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Sustainable Partnership.
Sustainable Solutions.

Bayer Technology Services – we stand for reliable, efficient and sustainable partnerships. Our key to success: holistic technology solutions along the entire life cycle of chemical and pharmaceutical plants and processes. We draw on a worldwide network of highly qualified technology experts to develop the best possible solution for our customers.

Our decades of experience and extensive know-how enable us to support you in the core areas of technology development, project management and engineering, and operation safety and support. Our first-class consulting and tailored services range from product and process development to the planning, construction and commissioning of plants as well as the automation and optimization of processes. Trust Bayer Technology Services – your partner for sustainable technology solutions.

Bayer Technology Services
info@bayertechnology.com
Some companies are governed by the rule, “We solve a problem by finding someone who solves the problem”. This may even work in one or the other case, but we at Bayer Technology Services see the world differently. We always act according to the principle that we ourselves want to be the solution!

“Be the solution” is therefore much more than just a slogan: it is a commitment. The conviction that we actually embody the solution is both motivation for us and a promise to our customers.

But what solution is the right one for our customers? Is it always a new one? Or always a proven one? Or is it perhaps always the same one over and over again? If so, wouldn’t you quickly find yourself ending up with an “off-the-shelf” solution?

On the contrary: the solutions that Bayer Technology Services actively pursues are always the same in one respect: we aim to create value for the customer – especially with a view to sustainable development.

We are self-confident enough to say that as one of the leading technology companies in the world, we are in a perfect position to deliver this promise. Our goal is to support customers gain better results than they would be able to achieve on their own. These better results may constitute economic or ecological aspects – or both. It all depends on the needs of the customer.

Indeed, we have found that our customers are only convinced by one factor: quality. For this reason, “Be the solution” can only mean one thing for Bayer Technology Services: as important as ideas and plans may be as success factors, what really matters is what is delivered to the customer.

In this issue of technology solutions you will find numerous examples of how seriously we have taken this principle to heart. And how much our customers have benefitted as a result.

I hope you enjoy the read.

Yours, Dirk Van Meirvenne
How to Tackle the Cartridges
One of the main requirements of the production of a new form of oral contraceptive was to package the pills absolutely hermetically in cartridges.

Is an Extra Batch Possible?
Thanks to the expertise of Bayer Technology Services, Bayer CropScience increased productivity at its site in Himatnagar, India, by 25 percent.

Code Name Akoya
Engineering is routine work for Bayer Technology Services. But converting a Japanese license to European standards is special.
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Before it is approved for medical use, each and every drug candidate is rigorously tested in numerous studies. And the active ingredient rivaroxaban is no exception. As part of the registration procedure of this modern oral coagulation inhibitor, experts...
working at Bayer Technology Services, together with their colleagues from Bayer HealthCare, simulated the coagulation processes in blood vessels – also using a computer. The mathematical models required for this purpose integrated data from hundreds of trials as well as from scientifically substantiated assumptions about coagulation. With the help of coagulation programs, it is possible to simulate the optimal dose range and to plan clinical studies more efficiently. More than 100,000 patients will have participated in the comprehensive program of clinical trials involving rivaroxaban by the time all the studies have been completed. This scanning electron microscope image shows elements of blood coagulation in 7,500-fold magnification: the red blood cells (erythrocytes) of a clot in a net of fibrin threads.
The Goal Is Zero Incidents

Safety is not everything, but without safety, all is for naught – this simple motto has shaped the professional career of Dr. Norbert Kuschnerus at Bayer Technology Services. In mid-2013 the physicist with a PhD in chemical engineering retired.

solutions: Norbert Kuschnerus, you are responsible for the vital area of safety at Bayer Technology Services...
Kuschnerus: ...to be more precise, the division is called Operation Support and Safety. Safety is certainly a very important aspect of my responsibilities, but by far not the only one.
solutions: What else does your division involve?
Kuschnerus: There are four main aspects to our work. In addition to reliability and safety, there are also the factors efficiency and flexibility.
solutions: Why do these different aspects play such an important role?
Kuschnerus: Consider, for example, the life cycle of a chemical facility, the median age of which is probably around 40 years in Germany. Our task is to get the optimal performance from this production plant in the face of strong international competition.
solutions: Can you specify what you mean by optimal performance?
Kuschnerus: It is really quite simple: you want to produce very efficiently, while at the same time you must be able to adjust relatively quickly to changes in the market. And, of course, the entire production process must be very safe.
solutions: And so the job of Bayer Technology Services is...
Kuschnerus: ...to support customers in their efforts to achieve the optimal performance by the most advanced technological means. Our combined holistic approach is a completely new way of tackling these challenges.
solutions: And who stands to benefit?
Kuschnerus: Effectively, the entire processing industry benefits. However, we mainly focus on the chemical and pharmaceutical industries. With the individual production processes commonly found in these fields, we have many more possibilities to help with our particular approaches and to design the best feasible processes than in the case of standardized manufacturing facilities.
solutions: That is easily claimed, but how does it measure up in concrete terms?
Kuschnerus: We are usually able to reduce energy consumption alone by ten percent. In terms of logistics costs, the savings are normally even higher. And the necessary investment costs are also reduced significantly. But, reliability and safety cannot be quantified in this form. After all, how should we claim that it is possible to guarantee a reduction in production downtimes by a factor of x? However, we can say that without our methodical approaches, the production facilities would be a lot less safe.
solutions: Does that mean Bayer’s production is safer today than it was in the past?
Kuschnerus: As a consequence of its acquisitions, Bayer actually did end up many sites in the past that were not up to Bayer’s standards. We have definitely improved this situation. With our new manual “Process & Plant Safety”, for instance, many things that used to be only recommendations are now obligatory – worldwide. This is obviously going to improve safety. And our clear goal is to achieve zero incidents!
solutions: Isn’t this perhaps an unrealistic goal?
Kuschnerus: I am not aware of any law of nature that would rule out this aim. On the other hand, it is clear that human error cannot be completely ruled out, and this is the reason why we have to make use of our technical expertise to catch any consequences arising from human error. At the same time, we must of

The career path

Originally from Hamburg, Norbert Kuschnerus studied physics and earned a PhD in chemical engineering. Directly after his studies, he joined Bayer in 1985. Until 2002 he worked for the then Polyurethanes Business Group in Dormagen and Uerdingen, Germany, and also at Bayer Japan in Tokyo from 1992 to 1995. From 2000 to 2002 he was Head of the Technology Center Isocyanates. Thereafter he became Head of Operation Support & Safety. Kuschnerus headed the “Standardization association for measurement and control in chemical industries (NAMUR)” for more than 10 years and is co-publisher of the technical journal “atp–Automatisierungstechnische Praxis”.

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course, train our plant operators.

**solutions:** How is this training implemented?

**Kuschnerus:** We have developed special simulators that plant operators use for regular training in much the same way as pilots work with flight simulators and are thus prepared for all situations. Before a new plant is commissioned, the operators practice at a computer for six months. If necessary, the facility can then be further optimized technically. As a consequence, our main customer, Bayer MaterialScience, has with our help become the worldwide leader in this field in the chemical industry. Furthermore, we recently drafted a project that combines safety training and operation simulators. This is a good example of how we can combine our know-how from various fields to create value for our customers.

**solutions:** Where, in your opinion, is the innovative strength still demonstrated in the company?

**Kuschnerus:** In very many places. Let’s take, for instance, the term product-related analytics. This refers to coupling online analytics with process control. We have often heard competitors say: “You succeed in process control by quality – and we can’t do that.” With this technology we are able to implement quality management continually during the process and in real time. In terms of measuring technology, we have already achieved a comparable standard in the field of biotechnology and have just initiated a project with the Technical University Dortmund to develop the corresponding process model. We are particularly proud of the fact that we can already measure all of the important parameters online – which no one else in the world has succeeded in doing yet.

**solutions:** What role do partners play in terms of innovation?

**Kuschnerus:** An increasingly important role, as it is impossible to assume that all the required knowledge is only available from one source. One example is our cooperation with the Fraunhofer Institute. We have jointly developed a tool for Asset Lifecycle Management.
that is based on neuronal networks and pattern recognition. This allows experts to detect at an early stage whether a plant unit or a processing unit will go off course. It has been a very successful cooperation.

solutions: You mentioned logistics as a key factor in the company’s portfolio. What can customers expect from Bayer Technology Services in terms of logistics?
Kuschnerus: Here too the aim is to identify bottlenecks. We have already developed several Track & Trace applications to industrial maturity, which allow us to trace products from their production up to delivery to the customer. We are advising the European Pharmaceutical Manufacturers Association on this subject and have contributed to the Europe-wide launch of the two-dimensional product code for all pharmaceutical packaging.

solutions: In which areas will we see important developments in the future?
Kuschnerus: We are continuing to press ahead with, for instance, the automation of biotechnological processes. This is an area in which we will collaborate with universities on further projects. And we still have not found an answer to the question how an Asset Lifecycle Management of the future will have to look. In this case it is a question of determining the condition of a plant early on. We currently only make use of just a few percent of all the information a plant has to offer. In this connection, we are carefully following the developments of Cyber-physical Systems and the “Internet of Things”. We are also taking the so-called “Industrie 4.0” project in Germany very seriously. Our colleagues in Manufacturing IT and Logistics are already in the process of elaborating proposals how we can make use of these emerging technologies for our subgroups to produce more safely and, at the same time, more efficiently.

solutions: Doesn’t this trend also mean that the influence of humans will be further diminished?
Kuschnerus: The priority is to keep the plant itself running robustly. This change in thinking implies putting a lot of trust in technology.

solutions: Isn’t there a risk that customers will think Bayer Technology Services comes across as a know-it-all in such questions?
Kuschnerus: We are trusted advisors. To remain a technological leader we are constantly investing in innovation. Our areas of interest range from process development and engineering to methods aimed at how to operate plants in the best way possible. Manufacturing expertise, in other words, the know-how in connection with a specific process, will always remain in the hands of the customer. A good cooperation based on trust always results in added value for both partners.

solutions: Bayer Technology Services receives a great deal of recognition...
Kuschnerus: …which sometimes overwhelms me. I prefer to say to my people that it is better to keep our feet firmly on the ground. But we know fully well that our good reputation is first and foremost an enormous obligation. However, I would

“We are all very aware of the fact that our good reputation is first and foremost an enormous obligation.”

Kuschnerus intends to stay in touch with the Bayer community.
“Marketing Is My Hobby”

When Dr. Norbert Kuschnerus asked Dr. Thomas Steckenreiter if he would like to succeed him, the manager from Stuttgart lost no time in giving his answer. Effective July 1, 2013, the candidate of choice joined the Management Committee of Bayer Technology Services.

Thomas Steckenreiter was born in Offenbach am Main in 1965. He studied chemistry at the Technical University Darmstadt, where he later also earned his doctorate.

Endress+Hauser in 2001, he held various positions dealing with process analysis technology. “My particular focus was to improve product quality as well as to increase the safety and efficiency by taking a holistic approach to processes.”

For Steckenreiter, the decisive factor in making the change was not least the excellent reputation that Bayer Technology Services has in the sector. “It is also fascinating to know that you can contribute to making the entire sector work even more efficiently and sustainably and can help recognize and implement new trends. That is a very exciting prospect!”

