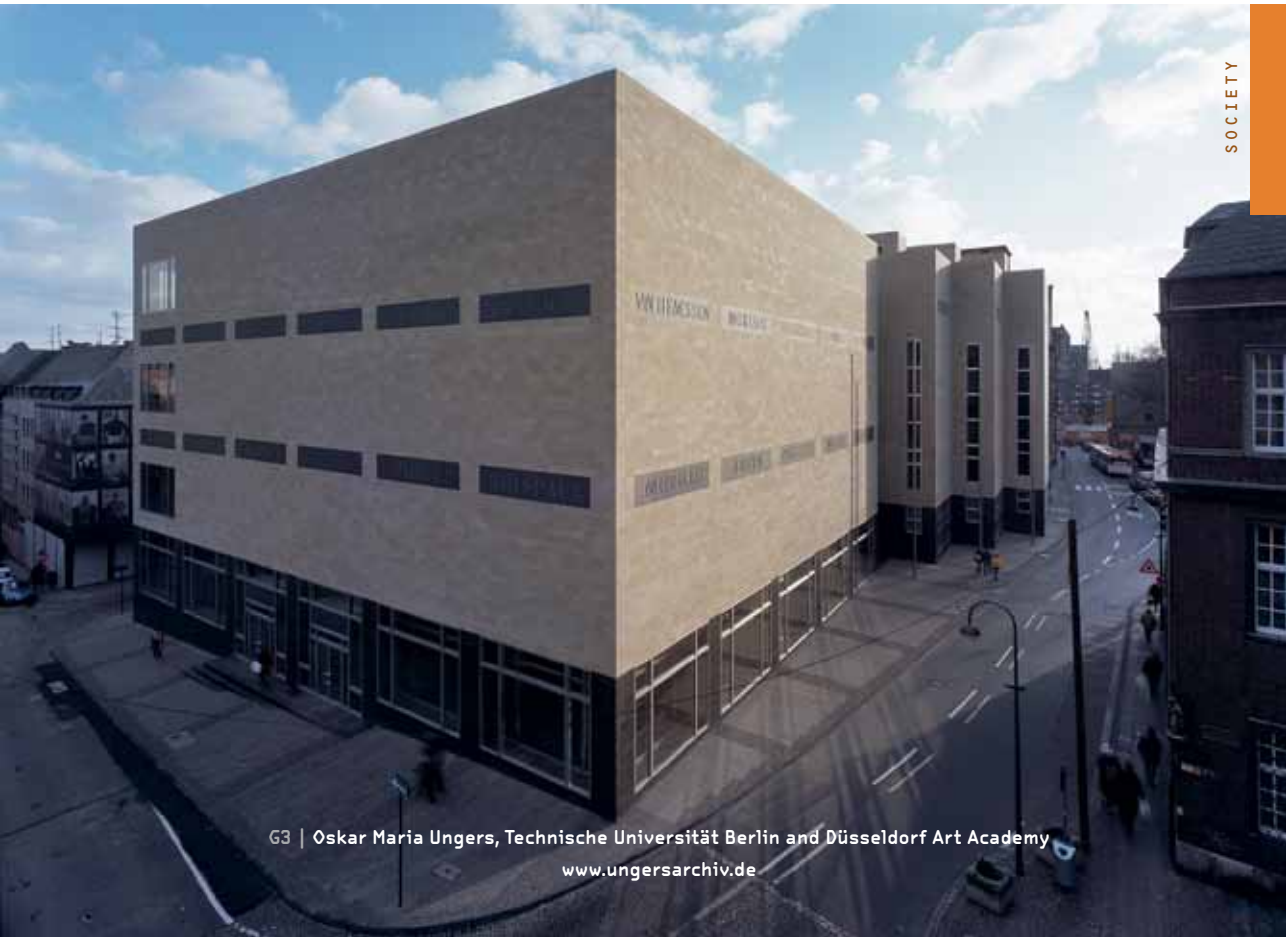
Sharp edges

Even an informed layperson can recognise a building by Oskar Maria Ungers at a glance. OMU, as he was known in professional circles, developed an austere use of form that stood out in any environment. This applies as much to his city centre Wallraff-Richartz Museum in Cologne as to his highly visible Hamburger Kunsthalle museum, and to his monumental gatehouse at the Frankfurt Messe as to his apartment complex at Berlin's Lützowplatz. His designs are always governed by an elemental and classical use of form untouched by contemporary trends.

