Dear Readers,

You have just opened the first issue of Ulm University’s English-language magazine. Over the next 47 pages we would like to share major success stories of the last few months with you—such as the approval of the Collaborative Research Centre in the field of trauma research by the German Research Foundation (DFG), or an ERC Starting Grant for a young scientist investigating the ‘architecture’ of the DNA. You can furthermore read about HIV research, autonomous driving, genome editing and more.

As a comparatively young university we have come a long way. According to the Times Higher Education ‘100 under 50’ ranking, Ulm University is among the top young universities in the world and ranked number one university under 50 years of age in Germany. Third-party funding is now at an all-time high of almost 100 million euros and we have established numerous cooperations with internationally renowned research institutions as well as with companies in the Science City Ulm and elsewhere. What is more, a publication analysis by Thomson Reuters has revealed that three of the world’s most influential scientists in their fields carry out research at Ulm University.

By now, more than 10,000 young people pursue their degrees in our Faculties: Natural Sciences, Mathematics and Economics, the Medical Faculty and the Faculty of Engineering, Computer Science and Psychology. More than ten per cent of our students have an international background. They are predominantly enrolled in English-taught master’s programmes or they opt for a PhD in the International Graduate School in Molecular Medicine, which is funded by the German ‘Excellence Initiative’. Over the next semesters we will happily welcome refugees from crisis regions all over the world to our University and to the city of Ulm, birthplace of Nobel laureate Albert Einstein.

I was elected President of Ulm University only a few months ago and look forward to shaping its future. Thanks to my predecessors, President Professor Karl Joachim Ebeling and his University Board, the starting position is excellent.

The title of this University magazine “Sciendo – Docendo – Curando” (Latin for „to do research, teach and care for patients“) is part of Ulm University’s logo, which was designed in the founding years. These objectives, however, are still pursued and excelled each and every day at Ulm University and its Medical Centre. In this magazine we hope to give you a first impression of our research foci and life on campus. Enjoy reading!

Professor Michael Weber
President of Ulm University
# Table of contents

## Research & Discoveries

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Treating trauma: New Collaborative Research Centre</td>
</tr>
<tr>
<td>8</td>
<td>CRISPR-Cas research group: Protecting yoghurt, cutting genes</td>
</tr>
<tr>
<td>10</td>
<td>Neotropical bats: Tongue as nectar pump</td>
</tr>
<tr>
<td>12</td>
<td>ERC Starting Grant: Biophysicist investigates DNA architecture</td>
</tr>
<tr>
<td>14</td>
<td>New joint project: Avatars as virtual nursing assistants</td>
</tr>
<tr>
<td>16</td>
<td>A molecular tweezer for fighting HIV</td>
</tr>
<tr>
<td>17</td>
<td>A sneak peek into the world of nanoscience</td>
</tr>
<tr>
<td>18</td>
<td>Experimental economics laboratory: Homo oeconomicus revisited</td>
</tr>
<tr>
<td>20</td>
<td>No way out for the overweight?</td>
</tr>
<tr>
<td>22</td>
<td>From the Contergan scandal to cancer treatment</td>
</tr>
<tr>
<td>23</td>
<td>Supercomputer strengthens Theoretical Chemistry</td>
</tr>
<tr>
<td>24</td>
<td>Engineers and computer scientists celebrate 25th anniversary</td>
</tr>
<tr>
<td>29</td>
<td>Most influential scientific minds at Ulm University</td>
</tr>
</tbody>
</table>

## Campus

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Ulm transfusion medicine: More than just blood donation</td>
</tr>
<tr>
<td>33</td>
<td>New master’s programme ‘Sustainable Management’</td>
</tr>
<tr>
<td>34</td>
<td>Autonomous driving: Cars interact with their surroundings</td>
</tr>
<tr>
<td>36</td>
<td>Industry 4.0 for small and medium-sized businesses</td>
</tr>
</tbody>
</table>

## Face-to-face

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>Molecular Psychology: Studying smartphone addiction in the genetics lab</td>
</tr>
<tr>
<td>40</td>
<td>New President for Ulm University</td>
</tr>
<tr>
<td>42</td>
<td>Wrangell Fellowship: Technology to identify emotions</td>
</tr>
<tr>
<td>43</td>
<td>Juniorprofessor from Oxford: Shining light on the brain</td>
</tr>
</tbody>
</table>

## Panorama:

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>1st Alumni Homecoming at Ulm University</td>
</tr>
<tr>
<td>46</td>
<td>Ulm University students explore the world</td>
</tr>
</tbody>
</table>

Cover: Ulm University, main entrance
Photo: Eberhardt/Ulm University
Treating trauma

In the Western world, most multiple traumatic injuries are caused by traffic and work accidents. These polytrauma can become life-threatening if complications occur. At a new Collaborative Research Centre doctors and scientists are jointly researching the systemic reactions of the body to traumatic injuries.
On a slippery winter road, two cars collide head on. The emergency doctor examines the unconscious patient. His initial assessment: multiple fractures, massive contusions, and internal injuries. The patient is rushed to the nearest trauma centre in a helicopter. Every minute counts. In the emergency room, where the patient receives an initial diagnosis and care, a team consisting of traumatologists, anaesthesiologists, radiologists, and operating room assistants sees to the young man. An ultrasound examination of the abdominal area reveals internal bleeding and injuries to organs. The liver and the lung are hit worst. With the help of whole-body computed tomography, the doctors obtain an overview of all substantial injuries. The result: multiple fractures and massive tissue damage.

Doctors speak in such cases of multiple traumatic injuries or polytrauma. Severe traumata have far-reaching consequences for the patient. ‘It isn’t just the massive loss of blood that is a problem for accident victims; severe multiple injuries trigger so-called multi-systemic inflammation processes that not only interfere with the healing process but can also threaten the patient’s life. For example, 80 per cent of all severely injured patients develop a whole-body inflammation, and 30 per cent experience multi-organ failure’, explains Professor Florian Gebhard, medical director of the Department of Orthopaedic Trauma, Hand, Plastic, and Reconstruction Surgery at the Ulm University Medical Centre, citing the German Trauma Register.

The traumatologist is one of the successful applicants and the spokesperson of Ulm’s new Collaborative Research Centre (Sonderforschungsbereich, SFB) on trauma research, which was approved for funding in November 2014. The centre brings together 23 scientists from the university and the medical centre to work on 20 individual interdisciplinary projects concerning the systemic reactions of the body to severe injuries. The interactions between damaged tissue, the immune system, circulation, and the psyche are exceedingly complex and still largely not understood in detail. ‘Physical traumata like severe injuries after accidents are the most common cause of death in persons under 45 years of age in this country and lead to healthcare costs of up to 30 billion euros per year. The approval of the collaborative research centre gives our proven expertise in musculoskeletal trauma research even more appeal on the national and international stage’, says University President Professor Karl Joachim Ebeling to the Ulm trauma researchers.

Collaborative Research Centre SFB 1149, ‘Danger Response, Disturbance Factors, and Regenerative Potential after Acute Trauma’, will receive over 11.2 million euros in funding from the German Research Foundation (DFG) and is designed to run for up to 12 years. A total of 18 departments and institutes at Ulm University and its Medical Centre are participating in the 20 individual projects to be conducted at the centre.
Other conditions that can carry additional risks include arteriosclerosis, certain lung diseases, or obesity. The scientists are also interested in finding out what impact factors like age have on the success of treatment.

Another focus will be on the molecular control of so-called physiological danger responses. Severe injuries to tissues or organs often set off dangerous inflammation processes. Whole-body inflammations and septic shock are life-threatening for patients. On the other hand, they also trigger processes that inhibit the inflammatory reactions in the body. Now the scientists want to find out which signalling mechanisms govern such reactions and hopefully learn how to control them in a therapeutically effective way. This is where a third focus of research at the centre comes in: the development of effective trauma therapies. It might be possible to use particular inflammatory mediators or stem cells to influence specific posttraumatic inflammatory processes, thus effectively promoting wound healing and tissue regeneration.

Great advancements have been made in trauma research and treatment in the past years. Patients benefit from ultra-modern emergency rooms at the trauma centres, where the latest imaging techniques ensure a prompt and gentle diagnosis and severely injured patients receive optimal initial medi-

Individual therapies improve the success of treatment

For a successful clinical trauma management, we need individualised therapies that take better account of the patients' personal preconditions, says deputy SFB spokesperson Professor Anita Ignatius, director of the Institute of Orthopaedic Research and Biomechanics. One of the areas the Trauma SFB will focus on is thus the role of individual factors like pre-existing conditions or accompanying illnesses. Healing processes can proceed in completely different ways depending on whether someone has a disease like diabetes, is a heavy smoker, or takes certain medicines.

How does the organism react to severe injuries? What does the trauma response look like on the cellular and molecular level? Not only are danger signals sent out locally, for example, but processes with manifold consequences are set in motion in the entire body. The Ulm doctors and natural scientists want to work together to understand things like which ‘pathophysiological’ processes trigger complications. In addition, they are searching for ways to use findings on the interaction between anti-inflammatory and inflammatory factors to derive strategies for improving wound healing. The long-term goal is to develop better therapies for trauma patients with life-threatening injuries.
cal treatment’, says Professor Markus Huber-Lang, head of the clinical research group and also one of the Trauma SFB’s deputy spokespersons. Recent findings from trauma research also help the scientists to better understand the medical complications of multiple injuries, to treat them effectively, and, in the best case, to prevent them from occurring in the first place. Today, for instance, broken bones of severely injured patients are not reconstructed until their circulation has stabilised to the point where they can handle an operation, as a rule after about a week. ‘We are in any case very pleased that this great joint scientific effort has led to success and that we thus now have the necessary financial basis to make further substantial contributions to this vital area of research’, the primary applicants Gebhard, Huber-Lang, and Ignatius all agree.

It is not least the victims of traffic and occupational accidents who stand to profit from the findings of the Ulm trauma researchers. After all, most multiple injuries and polytraumata are caused by accidents in road traffic or falls from great heights. Our accident victim, in any case, was lucky. The man is young, healthy, and physically fit. According to the trauma register, his chances are good: more than 60 percent of polytrauma patients recover. But it can end badly too: nearly every eighth patient admitted to the hospital with multiple traumatic injuries does not survive. If the chances for survival rise significantly in the future, the Ulm researchers hope to have played a part in making that happen. wt/dh
The research group is studying the immune system of bacteria and archaea. In the picture: Haloferax volcanii, a halophilic archaeon.

Protecting yoghurt and editing genes

DFG extends funding for research group on unicellular immune system CRISPR-Cas

The research group is comprised of eight subgroups specialised in microbiology, bioinformatics, structural biology, and mass spectrometry as well as three associated groups. The members hail from various institutions across Germany and the Danish city of Copenhagen and exchange findings at bi-annual meetings with around 30 participants each. The highlight of the first funding period was the organisation of the conference CRISPR 2014, which brought 170 scientists together in Berlin last year. In addition, Anita Marchfelder served as guest editor of an issue of the journal ‘RNA Biology’ on the CRISPR-Cas system.

Even germs can fall ill and die of a virus infection. A team of scientists led by the Ulm Professor Anita Marchfelder is studying how bacteria and other unicellular organisms (‘archaea’) defend themselves against deadly viruses. Now the German Research Foundation (DFG) has granted research group 1680 an extension worth 1.9 million euros in funding over the next three years.

At the core of the group’s work is CRISPR-Cas, the adaptive immune system of bacteria and archaea. If these single-celled organisms survive an initial virus attack, they incorporate parts of the virus DNA into their own hereditary material. In this way, the germ is placed on a kind of ‘wanted list’ and is identified as soon as it attacks the cell. Cas proteins then launch a counterattack on the virus and destroy it. Thanks to cell division, this immune system even has a memory and is passed on to the next generation. Among those to profit from these exceptional abilities are the dairy industry and biofuel producers. Another potential beneficiary of CRISPR-Cas is the field of genetics: The system could be used in the future as a kind of ‘genetic scissors’ to modify disease-causing segments of DNA.