And what does Steckenreiter feel qualifies him for the new assignment – besides experience and expertise? “I believe I am a very good listener.” After all, he knows fully well that “this is a fundamental prerequisite for developing innovations.” And in general, “Both exchanging with people around me and listening to their opinions are really very, very important to me.”
This distillation column with an evaporator, used by Bayer MaterialScience in China, weighs about 56 metric tons. The manufacturer Morimatsu delivers similar apparatuses from its Shanghai site (see photo at the top of the page) to various plants in the worldwide Bayer Group. Dr. Norbert Schweigler (right) keeps a watchful eye on the equipment to ensure it meets the specified quality standards.
There are many producers of the large-scale equipment used in chemical plants, but which ones can deliver the quality standard required by Bayer for the best price? Finding them is a job for Bayer Technology Services – for instance, in China.
It is another one of those frequent gray days in Shanghai: 24° C or 75° F, a dull beige sky with, as nearly every day in this bustling Chinese city, poor visibility. Yesterday the temperature was only 8° C, or 46° F. “I find it very difficult to get used to this climate,” says Dr. Norbert Schweigler, as he climbs into his car. The air conditioner is operating at full blast. Schweigler has already been working for Bayer Technology Services in Shanghai for three years, and he seems to have settled in. “Because in spite of the environment, it is really quite fascinating here.”

Schweigler is responsible for Process & Equipment. Together with his team and the materials specialists at Bayer Technology Services he is constantly on the lookout for producers of the various kinds of equipment that Bayer requires for its extensive manufacturing facilities – in China and elsewhere in the world. Schweigler sees his job as a “positive consequence of globalization”, as he describes it.

Some ten years ago he would not yet have been needed for this work – at least not at this location. In those days, the equipment for the construction of the Bayer plant near Shanghai was largely sourced from outside the country. To be more specific: some 90 percent of the equipment came from German or European manufacturers.

“In the meantime, however, the world has changed” says Schweigler, adding emphatically: “And the Bayer Group too.” Nowadays, the equipment for Bayer plants is manufactured all over the world. “It is our job to find out where the production is especially cost effective – as well as of particularly high quality.” After all, “Bayer standards for quality and safety are the same throughout the world.”

The Morimatsu (China) Group is on the program today. The Japanese manufacturer of plant equipment supplies a variety of industries. One of the plants is located in Jinwen Road, somewhere near the Pudong International Airport Industrial Park in the Eastern area of the megacity. The drive will take an hour and a half, Schweigler remarks completely unruffled. “In Shanghai virtually everything is far away.”

Initially, the excursion takes us past countless high-rise residential buildings, few of which are older than five years. New living space, which can be built quickly and inexpensively, is constantly required for the 25 million inhabitants of Greater Shanghai. This expanse is followed almost seamlessly by a whole jungle of high-tension pylons and power supply lines. After that, one industrial zone adjoins the next. “Ten years ago, there was nothing here,” says Schweigler, indicating with a stretch of his arm a wide expanse reaching to the horizon, but then immediately corrects himself: “What am I saying! It is more like five years ago!”

The Morimatsu (China) Group greets us in the middle of this former void: “Welcome Bayer” is written in illuminated lettering above the entrance of the company’s administration building. Behind this stands a production
“Nowadays, equipment for Bayer plants is manufactured all over the world. It is our job to find out where the production is especially cost effective – as well as of particularly high quality.”

Dr. Norbert Schweigler, Head of Process & Equipment PCS/DSB, Bayer Technology Services

A close partnership and a commitment to quality:
Windy Luo at Bayer MaterialScience and Sherry Zhao, Deputy General Manager of the Morimatsu (China) Group. Yangjie Lin at Bayer Technology Services in China (far left) is always on the lookout for the best and the most cost-effective producers.

“Quality!” she exclaims, as a wide smile spreads across her face.

However, it is not as if this quality has simply fallen into Bayer’s lap. “Ten years ago, for example, you still could not find any good welders in China,” Schweigler recalls. So, the company gradually set up a quality management hall, which is so enormous it could easily hold three or four jumbo jets.

Just a few years ago, the company proved it could handle even more expansion. In the available area of the new site there is enough space to recreate the Great Pyramid of Cheops twelve times over – each standing next to the other. “We are very pleased to have been able to build up such a strong business relationship with Bayer,” says Sherry Zhao, Deputy General Manager of the Morimatsu (China) Group. And she also knows the secret behind making this close relationship possible in the first place:
system, and from the beginning it was based on Bayer’s stringent requirements. At first this appeared to be a sheer insurmountable hurdle for suppliers in Asia. Schweigler: “Because the emphasis was simply always on the price, and almost never on the quality.” It is an experience that experts from Bayer Technology Services have made virtually all over the world. Whether in China, India or Brazil – at first their search for the required quality was almost always in vain.

However, in the meantime, the situation has changed significantly. Today, Bayer MaterialScience purchases about 60 percent of its high-quality equipment in China, and since 2011, also in India. With prices some 30 percent lower than those of European competitors, the cost advantage is enormous. But what does this mean in real terms? Schweigler does not take long to answer. “47 pieces of equipment were recently purchased here come to mind. We were able to save several million dollars as a result.”

With such significant cost advantages it is no wonder that the equipment is not only used in the gigantic TDI plant at Bayer’s site in Shanghai. A similar plant in Dormagen, Germany, is also fitted out with the corresponding equipment, as is the Baytown site in the United States. But why does Bayer MaterialScience rely on the expertise of Bayer Technology Services? Windy Luo, who is Head of Global Sourcing of Fabricated Equipment at Bayer MaterialScience, is quick to provide the answer: “The search for suppliers and, if necessary, their certification are very complex tasks, and Bayer Technology Services has the technical know-how to support us in this work.” We really have “had very good experience with the colleagues from Bayer Technology Services in the past”.

For instance, in the case of Morimatsu. Here, a 56-metric ton distillation column with an evaporator is currently being produced for a plant to be operated by Bayer MaterialScience, in which a raw material for polyurethane production will be manufactured. With sparks flying in all directions, the welders are working diligently to make sure the tight delivery deadline can be met. “Reliability is another very important criterion when choosing a supplier,” Schweigler stresses. “And of course the handling of our know-how as well.” What does he mean by this? “Well, to put it plainly, I mean intellectual property, which is a major issue here in China.”

Just how seriously this subject is taken is witnessed by the photographer on site. He is about to take an overview photo of the production hall when a Morimatsu employee gently pushes the lens of his camera to the side. So, he makes a new attempt, and again the man intervenes – politely, but firmly. “We kindly ask you to photograph only Bayer orders,” is the explanation. “We owe that to our other customers.” It is clear that Morimatsu is one of the ex-
only constantly searching for new challenges, but also want to move up the career ladder quickly and earn higher salaries. The obvious consequence is that some 20 to 30 percent of all staff members have to be replaced every year – by people who usually have not yet achieved the required level of expertise.

Quality control will thus remain an important task for Schweigler and his team. Furthermore, at least one new production plant is added to the market every year, which means the same questions of quality, reliability and prices arise. Schweigler says: “The market is in a state of flux. Hence, there is little chance of reaching a stage when we can rest on our previous accomplishments.”

Bayer began its search for appropriate manufacturers very early on, and even today, the company is still playing a trailblazing role. Nevertheless, it is obvious that despite all the technical progress in China, India and other countries with fast-growing economies, there is no way that Bayer’s requirements can entirely be met in these markets. The reason is simple: the production of static equipment does not require as much know-how as the fabrication of, for example, special pumps or stirrers. Such components continue to be sourced in Europe. “Generally speaking, this rule applies to everything that moves in production facilities.” Schweigler’s prognosis: “It will most certainly take a few more years before these parts can be produced in Asia and still fully meet our quality requirements.”

The clock shows 11.30 a.m. in the production hall of the Morimatsu plant. Where just minutes ago welders were busily working on the equipment for Bayer MaterialScience, everything has now suddenly stopped. Even the deafening background noise of minutes ago has fallen silent. From a distance, we briefly hear the sound of a door shutting, and then all goes quiet. “It’s the lunch break,” says Schweigler and adds, as an explanation for the visitors from Europe: “Lunch breaks are taken very seriously over here.” Not surprisingly, the Chinese thus have the saying, “To the people food is heaven.”

“To be perfectly honest, however, I prefer a different Chinese saying even more,” says Norbert Schweigler, because of its global relevance. The Chinese say learning is like rowing against the current: as soon as you stop, you drift backwards. “So, you see,” comments Schweigler with a smile, “That is the reason why I see China as a truly great nation of rowers as well!”

A set of rules for all suppliers

With more than 100,000 suppliers, Bayer purchases goods and services from all over the world. The respective principles for procurement are standardized.

The basis for Bayer’s sustainability-orientated supplier management is a guideline that is valid for the entire Group. These rules for the company’s sourcing policy are found in the binding code of conduct, describing the sustainability principles and requirements for suppliers. Suppliers who do not honor these principles cannot even take part in Bayer’s tendering process in the first place.

Those responsible check at regular intervals whether the suppliers actually implement the requirements specified in the code of conduct – and this review includes the entire supply chain. The checks are conducted with the help of supplier assessments and the appropriate audits. If the on-site audits show potential for improvement, mandatory action plans with firm implementation dates are agreed. After all, the goal of the company is to ensure stable and long-term relationships with its business partners.

“We are very pleased about the strong business relationship with Bayer. The secret behind our good cooperation is our common commitment to quality.”

Sherry Zhao, Deputy General Manager der Morimatsu (China) Group
A team at Bayer Technology Services has managed to get bacteria to produce phenol from glucose. A technology making use of agricultural wastes could thus pave the way for the sustainable synthesis of important phenol-based polymers, such as polycarbonates.

**Phenol from the Bioreactor**

And this is the goal Dr. Jørgen Magnus set for himself as a schoolboy. He had just read *Beyond the Limits*, a book about limited natural resources. He had already learned about the climate-damaging effects of increasing CO₂ emissions from an exhibition at the Norsk Teknisk Museum in Oslo. But another thing was clear to Magnus back in those days: saving the world would be impossible without biotechnology.

In the meantime nearly 25 years have passed, and in many respects, Magnus is now really working to save the world – at least to a certain extent he is. He studied biochemistry and process technology, earned his PhD and has become a specialist in biotechnology. Among other tasks, he is now researching at Bayer Technology Services to find ways to conserve fossil resources, thus helping to avoid fuel gas emissions. After all, more and more customers are taking an interest in sustainable production methods. And in fact, he has had success: in just a single year Magnus was able to induce bacteria to synthesize phenol in one particular project. The chemical industry utilizes some nine million metric tons of this important basic chemical every year. Most of this is used for the production of polymers such as polycarbonate or epoxy resins, while a smaller amount is required to synthesize active pharmaceutical ingredients, such as acetylsalicylic acid for Aspirin. Until now, phenol has exclusively been derived from oil.

