When Less Is More
The New INVITE Research Center - Modules in Miniature p. 24

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Qualification: For Bright Prospects p. 38
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.
Needs make the difference between aspirations and goals. Bayer Technology Services clearly has many goals. After all, we strive for nothing less than to further build the innovation capability and competitiveness of our customers on a long-lasting basis – through best-in-class technology solutions and highly qualified experts.

The appropriate steps are necessary to achieve these ambitious goals, which is why the company decided to further develop its strategy. Bayer Technology Services is now concentrating on the three areas of activity Technology Development, Project Management and Engineering as well as Operation Support and Safety.

We offer leading technologies and solutions for the entire life cycle of products, processes and facilities. This means we develop both enabling technologies and pioneering innovations. We also work persistently to ensure safe and reliable operations. And since human resources and technology are inseparable, we boost young talent and establish leading competencies.

This will enable our customers to achieve maximum and sustainable value. Of course, there is a much better chance we will succeed if both parties see each other as partners – and if each one has already had positive experience with the respective partner.

It is therefore no coincidence that Bayer Technology Services is now presenting itself at trade fairs under the slogan, “Sustainable Partnership – Sustainable Solutions”. With this slogan we want to make it very clear to our customers that sustainability is a central factor for our company and not merely a matter of paying lip service to a particularly trendy term. Nor is it some temporary policy that will soon be forgotten. On the contrary: sustainability is the very basis on which we develop solutions, and it is the guiding principle on which we orient the relationships with our partners.

Of course, all this leads to the desired success because our employees not only know how to address the problem, but also see themselves as providers of solutions – in line with the Bayer Technology Services slogan: Be The Solution.

Admittedly, this is a high demand, but we strive every day to live up to expectations. How we manage to accomplish this in detail is not least demonstrated in this edition of technology solutions. It presents many different examples of an approach always oriented to customers and solutions – and a multitude of ways to get to know Bayer Technology Services better.

I hope you enjoy the read!

Yours, Dirk Van Meirvenne
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A new electrode helps to save energy in the production of chlorine. Bayer Technology Services also contributed to this development.

Cover page: It does not always have to be a reactor with a capacity for thousands of tons. Microreactors (cover) are a new trend. They enable a module design with greater flexibility and a continuous reaction operation. To read more about future production concepts see page 24 f.

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sacks of storage bags with their inlet tubing stretching upwards in anticipation. The round joints are connectors that ensure sanitary filling of the bags. Bayer uses bags like these to store the in-process intermediates from the production of Bayer’s hemo-
philae A treatment Kogenate. For example, before further purification, a concentrate of the blood coagulation factor VIII produced in bioreactors using recombinant DNA technology is temporarily stored in these bags.

Factor VIII must be kept at temperatures of minus 30°C Celsius or lower to maintain the stability of the molecule during the storage period. As a result, the materials used in the bags and the fill lines also have to withstand these extremely severe conditions.

Bayer HealthCare produces Kogenate at its site in Berkeley, California. In recent years the company has continuously improved its highly complex production process with the help of experts from Bayer Technology Services (see also technology solutions 1/2011).
What knowledge achieves thinking like the customer

Bayer Technology Services has one big advantage over competitors: the company offers the unique combination of process know-how and engineering. The result is convincing. Customers can always count on getting the best solution for their project.

solutions: You have been the Head of Project Management & Engineering since early 2011. Is there a specific recipe for success?

Hinderer: The recipe for success means quite simply Bayer Technology Services. Our company offers a unique combination of process know-how and engineering.

solutions: And is this combination really something special?

Hinderer: Yes, it truly is, and I would even venture to say that this combination is the only one of this kind on the market. For every project there are many solutions. We always look for the best one, and in most cases we usually find it too. The most important thing is that, unlike many other competitors, we have a backward integration into production.

solutions: What exactly do you mean by that?

Hinderer: As part of the Bayer Group, we have the possibility to send our people directly into production facilities and then bring them back after this experience. In this way we are able to achieve unique close ties to operators and a high capacity for innovation because we strengthen our creativity through fresh ideas from a variety of different areas.

solutions: But other competitors are also professionals.

Hinderer: That is true, but many are merely professionals in the implementation of predetermined solutions. These companies are given a document of functional specifications, which are then executed. By contrast, we are directly involved in developing a solution in the first place. Our goal is to make a viable recommendation at a very early stage. The further projects have advanced, the more expensive corrections are going to be. This kind of collaboration is obviously only possible when there is a high level of mutual trust between the partners.

solutions: Does that mean you try to view things from the client’s perspective? You think like the customer?

Hinderer: Exactly. It is also one of the best possibilities to build a relationship of trust. Customers must be able to see that we are actually developing the perfect solution for them. To achieve this we must completely understand their business case. It is only then that we will be able to assess the added value and find the optimal solution.

solutions: And therefore the customer can get everything from a single source?

Hinderer: In theory, yes, but in practice, no. We mainly assume the leading function in projects and deliver essential information. This begins with the question of materials and extends to evaluating process and plant safety and even includes the demolition of old plants. This range clearly sets us apart from competitors. It is also an enormous advantage for our customers – especially now that engineers are in such short supply. Our competence in all these fields is one part of owner’s engineering – although not the most important.

solutions: What is then?

Hinderer: The most important factor is identifying with customers – with their ideas and intentions. When we take on a job, we consider every aspect through the eyes of the customer.

