

**BIOINFORMATICS: LEARNING
THE LANGUAGE OF CELLS**

**PROCESS TECHNOLOGY: USING
WASTE HEAT BETTER**

ELEMENTS

SEPTEMBER 2016

56



ESCORT DUTY FOR ACTIVE INGREDIENTS*



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Evonik. Power to create.



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Why the chocolate glaze sticks so well to the doughnut. **Page 36**

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EDITORIAL

Money well spent

What constitutes an innovative company? This is what we wanted to find out from customers, investors, politicians, scientists, and employees. So in early 2016, we had Forsa conduct a survey on Evonik’s innovative capabilities. Of the over 2,000 participants, more than 50 percent said that a company’s innovative capacity can be measured by “new and improved products.”

We share this opinion, because innovations are a key driver of profitable growth. This is why we invest in them so heavily. Our R&D expenditures for 2015 were €434 million. Over the last five years, we have increased that investment by an average of 6 percent annually. The results speak for themselves: Compared to the previous year, we increased the value of our innovation pipeline in 2015 by half a billion euros, and that amount will continue to grow. Our goal is ambitious. Over the intermediate term, we intend to generate 16 percent of our sales with products that are less than five years old.

We can achieve this only with creative employees, entrepreneurship, passion, and perseverance. To sharpen awareness of this goal, we have conferred our first Entrepreneurship Award. As the winner of our internal idea competition, Dr. Marta Canas-Ventura was given the opportunity to dedicate an entire year to working on and promoting her idea, intelligent inks that indicate the correct storage of medicines. We are providing her with a budget of €200,000, and I am certain that it is money well spent.

By the way, almost 50 percent of the Forsa respondents are confident that Evonik will become one of the most innovative companies in the world in the intermediate term. This reinforces our commitment and, at the same time, challenges us to persuade the other 50 percent.



Dr. Ulrich Küsthardt
Chief Innovation Officer
Evonik Industries AG
ulrich.kuesthardt@evonik.com

THE GENOME WHISPERERS

Evonik has used microorganisms to obtain high-quality products for many years. With their understanding of cell language and ability to analyze a cell's synthesis potential, the Group's bioinformaticians provide valuable assistance in this work. Their efforts pave the way for optimized or completely new production platforms.



Stephan Hans and Dr. Jessica Schneider

Genome researchers might seem to have it easy. The language that they seek to decipher and understand consists of only four letters: A, C, T, and G. The four nucleotides adenine, cytosine, thymine, and guanine are the building blocks of the genomes of all living organisms.

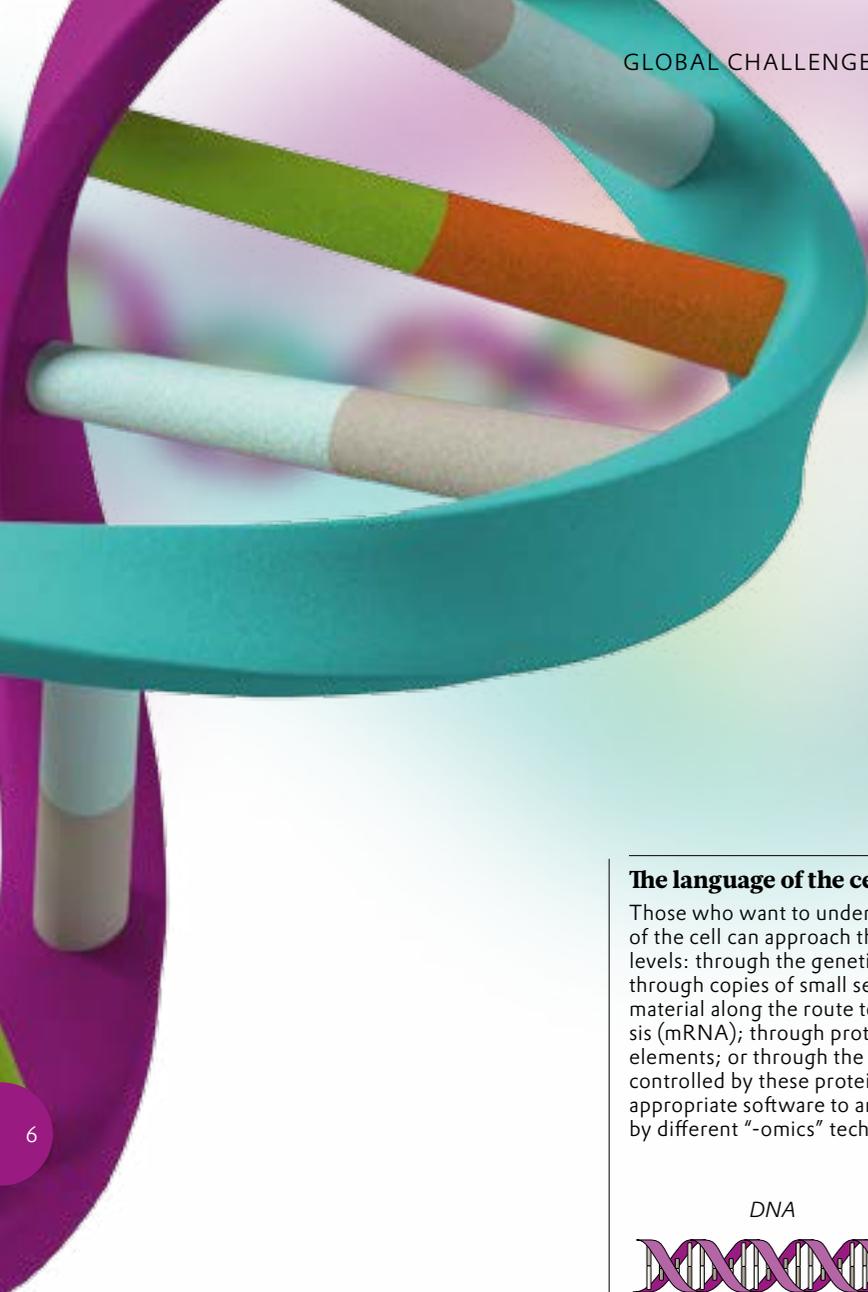
But learning the genetic language is far more difficult than a lay person would expect. The road from a simple letter sequence of the DNA to a biologically active substance is long. There are four key steps. First is decoding the nucleotide sequence of the DNA (experts refer to this as “genomics”). The DNA’s information is transcribed into mRNA in the cell, and this transcription must also be decoded (“transcriptonomics”). The

mRNA, in turn, encodes for the building of a certain protein whose function is analyzed as part of a discipline called “proteomics.”

The protein ultimately catalyzes a defined chemical reaction in the cell or initiates an entire reaction chain, in which the metabolic intermediate (metabolite) participates. The result is metabolic products that are vital or advantageous for the organism and can be analyzed by special methods (“metabolomics”). There are also a host of biological structures such as membranes, cell walls, and extracellular protective layers and sensors that are built from these metabolites. They are extremely important for the function of the organism.

Evonik has long used the complex translation work of nature to produce high-quality substances that would be costly and →

1 year was the time it took to sequence the *Escherichia coli* bacterium 15 years ago. Today the same task takes just six weeks, and the cost has dramatically decreased from €100,000 to €1,000.



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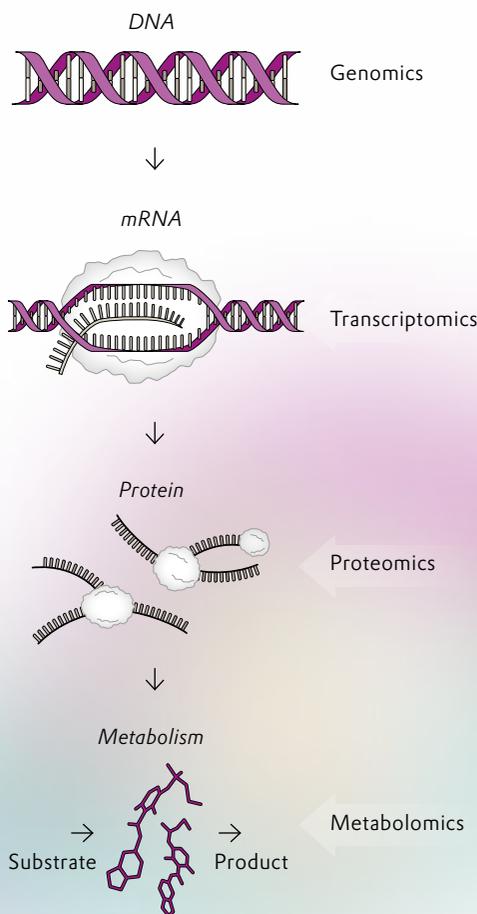
→ time-consuming to produce by the chemical route—if the chemical route can be used at all. Currently, five different organisms produce ten main products. These include several amino acids that, when used as additives in animal feeds, significantly improve the supply of nutrients to livestock in the mast. Another important area is particularly well-tolerated and rapidly biodegradable biosurfactants for personal care and cleaning products.

Looking into the cell with modern software

Anyone who wants to use living cells on the industrial scale will initially confront a number of closed doors. Which micro-organisms would even be able to produce the desired substance? Which method will produce attractive metabolites or cell functionalities for the Group? How many genes are involved? Even when it comes to established methods, questions always arise.

The language of the cell

Those who want to understand the language of the cell can approach the problem at various levels: through the genetic information (DNA); through copies of small segments of genetic material along the route to protein synthesis (mRNA); through proteins as functional elements; or through the metabolic processes controlled by these proteins. Bioinformatics has appropriate software to analyze data established by different “-omics” technologies.



How stable or how mutable is the genome over time? What mutations have occurred that could be influencing the yield?

Without modern bioinformatics it would be nearly impossible to answer these questions. In recent years, this discipline has become established as an independent science and a third pillar, in addition to theory and experiment. As defined by the specialist group of the chemical associations, bioinformatics is “the research, development, and use of computer-assisted methods to answer molecular biological and biomedical questions.” This definition implies two key ideas: one, that the discipline is based on advanced software that can process, structure, and evaluate large volumes of data, and two, that it asks a broad range of questions that are completely different from those of genetics, biology, and medicine.

For Evonik’s bioinformatics team at the Halle-Künsebeck site in East Westphalia, there are three main challenges: optimizing existing fermentation processes, analyzing the synthesis activity of new or related production strains, and searching for ways to understand the effect of biological substances in the organism. Because there are always enormous volumes of data and the individual research questions are always different, the five-person team covers a broad range of specialized knowledge—from biology through genetics and biostatistics to data processing and data management.

Cooperation is essential for success

In this work, cooperation is essential. Evonik’s bioinformaticians work in close coordination with the biotechnologists and process developers of the Nutrition & Care Segment. They also collaborate with academic partners such as the Center for Biotechnology at the University of Bielefeld and the Chair for Bioinformatics and System Biology at the University of Gießen.

At the Center for Biotechnology in Bielefeld, for example, they and their partners have developed extensive software platforms in all areas of the “omics” technologies over the past few years. As a result, advances from university research are directly incorporated into production. Their partners also include commercial software developers. This allows Evonik to introduce specific requirements for the tools as early as the development stage.

The successes of bioinformatics are closely linked to technical development. The programs and hardware on which “omics” technologies are based are significantly more effective today than they used to be. The biggest advances have been in the speed and quality of the decoding of the genetic code. To compare: Fifteen years ago, sequencing of the *Escherichia coli* bacterium, which is particularly important to commercial production processes, took one year and

devoured more than €100,000. Now, the same service takes only four to six weeks and costs about €1,000.

Dyes make genetic information visible

Today, single-strand sequencing is frequently used to determine the exact sequence of the four nucleotides adenine, cytosine, thymine, and guanine in DNA or RNA. The method is based on an intelligent trick: The nucleotides are first marked with four different colored molecules. When duplicating the DNA in the living cells, polymerases always link A with T and C with G. If, for example, a thymine base is incorporated in a certain place, the result is a light signal characteristic of the T nucleotide, which is captured by a high-resolution camera. Because several thousand pairs are detected at the same time in high throughput, a picture of the nucleotide sequence emerges per single strand.

In the past ten years, a whole industry of service providers has emerged that can decode the genetic information of nearly any organism and supply the customer with raw data in the form of single segments (reads) in a short period of time. This is where the real work of the bioinformatician begins. These scientists use special software to reconstruct, for example, a complete genome from a bacterium, and then predict the locations of the genes. In the end, the resulting gene puzzle must be correct and complete: The cell can form only those substances whose syntheses are anchored in its genome.

Today, however, the limiting factor is no longer the decoding and prediction of the genes but the subsequent evaluation and interpretation. For what purpose does a special gene code? How active or inactive is it at a particular time, and why? How many genes are involved in the production of a defined product?