Anita Marchfelder’s group ‘Unravelling the Prokaryotic Immune System’ has been conducting fundamental research for around four years – and their work has already led to significant discoveries. The context of the discovery that CRISPR-Cas is a part of the immune system for unicellular organisms was a practical one: the production of yoghurt and cheese. Since bacteria are used as starter cultures for these dairy products, virus infections can do great damage and destroy entire production series. Searching for a way to ‘vaccinate’ these starter cultures, dairy industry researchers ended up hitting on CRISPR-Cas – the key clue being peculiar repeat sequences. The DFG research group has been
studying the details of how this immune system functions as well as the differences between various bacteria and archaea since 2012. ‘In the first funding period we used methods from molecular biology, genetics, and biochemistry to analyse numerous subtypes of CRISPR-Cas, always with the goal of uncovering fundamental similarities in the system and type-specific properties’, explains Marchfelder, who conducts her research at the Ulm Institute of Molecular Botany. The area the Ulm coordinator has contributed her expertise to most in the group is archaea. These are single-celled organisms (prokaryotes) that yet share a number of properties with eukaryotes – that is, cells with a nucleus like those in the human body. Almost every organism in the domain ‘archaea’ has its own CRISPR-Cas system.

Genetic scissors for the wet lab
Following the cue of the dairy industry, now geneticists have also discovered a use for the CRISPR-Cas system: modifying genes. In the future, the variant Cas9 could be used as a cutting tool to remove disease-causing genetic sequences from the DNA – or to add desirable sequences. Dutch scientists, for example, have succeeded in applying this method to eliminate a mutation associated with cystic fibrosis. So-called genome editing is also one of the projects the group intends to focus on in the second funding period. In general, the scientists will continue to conduct fundamental research but will keep potential applications at the back of their minds. ‘Before we can even begin thinking about a clinical application, we need to reach a better understanding of the molecular mechanisms involved in genome modification. Genome editing needs to become more efficient, and the trick is to avoid unwanted genetic modifications as a consequence of gene cutting’, says Marchfelder on the topic of so-called off-target mutations. This is also one of the reasons why FOR 1680 has been expanded to include Cas9 co-discoverer Professor Emanuelle Charpentier from the Max Planck Institute for Infection Biology in Berlin. And CRISPR-Cas can do even more: The system makes it easy to switch genes on and off. Moreover, it enables scientists to quickly establish mouse models to study human diseases.

“CRISPR-Cas makes it easy to switch genes on and off.”

Finally, the scientists also want to concentrate on the production of biofuels in the second funding period. The problem is that cyanobacteria, which often serve as the starter culture, feed on sea water. As this water often contains large amounts of viruses, the goal will be to use the CRISPR-Cas system to immunise the helpful bacteria.

In the three years of its existence, the group has demonstrated that it is often only a small step from fundamental research to practice – and further potential applications are sure to follow. ■ ab/dh
Tongue as nectar pump

Novel drinking mechanism discovered in nectar-feeding bats

Professor Marco Tschapka, PD Dr. Mirjam Knörnschild, and Dr. Tania Gonzalez from Ulm University have recently been analysing the ‘tongue skills’ of neotropical nectar-feeding bats. As a result, they have discovered a form of nectar uptake that was unheard of until now: in addition to the usual lapping techniques, they observed some genera that use a pumping-tongue mechanism to extract nectar from the nocturnal plants.

The researchers hypothesise that over the course of evolution the bats’ fondness for nectar has evolved along two separate paths, and thus perfected entirely different mechanisms of nectar extraction. The team at the Institute of Evolutionary Ecology and Conservation Genomics published their findings, obtained through both fieldwork in Panama as well as from their bat husbandry work in Ulm, in the journal Science Advances.

Neotropical nectar-feeding bats, native to Middle and South America, feed on nocturnal flowers, which they pollinate during their visits. They developed protrusible tongues that may even exceed their own body length. Most of the bats visit the feeders in short hovering flights and lick them with their brush-tip tongues, which are covered with hair-like papillae. ‘We have known for some time that a few genera don’t have that kind of bristly tongue. Instead, deep longitudinal grooves run laterally along the entire length of their tongues, the function of which was unknown so far,’ Professor Tschapka explains. The biologists have ventured to understand these striking differences using a high-speed camera in a flight cage at the Bocas del Toro Research Station of the Smithsonian Tropical Research Institute in Panama. The cameras enabled them to monitor the nectar uptake of these nocturnal mammals from an artificial flower offering different nectar levels.

Unique drinking mechanism among mammals

High-speed video recordings revealed distinct differences in tongue movement patterns between the two bat species. There is the known lapping pattern, where the animals dip the tongue into the nectar and retrieve it back.
into the mouth. The nectar sticks to the hair-like papillae and can then be ingested. Four to seven of such lapping movements occur during a single floral visit. In contrast, other genera displayed a thus far unknown mechanism: ‘The bat lowers its tongue into the nectar and keeps it in contact with the liquid throughout the entire feeding visit. Nectar then moves along lateral grooves at the side of the tongue into the mouth. Deflections of these tongue grooves suggest pumping movements,’ Mirjam Knörschild explains. In no other mammal species has such a pumping mechanism been described. Not surprisingly, the nectar extraction proved more efficient for both groups when the flower was filled to the brim with nectar. Lower levels of nectar, on the other hand, were more challenging for the bats.

These significantly different drinking mechanisms of lapping and pumping support existing molecular kinship analyses, showing that the two different nectar uptake mechanisms have evolved independently from each other. Tschapka says: ‘Species with different tongues might prefer different flowers. Brush-tip tongues could be particularly useful in flowers that offer small and diffusely distributed amounts of nectar. In contrast, the pumping mechanism should be more efficient in flowers providing larger quantities of nectar concentrated in one single spot.’ One thing is certain – the biologists will not run out of research topics any time soon.

Reference:

Ulm University remains Germany’s best young university

Title defended! Ulm University, founded in 1967, has once again achieved outstanding results on the ‘THE 100 Under 50’ ranking of the British magazine Times Higher Education (THE). As in 2014’s ranking, it is the best German university founded less than 50 years ago.

The ranking included a total of 100 young universities from around the world. In international comparison, Ulm University placed a very respectable 15th – therefore improving on its result from the last ranking.

‘Our success in this highly respected international ranking for the second year running strengthens our conviction that we are on the right track. We already received the seal of quality as Germany’s best young university twice in 2014 in the rankings of Times Higher Education and Quacquarelli Symonds. It testifies to the research strength as well as the targeted growth of Ulm University and gives us an outstanding position in international competition’, comments University President Professor Karl Joachim Ebeling.

The Swiss École Polytechnique Fédérale de Lausanne tops 2015’s ‘THE 100 Under 50’ ranking, followed by East Asian universities at second through fifth place. In 2014 the German universities Constance, Bremen, Bochum, Bielefeld, Duisburg-Essen, and Bayreuth are all placed behind Ulm on the ranking. All of the universities were assessed according to 13 indicators. Ulm University received particularly positive scores on ‘Citations’. For this indicator, the ranking took into account around six million articles published over the space of five years on the citation index Web of Science. Ulm University is also the country’s strongest university with regard to the indicators ‘Industry income’ and ‘Teaching’.

The ranking is compiled according to the same stringent criteria as the traditional ‘THE World University Rankings’ – only the ‘Reputation’ of the institutions is assessed differently. ‘Many universities in this ranking have shown they can match the ancient global elite and have proven that with the right drive, what others have developed over centuries can be achieved in a matter of decades,’ says the editor Phil Baty.
It is hard to imagine that a string of genome of up to two metres in length even fits into the cell nucleus. With the help of a novel microscopy technique Professor Christof Gebhardt is now closing in on the spatial and temporal arrangement of the genome.

More than 50 years ago, the biochemists James Watson and Francis Crick won the Nobel Prize for discovering the structure of DNA. Today every schoolchild knows what the two professors once published in the journal Nature: The ‘blueprint of life’ lies folded in the shape of a double helix in the cell nucleus. But how can you get a chromatin fibre of genetic material measuring up to two meters in length to fit into a cell nucleus of only six micrometres in diameter? This is a question that is not just fascinating for artists specialised in wrapping objects. After all, the three-dimensional arrangement of DNA in chromosomes determines which genes are read in gene expression, how DNA is repaired, and how it is copied.

With the help of a specially developed microscopy technique, Professor Christof Gebhardt from Ulm’s Institute of Biophysics aims to unravel the mystery of the architecture of DNA. The 37-year-old has now been awarded a 1.5-million-euro Starting Grant from the European Research Council (ERC) for his project.

In his project ‘ChromArch’, Gebhardt aims to investigate the principles behind the spatial and temporal organisation of the chromatin structure of DNA – using individual molecules in living cells to do so. While Gebhardt’s project will be intended initially as fundamental research, his findings could also end up contributing to a better understanding of certain hereditary diseases.

‘The Starting Grant is a great tribute to Professor Gebhardt’s outstanding research. We are delighted that the ERC funding will enable him to continue to conduct his highly innovative scientific work’, said Ulm University President Professor Karl Joachim Ebeling of the award.

In the course of so-called gene regulation, DNA segments are switched on and off again. One of
the effects of this process, which can also be set off by environmental influences, is that it determines the appearance of an organism and its susceptibility to certain diseases.

The accessibility of the genes on the chromatin fibres also plays a role in this process. For example, loops ensure that enhancers and promoter regions interact and stimulate the transcription of a gene, that is, the conversion of DNA into RNA in the course of so-called protein biosynthesis. Protein synthesis involves the transport of a copy of DNA, the messenger RNA, from the cell nucleus to the cytoplasm and its translation into amino acids. It is the process by which important ‘building blocks’ of our body are produced.

Which molecular mechanisms cause the DNA to form particular chromatin structures in the cell nucleus? And how are such loops arranged? These are the questions Professor Gebhardt is going to tackle in his newly launched project ‘Single Molecule Mechanisms of Spatio-Temporal Chromatin Architecture’ (ChromArch). The biophysicist’s ultimate goal is to compare structures that differ with regard to only minute details in each cell.

From Harvard to Ulm University

A technique Gebhardt developed as a postdoctoral researcher at Harvard University will prove useful in this connection: ‘RLS microscopy enables us to illuminate very thin slices of a cell and observe processes that take place inside of it as well as its DNA structure’, the scientist explains. The microscope has a high degree of sensitivity for fluorescence applications. In another step forward, RLS microscopy (reflected light sheet microscopy) makes it possible to view individual cells at high resolution, whereas researchers previously needed a large number of cells to study the chromatin structure – but ultimately obtained only mean values.

While receiving the ERC Starting Grant, Professor Gebhardt will concentrate mainly on developing the methodology. He is well qualified for this task: After completing a degree in physics and biophysics (Ludwig-Maximilian-Universität in Munich), he went on to study molecular motors and protein folding for his doctoral dissertation at Technische Universität München. He later devoted his efforts to the inner life of individual cells. It was at Professor X. Sunney Xie’s lab at Harvard University, where he spent a three-year research stay on a scholarship from the Human Frontier Science Programme Organisation, that he developed the technique of RLS microscopy, which affords undreamt-of insights into the cell nucleus.

Gebhardt joined Ulm University’s Institute of Biophysics in summer semester 2013 and has now succeeded in obtaining a Starting Grant from the European Research Council. ‘The procedure in Brussels was very time-consuming, the chances of success slim’, remembers the biophysicist. Hence his great delight at receiving the grant. In the coming five years, Gebhardt will thus try his own hands at being a ‘wrapping artist’ and elucidating the arrangement of DNA with the help of RLS microscopy.

ERC Starting Grant

ERC Starting Grants are intended for outstanding junior researchers at European institutions who establish their own research group within two to seven years after completing their doctoral degree. The European Research Council (ERC) provides up to 2 million euros in funding over five years for projects selected by a committee of distinguished experts. This time around, 328 projects were selected from a total of 3200 applications. Seventy Starting Grants went to Germany – more than ever before. This is the third time a Starting Grant has been awarded to an Ulm University researcher.
New joint project on pain and emotion recognition in seniors

Avatars as virtual nursing assistants

Elderly patients, some of whom may be suffering from dementia, are often unable to inform their nurses whether they are in pain, and if so, how severely. This can lead to insufficient care, particularly in times of scarce health care resources. Computer scientists and psychologists at Ulm University and the University of Augsburg are working on solving this problem in the project ‘SenseEmotion’: They are developing a sensor-based automatic pain and emotion recognition system and an avatar to help nurses find the optimal therapy and to reduce the burden on staff at retirement homes and hospitals.