The career path

Graduate chemical engineer Jürgen Hinderer started his career at Bayer in Technical Development-Formulation Technology in 1995. After working as a staff manager in Polyurethane Technology, he was appointed Head of Global Product Management Polyether Polyols. In 2002 he assumed the position of Head of Propylene Oxide Asset Management and Polyether Polyols Master Planning in Pittsburgh, Pennsylvania. From 2006 until the end of 2010 he held worldwide responsibility for Safety & Technology in Industrial Operations at Bayer MaterialScience.
solutions: So, owner’s engineering includes a mental component as well?

Hinderer: Yes, indeed, and a strong one at that. The individual working on the job no longer has the status of an external employer or a contractor who has his or her hours paid and that’s it. We also act for the client in negotiations with authorities and suppliers. And as I said, all this is only possible with detailed knowledge of the business case.

solutions: Understanding the entire business case is quite a high expectation. Without wanting to question the qualifications of your engineers, I would assume that not all of them are born management experts.

Hinderer: Nor are they all born bookkeepers, so I agree it is a high expectation. But that is exactly the reason why we have introduced a position that addresses this problem: the venture manager. While the so-called bare-bone concept, i.e. realizing a plan according to the minimalist approach, is often effective with smaller projects, this function helps find the ideal solution for larger projects.

solutions: What responsibilities are involved with this job?

Hinderer: In the ideal case the venture manager should have the necessary business experience, coupled with a real sense for projects and technology. He is to manage the interface between business and vision.

solutions: What does that mean in concrete terms?

Hinderer: It means that the venture manager investigates the business idea, knows the business case and matches the two with reality. We all know how it usually goes. For instance, the person responsible for marketing has lofty plans: a larger building, better equipment – just to name a few examples.

solutions: And so what does the venture manager actually do?

Hinderer: He or she is the one who, if need be, tells the person with over-ambitious ideas that the current business simply does not yield enough to fund such dreams. The building is too big; the equipment oversized. The venture manager corrects the perceptions to match reality.

solutions: How do your customers react to these experts?

Hinderer: Ideally, the venture manager comes from the customer. We jointly select him or her with the customer to achieve a high acceptance among all parties because this is really necessary.

solutions: Has the introduction of this function...
already proved to be successful?

**Hinderer:** Oh, yes. For example, in India, where a so-called ecocommercial building was planned. The term ecocommercial building basically means bringing together the best materials, systems and technologies to construct an energy-efficient building that is in keeping with the local climatic conditions of the respective site.

With the help of a venture manager, the execution of this concept was an outstanding success in India. With his clear perspective of the situation, we were able to erect the office building at a much lower cost than anticipated. Instead of relying on material and equipment from Germany or the United States, he used locally available solutions.

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<th>solutions:</th>
<th>Is this experience really so beneficial?</th>
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<td><strong>Hinderer:</strong></td>
<td>Absolutely. We will now be able to make use of this experience when realizing future projects. In this respect, we can truly say ‘lesson learned’. Or to put it in a different way, it is a question of how to make a practicable project from a vision. With the construction of the ecocommercial building in India we showed that Bayer is the ideal partner for realistic, financially feasible and efficient solutions. This is exactly what we underpin with our expertise.</td>
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**solutions:** When would you say that Bayer Technology Services has reached its goal?

**Hinderer:** We execute projects efficiently and taking a cost-oriented approach over the entire life cycle of a capital investment. We have achieved our goal when we provide competitive services, while generating added value for our customers and ourselves.

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<th>solutions:</th>
<th>Why do you emphasize the competitive aspect? So far in our discussion it sounded as if you did not need to fear the competition.</th>
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<td><strong>Hinderer:</strong></td>
<td>Then I had better immediately correct this impression. Of course, there are some things that we are really very good at, and there may even be other things that our competitors are not able to offer. However, many of our staff are working in fields in which we have to assert ourselves in the face of strong competition. In this respect, competitiveness is a factor which we constantly have to keep in mind in our work.</td>
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<th>solutions:</th>
<th>The companies of the Bayer Group are your main customers. Aren’t you at all concerned that your employees will pass on internal knowledge to external clients, thus compromising Bayer in the process?</th>
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<td><strong>Hinderer:</strong></td>
<td>We are of course very careful to ensure that no core competencies in terms of processes are passed on to third parties. In all areas in which Bayer is a technology leader, the know-how always stays inside the company.</td>
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<th>solutions:</th>
<th>This is no doubt a severe constraint for you?</th>
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<td><strong>Hinderer:</strong></td>
<td>Not at all. It is completely self-evident that know-how and intellectual property remain with the customer. This principle is our top priority and is true for every customer. Cooperation based on mutual trust plays a decisive role for us. And there are still plenty of other services that we are able to market externally.</td>
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<th>solutions:</th>
<th>Doesn’t Bayer take up so much of your time and resources that such external projects are excluded from the outset because of a lack of available capacity?</th>
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<td><strong>Hinderer:</strong></td>
<td>That is a very valid question, but we manage our capacities accordingly.</td>
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<th>solutions:</th>
<th>So you are saying that your work for external customers continues to be a very important task?</th>
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<td><strong>Hinderer:</strong></td>
<td>Yes, of course. We want to see continued growth in this field in the future as well.</td>
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"We provide competitive services that generate added value for both our customers and ourselves."