The architect drew on historical precedent. His work incorporated principles from antiquity and masters such as Andrea Palladio and Karl Friedrich Schinkel. Ungers worked with squares, circles, cubes, and spheres – his buildings are defined by transformations and variations of these basic forms. Whereas critics mock his "squareness", his students and followers speak of a new clarity, and they view Ungers as the founder of German rationalism. His embrace of geometric order made him a leading theorist of the so-called Second Modernism of the early 1990s.

As a professor of architecture, he passed his knowledge on to several generations of students: at the Technische Universität Berlin, the Düsseldorf Art Academy, and the Academies of Applied Arts in Vienna, Boston and Los Angeles. In the 1950s Ungers started the development of the archive of Architectural Sciences. The library contains, among other things, the first edition of "DE ARCHITECTURA LIBRI DECEM" (1495) – Vitruv's foundational work for architectural theory of the modern era. Documents from the State Bauhaus in Weimar (1919–1923) can also be viewed here. All of this is to be found in the Library cube of Ungers' landmarked house in Cologne-Müngersdorf. Scientists from around the world use the archives for research because to this day it's not possible to study architecture if one overlooks Ungers.

Architecture of the Second Modern Era



G3 | Oskar Maria Ungers, Technische Universität Berlin and Düsseldorf Art Academy
www.ungersarchiv.de

Stories become history

G4 | Norbert Elias, Bielefeld University and University of Frankfurt | www.norberteliasfoundation.nl
www.uni-bielefeld.de/ZIF/Allgemeines/Personen/norbert_elias.html

Civilisation studies traces humans through the ages

Norbert Elias was fond of sharing anecdotes in order to illustrate aspects of his work. One, in particular, told of a Byzantine princess in the 13th century who shocked the Venetian court by using a fork at the table. The assembled company was horrified. How could she not want to eat God's food with her hands?

Elias was fascinated by such seminal moments. The sociologist analysed the change of European society between 800 and 1900, which he described in his famous work "On the Process of Civilisation." In his figuration theory Elias contends that not every object is of equal importance for the theory of civilisation, yet no object is unimportant. In his mind, sociology and historiography are intertwined. Seemingly peripheral changes such as those in eating habits, greater emotional self-regulation, a higher shame threshold, or the development of feelings of embarrassment are evidence of this process.

The members of each generation must in turn master the challenge in self-regulating themselves for the authority of civilising standards to prevail. Everyone must repeat a highly accelerated version of the civilising process in adolescence. It is only then that he or she can contribute to society. Known for many years only to a small circle of colleagues, Elias's theory of civilisation is now taught and recognised worldwide as part of civilisation studies. The author's work gained late recognition, not only in the form of honours such as the Adorno Prize, but also in very personal testimonies by colleagues, such as those at Bielefeld University who were inspired to dedicate an eloquent tribute to him with the Bielefeld Begegnungen honouring the impact of his personal and theoretical influence. One might take comfort in reading the last sentence of his key work as a hopeful prophecy: "Civilisation is not complete, but is still in the process of evolving."

Conscience of the nation

»There is no right life in the wrong one.«

Theodor W. Adorno | Minima Moralia

G5 | Theodor W. Adorno, University of Frankfurt
www.ifs.uni-frankfurt.de | www.hdg.de/lemo/html/biografien/AdornoTheodorW

Adorno's philosophy is still relevant today

It is his most famous saying: "There is no right life in the wrong one." Theodor W. Adorno wrote these words as part of his Minima Moralia, written between 1944 and 1947 while he was in exile in California. In no way did Adorno advocate accepting the world as it is; rather, he supported not losing our sense of what is right, even if a completely authentic life is impossible.