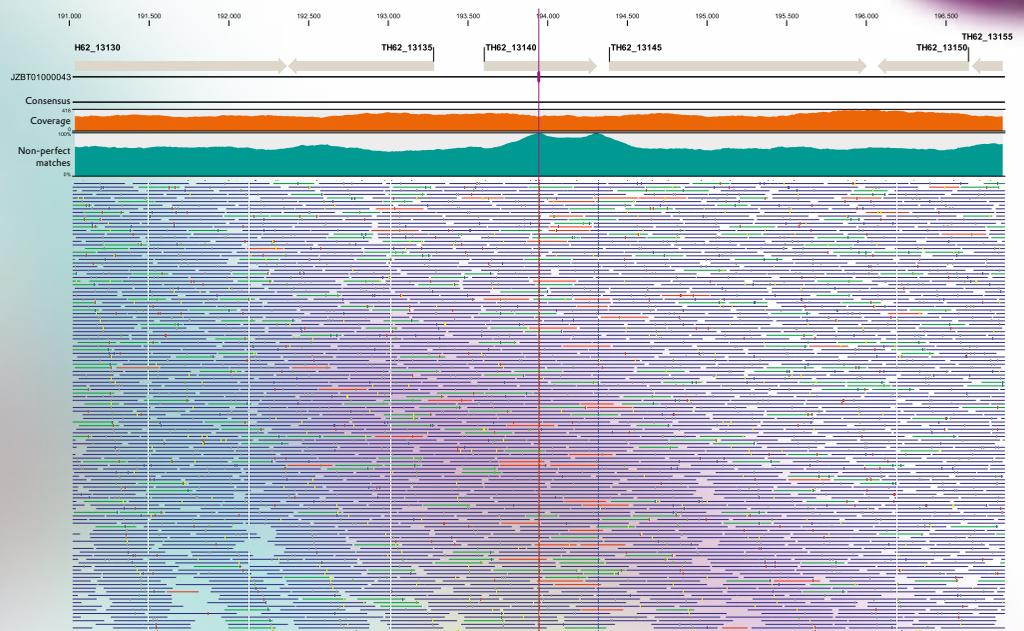
Answering these questions is not an easy task. In the simplest case, a gene on the DNA may code for a particular enzyme and therefore for a defined metabolite. Frequently, however, several enzymes—and therefore several genes—are involved in the formation of a metabolite. Many enzymes can use different educts and form a variety of substances from them. Other cell products occur only when several catalysts assemble to form complexes.

“A far greater value than science can currently grasp is sleeping in the genetic data of potent microorganisms.”

Stephan Hans

Process optimization using bioinformatics

Special software enables genome sequence data (known as “reads,” shown in the lower part of the figure) to be compared with a reference sequence and the genes on it (shown in gray). The dark green peaks show where mutations have occurred in the DNA.



Individual genes, therefore, interact with each other. They are also switched on and off through promoters. They mutate, change, and are subject to a variety of regulation mechanisms. And last but not least, the desired substance can be the product of the central metabolism of the cells or occur as a secondary metabolite on an alternative route. It can be present in the cells or forced out of them.

Bringing tired organisms back to their feet

To determine the activity of a gene, the bioinformaticians record the quantity of the mRNA formed. The more RNA, the more frequently the genetic code is read. This expertise can be key to optimizing an established biotechnical process. For example, it became apparent after the production of an amino acid, for example, that the cells were only partly active. Some of the bacteria had lost their productivity and the process

threatened to become unstable. The bioinformaticians then sequenced the genome of various less active strains. They discovered that, among the “tired” organisms, a defined gene had mutated. By installing an artificial promoter before the coded area on the bacteria DNA, it was possible to regain the activity and keep it going throughout production. The stability of the process increased, along with the yield.

A very similar solution was found for another process. In this case as well, the bioinformaticians increased the synthesis activity of the cells, although the ratio of the material derivatives that were formed shifted as a result. They identified the gene responsible for this, and colleagues from strain development reactivated it by installing a particularly strong promoter from another sector of the bacteria genome.

The genetic comparison of related strains also plays a large role. Bioinformaticians use this method to discover changes in the genome that influence the synthesis activity of the cells. The metabolic model of a single strain can comprise 500 or more individual processes.

Consequently, as part of a research project, the Evonik team developed evaluation criteria for mutations. Gene mutations with a big influence on the synthesis of the substance were given a high score, and less important mutations a low score. This scoring allowed the identification of certain areas on the DNA (targets) for which a selected →

→ mutation induces particularly productive candidates. In addition to these mutation analyses, the genomes can also be examined for specific characteristics for the purposes of a patent or product registration.

From microbe to microbiota

Bioinformaticians study more than just the language of genes. Increasingly, they are looking beyond the individual cell. A particularly attractive market for Evonik is probiotics for animal nutrition. Probiotics are organisms that have positive effects on the intestinal health of animals and also reduce the administration of feedstuff antibiotics. To scientifically verify these effects on chickens, for example, bioinformaticians had to analyze the entire microbiota—that is, the society of microorganisms in the intestine of the animal—and understand its interactions.

Any technical advance in the analytical tools means a whole host of new challenges. To analyze the metabolism of individual strains, experts also have to analyze an entire biological network. Which microorganisms indicate the health of the animal, and which show diseases or malnutrition? This calls for the analysis and evaluation of a far larger volume of data and requires the simulation of physiological processes. On the basis of this knowledge, we can try to understand the composition of a “healthy microbiota” and, building on that, establish services that show the effect of probiotics on intestinal health.

A similar strategic goal has been defined by the “Good Bacteria and Bioactives in Industry” (GOBI) alliance of the German Federal Research Ministry, in which Evon-

The experts



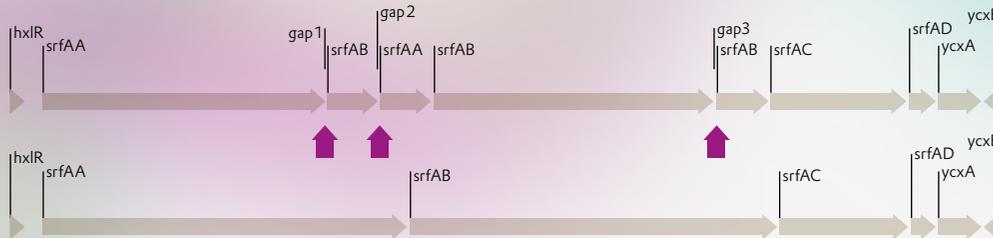
Stephan Hans has built, established, and headed the Bioinformatics Group at the site, and as of October 1 he will head the Knowledge Management and ESHQ units for biotechnological research in Künsebeck.
stephan.hans@evonik.com



Dr. Jessica Schneider succeeded Stephan Hans as head of the Bioinformatics Group on June 1, 2016.
jessica.schneider@evonik.com

Genomic information from bioinformatics

Modern sequencing methods enable researchers to fill in gaps in the genome landscape—in the present case, in part of a bacterial genome relevant to certain secondary metabolites. The old method produced gaps (marked by arrows in the upper part of the figure), which can be automatically filled in by modern sequencing methods (lower part of the figure).



Evonik participates. Established in 2015, GOBI's objective is to selectively optimize the positive effects of microorganisms on humans and animals and to transfer them to bioactive products.

Data mining and artificial intelligence will help

One thing is clear: Bioinformatics decodes complex causal relations within an organism and opens new avenues to insights that would not have been possible a few years ago. Knowledge of genes and enzymes simplifies costly experiments and increases the probability of success of laboratory studies.

But despite all the research and advances, there remains much to do. This is underscored by the fact that, unlike the model organism *E. coli*, the gene function of lesser-known bacteria is still largely unex-

plored. The function of up to one third of bacteria is understood. For another third there are assumptions, and the rest are shrouded in darkness.

Put another way, a far greater value than science can currently grasp is sleeping in the genetic data of potent microorganisms. This is good news for bioinformatics, because it not only works with living material but is itself a vibrant, living discipline. Its tools and methods are developing quickly. New questions are constantly arising. Through data mining and artificial intelligence, it will be possible in the future to understand cell processes that are currently unknown and to open up new synthesis potential.

At Evonik, bioinformaticians are working closely with the Group's R&D and Innovation units, with the assistance of university-level experts and tool developers, to meet the challenge of characterizing the synthesis activity of nature—for both existing processes and new products. In this endeavor, a widely known fact plays right into their hands: Even though biological systems are always more complicated than we want them to be, they can also beat conventional solutions by a wide margin in terms of efficiency, cost, and sustainability. ●

“Analyzing the complete microbiota of an animal is a major challenge for bioinformatics.”

Dr. Jessica Schneider

Companies such as the Californian start-up Deep Space Industries (DSI) already have specific plans as to which raw material could be recovered from asteroids that orbit close to Earth in order to build and supply new space stations.

10

DISRUPTIVE TECHNOLOGIES

The rules of the game are changing



"We don't like your music. And no one is interested in guitar music anyway." With this brief explanation, Decca Music rejected the Beatles in 1962—a momentous decision for the music label. The Kodak company made an even more fatal decision when it suspended further development of digital photography, even though it already held key patents for this technology. The result? Kodak filed for bankruptcy in 2012 and withdrew from this market completely after more than 120 years.

To ensure Evonik is prepared for changes in technologies, markets, and customer needs, the Corporate Foresight Team's next focal topic is "GameChanger." The name describes innovation fields that could fundamentally change existing markets and businesses, as well as entire industries, over the next ten to 20 years.

Under this topic, the team will examine such innovations as the self-driving automobile and its implications for Evonik. This technology could mean that as many as 80 percent fewer cars will be needed in the future. As a consequence it would also reduce the need for brake hoses, automotive paints, and headlight covers, which would have a direct impact on Evonik's business activities.

Corporate Foresight assumes that another, longer-term game changer will be the emergence of private space travel. Whereas up to now leaving the earth's orbit has been a government matter, private stakeholders are now setting out to conquer space. This is why the Foresight Team is analyzing potential new markets, such as space tourism, asteroid mining, and the need for new materials for the required spaceships. But Evonik's first task is to identify further game changers that will affect it.

HIDDEN HEROES

In the pharmaceutical world, active ingredients play the main role. But in many cases, additives combined with smart formulations decide when, where, and how long a drug works and how effective it is.

Hans Bär, Dr. Maria Montero Mirabet, and Dr. Brigitte Skalsky

It was an exciting, novel idea: In 1996, a US pharmaceutical company introduced a new pain reliever on the market. It featured an attractive mechanism. The API oxycodone, an opioid known since 1917, was released from the dosage form gradually over a defined period of time, instead of immediately. Up until that point, oxycodone had significant drawbacks when delivered via conventional tablets. Although the substance itself was better than morphine at fighting pain, increasing the dose compounded side effects such as constipation and nausea.

The main concern, however, had been the occurrence of lethal overdoses in some cases. Against this background, sustained-release tablets were developed that delivered the opioid steadily over several hours—with the intention of mitigating the complications.

However, optimism about these new dosage forms declined in the early 2000s when an increasing number of patients were admitted to US hospitals for opioid abuse. How did this come about?

The drug manufacturer had developed and marketed the sustained-release tablets as a means of alleviating post-surgical, bone, and muscle pain, as well as chronic

A family named EUDRA...

The name EUDRA is derived from the ancient Greek *eu* for good or well and the French word *dragée* for sugar-coated almond and means roughly “good coating.”

EUDRAGIT®
Range of pharmaceutical polymers

EUDRATEC®
Range of formulation technologies

EUDRAGUARD®
Range of polymers for nutraceuticals

“Drug formulation and the controlled release of active ingredients involve considerable expertise and creativity.”

Dr. Brigitte Skalsky



Perfect timing: With EUDRAGIT® polymers, the release of the active ingredient can be controlled exactly via pH and time-dependent dissolution.

pain associated with cancer, for example. However, some patients would drink a glass of whiskey or other alcoholic beverages along with their prescribed drug, hoping the combined effects would combat their acute pain even more effectively. Unfortunately, this habit exacerbated the severe side effects. The presence of alcohol enhanced the solubility of the formulation's components, disrupting the sustained-release mechanism. As a result, the API was “dose dumped” and absorbed into the body considerably faster than intended.

Conventional single-dose formulations are designed to release the API all at once. In such formulations, the quantity of the API is smaller than in sustained-release tablets. The latter are designed to release the API over a period of time ranging from several hours to an entire day. They therefore contain multiple doses of the API, sometimes up to three times more than the single dose. Consequently, if the concomitant consumption of alcohol disrupts the release control mechanism, significant overdosing and severe consequences may result.

Controlling the release of active ingredients

This phenomenon came to the attention of the US Food and Drug Administration (FDA) in 2005. Due to health concerns, the drug manufacturer was forced to recall the oxycodone product from the market. This was because clinical studies had proven that the formulation lost its controlled-release properties in the presence of alcohol, thus leading to immediate, premature release of the entire API dose within minutes. This process soon became known as alcohol-induced dose dumping (ADD).

In the following years, the FDA and some US governmental institutions developed regulations and guidelines directing pharmaceutical companies to evaluate existing drugs that might be susceptible to alcohol-induced dose dumping. In 2012, the STOPP (Stop Tampering of Prescription Pills) Act was introduced in the USA. It required the pharmaceutical industry to take stronger action against prescription drug abuse. It also promised a defined period of market exclusivity to those companies first able to market alcohol-resistant formulations of certain APIs. Those formulations found to be potentially hazardous →



The development lab in Darmstadt: Besides innovative formulation technologies, Evonik's Health Care Business Line offers extensive formulation services to the pharmaceutical industry.