The process engineer joined Bayer in 1995.
solutions: Why is external business so important for Bayer Technology Services?
Hinderer: We face competition both internally and externally. Here too we continue to improve and can further expand our business.

solutions: But there are also areas in which you are already very good and where you can scarcely improve even more.
Hinderer: Thank you for the compliment.

solutions: This is clearly the opinion of experts who were full of praise about the TDI plant at the Bayer MaterialScience site in Shanghai, China.
Hinderer: In all modesty, their assessment was not unfounded. It is truly an astonishing achievement to successfully realize a plant with a completely innovative technology: gas-phase phosgenation with all of its subprocesses. In any case, this is a task that should be of concern to the entire organization.

solutions: Have you got other plans that you would like to see implemented in the company?
Hinderer: Absolutely. For example, biotechnology springs to mind. It is a major challenge for us. But topics such as how to handle the shutdown of large-scale installations will also be a future focus of attention. Here we are currently developing the necessary competencies to adjust our portfolio to meet customer demand. But my biggest wish is that we continue to drive our business on a global level.

solutions: Aren’t you doing this already?
Hinderer: We have offices in ten countries and are working on projects worldwide, but what I mean is fostering our own talent pipeline at all our most important sites. This is why we are cooperating worldwide with top universities to recruit the best talent. And we are also promoting this talent through, for example, mentoring programs and our global network.

solutions: And yet if you are already operating on a global basis...
Hinderer: …then this is only possible because we also meet our requirements for experts locally through expats. However, we also want to expand our business in growth regions by improving our local competencies – among other things. And, of course, we always want to execute our projects at our different locations around the world at the same high level of performance. Ultimately, this means localization based on a global approach. This is most certainly an important task for the future.

“One of our strengths is the combination of process know-how and engineering, which is something we can really be proud of.”

Hinderer heads a strong Engineering team.
A Perfect Magic Triangle

If you want to use a new process for the first time on an industrial scale and are in a hurry, you need to find a reliable partner. Xstrata Zink GmbH chose Bayer Technology Services. And the customer was so satisfied with the results that the next joint project is already planned.
Industry needs zinc. Year after year the world market demand for this versatile metal increases by some four percent. In fact, the annual sales volume has doubled in the past 20 years. The burgeoning use of zinc-coated steel, particularly for the worldwide booming automobile industry, has especially spurred this demand.

While this trend offers zinc producers gratifying prospects, they are also faced with the major challenge of meeting the enormous demand. Several zinc mines are increasingly depleting. So, producers are now searching for new ways to obtain the popular metal. In order to meet this tremendous demand, experts estimate that mining companies will have to come up with new zinc sources with an annual output of seven million tons by 2020. Seven million tons is equivalent to more than half of the current annual production worldwide. In 2025 excessive demand could even reach 14 million tons.

One of the world's leading zinc ore mining and production companies is Xstrata Zinc, headquartered in Madrid. The subsidiary of the Swiss mining giant Xstrata holds an important trump card. Its Australian Mount Isa and McArthur River mines are probably the largest deposits in the world with reserves totaling some 55 million tons.

At least in the case of the McArthur River mine there is, however, a special challenge. In addition to zinc, some of the ore contains an above average amount of lead and other accompanying elements. With the otherwise well-established smelting process, it has previously not been possible to extract pure zinc in a commercially viable way. “The problem with the conventional roasting process is that liquid lead forms, and this can obstruct the jets through which the air required for the process is blown,” Dr. Piet Scheeren, Plant Manager at the Nordenham site of Xstrata Zink GmbH, explains. According to Scheeren, one can alternatively thermally process zinc concentrates containing lead, but this is an extremely energy-intensive method and only produces zinc of lower quality. So, to further expand its zinc production, Xstrata had to find a way to utilize the McArthur-River ore containing large amounts of lead economically.

In fact, a viable method has been available at Xstrata for the past 20 years. In this so-called Albion process, named after a district of the Australian city of Brisbane, the ore is very finely ground and then directly reacted with sulfuric acid. This process, also known as direct leaching, has already been successfully used with other metals. With zinc ore, however, the “acid test” had yet to be passed – particularly with regard to the use of the resulting byproducts.

After the first successful lab and pilot plant tests in which Xstrata adapted the original Albion process to treat bulk zinc/lead concentrates, the company initiated the search for a suitable site for a demonstration plant based on this process and eventually chose Nordenham. Zinc has been produced at this site located at the mouth of the Weser...
The service provided by Bayer Technology Services a few years ago already impressed us and that is why we immediately remembered the company again in 2010.

Carl van Dyken, Managing Director, Xstrata Zink GmbH

River in Germany since 1906. The operation has been a part of the Xstrata Group since 2002. Before this project was initiated, the annual capacity was 140,000 tons.

After deciding on the location of the new facility, the project progressed very quickly. Xstrata Zink GmbH, the local subsidiary, needed an engineering partner. The fact that they chose Bayer Technology Services is no doubt also due to the good experience that Xstrata Zink had already had with the Leverkusen experts. The two companies had known each other since 2006, when Nordenham commissioned the Bayer company to optimize a facility in which the sulfur dioxide released from the zinc roasting process is oxidized to produce sulfuric acid. “We were very impressed by their service, which is why we immediately remembered Bayer Technology Services in 2010,” recalls Carl van Dyken, Managing Director of Xstrata in Nordenham.