A philosopher, musicologist, and composer, Adorno was one of the great scholars of the 20th century. The question of why the Germans could have capitulated so completely to anti-Semitism was a lifelong theme for this empirical social scientist. He stated that, "Writing a poem after Auschwitz is barbaric," provoking resistance from writers and literary scholars. Adorno's intent, however, was not to ban all lyricism, but rather only that which promoted the obfuscation of real remembrance. Born in Frankfurt in 1903, Adorno became a lecturer at his home city's university in 1931. Just two years later the Nazi regime stripped him of the right to teach because of his Jewish roots, forcing him to emigrate. In 1949 Adorno returned to Germany and worked at the Frankfurt Institute for Social Research (IfS), which he headed from 1959 until his death in 1969. Since 2002, IfS has organized a series of annual Adorno Lectures.

To this day, the IfS is among Germany's legendary research institutions. The critical theory taught at the IfS, an analysis of capitalist society often referred to as the "Frankfurt School", inspired the 1968 student movement and influenced a generation of intellectuals, including many of Adorno's students like Jürgen Habermas and Oskar Negt. "The almost impossible task which faces us," wrote Adorno in Minima Moralia, "is not to let ourselves become dumbed down, neither because of the power that others hold over us nor because of our own powerlessness."

Sociology with a system

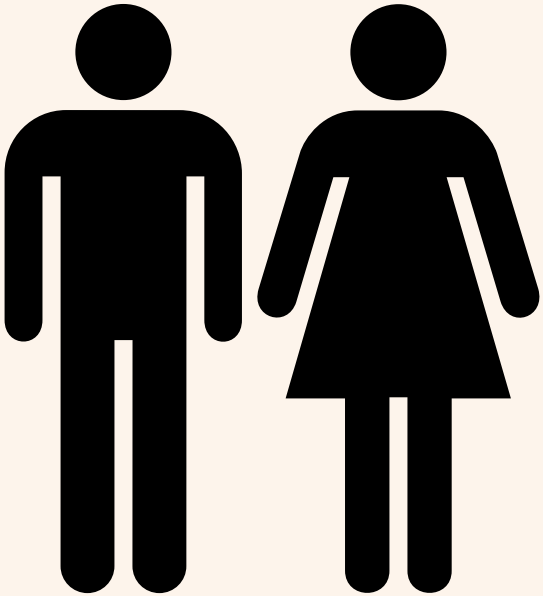
Researchers from around the world discuss the theories of Niklas Luhmann

Considered one of the greatest sociologists of the 20th Century, Niklas Luhmann taught for 25 years at Bielefeld University. But you won't find a monument to him on the campus. There is also no auditorium or lecture hall bearing his name – not even a bust. „We have no hero cults here," says Markus Göbel, assistant in the dean's office of the Department of Sociology. Instead, the department concentrates on the discipline itself through "substantive discussions on Luhmann's work."

This is an attitude that the famous sociologist certainly would have shared. Luhmann, who died in 1998, was considered a very objective person. He started as a professor in Bielefeld in 1968. It is here that he developed his universal theory about how social systems work. Luhmann understood society not as a collection of people, but as a complex process of communications.

It is therefore fitting that people communicate in his name today: the "Niklas Luhmann Visiting Professorship " was established in 2005. Internationally renowned social theorists are invited to Bielefeld, usually in the summer term. They present papers, give seminars, and discuss Luhmann's theses. Among the guest lecturers have been John W. Meyer of Stanford University, Nils Brunsson from Uppsala University, and Harrison White and Saskia Sassen of Columbia University. The Bielefeld sociologists also administer the legacy of the famous systems theorist. This includes the legendary box of index cards which was the source of Luhmann's approximately 60 books and 400 papers. A research project is underway to digitise this collection. The old master of systems theory remains a presence at the university – even without a bust. His successors ensure that the Bielefeld faculty remains one of the most important institutions for social science research and teaching in Germany.