→ were of necessity reformulated or even newly designed in order to reduce the risks when taken in conjunction with alcohol. The optimized oxycodone formulation was launched in 2010.

This opioid painkiller example impressively demonstrates how a drug's formulation can impact the safety, efficacy, approval, and commercial success of a marketed product. Appropriate drug delivery systems must be designed according to the needs of the clinical indication and by taking specific physicochemical and biopharmaceutical properties of the API into account. These include attributes such as solubility, absorption, half-life, and dosing requirements as well as the overall therapeutic concept.

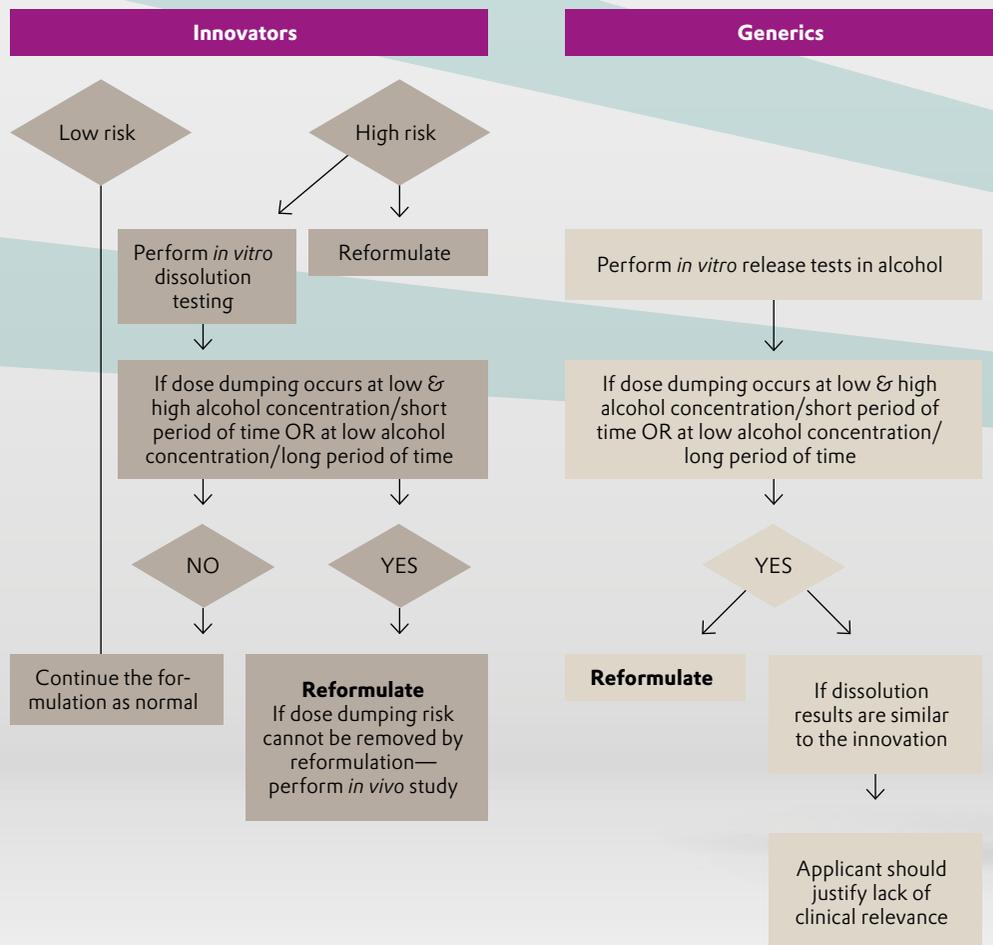
Active ingredients in the right place at the right time

Evonik offers a variety of formulation technologies, marketed under the name EUDRATEC®. They enable pharmaceutical manufacturers to achieve virtually all desired drug release profiles and thus reliably deliver APIs to the targeted destination at the right time. EUDRATEC® technologies are based on EUDRAGIT® polymers, which are functional poly(meth)acrylates. Depending on which functional groups are attached to the polymer side chains, coatings or matrices made of EUDRAGIT® polymers control drug release via pH and time-dependent dissolution or permeability change.

These technologies also exploit the physiological conditions of the gastrointestinal tract. The stomach is a particularly acidic environment, with pH values in the range of 1 to 3. Yet the further the drug travels down the gastrointestinal tract, the higher the pH becomes. At the end of the small in-

Figure 1: ADD risk decision tree

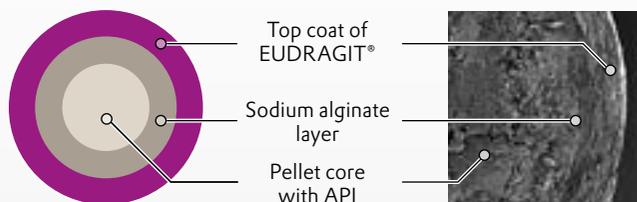
In accordance with a directive from the European Medicines Agency (EMA), which came into force in 2015 for controlled-release drugs, drug manufacturers must ensure that there is no risk of sudden alcohol-induced dose dumping.



Source: 1. EMA, Guideline on the Pharmacokinetic and Clinical Evaluation of Modified-release Dosage Forms (EMA/CPMP/EWP/280/96 Corr1), effective June 2015 (London, Feb. 2013).

Figure 2: Reliable protection against alcohol

To protect the active ingredient against sudden release in the presence of alcohol, in the EUDRATEC® ADD technology it is surrounded twice: with an inner layer of sodium alginate and an outer layer of EUDRAGIT® polymers.



testine the value is around 7. If, for example, a coating is made of a EUDRAGIT® polymer containing acidic functional groups, it will not dissolve in the acidic gastric juice while in the stomach. However, after leaving the stomach and entering the intestine, the pH value increases and triggers dissolution of the coating and thus drug release.

Last year, Evonik launched the technology platform EUDRATEC® ADD. It can be used to develop tailored coatings that prevent alcohol-induced dose dumping. Within the first months following introduction, experts from Evonik’s Health Care Business Line entered into discussions with several major pharmaceutical players. These are companies that require reformulation of their existing products or newly designed formulations in order to comply with the guidelines issued by the FDA and the European Medicines Agency (EMA) (Fig. 1).

The directives call for manufacturers to confirm that enteric or sustained-release

Protective shield: EUDRATEC® ADD protects against alcohol.

formulations show sufficient resilience against alcohol-induced dose dumping. This can be demonstrated by testing the *in vitro* dissolution behavior of formulations in acidic hydro-alcoholic media over specified time periods. The test conditions are meant to mimic the concomitant consumption of beer or alcopops (5% alcohol), wine (10%), liquor (20%) and spirits (40%).

Intelligent double layer against the influence of alcohol

EUDRATEC® ADD pellets consist of three parts, whereby the core contains the API (Fig. 2). This is surrounded by a layer of sodium alginate—a natural hydrocolloid typically extracted from brown algae and widely used in food, cosmetics, and pharmaceuticals. The uppermost layer consists of a EUDRAGIT® film. The desired drug-release profile (e.g. gastro-resistant or extended release) determines the EUDRAGIT® polymer to be implemented, its quantity, as well as the excipients it will be combined with. Usually, a large number of these pellets →

“We’re talking to renowned pharmaceutical manufacturers that want to use our EUDRATEC® ADD technology.”

Hans Bär



→ are packed into a capsule or compressed into a tablet to provide the final dosage form.

The EUDRAGIT® layer creates a “smart pellet” that controls where and how the API is released. Yet on its own, it would dissolve in gastric juice when alcohol is present, thus leading to premature release of the entire API dose. This is where the sodium alginate comes into play. Upon exposure to hydro-alcoholic gastric juice, the material swells, thereby clogging the pores that are formed in the EUDRAGIT® outer layer upon exposure to alcohol. In other words, alcohol triggers two opposing effects that cancel each other out: formation and clogging of pores. Consequently, these controlled-release pellets have a similar delivery profile in the presence and absence of alcohol (Fig. 3). This results in improved drug safety against unintended misuse or intentional abuse of alcoholic drinks and medication.

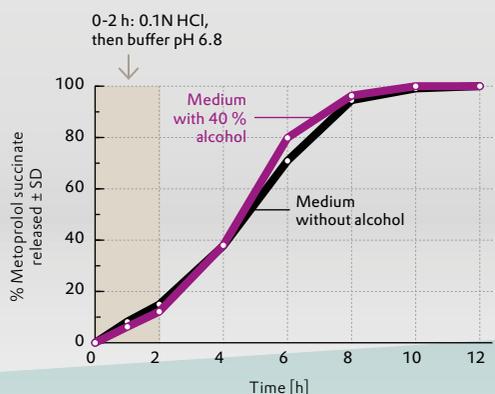
Although the EUDRATEC® ADD platform is not a one-size-fits-all standard solution, it is very versatile. Along with the supply of EUDRAGIT® polymers and licenses for EUDRATEC® ADD technology, Evonik also offers comprehensive formulation development services to pharmaceutical companies. During the development of customized formulations, meticulous attention is given to specific needs, for example in terms of the solubility of the API and the target dissolution profile as well as the size and type of the final dosage form.

Deliberately slower stomach transit

Within the broad EUDRATEC® portfolio, Evonik has created another sophisticated and innovative formulation technology that enables the prolongation of the gastric retention of drugs. It is called EUDRATEC® GRS (Gastro-Retentive System). When taken with a meal, tablets and capsules pass through the stomach in two to three hours.

Figure 3: Stable drug dissolution profiles

EUDRATEC® ADD enables stable release profiles up to an alcohol content of 40 percent—for example, for sustained-release formulations.



Better bioavailability: Anthocyanins from berry extracts remain longer in the stomach, where they are absorbed by the blood.

“Anthocyanins are absorbed into the blood especially well via the mucous membrane lining of the stomach. That’s why we’re using floating capsules.”

Dr. Maria Montero Mirabet

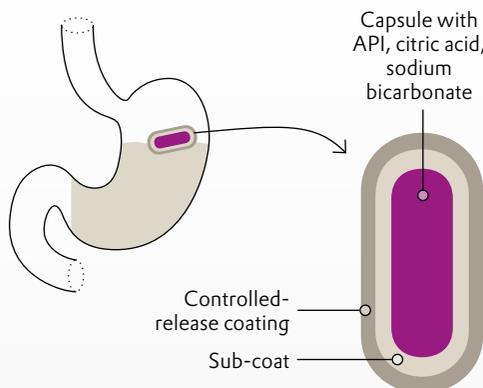
However, this period can decrease to just 30 minutes if a patient has not eaten for a considerable time and then administers the medication.

For those APIs that are highly soluble in the stomach and less soluble in the higher pH of the intestinal juices, prolonged retention of drugs in the stomach, independent of food consumption, can be a requirement. Besides that, there are also actives that are better absorbed into the bloodstream from the stomach. In both instances gastro-retentive formulations will increase the speed and level of the therapeutic effect’s onset and also enhance bioavailability. The advantage of longer gastric retention can thus be provided for drugs that are meant to act locally in the stomach, e.g. those affording relief from reflux or eradicating the notorious ulcer-forming *Helicobacter pylori* bacterium.

In general, there are diverse methods of slowing or delaying a drug’s journey through the body by retaining it in the stomach for an extended time. Medications can be tailored to increase adhesion to the gastric mucosa (the mucous membrane lining the stomach). They can also be expandable, unfolding to dimensions in the stomach that make them too big to leave through the pylorus and enter the small intestine. Furthermore, through use of an external magnetic field, magnetic nanoparticles incorporated in tablets or capsules can be used to retain the medication in a desired location. These methods all have certain disadvantages. Adhesive systems are likely to cause local irritation of the gastric epithelia cells. Swellable systems have an increased risk of unintentionally obstructing the esophagus. And magnetic nanoparticle formulations are expensive to manufacture and apply. By

Figure 4: Floating capsules

Due to a gas-forming mixture and a special coating, the polymer capsule is retained in the stomach for longer because it floats on top of the stomach's contents.



comparison, the EUDRATEC® GRS approach from Evonik is elegant and simple: The capsule floats on top of the stomach's contents and thus cannot leave the stomach (Fig. 4).

The first application of EUDRATEC® GRS was on Healthberry™ 865. This natural compound marketed by Evonik has a high anthocyanin content, extracted from bilberry and blackcurrant fruits. Due to its antioxidant properties it provides various health benefits, in particular to the cardiovascular system. Clinical studies suggest that anthocyanins are most effectively absorbed into the bloodstream via the gastric mucosa. Correspondingly, the longer they remain in the stomach, the more their

On top for longer: EUDRAGUARD® control makes capsules float on top of the stomach's content. That's why they remain longer in the stomach.

bioavailability increases. Laboratory tests in simulated gastric juice have proven the suitability of EUDRATEC® GRS technology for the enhanced efficacy and efficiency of Healthberry™.

The EUDRATEC® GRS floating capsules are manufactured in three steps. First, the drug and effervescent ingredients are filled into a conventional capsule. Then, the capsule is sealed with a polymer subcoat. Lastly, a final coat comprising a EUDRAGIT® sustained-release polymer and a pore-former is applied. This outer layer becomes increasingly porous in gastric acid, allowing the API and minute quantities of carbon dioxide gas to escape. The released gas provides buoyancy, so that the capsule floats and is retained in the stomach.