So they contacted Klaus Stemmer at his Leverkusen office in early 2010. Stemmer is in sales for the chemical industry at Bayer Technology Services, which includes customers in the metallurgical industry. The Bayer engineer is very proud of the fact that the Xstrata turned to them for help with a technology that is completely new and not yet in use at any other site worldwide. “It was an enormous act of faith to allow us access,” stresses Dr. Dierk Wiemann, who was appointed Project Manager at Bayer Technology Services.

The Bayer colleagues were quick to see that Xstrata wanted its plant as soon as possible. When the engineering team under the direction of Wiemann estimated just under 18 months until the commissioning of the facility in April, the reaction of their partners in Nordenham was restrained. It soon became clear that they hoped to push the start button in less than 12 months. “We needed the zinc from this facility as fast as possible in order to be able to utilize our site capacities for further processing to the full,” Xstrata Project Manager Scheeren explains.

If you are offered a cup of coffee in the offices of Dierk Wiemann or Klaus Stemmer, you are likely to get a mug with the inscription, “Speed up your process”. The slogan on the mugs is promoting BayQIK, a process developed by Bayer Technology Services for the efficient production of sulfuric acid (see also technology solutions 1/2011). From then on, speeding up the process also became the motto for Wiemann’s project in Nordenham.

The only real way to save time when building a facility is to pare down the planning phase. “Later, in the construction phase, little can be fast-tracked – alone due to safety con-
“Our advantage for a fast-track project is that we have fewer interfaces because we have almost the entire expertise in our own company.”

Dr. Dierk Wiemann, Project Manager, Bayer Technology Services

Concerns,” says Wiemann. That is why the pace has to be forced swiftly ahead right from the beginning. To accelerate the process the project team therefore carried out the phases simultaneously that would normally be undertaken in sequence – i.e. Basic Engineering, Detail Engineering and Procurement. The project was thus given fast-track status to ensure that it could be realized as quickly as possible.

Working simultaneously on project phases that would normally follow consecutively is more complicated than it sounds. Take, for example, Detail Engineering for the buildings. This meant specifying the dimensions and layout of the steel construction and the building foundation immediately after the start of the project – in other words, at a time when the size, installation location and weight of all the equipment were still not yet known.

When Wiemann recalls these early beginnings, he likes to refer to this time as “an amazing concurrence of things”. On the one hand, they had to make specific decisions on many important things at a very early stage. “And on the other hand, we also had to draft a design that allowed us a certain degree of flexibility,” says Wiemann. For example, they had to have the leeway to integrate additional equipment in the facility or to install further pipework at a later date.

For Dierk Wiemann it was therefore important from the onset to “bring together people with as much experience and vision as possible”. The team consisted of more than 70 people, and alone some 50 of them were from Bayer. Wiemann considers the circumstance of “having the majority of expertise in our own company” particularly advantageous. “With a fast-track project you try to have as few interfaces as possible.” In addition, Wiemann already sent as many team members as possible to Nordenham at the very beginning of the project. “I wanted them to get to know the company they were working for right away. It helps to motivate people.”

After only slightly more than two months, they were already able to submit the planning application to the authorities. A degree of flexibility was necessary here too, as Wiemann stresses: “After all, we had to assume that Xstrata might want to undertake steps to change the process during the optimization phase of the ongoing project.” And that is exactly what happened.

For example, the number, installation location and size of the tanks were all changed. In addition, the stirrer for a container several hundred cubic meters in size ultimately had to be enlarged, which also necessitated increasing the size of its drive. This in turn changed the demands on the structural engineering calculation of the steel construction. “We had to have this flexibility and for this reason, we had to prepare the planning application accordingly,” says Wiemann.

Their previous experience with German building authorities and regulations obviously also proved useful, as was the close coordination among all the participants. Wiemann was justifiably impressed when they were ultimately able to...
celebrate the erection of the top-story framework of the 750-m² building by the end of October 2010. “In the order of events of a normal project, we would more likely be at the ground-breaking phase at this time!” In this case, however, they were already able to begin with assembling the equipment.

The following weeks, however, were not without surprises. Plans are based on theory, but practice can sometimes be quite different. For example, what do you do when a particular stainless steel is not available for delivery? This kind of bottleneck was not provided for in their tight time schedule. Thanks to the enormous commitment and the good cooperation with suppliers, this gap could eventually be quickly filled. Needless to say, such experience can certainly fray the nerves!

Everything was eventually completed by January 2011, and Xstrata was able to begin with the direct leaching of its zinc ore. Just under two months later all the subsequent steps of the adapted Albion process went on stream. Not even one year had passed since the start of the project. “You delivered!” was the short, but appreciative comment from Xstrata. “We were very satisfied,” Project Manager Scheeren adds. Particularly because they initially had some faint doubts whether the project could actually be realized as quickly as they hoped. “We were especially impressed by the fact that the Bayer experts thought of everything during the planning phase and did not forget anything,” says Scheeren.

By May 2011 the company reported a production of 6,200 tons of zinc using the adapted Albion process, which was absolutely in line with the facility constructed for a total annual capacity of 20,000 tons. According to Scheeren, at 6.5 tons of zinc ore per hour the production facility now even achieves a somewhat higher capacity than had been originally planned.