A just society



Pioneer of gender equality and labour market research: The sociologist Jutta Allmendinger

Here's what the future of the German labour market looks like for Jutta Allmendinger: at least 30 per cent of the top positions in German companies are held by women, when women do the same amount of work as men, they earn just as much as men, and the income splitting taxation policy, which reflects West German society of the fifties, has been abolished. Full-day schools and day nurseries are so common that it's easy for mothers to plan their return to professional life. This also means that after giving birth, if they wish, they can start working full-time again and not just settle for part-time jobs. The work of caring for a family is no longer solely a women's issue and the term „bad mother" is only to be found in a lexicon of outmoded terms.

Allmendinger, President of the Social Science Research Center Berlin (WZB) and Professor of Sociology of Education and Labour Market Studies at the Humboldt-Universität zu Berlin, is one of the pioneers for equality in the German labour market. Allmendinger, born in 1956, studied sociology in Mannheim and pursued her post-graduate work at Harvard. She first became known for coining the term "education poverty".

In 2009, this renowned social scientist published the highly regarded study "Women On The Move". In it young women speak about their lives and their goals. In her latest book, "Verschenkte Potenziale?" (Wasted Potential?), Allmendinger analyses the situation of women who, despite being well educated, aren't active in the workforce. When it comes to equality, notes Allmendinger, a lot has been accomplished in the past years, yet a lot remains to be done.

A symphony of stone and steel

If musicians unexpectedly begin to play music in a public square, people form a circle around them. The observation of this simple phenomenon led Hans Scharoun to develop his masterpiece: the Philharmonie concert hall in Berlin, where the audience seating is organised concentrically upwards around the orchestra podium. Its acoustics are world-renowned.

The completion of the Philharmonie in 1963 marked the turning point in Scharoun's career. Scharoun had returned to his alma mater, Technische Universität Berlin, in 1946 as a professor, and he continued to teach there until 1958. This rounded out the extraordinary career of an architect who, although considered a genius in his early youth, only started to receive significant commissions in his later years.

