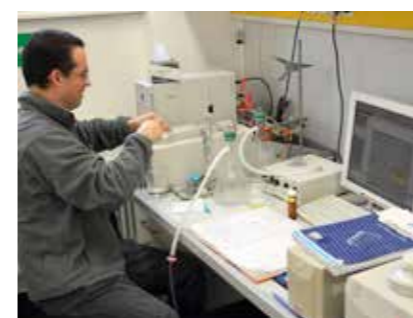
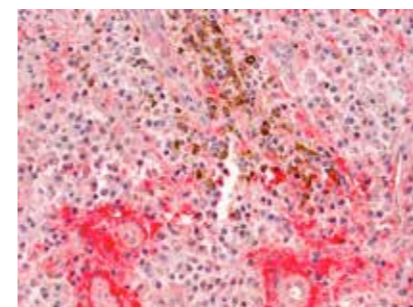


Art and Satirical Magazines: Criticism, Censorship and a New Dawn | Future of Science System: The Heart of Research | Pentecostal Movement: Power, Powerlessness and the Holy Spirit | Microsystems: Tapped Energy | Periodontitis: Inflammatory, Chronic and Highly Complex | Systemic Conservation Biology: Clarity Through Complexity



Cover: http://digi.ub.uni-heidelberg.de/diglit/pan1895_96_1/0001

Artistic and playful: A PAN cover from 1895. A digitisation project in Heidelberg is making an exceptional collection of art and satire magazines available online.



Commentary

Peter Strohschneider

The Heart of Research

2

On the future of the German research system and its funding

News

DFG Offices Reporting from Abroad

4

Moscow, Tokyo and New York – promoting international cooperation

Humanities and Social Sciences

Maria Effinger

Criticism, Censorship and a New Dawn

6

A unique collection of illustrated art and satirical magazines goes digital

Heinrich Wilhelm Schäfer

Power, Powerlessness and the Holy Spirit

12

Encounters with the Pentecostal movement in Guatemala and Nicaragua

Portrait

Britta Voß

Communicative Spaces

16

Architect Gesine Marquardt defines dementia-friendly environments

Engineering Sciences

Peter Woias

Tapped Energy

18

How technical microsystems can be used to enhance energy harvesting

Portrait

Rembert Unterstell

The Data Whisperer

22

Robert Schober and innovations in mobile communications research

Life Sciences

James Deschner, Søren Jepsen, Andreas Jäger

Inflammatory, Chronic and Highly Complex

24

New findings on understanding, preventing and treating periodontitis

Ulrich Brose

Clarity Through Complexity

28

Analysing networks today to predict the natural ecosystems of tomorrow

Natural Sciences

Alfred Blume and Jörg Kreßler

Multi-talented Membranes

32

Models help decode the basic properties of complex cell membranes

Peter Strohschneider

The Heart of Research

There is a danger that the debate regarding the future of the German research system will be reduced to the level of organisational conflicts. More important, however, is to consider the main purpose of research and how it should be organised in order to make the system as productive as possible.

One of the enjoyable duties of the President of the DFG is to reflect in these pages on key issues in research, research funding and science policy. I am, of course, not the only person to do this, but I have the pleasure of doing so on a regular basis.

Currently, the most pressing issue in German research is the debate regarding the future of our country's research system. This debate will lead to decisions that will define the structures of research for a whole generation. It is hardly surprising, then, that this is a highly complex matter that touches on many different issues and challenges relating to research, its organisation, its funding, and the policies by which it is governed – a complexity which must also be seen against the backdrop of the financial crisis and the German election campaign.

It is in the midst of this debate that I have taken office as the new DFG President. And when a new officeholder speaks, the audience expects to hear something new – a programmatic stance, perhaps, that will set the tone for all that follows. I am aware of these expectations, even if I am not in the position to accommodate them. One measure of the institutional quality of the DFG is the fact that it ensures continuity when changes in personnel occur. The organisation would not function if it did not enjoy the confidence of its members, of those who seek funding and of all those who contribute to the self-governance of research through the DFG, most of whom do so voluntarily, out of a fundamental commitment to the self-administrative principle itself.

The current research policy debate calls for a certain reserve where large programmatic gestures are concerned. At one level, this debate deals with technical, detailed questions (constitutional amendments, coop-

eration models, the right to award doctorates, project cost structures, etc.), while at another level it takes a bird's-eye-view of the research system as a whole. The relationship between the two, between the details and the big picture, is not, however, always clear: What might seem a promising solution to a specific problem may prove to be a mere narrowing of perspective; an apparent answer to a large-scale question may end up receding further into the distance, the closer we seem to be moving towards it.

So how should we approach the future development of the research system? We might start with two premises: that the complexity of modern research and modern research systems rules out simple master plans; and that questions of principle should not be confused with remoteness from reality. Some issues may appear to defy concrete definition at the present time, only to take on more solid form at a later date. Examples include the basic purpose of research and the principles on which it should be organised to make it as productive as possible.

Questions like these lead quickly to the universities and their special position within the research system. Only they bring together three things across the entire disciplinary spectrum: firstly, the ability to create the previously unthinkable, i.e. the formative potential of modern research, particularly basic research, motivated as it is by pure curiosity; secondly, the expectations and challenges faced by society; and thirdly, the intrinsic nature of research itself in addressing these expectations and challenges – involving not only concrete problem-solving but also new, fundamental, theoretical approaches in the interest of serving society. Research is more than just a means to a defined end; it is a cultural commodity.



Research and Innovation, and the Higher Education Pact. Policy-wise this might be achieved with a systematic framework agreement for the joint funding of research by the federal and state governments, which, through constitutionally expanded opportunities for collaboration, allows the various research functions to be carefully coordinated and creates financial scope to significantly improve core support for the universities.

This brings us to the DFG. If the universities are essential to the functioning of the research system, then the funding of university-based research must take this into account. This perspective in particular defines the DFG's specific role and responsibility.

The functions and performance of individual parts of the research system are important. Even more important, however, are those of the system as a whole. This system is effectively organised in an intricate arrangement of universities, non-university research institutions and funding organisations. However, a careful balance must be struck: between the different functions and qualitative levels of scientific activity (cutting-edge research would not be possible without a solid basis of "normal" research); an institutional balance between universities and non-university research institutions; and a balance and organisational separation of research and funding organisations.

This balance could serve as the guiding principle for joint action. What is certain is that the instruments with which policymakers shape the organisational and functional structure of the research system will be more effective the better they help maintain this balance.

An approach of the kind I am suggesting would allow us to outline – and begin to fill in – a framework on the basis of which the DFG will engage in the debate on the future of the research system. The continuation – and, I hope, the progress – of this debate will remain a topic to be addressed in the future.

Professor Dr. Peter Strohschneider
is President of the DFG.

It is this complexity which makes the universities the very heart of research, which sets them apart from the other institutions in the research system, and because of which we still need high-performing universities. The special position of the universities must be taken into account by the knowledge society in considering the future development of the research system, in all questions at issue: academic federalism; the relationship between teaching and research and between university and non-university research; the organisation of research and research funding; the proportional relationship between basic and third-party funding and between research carried out on a project basis and that pursued as an on-going task; and finally, the ongoing development of the Excellence Initiative, the Pact for

Building Connections

German-Russian collaboration: Clusters of Excellence and Collaborative Research Centres present themselves in Moscow



Illustration: DFG Office Russia / Jean Casparian

As part of Russia's Germany Year, the Russian Foundation for Basic Research (RFFI) and the DFG hosted a one-day workshop at the Presidium of the Academy of Sciences (RAN) in Moscow. The chosen theme was "Prospects of German-Russian Scientific Cooperation in Clusters of Excellence (EXC) and Collaborative Research Centres (CRC)", and researchers and academic administrators from both countries spoke about opportunities for expanding joint research activities.

The DFG and the RFFI have been funding bilateral projects involving researchers from Germany and Russia since 1995, but there is also growing mutual interest in long-term collaborations in large-scale research networks. So in 2012 the two organisations signed an agreement to expand the joint funding of International Research

Training Groups and Collaborative Research Centres. The recent workshop was designed to present funding programmes and opportunities on both sides.

Spokespersons for German Clusters of Excellence and Collaborative Research Centres travelled to Moscow to present their interdisciplinary long-term projects and opportunities for collaboration, particularly in the natural sciences, geosciences and engineering sciences. Russian research was represented by the directors of leading institutes of the Academy of Sciences and the administrations of federal and national research universities.

In view of the great public interest in research clusters, the discussion centred around new prospects for international cooperation. These were debated in a panel discussion with political and

business representatives. The event was supported by the German Embassy in Moscow and the German Centre for Research and Innovation (DWIH).

Clusters of Excellence are internationally visible research and training institutions at German universities. They are being funded by the DFG until 2017 through the Excellence Initiative of the German federal and state governments, each cluster receiving up to €35 million. Collaborative Research Centres receive DFG funding for a period of up to twelve years. Both programmes may include universities and non-university research institutions from abroad and business and industry partners for the purpose of knowledge transfer.

www.dfg.de/russia

Exchange Visit

Guests from Japan

In early March three research managers from the Japan Science and Technology Agency (JST) spent a week in Germany as part of the Personnel Exchange Training Programme, visiting the DFG and other research and funding organisations.

The JST team met German colleagues at the DFG's Head Office in Bonn, the Berlin office and a CRC review meeting, where they had the opportunity to discuss their areas of work and working methods. The recent visit is an indication of the excellent working relationship with Japan. The DFG has its own office in Tokyo.

www.dfg.de/japan/en

It was a memorable and forward-looking occasion on 28 February/1 March 2013, when twelve Heuss Professors from Germany and their colleagues from the New School for Social Research came together in New York City. The conference, entitled "Social Research in a Transforming World: Transatlantic Conversations" was held to mark the 50th anniversary of the Heuss Professorships, set up by the German government as a mark of gratitude, respect and recognition for the role of the New School during the Nazi period.

The New School for Social Research was founded in 1934 as a University in Exile to give sociologists who had been forced to flee the Nazi regime a new academic home. The Theodor Heuss Professorship, named after the first president of the Federal Republic of Germany, is held for a period of

50 Years of Heuss Professorships

DFG and New School hold conference in New York



Illustration: DFG Office North America / New York

one year by leading German sociologists. In his welcome address, DFG President Peter Strohschneider (far right in group photo) called the New School a "mythical place"

for anyone who is concerned with the history of German universities in the 20th century. Six panels, each consisting of equal numbers of Heuss and New School Professors, discussed topics such as "Globalisation and Inequality" and "The Future of Critical Theory". A public evening lecture was given by Prof. Wolfgang Streeck, the Heuss Professor for 2013, on the subject "The Crisis of the European State System".

There are plans to hold further conferences of this type, and the DFG has earmarked funds to initiate research collaborations for Heuss Professors.

Dr. Eva-Maria Streier

is the director of the DFG Office North America in New York.

A more detailed report:

www.dfg.de/en/dfg_profile/head_office/dfg_abroad/north_america/reports/2013/130326_new_school_bericht/index.jsp

DFG Office North America:
www.dfg.de/northamerica



Illustration: CDZ

Wen Jiabao meets foreign experts: Immediately prior to the Chinese Spring Festival, the then Chinese premier received 20 foreign experts in the Great Hall of the People for a 90-minute exchange of thoughts. In his address he stated that in spite of China's strong economic upturn, the country could only rise to the challenges of the future with an innovation-driven economy and an open society. China has long valued the input and collaboration of experts from abroad. Dr. Heike Strelen, director of the Sino-German Centre (CDZ) (front left in our photo), was invited to the event in recognition of the centre's twelve years of work in Beijing. The CDZ funds bilateral partnerships in basic research.

www.dfg.de/en/dfg_profile/head_office/dfg_abroad/beijing

Maria Effinger

Criticism, Censorship and a New Dawn

Around the turn of the twentieth century, art and satirical magazines flourished. Their agenda and aesthetics set the standard for the art and literature of the art nouveau movement. Now a digitisation project in Heidelberg is making a unique collection of magazines available online.

The first edition of *Jugend* – *Münchener illustrierte Wochenzeitschrift für Kunst und Leben* (“Youth – Munich’s Illustrated Weekly on Art and Life”) appeared on 1 January 1896. The new publication was bold, fresh and not in the least bourgeois – as indicated by the cover picture of the first issue, which depicted an ice-skater. *Jugend* would eventually give its name to one of the most influen-

tial international styles in art and literature: “Jugendstil” or art nouveau. The magazine itself developed into one of the most important platforms for the artistic and literary scene around the turn of the century.

In its first seven years, over 250 artists contributed to the magazine. For many of them, such as painters Max Slevogt and Ernst Barlach, *Jugend* provided one of the first opportunities to present their work to a wider audience. In the early years, major names like Arnold Böcklin and Franz von Stuck had a defining influence on the artistic style. After the First World War the magazine lost its links with new artistic movements. This situation did not change until the mid-1920s, when it once again began to welcome artists of a younger generation and published texts by Kurt Tucholsky and Erich Kästner and drawings by George

Cover of the first edition of *Jugend*, published in 1896. The magazine was a platform for “Jugendstil” or art nouveau. Right: Censorship! This caricature by André Gill depicts the situation of a caricaturist who must walk “on eggshells” without knowing what topic will fall victim to the censors.