Average life expectancy is on the rise in Germany, but seniors often have to cope with a diminished quality of life due to physical impairments and pain. In patients with cognitive and verbal impairments, it is particularly difficult to gauge emotional conditions, states of confusion, and pain intensity. Researchers at Ulm University and the University of Augsburg want to help staff at retirement homes and hospitals to determine the best possible therapy for such patients with the help of physiological measurements – for instance skin conductance – as well as language and motion analyses. They plan to use sensors, audio and video recordings, and so-called motion capture systems to collect these multimodal data and analyse them for nurses, providing them with indications on the condition of their patients. At times when no nurse is available, an avatar can soothe the retirement home resident and draw his or her attention away from the pain. This virtual nursing assistant advises the women and men to take a walk or diverts them from their pain by playing their favourite music’, explains Dr. Steffen Walter, research assistant at the Section for Medical Psychology. The avatar can be projected on the wall of the patient’s room and can even keep a kind of pain journal for the nursing staff.

The recognition of pain-associated emotions is entirely new territory for the research group: There are not yet any computer-assisted studies on how to precisely differentiate between pain and emotion. ‘Up to now, we have only used a technique like this in static situations in which the patients were sitting still. Now we have to adapt this technique to work with mobile users, which will involve problems with aspects like facial recognition. Other technical challenges include robust state recognition and data fusion’, adds Dr. Walter. It will of course also be necessary to build up trust and acceptance for the digital diagnostic instrument in the patients and their nurses. An important task in this context will be making the emotion and pain recognition sensors comfortable to wear and inconspicuous.
The researchers are planning two large-scale experiments on the path to implementing this technology. In the first, they will use biopotentials like electrocardiograms (ECG) and audio and video recordings to test the state recognition technology on young test subjects in the lab.

The second experiment will involve imitating the reality of the retirement home residents’ lives: In addition to the sensors, the test participant will wear ‘age simulation suits’ to simulate the daily lives of the residents. Clothing with weights, stiff joints, and special glasses that simulate limited eyesight will make it more difficult for the test subjects to wake up early, take their medications, or prepare for visiting relatives. The purpose of this experiment will be to determine how to identify critical situations in the seniors’ daily lives. In roughly two and a half years, the scientists will conduct a long-term pilot study at a retirement home. This will reveal how the residents react to pain and emotion recognition, and especially to having the avatar as a nursing assistant. ‘The goal of the project consists in optimising treatment for residents of retirement homes with physical and emotional pain by way of precise automatic pain recognition and personalised affect management to improve the well-being and the quality of life of elderly persons’, sums up the coordinator of the joint project, PD Dr. Jonghwa Kim from the University of Augsburg.

About SenseEmotion

The scientists developed ‘SenseEmotion’ in response to a call for proposals from the German Federal Ministry of Education and Research (BMBF) for projects in support of the elderly and their nurses. Their proposal was selected for funding, and the project will receive more than 1.3 million euros over the next three years.

The participating institutions Augsburg and Ulm offer outstanding conditions for the project: Preparatory work on emotion research, motion and behaviour analysis, and interaction design was done by a team of Ulm scientists partially within the context of the Transregional Collaborative Research Centre SFB/TRR 62 on human–machine interaction. Furthermore, the University of Augsburg will contribute their expertise on physiological analysis and multisensor data fusion.
New approach to microbicides

A molecular tweezer for fighting HIV

Microbicides — chemical substances that inhibit viral infections — are the great hope in the fight against HIV/AIDS. In the form of vaginal gels, they are a particularly promising way to protect women in developing countries from infections if their partners do not wear condoms.

The practical application of microbicides, however, has largely proven ineffective so far. Researchers from Ulm and Pennsylvania have recently presented a new approach: A ‘molecular tweezer’, developed at the University of Duisburg-Essen (UDE), does not only attack HIV and other sexually transmitted viruses, but also inhibits the infectivity-enhancing activity of the semen. Their study has been published in the journal eLife.

The majority of new HIV infections are transmitted via sexual intercourse. It seems that protein fragments, which form rod-like fibrils in the semen, play a vital role. In 2007, Ulm AIDS researchers Professor Jan Münch and Professor Frank Kirchhoff discovered ‘sticky rods’ (termed SEVI for Semen-derived Enhancer of Virus Infection), which bind virus particles and make it easier for the viruses to attach to the target cell. It therefore only takes a small number of virus particles to attach and to infect a cell. Researchers led by Professor Münch from the Institute of Molecular Virology at Ulm University and American fibril researcher Professor James Shortner now use a ‘molecular tweezer’, which inhibits the HIV-enhancing activity of the sticky fibrils by preventing the formation of virion-amyloid complexes, as well as destroying mature fibrils. More precisely, the ‘tweezer’ attacks residues of the amino acids lysine and arginine. The molecule CLR01 also cracks the viral membrane, which renders the pathogen non-infectious. In their study, the researchers were able to demonstrate this effect not only with HIV but also with other sexually transmitted viruses, such as herpes and hepatitis C. CLR01 could also potentially be used against the membranes of flu and Ebola viruses.

A microbicide based on CLR01 would therefore counteract the virus itself, while simultaneously inhibiting amyloid fibrils. ‘Because of this dual-function strategy, we believe that CLR01 could be more effective than previous microbicides,’ said Prof Münch. CLR01 can be synthesised easily and cost-effectively for clinical trials.

Professor Thomas Schrader at the University of Duisburg-Essen is one of the scientists who discovered the molecular tweezer. He initially used CLR01 against Alzheimer’s disease in mouse trials. A variety of scientists from universities in Germany and the US (University of Pennsylvania, University of California) contributed to this publication. Research efforts thus far have been conducted with support by the German Research Foundation (DFG) and the Volkswagen Foundation.

Reference:

Micrograph of HIV particles sticking to the cell surface
The research initiative for the development of a so-called low-voltage transmission electron microscope successfully enters its final phase. The German Research Foundation (DFG) and the state of Baden-Württemberg have been supporting the long-term project at Ulm University since 2009 with more than ten million euros.

SALVE stands for Sub-Ångström Low-Voltage Electron microscopy and is a project partnership between Ulm University, Heidelberg-based CEOS GmbH, which has been on board from the very beginning, and the US-American company FEI, which joined the cooperation in March 2015. FEI is one of the world’s leading manufacturers of platforms for transmission electron microscopy (TEM).

‘Main focus of the project is the development of a low-voltage transmission electron microscope that will be able to carefully image radiation-sensitive materials with molecular and even atomic-scale resolution’, says Professor Ute Kaiser, leader of the Electron Microscopy Group of Materials Science at Ulm University and project leader of SALVE. ‘Current-generation transmission electron microscopes typically operate at high voltages of up to 300 kV. This process accelerates the electrons to almost the speed of light and can damage or even destroy radiation-sensitive samples before they can be imaged,’ Trisha Rice, Vice President and General Manager for Materials Science at FEI, explains.

The redeveloped microscope is intended to operate at accelerating voltages from 20 kV - 80 kV, thus ensuring that sensitive samples, for example biomolecules or two-dimensional nanomaterials like graphene, will not be damaged before they have been imaged. Special corrective components compensate for chromatic aberrations, which helps achieve high resolutions. TEM devices that work with low voltage inherently produce a higher image contrast. The increased resolution further improves the image quality.

The technological challenge lies in the correction of electron-optical aberrations. ‘With medium-voltage transmission electron microscopy the essential component for optimising the image quality was the correction of spherical aberrations. With low-voltage transmission electron microscopy it is also paramount to compensate for colour aberrations caused by the objective lens,’ Professor Max Haider, founder of CEOS GmbH, explains. The company specialises in the development and production of aberration-corrected electron-optical systems.

Basis for the development of the entire low-voltage system is a transmission electron microscope that FEI optimised particularly for low-voltage microscopy. The model Titan Themis is one of the world’s first and most powerful commercial devices of its kind. The scientists at Ulm University mainly focus on application-related questions and the development of sample preparation methods as well as theoretical basics of low-voltage image generation. ‘This new technology opens up entire new fields of application in a major research area at Ulm University. Our device will be the first chromatic and spherical aberration-corrected microscope in this class worldwide, and it will be of great service particularly at the interface between materials science and life science,’ the researchers say confidently.
New laboratory for Experimental Economics

Ulm puts ‘homo oeconomicus’ to test

In lectures and textbooks economic models can sometimes appear to be neither realistic nor entertaining. However, the newly opened Ulm Laboratory for Economic and Social Sciences (ULESS) turns dull theory into first hand experience.

Under controlled conditions participants take decisions that have financial consequences which may also depend on the behaviour of others. The two directors of ULESS, Professor Gerlinde Fellner-Röhling and Professor Sandra Ludwig, use the results of these experiments in their research at the Institute of Economics. Students benefit from the opportunity to participate in experiments, and learn how to put theories to test and optimise traditional models.

Any economic theory becomes more comprehensible when compared to one’s own behaviour and decision-making.

How do people make decisions in different situations? Which factors are important? And how can decision-making behaviour be captured by theory? Experimental Economics draws upon data obtained from experiments in order to explore various economic questions and develop new behavioural models.

Having produced four Nobel Prize winners in the last 25 years, it ranks among the most successful research areas in Economics. The Institute of Economics at Ulm University is a place of such intensive research – now equipped with a new experimental lab. The experiments take place on computers in single cabins. After a brief introduction, the participants get confronted with a decision scenario. ‘Sometimes it can be important that the participants don’t know who they interact with. This helps eliminate influential factors like sympathy,’ Gerlinde Fellner-Röhling explains. One possible scenario is the so-called ultimatum game: player number 1, let’s call him Thomas, receives a certain amount of money – ten euros for example – of which he can pass on any self-determined amount to ‘Anna’. She can either accept the money or decline it. If she declines, they both get nothing. How will either of them decide? ‘The theory of the utility maximiser, homo oeconomicus, provides a specific prognosis for this kind of situation,’ Sandra Ludwig explains. Thus, Anna would accept any arbitrarily small amount (‘better than nothing’), and Thomas would offer the lowest possible amount. ‘In reality, however, we observe that many players share the money evenly, which is why the theory needs to be developed further: is the donor simply fair? Or are there social norms at play, do they fear...’
rejection?’ the economist exemplifies. Participants stay anonymous in such experiments. They also actually receive the respective payouts.

Throughout their lectures in Experimental Economics and Strategic Interaction the directors of ULESS have already conducted smaller experiments with pen and paper. These go down well with the students but they offer much less creative leeway than experiments that are conducted in a laboratory – the behaviour of others, for example, cannot be reported back. ‘Any economic theory becomes more comprehensible when compared to one’s own behaviour and decision-making,’ graduated economist and psychologist Fellner-Röhling affirms. She doesn’t necessarily feel the need for harsh criticism of a model though: ‘Classic economic theories are often helpful to predict outcomes in competitive environments like markets.’

The road to realising an experimental laboratory was long and arduous, especially the search for a suitable room. The lab is equipped with cabins and a computer network that hosts a globally used software programme for experimental economic research. The computers and software can be started remotely in an adjoining room. Through a window between the two rooms the researchers can keep an eye on the experiments. There are about 21 similar labs in Germany – ULESS is one of the biggest. In 1984, Nobel Prize laureate Professor Reinhard Selten already established an Experimental Economics Research Lab at the University of Bonn. Both Professor Ludwig and Professor Fellner-Röhling refined their ‘craft’ in this renowned laboratory.

The two directors keep silent about future projects at ULESS. Only so much is revealed: they will revolve around individual decision-making in the context of social and strategic interactions. The professors also plan research collaborations with the Institute of Psychology and Education. ‘Typically, the participants are not supposed to know what the experiment is about as this would influence their behaviour,’ they explain their secretiveness. Their objective is a large register of participants that allows them access to participants beyond prospective economists and psychologists. In order to cover a broad spectrum of people they encourage members of all faculties as well as anyone who is interested to participate in the experiments. Should experimental economic research not rather analyse the decision behaviour of top managers though? The professors have a clear answer to that: ‘The students at Ulm University are the decision-makers of tomorrow.’