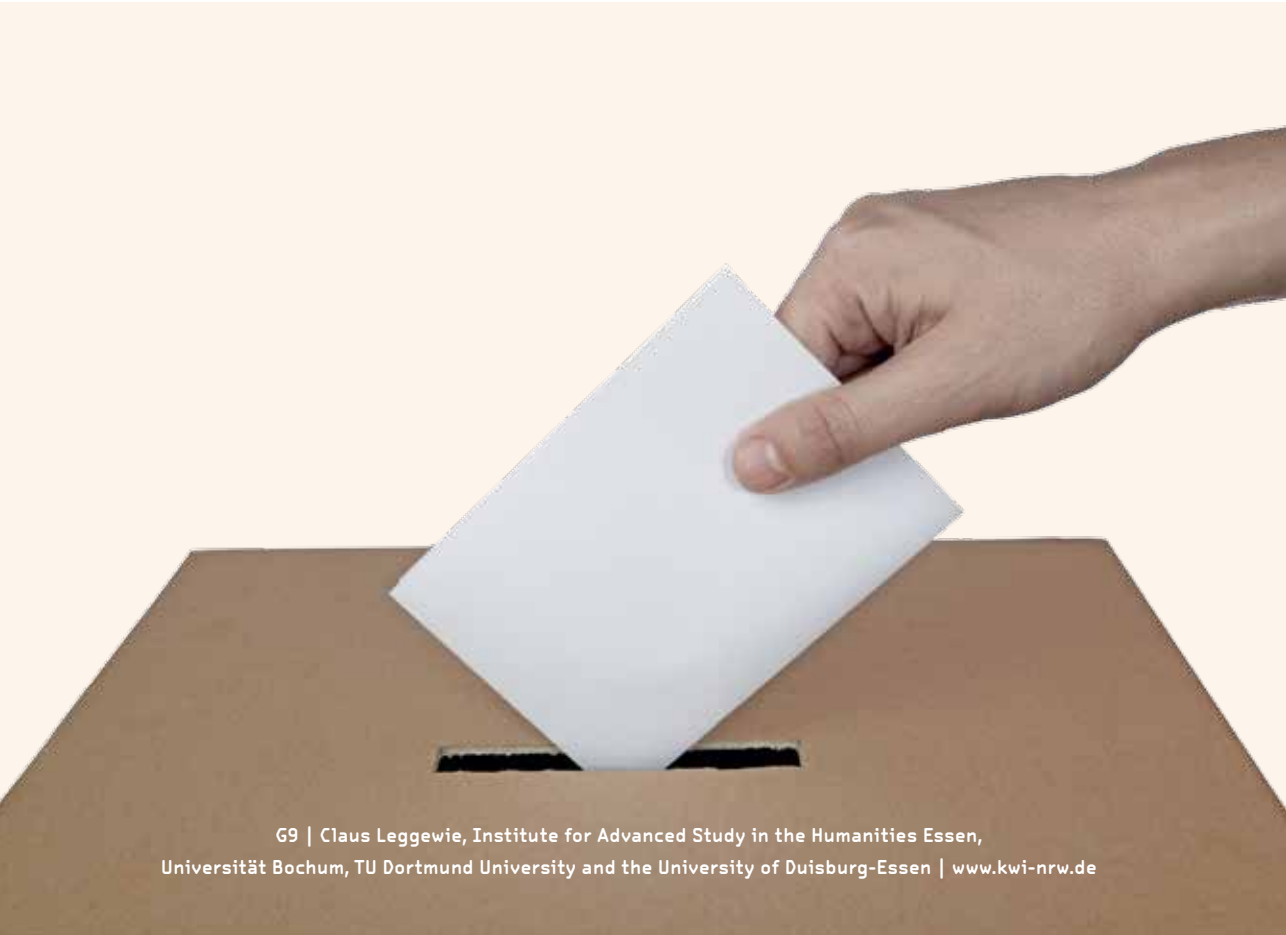
Scharoun became a major opponent of the way post-war architecture short-changed the general public: rationalism and prefabricated form schemas. To this day he is considered one of the most original and imaginative German architects and is also one of the most controversial. With his principle of organic design Scharoun created buildings with an eye to their future roles. The result was light-filled spaces where people could interact, and which harmonised with the surrounding landscape.

Scharoun's assistant, Edgar Wisniewski, built the Chamber Music Hall and the Museum of Musical Instruments using the architect's designs. This ensemble of buildings, located in the Mitte neighbourhood of Berlin, is unmistakable. They exemplify the architectural philosophy that a building's design should evolve from the building's function. Even if Scharoun stretched the load-bearing limits of his construction materials, as well as the nerves of the building team, to their very limits in the process: As Chair of the Department of Urban Planning, Scharoun insisted that students become actively involved in research projects. He guided them to examine the potentials and limits of construction materials so that they would learn not to let the materials dictate design, but instead be able to harness each material's potential.

Buildings in harmony with man and nature

G8 | Hans Scharoun, Technische Universität Berlin | http://www.mai-nrw.de/Scharoun-Schule-Stadt.100.0.html
http://opus.kobv.de/tuberlin/volltexte/2008/2012/html/festschrift/scharoun.htm
http://scharoun-luenen.de/

When anger becomes action



G9 | Claus Leggewie, Institute for Advanced Study in the Humanities Essen,
Universität Bochum, TU Dortmund University and the University of Duisburg-Essen | www.kwi-nrw.de

Models for the future of democracy

From Tunis to New York to Stuttgart, hundreds of thousands of people worldwide took to the streets in 2011. They protested against dictators, banks, or even the construction of a railway station. In the US, Time magazine chose “the Demonstrator” as Man of the Year. In Germany, the “Wutbürger” (literally, “enraged citizen”) became a metaphor for the rage of a people that stretches all the way into conservative circles.