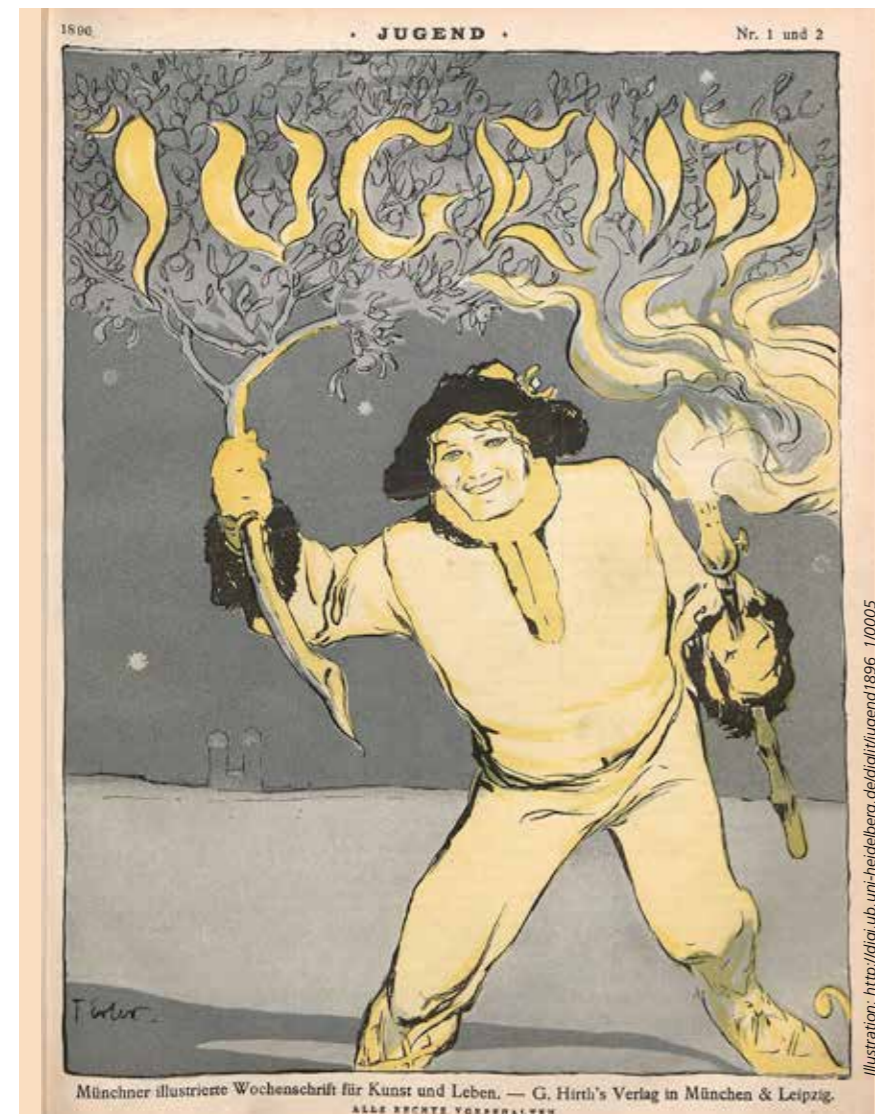


Illustration: http://digi.ub.uni-heidelberg.de/diglit/jugend/1896_1/0005



Illustration: <http://digi.ub.uni-heidelberg.de/diglit/jugend/1871/0110>



Title vignette of *Fliegende Blätter*. After the magazine was confiscated on several occasions, the publishers relocated the setting to "the Orient" (below). This is why all the characters in the 1856 volume wear Oriental dress.



Grosz. The magazine's adaptation to the art policy of the National Socialist party marked the end of *Jugend*, and it ceased publication in 1940.

The richly illustrated weekly paper *Fliegende Blätter*, which was also published in Munich, first appeared in 1844. Appreciated by contemporaries as a medium for a biting and satirical look at the Ger-

man bourgeoisie, it is now valued as a compendium of humorous criticism of the times. For almost a century *Fliegende Blätter* recorded the "mood of the nation" and became the most widely read satirical paper in Germany. As well as a mix of humorous poems, sentimental novellas, tricky puzzles, fantastical tales, humorous wordplay, ironic sayings and political jokes, the magazine also featured affection-

ate caricatures and satirical picture stories. Well-known characters in the serial stories included the bureaucratic "Staatshaemorrhoidarius" (Count Franz von Pocci) and the travellers Baron Beisele and his private tutor Dr. Eisele (Kasper Braun). Between 1854 and 1857, *Fliegende Blätter* was the platform for Weiland Gottlieb Biedermaier, the pseudonym used by Ludwig Eichrodt and Adolf Kussmaul. This

invented name came to refer to a whole era in art history.

The magazine's high production quality gives it an importance in artistic and printing terms. Its founder, Aschaffenburg-born Kaspar Braun, founded the publishing company Braun & Schneider together with Regensburg bookseller and children's author Friedrich Schneider. By training its engravers, and after 1885 with the introduction of the galvanising process, the company achieved astonishing printing capacity from the woodblock. This opened up new possibilities in illustration.

These are just two examples of the 40 illustrated art and satirical magazines dating from the 19th and early 20th centuries that have been digitised and made available online by Heidelberg University Library as part of a DFG-funded project launched in 2009. The list also includes well-known publications such as *PAN*, *Die Graphischen Künste*, *Der wahre Jacob*, *Deutsche Kunst und Dekoration*, *Kunst und Handwerk* and *Kunstwart*. The aim of the project is not only to give unrestricted digital access to this important historical source material, but also to index the text and images in detail. Publications were selected for inclusion on the basis of their historical significance and practical research benefit. Source works that can only be consulted in a special reading room must be protected against intensive use to ensure their long-term preservation. Making the material available online and offering intelligent data processing also enables instant, direct access from any location.

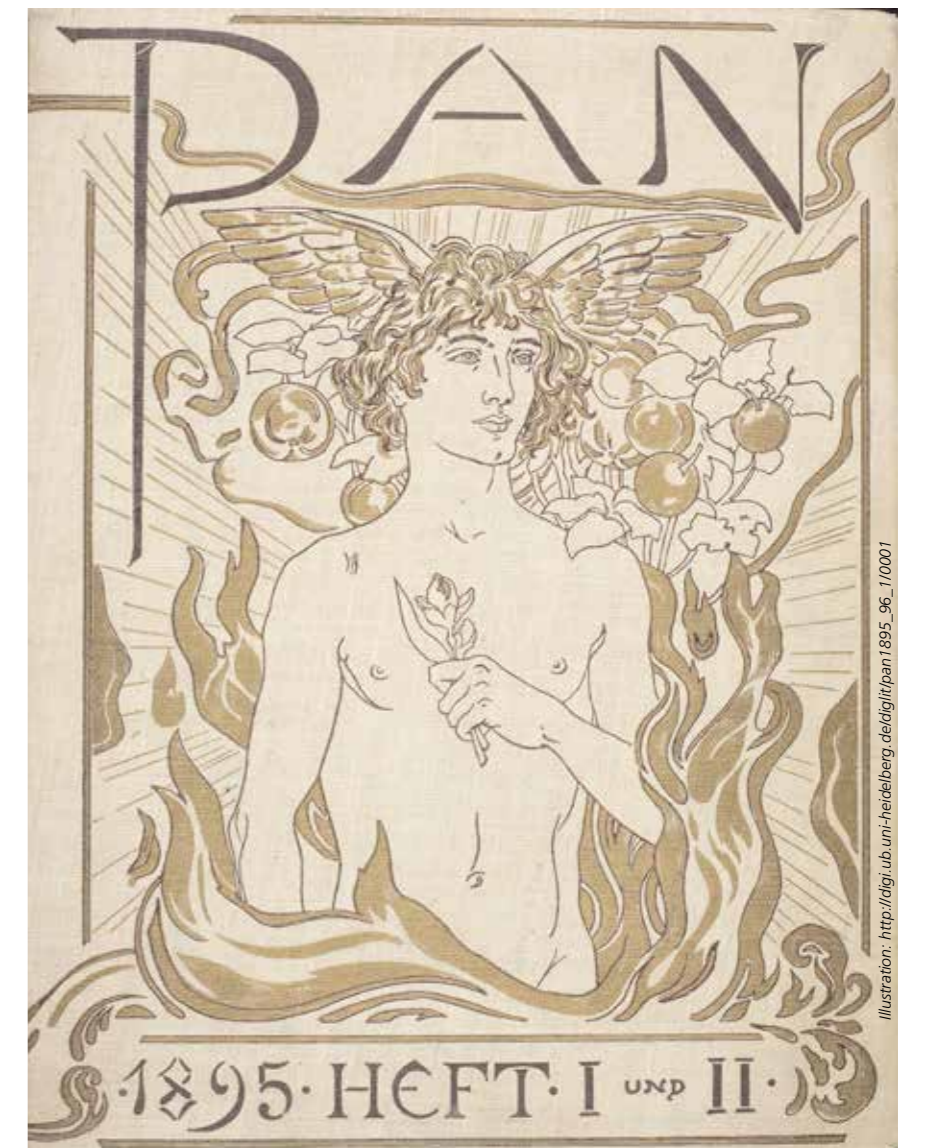
Once the magazines have been carefully digitised in the library's own digitisation centre, readers

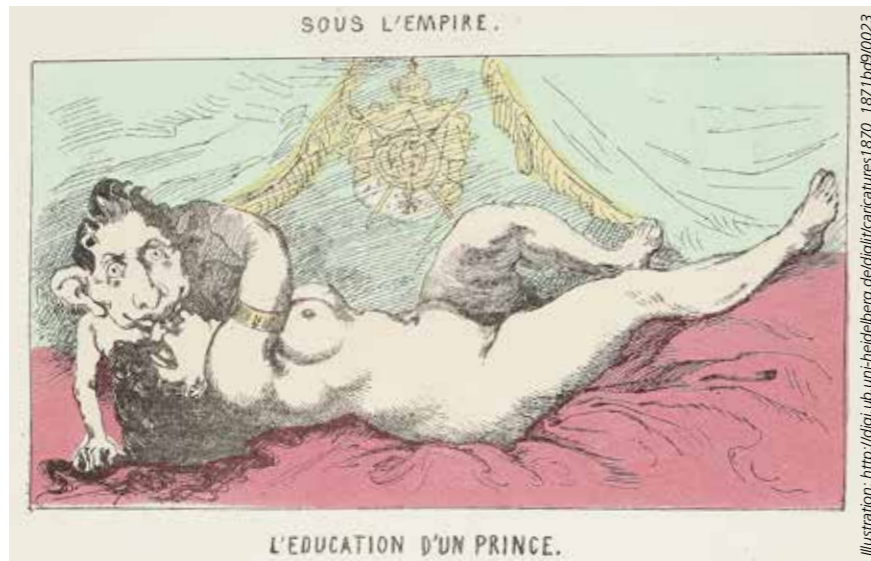
can simply browse through them on screen, and navigate within a publication using extensive search functions. For example, a full-text search is available for all volumes in modern fonts. All illustrations from the satirical magazines are also being added to an image database and indexed for study by art historians. Researchers will be able to search the database by artist, title, subject and iconographic mo-

tif. Essays from the art magazines will be included in library indexes for the purposes of national and international networking. Individual illustrations will be available to researchers on art and cultural history portals and in image databases.

These new means of access will also be offered for an omnibus of French satirical magazines and caricatures from the period of the Franco-Prussian war (1870–1871)

Ornate and playful cover image: *PAN* magazine, published in Berlin between 1895 and 1900, is considered one of the major platforms for the *Jugendstil*.





This erotic caricature entitled "L'education d'un prince" is taken from a French collection from the time of the Franco-German War of 1870/1871.

and the Paris Commune. This is another focus of the Heidelberg project, the reason being that in nineteenth-century France, magazines featuring satire and caricature, individual caricatures and humorous series of images enjoyed such popularity that in retrospect it can

be described as a "golden age" of caricature. The period from 1867 to 1885 saw the establishment of over 150 publications, many of which were short-lived. In spite of the considerable restrictions imposed by censorship, the caricatures portray political, cultural and social life in all

Below: In the digitisation centre at Heidelberg University Library – the collection of illustrated art and satirical magazines is scanned and then electronically indexed.



its diversity. Contemporary figures and current events are presented in a manner that is astute, amusing, often exaggerated and occasionally irreverent. They also provide a broad insight into the French press, and with their wide range of subjects and motifs, are of interest to more than just art historians.

Heidelberg University Library acquired its collection through a legacy from international London-based bookseller Nikolaus Trübner (1817–1884). In 1885, Trübner's valuable and extremely rare collection of French satirical magazines and caricatures made its way to Heidelberg. The collection includes the rare Parisian magazines *L'Éclipse*, *Le Grelot*, *Le Sifflet*, *La Scie* and *Le Fils du Père Duchêne*. Famous caricaturists and draughtsmen such as André Gill, Albert Humbert, Faustin Betbeder, Henri Demare and Alfred Le Petit were among the illustrators. Their work was frequently published under a pseudonym to protect the author.