However, this is not the only reason why phenol synthesis using bacteria is of major importance. From a purely technical point of view, Magnus had also achieved something very special. After all, not a single living organism existing in nature produces significant amounts of phenol as part of its metabolism. “There was no model of natural syntheses from which you could have simply transferred the corresponding genes to bacteria,” explains Magnus. Nevertheless, the Norwegian found a way to get the cells to do this very thing.

When describing to laypeople exactly what he has managed to achieve, Magnus often chooses a subject with which most of us are very familiar: traveling by car. “In metaphoric terms, we took an existing highway and connected it to a new destination. We then increased the number of lanes, blocked certain exits and got rid of construction sites and other bottlenecks.” Generally speaking, they took a number of steps to ensure that as much traffic as possible reached its goal, or, in other words, to allow as many phenol molecules as possible to be produced.

Specifically, this means, “We first looked for bacteria whose metabolism creates a substance from which you might possibly be able to derive phenol,” says Magnus. This was the search for a highway that already comes quite close to the desired new destination, or in this case, comes close to the desired goal. The team hit the jackpot with a certain strain of Escherichia coli –
The raw material glucose could be obtained from waste wood (above). But the cells, from which phenol can be synthesized, must first be prepared and then reproduced (below).
What knowledge achieves i.e. species of bacteria of which there are also examples found in the human intestines.

When these coli bacteria metabolize simple glucose molecules, the conversion chain eventually leads to chorismate. And this is the very substance that Magnus tipped as a good starting point. "Phenol can be synthesized from chorismate in just two steps." The first step leads to a substance called 4-hydroxybenzoic acid, and the second to phenol. For these two steps, the bacteria are only missing two enzymes that would induce the respective reactions. Luckily, these two enzymes can be found in other strains of coli, and the genes for these enzymes were therefore known. The only thing Magnus and his team had to do was to cut out these genes from the other bacteria and smuggle them into the genome of the bacteria with the chorismate. And so, going back to our metaphor, this would be the new highway to phenol production.

To increase the yield, Magnus had to ensure that the bacteria cells produce a larger than usual amount of chorismate from the glucose – a lot more. "We therefore copied the genes for three enzymes that are involved in producing chorismate." That was equivalent to creating new lanes for the highway.

Unfortunately, there was one interfering factor. The bacteria continued to process the chorismate to two amino acids that are particularly important for them. As this would have impaired the phenol yield, Magnus wanted to prevent the amino acid production. "To accomplish this, we had to cut out two genes for the corresponding enzymes," explains Magnus. It was as if they had blocked a highway exit or turnoff so as to prevent too many vehicles from leaving the highway.

And then there was one final hurdle to overcome. Cells have a feedback mechanism, which, under certain circumstances, inhibits the production of a chorismate precursor and thus the chorismate synthesis itself. In this case it was sufficient to modify the gene for the corresponding enzyme at one particular spot, thus suspending the feedback. Magnus compares this to

"Cells are very versatile reactors. They can produce thousands of different molecules. No chemist can achieve this. I see unlimited possibilities for biotechnology."

Dr. Jørgen Magnus, Process Design & Optimization, Bayer Technology Services

Utilizing nature

Nature can do an amazing number of things, and white biotechnology is increasingly making use of this talent. Unlike biotechnological applications in pharmacology and medicine (red biotechnology) or in agriculture (green biotechnology), white biotechnology involves utilizing the toolbox of nature for industrial purposes. Some examples are obtaining ethanol from biomass (bioethanol) or using biotechnological methods to produce enzymes for detergents. White biotechnology is also becoming increasingly interesting for the synthesis of important basic chemicals from renewable raw materials or even from their waste products – thus offering an alternative source to oil.

Metabolic engineering is a special field in white biotechnology or, better said, one of the methods used. In this process, existing organisms, usually single cell organisms such as bacteria, are modified so that they perform industrial tasks. One goal can be, for instance, to deliver higher yields of a substance generally produced as part of metabolism. But it can also involve reprogramming the metabolism in such a way as to induce the organisms to synthesize something completely new. This is exemplified by the case described in the main text, i.e. phenol synthesis with the help of coli bacteria.

Those who are optimistic about white biotechnology can already envision a largely biobased industry, in which renewable raw materials replace the classic fossil fuels as completely as possible. Technology is not there yet, but companies and scientists are researching towards this goal. And Bayer is one of them.
the removal of a construction site where the traffic had previously jammed.

In the end the day came when Magnus had managed to smuggle all the necessary genetic modifications into the coli cells, and they then reproduced. A simple shaking flask had been enough to prove whether the principle functioned in practice. The flask held a mixture containing reproduced coli bacteria, some nutrient solution and, of course, sugar. After a while, Magnus checked to see if phenol had formed in the mixture. But the chromatogram of the extract he examined showed a flat line. No peak, which meant no phenol. It was a shock.

What could be the reason? Was something wrong with the culture medium? Suddenly, Magnus had a different suspicion. Had he perhaps made a mistake during the proliferation of the modified cells? This is where a trick comes into play: To prevent the coli bacteria with an unmodified genome from multiplying with the others, the modified genome is equipped with a resistance against a certain antibiotic. This particular antibiotic is then applied to the cells, with the consequence that only the bacteria cells with the modified genome (and the resistance) multiple and all the others die. Had Magnus used too little of this antibiotic? So, he increased the amount in a second try.

**Wednesday, June 13, 2012:** it is about 6 pm, and Magnus is the last person in the laboratory, when he injected a new sample from the shaking flask into the liquid chromatograph. After about 20 minutes, the ultraviolet detector actually registered a substance; a peak appeared. Magnus knew exactly what substance showed up at this spot in a chromatogram: phenol. In his home country of Norway, it was the time of the year when it is barely dark at night and the mid-summer night parties were in full swing. Magnus may have been far, far away in his Leverkusen lab, but he too was in a mood for partying!

Later he repeated the experiment in a bioreactor with a capacity of one liter. Here the phenol peak was even greater, and the yield higher. Despite these sensational successes, Magnus remains cautious as he is all too aware of the further hurdles to overcome. “Until now we have only confirmed the operating principle. There is still a lot to do before this principle can be transferred to an industrial scale production of meaningful dimensions.” Presumably another bacterial strain will even be necessary. “From a certain concentration phenol is toxic for the coli strain used until now,” Magnus admits. Another question is how you can extract the finished product, if possible, continuously from the bioreactor so that it cannot concentrate in the first place.

On the other hand, it is very clear where one could obtain the necessary starting material, glucose. The various plants for sugar production would be one possible source. However, cellulose, which can be obtained from plant waste, would be another possibility, Magnus stresses.

Magnus has no doubts as to the question whether small bacteria will be able to produce the industrial product on a scale of several million tons. “There are already facilities in which yeasts produce up to one million tons of bioethanol every year.” He is therefore confident that biophenol production plants of a similar size as those in the chemical industry are achievable.

But one thing is for sure: the Norwegian expert is absolutely certain about the future of biotechnology in the chemical indus-
Elke Bartl (44) has been appointed Head of Human Resources at Bayer Technology Services. The former Head of HR//direct in the HR//Services Business Unit of Bayer Business Services in Leverkusen succeeds Astrid Geißler, who has transferred to HR Germany of Bayer AG to assume the position of Head of Talent Management & Workforce Management.

As a Member of the Management Committee, Elke Bartl is responsible for the worldwide recruiting of engineers for the Bayer Group. Among her other duties is talent development for Bayer Technology Services and the Bayer Group. “Elke Bartl has extensive experience in the areas of personnel development and promotion, which are important for the strategic role of Bayer Technology Services in the Bayer Group,” stresses Dr. Dirk Van Meirvenne, Managing Director of Bayer Technology Services.

Elke Bartl studied business administration with a focus on human resources and marketing at the University of Paderborn in Germany. She worked in numerous HR positions at Schlumberger in Karlsruhe and Hanover before joining IBM in 1999, where she successively assumed HR leadership roles in the U.K., France, Hungary and Germany, respectively. Elke Bartl has served as Head of HR//direct since July 1, 2006 and thus played a major role in the reorganization of human resources administration at Bayer according to the shared service concept.

Dr. Van Meirvenne thanked Astrid Geißler for her “very successful work”, which has significantly helped to enhance the reputation of Bayer Technology Services in the Bayer Group worldwide. As Head of HR and a Member of the Management Committee, she contributed “substantially to the further development of Bayer Technology Services as a leading technology company”. Among other things, Astrid Geißler introduced the “perspective” career model, which allows employees to better develop their capabilities individually as experts, project managers or managers. In addition, she helped to implement, in cooperation with employee representatives, the new strategy of Bayer Technology Services.
Habilitated in Biothermodynamics

**Dr. habil. Stephanie Peper**

Dr. habil. Stephanie Peper has successfully completed her habilitation dissertation colloquium at the Helmut Schmidt University in Hamburg. One of her focuses is biothermodynamics – a field that is becoming more and more important in Life Sciences. Stephanie Peper is currently a Senior Specialist at Bayer Technology Services in Property Data & Thermodynamics.

The scientist and mother of two children thus joins the company’s small group of four habilitated employees, whereby Stephanie Peper is the only woman.

**MAINTENANCE NETWORK**

Maintenance work can be conducted in different ways. You can service facilities at regular intervals or step in ahead of time when something has to be repaired. However, the use of smart maintenance systems and procedures is more economic and safer. With these systems it is possible to determine the – theoretically – right time for turnarounds.

These innovative methods are being developed at the University of Tennessee in Knoxville, which is a worldwide leader in this area.

Thanks to a cooperation with the U.S. university, Bayer Technology Services has been able to obtain access to this know-how and gained qualified and talented engineers in this special field.

**CHANGE IN MANAGEMENT**

The new Head of the Operation Support & Safety Division is Dr. Thomas Steckenreiter (47). In July 2013 he succeeded Dr. Norbert Kuschnersus, who has retired after nearly 30 years at Bayer (see the interview on pages 8-11).

Steckenreiter was formerly Director of Marketing at Endress+Hauser Conducta GmbH. He has “in-depth experience in process safety and process analysis technology” and therefore possesses the special qualities that will be of particular importance for the expansion of the portfolio and thus the future business of our company, said Managing Director Dr. Dirk Van Meirvenne. He thanked Kuschnersus for his “very successful work, which has helped to shape the company’s excellent reputation worldwide”.

**EXPECTATIONS EXCEEDED**

The European Commission usually has to prolong projects because something has gone wrong. The situation was quite different with the €30-million “F³ Factory – Factory of the Future” research project in collaboration with 25 partners from nine EU countries, which Bayer Technology Services coordinated since 2009 and has now successfully concluded. Among the partners were BASF, Evonik, Procter & Gamble, AstraZeneca and Solvay. “F³ Factory is the European example of open innovation with which industry and universities jointly achieve pioneering leaps in technology despite their differing interests,” said EU Research Director Dr. Søren Bøwadt at the closing event at BayKomm in Leverkusen.

**Unique production module in the INVITE Research Center**

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ever before have I had to enter so much unchartered territory.” And Jürgen Evers is by no means a newcomer in his profession. He has already worked at Bayer Technology Services for more than 15 years. During this time the project manager has been involved in the construction of several production facilities. However, this project, focusing on the new application of an oral contraceptive, was definitely something special – and not only because it was “uncharted territory”. “Never before have so many specifications been changed during the course of a project,” Evers added.