About the laboratory

Students, university employees and anyone else who is interested can participate in experiments at the Ulm Laboratory for Economic and Social Sciences (ULESS). The computerised experiments usually take one to two hours. Each participant is paid in cash according to their own and the decisions of others, as well as random influences. Those who are interested need to register. They then receive an email invitation to participate in randomly selected experiments. Further details: https://www.uni-ulm.de/mawi/uless.html

Prof. Gerlinde Fellner-Röhling (left) and Prof. Sandra Ludwig at the opening ceremony of ULESS
Half of Germany is overweight, and 15 per cent of our children already weigh too much. ‘Fat’ people have to endure a lot of criticism – they are regarded as undisciplined, lazy, and irresponsible. In a word, many people think that they have only themselves to blame for their appearance and their health problems. Two recently published studies conducted at the Department of Pediatrics and Adolescent Medicine of the Ulm University Medical Centre show that this equation is too simple.

On the one hand, a team of scientists led by Professor Martin Wabitsch succeeded in demonstrating that overweight mothers pass on metabolic functions to their children during pregnancy that can predispose them to obesity. On the other hand, the researchers also discovered a previously unknown disease: A child with a conspicuously insatiable appetite already weighed 30 kilograms at the age of two and a half years. The cause turned out to be a dysfunction of the satiety hormone leptin. With the right treatment, the boy lost a full third of his body weight.

‘The obese boy is of course a special case, but it is still wrong to blame children and adolescents for weighing too much’, says Wabitsch, head of the Division of Pediatric Endocrinology and Diabetes. Besides our genetic make-up and our behaviour, it is above all our living conditions that determine how much we weigh. And they are unfavourable: a lack of exercise, excessive media consumption, and fattening foods that are available around the clock lead to unpleasant surprises on the scale. ‘If we compare the average body mass index in the 1960s with that of today, it becomes evident that there has been a shift toward obesity’, the doctor explains. As a reminder, body mass index is a value that places an individual’s height and weight in relation with one another. High body weight has far-reaching consequences: in addition to health problems, it also often leads to social isolation. Overweight youths have a hard time finding an apprenticeship position and their quality of life is comparable to that of persons of the same age with cancer.

Anyone who has ever tried to go on a diet knows how difficult it is to lose weight – and due to the ‘yo-yo effect’, the effort is often all for naught. In any case, what is actually responsible for long-term weight control is a homeostatic feedback loop regulated by the hypothalamus, the energy control centre in the brain. This feedback loop – which, incidentally, goes all the way back to our ancestors in hunter-gatherer societies – is programmed in the second trimester of pregnancy and can influence our weight throughout our lifetimes. This connection was made by Professor Martin Wabitsch and Dr. Stefanie Brandt in cooperation with Professor Dietrich Rothenbacher (Epidemiology and Medical Biometry) in a recently published analysis of an Ulm study on children. The scientists collected data on 1000 children and their mothers for eight years, starting when the children were infants. They found that many daughters and sons of overweight women already exhibit elevated insulin levels at primary school age. ‘The hormone insulin distributes the blood sugar we digest in the body. Children
with elevated levels of insulin get hungry more quickly and are later more susceptible for type 2 diabetes’, the scientists explain.

In many cases, an elevated insulin level was detected even in the umbilical cord blood. A possible explanation for this is that severely overweight mothers already become insulin-resistant in the second trimester of their pregnancy, and the foetus is thus provided with more blood sugar than otherwise usual, possibly as a result of changes to the satiety centre of the brain or the insulin-producing beta cells in the pancreas. The underlying cause is likely epigenetic processes that influence the expression of regulating genes.

Hence, mothers determine which genes are switched on and off by way of their weight status. ‘Newborns of overweight women are heavier than average and are born with an elevated insulin level. Once it has been programmed for excessive weight, the feedback loop is difficult to correct’, sums up Wabitsch. In Germany, around one-third of pregnant women weigh too much.

**Little boy, insatiable appetite**

Even the obese boy the media reported so much about had a dysfunctional homeostatic feedback loop. The cause was a previously unknown disease. And so, the doctors were long at a loss. The child of slim parents began attracting attention already at the age of one. ‘Newborns of overweight women are heavier than average and are born with an elevated insulin level. Once it has been programmed for excessive weight, the feedback loop is difficult to correct’, sums up Wabitsch. In Germany, around one-third of pregnant women weigh too much.

The boy finally received help, but for around 400 youths being treated at five centres across Germany in the course of the holistic JA Study (‘Jugendliche mit extremer Adipositas’ – ‘Youths with Extreme Obesity’), the prognosis is unfavourable. ‘The three years since our JA Study was launched have shown that sometimes biology is too strong. Weight can’t simply be reduced’, says Wabitsch, coordinator of the study, which receives funding from the German Federal Ministry of Education and Research (BMBF). All one can do in these cases is to try to integrate the youths into the labour market despite their condition and boost their self-esteem. In obese persons with severe health problems, a gastric bypass might also be worth considering. After this operation, however, it is necessary to adhere to strict dietary rules for the rest of one’s life.

So is there no way out for the overweight? There is evidently at least hope for five- to six-year-olds. Around 600,000 school entrance check-ups from 2008 being analysed for all of Germany in Ulm by Professor Wabitsch and Dr. Anja Moss show a stagnation of obesity. Several German states even show a slight decrease. Professor Wabitsch puts this down to the more nutritious foods being served at nursery schools and primary schools. Thus, it turns out that the old platitude ‘you are what you eat’ does have some truth to it. Yet again, the most important factor besides our genes is our environment.

References:
Thalidomide gained notoriety as the active ingredient of the hypnotic drug Contergan: More than 50 years ago, countless babies were born with malformed limbs, because their mothers had taken Contergan during their pregnancy. But there’s another side to the drug: since the 1990s it has been used successfully in the treatment of certain bone marrow cancers like multiple myeloma or myelodysplastic syndrome.

Signs of an anaemia, bleeding from the gums to the gastro-intestinal tract, and frequent infections – these symptoms can be an indication of a myelodysplastic syndrome (MDS), which can develop in the worst case into an acute leukaemia. The drug lenalidomide, a successor of thalidomide, improves the condition of many patients. But for many years, the mode of action of lenalidomide and its analogues (thalidomide, pomalidomide) was completely unknown: Dr. Jan Krönke studied precisely how these immunomodulatory drugs take effect during a three-year research stay at the Harvard Medical School’s Brigham and Women’s Hospital and at the Ulm University Medical Centre’s Department of Internal Medicine III. Krönke, Professor Benjamin L. Ebert, and their team published their findings on the mode of action of MDS in the renowned journal Nature.

In 2014, Jan Krönke and his colleagues already succeeded in demonstrating that the agent binds to the so-called cereblon ubiquitin ligase – a kind of ‘protein waste disposal service’ for the cell. In this way, certain proteins (ikaros, aiolos) on which multiple myeloma cancer cells depend are broken down. But how does the drug take effect in the case of myelodysplastic syndrome, in which only one copy of the chromosome 5q is present? The researchers used protein analyses, molecular biological tests, and mouse models to search for further substrates of the cereblon ubiquitin ligase that are regulated by lenalidomide.

What they found out is that the drug uses the cereblon ubiquitin ligase to mark and degrade the protein casein kinase 1A (CK1A). Since the CK1A gene lies on the lost chromosome 5q, the MDS cells possess only small amounts of this particular protein in the first place and are therefore especially sensitive to lenalidomide. ‘Hence, lenalidomide takes advantage of the loss of a gene in the cancer cells to kill them’, explains Krönke, who leads an Emmy Noether Junior Research Group at the Ulm University Medical Centre. The researchers were also able to demonstrate that only lenalidomide – not its analogues – has the desired effect on the bone marrow disease. This finding is significant for the development of new drugs with similar effects that break down specific proteins related to the disease, because even the slightest chemical modifications evidently change the effect of the parent drug thalidomide.

In the course of their research, the German-American research group conducted the first-ever experiments with lenalidomide in mouse cells. This was previously impossible, since mice are naturally resistant to the effects of thalidomide and lenalidomide. There were thus no indications of the fatal side-effects of Contergan when the drug was tested on rodents 50 years ago. By genetically modifying the target protein cereblon, the scientists succeeded in sensitising the mouse cells to lenalidomide, opening up possibilities for further studies in this model in the future.

The 36-year-old Jan Krönke recently received the Arthur Pappenheim Prize from the German Association for Haematology and Medical Oncology, worth 7500 euros. He has also already received an award for his next project, in which he aims to elucidate resistance mechanisms to lenalidomide and search for corresponding genetic markers: the oncologist won the project prize from the foundation of the Württemberg Cancer Prize in early October 2015. Krönke will undoubtedly also use the 20,000 euros from this prize to further individualise the treatment of MDS patients.

The research was funded by the German Research Foundation (DFG) via Jan Krönke’s fellowship from the Emmy Noether Programme and Collaborative Research Centre 1074, ‘Experimental Models and Clinical Translation in Leukaemia’. The scientists received additional support from the Else Kröner Fresenius Kolleg Ulm and a cooperation agreement with the company Celgene, the manufacturer of thalidomide and lenalidomide.

Reference
Kronke J, Fink EC, Hollenbach PW, MacBeth KJ, Hurst SN, Udeshi ND, Chamberlain PP, Mani DR, Man HW, Gandhi AK, Svinkina T, Schneider RK, Bullinger L, Cathers BE, Carr SA, Chopra R & Ebert BL. lenalidomide induces ubiquitination and degradation of CK1a in del(5q) MDS. Nature. doi:10.1038/nature14610

From the Contergan scandal to successful treatment of bone marrow diseases

Modes of action of thalidomide and lenalidomide further elucidated
JUSTUS strengthens Computational Chemistry in Baden-Württemberg

Ulm University has a new high-performance computer. JUSTUS – named after famous German chemist Justus von Liebig (1803 - 1873) – is listed among the 500 fastest supercomputers worldwide. It sports a processing speed of around 273 teraflops and weighs more than seven tons, which are spread across eleven glossy black cabinets. JUSTUS was put into operation in 2015.

‘This supercomputer is entirely in the service of chemistry. A cooperative service model enables scientists from all over Baden-Württemberg to utilise storage space and processing capacities for their research projects,’ says Professor Stefan Wesner, Director of the Communication and Information Centre (kiz) at Ulm University. The federal state of Baden-Württemberg and the German Research Foundation (DFG) created a computer cluster (bwForCluster) at Ulm University specifically for the research area of computational and theoretical chemistry. With a total of three million euros funding, state and DFG shared the costs of this investment equally.

The technical challenge: processing capacity as well as storage space had to be customised precisely to the highly specific and demanding requirements of this particular field of application. The GreenGem of Japanese electronics group NEC was the one best suited for this purpose. It is not only extremely powerful but also environmentally friendly. ‘The NEC Way is based on a combination of more than 1,000 solid-state disks – four per node – and therefore on extremely fast local SSD storage media, as well as on a central block-storage which is connected via a high-speed communication network,’ Tomoyasu Nishimura explains. The General Manager of NEC’s IT Platform Division came all the way from Tokyo to join the celebration of putting JUSTUS into operation. The supercomputer’s inner workings comprise more than 7,100 CPU cores which are allocated to 444 nodes.

The developers also gave thought to environmental aspects. The system’s considerable energy requirements are covered entirely by hydroelectric power. Under load the mainframe computer consumes up to 160 kW – the equivalence to the power consumption of 300 single-family homes. As long as the outer temperatures don’t exceed 24 degrees Celsius, a so-called free cooling system can compensate the high operating temperature of the NEC GreenGem server with the help of integrated heat exchangers. Energy-intensive external cooling is thus redundant. ‘This makes JUSTUS not only a very powerful but also climate-friendly computer system,’ says kiz Director Professor Wesner.

‘By way of computer simulations the mainframe computer will help scientists to better understand complex chemical processes. This includes, for example, matters of energy storage and conversion, catalytic processes, the effects of prescription drugs, and also fundamental questions of molecular mechanics,’ explains Vice President of Research, Professor Axel Groß. The Director of the Institute of Theoretical Chemistry is co-petitioner for the Ulm Cluster, as well as future user.