The highlights of the Heidelberg collection are nine large-format volumes bound in red leather containing almost 2000 broadside caricatures. Outside Heidelberg, volumes like these can only be found in four British libraries. Politicians and members of the imperial family are favourite targets of criticism. Frequently recurring themes include the siege and capture of Paris, people and events during the Paris Commune, and day-to-day Parisian life. Often, the lithographs are accompanied by humorous or even sarcastic commentaries.

In order to exert influence, be it aesthetic or political, a magazine must express opinions, take up a position and defend it. German and



French caricature of the crowning of Emperor William I in 1871: The emperor, wearing the crown of Napoleon III and holding the imperial orb, enters Paris accompanied by Otto von Bismarck, who leads the emperor riding on a pig to the Arc de Triomphe.

Austrian art magazines from the turn of the century are prime examples of this, providing a vehicle for contemporary aesthetic ideas like no other medium. In this way they helped to raise the international profile of pioneering artistic developments and encouraged a European cultural exchange.

The illustrations in the likes of *PAN* or *Jugend* served as pattern books, so to speak. Their vignettes

and decorative borders, designed as book decorations by major artists of the period such as Henry van de Velde and Peter Behrens, were later incorporated in architecture, furniture and tableware. All the art magazines selected for inclusion in the project played an important role in the artistic advent of the modern age, serving to propagate it and providing commentary. The art nouveau move-

ment, which at the dawn of the 20th century radically broke with the tradition of imitating historical styles, is largely owed to the influence of *Jugend*. In its fruitful dual role as documentary witness and opinion-forming platform, it continues to charm and fascinate people today. The same applies to the caricatures of any period which serve to articulate and condense public discourse. Satirical drawings were produced by artists and in many cases bought and kept by collectors. It is therefore unsurprising that artists, art audiences and the art business should not escape the caricaturist's pen.

It is no overstatement to say that as central sources, both art magazines and satirical magazines with their caricatures are essential to our understanding of the art history and cultural history of the 19th and early 20th centuries. The process of digitisation acknowledges the scarcity value of these historical documents and conservation concerns. The wealth of information these sources have to give us can now be studied more effectively on screen and, we hope, provide a rich resource for different areas of study.

Dr. Maria Effinger

is the head of the Department of Manuscripts and Early Printed Books and a specialist in art history at Heidelberg University Library.

Contact: Universitätsbibliothek Heidelberg, Plöck 107–109, 69117 Heidelberg, Germany

DFG-funded project: Digitisation and Indexing of Illustrated Art and Satirical Journals of the 19th and Early 20th Centuries



www.ub.uni-heidelberg.de/Englisch/helios/fachinfo/www/kunst/digilit/artjournals/Welcome.html

Heinrich Wilhelm Schäfer



Illustration: Ariadny Brito & Tiago Bertulino / www.tiagobertulino.com

Power, Powerlessness and the Holy Spirit

In countries such as Guatemala and Nicaragua, a large proportion of the population belongs to the Pentecostal movement. Encounters with this faith community provide researchers with insights into a complex of religious practice, social inequality, and violence.

Brothers, we stand before the reality of the agents of Satan with their extraordinary and supernatural powers. (...) And we are the agents of God, the Almighty! So I believe, brothers, we are at the beginning of a worldwide conflict between the satanic powers and their agents and the

genuine power of the agents of God."

This warlike rhetoric, which might almost seem to be taken from a Hezbollah radio broadcast, was delivered by an upper middle-class Pentecostal preacher during the Guatemalan civil war. His words represent the growing

presence of religious movements and organisations in political life. They presuppose an environment in which interpreting and coping with life on the basis of religious belief appears to be the only reasonable choice.

A poor indigenous Indian farmer has a different story to tell:

"The soldiers dragged my brother-in-law out of his house during the night. When he was found the next morning, he had been tortured and his throat had been cut. (...) Now the Bible itself says that when the end of the world is approaching, all these things will happen."

Both statements date from the time of the civil wars in Guatemala and Nicaragua and were recorded as part of a research project carried out by the author in the mid-1980s. They point to characteristic differences associated with the social status of the speakers.

The first, a professional preacher, belongs to the upper middle class, for whom war and economic crisis brought about a crisis of their upward mobility. He swears himself and his fellow believers to a strategy of power and influence: We can bind all the powers of darkness ...! The second opts for a retreat into his congregation. This is the only security one has: to prepare oneself in order to be ready to meet the Lord. Both men belong to the Pentecostal movement that has spread rapidly in Latin America since the 1960s. Its members believe in the ecstatic experience of the Holy Spirit, await the coming of the Kingdom of God, and frequently emphasise the autonomy of local churches.

However, sociological observation reveals that both men, who supposedly share the same Pentecostal theology, derive quite different religious beliefs and social and political strategies from it.

Thirty years after my first research project in Guatemala and Nicaragua, the marked polarisation of war-torn societies

has given way to greater social and political diversity. Opportunities to participate in political life have significantly increased. The Pentecostal churches have also become more diverse. The wealth of Pentecostal symbolism, and the freedom with which its different aspects may be combined produce very different variations of religious practice in different social classes, age groups, and marginal social groups.

In both countries, for instance, violence has changed its face. It is no longer military, but crime is all-pervasive in civil society. A belief in the protection of the Holy Spirit creates a feeling of security. In many impoverished areas of the large cities, for example, one of only two laws prevails: the armed law of the drug dealers on the streets or the law of the "Lord of

Hosts" in the churches. For young people, in particular, the Pentecostal churches often provide the only opportunity to escape the gangs, to banish the "demons of violence", and to seek an alternative means of social integration.

The fight for social participation has also changed. The price of having a share in the aspirations of the emerging middle classes is extreme pressure – the threat of sliding down the ladder again in the event of the smallest slip in discipline. Services at middle-class Pentecostal churches supply an antidote to stress and burnout and special career coaching – all through the power of the Holy Spirit and of the Risen Christ. Religious shows at so-called megachurches respond to these expectations by driving out the "demons of failure" or "despondency" and

Left: A mass baptism in São Paulo. Below: Rural poverty in Guatemala.



Illustration: Natalie Fobes / Corbis



Left: Heartfelt prayer, seen here before a baptism, is an integral part of charismatic religion. Below right: Intercessory group prayer with the blessing of a boy at a service in Guatemala.

cesses with their social environment, many classic questions in religious sociology return to the fore: the function of religion as a way of coping with uncertainty; the relationship between Max Weber's status groups, social classes, and religion; the delineation of a specific religious sphere as opposed to a political or economic sphere; and the transformation of religious identities into cultural and political strategies. The decisive factor in religious practice is, of course, to use Max Weber's words, the "subjective meaning" that actors ascribe to their actions: their religious beliefs.

Our approach, which is based on the sociology of Pierre Bourdieu and his theory of practice, allows us to view these perspectives all together. It enables us to reconstruct the beliefs of religious actors within the context of their experiences and within a framework of social competition and functional differentiation – as religious practice. This approach combines the examination of subjective religious meaning with questions relating to the sociology of authority and differentiation. On this basis we developed the method of "habitus analysis".

This method allows us to make use of qualitative material such as interviews, sermons, texts, and web presentations, as well as visual documents and ritual practices. It is based on the simplest of assumptions: that all human beings

are expounding to audiences the goals of a quasi-entrepreneurial self-management.

In the wake of democratisation, this form of religious practice is also acquiring greater social influence through better opportunities for political participation. Individuals and organised groups can be politically active not only by exercising the right to vote and joining political parties, but also through civil engagement at local level. Within this context, the leadership elite in Pentecostal churches are becoming increasingly aware of their social importance. By providing social care, private schools, and even urbanisation projects, they are competing with the state and evolving into powerful non-governmental organisations. Some religious leaders are even setting up their own political parties and putting forward presidential candidates – a fact which is viewed

with scepticism by members of many small Pentecostal churches in marginalised areas.

The Catholic Church is particularly sceptical, because Pentecostalism has grown to become a serious competitor. Having begun in the USA in the early 20th century, the movement quickly spread to Latin America, where it has grown with great rapidity since the 1970s. Today almost 45 percent of the population of Guatemala belongs to the Pentecostal or the Evangelical faith, while the figure in Nicaragua is about 40 percent. In Guatemala the movement competes with a Catholic church that tended to be rather critical of the state, while in Nicaragua it is in the shadow of a Catholic hierarchy that is traditionally closely allied with power.

To understand the complex interactions of these religious pro-

accumulate positive and negative experiences and interpret these in a manner relevant to them, whether religious or non-religious. Experiences and interpretations relevant to the actors in question can thus be methodically compiled in a system. In this way the analysis reveals a network – a cognitive map of religious actors which can be interpreted within the context of their environments.

This method of analysis sheds light on the examples given at the beginning. It becomes possible to explain why the "agent of God" with the power of the "Holy Spirit" not only drives out the demons of war-related stress (be it alcoholism, bulimia or paranoia), but also the demons of the trade



unions and the guerrillas – and why he supports the elimination of the indigenous Indian population by the military regime. It also becomes clear why the farmer retreats into his congregation and hopes for the end of the world. Finally, it becomes obvious why the Pentecostal farmer has nothing in common with the above quoted Pentecostal preacher, nor wishes to have, but in fact fears him.

This approach has been continuously developed over the course of 30 years of research on religion by the head of the current research team. During a nine-year academic appointment in Latin America, it was amply validated through other empirical studies partly involving members of the Pentecostal church. Since 2006, it has been tested and refined at Bielefeld University in projects on religious peacemakers in Bosnia and Herzegovina (a DFG-funded project), religious styles in Argentina, religious diversity in Mexico, as well as a comparative study on Islamic and US fundamentalism. A research project based on this approach is currently being carried out in Guatemala and Nicaragua – the field research areas of the project head in the 1980s.

It is intended that the synchronic comparison of the two countries will later be complemented by a comparison between the situation in the 1980s and the situation today. This 30-year period has seen the end of the guerrilla wars and the arrival of peace processes involving religious actors. Social inequality has become more marked and violence has gone from being a military phenomenon to being a phenomenon of civil society. In

view of the changed social environment, it is likely that we will uncover significant change in religious beliefs and practice.

A wealth of evidence points to increased political activity on the part of various religious groups – in contrast to what is referred to (primarily) in Europe as "secularisation". The extent to which these activities contribute to peace or conflict, and the effect of the growing influence of religion on society and politics, are questions that remain to be examined.



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This article was written by Prof. Schäfer as Fellow at the Lichtenberg-Kolleg of the University of Göttingen.

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Britta Voß

Communicative Spaces

People with dementia often experience problems with orientation. To make everyday life easier for them, hospitals and nursing homes require architectural modification. Emmy Noether junior research group leader Dr. Gesine Marquardt is a pioneer in this area.

She develops recommendations for living spaces for people with dementia who have lost their sense of orientation – from large, clearly marked toilet doors to straight corridors and permanent common rooms as points of reference. Dementia – the feared disease that dramatically alters thinking, perception, memory and orientation to place and time – affects 1.3 million people over the age of 60 in Germany, and the figure is continuing to rise.

It is amid this alarming situation that Marquardt carries out her academic research. The 38-year-old is

primarily concerned with orientation aids for people with dementia. Over the next five years, she and her Emmy Noether group intend to develop a set of criteria to help hospital wards prepare for the growing number of dementia patients through appropriate architectural design. “For many dementia patients, a hospital is currently just a stopover on the way to a nursing home,” says Marquardt. For this reason, she believes hospital wards have a responsibility to take every possible step to improve quality of life and where possible the degree of independence for these patients.

At the Agaplesion Bethanien Hospital in Heidelberg, Marquardt has found a hospital which already has some experience in creating “dementia-friendly” environments. In 2004 a ward was specially equipped for patients with both physical and neurodegenerative diseases.

The geriatric internal ward for acute dementia patients (GISAD) is led by managing senior physician Dr. Tania Zieschang. Many of the recommendations made by Marquardt on the basis of her previous studies are in evidence on the ward. What makes the hospital’s task difficult is the fact that dementia patients often react with confusion, anxiety or aggression to a situation that is new to them, such as a stay in hospital. GISAD is therefore separate from the other wards and the exit is designed to look like a section of wood-panelled wall and not a door. This prevents patients from wandering off without knowing where they are going.

For a more relaxed atmosphere and to make the ward more manageable for both patients and staff, the number of patients is limited to six. Marquardt believes that, in addition to other factors that have not yet been sufficiently researched, such as the use of colour and light, the layout of a ward determines how well patients are able to move about and orient themselves within it. “Basically, either patients can find



Illustration: DFG/Voß



Illustration: Gerd Altmann / pixelio.de

Left: Gesine Marquardt designs “dementia-friendly environments” for people who have lost their orientation to place and time.

their room or they can’t. It may sound mundane, but it’s essential to the wellbeing of a person with dementia,” she explains.

Marquardt had to do a lot of research to obtain this insight. In her doctoral thesis she analysed and compared the design of around 30 dementia wards at nursing homes throughout Germany. Using a standardised questionnaire, she surveyed nursing staff on the ability of 450 residents with different severities of dementia to cope with everyday life.