Project Management & Engineering, Healthcare is the title on his business card. This basically means the German engineer designs and builds facilities in which pharmaceutical products are manufactured in compliance with the strict regulations of Good Manufacturing Practice (GMP). And this is exactly the field he studied. “Pharmaceutical Technology” was the name of his special course of studies at the Albstadt-Sigmaringen University of Applied Sciences in Southwestern Germany.

Consequently, Evers already knows a lot about production facilities in which, for example, tablets with sensitive ingredients have to be packaged. However, this case did not simply involve tablets. The element Evers most closely associates with this particular project is a special cartridge, which is namely the core aspect of the entire process when it comes to the packaging concept.

The springboard was an innovative administration regimen that Bayer HealthCare planned for one of its well-established oral contraceptives. The new version of this product carries the added description “Flex”, because it gives women the flexibility to go up to 120 days without getting their period, if they choose not to do so.

The 120-tablet regimen allotted per cycle is packaged in cartridges containing 30 pills each. The users place the individual cartridges in a digital dispenser called a Clyk, which “smartly” assists her with the usage. The Clyk sounds a daily alarm to remind the user to take the pill. Should the user nevertheless forget the tablet, the dispenser will inform her what to do. And if the woman decides she wants to have a period, all she has to do is stop taking the tablets.

The principle may sound simple, but the challenge was to develop a complex packaging line for the many processing steps and components. The dispensing cartridges, in particular, caused some headaches. Due to the sensitive active ingredients and the other contents, the tablets – and therefore also the cartridges – must be protected against oxygen and humidity. Only a hermetically sealed pack can ensure the efficacy and shelf-life of the product in all climate zones.

Blister packs were found to be perfectly suitable, and of course they are not unusual in pharmaceutical applications. And yet there was nevertheless a problem. At the lower end, where a special mechanism allows the dispensing of each individual tablet, the packs are just under two centimeters thick. “Until now there hasn’t been a single product with these proportions that is blistered for pharmaceutical requirements,” explains Evers. A drawing depth of two centimeters had always been considered too much.

At first the team favored a pouch system, by which the cartridges are packed in sealed bags. However, a risk evaluation showed that the absolutely essential air tightness of the bags could not be sufficiently guaranteed at the high production speeds required for series manufacturing. As a result, the team decided instead to seek the advice of leading manufacturers of blister machines. Within three months a plausible and functioning packaging concept was developed with two producers. Eventually, an agreement was reached with one of them, and the work began.
The solution is a double-chamber blister. “Each of two foils is extended over half of the required depth,” says Evers. A cavity of just under two centimeters is formed after bonding the two halves together. The cartridge fits perfectly into this space, and the blister can be sealed. It is a real innovation!

However, this development only resolved one of the many challenges. Changes in the product details also kept Project Manager Evers busy. Plans for the packaging line were in full swing, when, for example, the dimensions of the cartridge were modified once again. For Evers’s team it was roughly as if they were supposed to plan a house, although the designated living space was changed on a daily basis.

“The cartridges had to be placed onto a conveyor belt mechanically, filled with the tablets, weighed, placed in collapsible boxes and then finally packed in cartons,” says Evers, listing only some of the processing steps that had to be adjusted to the new dimensions of the cartridge. So, each and every modification had consequences for the respective function in the packaging line.

Another challenge was printing on the cartridges, which was also new territory because of the curved surface. Here too adjustments were necessary up to the final stages of the project because major label elements were only specified by the authorities as part of the registration process.

By completion, Evers and his project team had developed and implemented a packaging line some 250 meters in length, which involves assembling the various individual components of the Clyk and the cartridges, handling, filling and blistering as well as packing the final product in cartons and palletizing them. This kind of packaging line is absolutely unique worldwide. “It is designed to manage 250 blisters per minute,” Evers adds. This means 7,500 tablets are processed every minute.

Bayer HealthCare divided the various production steps between two sites. The cartridges and the Clyk dispensers roll off the production line of a subcontractor, whereas the actual filling and packaging take place at Bayer HealthCare’s Supply Center Berlin. Dr. Hans-Joachim Raubach, Site Management Berlin, is clearly impressed by the results: “In terms of the time schedule, costs and quality, you have been on target or even better. That happens only rarely, especially considering the many technical innovations and constant modifications – literally up to the last minute.”

The project was a fulltime job for Jürgen Evers for three years. He has long since moved on to the next construction project, but he did feel proud when women in Australia obtained the very first product packaged at the Supply Center Berlin in late 2012. During 2013 the product will become available in pharmacies of some EU countries as well.
From the onset safety concerns are taken into account in the engineering of new Bayer plants. Assisting in this process are experts from Bayer Technology Services, such as Augusto Perico-Cortes – a proven specialist, especially in manufacturing and processing facilities for phosgene.

Two large ficus trees rise to the ceiling of Augusto Perico-Cortes’s office in Leverkusen. The fact that they have grown so tall is not least thanks to the care and attention of a close colleague. On his own, Perico-Cortes would never have been able to look after them sufficiently. Because of his business trips to all corners of the world – to Belgium, Spain, Brazil, China, Japan, Thailand, just to name a few destinations – there are periods when the native of Colombia is away from the office for days or even weeks at a time. Once he spent nearly six months in the United States with only short breaks in between.

Perico-Cortes is one of some 60 colleagues working in Process & Plant Safety (PPS) at Bayer Technology Services in Leverkusen. About a third of this staff investigates important substance properties in the laboratory. The rest, including the Colombian, are sent to locations all over the world where Bayer or some other client is planning a new facility or the reconstruction of an existing one. As PPS employees, they know all about how to effectively prevent hazardous situations that may occur in chemical facilities. The secret is preparing suitable safety concepts, and since these plants are built throughout the world, PPS staff members are frequently found in jetting off to far away places and spending the night in hotels.

Sometimes, however, Perico-Cortes is simply on assignment in northern Germany, or not even 30 kilometers away from Leverkusen in Dormagen. For example, Bayer MaterialScience is currently building a new facility in Dormagen for the production of the polyurethane raw material TDI. Perico-Cortes spent a lot of time there when the construction of this plant was being prepared. The work began in January 2009 with a safety review of the plant concept.

TDI is an isocyanate, and a plant for the production of phosgene is always part and parcel of every facility involved in the manufacture of isocyanates. At the preliminary production stages the amine groups are converted into isocyanate groups with the help of this chemical. This is the conventional process in isocyanate synthesis.

Under normal conditions, phosgene is a gas. Even in small quantities it is toxic for humans, and therefore the handling of phosgene requires very special safety measures. Here it is important to remember phosgene is needed solely as an intermediate that is directly and completely further processed. As mentioned above, it reacts with amines to form isocyanates. The required quantities can thus be calculated so that only the amount needed for further processing is synthesized at one particular time. For this reason the chemical does not have to be stored. In addition, at all sites where Bayer MaterialScience requires phosgene, the rule is that the phosgene synthesis must take place in immediate proximity to the further processing unit. As a consequence, any pipelines carrying phosgene can be kept short.

Nevertheless, a number of safety precautions are still necessary. Among these are measures to prevent phosgene from escaping into the atmosphere. This may include, for example, pipes with a double wall.

Augusto Perico-Cortes is among the employees in the Bayer Group with the most experience in dealing with phosgene.
Augusto Perico-Cortes cannot always care for his ficus trees himself (above). The expert for engineering plant safety (below left) is often away on business trips (below right).
What Affects the World

“The safety experts at Bayer Technology Services contribute to the fact that the handling of the intermediate phosgene at Bayer is safe, environmentally correct and highly efficient.”

Dr. Kurt Meurer, Head of the Global Phosgene Steering Group, Bayer MaterialScience

The TDI plant at Bayer in Dormagen was safely planned from the onset.

plant safety. His first involvement with a phosgene plant was in 1984, when the engineer had been with Bayer for just two years. At the time he was employed as a process control engineer at the company’s Belford Roxo in Brazil, where a manufacturing facility for MDI was just being built. MDI is another isocyanate that is required for the production of polyurethanes, and like TDI, it is produced with the help of phosgene.

That was nearly 30 years ago, and in the meantime, Perico-Cortes has helped engineer the safety features of many new plants. Working as a PPS expert since 1990, he has been involved in 22 phosgene plants around the world over the years. It is therefore no surprise that for some colleagues at Bayer, he is known as “Mr. Phosgene”. And this nickname is not so far from the truth, considering that he has been a long-standing member of the Bayer Global Phosgene Steering Group (PSG). As Chair of the PSG PPS Group he has provided valuable services for Bayer’s phosgene safety for many years now.

Perico-Cortes does not protest when people refer to him as Mr. Phosgene, but he feels the association is actually far too simplistic. “We always work in a closely coordinated team,” he

Various applications for phosgene

Phosgene plays an important role in many chemical syntheses — for instance, when it comes to converting amines into isocyanates. In turn, isocyanates are an important starting material for the production of polyurethanes, one of the most versatile classes of polymers. Phosgene is also a primary component in the synthesis of polycarbonates, which are used, for example, to produce CDs and DVDs, as well as many components for application in the automotive, energy and leisure sectors. Phosgene is also important as an intermediate for the production of crop protection agents and active pharmaceutical ingredients as well as of special chemicals used in high-tech applications.
stresses. “The contribution of each individual is important and therefore we form a Phosgene Team.”

As such, Perico-Cortes collaborated right from the beginning in a large team to plan the safety requirements for the TDI plant in Dormagen. Engineers, chemists, production foremen, automation experts and specialists in environmental protection, occupational safety and many more were all involved. A lot of them were employees of the client and later plant operator, in this case Bayer MaterialScience. “Bayer Technology Services offers bundled expertise encompassing planning, construction and commissioning of facilities,” explains Perico-Cortes. The plant safety experts from PPS contribute, in particular, know-how collected over many years in the special fields of explosion and fire prevention as well as occupational safety.

The team first runs through all possible scenarios in advance. What would happen if the temperature here or the pressure there were to suddenly increase? What if a chemical got into the wrong pipe? Or if valve x or pump y malfunctioned? Or what if a sealing gasket on a reactor leaked? “In the early days of industrialization, people just reacted to accident events,” says Perico-Cortes. “Today, we try to anticipate any possible events beforehand – and either through suitable precautions prevent them from happening in the first place or ensure that any incidents remain without consequences.”

But why is it necessary every time you build a new plant to make such an effort years before construction even begins? After all, Bayer MaterialScience operates many other large-scale TDI plants around the globe. Hasn’t it already become common knowledge and perhaps even standardized, where certain safety measures are required? “We always consider everything very carefully – even if it is for the umpteenth time,” stresses Perico-Cortes. For one thing, technical knowledge is constantly increasing, and for the other, each plant is unique when it comes to its integration in the existing infrastructure of a site. Among the special features are, for instance, energy supply and the feed of intermediates. Taken in this context, the large-scale facility in Dormagen is also unique.