The installation of a supercomputer at Ulm University was realised in the course of bwHPC, Baden-Württemberg’s concept for High Performance Computing. According to Peter Castellaz from the Ministry of Science, Research and the Arts (MWK) in Baden-Württemberg, the availability of computing resources is becoming increasingly relevant for research. ‘Not least due to the fact that simulation is gaining more and more importance as the third pillar of science, alongside theory and experiments. The universities set up allocated centres of expertise with the help of the state initiative bwHPC. The new supercomputer in Ulm is an important component in this.’

JUSTUS, the new mainframe computer at Ulm University, is listed in the Top 500 of the world’s fastest supercomputers.

Photo: Eberhardt/Ulm University
A stroke of luck for the region

Engineers and computer scientists celebrate 25th anniversary

Strong in research, well connected, and international – that’s the image of itself the Faculty of Engineering, Computer Science, and Psychology presented at its 25th anniversary celebration in June 2015. Scientists, students, and local dignitaries like Ulm’s mayor Ivo Gönner held a ceremony and an open house at the Uni Forum to mark a successful quarter of a century.

The innovations presented by the institutes and departments at the forum included 3D glasses, chips for retina implants, and a ‘virtual piano teacher’. In addition, a highly automated test vehicle from the Institute of Measurement, Control, and Microtechnology entered the Uni Forum through a special door, and the student team ‘Spatzenheim’ (Sparrow’s brain) set up a circuit to demonstrate a self-driving model car that has been very successful in construction competitions.

‘A faculty with engineering, computer science, and psychology – that makes for an exciting combination and creates new possibilities’, said the psychology professor Tina Seufert at the ceremony. The learning and instruction researcher took charge of the faculty in 2013, thus becoming the first female dean in the history of Ulm University. And nothing can illustrate the successful combination of technical disciplines and behavioural sciences better than the research focus ‘human–machine interaction’. It has only been a few months since psychology was added to the faculty’s name. Third-party funding at the faculty has increased to 10,645,000 euros.

University President Professor Karl Joachim Ebeling described the foundation of the faculty as an ‘exceptional stroke of luck, made possible by the initiative to establish Ulm’s Science City.’ Ebeling continued by pointing out that engineering, computer science, and psychology contribute to the common good and that Ulm University graduates are important for the region’s employment market. To counteract the current shortage of skilled workers, he said, it will be necessary to rely more on in-service continuing education of the kind represented by the School of Advanced
Professional Studies (SAPS) as well as internationalisation. The faculty has an especially large amount of students with foreign passports – due primarily to English-taught master’s programmes like Communications Technology.

The programme also included lectures on the research foci ‘intelligent automobiles’ and ‘cognitive technical systems’ as well as witty presentations by students and doctoral candidates. The organisers even had the researchers of tomorrow in mind: Girls and boys went on a scavenger hunt, learned about data security on Facebook, and experienced seeing from a psychological perspective.

**About the Faculty of Engineering, Computer Science, and Psychology**

The Departments of Computer Science and Electrical Engineering opened their doors for Ulm University students in winter semester 1989/90. Computer scientists and engineers have cooperated closely ever since. The degree programs offered by these departments (Electrical Engineering, Computer Science, Media Informatics, Information Systems Technology, Software Engineering, Communications Technology, and Cognitive Systems and Psychology) are all long since established at Ulm University. There have also been many successful collaborations with ‘traditional’ fields like medicine, physics, and biology. In 2009 the newly founded Institute of Psychology and Education joined the faculty, which was recently renamed the Faculty of Engineering, Computer Science, and Psychology. The behavioural scientists focus on the users of technology, bringing their knowledge on how humans act and think to bear to give new impulses to the technical disciplines.

One of the faculty’s flagship projects is the Collaborative Research Centre/Transregio 62, in which scientists from all three disciplines conduct research on future intelligent technical systems. These technical ‘companions’ adapt themselves to their users in highly individual ways. Besides human–machine interaction and intelligent vehicles, the faculty also focuses on ‘adaptive software-intensive systems’, ‘sensor technology and signalling’, ‘microwave and high-frequency systems’, and ‘semiconductors and nanomaterials’.

The faculty currently has 2500 students.

**Brief history of the faculty**

- **1989**: Inception of teaching Electrical Engineering and Computer Science
- **1990**: Faculty of Computer Science founded
- **1990**: Foundation of the Faculty Council of Electrical Engineering
- **2009**: Establishment of the Institute of Psychology and Education, Start Study Programme Psychology
- **2015**: 25th anniversary of the Faculty of Engineering, Computer Science and Psychology

**Students in 1989/90**
- 92 in Computer Science
- 122 in Electrical Engineering
- 7 Professors

**Students in 2006**
- 1157 at Faculty of Engineering and Computer Science
- 38 Professors

**Students in 2009**
- 54 in Psychology
- 1294 at Faculty of Engineering and Computer Science
- 40 Professors

**Numbers in 2015**
- 18 Study programmes,
- 2411 Students
- 50 Professors
- 272 acad. staff
It’s a hot summer day. The sun is low in the sky and blinds the driver. Taking a left turn at a busy intersection, the 80-year-old motorist fails to see a car with the right of way in the oncoming traffic. He slams into it. ‘Accident situations like this are typical of older road users’, says Professor Martin Baumann. The scientist has been studying the psychological foundations of driving at the Institute of Psychology and Education since 2014. Baumann presented his research at the faculty’s open house in summer 2015.

The psychology professor’s area of expertise is human factors research. One of his new research projects, which he is conducting together with Dr. Nicola Fricke from his department, is devoted to the specific problems of older drivers. ‘The elderly have an especially hard time navigating difficult intersections in busy city traffic’, the 45-year-old explains. Although we gather a wealth of experience in the course of our lives, our cognitive ability decreases in old age. ‘The abundance of information is sometimes more than seniors can handle in complex situations’, says Baumann. However, older persons have a stronger risk awareness than other road users and are better at judging their abilities.

‘Older drivers in particular have a lot to gain from self-steering cars if the technology supports them without overstraining them’, Baumann says. Driver assistance systems can only help if the user can control them and the technology meets with sufficient acceptance. The scientist sees the concrete challenge in providing a certain degree of transparency so the user can build up enough confidence in the system. In the area of driver–car interaction, the purpose of human factors research is to ensure that the way the technology is deployed makes sense and is oriented towards the needs and abilities of the user. ‘It also has the task of making the best possible use of specific human abilities’, adds Baumann.

‘As social animals, we are experts at interaction and cooperation’, says the cognitive psychologist, whose research deals not only with driver assistance systems and human–machine interaction but also general cognitive processes on the capacity for judgement or problem solving. Scientists like Professor Martin Baumann are now working to promote cooperative behaviour in road traffic, an area that many drivers occasionally experience more as a battle zone. This field of research goes by the name of ‘cooperative driving’. The idea is to use car-to-car communication to encourage cooperative behaviour on motorways, country roads, and city streets by technical means. For example, imagine a car wants to pass a slow lorry on a two-lane motorway. ‘In this case, a cooperative system would ensure that cars coming from behind slow down early on to make it easier for other cars to change lanes. This makes it possible to prevent massive chain braking reactions and the formation of traffic jams in dense traffic’, says the scientist, who is cooperating closely with Ulm University engineers, computer scientists, and psychologists at the Interdisciplinary Research Centre for Cooperative, Highly Automated Driver Assistance Systems and Driving Functions F3.

Another research field Baumann is concentrating on is hazard perception and attention research. The cognitive psychologist is sceptical as to whether it is possible at all to avoid distractions while driving over an extended time period. ‘The objective of our research is to find out which non-driving-related activities are particularly dangerous while driving a car and how they decrease the driver’s attention’, explains the scientist, who studied the potential of hand-held devices in cars for distracting drivers in his time as a postdoctoral researcher at the Federal Highway Research Institute. Incidentally, talking on the telephone and writing text messages aren’t the only things that distract drivers. It’s enough to lose oneself in thought about a particular problem, whether private or scientific in nature.
They are smaller than the head of a needle but can make blind people see and improve our understanding of the human brain: integrated circuits for implantable systems.

‘In the production of “chips” for implantable systems, billions of electronic parts are applied to silicon: Up to 100,000 circuit transistors whose structures can be seen only under the most powerful microscopes are arranged precisely on a surface with the diameter of a human hair’, reports Professor Maurits Ortmanns, director of the Institute of Microelectronics. This involves challenges like achieving high functionality in the smallest of spaces, low energy consumption, and adherence to high safety standards for the technologies and their users. Other obstacles include providing a wireless energy supply and ensuring data transport out of the body. Hardly any patients want to have wires protruding out of their skin, and they are associated with a higher risk of infection anyway.

Prototypes of integrated circuits like these are being continually optimised for various biomedical applications at the Institute of Microelectronics. The institute took advantage of the open house held by the Faculty of Engineering, Computer Science, and Psychology to present retina implants, a stress monitor, and a neuromodulator designed among other things to help patients with neurodegenerative diseases.

Patients inflicted with the eye disease Retinitis pigmentosa often begin losing their sight as children, before ultimately becoming blind altogether. The disease is caused by the progressive degeneration of photoreceptors on the retina. In seniors, on the other hand, the main cause of visual impairments leading to blindness is macular degeneration. People suffering from these and other diseases affecting the photoreceptor cells on the retina can be helped with a retina implant. However, there are two important preconditions: The link between the brain and the retina must still be intact, and the patient cannot have been born blind.

Retina implants based on integrated circuits replace the defective photoreceptor cell and use the still intact connection from the retina to the brain.
Implants allow patients to recognise facial expressions again or distinguish between objects.

The ongoing research projects at the Institute of Microelectronics are being funded by the German Research Foundation (DFG), the Federal Ministry of Education and Research (BMBF), and industrial partners.
No less than three of the world’s most influential scientists in their field carry out research at Ulm University. This fact was revealed by the North American media corporation Thomson Reuters in its publication analysis ‘The world’s most influential scientific minds 2014’.

The list was compiled using information from the citation indices ‘Web of Science’ and ‘InCites’ to determine which researchers had been cited most frequently (top 1 per cent in the year of publication) by their peers in specialist articles between 2002 and 2012. Among these 3,200 or so pioneers from 21 subject categories are two physicians from Ulm, Professors Hartmut Döhner and Heiko Braak. The third scientist from Ulm is the physics professor Fedor Jelezko.

The recently published table also includes scientists who were cited frequently in 2012 and 2013. These ‘hot papers’ are considered to be highly relevant. This publication analysis confirms that Ulm University is an attractive location for leading world-class researchers,’ enthuses Professor Axel Groß, Vice President for Research and Information Technology at Ulm University.

Heiko Braak, senior professor at the Department of Neurology / Centre for Clinical Research at Ulm University Medical Centre is one of the most cited researchers in the field of neuroscience and behavioural science. Braak explores neurodegenerative diseases such as Alzheimer’s and Parkinson’s disease. One of the medical scientist’s successes was to develop a classification scheme used all over the world to classify into stages typical changes to the brain during the course of Alzheimer’s disease.

Professor Hartmut Döhner, Medical Director of the Department of Internal Medicine III and spokesperson of the ‘Comprehensive Cancer Center Ulm’ primarily conducts research into the most common blood cancers in adulthood, namely acute myeloid and chronic lymphocytic leukaemias. He identified genetic changes that may reveal information about the progression of the disease and the success of the therapy.

Based on these findings, new molecular-targeted therapies can be developed. International guidelines used to treat leukaemia are based on Döhner’s cancer research. According to Thomson Reuters’ publication analysis, Döhner is one of the most cited scientists in clinical medicine.

A physicist from Ulm is also listed by Thomson Reuters: Professor Fedor Jelezko’s research focuses on colour centres in diamonds, where impurity atoms can be stored and controlled. This is by no means abstract basic research. In fact, it is important for all technologies based on quantum coherence – examples include high-performance sensors, imaging techniques and novel quantum computers. Together with his colleagues Professors Martin Plenio and Tanja Weil (BioQ group), Jelezko was awarded an ERC Synergy Grant worth 10.3 million euros at the end of 2012.

The former Head of Ulm’s Centre for Solar Energy and Hydrogen Research (Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, ZSW) Professor Jürgen Garche and Professor Bruno Scrosati from the Ulm Helmholtz Institute for Electrochemical Energy Storage (HIU) are also listed among the most influential researchers.