She discovered that the previous assumption that dementia patients can orient themselves better in a circular layout cannot be scientifically substantiated. “A corridor with lots of turns and changes of direction is simply too confusing for someone with dementia,” she says. A straight corridor, on the other hand, punctuated by visual “anchor points” such as a group of chairs, pictures, or col-

lages representing everyday environments like an office or shopping centre facilitates orientation.

Ever since her student days, Marquardt has been engrossed with the question of how to design an environment that communicates with patients by giving them clues as to where they are. She studied architecture in Dresden and Stuttgart and at the New York Institute for Technology. During a placement at an architect’s office in Munich, by chance she found herself involved in planning a hospital refurbishment. “I was fascinated by the way in which processes in surgery, for example, could be translated into a floor plan,” she recalls. “I realised for the first time the responsibility the architect has in places to which people are ‘shipped’, so to speak, such as hospitals or nursing homes.”

After graduating she spent some time working at another architectural firm. In 2001 she became a research assistant to the chair of

Social- and Healthcare Building and Design in the Department of Architecture at the Technical University of Dresden (TU Dresden) and since then her work has been in the overlap between architecture and health research.

Marquardt’s work breaks into new academic territory. In 2008 she won the Deutscher Studienpreis awarded by the Körber Foundation for her doctoral thesis, while the book of her dissertation, entitled “Criteria in Dementia-Friendly Architecture”, has sold over 500 copies – exceptionally high for a specialist title. In 2011, together with a fellow architect, she set up universal-RAUM in Dresden, which provides consulting services for healthcare architecture as well as undertaking other projects. As a group leader of the first Emmy Noether group for architecture, which began to receive DFG funding in 2012, Marquardt now hopes to establish a new field of research: architecture and demographic change. She might justifiably describe herself as a pioneer in this field.

Pragmatic, practical and real: these qualities apply equally to Marquardt herself and to her work. When she talks about her research, you can sense her desire to make things happen; “transfer” is a word she uses a lot. Her research work is still in its early stages. And even if designing contemporary architecture for hospitals and nursing homes only deals with one aspect of living with dementia, the results so far carry the promise of further recommendations that can be translated into real design. In our ageing society, that is precisely what we need.

Britta Voß

was a trainee in the DFG Press and Public Relations Office.

Peter Woias

Tapped Energy

Whether in an espresso machine or a bulldozer – embedded technical microsystems are in demand. Through “energy harvesting”, it should be possible to supply them with power from their immediate surroundings, without the need of batteries or power cords.

They have long been indispensable in our daily lives, but they are often inconspicuous and familiar only to the specialist. In every motor vehicle, numerous networked sensors do their jobs: they determine the temperature of the motor oil, control the air conditioning in the interior or measure the air pressure of the tyres. In modern residential and office buildings, wireless, radio-controlled switches and sensor systems serve to monitor ventilation or lighting. And, during the transport of expensive or perishable goods on the road, data loggers – which are affixed to the goods – record physical shocks or temperature curves to detect unpermitted conditions. This handful of examples demonstrates that there are many “distributed and embedded systems” in our modern, high-tech world. They are the nodes of small and large networks that supply us with information and often support us inconspicuously.

A fundamental dilemma arises in the event of a malfunction of these embedded systems. If the battery in a cell phone, MP3 player or navigation system fails at the decisive moment, a problem with which all embedded systems are faced is made apparent to us: the more we distribute these system nodes, the more the distance between them increases and the deeper we embed them at their

place of use, the more difficult it is to supply them with power.

With permanently installed systems, power is usually supplied via a cable. As a result of this, local power grids grow into our technical infrastructure. For instance, the total length of the electrical wires in a medium-size car is about three kilometres. The currently largest passenger aircraft in the world carries approximately 500 kilometres of cable through the air. Power grids are, however, susceptible to failure, heavy and expensive – furthermore, they must be installed, extended and maintained manually. Moreover, astonishing numbers can be calculated for the energy transported through such a “small” power grid in relation to the energy used for its production: For instance, the fabrication of one metre of a thin, three-core copper wire consumes as much energy as would be required to supply a small, embedded low-power sensor for approximately 30 years. In other words: We provide “power highways” as roads for a “few bicycles”.

Batteries are used in mobile systems but are only seldom a good alternative: from a technical perspective, temperature, vibration and corrosion set narrow limits, as do maintenance and disposal from an economic point of view. According to figures from the German Federal Environment Agency, batteries with

a total weight of 33,000 tons were sold in 2004. Due to the heavy metals contained in this “mountain of batteries”, the environmental balance is poor even with ecologically sound disposal and recycling. Furthermore, the manufacture of batteries is disproportionately energy intensive. In addition, while it may only take seconds to change a battery, e.g., in a wireless thermometer in the kitchen, it means a stressful medical intervention for the wearer of a cardiac pacemaker, which is a good example of an “embedded”, i.e. not easily accessible system.

“Energy harvesting” stands for a novel concept that reliably supplies distributed and embedded systems – preferably robust and low-power microsystems – with power without cables or batteries. This technology uses the same principle as biological energy systems. In other words: the electrical energy is “harvested” from the surroundings. The concepts for harvesting energy are manifold, as are the resources of ambient energy: Mechanical energy from vibrations, sound or fluid flow can be captured with piezoelectric, electromagnetic or other generators, thermal energy can be captured with thermoelectric converters, energy from light can be captured with solar cells and chemical bond energy can be captured with microbial fuel cells.



The electrical energy is collected in a storage element and rationed via an intelligent energy management system in such a way that the system node can reliably perform its task. The University of Freiburg has been – and is – researching energy conversion, energy storage and energy management in the Research Training Group “Micro Energy Harvesting” with 20 doctoral researchers since 1996. The “micro” in the name is a clear indicator that the required quantities of energy do not need to be large for today’s embedded systems: a cardiac pacemaker requires about 10 microwatts, a watch needs just 5 microwatts.

From this arises the vision for energy self-sufficient systems: their system nodes supply themselves with energy. Power grids and battery changes are no longer needed. Another advantage: they function in places that have been difficult or impossible to access. For example, in the interior of automobile tyres, in medical implants and all types of technical systems – from espresso machines to bulldozers. The system is expanded simply by installing new

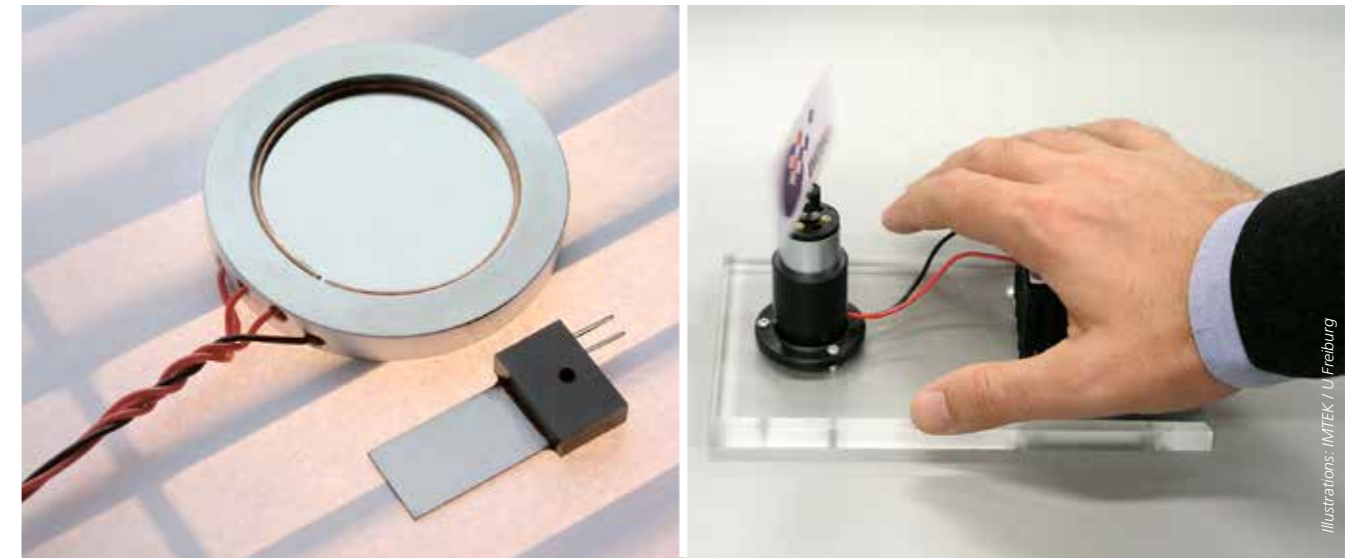
nodes. The result is a “living, technically active environment” made up of networking sensor nodes that are able to power themselves without intervention from us.

Where would it be sensible to use micro energy harvesting? The harvesting of energy available on or in the human body is one of the many conceivable scenarios. Using people as an energy source is not a new idea. Studies from the USA demonstrate with widespread appeal that 20 fitness enthusiasts can produce about three kilowatts of electrical power while spinning on stationary bikes. Therefore, a fitness centre with four spinning sessions per day would produce about 300 kilowatt hours per month.

Offering more promising application perspectives is “incidental” or “unobvious” energy harvesting: The Seiko company, for example, introduced a watch in 1998 that used the heat from the wrist as an energy supply. Over ten years ago, the Massachusetts Institute of Technology (MIT) presented a sports shoe in which various mechano-electrical generators captured energy from every step. The technology used

there interfered with the movement pattern of the wearer, however. In one study, we are currently developing an energy self-sufficient pedometer that unnoticeably harvests energy in a sports shoe during jogging to determine cadence and speed.

The Research Training Group also develops microbial fuel cells, which, as implants, will catalytically convert blood sugar, and thereby produce electrical power. This could be used to support the battery of a cardiac pacemaker and extend its operating time. We are likewise working on thermoelectric microgenerators that attempt to use both the body heat of people as well as numerous other heat sources. Applications in technical infrastructure are also conceivable: within the scope of a project funded by the BMBF, piezoelectric and thermoelectric generator systems were developed to harvest the energy in road and railway tunnels. One underlying application scenario would be a self-powered train passage detector: piezoelectric generators mounted by the rail sleeper a radio module with energy while a train passes over them. The sensor system



Left: Piezo generators convert pressure (large object) or vibrations (small object) to energy. Right: A person as a supplier of energy – here with the aid of a hand-warmth generator.

calculates the position and speed of the train in the tunnel, reports unscheduled stops and, in the event of a catastrophe, supplies the precise coordinates to rescue workers.

The “tapping” of ambient energy can be used in numerous fields of application and can already be seen in some products: the battery-free, wireless switch from the company EnOcean harvests energy when a user presses a button to then send a wireless telegram to a controller. Several automotive suppliers are working on energy self-sufficient, tyre-pressure sensors that harvest energy from impacts and accelerations in the car tyre. Also conceivable are alarm transmitters which harvest energy from malfunctions that they monitor, or “smart” pills that harvest energy from chemical processes in the digestive tract with the objective of delivering medications in defined doses or to wirelessly transmit sensor data to the outside. This latter example is indeed very old and was already realized in the 1960s with an energy-au-

tonomous gastrointestinal pH probe, known as the “Heidelberg capsule”.

But the vision has still broader applications: biological systems – the natural role models for energy harvesting – generally live according to the principle of “function follows energy”. In the long term, this approach promises revolutionary, biologically inspired, embedded systems that live a “technical life” in their surroundings. Their design and operating concept are structured in a “lifelike manner” analogous to biological principles. One key advantage: the function is maintained even if the available energy and data fluctuate. Like biological organisms, they adapt their activity to the amount of energy that is available, use various energy sources, know their stored and actual energy resources and use them efficiently.

This sentence should end the last paragraph: This radical change to an energy- and data-oriented design increases the operational reliability of embedded systems and opens completely new perspectives that go far beyond energy self-sufficiency.

At present, energy harvesting is one of the most remarkable future technologies, the significance of which is undisputed for the embedded systems of today and tomorrow. An exciting question will be whether and when we can begin to adapt other successful principles from nature for the embedded microsystems of the future to create a truly “living, technical environment”.