Low costs, high quality, rapid completion – anyone who undertakes projects knows this magic triangle – and also knows that one target factor is often optimized at the expense of another. This was out of the question for Dierk Wiemann. He made no compromises – and certainly not in quality! Nor was he willing to cut corners with safety. Accident-free work for employees was a top priority of all those involved. The project manager is therefore particularly proud that he was not only able to stay within the time allotted and budget plan, but also met the most important goal of managing to complete the project without a single accident. A perfect magic triangle!

The participants now have their sights on the next project. If all goes according to plan, the parent company intends to expand operations at the Nordenham site significantly. There is talk of an additional annual capacity of some 160,000 tons of zinc – to be produced using the adapted Albion process. In fact, Xstrata Zink has since contacted Klaus Stemmer again – even though a final decision has not been reached, joint preparations for this major project have already begun.

Xstrata Zink GmbH in the Friedrich-August-Hütte district of Nordenham, where zinc has been produced since 1906. This plant has belonged to the Xstrata Group since 2002.

“‘They really thought of everything in the planning phase and did not forget a single thing. You can commission Bayer Technology Services and simply let them get on with it.’

Dr. Piet Scheeren, Project Manager, Xstrata Zink GmbH
GRADUATES HONORED

Bayer Technology Services has honored the outstanding graduates from the Biochemical and Chemical Engineering programs at the TU Dortmund. The honorees were Markus Arndt with a grade point average of 1.3 in biochemical engineering and Frederik Scheiff with 1.1 in chemical engineering. The company is further solidifying its partnership with the renowned institution that ranks among the top universities for chemical engineering in Germany. In recent years Bayer Technology Services has recruited a significant percentage of its young engineers from the TU Dortmund, with which the company is also collaborating on a number of research projects, including INVITE GmbH.

New SusChem Chairman in Brussels

Dr. Klaus Sommer, Head of Customer and Product Management and Senior Vice President of Bayer Technology Services, was appointed as the new Chairman of SusChem, the European Technology Platform for Sustainable Chemistry, at its Board meeting in Brussels. He succeeded Dr. Paul-Joël Derian, who is now responsible for Research and Innovation at Suez Environnement S.A. Sommer has been a member of the SusChem Board for several years. Most recently Sommer acted as head of the SusChem Reaction and Process Design workgroup, which played a central role in realizing the €30 million EU research project, F³ Factory – Factory of the Future – (see also p. 24 f.).

THESIS AWARDED

Dr. Constantin Frerick, Process Design & Optimization of Technology Development at Bayer Technology Services, won the European Federation of Chemical Engineering’s 2011 Excellence Award in Fluid Separations. The award honors a PhD thesis in the field of separation technology. Frerick completed his thesis on “Rigorous Modeling, Simulation and Evolutionary Optimization of Generic Protein Downstream Processes” in 2009 under the supervision of Professor Andrzej Góra at the TU Dortmund. The jury found the thesis to be of the highest quality in terms of its breadth and depth, innovation, industrial relevance, dissemination of results and scientific impact.

A SUCCESSFUL START

Bayer MaterialScience has successfully started up its new facility for the production of the polyurethane raw material TDI in Shanghai. The plant, which was planned and constructed with the help of Bayer Technology Services (see also technology solutions 1/2010 and 1/2011), is the first world-scale facility, in which the final stage of synthesis is carried out in the gas phase. Compared with conventional facilities of a similar size, the new process reduces solvent use by some 80 percent and energy consumption by up to 60 percent. The use of this technology also lowers carbon dioxide emissions by roughly 60,000 tons per year (see also p. 50). The annual production capacity of the TDI plant is 250,000 tons.

* The photo also shows INVITE Managing Director Dr. Thomas Bieringer (left) and Professor Sebastian Engell, Dean of Biochemical and Chemical Engineering at the TU Dortmund.
Accident-Free with a Passion

Process Analyzer Technology (PAT) in Baytown managed an outstanding achievement in the fall of 2011: the PAT Group has not had a single accident in the past 12 years! The basis for this impressive success is the staff’s changed attitude to safety.

If you search for Rita Bayerwaltes on team photographs you have to look very closely to spot her. She always seems to be in the background, preferring to push those into the front rows who are in her opinion more important: her 12 staff members. The Head of PAT Maintenance at the Baytown site in Texas is indeed very pleased with all of them. When she talks about their work and commitment, her pride in a very special achievement – in addition to her recognition of their capabilities – is clearly conveyed in the revelation that they have worked 12 years without an accident.

It is a record the maintenance staff shares with the engineering team, which consists of a planner, a supervisor and four engineers. These 17 employees at Bayer Technology Services make up the PAT – Process Analyzer Technology – Group. Established 12 years ago, it is currently responsible for some 1100 analytical devices. Bayer MaterialScience, Lanxess and various firms that supply raw materials and utilities to both companies are based in Baytown. They all trust in the competence and experience of these experts in process analyzer technology – and especially in their attention to safety.