A total of 159 German scientists are mentioned in the ranking list, including 21 from Baden-Württemberg. Eight of these are researchers at Heidelberg University. On a par with Ulm University, Karlsruhe Institute of Technology and the University of Hohenheim each have three scientists included on the list. If Professors Garche and Scrosati (honorary professor at Ulm Uni) had counted as Ulm researchers, Ulm University would even have been represented on the list with five researchers.
More than a blood donation centre

Ulm transfusion medicine combines research and treatment
The Institute of Clinical Transfusion Medicine and Immunogenetics (IKT) at the Ulm University Medical Centre provides more than 130 medical facilities in the State of Baden-Württemberg with blood products as well as stem cell and cell therapy preparations. In addition, the stem cell donation file at IKT Ulm lists around 70,000 persons. But providing services for blood donors and recipients isn’t the only activity the ‘blood donation centre’ is engaged in: Scientists at the labs are also conducting innovative research with links to numerous university institutes. Their work benefits trauma researchers, haematologists, oncologists, and last but not least patients at the medical centre.

There is a rich tradition of haematological research at Ulm University: This is where the recently deceased former university president Professor Theodor Fliedner conducted his legendary experiments demonstrating the existence of stem cells – including experiments on himself and with a dog model – and laid the foundations for blood stem cell donation. In collaboration with ‘blood pope’ Professor Hermann Heimpel, he also studied haematological diseases and contributed to the establishment of bone marrow donation in Ulm. Today one of Heimpel’s students, Professor Hubert Schrezenmeier, is at the helm of both the university’s Institute of Transfusion Medicine, which focuses primarily on research, and the health care facility IKT. The scientists working under Medical Director Schrezenmeier conduct classical research on the molecular basis of blood groups and transplantation antigens as well as studies on cell therapy, gene correction, and mesenchymal stem cells.

Mesenchymal stem cells (MSC) have useful properties: They can differentiate into a variety of other types of cells, including bone, cartilage, and fat cells, and inhibit excessive immune responses. Studies indicate that these stem cells can work wonders for nonhealing fractures and chronic wounds. A patient at the Ulm University Medical Centre whose fracture had not healed in more than six months was recently treated with the versatile stem cells by trauma surgeon Professor Florian Gebhard – and the initial results are encouraging. Other projects involving MSC include hip necrosis treatment and jaw reconstructions prior to dental implants. There is just one problem: ‘MSC are found almost everywhere in the human body, but only in small numbers – only five of 100,000 bone marrow cells are mesenchymal stem cells. But we need more than 200 million of them for treatment – per patient’, describes Professor Schrezenmeier. These valuable ‘engineers’ are thus being cultured according to stringent guidelines (GMP or ‘good manufacturing practice’) in the institute’s ultramodern clean rooms and multiplied to an average of 60,000 times the original amount. All that is required for this procedure is 25 millilitres of bone marrow. After a period of around three weeks, the cell therapeutic agent is ready to be administered to the patient – for instance in surgery – where it supports the healing process in the bones or the tissue. To monitor the ‘behaviour’ of these stem cells as well as that of bone marrow cells used to treat conditions like acute myocardial infarction, the scientists plan to use nanoparticle labels.

Interdisciplinary studies between basic research and practice

As these examples demonstrate, Hubert Schrezenmeier works closely with Ulm trauma researchers in the research focus ‘Stem Cells and Cell Therapy’, making valuable contributions to projects like those at the recently approved Collaborative Research Centre 1149. The second research focus at the Institute of Transfusion Medicine, ‘Molecular Pathophysiology, Diagnostics, and Therapy’, aims at elucidating the molecular features of blood types and tissues. This involves a lot more than just identifying blood types: With support from the José Carreras Leukaemia Foundation, for instance, the scientists are investigating non-classical HLA features (human leukocyte antigens). In doing so, they hope to improve the process of selecting donors on the one hand...
and to better understand the causes of blood formation defects on the other – ideally as a basis for mutation-specific gene correction. ‘Our goal is to remove haematopoietic stem cells from the patient, eliminate the mutation, and reintroduce the cells into the patient’, explains Schrezenmeier.

“If there’s a patient who urgently needs a bone marrow or blood stem cell donation, we can usually help him within two workweeks”

To determine relevant features for blood and stem cell preparations as quickly as possible, scientists at the institute are working on improved sequencing techniques (‘next-generation sequencing’) – another example of how the Institute of Transfusion Medicine is building bridges between research and practice.

While the research is conducted at the Institute of Transfusion Medicine, the ‘routine work’ of providing hospitals with blood and stem cell products is done at the IKT, a joint facility of the German Red Cross Blood Donation Service Baden-Württemberg–Hessen and the Ulm University Medical Centre. In cases involving the transplantation of haematopoietic stem cells, Schrezenmeier and his team communicate regularly with colleagues from the medical facilities, including the Department of Internal Medicine III as well as the Department of Pediatrics and Adolescent Medicine at the Medical Centre. ‘If there’s a patient who urgently needs a bone marrow or blood stem cell donation, we can usually help him within two workweeks. We start by examining family members, and if it’s necessary to find an unrelated donor, our specialised unit coordinates the worldwide search. We have a hit rate of around 90 per cent for Central Europeans. Then the matching donor undergoes a health check’, describes the specialist in internal medicine/haematology and transfusion medicine. For most donations, the institute has adopted the gentle method of peripheral blood stem cell donation once developed by Theodor Fliedner. It involves administering a growth factor that stimulates blood stem cells to leave the bone marrow and circulate in the blood. The stem cells can then be isolated from the donor’s blood. A surgery like in classical bone marrow donations is unnecessary.

The institute processes more than 200,000 blood donations of 500 millilitres each per year. The IKT then distributes the various blood products to the Ulm University Medical Centre and many hospitals in the region.

It’s plain to see the delight in Hubert Schrezenmeier’s eyes when he talks about the new building for 280 employees and the renovated annex at the institute: ‘Our transfusion clinic, our labs for preparing and testing of blood products in accordance with the strict regulations, and our storage and logistics facilities are finally all state of the art and all in the same place again.’ This benefits the scientists in Ulm as well as patients in 130 medical facilities across the State.
Unique in Southern Germany

Ulm University launches new master’s programme ‘Sustainable Management’

Scarc resources, destruction of the environment, climate change – our society needs responsible economists who keep the ecological and social consequences of their decisions in mind. Starting in winter semester 2015/16, Ulm University will help prepare students for this role in the master’s programme ‘Sustainable Management’. Just over 300 applicants from across Germany have competed for the 30 places in the programme. Developed at the Faculty of Mathematics and Economics with the explicit aim of addressing these challenges in environment and society, the programme is the first of its kind at the university level in Southern Germany.

The declared goal of the interdisciplinary degree programme ‘Sustainable Management’ is to teach students a wide range of skills in environmental and resource economics as well as business ethics, thus enabling them to make sustainable business decisions. To achieve this, the programme includes a combination of well-founded economics knowledge and specialised content on sustainability. The young economists will acquire know-how about environmental management systems, social standards, and socio-ecological control variables like life-cycle assessment. Another important focus will be personality development.

Equipped with these skills, graduates will be qualified for positions at companies in various industrial sectors, at government agencies, or at non-governmental organisations (NGOs). ‘Even just the solid training in economics promises excellent career prospects’, says Professor Martin Müller, director of the institute ‘Sustainable Management’ and initiator of the degree programme. ‘The additional qualification of being able to assess situations from a sustainability perspective and to resolve resulting conflicts of aims gives them an additional competitive edge.’ Students can select individual areas of emphasis to strengthen their ‘sustainability’ profile or extend their qualifications in economics. This means that more classical career paths, such as controlling or supply chain management, also remain possible. In addition, the concept of providing practice- and research-oriented teaching to a total of only 30 students per year guarantees a good student-teacher ratio. The degree programme is receiving funding from the state programme ‘Strengthening the Contribution of Science to Sustainable Development’.

It is even possible to establish initial contact with potential employers while completing the programme. This is made possible by the university’s close relationship with the ‘Ulm Initiative Group for Sustainable Economic Development’, which supports economic partnerships and networks in the region. The focus on sustainability research at Ulm University promotes interdisciplinary and inter-faculty networking, which can lead to collaborations in the areas of regenerative energies and electromobility.

The international degree programme also provides sufficient scope for study abroad, for instance at universities in Spain, Italy, France, USA, Mexico, Sweden, or Canada. mb/dh

Further information: http://www.uni-ulm.de/mawi/nachhaltige-unternehmensfuhrung.html
Two driverless cars are now on the road around the Ulm University campus: A team of engineers led by Professor Klaus Dietmayer has put another self-driving car with even more powerful sensors and more processing power into operation. They intend to use the two cars primarily to conduct research on cooperative driving. The cars will thus communicate with each other and with their surroundings.

The Institute of Measurement, Control, and Microtechnology’s highly automated test car has covered around 5000 kilometres around Ulm University since the middle of 2014 – without encountering any problems and of course without getting into any accidents. Now Professor Klaus Dietmayer and his engineers have added to their fleet a second self-driving car with even more powerful sensors and more processing power. Like its older sibling, the new test car, a modified Mercedes E-class T-model, is cleared for use on all public roads in Germany thanks to a special permit from the regional administrative authority. A safety driver who can take over at any time in the case of malfunctioning is naturally always on board. ‘We want to use the two test cars chiefly to study cooperative highly automated cooperative driving. The cars will also communicate and adjust their driving characteristics to each another’, explains Professor Dietmayer.

The activities at Ulm University involving self-driving cars that communicate with each other and their surroundings are concentrated at the Research Centre for Cooperative, Highly-Automated Driving Assistance and Driving Functions (F3). Funded by the Carl Zeiss Foundation, the centre unites engineers, computer scientists, and psychologists, all working together to develop the intelligent car of the future.

Highly automated driving, and one day even autonomous driving, will help to make our streets safer and prevent accidents. Moreover, they will make driving more comfortable: One day it could even be possible for people without a driving licence to take a car into the city and read a book on the way. At present, however, highly automated driving only works for individual manoeuvres and on familiar routes. Especially in challenging urban traffic, in which pedestrians, cyclists, and cars all share the same tight space, all manner of technical aids are necessary: The researchers have built seven radars, five cameras, and a laser scanner into the new test car – most of them employing serially produced sensors. These sensors constantly send data to three computers integrated into the car, which then evaluate the situation and plan the wisest course of action, before finally taking control of
the gas pedal, brakes, and steering wheel. In the future, this planning will also be coordinated with that of other nearby cars. The cars will exchange data on their position, speed, and planned actions via wireless communication. In addition, the engineers are studying how the intentions and plans of other road users can be captured by sensors and processing algorithms and included in the planning process of the test cars. ‘Cooperative, highly automated driving could be used, for instance, to remove blind spots or perfect the process of merging into a reduced number of lanes, all without a driver’, explains Dietmayer.

Teams of engineers, computer scientists, and technicians at the Institute of Measurement, Control, and Microtechnology have been working on achieving the vision of autonomous driving for a full fifteen years. To date, more than 20 doctoral dissertations and 100 final degree theses have been written on topics related to highly automated vehicles at Ulm University. The test cars are now capable of navigating through pedestrian crossings without any kind of driver intervention, they can turn into the street from the university car workshop on their own, and their traffic light recognition is also greatly improved. In the future, the cars will integrate typical behaviours of their owners into their driving style and planning processes and interact even better with other road users and the road infrastructure. How much control does the driver want to give up to his car? And at what point does he feel like he is being told what to do? These and other questions concerning the ‘psychology of driving’ will also be studied at F3. Even now, the driver can take over control of the highly automated test cars at any time – by pressing a button or stepping on the brake pedal.

Soon Ulm’s test track at Berliner Ring/Albert-Einstein-Allee will be expanded toward the city centre – and will thus include new challenges like a roundabout at Blaubeurer Ring. In addition, the two self-driving cars will need to coordinate the process of merging into a busy road. Drivers in Ulm aren’t the only ones to agree that situations like these demand cooperative behaviour between all users of the road.

Further research

In addition to the research at F3, the Institute of Measurement, Control, and Microtechnology cooperates with engineers from Daimler AG at the innovation centre driveU. Work at the centre focuses on driver assistance systems, vehicle safety, and automated driving functions.