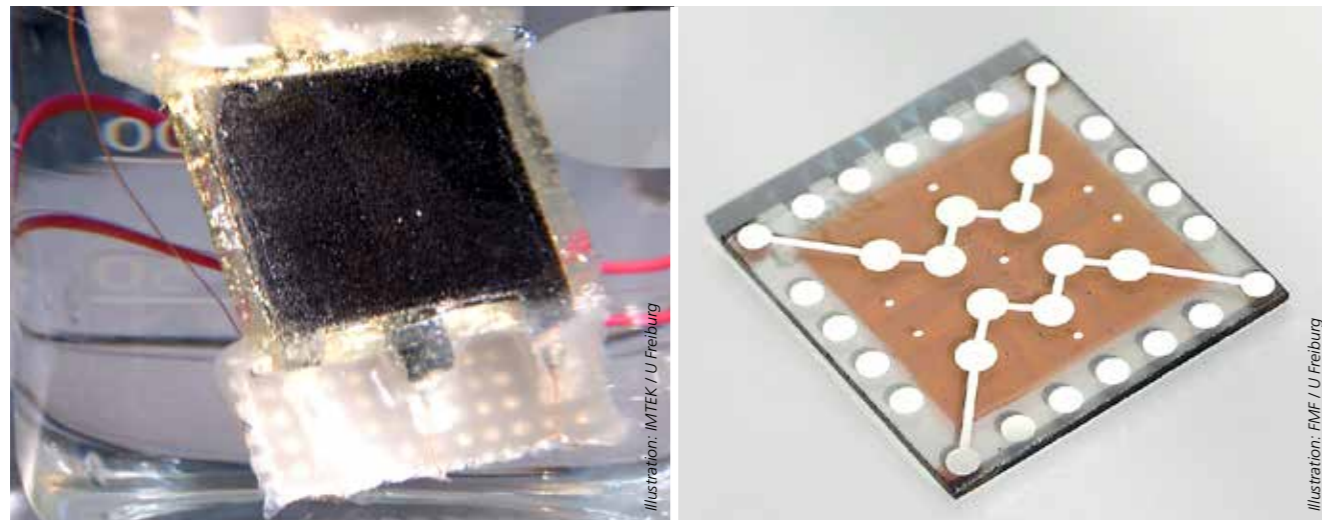
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www.micro-energy-harvesting.de
www.imtek.de

Left: Microbial fuel cell in a test container. Right: The potential of organic solar cells – shown here on glass substrate – is promising.



Rembert Unterstell

The Data Whisperer

Innovations in mobile communication: communications engineer and Humboldt professor Robert Schober works at the interface between basic research and industry. "There's nothing more practical than a good theory."

His academic career wasn't handed to him on a silver platter. Robert Schober grew up on his parents' farm in Kehl Münz, a tiny village in Bavaria, which he describes thus: "When you enter the village you can already see the sign marking the end of it." Here, opportunities like studying to get into university "simply didn't exist". Yet with great determination he succeeded not only in getting into the University of Applied Sciences in Nuremberg to study communications engineering, but also in getting a degree in electrical engineering from Erlangen University, where he soon went on to do a PhD before beginning a stellar career at two Canadian universities.

Today, Professor Robert Schober (41) is an internationally leading, multi-award-winning engineer specialising in digital transmission. A year ago, an Alexander von Humboldt professorship drew him back to the University of Erlangen-Nuremberg from the University of British Columbia in Vancouver. "I wouldn't have gone to any other university in Germany," he says. "Only home to Franconia." He and his family now live on the farm in Kehl Münz.

In Robert Schober, a down-to-earth attachment to roots and family and the dizzy heights of academic excellence don't seem to be

a contradiction. When you meet him in person in his department, he is friendly and open and obviously keen to explain his strongly mathematical area of research. You can't imagine him blowing his own trumpet any more than you can imagine him making a polished stage appearance. Schober is a man of contemplative tones – not to mention concentration.

His intense concentration is devoted to digital transmission in mobile communication and the question "How can we make communication as efficient as possible with growing data rates and minimum resource consumption?" The dramatic, previously unimagined rise in popularity of mobile phones has resulted in enormous volumes of data, more and more users and ever stricter quality requirements. But how can the capabilities of wireless communication networks and technologies keep pace with this growth? How can we increase their capacity, reliability and quality?

As a doctoral researcher of Prof. Johannes Huber in Erlangen, Schober studied what is known as "incoherent transmission". Passionate about mathematical problems from an early age, he developed new modulation and receiving techniques that exhibit greater robustness in mobile communication. He also drew on the principles of

coherent (phase-modulated) transmission such as channel equalisation, interference suppression and decoding processes and applied them to incoherent data transfer. In 2002 the DFG presented him with the Heinz Maier-Leibnitz Prize, Germany's foremost accolade for



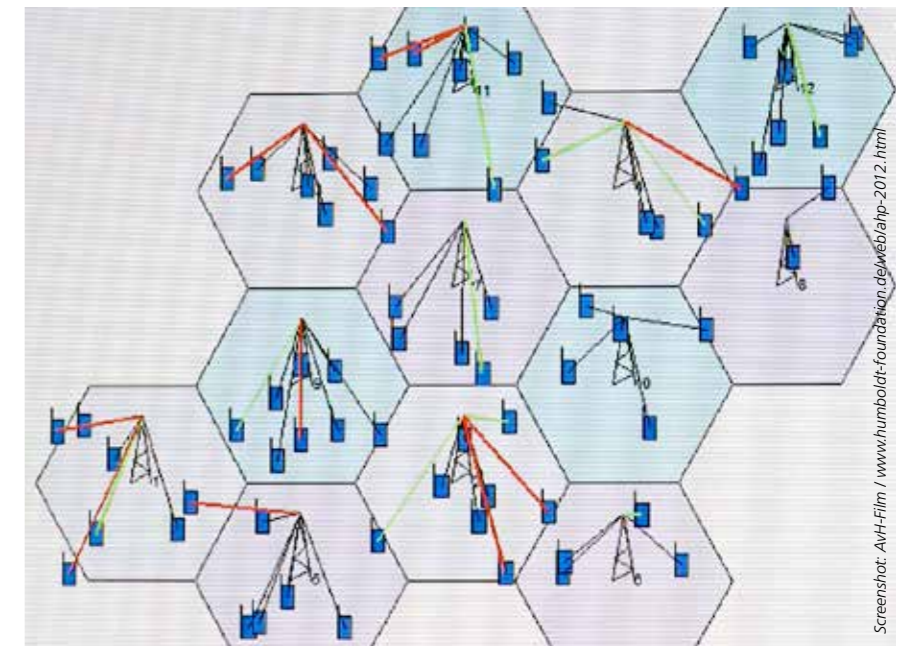
Illustration: Unterstell

early career researchers, for his pioneering work.

It was only the beginning. As part of a team of Erlangen engineers, which included his PhD supervisor, he won the Vodafone Foundation Innovation Award 2004 for the software Single Antenna Interference Cancellation (SAIC). This patented process automatically filters out interference in mobile communication networks, resulting in less voice distortion, fewer dropped calls and faster data transmission. The reduced transmission load also means lower costs. SAIC is now found on millions of mobile phone chips and mobile operators are describing it enthusiastically as a "quantum leap", at least for the globally dominant GSM standard.

But the success has not enticed Schober to move into the mobile phone industry. On the contrary, he likes "the decision-making freedom and independence of university basic research". In 2001, as a postdoctoral student expanding his area of work into multi-antenna systems, he went to Toronto before becoming Assistant Professor and then Full Professor at the University of British Columbia in Vancouver. There he was awarded the E. W. R. Steacie Memorial Fellowship, worth US\$250,000, and in Germany the Humboldt Professorship, worth €3.5 million.

What are the reasons for his success? "Encouraging mentors who demanded high standards, good luck, and a lot of hard work", says Schober. There is also the fact that his work takes place at the interface between theory and application – motivated by a principle that was well demonstrated by Gottfried Wilhelm Leibniz and Immanuel Kant: "There's nothing



Screenshot: AvH-Film / www.humboldt-foundation.de/web/avh-2012.html

The basic principles of sender/receiver communication are well understood, but in-depth research is still needed in network-wide optimisation.

more practical than a good theory." Schober's work more than confirms this dictum.

The future research agenda is already well filled. Schober, editor-in-chief of leading international journal IEEE Transactions on Communications, mentions network-wide optimisation – which requires, if not a paradigm shift, then a change of viewpoint – from a point-to-point, sender-to-receiver perspective to a whole, dynamically changing network. He also believes that the usability of communication and information theory, on which mobile communication is based, must be analysed for other potential applications. One of his doctoral researchers, for instance, is studying whether and how processes and principles in digital data transmission can be used to understand molecular cell communication in organisms.

You might expect a mobile phone specialist to have a smartphone in every shirt and trouser pocket – but you'd be wrong. Schober doesn't even own a mobile phone. "I don't want to be disturbed all the time", he says. This might seem surprising, even odd, but in actual fact it shows his consistent desire for absolute concentration on his work. For Schober, the "data whisperer", his research is about far more than knowledge for its own sake. He wants to develop theoretical concepts for mobile communication (as well as other applications), or in other words: "To develop algorithms that can be turned into innovative products with the help of industry." That is his dream as an engineer.

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

www.idc.int.de/en/mitarbeiter/heads/schober

James Deschner, Søren Jepsen, Andreas Jäger

Inflammatory, Chronic and Highly Complex

Periodontitis is a widespread disease. A better understanding of the intricate interactions between the periodontium, the oral cavity and the organism as a whole could result in more effective prevention, diagnosis and treatment of this common affliction.

Often it's not a tooth that causes a dentist concern during a check-up, but the periodontium – the tissues that surround and support the tooth. The inflammation of these tissues, known as periodontitis, is a widespread problem which, according to the latest German Oral Health Study, is becoming increasingly common. Periodontitis is a

chronic disease that leads to the destruction of the tooth-supporting tissue and is associated with gum pockets and the loosening and even loss of teeth. Periodontitis may affect a single tooth or all teeth, and may also occur in children and adolescents.

The shift in medical understanding of this disease over the

last few decades is reflected in the modern term “periodontitis” – the suffix “-itis” indicating that it is an inflammatory disease and not, as previously assumed, an age-related degenerative disease (referred to as “periodontosis”). Periodontitis is caused by certain bacteria in dental plaque. Although we know that the likelihood of periodontitis is

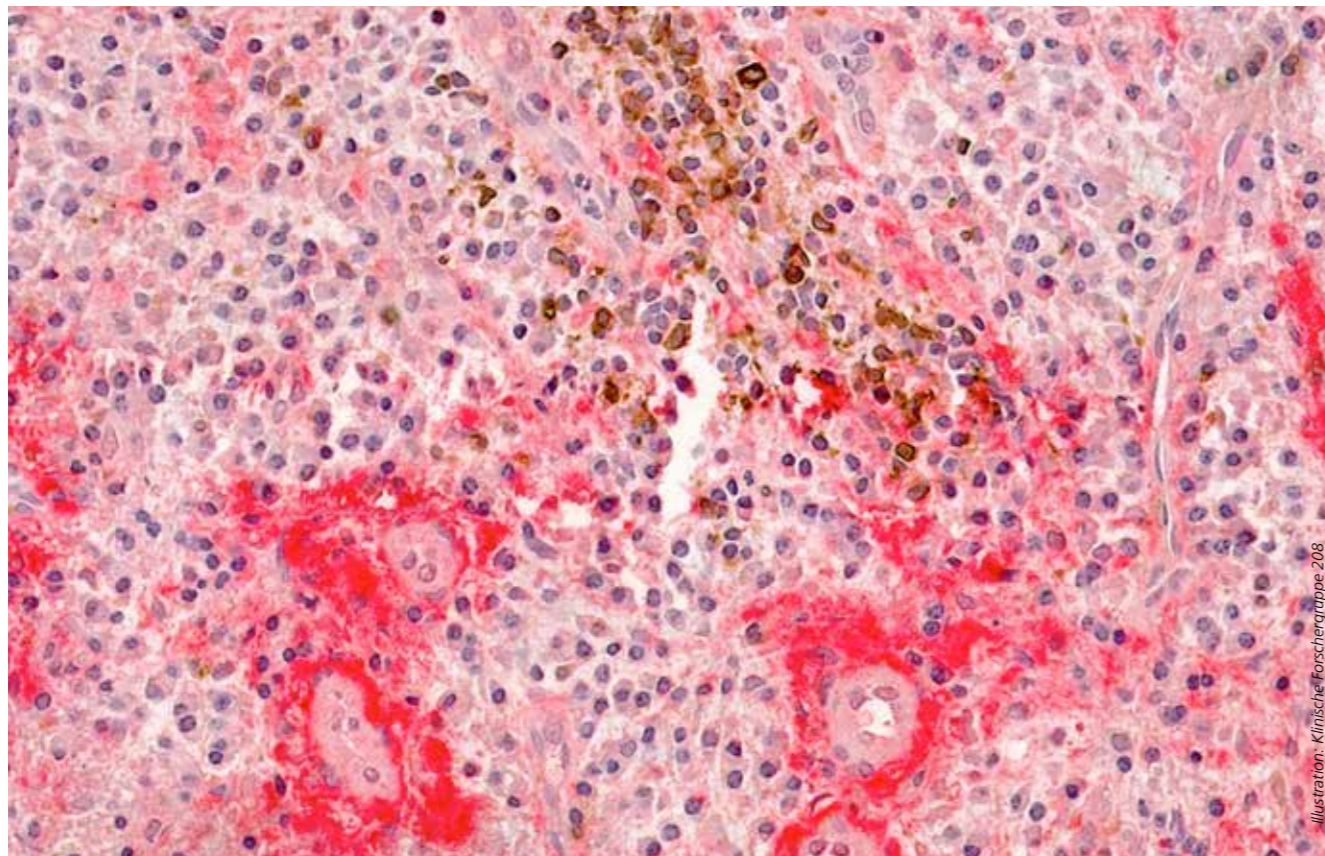


Illustration: Klinische Forschungsguppe 208

increased by other factors, such as smoking, heredity and certain diseases of the whole organism, there are still many research questions that remain unanswered.