Stricter regulations in some cases

Manufacturing EUDRATEC® GRS formulations is simple and does not require water. This innovative system is thus of great interest for moisture-sensitive pharmaceutical or nutraceutical active substances.

The regulations governing nutraceutical excipients can be even more stringent than those for pharmaceuticals—simply because they can be ingested in greater quantities. Evonik's recently launched EUDRAGUARD® control polymer is specifically developed and approved for use in nutraceuticals. Applying it in EUDRATEC® GRS floating capsules provides the industry with an entirely new system for advanced formulations.

As these examples show, the controlled and tailored release of active ingredients involves considerable expertise and creativity. Evonik's new EUDRATEC® technologies draw on over 60 years of experience in the development and deployment of functional EUDRAGIT® polymers, deep market understanding, and extensive formulation expertise.

The experts



Hans Bär leads customer projects related to the development and application of oral drug delivery formulations, services, and technologies in the Health Care Business Line.
hans.baer@evonik.com



Dr. Maria Montero Mirabet also leads customer projects related to oral drug delivery formulations, services, and technologies in the Health Care Business Line.
maria.montero-mirabet@evonik.com

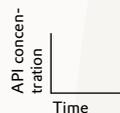


Dr. Brigitte Skalsky heads the Scientific Communication unit in the Health Care Business Line.
brigitte.skalsky@evonik.com



Controlled release

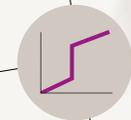
The way a drug is formulated can control where and how fast the active pharmaceutical ingredient (API) is released.



Gastro-resistant (delayed)



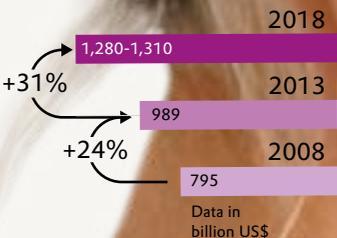
Pulsatile



Zero order



Sustained



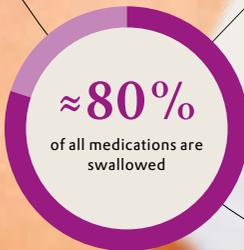
The pharmaceuticals market

Global drug expenditures could rise to about US\$1.3 trillion annually by 2018. Growth drivers include market expansion in threshold countries, as well as generic drugs.

Source: IFPMA

Medication intake

Most medications are taken orally: in the form of tablets, capsules, drops, juices, etc.



R&D expenditures

The pharmaceutical industry spends US\$141.6 billion per year on the research and development of new drugs—five times as much as the defense and aerospace industry.

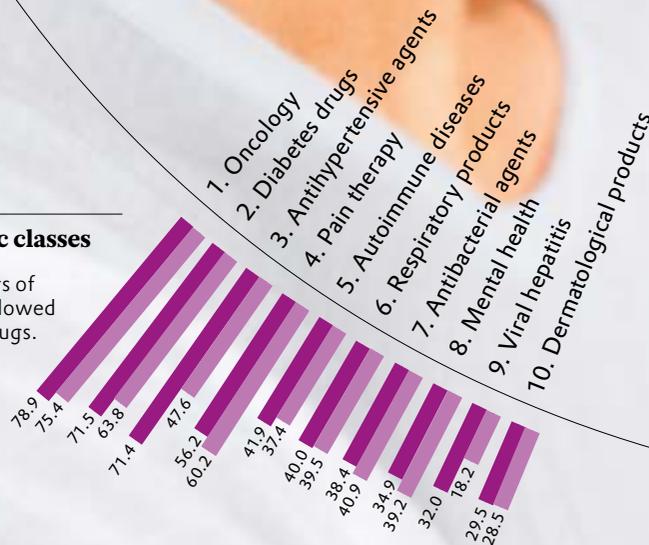
Source: IFPMA

Highest-revenue therapeutic classes

Cancer drugs top the sales rankings of therapeutic agents worldwide, followed by diabetes and blood-pressure drugs.

Source: Statista 2016/Evaluate

Sales in billion US\$



5x



DATA MINING

The pharmaceutical industry

The pharmaceutical industry is regarded as one of the strongest research sectors and is the source of life-saving drugs. In addition, the pharmaceutical industry is a key sector of the world economy and an important target market for Evonik products. A look at sales and expenditures, leading companies and markets, therapeutic classes, and dosage forms.

Drug expenditures by region

North America, Asia/Australia and Europe make up the largest percentage of global drug expenditures.

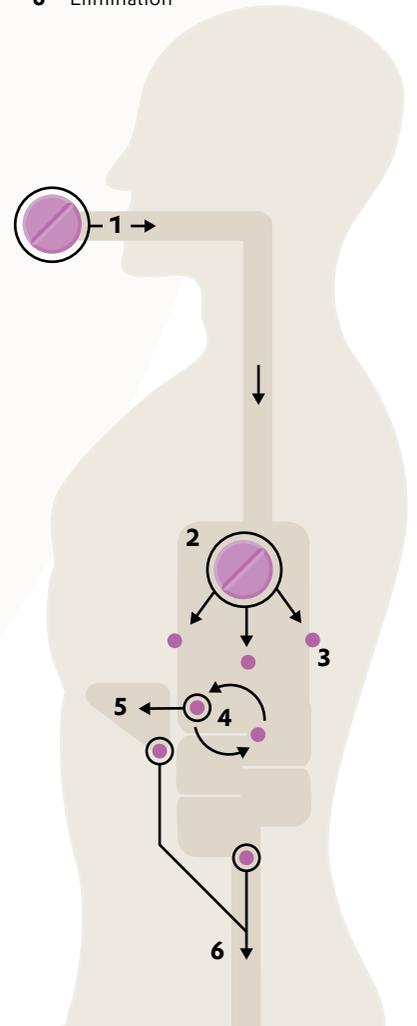
2013, data in %
Source: IFPMA



Path through the body

Drugs taken orally must pass through the gastrointestinal tract on their way to the target organ.

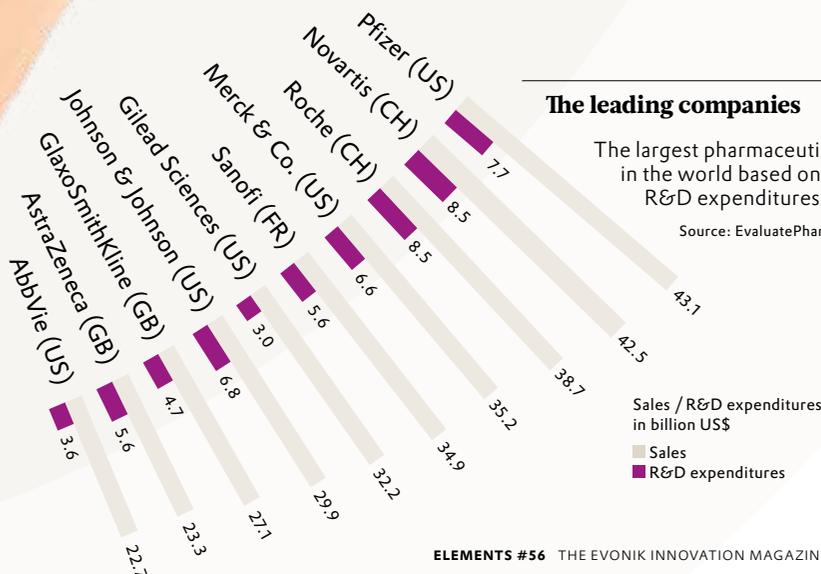
- 1 Administration
- 2 Release of the active ingredient in the gastrointestinal tract
- 3 Absorption of the active ingredient in the bloodstream
- 4 Distribution in the body
- 5 Metabolization primarily in the liver
- 6 Elimination



The leading companies

The largest pharmaceutical companies in the world based on sales, and their R&D expenditures in 2015.

Source: EvaluatePharma 2016





The core of the ORC plant: a reciprocating engine, where the expansion of the organic working medium drives the electrical generator.

NEW FLUIDS UPGRADE WASTE HEAT

Numerous Evonik plants generate waste heat at temperatures of 80°C to 200°C, and this energy can be converted into electricity. Evonik has developed new fluids for ORC technology that make utilization of low-caloric waste heat more efficient and ecological.

Dr.-Ing. Laura Grundemann

Waste heat is not a worthless by-product. In many instances, its use makes economic sense and helps protect our climate. The chemical industry is a pioneer in this area. Sites with integrated production networks, such as those operated by Evonik, have long been strategically integrating and thus using waste-heat flows ranging in temperature from 200°C to 450°C. One way of doing this is by running hot and relatively cool processes in series so that as little heat as possible ultimately escapes.

For waste heat flows that cannot be integrated, organic Rankine cycle (ORC) technology allows us to make use of that heat by converting it into electricity. ORC is analogous to the familiar steam cycle used in coal plants, except that in this case the water is replaced by an organic fluid that evaporates at lower temperatures, giving it superior thermodynamic properties.

Typical ORC heat-transfer fluids include ethanol, silicone fluids, and coolants. The first step is to use the waste-heat flow to evaporate the fluid, allowing it to pass into an expander designed as an engine or turbine. Here the gas expands under reduced pressure, after which it is fed into a condenser, compressed to a higher pressure, and then evaporated once again.

Electricity from “cool” waste heat

In 2013, an ORC system went on stream at Evonik’s Worms site as a demo plant. Made by DeVeTec, the unit generates electricity from previously unutilized waste heat from a sulfuric acid plant. The heat source in this case is cool air—still roughly 350°C—from the catalytic reactor in the acid hydrolysis plant. The plant frequently operates in the partial load range, and the flow of hot air can vary greatly. This is what made this site a good candidate for determining how an ORC system might work when waste-gas streams are not continuous.

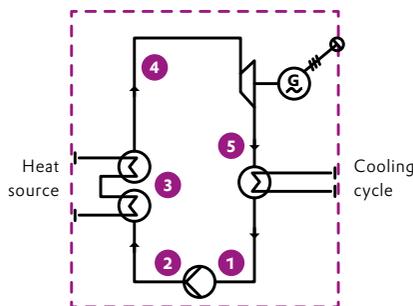
It was also the first time that a reciprocating engine had been used as an expander. Tests show that the medium could be reliably liquefied without seriously compromising usable electric power—even when external temperatures were high. Making cost-effective use of low-caloric waste heat, i.e. at temperatures below 200°C, is more difficult, however. In these cases, the energy content of the heat source is low, making cost-effective, efficient utilization no easy task. At the same time, however, there is considerable demand in the chemical industry for cost-effective, ecologically sound use of low-energy waste heat.

Evonik and DeVeTec have been working together as part of the joint ORCent project

The circulating fluid has a critical influence on the effectiveness and thus the efficiency of the overall process.

The ORC cycle

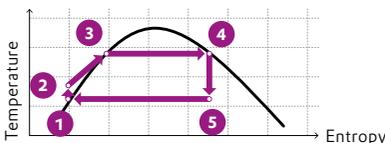
ORC plants convert waste heat into electricity, using an organic working medium. The working medium is evaporated (3-4), depressurized in an expander (4-5), transferred to a condenser (5-1), compressed to a higher pressure (1-2), and evaporated again.



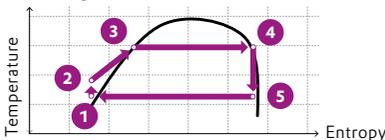
Thermodynamic behavior of organic ORC heat-transfer fluids

The expansion phase (4-5) for a dry fluid produces superheated steam at a temperature above the condensation temperature—the steam is therefore dry. For wet and isentropic fluids, the vapor is only slightly or not at all superheated following expansion; this results in the formation of liquid droplets.

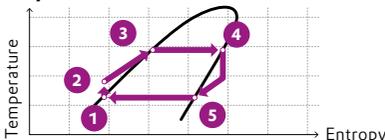
Wet fluid



Isentropic fluid



Dry fluid



sponsored by the German Federal Ministry for Economic Affairs and Energy to study two major questions surrounding the use of low-caloric heat. What potential is there for using reciprocating engines as expanders, instead of commonly used turbines? Turbines are ideal only within a narrow operating range; this makes them significantly less efficient when operated under partial load conditions and fluctuating waste-gas flows. Engines, on the other hand, are easier to adjust and thus can be adapted to partial load conditions.

The second question: What properties do fluid media need to have if they are to make efficient use of cooler waste-heat flows? In the past, ORC research has largely focused on the right way to construct a plant for a given application, generally neglecting questions of fluid optimization. The circulating fluid, however, has a critical influence on the effectiveness and thus the efficiency of the overall process. For the process to be highly effective, the fluid has to be perfectly matched to condensation and waste-heat temperatures. In addition, it must not be toxic, flammable, or corrosive, and it should have very little impact on the environment and the climate.