More information: http://www.uni-ulm.de/in/iui-drive-u.html
The fourth industrial Revolution does not only happen in major corporations. Small and medium-sized businesses might also benefit from digitalisation and data exchange. The newly established working group ‘Industry 4.0’ will provide answers to their questions regarding business-management.

The shop floor is bustling with electronic data exchange: machines, transportation containers and workpieces are in constant communication with each other in order to optimise their production rhythm. The total digitalisation of production and logistics is hoped to make factories more efficient. Simultaneously, it heralds a shift away from standardised mass production. The shop floor of the future allows customers to individually define the properties and features of a product. Not only the production is smart, the products are as well. Data analyses notify manufacturers when machines need to be serviced and allow them to intervene before an outage happens. We are talking about the fourth industrial revolution, Industry 4.0.

On some shop floors of big corporations the digital age might have started already. The question is: are small and middle-sized companies in Ulm and its surrounding region ‘Swabia’ ready for digitised value chains? Industry 4.0 will not just bring about technical innovations but also challenges for management and administration. Innovations necessitate considerable investments. The benefits may be obvious in many cases - but they are not easy to quantify. At the end of 2014 the International Performance Research Institute gGmbH (IPRI,
and the Institute of Technology and Process Management (ITOP, scientific director: Professor Leo Brecht) at Ulm University started the working group industry 4.0, which focuses on these particular economic questions.

The most important members of the group, however, are the 20 companies – including one or two Swabian family-run business. ‘There are many managers who don’t know what exactly Industry 4.0 means. Yet they are aware of the importance of the topic and don’t want to miss out,’ says IPRI scientific director Professor Seiter. He has been busy talking to decision-makers about their understanding and the implementation of the ‘fourth industrial revolution’. The economist wants to reach out to those who are interested and guide them into the digital future – all this is also part of a science project of course.

The working group, which is supported by the Ulm Chamber of Commerce (IHK) as well as the International Controller Association (ICV), is unique in two respects: The working group Industry 4.0 works on economic and non-technological questions. They also focus on manufacturing businesses in the surrounding areas of Ulm and Stuttgart, like machinery and plant manufacturers or electrical engineering companies. This is how Seiter and his research colleagues want to bring Industry 4.0 to Swabia: firstly, the group develops a methodology with which businesses can create their individual plan of action on their way into the digital future. ‘Such a “roadmap” includes company-specific potentials and their prerequisites for Industry 4.0. The next step will then be a cost and performance assessment,’ Seiter explains. After this, the scientists plan to explore further economic questions in the context of digital production. The research team is convinced: ‘Industry 4.0 is not a matter of company size but a matter of how much a business is willing to engage in digitalisation and networking.’ This offers great opportunities for small and middle-sized businesses as well, they say.

Professor Péter Horváth, founder of IPRI, was one of the initiators of the working group and is known for his great instinct for trends and developments. As a reminder: The business consultant (Horváth AG) and emeritus professor of the University of Stuttgart has transferred 50 per cent of the International Perfor-

mance Research Institute gGmbH to Ulm University. So now research is being conducted not only at the headquarter in Stuttgart but also at its branch in Ulm – application-oriented and across faculties. ‘Germany is at risk of missing the train to the future’ was the recent headline of a trans-regional medium on the topic of Industry 4.0. This is a fate that small and medium-sized businesses in Ulm and surrounding regions don’t need to fear. ab/dw

About IPRI

The International Performance Research Institute (IPRI) is a non-profit research institute with currently 15 employees and a focus on economics. Main topics at present are Industrial Services, Supply Chains, Controlling & Sustainability as well as Business Analytics. The Institute was founded in 2002 and has its headquarter in Stuttgart. Scientific director, however, is Professor Mischa Seiter at Ulm University. The Institute in Ulm collaborates very closely with the Institute of Technology and Process Management (ITOP). Several students have written their theses in the course of IPRI projects by now.

For their third-party-funded research endeavours the IPRI economists usually enter three-year-long collaborations with technically oriented partner institutes. Businesses also take part in these research consortia – practical relevance is therefore granted.

Current projects, involving scientists from all over Germany, address, for example, the second career of senior employees (‘company skills management’), ‘sustainability reporting’, and opportunities for smaller operators in the intercity coach services market.
New Heisenberg Professorship in Molecular Psychology

Studying smartphone addiction in the genetics lab
WhatsApp, Facebook, and mobile phone games – Germany’s youth is always online. Is this excessive media consumption just a passing fashion or is it legitimate to speak in certain cases of a computer or smartphone addiction? Professor Christian Montag conducts research on media use – with the help of molecular genetic methods.

‘The smartphone livens up our day: When we activate the device, a reward often awaits us – in the form of a nice message, a Facebook comment, or a game’, says Ulm University’s new Heisenberg Professor in Molecular Psychology, Christian Montag. ‘When the device is not available, some users even exhibit withdrawal symptoms as with recognised addictions.’

Within the context of the project ‘Biological Basis of Internet Addiction and Online Video Game Addiction’, funded by the German Research Foundation (DFG), the psychology professor is investigating whether there are genetic variants that favour excessive media consumption – like those that play a role in nicotine or alcohol addiction.

Students activate their smartphone every twelve minutes: This is the average calculated by ‘Menthal’, an app developed for study purposes by Christian Montag and the Bonn computer scientist Juniorprofessor Alexander Markowetz. Hence, the working and private lives of these people are constantly being interrupted by their phone – and they are often not even aware of it. ‘If we were to ask young adults about their smartphone usage, we would receive very imprecise and possibly even “socially desirable” answers. We are therefore relying – with the consent of the roughly 50,000 people to use Menthal so far – on the smartphone itself as an economical and long-term data source’, explains Professor Montag. The researchers are using their app to study how much smartphone use is normal.

Montag defines smartphone or Internet addiction as, among other things, the constant use of and preoccupation with online content, especially with social networks and games. Other factors that play an important role include withdrawal symptoms and the development of a tolerance – meaning that the user needs to constantly increase his or her media consumption to experience the same feeling of happiness.

When the device is not available, some users even exhibit withdrawal symptoms

The mobile telephone is thus at the same time a potentially addictive device and a psychological measurement instrument. In addition, it could also play an important role in psychotherapy: Montag is testing whether patients in depressive phases change their mobile phone use behaviour, communicate less with others, and – GPS reveals it – spend more time at home. In the future, psychologists could use quantitative mobile phone data of this kind to follow the course of an illness and intervene promptly. ‘Companies like Google and Facebook collect our data for commercial purposes. If the process is sufficiently transparent, I don’t see any problem in using this data for research or therapy’, says the psychologist. A team of

Christian Montag is the new Heisenberg Professor in Molecular Psychology

QR code: More about Prof. Montag’s research

App Menthal Balance: https://menthal.org/
Professor Michael Weber takes over presidency from Professor Karl Joachim Ebeling

Baton change at Ulm University

Ulm University has a new President. Professor Michael Weber, director of the Institute of Media Informatics, succeeds Professor Karl Joachim Ebeling in this position with effect from 1 October 2015. The director of the Institute of Optoelectronics had been the University’s President from 1 October 2003 to 30 September 2015. 

Notables from politics, science and the business world came together in a grand festive event to celebrate the transfer of office, during which the former President handed the golden chain of office to the new President.

Over the course of his twelve-year-long term of office, Professor Ebeling, who once graduated as a physicist, has evidently set the University up for success. Ulm University has not only been rated as Germany’s best young university but also achieved high ratings in various international rankings. Under his aegis the number of students has increased significantly to above 10,000, while third-party funds doubled to around 100 million euros since his inauguration. Both the inception of the International Graduate School in Molecular Medicine Ulm (IGradU) as part of the German Universities Excellence Initiative and the inception of four Collaborative Research Centres, which are all funded by the German Research Foundation (DFG), took place during Ebeling’s term. These collaborations are highly renowned. Their research areas are quantum technology, human-machine-interaction, leukaemia and trauma research. And then the Helmholtz Institute Ulm (HIU) became the first...
non-university federal research institute on the campus at Oberer Eselsberg. HIU investigates and develops electrochemical energy storage. Its battery research constitutes yet another important facet of the University’s research profile. Ebeling, who spent several years in the USA and has relevant experience in the industry sector, earned personal scientific merits for his research on integrated optical modulators and high-performance vertical cavity lasers, which, among others, have been awarded with the Leibniz Prize and the Karl Heinz Beckurts Prize.

Professor Michael Weber is the first computer scientist in the presidential office. The director of the Institute of Media Informatics has been researching and teaching at Ulm University for more than twenty years. In 1994, when he was 34 years old, he took up the Professorship for Distributed Systems at the University. In 2000 he became director of the newly-founded Institute of Media Informatics. His main research topics are ubiquitous computing, human-machine-interaction and adaptive multimodal systems. Having acquired about 5.6 million euros in third-party funds, he is one of the most successful scientists at Ulm University. Weber also co-initiated one of the University’s flagship projects, the DFG-funded Collaborative Research Centre of companion technologies. As Dean of Studies and Dean, the computer scientist has been co-determining the course of the Faculty of Engineering, Computer Science and Psychology over many years. He gained industry experience shortly after finishing his doctorate by developing aviation system software. As the new president, he wants to continue the successful path of his predecessor and give new impetus at the same time. Like establishing professionalised support with the acquisition of third-party funds for research and teaching, for instance, to ensure that Ulm University continues to succeed on an international level.

Former president Prof. Karl Joachim Ebeling

New president Prof. Michael Weber
Wrangell Fellowship for Dr. Dilana Hazer

Using technology to identify emotions

She is polyglot, mathematically gifted and a “tech whiz”. The engineer Dr. Dilana Hazer, Lebanese by birth, was awarded a Margarete von Wrangell Fellowship for the research on human-machine interaction she is conducting to qualify for a professorship.

‘Thanks to the habilitation fellowship, I now have five years time to prepare for a professorship’, the Wrangell fellow is happy to report. Named after the first German professor, Margarete von Wrangell, the funding programme of the State of Baden-Württemberg is designed to make it easier for excellent young female researchers to work their way up to a full professorship. The state provides funding for an appropriate position for the first three years, and the university funds it for an additional two years.

The Ulm fellow is Lebanese by birth. Dilana Hazer was born in Beirut in 1982 and completed her schooling there. The mathematically talented young woman was interested in technology and wanted to become an engineer. She studied for a year in the Lebanese capital before gaining admission to the degree programme ‘Engineering Physics’ at the University of Oldenburg (Germany). There she was drawn above all towards biomedical topics. She thus decided to return to Oldenburg after her stay in the French city of Lyon on an Erasmus scholarship, where she wrote her bachelor’s thesis in the field of computational neurosciences at the renowned CNRS. Hazer then earned a master’s degree from the University of Oldenburg in the degree programme ‘Biomedical Physics’, writing her thesis on radiotherapy at Siemens Medical Solutions in Heidelberg.

She also focused on a biomedical application for her dissertation at the Karlsruhe Institute of Technology (KIT). The engineer developed a computer-based system for improving the diagnosis of cardiovascular diseases. On the basis of data from individual patients, Hazer succeeded in designing 3D models of the blood vessels of specific patients with the help of CT and MRT images in order to simulate patients’ blood flow dynamics and vascular wall mechanics individual. ‘These computer models help the vascular surgeon to plan and conduct minimally invasive interventions’, the scientist explains. She is also focusing on a computer-based system for cardiovascular diagnostics for her habilitation project. However, this time she is developing a cognitive-technical system capable of ‘automatically’ identifying stressful emotions and mental strain on the basis of cardiovascular information. ‘With the help of ECG data or other biomedical signals, doctors can use the system to identify highly emotional states of patients that could place them at an elevated risk of having a heart attack or stroke’, explains the researcher, who enjoys engaging in football, tennis, and mountain biking in her free time to keep fit.