The Clinical Research Unit “Aetiology and Sequelae of Periodontal Diseases – Genetic, Cell Biological and Biomechanical Aspects” is seeking to achieve a better understanding of the causes of periodontitis and therefore more effective prevention, diagnosis and treatment. One of the key questions is: Why do some patients succumb to periodontitis in spite of good oral hygiene while others remain unaffected? Everyday experience in clinical and dental practice shows that there are considerable differences in individual susceptibility to bacterial problems in the oral cavity and the way in which the organism reacts to them. These differences are partly due to our genes, but as yet we have little idea which genes are actually involved. The analysis of genetic risk factors is therefore a crucial aspect of the work of the Clinical Research Unit. Some genes or gene sequences have already been identified as risk factors for periodontitis, but the picture is still incomplete.

How does the periodontium become inflamed in the first place? Periodontitis starts when the bacteria in plaque provoke inflammation of the gum – a process involving many of the body's immune cells. These cells release inflammatory molecules and enzymes which fight the bacteria but also cause the destruction of the periodontium. As long as the inflammation remains

Affected gum with cells producing inflammatory molecules (brown).



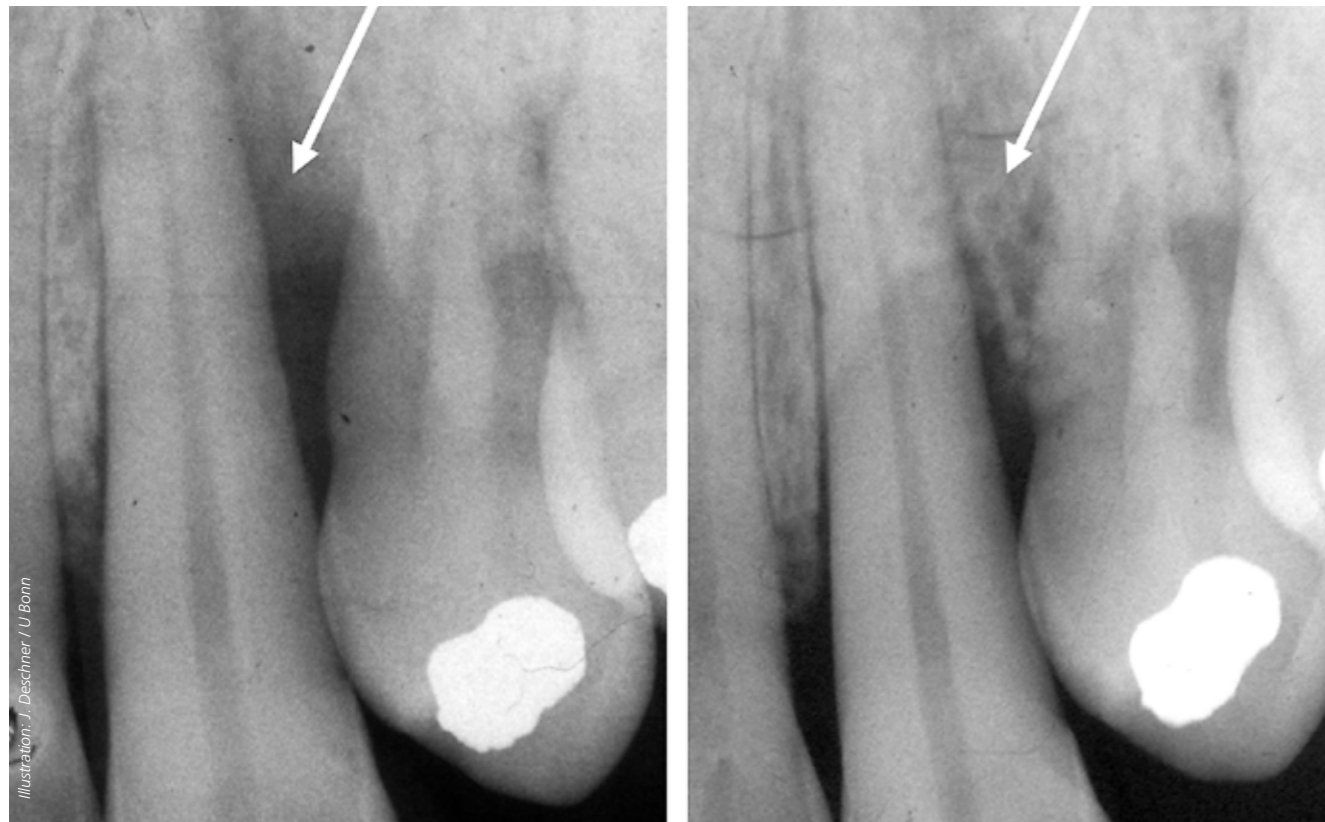
Illustrations: J. Deschner / U. Bonn

Above: Measuring a gum pocket with a periodontal probe. Below: The bone loss resulting from periodontitis becomes visible during a gum operation.



limited to the gum (a condition known as gingivitis), all these processes are reversible. But if the processes of inflammation and destruction spread to the underlying tissue of the periodontium, the result is periodontitis. Previously it was assumed that periodontitis was caused by the reduced function of the immune cells. However, it now appears that in periodontitis patients these cells actually overreact, encouraging the destruction of the periodontium.

At present we have only a partial understanding of which immune cells are involved in the inflammation of the periodontium and exactly what role they play. Our basic research is therefore also concerned with studying inflammatory processes and the presence and localisation of special immune cells in the periodontium in affected patients. The study of inflammation has shown that cells release a multitude of antibacterial molecules in order to fight a



In the X-ray on the left, bone loss is clearly visible. The image on the right shows partial regeneration ten months after special periodontitis treatment. Below right: Regular check-ups are essential for periodontitis patients.

bacterial infection. However, more detailed research is still required to establish the extent to which these antibacterial substances are produced by the cells of the periodontium itself and whether they could be used in diagnosis, risk assessment and treatment for periodontitis. Research carried out to date suggests that cells in the periodontium produce various antibacterial molecules when stimulated by periodontitis bacteria, and that these molecules can in turn influence cell behaviour – a complex set of interactions.

Whenever the patient chews or brushes the teeth, bacteria from the periodontium enter the bloodstream. The more ad-

vanced the periodontitis, the more bacteria there are. These bacteria and their components can then directly damage the cells of the blood vessel walls or stimulate immune cells in the blood to secrete inflammatory molecules. As a result, the concentration of inflammatory molecules in the blood rises. The circulation then carries these inflammatory molecules to all parts of the body, where they may again change blood vessel cells and also inhibit glucose uptake in the body's cells. We can see, then, why periodontitis increases the risk of cardiovascular disease and can cause the onset or worsening of diabetes.

The negative effects of periodontitis are also illustrated by the

fact that treatment for periodontitis can improve vascular function and reduce blood sugar levels in people with diabetes. Conversely, diseases of the whole organism can promote the onset and progression of periodontitis. There are still many unanswered questions as to the causes of the various interactions involved in this disease. For example, we want to find out what effect periodontitis has on the regenerative capacity of vascular wall cells and, conversely, the extent to which the restoration of blood vessel function can result in improvements in the periodontal tissue.

Experiments to date suggest that when periodontitis is present, fewer “replacement cells”

are produced by the bone marrow, significantly reducing the regenerative ability of a damaged vascular wall. Periodontitis is also associated with oral tumours. An interdisciplinary project is currently underway to find out what mechanisms could be responsible for this.

If periodontitis is left untreated the destruction of the periodontium may progress unimpeded, eventually resulting in the loss of teeth. However, periodontitis can now be successfully treated. The main aim of treatment is to reduce or eliminate periodontitis bacteria in gum pockets using special instruments and procedures. In some cases, surgical intervention or the use of antibiotics may be necessary. Treatment can halt or slow further destruction of the periodontium,

although it is not usually possible to rebuild lost tissue. However, with the help of modern treatment methods, regeneration of the periodontal tissue is sometimes achievable – although it is currently very difficult to predict the results of regenerative treatment. A range of factors may be responsible for this, for example bacterial infection, inflammation, excessive loading to the teeth or disease of the organism as a whole.

The Clinical Research Unit is therefore examining the question of how periodontal regeneration can be supported and what conditions might be conducive to or indeed optimal for this process. Studies indicate that various growth factors, parathormone and enamel matrix proteins have the potential to support regeneration of the periodontium. However, inflammatory processes, heavy chewing and molecules from fat tissue can all inhibit this regeneration-promoting effect. The age of the patient also influences the success of the treatment. The awaited results should help to improve periodontal regeneration and make it easier to predict the outcome.

One question that has already been mentioned is whether and how the level of use of the teeth, for example through chewing, contributes to periodontitis. Computer models are used to simulate different conditions in the periodontium to predict how increased chewing, for example, affects the progress of the disease. A factor closely linked to periodontitis and chewing force is tooth mobility. Researchers are therefore trying to develop a special apparatus to measure this factor. It is hoped that the careful measurement and re-

coding of changed tooth mobility will improve accuracy of prognosis and treatment planning for patients with periodontal disease.

It is clear that periodontitis is a highly complex disease and research for the purposes of prevention, diagnosis and treatment of periodontal disease is and must be equally complex. Interdisciplinary collaboration outside the limits of dental medicine is essential to the development of new treatment concepts and the reduction of health risks to the whole human organism.



Prof. Dr. James Deschner is the leader of Clinical Research Unit 208 and Professor of Experimental Dento-Maxillo-Facial Medicine.

Prof. Dr. Dr. Søren Jepsen is a spokesperson for Clinical Research Unit 208 and director of the Department of Periodontology, Operative and Preventive Dentistry.

Prof. Dr. Andreas Jäger is a spokesperson for Clinical Research Unit 208 and director of the Department of Orthodontics.

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Ulrich Brose

Clarity Through Complexity

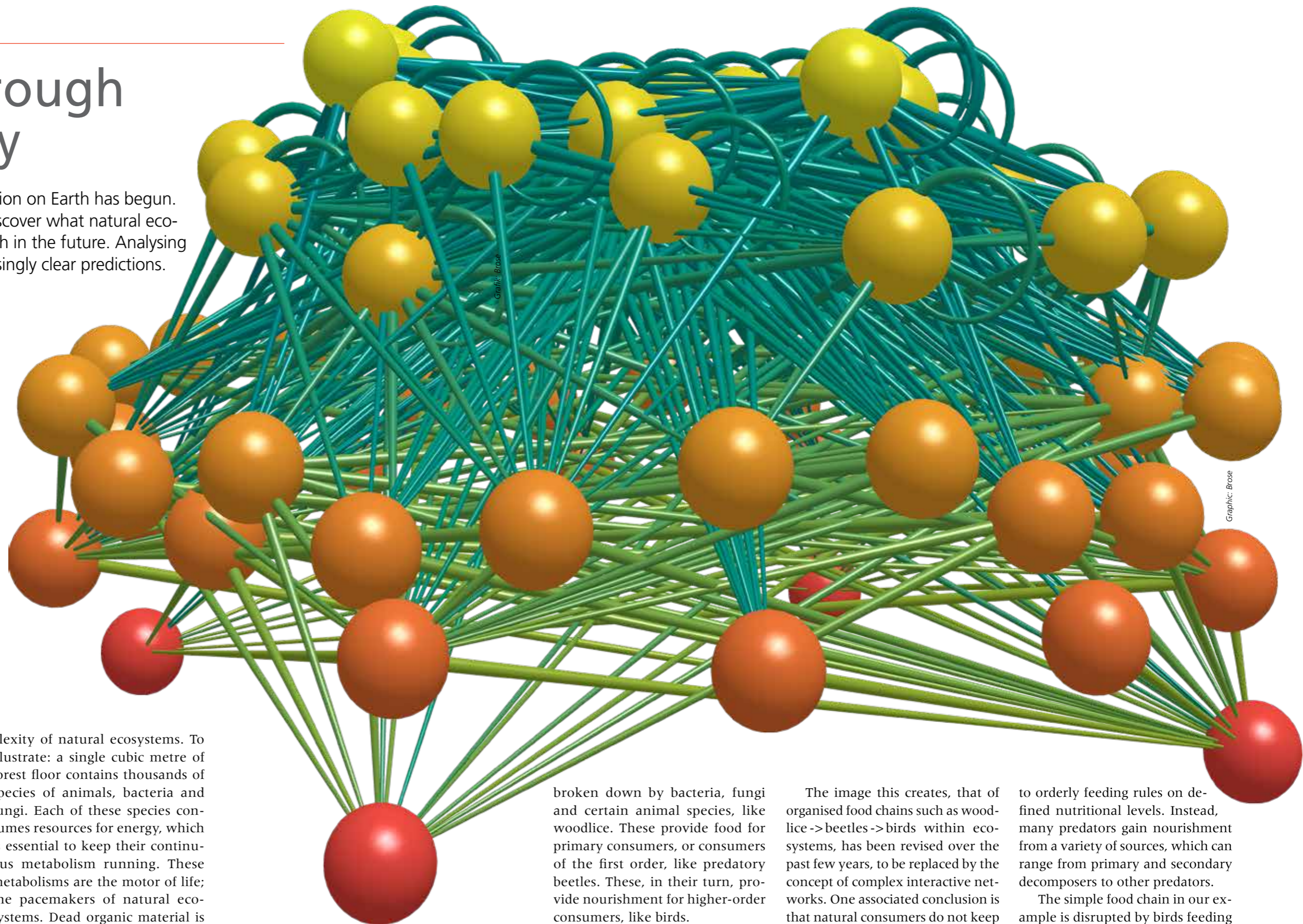
The sixth wave of species extinction on Earth has begun. Research is already looking to discover what natural ecosystems will have to contend with in the future. Analysing networks has led to some surprisingly clear predictions.