The search for better heat-exchange media

A key characteristic that distinguishes one fluid from another is the condition of the vapor after expansion. For traditional ORC applications with turbines, the fluid must undergo dry expansion in order to prevent damage to the turbine blades caused by droplets of liquid. Reciprocating expansion engines, on the other hand, can use wet media. In these systems, the vapor is only slightly superheated after expansion—the fluid expands into the wet vapor range. This eliminates the need for additional cooling, and that, in turn, simplifies the ORC process. The third group consists of what are known as isentropic fluids—materials hallmarked by the fact that their entropy remains virtually constant during expansion, even when temperatures fluctuate.

Working with the support of the company’s Process Engineering department, a →

The new fluid improves electricity yield and reduces CO₂ emissions.

→ team from Creavis, Evonik's strategic innovation unit, conducted a comprehensive search for new media to make the process as effective as possible. The team compiled and evaluated potential candidates from patent and literature searches and from major material databases such as the Dortmund Data Bank. They then filtered these candidates according to their own data profile. The pool also included potentially suitable materials from the product portfolios of multiple Evonik business lines.

In order to assess the suitability of a candidate, the team generated a model of the cyclical process using the Aspen Plus simulation tool. The developers used the results to determine the thermal effectiveness of roughly 200 alternatives, varying the maximum evaporator temperature between 100°C and 250°C. The simulations showed that a number of materials were significantly more effective at low operating temperatures than ethanol, the material used as a comparison.

A key factor in the ORC process other than effectiveness is the long-term stability of the heat-exchange medium. To address that parameter, the team of developers selected a total of nine alternatives that performed exceptionally well during the simulation and subjected them to practical testing. Process engineers at the Hanau site used a variety of test methods to study the thermal and long-term stability of the fluids. At the end of this selection process, only two isentropic fluids remained. These were hallmarked by good long-term stability at 150°C, tolerable corrosiveness, and an exceptionally high level of thermal effectiveness.

More effective, less CO₂

One of the two new fluids was tested at temperatures ranging from 130°C to 150°C on the ORC test stand maintained by partner DeVeTec. The results were good: The new fluids were twice as effective in the temperature range under investigation as the ethanol control medium, and the engine performed significantly better.

The CO₂ footprint calculated for the new medium was also positive. Although manufacturing and raw material production for the new fluid require more energy than is the case with ethanol, the increase in effectiveness significantly improves the electricity yield from the same amount of waste heat. As a result, CO₂ savings are greater with the new fluid than in conventional electricity production. The CO₂ calculations were based on a 250 kW plant, a service life of ten years, and 8,000 annual operating hours.

The Utilities & Waste Management Business Line within Technology & Infrastructure will assume responsibility for the system in Worms and will select the most suitable location within the Group for its continued operation. The company plans



This container in Worms houses the ORC plant.

to determine whether the potential of ORC technology could be more effectively exploited by coupling it with other waste-heat utilization processes.

After years of research, the results demonstrate that ORC technology can make efficient use of waste heat from chemical plants and thus is an important component of the Group's comprehensive energy and load-management concept.

In implementing this concept—which applies to all of the company's sites in Germany—Evonik is not relying on just one type of plant technology. Instead, the company intends to study all of the technologies available on the market to determine whether they are suitable for energy and waste-heat utilization and to adapt them to the specific demands of sites with integrated production networks. The company's aim here is to make flexible use of waste-heat flows, offset its own consumption peaks, and put itself in the best possible position for meeting the challenges of a highly volatile energy market.

The expert



Dr.-Ing. Laura Grundemann worked at Creavis as project manager for the ORCent project.

laura.grundemann@evonik.com

Company News

PROBIOTICS INSTEAD OF ANTIBIOTICS

Evonik is acquiring NOREL's probiotics business, thus obtaining access to interesting products and markets. Evonik's goal is to further assess the potential of probiotics for animal nutrition.

Evonik has signed a purchase agreement for acquisition of the probiotics business of the Spanish company NOREL, a global supplier of animal feed ingredients. The agreement sees Evonik acquiring NOREL's probiotics product portfolio as well as the company's site in León (Spain). The business will be integrated into Evonik's Animal Nutrition Business Line.

Evonik is currently expanding its portfolio of sustainable and healthy solutions in the field of animal nutrition and striving to provide innovative solutions for antibiotic-free livestock management. In this area, probiotics play a key role. They are living microorganisms and have a positive effect on the gastroenteric systems of animals, as scientific studies have

shown. In particular, they play a key role in maintaining the gut health of animals and have the potential of making the usage of antibiotics in livestock farming redundant. However, the full benefits of probiotics as well as their potential positive impact in other health areas have not yet been fully exploited.

The NOREL product range comprises a series of probiotic products that have been scientifically proven to be effective in the areas of poultry and pig farming and aquaculture, including such products as Ecobiol and Fecinor. NOREL's probiotics business gives Evonik access to this product range and to more than 20 markets including the European market.



Biotech company acquired

Evonik has acquired Transferra Nanosciences, Inc., a biotechnology company based in Burnaby close to Vancouver (Canada). Transferra, formerly known as Northern Lipids Inc., is a Contract Development and Manufacturing Organization (CDMO) that provides services as well as products to biotechnology companies engaged in the development of pharmaceutical products, using the company's unique expertise in liposomal drug delivery systems.

The acquisition allows Evonik to further expand the portfolio of its Health Care



Production of parenteral drugs at the Evonik facility in Birmingham (Alabama, USA).

Business Line in the area of parenteral drug delivery technologies and services. "We can now support our customers in the most important areas of complex injectable drug formulation technologies for the benefit of our customers and the patients alike," says Dr. Jean-Luc Herbeaux, head of the Health Care Business Line at Evonik.

Aiming for a record with Evonik

Using technologies and materials from Evonik, the German-Danish sailing team TeamGäbler intends to build the world's fastest all-round two-person sailing boat. The boat, which is named the SpeedFoiler™, belongs to the latest generation of foiling catamarans. The extreme light weight and the innovative design of the sails, hull, and attachments allow these boats to sail at high speeds barely above the water's surface.



The Gäbler German-Danish sailing team on its catamaran.

Evonik offers a broad portfolio of composite and raw materials. These are sold under the brand names VESTAMIN®, VESTANAT®, NANOPOX® and ROHACELL®, for example. Such composite applications can be processed in parts of the fiber, in the plastic matrix and the foam core. With various raw materials and additives from Evonik, composites are incredibly stable despite their light weight.

2015 Sustainability Report

Evonik already generates around half of its sales with products for resource-efficient applications. That is shown in the Sustainability Report 2015, which was published recently.

In 2015, Evonik achieved a reduction of 3 percentage points in specific greenhouse gas emissions and specific water intake. In the area of occupational safety, accident frequency in the reporting year was 1.0, which was again below the Group's self-imposed target of 1.3. This parameter shows the number of accidents in the workplace involving Evonik employees and contractors' employees under Evonik's direct supervision resulting in absence from work per 1 million working hours.

Evonik is also well positioned in important ratings and rankings. For example, in 2016 the company was included in the Sustainability Yearbook published by RobecoSAM as a Sustainability Leader with the distinction "Silver Class"—placing Evonik among the top ten of the approximately 70 chemical companies rated worldwide.

www.evonik.com/responsibility.

Storing renewable energy

Through its strategic innovation unit Creavis, Evonik is participating in the Kopernikus Initiative started by the BMBF (the German Federal Ministry of Education and Research) to develop technologies for the transition to renewable energy sources. Creavis is conducting research into the storage of excess power (Power-to-X), in which a total of 62 partners are participating.

The partners plan to jointly work out the commercial-scale prerequisites for storing more than 90 percent of the surplus energy from renewables. Power-to-X technologies will allow the use of energy from renewable sources to electrochemically generate hydrogen, carbon monoxide, and synthesis gas and to convert these to various other products. Along with Siemens, Evonik is following the approach of using energy to reduce CO₂ to CO, which is then further reacted biotechnologically by gas fermentation.

New additives for printing inks

TEGO® Rad 2800 is a new release additive for printing inks and varnishes. The new product displays the highest release effect in Evonik's Rad portfolio and thus takes a further step toward completing the range of radiation-curing glide and release additives. TEGO® Rad 2800 has a pronounced silicone character, combining strong hydropho-



The release effect in the test: The adhesive strip can be easily dissolved and leaves no residue.

bing properties with optimum system compatibility.

The Rad portfolio from Evonik is unique because the additives can be crosslinked into the coating; the resulting glide and release effects are particularly durable. With conventional additives, the release effect is markedly weaker and less permanent because the additives are not bound into the coating.

Fifth essential amino acid

With L-valine (ValAMINO®) Evonik has launched the fifth essential amino acid for animal nutrition in the company's portfolio. It



L-valine is especially used in the feed for pigs and poultry.

will make pig and poultry feed more efficient and sustainable.

L-valine is needed for protein biosynthesis in the organisms of animals and forms part of all important proteins. The low valine content of plant-based raw feed materials frequently limits the utilization of other protein building blocks. Valine is the fifth limiting amino acid in pigs and the fourth in poultry.

The addition of specific amino acids makes it possible to further reduce the crude protein content of feed without any loss of animal growth performance. This lowers feed costs and conserves natural resources in agricultural feed production. This in turn reduces land use, greenhouse gas emissions, and potential eutrophication and acidification.

Working on tomorrow's concrete

Within the project Carbon Concrete Composite (C3), Evonik's Interface & Performance Business Line is working on carbon-reinforced concrete. Whereas today steel is being used to reinforce

concrete, carbon fibers will be used tomorrow. In Germany's largest construction research project more than 130 partners from research, industries, and associations have come together.

In the first phase of the project, which is scheduled to run until 2018, the Interface & Performance Business Line is working on a decisive improve-

ment in the binding qualities of carbon fibers and cement, thereby creating an important basis for the future of this kind of reinforced concrete. The experts from Evonik, together with their partners from Bauhaus University Weimar and Deuna Zement GmbH (Dyckerhoff AG—part of the Buzzi Unicem Group), are working on developing a coating that will serve as a bonding agent between the carbon fibers and the concrete. This could bring about a sixfold increase in the carrying capacity of the concrete while reducing its weight fourfold.



The new thin-film composites plant in Marl (Germany).

the brand names DuraMem® and PuraMem®, which can be used for the efficient recovery of homogeneous catalysts, solvent recycling, or gentle processing of natural oils. The membrane technology offers the advantages of lower energy consumption, higher yield, and particularly high separation precision.

In the new plant, thin membrane films are coated with special silicone or other materials. The resulting composite membranes are then turned into solvent-resistant or gas-tight spiral-wound modules in a further production process. The corresponding silicone coating, also manufactured by Evonik, is a key factor for the separation properties of the membrane.

ENGAGEMENT IN 3D PRINTING

Evonik is driving forward its commitment to the 3D printing market. It will participate in HP Inc.'s Open Platform program and introduce new polyamide 12-based powders on the market for HP Multi Jet Fusion™ technology. For many years, Evonik has been developing special polymer materials that enable the industrial manufacture of high-tech components in 3D printing. As a result of its active participation in HP's Open Materials program, Evonik expects to see further development in additive manufacturing technologies in the direction of the large-scale production of components such as those used in the automotive and aircraft industries. Therefore, the Group intends to launch special polyamide 12-based powders for this innovative 3D printing technology in HP's Open Platform program. "HP's technology opens up new 3D printing applications and, in doing so, creates the basis for researching new materials for the future," says Dr. Matthias Kottenhahn, head of Evonik's High Performance Polymers Business Line.

Guest professorship for Ulrich Küsthardt

Jiao Tong University in Shanghai, a long-standing strategic partner of Evonik, has presented Chief Innovation Officer Dr. Ulrich Küsthardt with a guest professorship.

"Linking our company with universities is a key element of our innovation strategy," says Küsthardt. "I'm therefore extremely delighted about this title, which serves to underline the excellent collaboration



Dr. Ulrich Küsthardt (left) and the President of Shanghai Jiao Tong University, Prof. Jie Zhang.

we have enjoyed so far with Shanghai Jiao Tong University (SJTU)." As a guest professor, Dr. Küsthardt will hold lectures at the university in the future.