However, Dilana Hazer also knows a life outside of academia. The ambitious scientist has several years of experience in the private sector. She is urbane and a polyglot; the engineer is a native speaker of Arabic and Lebanese and also speaks fluent French, English, and German, as well as some Spanish. Her curriculum vitae includes many awards and scholarships, and even more impressive is her list of volunteer work. Not only does she appreciate the work of the scouts; she also volunteers in the charitable organisation ‘Friedensdorf International’ as vice-director of the Ulm section. In addition, she has been an active member of the booster association of the ‘Behandlungszentrum für Folteropfer Ulm’ (BFU), a treatment centre for victims of torture, for three years. Hence, the successful young woman is also well aware of the darker aspects of life.
New Juniorprofessor from Oxford

Shining light on the brain and schizophrenia

The neuroscientist Dr. Dennis Kätzel is a new Juniorprofessor at the Ulm Institute of Applied Physiology. The appointment was made possible by the returnee programme for top medical researchers of the Else Kröner-Fresenius Foundation and the German Scholars Organisation e.V. (GSO). The biologist and philosopher focuses primarily on the poorly understood mental disorder schizophrenia.

‘Once we have succeeded in understanding schizophrenia, we will understand a large part of the human brain’, says Dr. Dennis Kätzel, ‘because there is hardly any brain area and hardly any brain function that is not influenced by this disease.’ The neuroscientist, who previously worked at the University College London and the University of Oxford, assumed duties as Juniorprofessor at Ulm University in the winter semester 2015/16. What attracted him to Ulm’s Institute of Applied Physiology was not just the funding of 110,000 euros from the Else Kröner-Fresenius Foundation and the GSO, but also the generous support he received from the institute’s director Professor Birgit Liss, the Faculty of Medicine, and Ulm University.

Dennis Kätzel has been fascinated by the largely unexplained disease schizophrenia ever since his years as a student of biology and philosophy at the University of Marburg. It is still not possible to treat this psychiatric disorder, which is characterised by delusions and hallucinations. Dennis Kätzel uses mouse models to study what goes on in the brain of individuals with schizophrenia. One of the techniques he applies in his experiments is optogenetics: ‘This method enables us to switch specific neurons on or off in the intact brain using light. In this way, we can identify the function of individual cell types very directly’, explains Kätzel, whose PhD supervisor, Professor Gero Miesenböck (Oxford), was a pioneer of optogenetics. Furthermore, Dennis Kätzel applies electrophysiological methods to measure the activity of many nerve cells in the intact brain.

The Juniorprofessor, who acquired his methodological knowledge in some of the world’s leading optogenetics laboratories at Stanford, Yale, MIT, and Oxford, plans to establish a behavioural laboratory in Ulm. He will use the lab to study the behaviour of genetically modified mice to serve as models for schizophrenia and other psychiatric disorders. In addition to their social behaviour, their motivation, and their memory capacity, the researcher will of course also keep tabs on the rodents’ brain cells: ‘If the animals’ symptoms improve when we switch particular nerve cells on or off, they could play a causal role in schizophrenia’, says Kätzel.

Which nerve cells work differently in a diseased brain compared to a healthy one? Which neural networks do antipsychotic drugs act on? And how can we develop better animal models to identify suitable drug candidates? The messenger dopamine plays a key role in this process, since its activity appears to be thrown out of balance in schizophrenia patients. A team of researchers led by Professor Birgit Liss have been studying this dopamine system and its dysfunctions for many years. Kätzel and Liss plan to work together to search for molecularly defined points of attack for potential new pharmacological therapies. This also explains the great interest Dennis Kätzel and Birgit Liss have shown in bringing their scientific work together at the Institute of Applied Physiology in Ulm. The Juniorprofessor is also interested in collaborating with a team of scientists in the Department of Neurology at the Ulm University Medical Centre and the Institute of Anatomy and Cell Biology, which are conducting research on neurodegenerative diseases and autism, respectively.

‘It is very difficult to obtain research funding in England at the moment. The Juniorprofessorship at the Institute of Physiology, by contrast, is very attractive. It comes with outstanding resources and is embedded in the strong Neurosciences environment at Ulm University’, says the new Ulm citizen Kätzel.
First Alumni Homecoming

Back to the alma mater
More than 170 alumni and their families returned to Ulm University on ‘Schwörwochenende’ (‘Swear Weekend’, a local holiday) in mid July to celebrate a reunion. Some of them had completed their studies only recently, while others belonged to the first graduating class. Former students travelled from as far away as Pakistan and South Africa to attend the first alumni homecoming, which included talks, guided tours, and a ‘market of possibilities’.

When Dr. Hans-Paul Kienzle began studying medicine in 1969, the new Surgery Centre and the ultramodern Theatrum Anatomicum weren’t even on the drawing board yet. The first class of medical students spent their first year in just three rooms on Parkstraße in the city centre – a ‘lecture hall’, a ‘library’, and a room with anatomical specimens. The engineering school (today the Ulm University of Applied Sciences) opened up the doors to its laboratories for practical courses. ‘I grew up in Ulm and applied to the young university out of a feeling of local patriotism and for financial reasons. Like three other classmates, I was granted admission by the Central Office for the Allocation of Study Places’, the 64-year-old recollects.

A lot of things were provisional in the early years, but the student-teacher ratio was outstanding due to the fact that there were only 50 students in his class. In the third semester of the program, the first main anchor of the faculty was completed on the Eselsberg Campus, where the anatomic dissection halls were located. ‘For clinical disciplines like orthopaedics and neurology, we used to have to ride a bus to the surrounding hospitals. And two learning-intensive weeks at the Psychiatric Hospital in the Swabian city Weissenau really helped to create a strong bond among the class’, remembers Kienzle, today a specialist in paediatrics and general medicine. In this way, the first graduating class of medical students – from Swabian family practitioners to professors at the Charité in Berlin – have remained in contact to this day. The last class reunion took place in 2009, and after the Alumni Homecoming and met many old friends. Afridi came to Ulm on a scholarship in 2007 after completing a bachelor’s degree in computer systems engineering. Now 32 years old, he has mostly fond memories of his time as a student in Ulm: ‘It was difficult in the beginning. I was used to learning in groups. In Germany I had to work through the material on my own for the first time’, remembers the engineer, who wrote his master’s thesis at Daimler TSS. But this independence and discipline ended up being the things he profited from most. The lecturer Afridi often tells his students anecdotes about his time in Germany, and he has already managed to get a relative interested in applying for the Ulm degree programme Communications Technology.

The doctors Simone Wittig (29) and Lucia Breckerbohm (30) used the words ‘well organized’ to describe the first Alumni Homecoming at Ulm University. Having graduated in 2011 and 2012, respectively, they still have fresh memories of their time as students.

In addition to various guided tours, the homecoming event included lectures on focus areas at Ulm University. The topics ranged from trauma research and future energy storage devices to in-service continuing education.

Muhammad Tariq Afridi from Pakistan completed the English-language master’s programme Communications Technology (CT) in 2011. He returned to Ulm University for the first time since graduating for the Alumni Homecoming and met many old friends. Afridi came to Ulm on a scholarship in 2007 after completing a bachelor’s degree in computer systems engineering. Now 32 years old, he has mostly fond memories of his time as a student in Ulm: ‘I grew up in Ulm and applied to the young university out of a feeling of local patriotism and for financial reasons. Like three other classmates, I was granted admission by the Central Office for the Allocation of Study Places’, the 64-year-old recollects.
Around 200 Ulm University students are studying or working abroad at the moment. The young scholars are taking advantage of programmes organised by the International Office or the faculties, work placements, and international clinical traineeships, and the destinations they have chosen aren’t just the ‘classic’ ones like England or Spain. The Ulm medical student Philipp Gauckler experienced the healing power of the papaya in a Peruvian hospital, and the CSE student Alexander Dürr lived in a luxury dormitory in Singapore but also speaks of dangerous pressure to do well on exams.

The prospective doctor Philipp Gauckler had already discovered his interest in the Spanish-speaking world as an ERASMUS student on Tenerife. And so it was that he decided to spend the first four months of his practical year, from April to July, in South America – and not at a tourist destination. He chose a hospital in Trujillo, Peru, the third largest city in the north of the country. During his time as an ‘interno’ in surgery, Gauckler experienced a health care system that is completely different from that of Germany. ‘Half of the population in Peru has no health insurance. Municipal hospitals like my place of work thus provide patients with nothing but a bed. When they need medicines and even needles or examination gloves, they have to send relatives to the pharmacy and pay for them out of their own pocket’, explains the trainee doctor. Family members also often help care for the patients.

Interns and trainees in Peru usually do routine work like changing bandages, cleaning wounds, and doing a lot of paperwork, but Philipp Gauckler was lucky enough to be allowed to work at the casualty ward relatively soon after his arrival. The injuries he saw there were unlike those one might expect to see at the Ulm University Medical Centre: Again and again, the German was confronted with gunshot wounds and stab wounds. Young men in particular were often admitted with severe injuries from automobile or motorcycle accidents. ‘Unlike in Germany, imaging techniques like CT and ultrasound are more the exception. Even in emergencies, the focus is often on physical examinations’, reports Gauckler. Some Peruvian doctors also employ unconventional remedies: the German couldn’t believe his eyes when he saw a wound being cleaned with grated papaya. He was told that the fruit ‘metabolised’ bacteria.

In Peru, anyone who can scrape together enough money goes to a private hospital for treatment. Gauckler’s hospital, on the other hand, admits poor people from the entire region whose dis-
eases are already in an advanced stage. Accordingly, the doctors have to put in long shifts – a seven-day week at ten hours a day is not uncommon. ‘But medicine is still a truly prestigious profession in Peru’, says Gauckler. Although he too had to work more than his German classmates, he still found enough time to get to know Peruvian culture and travel on his days off. ‘My 300-euro PROMOS scholarship was enough for me to live comfortably in a fishing village near Trujillo – and I could go surfing right near my doorstep’, says the student. A highlight of his stay was a trip to visit a recovered patient, a man from the mountain rainforest who had been treated for a stab wound, on a coffee plantation far away from all civilisation. ‘Although the family was bitterly poor, they gave me their best room and slaughtered a goose for my visit’, says the medical student, who returned the favour by helping out with the coffee harvest.

Although his time as a trainee in Peru wasn’t entirely free of complications – he had to change hospitals on his first day there, for instance – Gauckler describes it as ‘a once-in-a-lifetime experience I’m glad to have had’. Incidentally, Philipp Gauckler was allowed to conduct an appendix operation on his own as a parting gift. The station’s head surgeon assisted him.

Singapore instead of Sigmaringen

‘An opportunity like this only knocks once’, is also what Alexander Dürr thought when he signed up for a semester abroad at the renowned National University of Singapore (NUS). The student travelled to the tropical city state last year with a 600-euro Baden-Württemberg Scholarship and thought himself in paradise. With a swimming pool and a fitness centre, his lodgings resembled a four-star hotel more than a dormitory, and it goes without saying that the 23-year-old also profited academically from his semester abroad: ‘My English has improved entirely. He serves as a ‘buddy’ for Asian students despite the humidity, and discovered the city’s nightlife. He took advantage of weekends and ‘reading week’ to take trips to Thailand, Malaysia, Indonesia, and Hong Kong. After his semester abroad, he even explored Japan.

Dürr was back at his parents’ home near the German city of Sigmaringen in time for Christmas. But he hasn’t left the tropical paradise behind entirely. He serves as a ‘buddy’ for Asian students at Ulm University, takes courses in Chinese, and cooks Southeast Asian dishes for his family and friends. Alexander Dürr was at the Stuttgart Beer Festival and on Lake Constance with acquaintances from Singapore he had convinced to come to Germany. Last but not least, the 23-year-old also profited academically from his semester abroad: ‘My English has improved and I use the things I learned at the NUS for my student job at Bosch-Rexroth’, the future master’s student says.

Understanding the English language was more difficult for me than understanding the material itself, because most lecturers speak the dialect “Singlish”, says Dürr. During the examination period, however, he also became acquainted with the dark side of paradise: the exams are so difficult that it’s almost impossible to achieve the maximum amount of points. Chinese students, whose families often have to pinch and scratch to come up with the 10,000 euros per semester in tuition, are particularly susceptible to the pressure of performing well on exams – some have even been known to have committed suicide. As an exchange student, Alexander Dürr was exempt from paying tuition. He got mostly good grades, and was able to enjoy life. He took cooking courses, played football in a team of exchange students despite the humidity, and discovered the city’s nightlife. He took advantage of weekends and ‘reading week’ to take trips to Thailand, Malaysia, Indonesia, and Hong Kong. After his semester abroad, he even explored Japan.