The prerequisites for twelve years without any accidents at this site were created by Thomas Schwindack. Twelve years ago, the current Head of Process Control Technology Americas not only helped set up the PAT Group, but also initiated an innovative safety concept in those days that is still in place today. A great deal of importance is attached to safety at work in the United States, says Schwindack. This is why employees participate in various training courses on safety. Particular emphasis was and still is placed on e-learning. But despite this knowledge, accidents unfortunately still occur – some more, some less serious. And these incidents do not even include the near misses. Schwindack thought long and hard over the problem and came to the conclusion that although theoretical knowledge is important, it is far from everything. “Awareness of safety must come before thinking of safety,” says the physicochemist. The project that Schwindack launched back then – and has resulted in about 375,000 man-hours without an accident as of March 2012 – is based on the ADKAR concept. ADKAR is an acronym derived from the terms Awareness, Desire, Knowledge, Ability and Reinforcement. And there is a specific reason for placing awareness at the beginning: those who become consciously aware of this concern change their attitude to safety. Schwindack: “As soon as people realize that over and above their duty to ensure the safety of facilities and processes, they also bear responsibility for the life and welfare of their colleagues, their attitude and actions change.” And this is true of both sides.

Regular team meetings underscore this experience. Once a month the PAT Group gets together for open and honest exchanges. What has gone well? What hasn’t? What are the causes for this? They then work together to search for solutions – and usually find them. It is now completely natural for colleagues to openly admit their own weaknesses. However, Rita Bayerwaltes can still remember the time when her co-workers were unwilling to disclose any information – whether positive or negative. On the one hand, “they were afraid that others could use the information to

“The PAT Group’s awareness of safety concerns is the basis for our successful cooperation.”

Gerrit Vogel, Head of Process Control Technology, Bayer MaterialScience, Baytown
Their own advantage” and on the other, “they worried about looking dumber than their colleagues,” says the expert in process analyzer technology, who has lived and worked in Baytown for 14 years.

It was only after the PAT team realized that not even near misses would be accepted and improvements would be rewarded that they changed their attitude. Near misses are promptly discussed in a small team, and measures for improvement are undertaken. But that is not all: such near misses are also reviewed at monthly meetings. “So that everyone can learn from them,” says Schwindack. Just how strongly the PAT employees identify with the ADKAR idea of safety is visible in their offices: in addition to the bonus rewarding success, each colleague receives a pin board to post suggestions for improvement. These are the most visible signs of their silent vow: “We will be vigilant about our own safety as well as the safety of others – here in the company just as we are at home.”

“Caring for the safety of your colleagues is the best prerequisite for mutual trust.”

Rita Bayerwaltes, Head of PAT Maintenance, Bayer Technology Services, Baytown
Why is the cooling water getting so hot? It actually should have a temperature of 25° Celsius, but the display is already showing 31°. The operator stares at the display and frowns. A blink of the eye later the piercing alarm sounds and the message line “Product temperature too high!” appears on the monitor. The cooling water is no longer able to cool down the product sufficiently, which has now reached 80 degrees.

He anxiously scrolls down the monitor. Is there perhaps an additional cooling possibility that he can switch on? No, apparently not. There is only one option left: he will have to cut back the flow of the starting materials so that less product forms – and less heat is produced. A few mouse clicks later the problem appears to be resolved. The temperature gradually lowers, and everything has been rectified.

Fortunately, even if a mistake had been made, there would not have been any direct consequences. In actual fact no cooling malfunctioned, and no product became too hot. The operator was simply working a computer program that simulated an incident in his facility.

A scene from operator training in Brunsbüttel: When Bayer MaterialScience introduced a new process control system for the production of the polyurethane raw material MDI at its site in Northern Germany, all employees involved had to take part in this special training before the system went on stream. For three weeks each colleague was intensively trained in the use of this simulation program. Not unlike the way pilots in training prepare for their future routine in the cockpit under the deceptively similar conditions of a flight simulator, the plant operators meticulously learn the proper handling of their new production facility.

Experts call this simulation program an “operator training simulator” (OTS). Bayer Technology Services developed the training device used by the production staff in Brunsbüttel. In the meantime, their Unit Operation Support has gained some ten years of experience in this sector. And ten years is a long time in this relatively young field.

Such simulators have long been standard practice in work associated with refineries, but business in the chemical industry is only now gathering momentum. “The processes used in the chemical industry are more varied and more complex, and as a result, they are more difficult to simulate,” Senior Expert Adrian Prata explains why the use of OTS is only now beginning to catch on in this field.

Elaborate process control systems ensure that almost the entire operation of modern chemical facilities is automatically regulated. Today’s production operators therefore spend much more time in front of a computer screen than wielding a wrench while working on a valve or a pump. Com-
Deceptively similar: flight maneuvers can be practiced with a flight simulator under realistic conditions. This same principle is now used in chemical processing.
Computer screens have increasingly replaced the old control room with its myriad of buttons and controls. For this reason it is now also possible to simulate the process control in an amazingly authentic manner. On the surface, such a training simulator is practically a replica of the genuine process and the actual process control system. “The goal is that the operator cannot see any difference between the actual and the simulated operational control,” says Prata.

Admittedly, it is not easy to implement this goal. The simulator must react to every operation in the exact same way it would occur in the real facility. If for instance a valve is opened with a mouse click, the simulation program must “know” exactly how much material flows in or out per minute, how that affects the happenings in the reactor, how the temperatures or pressures change, etc.

“We set up an appropriate dynamic mathematical model of the entire facility,” Prata explains. Absolutely everything is included in the model: the lengths of pipes, the diameter, the heights of the apparatuses, the respective heat conductivities of the equipment materials and, of course, the properties of the substances concerned, including viscosity, melting and boiling points, as well as the reaction behavior with certain other materials involved in the process. A commercially obtainable software platform serves as the basis. Bayer Technology Services uses this software to develop a customized training simulator for each respective application.