New membrane coating facility

Evonik has started operating a plant to coat membranes for use in organic solvent nanofiltration and gas separation at its Marl site in Germany. The Group sells hydrophobic polyimide membranes under

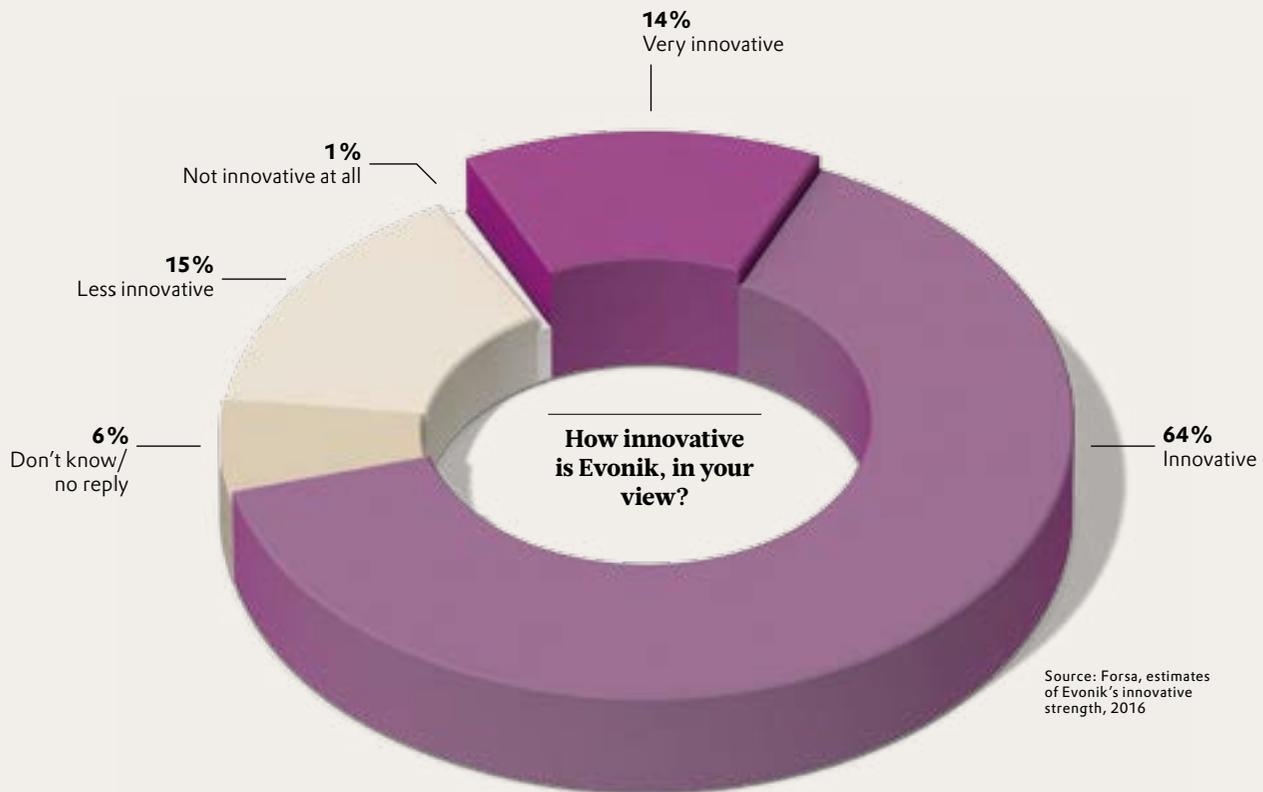
Biosurfactant wins award

Evonik's Household Care Business Line was honored with the 2016 Bio-Based Material of the Year award. The award was presented at the International Conference on Bio-Based Materials in recognition of the outstanding properties of the REWOFERM® SL 446 biosurfactant.

REWOFERM® SL 446 is a novel biosurfactant that Evonik manufactures from sophorolipids using biotech methods. The reasons given for the award highlighted the fact that REWOFERM® SL 446 is 100% bio-based, has excellent cleaning properties in addition to an outstanding toxicological and ecological profile, and is completely biodegradable. Each year, the nova Institute for Ecology and Innovation in Hürth, Germany, recognizes the three most innovative materials in the bio-based economy.



Components manufactured with HP Inc.'s Multi Jet Fusion™ 3D printing technology.



VALUE OF INNOVATION PIPELINE INCREASED

Last year Evonik increased the value of its innovation pipeline by half a billion euros. This now places the value of the pipeline in the lower single-digit billion euro range—a figure that is expected to continue growing over the next few years.

Our innovation campaign is bearing fruit,” said Klaus Engel, Chairman of the Executive Board of Evonik Industries. “The constant flow of new products, applications, and business models is a major driver of profitable growth at Evonik. Innovations are to make an even larger contribution to sales and profit going forward.” In the medium term, the Group aims for products and applications developed in the past five years to account for over 16 percent of sales. Currently, these constitute around 10 percent of sales.

“It’s an ambitious goal,” said Evonik Chief Innovation Officer Ulrich Küsthardt, “and we have taken additional steps

in order to meet it.” Evonik has brought its innovation portfolio into focus, redefined its growth fields, and taken the development of its innovation culture still further. Küsthardt said, “We have a total of six growth fields, which we expect to contribute over €1 billion in additional sales by the year 2025.” These fields are in highly attractive markets where Evonik can offer new products and solutions in line with its core competencies. Examples here include sustainable nutrition, healthcare solutions, and cosmetic solutions.

Reorganizing these growth fields goes hand in hand with focusing on the innovation portfolio. The streamlined

innovation portfolio now includes a more significant portion of larger innovation projects, as well as those to be carried out over the medium and long terms. This will allow the company to make more efficient use of resources. Idea competitions and fostering entrepreneurship are additional ways of improving the culture of innovation.

The planned acquisition of the specialty additives business (the Performance Materials Division) of US-based Air Products is likewise expected to strengthen Evonik’s innovative power in the field of specialty additives. Air Products’ specialty additives business employs excellent R&D person-

nel and maintains a powerful R&D pipeline.

“We want to become one of the most innovative companies in the world,” said Küsthardt, underscoring the ambitions of Evonik as a specialty chemicals company. According to a Forsa survey, nearly 50 percent of those surveyed trust Evonik to meet this goal over the medium term. Over 75 percent of those surveyed regard Evonik as an innovative company. Early this year, Evonik contracted Forsa, an independent opinion research institute, to conduct the survey among selected target groups such as customers, investors, politicians, scientists, and employees.



Technische Universität München (TUM) is currently educating nearly 40,000 students, about 2,000 of them in the Chemistry department.

“THERE’S NO LACK OF AMBITION HERE.”

Prof. Wolfgang Herrmann, president of TU München, talks about young academics, gaps in modern education, and the pitfalls of university entrepreneurship.

Top performance is achieved only by a top team—and that’s why Evonik has a strong interest in qualified specialists. Prof. Wolfgang Herrmann, who himself has a doctorate in chemistry and is the President of TU München, describes the tertiary education of chemists and their appropriateness for a career in industry.

Professor Herrmann, we hear a lot of complaints about the quality of the next generation of scientists and engineers. Are you complaining too?

Wolfgang Herrmann: (laughs) If it were up to me, all of our chemistry students would have to be able to play the piano too. But seriously: Today’s young people are more mobile than ever, and they’re not lacking in ambition either.

You yourself play organ in Munich’s Symphonisches Ensemble. Doesn’t your work in science management keep you busy enough?

Chemistry is a tough field that demands a lot of you—and that can easily tempt people into becoming highly specialized. That makes taking time out to catch your breath all the more important.

You warn about the hazards of becoming overly specialized. Isn’t chemistry interdisciplinary enough?

Quite the opposite. →



Prof. Wolfgang Herrmann has been the President of Technische Universität München since 1995 and is also a member of the Supervisory Board of Evonik Industries AG.



Employer Branding: Clear positioning, successful networking

As one of the world's leading specialty chemicals companies, Evonik offers talented young chemists and engineers a wealth of career opportunities.

"To attract and retain the best people for Evonik we need a credible employer brand that comes alive," says Thomas Wessel, Chief Human Resources Officer of Evonik Industries. Defining this clearly and making Evonik known as an attractive employer inside and outside the company is the job of Employer Branding.

With its promise "Exploring opportunities. Growing together." Evonik encourages current and potential employees to help shape their career paths, to remain curious, and to grow through challenges.

The Employer Branding department initiates contact with young talents through workshops and information sessions at universities and career fairs and through social media and forges links to the other departments in the company.

→ What is your concern, then?

At German universities, we provide a rigorous education geared toward modern research and instill the scientific spirit in our students. We fall short, though, when it comes to knowledge going beyond their specific fields.

For instance?

Like the ABCs of intellectual property law, business and labor law, leadership, and team spirit. And how interest groups function within the economy: employers, unions, associations, etc. We don't even give our young graduates an inkling of those areas, even though they're becoming increasingly important aspects of working within a global context.

Why is that?

As a field dedicated to highly skilled "intellectual labor," chemistry had to specialize at an early point in its history. This caused broader knowledge to simply fall by the wayside. Even just 30 years ago, for instance, challenges such as environmental chemistry were regarded with suspicion. But there has been a shift in our perspective since that time. "Green chemistry" is now fully accepted as the guiding principle underlying our work. Our environmental technologies lead the world. We German chemists might be slower sometimes, but we're better and we work with an eye on the long term. And now industrial biotechnology is coming up on the horizon.

Is big data an issue in education?

Not as much as it should be. University students are going to have to learn how to deal with the massive amounts of data generated by NMR spectroscopy, X-ray analyses, neutron diffraction, and theoretical chemistry. Big data is the driving force behind tomorrow's technological advances.

What can universities do to unite theory and practice?

We can work with industry—not as an extended lab bench, but as equals. When I was a young lecturer, that kind of relationship was more the exception than the rule. In today's culture of cooperation, industry seeks out those scientists who not only demonstrate exceptional competence in a specific field but also have an interest in practical applications. We worked for over 15 years with the former Ruhrchemie, for instance, on a two-phase catalyst system for hydroformylation. That was a highly productive relationship. We've learned from industry too, and moved beyond our old-school textbook knowledge.

How has globalization changed the way we educate chemists?

The world's scientific center of gravity is shifting toward Asia. The Chinese, for instance, are no longer imitating others, as one

"At university we fall short when it comes to knowledge going beyond the specific fields."

study at the TUM has shown—their research efforts are bearing fruits of their own. China is already ranked fourth in terms of patent registrations after the US, Japan, and Germany. That makes it important for us to be more sensitive to the value of intellectual property. We have a lot of catching up to do. When I was a student—in the late 1960s—patent law wasn't even an issue.

And now?

New knowledge that could potentially advance science needs to be protected at universities too. Distinguishing themselves by publishing in top-ranked journals is both important and the right course of action for our scientists. But that doesn't mean we shouldn't be patenting the technologies at the heart of the papers we submit. A lot of scientists aren't inclined to do this, however, because the financial incentive seems too small relative to the work involved. That's why universities themselves need to take an active role. We need a scouting system that channels the proper technical expertise—we need to review ongoing research to determine whether the results merit protection. That requires experienced experts who understand both sides, and this is where I see an interesting model for German industry as a whole. But we need state support for that to happen.

What might that look like?

The government updated employee invention legislation 15 years ago and regulated the conflict between labor law and intellectual property law as it applies to inventions by university employees, for instance. A few universities may indeed have a handle on patent protection procedures. But what about licensing? Or even defending patent rights? Legal disputes can often last years and cost millions—we don't have the budgets for that, which makes us easy prey for patent infringers! The state hasn't given that any thought.

What is the status of university spin-off companies?

That's a similar problem: You invent something, and people are interested. So you spin off a company, and the university is on board—usually owning a share in propor-



700

companies have been founded since 1990 as a result of TUM projects, most of them in IT.



Prof. Wolfgang Herrmann was awarded the title of University President of the Year by the German Association of University Professors and Lecturers in 2012.

“The young generation is clearly more entrepreneurial inclined. When I was a student, few thought about establishing a company.”

tion to the value of the company’s patent portfolio. Everything works out, the market seems ready, the outlook is good—so you start financing talks. But the university doesn’t have any money for the venture, so it has to reduce its share. That doesn’t exactly have a motivating effect on universities. A court of arbitration recently awarded the TUM €1.5 million. Despite the possibility that we might not win, we risked the hefty legal fees in a spirit of entrepreneurship. After all, we wanted to demonstrate that the university can stand up for itself.

Aren’t there any associated venture capital firms?

UnternehmerTUM GmbH, TUM’s innovation and business incubator, gives us venture capital, for instance, but we’ve got some catching up to do there across the board.

Are your lecture halls filled with potential entrepreneurs?

The younger generation definitely marches to the beat of a more entrepreneurial drummer than mine did. When I was a student, I wanted to be a plant manager at a chemical plant. Very few people gave any thought to starting their own company back then. Fortunately, that has changed. TUM projects have spun off around 700 companies since 1990, most of which, admittedly, are in IT, which requires less investment. We have some catching up to do in chemistry. That’s one of my dreams: that we could spin off even more companies in chemistry.

AMSilk is a well-known example...

Exactly. Thomas Scheibel and his team at the TUM developed a biotech method for precisely replicating natural spider silk—a

material that is exceptionally strong and elastic, and that could be used in a number of interesting applications. The project resulted in AMSilk, and the university is a part owner, because the patents belong to us.

You’re seeing entrepreneurial ambitions. But at the same time, “Generation Y” is saying that their work-life balance is very important. Do those two things go together?

If you have an entrepreneurial spirit, you can also do a better job of creating a life outside of work. I don’t see any contradiction there. There are, of course, growing numbers of young scientists who aren’t going to just adapt to industrial or scientific structures—they want to develop their own business ideas. The university needs to foster that. And when that results in interesting niches for innovative products, processes, and services, and new partnerships for big companies, that’s ultimately in the best interests of industry too.

In 2001, TUM became the first German university to establish a branch campus in Asia. How has that worked out?

Singapore has helped foster our international mindset—one in every five of our chemistry students is from abroad. The chemical industry has played a critical role in making TUM Asia Pte. Ltd. a reality—“Industrial Chemistry” was the first course there that I participated in. Our master’s programs there continue to produce graduates from Asia who then go on to work for Evonik, Wacker, Clariant, BASF, and other companies.