By the time construction begins, Perico-Cortes has long moved on to the next projects. Among other things, he is currently working on two existing MDI facilities – one in Uerdingen and the other in Brunsbüttel. In Brunsbüttel it is a case of reconstruction and expanding, and in Uerdingen it is another periodic safety review. As Bayer has prescribed in its own safety management procedures, all facilities are reviewed in relation to their plant and process safety every five years. “For example, we always check to see whether there are new insights that will help us tighten the safety net even more,” explains Perico-Cortes.

As in Dormagen, parts conveying phosgene will also be included in the MDI facilities in Uerdingen and Brunsbüttel. Not surprisingly, the colleague from PPS who will participate in team meetings is Augusto Perico-Cortes. Since most of this year’s work will be in Germany, his ficus trees stand to benefit as well. For once the specialist in phosgene plant and process safety will be able to water them himself more often.

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**“We want to protect people and the environment – and to gain social acceptance for our activities. We constantly further develop our technological competence to ensure we operate our plants safely.”**

Dr. Hans-Erich Gasche, Head of Process & Plant Safety, Bayer Technology Services
The name of the manufacturer is clearly visible on the steel, and yet the unit located at the Lanxess site in Zwijndrecht near Antwerp in Belgium cannot be ordered from the company’s product catalogue – at least not the inner workings of this steel cylinder several meters long. “We changed quite a bit,” Dr. Thomas König explains, and it was indeed necessary. “Nowhere in the world is it possible to order an extruder like the one needed for the task at Lanxess,” says the process engineer working at Bayer Technology Services. For this reason, König and his team purchased a commercially available extruder and then modified it with the help of a further partner so that it was able to do the job.

The usual task of an extruder is to knead a more or less viscous material while conveying it, thus homogenizing it, or, as the case may be, to thoroughly mix two different components in the process. Thermoplastic melts are often processed in this way. One or several screw-like shafts rotate, thus moving the material to be processed from one end to the other. The basic principle of this technology was discovered by the Greek scholar Archimedes more than 2000 years ago. However, he had other applications in mind. With his Archimedean screw, he succeeded in transporting low-viscosity water upwards against the force of gravity.

The customized extruder in Zwijndrecht has a very different function. Its job is to free freshly synthesized butyl rubber from the solvent in which the synthesis has previously taken place. Until now Lanxess had used a stripping technology at this stage of the process. Here, hot steam is fed through a mixture of rubber crumbs and liquid, and the steam then carries away the solvent. However, this process is extremely energy-intensive. In fact, it is the main reason why nearly nine metric tons of steam are required per metric ton of synthesized butyl rubber. With the demand for butyl rubber increasing from year to year (see the adjacent box), Lanxess is striving to improve the energy balance of its production. In collaboration with Bayer Technology Services, the chemical company in Leverkusen has succeeded in optimizing its process in recent years. The result of this development is the large-scale pilot plant now located on the River Schelde in Zwijndrecht. The customized extruder that removes the last of the solvent is part of this new plant.

As the solvent evaporates at the temperature conditions in the extruder, this process is also referred to as degassing. Degassing polymers in extruders is not really new, but there are always additional challenges involved in degassing rubber. The more solvent removed, in other words, the higher the rubber content of the remaining mixture,

**Popular rubber**

Tubeless tires were first introduced in the 1950s. Ever since virtually every tire available on the market has been lined with a coating of butyl rubber, Lanxess is one of the leading manufacturers of this special polymer made from isobutene and isoprene. More than three quarters of the some 300,000 metric tons produced every year end up in the tire industry. This industry’s demand for gastight rubber is increasing – especially in the booming economies of Asia. Experts calculate that by 2020 China, for instance, will require an average of 8.8 percent more tires every year. Incidentally, another application for butyl rubber is chewing gum.
Move along and knead – a twin-screw extruder does both. The colors in this illustration show the distribution of pressure and thus the kneading power along the extruder screws.
technology solutions  2013

What Affects the World

the more viscid and sticky it will be. When using the term viscid, a consistency something like honey may come to mind. But pure butyl rubber is almost like a solid. If a glass with butyl rubber were to be turned upside down, it would take ages before something would run out.

As a lot of energy is added to the rubber through kneading, its temperature increases along the length of screw-like shaft in the extruder. “This is a problem because at some point it can become so hot that the rubber would chemically decompose,” explains Thomas König. Clearly this is undesirable.

And there is another factor that complicates the degassing of butyl rubber: its low gas permeability. This is actually considered a desirable property from the point of view of the main users of the rubber: tire manufacturers. After all, it is the coating of butyl rubber on the inside of all tires that makes them airtight. However, it is easy to imagine that this very gas impermeability can also be a real obstacle, if you want to remove the existing gaseous solvent from the rubber mixture.

König and his team colleagues were exactly the right people to work out a solution despite this problem. Principal Expert High Viscosity Systems is the title on König’s business card. Highly viscous systems are what experts describe as substances which are so viscid that they can hardly be called liquids at all – just like synthetic rubbers. König has worked in highly viscous technology for more than 15 years.

In fact, Bayer has amassed expertise in this field over decades. But that is not all: the company has even shaped this area of process technology through its own pioneers and innovations. “Device for the kneading, gelatinizing and pressing of plastic masses” is the title of a patent specification that was first drafted in 1944 and granted at the beginning of the 1950s. The authors were Bayer employees, and the “device” to which they referred was none other than a “co-rotating twin-screw extruder”, i.e. an extruder with two intermeshing screws, both of which rotate in the same direction. In certain applications, this

Dr. Thomas König, Principal Expert High Viscosity Systems, Bayer Technology Services

It may come as a surprise, but pure (butyl) rubber is white (left). Tire manufacturers are the main users of the dried crumbs. All modern radial-ply tires are coated with halobutyl rubber (right).
A co-rotating twin-screw extruder was also the favored solution for degassing butyl rubber. Unfortunately, however, the models that were commercially available were not suitable for the task. “The increase in temperature resulting from this method would simply have been too high,” says König. So, König and his team proceeded to modify the inner workings of the extruder to meet their needs. For this, there are two basic regulating possibilities: one for the geometry of the screw and the other for the size of gap between the two screws. The mixture is kneaded in this space, and it is also transported through this space. The smaller the space, the greater the built up of pressure – and thus the degasification effect. But the friction and temperature also increase as the compound is conveyed along the screws, and therefore the whole process is an extremely sensitive balancing act for engineers.

Fortunately, König and his team colleagues had a small scale version of twin-screw extruder at their disposal in the pilot plant in Leverkusen. During the course of the project, they tested a wide variety of geometries for the screw elements in this Center. “All of them were custom-built models, for which we commissioned another supplier,” says König.

In order to ensure the model dimensions were not random choices, practical tests were conducted hand in hand with theoretical considerations. Bayer Technology Services colleagues from Computational Fluid Dynamics helped in these efforts. They are well-versed in the flow simulations of liquids and gases. Although it is true that simulations of rubbers are extremely difficult, as König explains, computer modeling has nevertheless provided important services in terms of coming up with the specific configurations of screw elements.

\textbf{For obvious reasons, König does not want to reveal exactly how the optimal screw elements will look. However, the fact remains that they are now able to almost completely remove the solvent from the rubber mixture, without the rubber becoming too hot. This was confirmed on a small scale in a pilot plant operated by Lanxess near Zwijndrecht. After this came the conversion to a large pilot plant in full-scale industrial production. The extruder for this operation is nearly eight meters long. The still gel-like rubber-solvent mixture is fed into the top at one end of the apparatus, and the white, viscous crumbs come out at the other end. These crumbs are then processed into pellets. At its maximum operating performance, up to several metric tons of rubber pass through the extruder per hour. Despite the long distance, the respective residence time in the extruder is in the range of just a few minutes.}

Experts at Lanxess are also pleased with the results. The first tests have shown that, with the new process, the chemical company can save more the 70 percent of the amount of steam required using the conventional method. And the \( \text{CO}_2 \) emissions resulting from production are reduced proportionately. Both are nice contributions to protecting the climate.

With this success, the Project Manager for Lanxess, Dr. Hanns-Ingolf Paul, is already thinking ahead: “This process is not only attractive for butyl rubber. We intend to successively make use of this technology in the production of other elastomers as well.” Lanxess manufactures many additional types of rubber in its Performance Polymers Segment. Steam stripping is currently still the common practice for a number of these rubbers, but there is now the energy-saving alternative found for the production of butyl rubber.
How often are your raw materials not delivered because the workers of the supplier go on strike?” Or, “has the train service between Leverkusen and Dormagen ever been interrupted because of weather conditions so that your required intermediate cannot be transported?” “And how long does such a downtime then last on average?” Or also: “What are the flow rates in the pipelines between your production and the storage tanks?”

Indeed, Dr. Michaela Graf and her team working at Bayer Technology Services had a lot of questions for their contacts at Bayer MaterialScience. In fact, they wanted to know some particulars in such detail that sometimes the Bayer MaterialScience colleagues even had to make their own inquiries in order to deliver the answers.

Graf and her team required these data to produce a computer simulation that is as close to reality as possible. This information was meant to clarify how well the existing infrastructure of Bayer MaterialScience is prepared for the expansion of production of polyurethane-based raw materials for certain coatings at the Leverkusen site. Bayer MaterialScience raised this question with Supply Chain Engineering & Technology Consulting at Bayer Technology Services, and Michaela Graf was their contact. The German business economist had already gained experience with logistics simulations in connection with her doctoral thesis.

Polyurethane-based raw materials are processed into high-quality coatings for cars, aircraft, furniture, industrial plants or textiles. High-performance adhesives are also made from these raw materials. The demand for such products is currently growing worldwide – in Europe it is rising by three to five percent per year. One reaction to this trend is the capacity expansion in Leverkusen initiated in 2012.

However, constructing the newly planned facility for two aliphatic isocyanates alone is not enough. “These two substances are integrated in a complex network,” explains Michaela Graf. “It was necessary to determine whether the existing infrastructure was suitable for the planned capacity expansion or whether it might have to be adapted.

This “complex network” begins with the delivery of the raw materials required for production. Following production, the manufactured substances are stored in tanks at a different location of the site. However, only some of these products are sold directly to external customers. Bayer MaterialScience itself processes most of them into additional special coating raw materials, and not only in Leverkusen. Some have to be transported about 50 kilometers by train to another Bayer site on the opposite bank of the Rhine River in Dormagen. And it was also necessary to integrate the production in Leverkusen into the global manufacturing network. For example, Bayer MaterialScience is currently expanding its facilities for the production of one of the coating raw materials in China.

“The main aim of the simulation was to depict the chronological sequences of the material flows as accurately as possible,” Michaela Graf explains. How much of the intermediate is produced at a given time and then stored in the tanks; how much of the product is collected from here during the same time period to be sold or further processed, and so on. Pertinent data for this network were gathered in detailed and carefully documented interviews with the respective production and shift managers.

The particulars included the sizes of the tanks, production rates, time designations in connection with filling and discharging containers, frequency and duration of unscheduled downtimes, key data regarding the transport by train from Leverkusen to Dormagen and much more. The team obtained information on the annual sales development as well as market and demand prognoses from the marketing departments. These details were then presented with the help of probability distributions. Ultimately, all the collected information was entered into a simulation programme.

“Up to 25 percent less fixed capital and yet the delivery capability is still guaranteed – fantastic!”