In total, five major waves of species extinction have shaken the diversity of our planet's flora and fauna to its foundations. During each of these waves, more than 80 percent of the existing species were irrevocably lost. These included both primeval trilobites (an extinct group of marine arthropods, a family, which also includes insects and arachnids), which today can only be admired in their fossil form, as well as vertebrate groups like dinosaurs.

The previous waves of extinction made deep inroads into global species diversity, and its causes are still a controversial topic of discussion. In contrast, the causes of the current, sixth "extinction wave" are both more diverse and less disputed: intensive use of land by man is displacing, reducing and destroying the natural habitats of many species and changing the global climate in a way that will have far-reaching consequences. The following questions are, therefore, becoming increasingly urgent: "What effects will these processes have on individual ecosystems – and how can they be predicted?"

Until now, attempts to explain these have been made more difficult by the diversity and com-

plexity of natural ecosystems. To illustrate: a single cubic metre of forest floor contains thousands of species of animals, bacteria and fungi. Each of these species consumes resources for energy, which is essential to keep their continuous metabolism running. These metabolisms are the motor of life; the pacemakers of natural ecosystems. Dead organic material is



broken down by bacteria, fungi and certain animal species, like woodlice. These provide food for primary consumers, or consumers of the first order, like predatory beetles. These, in their turn, provide nourishment for higher-order consumers, like birds.

The image this creates, that of organised food chains such as woodlice -> beetles -> birds within ecosystems, has been revised over the past few years, to be replaced by the concept of complex interactive networks. One associated conclusion is that natural consumers do not keep

to orderly feeding rules on defined nutritional levels. Instead, many predators gain nourishment from a variety of sources, which can range from primary and secondary decomposers to other predators.

The simple food chain in our example is disrupted by birds feeding

on beetle and woodlice populations. This creates complex nutritional networks, which link all the species in an ecosystem through their interactions. These also preserve ecosystem functions, which are important for human population, such as the decomposition of organic leaf mulch in forests.

In these complex ecological networks, the fate of one species is closely entwined with the fate of all other species in the same ecosystem. In these interaction networks, the extinction of a species can send a shock wave, like an earthquake, through the network from species to species. The extinction of one species changes the circumstances of its direct consumer and resource species, causing their numbers to decline and potentially leading to secondary extinction. If, for example, woodlice were to die out, the beetles' main source of food would be reduced, as would – indirectly – that of the birds. This could lead to the extinction of these species. When this process develops a momentum of its own and ripples through the network like a cascade, we call this a secondary extinction wave.

This avalanche-like perpetuation of the wave through various ecosystems makes secondary extinctions particularly dangerous. At

Ecological microcosms (r.): The prognoses produced using network models are tested in miniaturised worlds. Below: A forest ecosystem comprises both above- and below-ground habitats.

the same time, the cause and effect (the primary and secondary extinction) are often separated from each other by many years. The effects of current human intervention in our ecosystems will not be visible until years later.

This type of process can be compared to taking out a loan in which the amount of interest actually levied becomes apparent only at the end of the term. The true costs of human land and resource usage are currently not calculable. We are in the middle of a global experiment and do not yet know whether our earth's ecosystems will survive the sixth wave of mass extinction with their primary functions intact. Questions arise: Which species will disappear in the long term? What will the natural ecosystems of the future look like? And which ecosystem functions will be reduced or eliminated entirely? The search for answers requires scientific methods, which can predict the effective interest levied on our ecosystems.

Ecological network research has achieved significant break-



throughs over the past decade. Patterns have been detected in the network structures, which show that “who-eats-whom” interactions are not randomly distributed. Instead, they are highly organised. Clear rules based on the average species body mass define, which creatures can physically overpower and consume which other creatures. This creates an “architecture of natural ecosystems” in which the smaller species tend to form the basis of the ecological

network, while large species are often the systems' top predators. This conspicuous structuring of systems according to body mass has been discovered and documented in both aquatic and terrestrial habitats.

At the same time, there is a close correlation between species body mass and metabolic rate. Large species have more complex respiratory systems and correspondingly larger energy requirements than smaller species. These

initially simple, universal correlations can be used to build models of ecological networks, which both predict the network architecture of interaction and define the metabolic engine of the ecological processes. These create dynamic models of ecological networks with interactions between populations and between the biological processes of respiration, growth, death and consumption. These network models facilitate new predictions of the consequences of species extinction, enabling the process to be studied using ethical, long-term methods.

Analysis of ecological network models has shown that large species are particularly significant in stabilising ecosystems. If these species die out, the risk of secondary extinctions increases, and the interest levied on the ecosystem is particularly high. This results in major shifts in the population densities of other species. Species with highly dense populations are particularly affected. In the long term, these density shifts in the species fabric can lead to secondary extinctions. This can have dramatic consequences for the remaining species in the network and undermine the stability of important ecosystem functions. It is significant that the decisive

role of a species with a large body mass was determinable only using complex models of ecological networks. Simple, strongly simplified models, like those represented by simple food chains, generated considerably more complex results with numerous, partly incalculable parameters.

These and other results suggest that it is easier to predict the consequences of species extinction using complex models of ecological networks than to do so using simplified models. At the same time, they also pave the way for simple and implementable action plans aimed at reducing the interest levied on natural ecosystems by protecting species with larger body masses. This type of action plan might, at least, mitigate the consequences of the sixth wave of extinction.



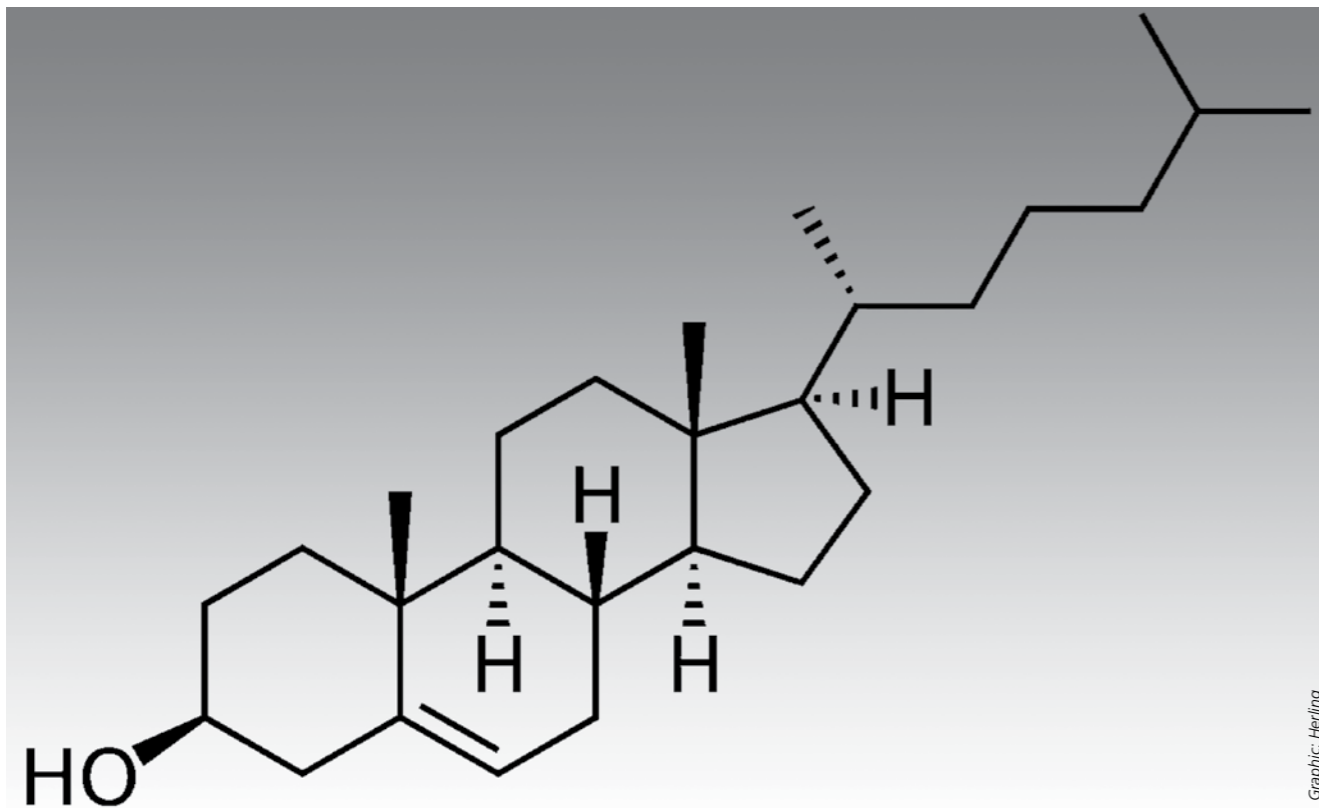
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www.uni-goettingen.de/en/189430.html



Alfred Blume and Jörg Kreßler



Graphic: Herling

Multi-talented Membranes

Between bridge and barrier: The structure of cell membranes is exceedingly complex. But their basic properties are often more easily decoded using model membranes of lesser complexity. This area of research is of significant relevance to biomedicine.

As is generally known, cell membranes surround living organisms, protecting the interior of the cell. But a closer look reveals that what keeps cells together is more than just a plain shell. The structure of cell membranes is extremely complex, their functions numerous and as yet poorly understood. To understand the basic characteristics of cell membranes, we need to study how cells are constructed and how they work. To do this, researchers use model membranes with a defined, reduced complexity.

To take a familiar example, we use molecules with both hydrophilic (water-loving) and hydrophobic (water-repellent) properties every day in the form of soap. The hydrophobic part of the soap molecules, which consists of long hydrocarbon chains, surrounds the dirt particles while the hydrophilic part – the carboxyl group – allows them to be dissolved by the water. But these versatile molecules aren't just useful for washing our hands. So-called amphiphilic molecules (with both hydrophilic and

lipophilic properties) also occur in nature – in the form of lipids in cell membranes. As well as lipids, they include transmembrane proteins and peripheral proteins – for example in the form of the cytoskeleton, which is needed to give the membrane mechanical stability as the lipids are arranged in a bilayer in a liquid crystal state, making the membrane as flexible as a rubber wall.

Essentially, the membrane consists of a hydrophobic inner part of fatty acid chains, which is sepa-

Left: Structural formula of a cholesterol molecule. The flexibility of biological membranes is controlled by other molecules, for example embedded cholesterol.

rated on both sides from the aqueous phase by the hydrophilic head groups of the lipids. This keeps both aqueous compartments, within and outside the cell, separate from each other. The inner part of the membrane bilayer is completely hydrophobic, and this is what constitutes the barrier to the exchange of substances. However, nature has created channels that transport water and ions through the membrane wall with the help of proteins. This enables the constant transport of substances into and out of the cell, allowing it to be continuously supplied with nutrients, sugar and oxygen.

Products of metabolism also have to be constantly transported out of the cell. The organism is made up of a large number of cells of very different types. If all the lipids from every cell in the human body were spread out flat, they would cover an area the size of a football pitch.

One major class of lipids forming part of natural membranes are the phospholipids. These are glycerol esters, compounds consisting of an alcohol (in this case glycerol) and acids, which also occur in fats. The main difference between these and “normal” fats is that the third hydroxyl group of the glycerol is linked to phosphoric acid, which in turn is linked to a further short-chain alcohol. This makes the molecule “amphiphilic”.

One example of a phospholipid is phosphatidylcholine, also known

as lecithin, which is widely used in the food processing industry and food technology. It is added to bakery products to prevent the dough from sticking and is also used as an additive in chocolate to achieve the desired consistency. The flexibility of biological membranes is also controlled by other molecules, for example cholesterol. Cholesterol is an essential component of the cell membrane because it increases its stability.

Phospholipids are chemically unstable at high temperatures and low pH levels because the fatty acid chains can be cleaved off. So the phospholipid membranes themselves become unstable under these conditions. But to enable survival in hostile conditions, such as a pH of 1 or a temperature of 90 degrees Celsius, nature has a solution – just like the Archaea, which can also exist in tough conditions. In these single-cell microorganisms, evolution has produced a class of substances called bolaamphiphiles to build the cell membrane. These molecules consist of two long non-polar hydrocarbon chains connected at both ends to a polar head group by ether bonds. This results in a mechanically and chemically more stable membrane that can withstand the harsher conditions found in environments such as volcanic lakes.