But what happens when the anger fades? Protest alone is not enough, says political scientist Claus Leggewie: opposition should lead to civic engagement. “Ending the world that we all know requires individual and collaborative decisions of often breathtaking scope and an uncertain outcome. Financial markets have to be restrained, climate crises must be contained, mistrust of the government has to be addressed, and Europe must be saved,” writes Leggewie in his latest book “Courage Instead of Anger: The Dawn of a New Democracy”.

Leggewie is one of the most respected political scientists in Germany. He has taught in New York, Paris, and Vienna, and is currently a member of the German Advisory Council on Global Change. Since 2007, he has led the Institute for Advanced Study in the Humanities in Essen (KWI). This interdisciplinary research centre – a collaboration of Universität Bochum, TU Dortmund University and the University of Duisburg-Essen – is a think tank that addresses all issues affecting society today. International experts and junior researchers examine the future of democracy at the KWI; they analyse, for example, digital communications, climate change, migration, and Islam. The KWI hosts some 70 events each year and collaborates with cultural organisations and important media outlets. For Leggewie, democracy means that all of us – whether citizen, politician, or scholar – must come together to discuss the issues affecting our future.

Literatures of the world in focus

“Only in the search itself does the human mind find the secret that it seeks”

Friedrich Schlegel | Lucinde

Friedrich Schlegel Graduate School of Literary Studies (FSGS)

As a cosmopolitan intellectual and a man of letters trained in philology, the poet and scholar Friedrich Schlegel (1772–1829) represents a cultural consciousness that transcends national boundaries. As patron of the Friedrich Schlegel Graduate School (FSGS) of Literary Studies, Germany's only graduate school to focus solely on literary studies, he stands for theoretically sophisticated and methodologically innovative research.

The academic profile of FSGS is determined by its emphasis on literary and comparative analysis of world literatures, covering an extraordinary range of subjects. It includes literature from many European countries, but also from non-European languages, including above all the Arabic and the East Asian regions.

Within this focus, the historical depth covered is unique – with all eras, from ancient times to the present day, being studied. A team of university lecturers and professors from various disciplines supervise approximately 50 doctoral and postdoctoral researchers. Since 2012, the FSGS has established a distinct research presence within the academic community of the German capital and is now collaborating with Humboldt-Universität zu Berlin and Berlin's two Max Planck Institutes. With its numerous associated programmes, including the project "The Future of Philology", funded by the state of Berlin, FSGS is a well-known, both regionally and internationally, as a hub for innovative text interpretation and for historically and culturally grounded scholarship.

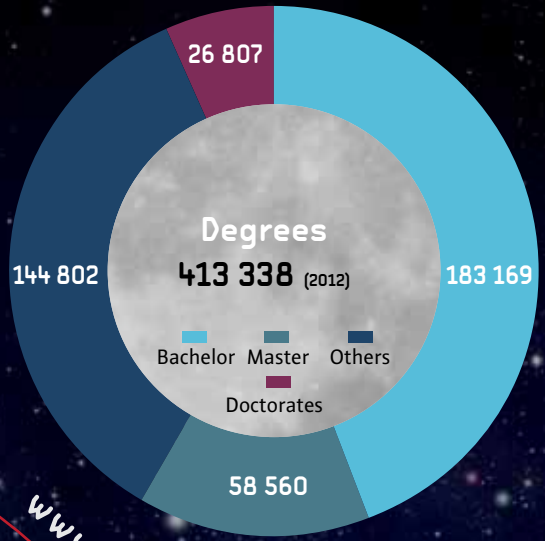
How Jesus came to India

A Cluster of Excellence in Heidelberg investigates cultural exchange between Asia and Europe