Is Germany attractive to non-German-speaking students?

At most German universities, there’s not much you can do in English. That’s why we’re in favor of holding all of our masters courses in English. The German Language Association (VDS) jumped on that by naming me their “Language Abuser of the Year” for 2015. What an honor!

What else do you need?

We offer the same range of services as good American universities do. Despite that, excellent students from all over the world continue to flock to top English-speaking universities, where they pay a lot of money for their education. All of our universities need to promote themselves with fee-based services: degree programs in English, places to live, and, of course, intensive German study. Unfortunately, our politicians ignore the inescapable correlation between the quality and the cost of a competitive university degree. ●



Dr. Ronny Sondjaja in Evonik's performance testing lab for oil additives in Darmstadt (Germany).

DR. RONNY SONDJAJA

Intercontinentally

Singapore, the United States, or Germany—a company with global operations offers many opportunities for an international career. Dr. Ronny Sondjaja seized on these, and his journey is still ongoing.

Even as a boy, Dr. Ronny Sondjaja dreamed of living abroad. This Indonesian native now works in Germany as a global product manager in the Oil Additives Business Line, where he markets and manages the product portfolio of VISCOPLEX[®] lubricant viscosity index improvers and VISCOBASE[®] high-performance base fluids for driveline/transmission applications.

“The Oil Additives Business Line delivers energy-efficient formulation solutions through our high-performance additives for automotive and industrial lubricants, hydraulic fluids, fuels, and refinery processing,” Sondjaja explains. “These additives are based on our proprietary polymer architectures that optimize the viscosity/temperature relationship by reducing the viscosity at low temperatures while maintaining the viscosity at high temperatures to avoid wear and fatigue. That ability, in turn, makes engines and transmissions more energy-efficient and improves the overall fuel economy of the automobile or machine.” Sondjaja’s fascination with these technologies is not the only reason he feels good about his work at Oil Additives. An international working atmosphere prevails in Building A45 in Darmstadt: His colleagues in Strategic Marketing represent three different continents—in his hall alone—and therefore English is the official language.

Exploiting international opportunities

“An international atmosphere has always been important to me. I always told my parents that before long I’d be living in Singapore, the USA or Germany,” the product manager recalls. Yet he could never bring himself to settle on just one of those countries. So after earning his bachelor’s degree in chemical engineering in his home city of Bandung, he decided to pursue a master’s degree program operated jointly by the National University of Singapore and the Technical University of Munich. “Two countries out of three in one program—pretty much my international dream come true,” he says.

Sondjaja spent half of the 18-month industrial chemistry program in Singapore and the other half in Burghausen (Germany). He was not disappointed. The cultural

differences between the West and Asia fascinated him so much that when he decided to pursue a Ph.D. he once again applied for an international program—one offered jointly by the University of Singapore and the Massachusetts Institute of Technology. He spent a total of four years pursuing his doctorate in molecular engineering at the two universities, working with a research group investigating how magnetic nanoparticles can be used for controlling the release of active agents for drug delivery systems. His particular responsibility on the team was the synthesis of the polyacrylates needed in this encapsulation system through controlled radical polymerization.

It was this work that first brought him into contact with Evonik. Degussa, at that time, had been looking for a polymer chemist for its Oil Additives Business Unit in Singapore to develop acrylate-based polymers as flow enhancers for biodiesel. “I applied as soon as I saw the job posting,” says Sondjaja. “The job gave me a chance to use my polymer background and I couldn’t miss the opportunity for a job at an international company.” At the job interview it turned out that he was a better fit for the job than he had realized. Three major sites for the Oil Additives Business Line are in Singapore, Horsham (USA), and Darmstadt (Germany)—the very countries that had captured Sondjaja’s imagination as a child. He got the job and worked in Singapore for three years on a biodiesel project and developed VISCOPLEX[®] series 10 cold flow improver (CFI) additives that prevent biodiesel from crystallizing at low temperatures.

It was the perfect start to Sondjaja’s career. On the one hand, it gave him a chance to build his project management experience by managing a project with clear objectives. On the other hand, the work required a global approach. The target of the project was to develop a global product portfolio for

different biodiesel feedstock used in various regions, such as rapeseed in Germany and palm kernels in Asia. As a consequence, the project brought Sondjaja into contact with colleagues from all over the world. After successfully completing the project and commercializing various VISCOPLEX[®] series 10, seeking new challenges abroad seemed the obvious next step.

Working at the interface

He found what he was looking for at the Darmstadt site, where the business line was starting up an innovation project that would play an active role in the future development of lubricant additives. The scientists on the project grappled with questions about the future of lubrication and its fit with the capabilities and technologies of the Oil Additives Business Line. Throughout the three-year project, Sondjaja and his team developed the idea of establishing the Friction & Motion Competence Center, which is currently under development as a strategic explorative initiative for Oil Additives and the Resource Efficiency segment in the tribological field.

Sondjaja enjoyed his second stay in Germany so much that, rather than looking for more assignments abroad once the Competence Center had been established, he took on a new position in Darmstadt. As a product manager, he now combines his technical expertise with his knowledge of the market, serving as an interface between innovation, production, and sales.

Of his three adoptive countries, where does the project manager see the future taking him? “I’ll just go with the flow,” says Sondjaja. “I’m not at my destination yet.” Only later does he notice that he had paraphrased the Oil Additives motto: Let It Flow! “Pretty appropriate,” he notes with a laugh. “This is probably where I belong.” ●

“I appreciate the technologies and the international atmosphere at Oil Additives.”

Dr. Ronny Sondjaja

LET'S HEAR IT FOR THE FICTIONEERS!

People who dismiss science fiction as fantasy are missing opportunities. It pays to analyze bold visions of the future and ask ourselves whether they can teach us new approaches to innovation management.

Arno Dirlewanger

The first science fiction book I ever read was *Astropol* by Alfred Fritz. Published in 1951, the book centered on the idea of an outer space vacation—in 2003—and whether something like that could ever be possible. Well, the International Space Station (ISS) has been in existence since 1998, and individuals with enough money have been able to afford space tourism since 2001.

Later, while studying computer science, I read an essay about science fiction and technical innovation that fascinated me, and I've had a keen interest in the link between the two ever since. Many companies have established innovation management programs—i.e. strategic approaches to generating and implementing new ideas for products, services, and processes. Yet, while the goal is for people to think outside of the box, their energies are often channeled into defined processes, i.e. the stage-gate process—a rigid approach that equates developing ideas with procuring a warehouse, and that makes the overall process counterproductive. Many ideas, after all, are late bloomers and need to be nurtured until they can stand up to tough criteria. Demanding a market assessment or, worse, a business case at an early stage in the process is expecting too much—a much more appropriate question during the early development stage is whether the idea itself has potential.

This is why I think we desperately need to overhaul innovation management. Fossilized routines need to be loosened up, and we need to risk more experiments. We need to expand our imaginative capacity as individuals, and this is where science-fiction authors can serve as role models. In 1931, for example, Hans Dominik described a device that would someday bring us “new sounds and images from every corner of the earth”—television was in its infancy then, and the Internet came along in 1990.

Science and fiction do not need to be seen as opposites. Turning certain ideas into re-

ality requires knowledge and technologies. However, it also requires fiction and inventiveness. What we need is a basic attitude that encourages and supports both components. It might even mean having to turn today's engineers into fictioneers. We need experimental spaces for innovative thinking and development. And we need training opportunities that will expand imagination in companies. In other words, we need parallel worlds within the company. Today's innovation management has to become science and fiction management.

Parallel worlds open up opportunities

How can sci-fi be put in the service of innovation? For example, as a model for the attitude toward the unusual. Everyone knows the protagonists of the cult series “Star Trek,” who represent different decision-making types: Mr. Spock (“Well, why not?”), Scotty, the ship's engineer (“That could work if...”), and Captain Kirk (“Let's try it”). Thus ideas can suddenly appear in a new light.

A key element is the concept of parallel worlds existing outside of and parallel to our known world. These worlds bring the familiar and the unfamiliar into balance—they are at once foreign and very familiar to us. They could, for instance, be designed around a counterfactual principle: What if the transistor had never been invented? What if we could have invented portable computers 150 years earlier and Goethe had written his *Italian Journey* on the road?

Another type of parallel world is one that operates according to laws that differ from those we know. In his Mesklin series, the chemist H. C. Stubbs describes a planet with high rotational velocity and a g-force ranging from 3 g at the equator to 700 g at the poles. Fall and winter on this planet (where a day lasts only 18 minutes) last only two months, while spring

“Well, why not?”

Mr. Spock, science officer and first officer



and summer last 28 months. What characteristics would its inhabitants need in order to exist under conditions that extreme? The answer requires imagination and creativity.

In companies, parallel worlds open up both physical and intellectual opportunities, where pursuing unusual thoughts and ideas poses little risk. Geneticist and Nobel Prize winner François Jacob described this kind of thinking as “night science”—the side of the natural sciences that the public does not see, where scientists doubt, search, have hunches, make mistakes, and run into dead ends. In *The Man Without Qualities*, the



“Let’s try it.”

James T. Kirk, Captain of the USS Enterprise

Unusual challenges? The protagonists of the cult TV series “Star Trek” could serve as role models here.

Photography: Corbis via Getty Images, Evonik, PR

author Robert Musil describes this phenomenon in a passage about Ulrich, an engineer: “To pass freely through open doors, it is necessary to respect the fact that they have solid frames. This principle ... is simply a requisite of the sense of reality. But if there is a sense of reality ... then there must also be something we can call a sense of possibility.”

Expansion of the human imagination

Science fiction also helps us generate ideas, explore them, think through their consequences, and develop ideas for implementing them. It helps to deliberately change perspectives: How does an idea appear from the viewpoint of production? And from that of the user?

In the USA, 40 sci-fi authors have come together to form the SIGMA group, which offers consulting to the Department of Energy, the Department of Homeland Security, NATO, NASA, and Microsoft. In the words of the British astrophysicist Stephen W. Hawking, “Science fiction such as ‘Star Trek’ is not only good fun but also serves a serious purpose, that of expanding the human imagination.”

In one of my classes, students were asked to come up with applications that a biotech company could use for a novel material made by microbes. One idea was to grow diver fins from the material. But the material was water-absorbent, so didn’t that make the idea unfeasible? One of the scientific assistants countered that concern, saying, “Then we just spray them with something to make them waterproof.” That saved the idea. Because the possible make-up of the material was a detail with no solution at the moment, it was simply bridged with a placeholder and not worked out until later—a method that does not come easy to engineers with their logical approach to problems.

Many sci-fi ideas that were once hard to imagine are now reality: the smartphone, which is the equivalent of the communicator from “Star Trek”; the magazine-writing robot, which Isaac Asimov thought up back in 1957; or geostationary communications satellites, an idea that Arthur C. Clarke proposed in 1945, nearly 20 years before they became a reality. One idea from an innovation project that I moderated was “blue air”—the notion that the air inside a vehicle could change color to signal a dangerous situation. “Are you suggesting we paint air molecules different colors?” I was asked. A few weeks later, I was reading Ray Bradbury’s 1950 sci-fi classic *The Martian Chronicles* and came across the idea of people wrapping blue air around themselves like a scarf. Two absurd ideas?

BMW has since begun offering interior lighting that changes with the temperature, and Mercedes offers the Airscarf, a warm-air vent integrated into the headrest. ●

The expert



Arno Dirlwanger studied aeronautical engineering, IT, and experimental design, and works as a consultant and instructor in the fields of innovation management and creativity training.



Arno Dirlwanger: *Innovation der Innovation. Vom Innovations-Management zum Science & Fiction-Management* Peter Lang, Bern 2016

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LICENSE TO GET GOING

A newly minted entrepreneur: After winning Evonik's first-ever Entrepreneurship Award in June, the physicist Dr. Marta Canas-Ventura will now research the concept of an intelligent ink.

Dr. Marta Canas-Ventura, a physicist and business developer at Evonik, won the Group's first Entrepreneurship Award in June with a proposal to develop an intelligent ink that indicates whether sensitive products have been stored properly. Canas-Ventura came up with the idea for the BitFlip Ink formulation together with her team of four. When applied to drug or chemical packaging, the ink should show whether the products have been properly stored or whether their quality may have been impacted by environmental factors such as heat or light.

As the winner of the internal Global Ideation Jam of Evonik, Canas-Ventura now has a year to advance her idea further with a budget of €200,000. "I can't wait to get started!" she said after the award ceremony. As a researcher, she has all the attributes of a successful entrepreneur in the company: technical know-how, team spirit, enjoyment of research, and no fear of failure.

An online search for creative approaches for new businesses

Evonik initiated the Global Ideation Jam earlier in the year to identify ideas with potential to become marketable innovations. The idea contest is a fixed component of the company's innovation culture. The event marked the third time all employees were invited to post their ideas for new products, applications or production processes



Dr. Marta Canas-Ventura is the winner of Evonik's first Entrepreneurship Award.

in an online platform. In all, 84 ideas were submitted by employees around the world, some of whom had formed teams ahead of the contest. Over 1,700 employees followed the Global Ideation Jam in an online community, commenting on the suggestions and providing advice on further development.