Because both sides of the cell membrane are in contact with aqueous phases, the molecules present in the solutions can interact with the membrane. The most simple form of interaction is the

Aesthetically beautiful: Lipid domains in a monolayer on the water surface, imaged with a fluorescence microscope.

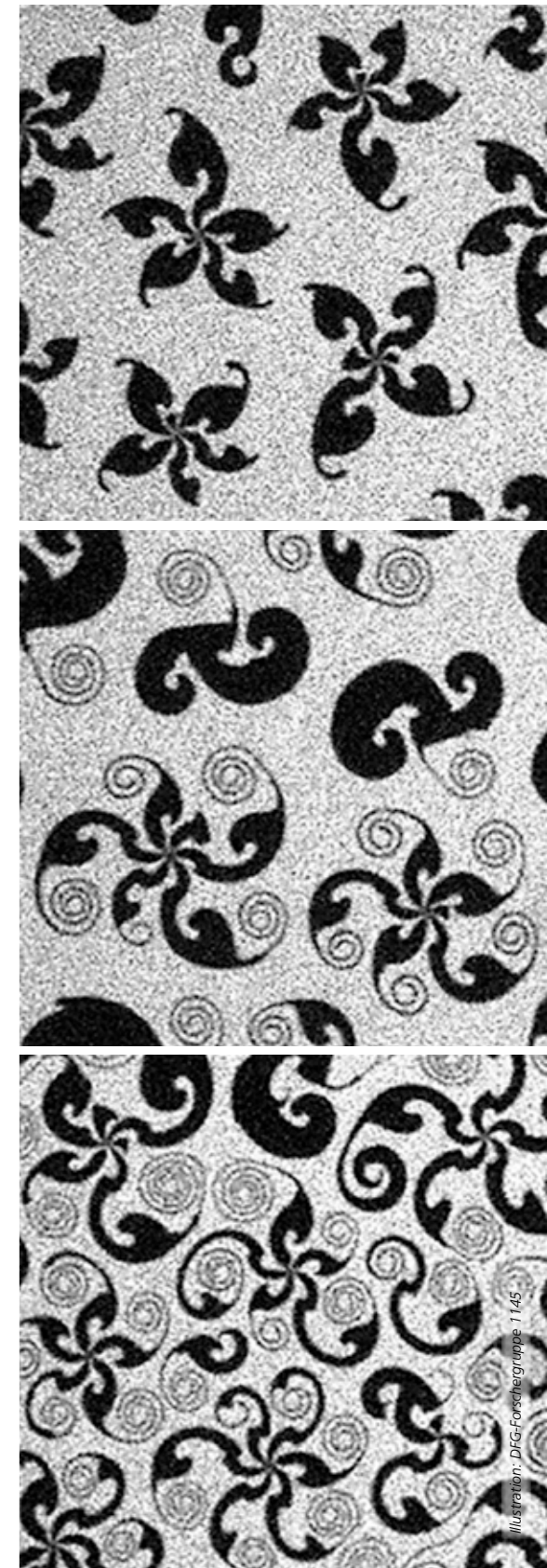


Illustration: DFG-Forschungsgruppe 1145

adsorption of molecules on the outer cell surface. Because cell surfaces are often negatively charged, there may be strong electrostatic interaction with positively charged cationic compounds. However, non-charged amphiphilic molecules such as detergents (wash-active substances) can also interact with the cell surface. Detergents are embedded into the cell membrane, where they form defects or pores. This causes the cell to die off as the membrane no longer forms a sealed barrier.

These particular properties of amphiphilic molecules offer enormous, as yet untapped potential in pharmacy and biomedicine. For instance, in chemotherapy to treat cancer and in gene therapy, drugs and DNA respectively are

Studying the water surface with fluorescence microscopy.



Illustration: DFG-Forscherguppe 1145

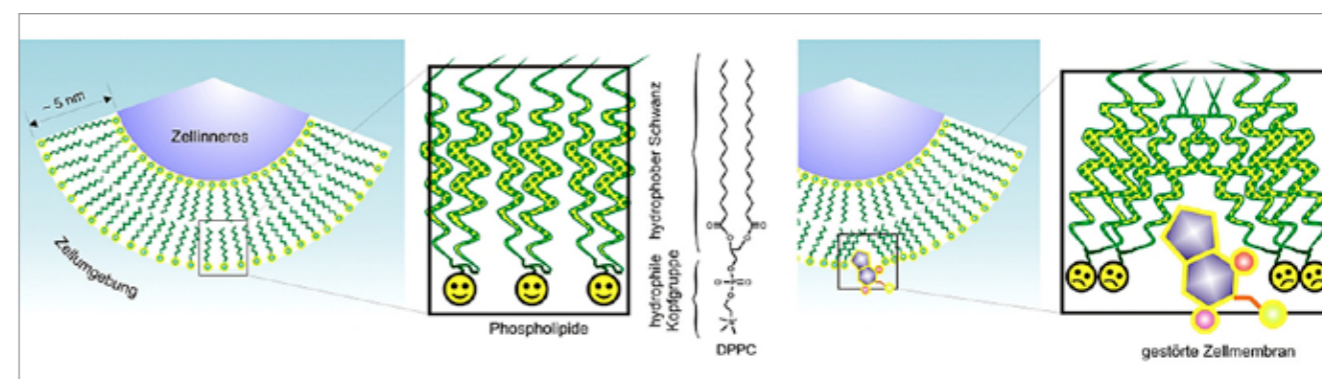
transported into the cell through the cell membrane. Pore-forming amphiphilic molecules can perform this very task. Conversely, injuries resulting from electric shock, radiation exposure or burns are associated with increased permeability of the cell membrane. In these scenarios, amphiphilic molecules with pore-closing properties are called for, and could be used to develop better treatments.

At Martin Luther University Halle-Wittenberg, members of the DFG Polyphiles Research Unit, which brings together chemistry and physics working groups, are studying what are known as polyphilic molecules, which control membrane properties and may also themselves be controllable (for example by means of light, pH or magnetic fields). In addition to hydrophilic and hydrophobic groups, polyphilic molecules pos-

sess at least one additional “philic” characteristic, such as liquid crystal segments or sites capable of selective binding. In water, these materials form structures, which differ significantly from classic liquid crystals.

Polyphilic molecules can perform various functions in the cell membrane. For example, they may contribute to its mechanical stability, influence its flexibility and porosity, build defined channel structures or form active binding sites. Molecules containing fluorine exhibit yet more properties. Many of these molecules are neither hydrophilic nor lipophilic (fat-loving), so they form special structures on and in cell membranes. The lipophobic and hydrophobic properties of these molecules are already widely used in Teflon-coated frying pans.

So what about other beneficial properties of cell mem-



Graphic: DFG-Forscherguppe 1145

Structure of a lipid bilayer as part of a model membrane and formation of pores in the membrane by amphiphilic molecules.

branes? And what about other model membranes? One further example is the Langmuir film, a monomolecular layer of a phospholipid floating on a liquid. This monolayer represents one half of a membrane and is ideal for microscopic and spectroscopic measurements because it allows a large, even area to be studied. Crucially, it also allows the state of the lipids to be varied by pushing the molecules together with the aid of a moving barrier.

Another simple model system is provided by liposomes. These spherical structures, just nanometres across, are already widely used in pharmacy for controlled drug release. They also have many applications in skincare products. A somewhat more complex task is forming lipid bilayers on solids. Here, the phospholipids are chemically bonded to a gold surface. Because a thin layer of water remains between the lipid bilayer and the gold, this model can be used to study the passage of other molecules through the membrane.

So far, the findings of the Polyphiles Research Unit show that both newly synthesised polyphilic small-molecule compounds and new polymers (block copolymers) can produce surprising new structures. Researchers are particularly interested in the phenomenon of self-association in interaction with lipid monolayers and bilayers. For example, it has been observed that when a small-molecule polyphilic substance is embedded in a cell membrane, the lipid membrane not only becomes porous but may also completely disintegrate. In terms of the interaction between a block copolymer with fluorophilic groups and a lipid monolayer at the water-air interface, new domain structures have also been identified, which – apart from their other properties – are aesthetically beautiful and reward observation. These structures can be observed and imaged using fluorescence microscopy.

The synthesis of new polyphilic compounds and their physical and chemical characterisation will also enable us to understand basic phenomena in the interaction between molecules and membranes and thereby improve our understanding of biological membranes. This is of tremendous importance in biochemical medicine, particu-

larly in relation to membrane permeability and the accumulation of substances inside cells, because drugs and other substances can only take effect once they have diffused into the cell.

A related problem is the undesired uptake of damaging substances into a cell, the health hazard of asbestos in buildings being just one example. The Research Unit therefore has a clear objective: in the interests of basic research, to contribute to the understanding of elementary processes in the interaction of polyphilic molecules, and to identify – and hopefully enable – potential applications of these substances.



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The Deutsche Forschungsgemeinschaft

The Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) is the central self-governing organisation responsible for promoting research in Germany. According to its statutes, the DFG serves all branches of science and the humanities. The DFG supports and coordinates research projects in all scientific disciplines, in particular in the areas of basic and applied research. Particular attention is paid to promoting young researchers. Researchers who work at a university or research institution in Germany are eligible to apply for DFG funding. Proposals will be peer reviewed. The final assessment will be carried out by review boards, the members of which are elected by researchers in Germany in their individual subject areas every four years.

The DFG distinguishes between the following programmes for research funding: In the *Individual Grants Programme*, any researcher can apply for financial assistance for an individual research project. *Priority Programmes* allow researchers from various research institutions and laboratories to cooperate within the framework of a set topic or project for a defined period of time, each working at his/her respective research institution. A *Research Unit* is a longer-term collaboration between several researchers who generally work together on a research topic at a single location. In *Central Research Facilities* there is a particular concentration of personnel and equipment that is required to provide scientific and technical services.

Collaborative Research Centres are long-term university research centres in which scientists and academics pursue ambitious joint interdisciplinary research undertakings. They are generally established for a period of twelve years. In addition to the classic Collaborative Research Centres, which are concentrated at one location and open to all subject areas, the DFG also offers several programme variations. *CRC/Transregios* allow various locations to cooperate on one topical focus. *Cultural Studies Research Centres* are designed to support the transition in the humanities to an integrated cultural studies paradigm. *Transfer Units* serve to transfer the findings of basic research produced by Collaborative Research Centres into the realm of practical application by promoting cooperation between research institutes and users.

DFG Research Centres are an important strategic funding instrument. They concentrate scientific research competence in particularly innovative fields and create temporary, internationally visible research priorities at research universities.

Research Training Groups are university training programmes established for a specific time period to support young researchers by actively involving them in research work. This focusses on a coherent, topically defined, research and study programme. Research Training Groups are designed to promote the early independence of doctoral students and intensify international exchange. They are open to international participants. In *International Research Training Groups*, a jointly structured doctoral programme is offered by German and foreign universities. Other funding opportunities for qualified young researchers are offered by the *Heisenberg Programme* and the *Emmy Noether Programme*. In so called *Reinhard Koselleck Projects*, the DFG supports especially innovative research undertakings by outstanding scientists and academics.

The *Excellence Initiative* aims to promote top-level research and improve the quality of German universities and research institutions in the long term. Funding is provided for graduate schools, clusters of excellence and institutional strategies.

The DFG also funds and initiates measures to promote scientific libraries, equips computer centres with computing hardware, provides instrumentation for research purposes and conducts peer reviews on proposals for scientific instrumentation. On an international level, the DFG has assumed the role of Scientific Representative to international organisations, coordinates and funds the German contribution towards large-scale international research programmes, and supports international scientific relations.

Another important role of the DFG is to provide policy advice to parliaments and public authorities on scientific issues. A large number of expert commissions and committees provide the scientific background for the passing of new legislation, primarily in the areas of environmental protection and health care.

The legal status of the DFG is that of an association under private law. Its member organisations include research universities, major non-university research institutions, such as the Max Planck Society, the Fraunhofer Society and the Leibniz Association, the Academies of Sciences and Humanities and a number of scientific associations. In order to meet its responsibilities, the DFG receives funding from the German federal government and the federal states, as well as an annual contribution from the Donors' Association for the Promotion of Sciences and Humanities in Germany.



Lively and witty: At the end of March 2013, DFG Secretary General Dorothee Dzwonnek and the Mayor of Bonn, Jürgen Nimptsch (second from left), hosted an event at the Redoute in Bad Godesberg to welcome the new DFG President Peter Strohschneider (second from right) to Bonn. In her welcoming remarks, Ms. Dzwonnek emphasised the DFG's position as a self-governing organisation of members with the universities at its heart and a special connection to Bonn, a city renowned for its links to science. Mr. Nimptsch and the Rector of the University of Bonn, Jürgen Fohrmann (left), both German philologists, then took turns reading aloud some amusing Middle High German verses, before the keynote speaker for the afternoon, Hans-Georg Soeffner (right) from the Institute for the Advanced Study of the Humanities in Essen, delivered a cuttingly satirical and sparkling talk on "Wissenschaftsbetriebslehre". This was much enjoyed by the 150-plus guests and also by Peter Strohschneider, who expressed his thanks for his warm welcome to the DFG and to Bonn.

Impressum

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