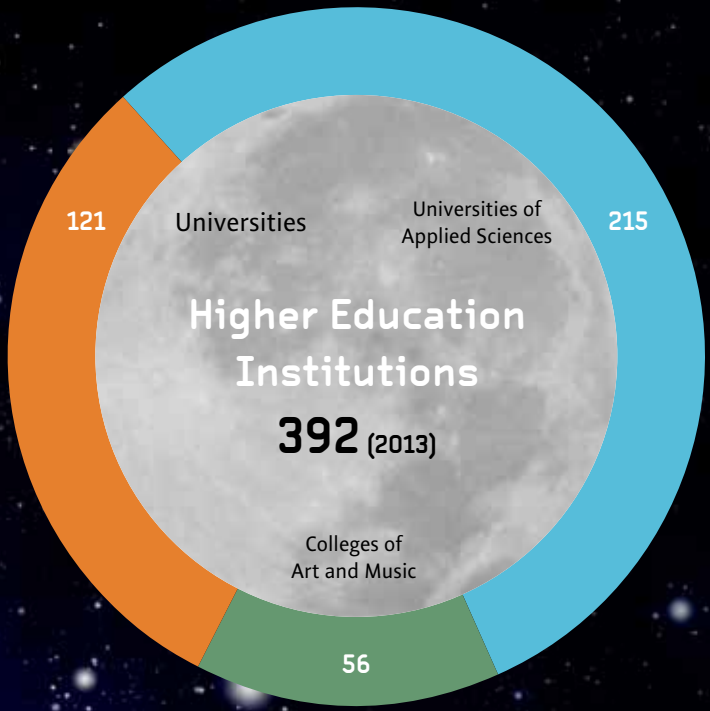
Take Leonardo da Vinci's „The Last Supper", the famous mural by the universal genius from Italy. Jesus is seated at a table with his disciples and has just revealed that one of those present will betray him. Everyone knows this Renaissance masterpiece. What is largely unknown, however, is that the same motif also appears in the works of Indian artists.

How are objects, images, themes, and perspectives transferred from one culture to another – for example, from Asia to Europe or vice versa? And how are they received and developed further? These are the key issues that occupy the approximately 200 researchers within the Cluster of Excellence "Asia and Europe in a Global Context" at Heidelberg University's Karl Jaspers Centre for Advanced Transcultural Studies.

These experts are seeking answers to exciting questions: to what extent have Kant's works influenced philosophy and logic in China? Why were images of Mao so popular during the 1968 protest movement in the West? How did the melody of the French children's song "Brother John" come to be used for propaganda purposes in China? Transculturality is the defining key word at the Heidelberg Cluster of Excellence, referring to the dynamics of exchange processes between cultures. The researchers are examining these processes in the following areas: Governance and Administration, Public Spheres, Health and Environment, and Historicities and Heritage. Experts from the most diverse areas of research are contributing their knowledge to the cluster: Egyptologists are collaborating with historians, medical scientists, Indologists, Japanologists, and Sinologists – who are, in turn, working with art historians, Islamic studies scholars, sociologists, and many others.



www.hrk.de/higher-education-in-figures



www.higher-education-compass.de

Higher Education Expenditure on Research and Development (2011)

13.4 billion EUR

Research Explorer:
The German Research Index –
over 19,000 institutes

www.research-explorer.de

www.research-in-germany.de

www.hrk.de/researchmap

Research Map:
The Institutional Research Priorities of German Universities

Quellen

Data sources

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Chart “Higher Education Institutions”:
HRK Higher Education Compass

Charts “Degrees”, “Staff”, “Higher Education Expenditure on Research and Development”:
Federal Statistical Office

Wherever required by the context, any word or pronoun written in the masculine form also includes the feminine.

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Deutsches Museum: D3
HAW Hamburg: A11
LMU München: B1,
Maqbool Fida Husain, „Last Supper in Red Desert“: G11
RWTH Aachen: D10, E6
Stefan Müller, Berlin: G3
TU Berlin: A6 (Rotorlibelle)
TU Dortmund: F10
U Bielefeld: D8, E1,
U Bielefeld, Norma Langohr: G6
U Frankfurt: B8
U Stuttgart: F9
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Witters: B7 (r)
www.toscanaviva.com/Anghiari/affresco_di_leonardo.htm: B7 (l)