Dr. Martin Hecker, Head of Production LPD, Bayer MaterialScience
that was created specially for this task. Dr. Andreas Schluck, an expert on material flow simulations at Bayer Technology Services, had customized and further developed a software product that was already commercially available.

But how does the team factor in imponderables, for instance, in connection with the delivery of raw materials? Or transport delays due to winter conditions? Or unscheduled down-times? “On the basis of the interviews, we were able to estimate the probabilities for all these situations and also to quantify the respective consequences for the material stocks,” says Graf. In the case of raw materials, for example, there are on average delivery delays of seven days once a year due to strikes or weather conditions. This can be calculated mathematically. But delays of on average five hours also occur once a year during the transit between Leverkusen and Dormagen. However, these are mean values, and the fluctuations each year can also be substantial. For this reason, the team usually simulated some 100 annual runs, whereby some imponderables were left to chance according to the probability of their occurring. “When simulating 100 runs,” says Graf, “the worst possible scenario is also taken into account, such as a catastrophic winter coming together with a strike and a plant shutdown.” The statistical analysis eventually showed where the infrastructure had to be modified. For example, higher flow rates were necessary between production and storage in Leverkusen. The customer resolved this problem by introducing more powerful pumps. The simulation also indicated the optimal tank capacities for all the production facilities. In the case of Dormagen, for instance, it turned out that a second filling station would be more advantageous than a new tank that was close to being planned. Generally speaking, Graf’s team had always reserved a certain buffer stock in the tanks to ensure the delivery capability requested by the customer. “And yet despite this, it was still possible to reduce the working capital by up to 25 percent,” Dr. Martin Hecker, co-initiator and during the project Head of Coatings Raw Materials Production in Dormagen for Bayer MaterialScience, is pleased to say.

In addition to this economic success, Graf also found the project a lot of fun and especially enjoyed the exchanges with colleagues involved in the different disciplines, such as marketing, production, transport and also stock logistics. “The quality of our subsequent simulations ultimately depended on the information obtained during these interviews.” She believes such simulations could help many production facilities systematically optimize their infrastructure. For example, the same simulation model also works well for multi-component production spread over several sites.
Is One More Batch Possible?

Many products in the chemical industry are solids – and therefore often not easy to handle. Bayer Technology Services has its own team to provide expertise on all aspects of solids processing. With their help a Bayer plant in India was able to increase productivity by 25 percent.

When Dr. Lars Frye is asked this question in casual conversation, he sometimes begins his explanation with the example of a sand box. Everyone who has played in a sand box will remember some aspects that are equally important in Frye’s work. The sand should be damp enough to build stable figures, but dry enough so that it can easily trickle through a funnel. “In simplified terms, I deal with similar issues, but in an industrial context,” says Frye.

Frye is a solids processing engineer, and although his work does not involve sand, certain principles are indeed the same. For instance, how can powder be stored in silos so that it doesn’t cake or cause discharge problems? How should dust-forming substances be handled in production? How do you best remove any residual moisture from a certain product? These are the typical questions that customers ask Frye and his team. And Solids Processing is the name of the group that he heads at Bayer Technology Services.

For example, at the beginning of 2012 Bayer CropScience had a very specific request. “Can you help us improve the efficiency of our facility in Himatnagar in India?” asked Wolfgang Korzeniewski, who at the time provided technical services to six of Bayer CropScience’s formulation plants in Asia. In this case, formulating means converting pure active ingredients into a form suitable for application. This can be a liquid concentrate – or also a granular formulation.

Besides the actual active ingredients, these formulations usually also contain several different auxiliary materials. In the case of products for agricultural applications, for example, these can be substances that ensure a good distribution of the active ingredient in a spray mixture. Or additives that provide for an even distribution of the crop protection agent on plant leaves after spraying.

In the town of Himatnagar in India Bayer CropScience formulates granules used to protect crops against insect pests. Since the demand for such products has recently increased significantly, especially on coffee and sugar cane plantations, Bayer wanted to expand its production in India. So, Frye and Korzeniewski flew together to India for the first time in February 2012. Over the period of a week,
Frye was shown all the details in order to develop the leverage required for an increase in production based on this information. He spoke to many employees, listened to their experience and made a number of his own observations.

The core element of the facility is a fluidized bed granulator, a round stainless steel hopper that tapers towards the bottom and has various connections. An aqueous suspension of all the ingredients is sprayed into the granulator. The contents are continuously atomized and then dried in a hot stream of air. When the moisture eventually evaporates, fine granules form in the lower part of the hopper, known as the fluidized bed. After this drying process the powder is transferred to a sifter to separate out all the undesirable particle sizes. After this procedure, the next batch begins.

When Lars Frye inspected the granulator for the first time, it had a capacity of about four batches per day. “We wanted to increase this to five batches,” says Wolfgang Korzeniewski. This translates to an ambitious increase of 25 percent. Every evening, when Korzeniewski and Frye drove back to their hotel in Ahmedabad, maneuvering through the dense traffic on India’s highway 8, they shared their observations and possible approaches to the task.

“At first the colleagues in India believed there should be room for speeding up production mainly in the drying process,” Frye recalls. However, he himself thought that the downstream process could also be optimized – in other words, in the transferring of the granules to the sifting unit. Normally, the transfer took place through a thick tube to which vacuum created by a corresponding conveying system is applied.

Sugar cane crops have many enemies. Due to the growing demand for protection against pests, Bayer has increased its insecticide production.
“Every kilogram of product counts, and for this an optimal use of the plant is essential. Bayer Technology Services is our partner for such process optimization.”

Bernd Nowack, Head of Plant Technology, Bayer CropScience

For time reasons, however, the colleagues in Himatnagar preferred the mechanical discharging of the granulator. The lower part of the granulator is simply dismantled and the product is manually filled into the sifting unit. The advantage is that the production of the next batch can begin in the granulator while the preceding batch is sifted, by simply installing a second bottom bin. However, this procedure has to be conducted very carefully because of the extreme safety precautions necessary due to the open handling of the highly concentrated formulation and is therefore quite complicated. So, Frye wondered whether the non-time dependent sifting process could perhaps be combined with an accelerated discharge of the particles.

Frye had noticed that the tube leading to the vacuum conveying system ascended several meters high. What would happen if the entire processing steps were moved to the floor below? The existing lower part of the granulator could be used as an intermediate hopper so that the next batch can then immediately begin. But above all, the tube could run on a slope. The benefit of this concept can once again be illustrated using a sand box. Sucking the grains of sand upwards through a straw requires far more power than sucking in a horizontal direction.

Frye especially praised how helpful the committed and qualified work of his Indian colleagues has been. Frye was not the only one to be pleased about the comparably low investment costs necessary to achieve this improvement. Wolfgang Korzeniewski was equally enthusiastic. “I liked the way Lars approached this challenge with such an open mind and without preconceived ideas,” says Korzeniewski. “Every kilo of product counts, and for this an optimal use of the plant is essential,” says Bernd Nowack, Head of Plant Technology at Bayer CropScience. “Bayer Technology Services is our partner, for such process optimization.”

As part of the process optimization, Bayer CropScience invested in a second granulator to further increase the capacity in Himatnagar. Frye’s findings and observations had an impact on this investment too so that modifications to some of the components could be arranged directly with the producer.

When the new granulator was commissioned in October 2012, Frye was once again in Himatnagar. Everything went according to plan. With the commissioning, the project was completed for him – and yet he still receives news from India. At the end of April Korzeniewski reported that the new and the revamped granulators are still producing five batches a day.
ON THE DECHHEMA BOARD

The Managing Director of Bayer Technology Services, Dr. Dirk Van Meirvenne, has become a Member of the DECHHEMA Board. The Society for Chemical Engineering and Biotechnology brings together experts from a wide range of disciplines, institutions and generations to stimulate scientific exchange in chemical engineering, process engineering and biotechnology. DECHHEMA is the central platform to seize on new technological trends at an early stage and translate them into applications, says Van Meirvenne. Through this cooperation the company is in a better position to fulfill its strategic responsibilities – especially in terms of developing talent and designing innovative technologies for Bayer.

HONORS FOR THE BEST

Bayer Technology Services has paid tribute to the two best graduates of the biochemical and chemical engineering study programs at the Technical University Dortmund. Both bioengineer Linda Lange and chemical engineer Martin Dirks achieved a grade point average of 1.4 for their university studies.

At the graduation ceremony in Dortmund, Dr. Günter Bachlechner, Head of Technology Development at Bayer Technology Services, stressed how important qualified young graduates are for an innovative company.

Many of the young engineers who have joined Bayer Technology Services in recent years graduated from the Technical University Dortmund. The company and the university have collaborated on many research projects – including the INVITE Research Center.

OUTSTANDING

20 percent less energy, 60 percent less water consumption – when a team of chemists and engineers from Bayer Technology Services (BTS) and Bayer MaterialScience collaborated to optimize the continuous melt condensation process for the production of Bayer polycarbonate Makrolon, the result is truly remarkable. Head of BTS Antwerp Johan Vanden Eynde, Marc Buts, Dr. Yun Chen and Dr. Rolf Wehrmann were recently awarded an Otto Bayer Medal for this excellent achievement.

In memory of the inventor of polyurethane chemistry and the former Head of Bayer Research, Professor Otto Bayer, this award is presented annually to outstanding researchers in the company.

A NEW CELL BIOLOGY CENTER

Bayer has invested €35 million in its new Cell Biology Center at the company’s Wuppertal site in Germany. The some 20 staff members at the new facility produce biologicals to be used in clinical trials. The focus is on the biotechnological production of antibodies and other therapeutic proteins for, among other things, cancer therapy. The building, 20m in height, is equipped with all available cutting edge technology and includes the entire range of necessary steps for biotechnological processes.

Engineers from Bayer Technology Services supported Bayer HealthCare in the engineering and construction of the Center. They developed a modular building concept, which ensures the highest level of flexibility.
Fishing in a Sea of Data

Bayer Technology Services and the RWTH Aachen University in Germany intend to build a Joint Research Center for Computational Biomedicine. One of the two managers in charge of this exciting project is Professor Andreas Schuppert.

October 9, 2012 is a date Professor Andreas Schuppert will never forget. It is the day Dr. Dirk Van Meirvenne, Managing Director of Bayer Technology Services in Leverkusen, and Professor Ernst Schmachtenberg, Rector of the RWTH Aachen University, announced their intention to establish a Research Center for Computational Biomedicine at the RWTH Aachen University. Two experts are to be in charge of this new institution. A worldwide search is currently underway to find one of the managers, but the other expert is a well-known and highly regarded personality at the RWTH Aachen: Andreas Schuppert.

With this appointment the key expert for industrial mathematics is one major step closer to realizing his lifelong ambition. In addition to his position at Bayer Technology Services, for several years now the 55-year-old German has been working two days a week as a university professor at the Aachen Institute for Advanced Study in Computational Engineering Sciences. His assignment there is to develop models for systems biology and biomarkers for clinical diagnostics and to monitor biological processes. With this new responsibility, his sphere of activity will now be considerably broadened. The main goal of the new joint venture is to develop new methods in the field of computer-based modeling of complex biological processes.