Customers mainly use the simulator for training their employees. By training them in how to react when faced by possible incident scenarios before the production start-up, they minimize the downtime of the facility in case of emergency. However, that is not all: as continually operating chemical facilities run non-stop for many months, the start-up and shut-down operations of an installation only occur rarely in practice.

But in fact, these are the very process phases that are so highly complex – and can take a lot of time. “This is exactly the time when the operational effort is particularly high, because, for instance, the tank has to be filled in a certain way and the pumps have to be controlled,” says Klaus-Dieter Janko, Project Manager, Lurgi.
Ludwig, who is responsible for Process Control Technology at Bayer MaterialScience in Brunsbüttel.

In light of this situation it is highly beneficial that start-ups and shutdowns can be simulated with the OTS developed by Bayer Technology Services. These procedures then usually run a lot smoother in practice, which results in true cash savings for the company. “The faster a new production facility operates so smoothly after start-up that the finished product is able to meet all specifications, the better our capacity utilization,” says Ludwig.

“Our experience is that it has paid off for every customer up to now,” Adrian Prata adds. The process engineer even knows cases in which prior simulation detected real mistakes in the facility design. “We once discovered with the simulator that one of the tanks was the wrong size. The pressure would not have been sufficient to transport the liquid to the next tank.” Because this deficiency was detected early enough, the customer was spared considerable problems during the start-up of the installation.

In another case it turned out that the planned regulatory approach for a column was not robust enough. Thanks to the help provided by the simulator, the customer was able to optimize the control system before startup of the facility.

Experts at Lurgi also praised the possibility to test the design of a facility before the actual startup. In 2009 the global engineering company based in Frankfurt “tested” a facility for the production of propylene using an OTS developed by experts at Bayer Technology Services. “It was particularly important in this case because we did not have any industrial-scale references for this process as yet,” says Dr. Lutz Janko, Project Manager from Lurgi.

After the petrochemical industry, more and more chemical companies now also seem to be recognizing the advantages of a dynamic process simulation. Adrian Prata and his colleagues have noticed this – not least because of the increasing numbers of inquiries they have received from external companies.

Incidentally, in the scenario described at the beginning of this article the problem was a defect heat exchanger. Due to so-called “fouling”, i.e. the formation of deposits on the walls of the heat exchanger, the cooling performance was no longer sufficient. This is an absolutely realistic case. In reality, however, it is not simply a question of turning on a second cooling facility or reducing the feed of material. “In such a case, our people will naturally have to go to the facility and clean the inside of the affected heat exchanger,” says Ludwig from Brunsbüttel.

It was the first time that the expert in process control technology from Bayer MaterialScience worked with the OTS, and he was very impressed. “It is quite astonishing how exact the mathematical model simulates the real situation.” Eventually, it turned out that they altered most of the control devices based on the model, according to Ludwig. In any case, the OTS can be used very successfully “to further improve the operation of a facility.”

Even after the introduction of the new control system for the MDI facility, the experts want to continue to use the training simulator in Brunsbüttel. The idea is for colleagues in the other production areas at the site to train with it as well. A maintenance contract is part of the normal service package agreement offered by Bayer Technology Services. Much the same as a navigation system for a car has to be regularly updated with new street maps, there are also constant changes in production facilities, such as new regulatory approaches or updates for the process control system. Prata: “Just as pilots have to adjust to new aircraft types, production operators never stop learning!” And both professions are helped by state-of-the-art training simulators. Because blind flying is absolutely out of the question!

“The goal is that the operator at the computer cannot see a difference between the genuine and the simulated operational control. In other words, a simulator has to react exactly as a facility would.”

Adrian Prata, Senior Project Manager, Bayer Technology Services
INVITE Managing Director Dr. Thomas Bieringer is convinced that future reactor components need not be any larger than this. 200 tons of product could be produced in this LH25 from Ehrfeld Mikrotechnik BTS per year.
Invitation to the Future

A growing world population on the one hand with increasingly scarce resources on the other is also a challenge for the chemical industry. The new INVITE research center is working on innovative production concepts to address this dilemma. The aims are a better utilization of resources and more flexibility.
The enthusiasm in Professor Ursula Gather’s face was clearly visible: with INVITE two institutions have come together that can benefit from each other in a very special way and can create something extraordinary in this cooperation, said the Rector of the TU Dortmund at the inauguration of the research center. The partnership between the TU Dortmund and Bayer Technology Services also serves as a role model. INVITE accelerates the transfer from research into practice and therefore helps bridge the divide that is often found between university research and its application. Indeed, the new research center offers both un

Close ties between industry and academia

How will the chemical industry of the future manufacture its products? Dr. Thomas Bieringer does not take long to answer: “Many production facilities will be smaller, and the processes will be even more efficient,” replies the Managing Director of the INVITE research center, which was inaugurated in Leverkusen in September 2011. And the German physicist has another prediction: “Some chemical production facilities will operate according to the Lego principle. Just imagine a building design consisting of standardized modules that you can combine and interchange depending on the particular process required.”

Bieringer only has to walk a few steps from his office to show visitors to the new research center. In the large pilot plant that effectively forms the core element of the building, there is a facility based on this modular principle: a linear box-like structure with open sides. The observer’s attention is immediately drawn to the vast amount of shiny metal: stainless steel components in all shapes and sizes, angular and round containers, here and there a glass flask and metal pipes everywhere. Every single centimeter seems to be put to use.