“Given the number of excellent proposals, it was not easy to select the most promising one,” says Dr. Peter Murphy, who was involved in the decision as a member of the expert jury. Ultimately, 21 employees in six teams were given the opportunity to advance their ideas in a boot camp. With support from a renowned consulting firm, the teams worked for three days to analyze their projects in detail for market value, benefit, cost, and weak points. “The results of the intensive project work were impressive,” says Chief Innovation Officer Dr. Ulrich Küsthardt. “The teams used their time well, developing specific business models and business plans.”

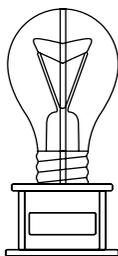
Systematically promoting entrepreneurial thinking

Designed to promote creative collaboration across departmental and national boundaries, the idea contest is part of the open innovation culture at Evonik. Employees with unusual ideas are given the opportunity to develop and work on a business model for their concepts. Moreover, the contest provides talented scientists with tools for strategic business development.

“The internal support was invaluable,” says Canas-Ventura. During the idea generation process, Evonik teams could count on the assistance of coaches who had led similar projects to success at the Evonik Group in the past. They supported the participants with their entrepreneurial know-how, industry knowledge, and “a network of experts who were able to answer application-related questions down to the smallest detail and thus made key contributions to the development of the idea,” the winner noted.

The best idea and the winner of the Entrepreneurship Award were finally selected jointly (50:50) by employees and a jury of executives of Evonik. During the grand finale, each idea was presented by one team member. Vadym Bakumov and Natalia Savietto both introduced innovative packaging concepts to extend the shelf life of foodstuffs, while the team around Tilman Sauter had come up with a new tea bag concept that can control the intensity of tea aroma. Kira Khaletskaya presented a combined fragrance and carrier concept that makes the packaging of foodstuffs or personal care products even more attractive for consumers. Meanwhile, the team working with Zachary Woods focused on digitization and presented an app for use by employees and customers alike.

The audience voting was a close contest.



With the Entrepreneurship Award, Evonik is breaking new ground in innovation management. The award, aimed at promoting entrepreneurial thinking, comes with a budget of €200,000; winners can use this to develop their ideas free from the pressures of everyday work, initially over a period of one year.



At the grand Entrepreneurship final in Essen the participants presented their ideas to about 230 employees, executives, and managers.

“The entrepreneurial spirit of the participants and the development of ideas are the outcome of our innovation culture. We have demonstrated that we are able to identify previously unknown needs for implementation in business models and ultimately in technical applications. The ideas we just heard about all have great potential for future business,” noted Küsthardt at the award ceremony. The ideas will also be evaluated by the operational segments and developed further there if required.

BitFlip Ink prevailed by a small margin. Canas-Ventura is looking forward to her research in the coming year and relishes the challenge of making BitFlip Ink a success: “I am confident it will work.”

“The ideas we heard about all have great potential for future business.”

Dr. Ulrich Küsthardt



Sachertorte and many other bakery delights would not taste half as good without the chocolate frosting. To make sure the icing adheres well to the cake, professional bakers use ingredients that contain special cooking oils and fats, which, even though they may originally come from plants, are not left in their natural state—and with good reason. For instance, freshly extracted vegetable oils contain impurities that must be removed. The biggest problem, however, is that some of the carbon atoms in their fatty-acid chains are linked together with double bonds. Oxygen in the air attacks these bonds, causing the oils to spoil rapidly and giving them a rancid odor.

To prevent this odor, the oils are hydrogenated, i.e. hydrogen is reacted with them. This process is frequently referred to as hardening, because converting double bonds into single bonds thickens or even solidifies the oils. Another advantage is that hydrogenation raises the smoke point, so that these oils can be used for frying.

CUSTOMIZED FATS

To prevent oils and fats from going rancid and breaking down while frying, they are subjected to hydrogenation, a chemical reaction that can be used for controlling their properties. Evonik has recently joined the ranks of companies who produce the catalysts for this reaction, thanks to the successful acquisition and integration of Monarch Catalyst of India, which now operates as Evonik Catalysts India.

The metal cycle

Monarch Catalyst began recovering nickel from used and deactivated catalysts back in 1982, and it has been recycling spent precious metal catalysts since 2005. Today Evonik Catalysts India, as Monarch is now called, offers its customers an ecologically and economically attractive service. The company accepts catalyst-containing, typically corrosive, waste and com-

pensates its customers for the value of the recovered nickel, thereby providing a fairly cost-effective way of maintaining compliance with environmental guidelines. Evonik Catalysts India processes waste that contains precious metals and feeds the recovered metals into direct and indirect material recovery cycles. India's Ministry of Environment, Forest and Climate Change has authorized Evonik Catalysts India to accept these used catalysts from



all Indian states and even to import such waste from abroad for the purpose of recycling. All of the company's workup processes meet Evonik's guidelines for environment, safety, and health. Because these processes have been designed according to global standards, Evonik Catalysts India can support efforts to recycle base and precious metals not only from India, but also from Southeast Asia and other parts of the world.

MONCAT™ catalysts are used to hydrogenate natural oils and fats to make them more durable—for example, for a tasty doughnut glaze that doesn't run off.

The industry uses catalysts that make hydrogenation fast and economical. "Monarch Catalyst of Dombivli, India, possessed an outstanding level of expertise in oil and fat hydrogenation catalysts and was a global leader in this field," says Dr. Steffen Hasenzahl of Evonik, the Head of the Catalysts Business Line. "Acquiring Monarch Catalyst in June 2015 and successfully integrating the company into our global production network as Evonik Catalysts India has given us the perfect addition to our catalyst business." Known under the brand name MONCAT™, the catalysts are based on nickel with carriers made of inorganic porous solids.

Confectionery ingredients are a drop in the bucket in the overall market for fats hydrogenated with the help of MONCAT™. The food industry also uses the catalysts in applications such as the production of shortening and additives that make butter and margarine easier to spread.

Even apart from the food industry, however, there is a huge market in which these catalysts play an important role. They are also used in processes that convert natural fatty acids with 18 carbon atoms into stearic acid. While it is used in large quantities for the production of rubber tires and other molded rubber goods, stearic acid—in the form of metal stearates—also plays a role in metal surface treatments.

Starting out near Mumbai, the catalysts from Dombivli make their way through the supply chain to central Europe, where they make life a little more pleasant and cheerful, even though we don't typically notice them. Plant-based fatty alcohols and hydroxystearic acid are widely used in shampoos, shaving creams, and decorative cosmetics.

The applications of oils and fats are as varied as their sources: fruits, nuts, and seeds, which are used for producing sunflower oil, palm oil, coconut oil, soybean oil, rapeseed

oil, peanut oil, and castor oil. Other oils include those extracted from the germ of corn or rice.

The composition of each type of oil varies greatly, depending in part on the dominant climatic conditions in the regions where the oil plants are grown, which cause the properties of the oils to differ. "Selecting the catalysts and technology for the hydrogenation process has to be based on these properties," explains Shrinivas Y. Modak, who manages the oils and fats hydrogenation catalysts business.

In addition, special requirements have to be met for each application. The experts at the plant in Dombivli have continually developed the MONCAT™ catalyst family with consideration for these overall boundary conditions, applying their profound understanding of the demands both of the market and of their customers.

"Evonik benefits from the knowledge and experience of our new Indian colleagues and—most of all—from their relationships with customers and users," says Harish Davey, Evonik's regional president for India. "And for our colleagues in India, the acquisition presents new opportunities, as the strengths of a global specialty chemicals company will open many doors for them." ●

300

employees were transferred from Monarch Catalyst (India) to Evonik Catalysts India Pvt. Ltd. in June 2015.

Prof. Michael Dröscher

is the General Secretary of the Society of German Natural Scientists and Physicians (GDNÄ e.V.) and the manager of the CHEMIE.NRW cluster, and has served as an adjunct professor at the University of Münster since 1988. A full professor (Dr. habil.) in macromolecular chemistry, Dr. Dröscher has worked at Evonik and its predecessor organizations for 27 years, a career that has included a period as managing director of Creavis and as head of Innovation Management (now Corporate Innovation). He also chaired the German Bunsen Society for Physical Chemistry (DBG e.V.) from 2005 to 2006, and was president of the German Chemical Society (GDCh e.V.) in 2010 and 2011.

WHAT I HOPE FOR FROM SCIENCE

Michael Dröscher

HYDROGEN FOR EVERYONE, EVERYWHERE

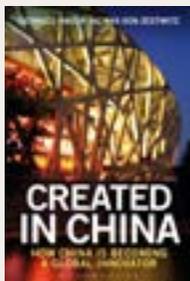
Can we expect science to make our wishes to come true? Absolutely, if Jules Verne was right when he said, "Anything one man can imagine, other men can make real." I think science will actually achieve more than what we can imagine at any given point in time. For example, nearly 50 years ago, when we solved our physical chemistry problems using logarithmic tables, we probably would have loved to have handy electric calculators. Yes, we had computers back then, but they were still huge machines that you had to feed with punch cards. No one could have predicted modern IT products, even though there were already tablet-like devices in science fiction.

Fifty years from now, will science make my wish come true too—and then some? My wish is for the dream reaction: using sunlight for direct catalytic cleavage of water, producing high yields, allowing us to generate hydrogen in any amount at any location on earth, and solving our energy problem and the question of raw materials. For it to work, we'll need equipment and the infrastructure to generate energy from hydrogen or to combine it with CO₂ as a source of carbon for synthesizing consumer goods and for use in mobility applications. Maybe we'll start out with large-scale plants and then later we'll even have individual generators for everyone. My wish for all of us is that science will find solutions for the dream reaction.



NON-FICTION BOOKS

On innovative strength, global diversity und open innovation



Innovative China

Never before in the history of the world has a country developed so fast economically—without China, today's global economy would collapse. In China, 650 million people have Internet access. This enormous country invests 8.5 percent of its gross national product in infrastructure annually, and it actively promotes startup companies for new technologies. Two authorities on China, Georges Haour, professor of innovation management, and Max von Zedtwitz, expert in the globalization of research and development, analyze the human factor and the conditions under which China is developing into a driving force for innovation globally.

Georges Haour, Max von Zedtwitz: *Created in China. How China Is Becoming a Global Innovator* Bloomsbury, London 2016



Pathbreaking bioeconomy?

The bioeconomy, on which the future of industry, agriculture and, not least, the biosphere depends, is a dominant economic sector of this century. In her book, the journalist Christiane Greffe of *Die Zeit* engages scientists, engineers, farmers, and politicians on the questions of what resources will supply the planet with energy, food, and raw materials in the future, and which technologies will be useful and necessary. Will global diversity survive, and who will decide? Is bioeconomy a “totalitarian” approach or do new technologies make sense? One thing is certain: bioeconomy affects pretty much all areas of life—all over the globe.

Christiane Greffe: *Global Gardening. Bioökonomie – neuer Raubbau oder Wirtschaftsform der Zukunft?* Antje Kunstmann, München 2016



Inventive users

The innovation process has changed fundamentally over the last two decades. The knowledge economy now routinely exploits the potential of open innovation to address key technological and organizational problems. Renewal comes not just from producers but more often from the users of products and services. In this book, published by Dietmar Harhoff, the director of the Max Planck Institute for Innovation and Competition in Munich, and Karim R. Lakhani, a professor of business administration at Harvard Business School, international experts examine user-driven innovation.

Published by Dietmar Harhoff and Karim R. Lakhani: *Revolutionizing Innovation. Users, Communities, and Open Innovation* The MIT Press, Cambridge 2016



THE COVER #56

Superheroes are experts with extraordinary skills. Take EUDRATEC® from Evonik: With these formulation technologies, customers in the pharmaceutical industry can control when, where, and how long a drug works. For example, the new development EUDRATEC® ADD is a protective shield against alcohol—it prevents sustained-release drugs from releasing their entire active ingredient at once if alcohol is consumed at the same time, which could cause an overdose.

Masthead

Publisher

Evonik Industries AG
Dr. Ulrich Küsthardt,
Christian Schmid
Rellinghauser Str. 1–11
45128 Essen, Germany

Publication Manager

Urs Schnabel

Consulting and

Concept

Manfred Bissinger

Editor in Chief

Dr. Karin Aßmann
(responsible)

karin.assmann
@evonik.com

Annette Locher

annette.locher
@evonik.com

Contributing

Editors

Dr. Frank Frick
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Nadine Nösler
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Managing Editor

Dr. Sebastian Kaiser

Editorial Consulting

Tom Rademacher
Dr. Edda Schulze
Dr. Petra Thorbrietz

Scientific Advisory Board

Dr. Felix Müller
Dr. Friedrich Georg Schmidt
Dr. Joachim Venzmer

Picture Editing and Layout

C3 Creative Code and Content GmbH

Agency

BISSINGER[+] GmbH
Medien und Kommunikation
An der Alster 1
20099 Hamburg,
Germany
info@bissingerplus.de

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Hamm, Germany

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Contact

elements@evonik.com



*** ...SO THAT ACTIVE INGREDIENTS GET TO WHERE THEY'RE NEEDED.**