“The task is quite ambitious: in systems biology it is a question of understanding and modeling the complex and dynamic processes of a cell or an organ – for example, when it comes to environmental adaptability, aging or immunological defenses. The vast amount of data on individual cell components and cell functions, gathered at various levels of life processes, must be put in a meaningful overall context and modeled on the computer so that simulations and forecasts are possible without laboratory experiments.

The first scientists to pursue this idea were British neurophysiologists Alan L. Hodgkin and Andrew F. Huxley. With their mathematical model of a nerve cell, they laid the foundation for the simulation of life processes, and as a result, they are regarded as the pioneers of systems biology. In 1963 they were awarded with the Nobel Prize for their fundamental findings.

After coming up with this first model, however, it took another five decades before systems biology’s real wave of de-

Tasks for the future

Anti-tumor drugs do not work in the same way with all patients and all tumors. Another shortcoming of these medicines is that as yet it has not been possible to predict whether they have any effect at all – even if there is sufficient data available based on cell cultures and animal experiments.

As part of the MEDSYS research collaboration, supported by the German Ministry for Education & Research, Bayer Technology Services, Bayer HealthCare, RWTH Aachen and the German Cancer Research Center may be close to a solution thanks to a new process. Each member of the consortium contributed its own specific know-how to this development.
development began. Schuppert: “Scientists were faced with enormous amounts of data on the individual cell components and the cell functions that these cells delivered. What was missing was a general overview.”

In collaboration with his work groups, Schuppert handles this gigantic sea of data to which immense quantities of further information are added every day. Their common goal is to develop filters that can sort out the relevant information from this vast amount of data. “The big trick is to set up these filters.” These data are expected to provide vital information on how cells react – for instance to external stress. In addition, it is hoped they will be able to offer important details of the actual behavior of cells and to shed light on how they reprogram themselves.

Professor Andreas Schuppert has perfectly mastered the art of data mining. The researcher with a PhD in mathematics studied physics as well. But he also attributes a large portion of his success to his studies of business administration. “In economics you learn there is not only one right way, because it is the logical one, but rather that there are many possibilities.” When translated into his daily work, this means you have to be mindful of the different challenges offered by the various life sciences. After all, “biology deals with completely different questions than physics or mathematics”. In other words, it takes many individual parts to make a complete picture.

So, what does Schuppert think is the biggest challenge in the near future? His answer does not require long deliberation: “We have to learn to understand how cells react to external stress and how they can be reprogrammed. When we know these answers, we can then explain how drugs take effect.” And these findings will result in a “whole bunch of new applications that we have only come up with so far through trial and error”.

The new research center in Aachen is set to start with 10 scientists and will then be rapidly expanded until 2018. It will be associated with both Modeling and Simulation Research at the RWTH Aachen as well as with the medical faculty of the university. In this constellation, the Center for Computational Biomedicine clearly fills a gap in the research landscape. There are only a few comparable collaborations anywhere else in the world that can boast such a wide spectrum of competence and experience in the implementation of basic research into practical application.

“This research is helping to shed light on basic physiological processes.”

Professor Ernst Schmachtenberg, Rector of RWTH
What Inspires Partners

Code Name Akoya

Converting a Japanese chemical process to European conditions is no simple feat. Indeed, Bayer Technology Services had to pull out all the stops for the Grillo-Werke in Germany, before everything worked properly. The result is very convincing – a veritable pearl, in fact.

The prescribed pipes made from ordinary steel were out of the question for this project,” says Günter Möwius, shaking his head. Among other things, they were too prone to corrosion for the conditions at the site chosen for construction. “Despite the thick-walled steel, another protective coating would be necessary, which was why we wanted to use stainless steel pipes.”

In the European chemical industry stainless steel pipes are absolutely nothing out of the ordinary. On the contrary, they are considered the standard. However, they can become a problem, for instance, if a facility is being built under license. Or if the licensor is located in Japan, where the customary “simple” steel pipes are stipulated instead of the stainless steel version. With every deviation from the specifications, subsequent warranty claims made by the licensee are at stake.

This is exactly happened with the project that Günter Möwius managed for nearly three years on behalf of Bayer Technology Services. It involved the construction of a facility for the production of dimethyl ether (DME). The customer was the Grillo-Werke, located in Duisburg, Germany. DME is an intermediate that is mainly required for further processing into dimethyl sulfate. Until now, Grillo had purchased the chemical. Having the company’s own production would reduce its dependence on suppliers and market fluctuations.

The Grillo plant in the Hoechst Industrial Park in Frankfurt was chosen as the site for the planned facility. For this purpose the company had obtained a license for the process, and thus also for the plant itself, from the Mitsubishi Gas Chemical Company and JGC Corporation in Japan. As a tribute to its Far Eastern partners, Grillo gave the project an appropriate code name: Akoya, for a particularly beautiful type of cultured pearl, mainly found in Japan.

Round, a flawless surface and exquisite luster – these are the qualities associated with Akoya pearls. Unfortunately, the project itself did not proceed as smoothly and brilliantly at first – also because of the very exacting specifications from Japan – for instance, for the facility design and the materials to be used.

The problem with the steel was just one of many issues that caused Möwius and Grillo’s Project Manager Dr. Oliver Groß headaches. “The Japanese have, for example, rotary pumps with 14,000 rotations per minute, however, these are not commonly used in European chemical facilities,” explains Möwius. But what happens when you simply use the standard pumps for Europe with 3,000 rotations? This was just one of the many questions that had to be addressed.

The team from Bayer Technology Services eventually decided to eliminate some pumps completely – in those locations where the system pressure of the facility was sufficient to cover the necessary flow pressure. Furthermore, the team

**Versatile DME**

Dimethyl ether (DME) is an important intermediate for the synthesis of dimethyl sulphate (DMS). Among other applications, Grillo’s customers use DMS for the manufacture of tensides, which are found, for example, in fabric softeners. DMS is also known as a so-called methyleating agent for the chemical syntheses of, for instance, active ingredients used in crop protection products. However, Grillo also markets some of the DME that it produces directly to customers. The main users are manufacturers of spray cans for cosmetics. DME is a preferred propellant because of its low boiling point.
in Germany wanted to make changes to the design of the distillation columns as well as to some of the more than 20 heat exchangers. Because of the stainless steel pipes, these had to be modified anyway. The punch disks used to regulate the flow of liquids and gases through the pipes under high pressure were another issue. Here, too, the engineering team members developed their own designs. The colleagues from Technology Development always helped with these kinds of decisions. They made calculations for many of the apparatuses, thus testing the feasibility.

"Because of the later warranty, we had to have each of these changes approved by our Japanese partners," explains Möwius. What sounds like a formal act was in reality an extremely challenging task, for example, when it came to the materials and the piping components. "Japanese pipe classes are often not identical with those in Europe or the U.S.," says Möwius.

And then there were also the language and cultural challenges that had to be overcome. Möwius refers to the intercontinental communications as "time-consuming", while Groß calls them "stressful". One team colleague described the de-
What Inspires Partners

“It was impressive how the colleagues from Bayer Technology Services identified with the project and truly made this undertaking their own!”

Dr. Christian Ohm, Board Member of the Grillo Werke AG responsible for the Chemicals and Zinc Oxide Divisions

viations in the license process as a “balancing act”. Perhaps it was this very delicate balancing act that bonded the colleagues from Grillo and Bayer so tightly together from the beginning. In any case, both sides are full of praise about the particularly close, as well as pleasant collaboration.

In the end everything worked out well. The Japanese granted permission for all the modifications, and the facility was eventually built in line with the engineering of Bayer Technology Services. Just three days after the plant went on stream, it delivered what is called “premium quality” in technical jargon. Oliver Groß still recalls the emails he received late in the evening of September 27, 2012: “3 tons produced. Gas chromatography: everything in accordance with specifications.” “The fact that it went so quickly was actually a big surprise for me,” Groß admits. The satisfaction was even greater as it was the first larger investment project of his career.

Of course, the smooth start-up of the facility without any teething problems did not come of its own accord. The experienced team working with Möwius had prepared everything down to the last detail and paid careful attention to a whole range of things. For example, there was the meticulous pre-cleaning of all parts of the facility. “The more thoroughly this is done, the purer the product will be from the beginning,” says Möwius.

Another important factor was the good preparation of the Grillo personnel at the Frankfurt plant. When Grillo considered sending some of its staff to Japan to be trained there, an Operator Training Simulator (OTS) was suggested. This is a software that simulates processes in a facility so realistically that when they are shown on a computer monitor, they cannot be distinguished from the process control system in a production control room (see also technology solutions 1/2012, page 20 f.). An OTS is thus the perfect basis for realistic dry runs, without having to start-up a reactor or pump in any liquids. In the end Möwius’s colleagues from Operation Support & Safety developed a customized OTS for the DME facility. And as a result, the Grillo employees in Frankfurt had completely mastered the control of their new facility long before it was even commissioned.

And that was not the only special service. During the course of the project Bayer Technology Services offered over and over again solutions for which Grillo had never originally considered Bayer. Take, for instance, when it came to a process analyzer technology container for quality control and wastewater monitoring. Or another example was when they needed support for a safety concept. After all, DME is an easily volatile and at the
same time highly flammable substance. They also helped with the quality control of the delivered plant components, which became particularly interesting when a pipe sprung a leak during commissioning despite all the testing prior to the start-up. An expert from Bayer Technology Services found the fault in a longitudinal welding seam resulting from a fabrication error. After this same fault was discovered in several different places in the facility, all of the installed pipes from the same delivery batch were eventually replaced. It was only possible to rectify this problem within such a short time because of the painstaking construction site documentation.

“It was really an all-round carefree package,” as Oliver Groß summarizes the service provided by Bayer Technology Services. The project manager, who is also the Head of the Grillo Sulphate Division, also liked the fact “that everyone in the team fully identified with the project”. From Bayer’s viewpoint, this is completely self-evident and also has an official name: owner’s engineering. As Möwius sums it up: “We represent the interests of our customer, find solutions and accompany planning and construction up to the commissioning of the facility – and often beyond.”

The process engineer has worked at Bayer for 30 years. He has experienced many projects in this time, most of which he also managed. However, the Grillo cooperation was special for him. “We were a real team, and nobody differentiated between ‘them’ and ‘us’.” Groß also stresses how much they “were on the same wavelength”. The many evenings spent together after the project work no doubt helped – for instance, during visits to Japan.

Talking about Japan, despite the many modifications, the Japanese licensers were also very satisfied with the end result. Several representatives from Mitsubishi and JGC attended the successful production start-up in Frankfurt and tested the flawless operation. Marking this outstanding joint accomplishment, both German and Japanese flags flew high over the 38-meter facility.

The plant produces DME with a purity of 99.99 percent and thus in a higher quality than the 99.9 percent guaranteed in the license. This too is a result that pleases the experts at Grillo. Oliver Groß is equally impressed that Bayer Technology Services did not immediately abandon the camp, but continued to be available after the facility was commissioned. Among other things, the chief technician employed by Bayer helped to set up a service logbook, which will come in handy later for planning or when carrying out turnarounds as well as for maintenance and revision activities. For Bayer Technology Services this added assistance is simply part of the package!
How to Attract Promising Talent

Recruiting talented engineers is not easy, as Bayer has to compete with many other companies at its various sites. The strategy to show prospective employees what makes Bayer so attractive is succeeding. The United States is a case in point.

Any company supplying products to the health care and agricultural sectors and whose materials we encounter in many areas of daily life is just great!” Meredith Boyd is really enthusiastic when she talks about Bayer’s range of products and how they have improved people’s lives. Basically, this is the very reason why she submitted an application for practical training at the company back in 2011 – with success. The future chemical engineer spent 12 weeks learning all the various aspects of MDI production, an important starting material for rigid polyurethane foams, used, for example, to insulate refrigerators and buildings. “I learned a lot,” Boyd recalls from her summer at Bayer MaterialScience’s Baytown site in 2011. She also met many nice colleagues, who were extremely helpful in explaining everything and showing her the ropes. They were friendly and fun to be with too.

Meredith Boyd could actually imagine working for Bayer after completing her Bachelor’s degree. And her talks with Human Resources staff made it clear that the company also showed great interest in her as well. She appeared to have good prospects for a job at Bayer Technology Services – Bayer’s portal of entry for young engineers.

So, she lost no time in applying for a fulltime position in the fall of 2011. After receiving a firm job offer following an interview in November, she stopped all further efforts to find employment elsewhere. “Obviously, I applied to other companies as well in order to keep as many options open as possible,” she explains. “But I really only wanted to go to Bayer.”

Meredith Boyd ultimately moved from the Northeastern corner of the United States to Houston in June 2012. Since then she commutes every day to Baytown, located in the eastern part of the city. She is particularly pleased to have ended up with Bayer Technology Services within the Bayer Group. “We support all of the other subgroups and, as such, we cover the entire diversity of the Group in terms of content,” says Meredith. In fact, her initial projects highlighted the broad spectrum of her new employer. The first challenge involved a recombinant factor VIII product for the treatment of hemophilia A, manufactured by the subgroup Bayer HealthCare. Meredith Boyd’s task was to take care of the safety aspects of a modified production process introduced at the company’s site in Berkeley, California.

In the meantime, she is back at Bayer MaterialScience in Baytown. Here, too, she is concerned with plant safety. Among other things, Boyd is working on measures to prevent overpressure-induced incidents, as well as coming up with countermeasures to help in case such emergencies nevertheless occur.

The fact that Meredith Boyd chose Bayer of her own accord is a strike of luck for Roxanne Williams. Among other responsibilities, the Human Resources (HR) Business Partner at Bayer Technology Services in the United States is charged with hiring talented young engineers. And they do not always stumble onto the company on their own. “Many people still only associate Bayer with Aspirin and have no idea that the Group offers such a wide range of assignments for engineers,” explains the HR expert. Depending on the various regions of the U.S., there can be even after two years with Bayer, Elias Keedy still has the chance to learn something new every day – and not just at the time of planned turnarounds.
BMS Baytown Vision and Values

We will be recognized as the premier Bayer MaterialScience manufacturing site.

As “One Business -- One Team” we will deliver the best goods and services to the global business with an urgency for proactive change that consistently demonstrates:

- Leading safety & environmental performance
- Reliable and efficient operations
- Competitive, superior quality materials that drive market growth
- Innovative technology & process advancements

We will accomplish our vision through a “can do” attitude and work culture that values our people and our community.
lots of other companies that are considered potentially attractive employers. Specifically the Gulf Coast area of Texas, where Baytown is located, is teeming with oil and gas companies. “It is quite obvious that they need engineers,” says Williams. “However, we have to make an active effort to explain that Bayer also employs engineers.” It is equally important to show that the range of engineering work at Bayer is much wider than it is in the oil and gas industries.

That is why the team of recruiters with representatives from all of the Bayer subgroups has concentrated on spreading this message specifically among prospective engineers at universities. “A number of our engineers will be retiring in the coming years,” says Williams to stress the importance of this strategy. “With this in mind, we have to start early to ensure we have enough adequate engineering talent to feed the pipeline.”

The U.S. team is part of a global Recruiting & Development Platform. Representatives from each of the Bayer subgroups, together with managers from Bayer Technology Services, determine jointly in this team how many engineers with which qualifications will be required in the years ahead. Based on this information, the active search for new employees then begins. For some three years, the recruiting team has even intensified its activities. “In the next years many colleagues will reach the age at which people in the States can begin to think about retirement,” explains Williams.

The case of Meredith Boyd shows that you don’t always have to search too far away to find good people! “We look very closely whether there are suitable candidates among the many summer interns who come to Bayer every year – and if so, we’ll make them an offer at the end of their internship,” says Williams. Nor do they wait to see if new engineers come across the company on their own.

Another method of targeting young talent is through selective job ads. This is how Dr. Jim Green found his way to Bayer Technology Services in Berkeley. “Following several different internships in the biotech sector, I wanted to specialize in the field of biologicals after earning my PhD, which is why the position at Bayer in Berkeley caught my eye,” the chemical engineer says. This is where Bayer HealthCare produces the recombinant factor VIII treatment – a biological. He interviewed for the job in Berkeley in May 2011 and moved to the West coast two weeks later. As he is an engineer, he started with Bayer Technology Services, which assists Bayer HealthCare with several projects. It is this service function, involving project-related thinking and designing and testing process modules, that has appealed to him ever since – as well as the fact that he will have the opportunity to spend some time in Germany in 2013.

To specifically target prospective graduates, the team of cross-subgroup recruiters has strengthened its presence at the career fairs held at prestigious universities in the U.S. Employees manning the information booths not only present details of the company as a whole, but also inform future graduates about the interesting career opportunities at Bayer. This includes working conditions, where Bayer scores particularly high thanks to a number of measures ensuring a good work-life balance. Compared with other employers in the United States, Bayer offers, for example, relatively generous vacation time, alternative work schedules and parental leave. In addition, employees who participate in charitable activities receive paid leave via Bayer’s volunteering program.

Elias Keedy became acquainted with Bayer at one of these university events. Born in Lebanon, Keedy transferred to the University of Houston in 2008 to gain a Masters in industrial engineering after earning a Bachelor’s degree in electrical engineering in Beirut. “I immediately noticed Bayer’s scientific spirit at the booth and I liked that,” says Keedy, recalling his impressions at the career fair. He also liked the fact that the people took the time for him and his questions. As a Lebanese student in the U.S., the international orientation of the German company also appealed to him – as well as the importance of the products. “All of them innovations that change
A GLOBAL NETWORK SEARCHING FOR TALENTED PEOPLE

Bayer Technology Services is the worldwide entry portal for engineers employed within the Bayer Group. The service company hires young talent based on the expected demand in the individual geographic regions and subgroups. They usually work within Bayer Technology Services for several years before many of them transfer to other parts of the Group, depending on specific needs of the subgroups. By this time, almost all of them will have gained experience with at least one of these subgroups – through projects carried out by Bayer Technology Services at their various locations.

In their search for talented young engineers, the Human Resources experts at Bayer Technology Services leave nothing to chance. Instead of waiting to see who chooses the company, they actively cultivate close relations with numerous prestigious universities throughout the world. In Germany ten technical universities form the core of this network; a further nine universities are targeted in the United States, including the University of Houston in Texas mentioned in the main article. More recently, Bayer Technology Services has expanded its contacts to top Asian universities. In China alone six renowned universities belong to the network. With the diversity of these contacts, the company can be sure to obtain young talent with a wide spectrum of knowledge, skills and personal qualities for the Bayer Group.

By far not everyone begins with a permanent position. Every year some 100 young or future engineers complete an internship program with Bayer Technology Services. This gives both sides the opportunity to get to know one another.

people’s lives in a positive way. I could immediately see myself wanting to be a part of this company.”

He applied for a position in January 2011 and interviewed for a job in March. By July, Keedy had started his first day of work at the Baytown site, where he is also participating in the new Engineer program. In the first six months, he “only concentrated on learning”, and everyone helped. He now works at the Bayer MaterialScience’s MDI production facility where Meredith Boyd spent her internship. Keedy belongs to the team working on process control and troubleshooting. He continues to learn something new every day and is very happy. As a newly engaged engineer, he is closely supported by his management and HR. This includes special courses, for example, to improve his communication skills. Apart from that, he now spends little time in the classroom. He is pleased about this arrangement because he prefers to learn by working directly with the machines – in other words, learning by doing.

Keedy likes the fact that after just half a year he was already allowed to meet with customers. And he also finds it preferable that the trainee phase does not follow a strict pattern of two months here and then four weeks there. “I am generally able to steer things in the direction I want, based on my own interests,” says Keedy. For example, he himself was allowed to choose the plant where he was supposed to gain process control experience. He also has a mentor, an experienced employee at the job with whom he meets twice a month to discuss all sorts of aspects of the work.

After the two years it may well be that Keedy will transfer to a different Bayer company, which is actually the typical path for many engineers who begin at Bayer Technology Services. He would like that, but in any case, he plans to complete his PhD studies before the end of the year.

Roxanne Williams is happy about the success of her recruitment efforts. “We hired 17 engineers in 2011 and 2012, and there will be 10 new hires over the course of this year.” This is a good number to cover demand for the near future, but the recruiting efforts will have to continue. Williams: “The only way to prevent the potential loss of know-how is to start early with the hiring and development of young talent.”

Bayer’s specialties caught Dr. Jim Green’s eye.
Would You Believe It?

0,7 percent is the salary difference between male and female employees working at Bayer Technology Services in Germany. This is the finding of a scientific investigation based on the compensation levels in 2011. The actual differences in salaries were adjusted for personnel- and job-related characteristics in the analysis. Among these are, for instance, the length of employment, the respective qualifications and the specific professional requirements. The analysis was performed with Logib-D (the German abbreviation for gender pay gaps in workplaces – Germany). This tool, supported by the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, helps companies identify and then eliminate any possible pay inequalities between men and women.

150 is the number of years since Bayer was first established. In addition to businessman Friedrich Bayer, the other half of the founding duo in the year 1863 was the proven technical specialist, dyer Friedrich Weskott. The importance of technological expertise for the development of new products and their corresponding production processes has not changed to this day. Most of this technical expertise is now concentrated at Bayer Technology Services. When Bayer develops new drugs to treat cancer or pulmonary hypertension, new fungicides or improved polymer syntheses, colleagues from Bayer Technology Services are sure to be involved.

26000 employees working in production within the internationally operating Bayer Group have been trained in the field of process and plant safety. As the technological backbone of the Bayer Group, Bayer Technology Services was responsible for the worldwide initiative aimed at process and plant safety, together with the Bayer subgroups, in order to continuously improve the safety culture and the safety standards in production facilities and laboratories. This involved, among other things, setting up a worldwide network of experts with standardized risk assessments along with a comprehensive list of measures.

FORWARD-LOOKING STATEMENT: This publication may contain forward-looking statements based on current assumptions and forecasts made by Bayer Group or subgroup management. Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future results, financial situation, development or performance of the company and the estimates given here. These factors include those discussed in Bayer’s public reports, which are available on the Bayer website at www.bayer.com. The company assumes no liability whatsoever to update these forward-looking statements or to conform them to future events or developments.
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