“A complete production plant for a two-step synthesis process is housed in this container,” Dr. Lars Frye from Bayer Technology Services explains to the amazed visitors. Frye is responsible for the construction of the container. Upon closer inspection, you can easily detect the modular design to which Bieringer had referred. Each component takes up the same floor space. Similar to a chess board, the container floor is divided into 40 square fields of equal size, each measuring some 57 by 57 centimeters. “This standardization makes it possible to combine and interchange the individual components,” says Frye. For example, if a distillation apparatus is required after the actual reactor for one process, but a separating funnel is necessary for another, the respective modules can be exchanged – quickly and easily.

And the container itself is also standardized. “It has the exact same dimensions as a standard 20-foot container like those used in shipping and road transport,” says Bieringer. As a result, it can be easily transported. This constitutes a paradigm shift in chemical manufacturing: “If the raw materials and the customers for a certain product are located, for example, in France, the company will be able to move the production facilities to that very site, thus eliminating unnecessary transport routes in future.”

Tobias Grömping is also thrilled about the container in the INVITE research center. “This facility is one of the first consequences of the so-called F³ Factory project,” reports Grömping,

INVITE aims to be the leading address for innovative process development in the chemical and pharmaceutical industries.”
Professor Wolfgang Plischke, Board Member for Innovation, Technology and Environment, Bayer AG
“INVITE accelerates the transfer from research into practice. In addition, our students benefit from projects performed under real production conditions.”

Professor Ursula Gather, Rector, TU Dortmund

Universities and industrial companies the unique opportunity to develop innovative technologies even more efficiently. Participating students about to earn their diploma and doctoral candidates at the TU Dortmund benefit from projects performed under real production conditions. They can get to know the latest technologies – where they are developed and implemented. For their part, they contribute their special theoretical and academic knowledge, which helps their industry partners.

The cooperation is in full swing, said Gather. There is already joint research in projects such as F³ Factory, and the partnership is also evident in the lecture halls of the TU: Bayer Technology Services is sponsoring a professorship in Apparatus Design (Professor Norbert Kockmann, see technology solutions 1/2011) in the department of Bio- and Chemical Engineering.

It opened in September 2011 and ever since it has been an address for specialists working on the factories of the future: the INVITE research center in Leverkusen. Some parts of the building are deliberately easily accessible to the public.

who manages this project for Bayer Technology Services. The three “F’s” stand for “flexible, fast, future” – terms that represent the essence of factories of the future. The F³ Factory project is supported by the European Union and coordinated by Bayer Technology Services. A total of 25 partners are participating. In addition to Bayer, this includes a number of leading European chemical companies, such as BASF, Evonik and AstraZeneca. They work across competitive boundaries with research institutes and universities.

However, F³ Factory is not the only project on which the experts at the INVITE research center are working with great intensity. Its name is derived from Innovations, Visions and Tech-
nologies, and it is meant quite literally as an invitation. Under the auspices of INVITE, colleagues from university research and industry are offered a forum to meet and learn from each other—in an open, creative and interdisciplinary exchange. The cooperation among companies that are normally in competition with each other is explicitly welcome here, says Bieringer. “Only if we sit together at the same table will we be able to develop a binding standard for future concepts,” says Bieringer with conviction.

The research company is also promoting a closer alliance between the academic world and industry. INVITE was founded in 2010 as a joint venture between Bayer Technology Services and the Technical University Dortmund. The ambitious goal of this public–private partnership is to develop production concepts for the factories of the future—flexible, efficient, while at the same time conserving resources. “INVITE aims to be the leading address for innovative process development in the chemical and pharmaceutical industries,” stressed Professor Wolfgang Plischke, who is a member of the Bayer AG Board of Management responsible for Innovation, Technology and the Environment, at the inauguration of the building.

The interdisciplinary approach, creativity and openness are already reflected in the building’s architecture. It is not without good reason that only half of the research center is located on the site of the Chempark Leverkusen. The other half is easily accessible to the public. And even those who are not authorized to enter the factory part of the building can observe through large windows what projects scientists and technicians are currently working on.

One example is the F³-Factory container, which has already been construed based on a very specific application, as Dr. Sigurd Buchholz, Head of the Process & Flow Chemistry Group at Bayer Technology Services, explains: “We integrated the first two steps in the synthesis of a potential active ingredient for cancer treatment here.” The active ingredient developed by Bayer HealthCare is currently undergoing clinical testing.

Another decisive pioneering change is that the facility works continuously and not, as is common in the pharmaceutical industry—in batchwise production. This means the raw materials can be added and the product obtained continuously—without having to interrupt the process.

Such an approach also represents another true paradigm change in future manufacturing. “If you can produce continuously, you are able to keep less raw materials in stock, have less downtime and spend less time on equipment cleaning. In short, costs are lower,” says Buchholz. In addition, it is possible to run continuous reactions in smaller reactors, which is an important prerequisite for the compact factory in a container design. In the case of the two-step synthesis of this particular active ingredient, the reactor holds just 160 liters—far less than in the classical batch process.

What is the secret to optimal production?

Anybody who undertakes chemical syntheses faces this question. flonamic helps optimize every process—quickly, individually and in a customized way.

Regardless whether it is a question of active ingredients, additives, specialty chemicals or polymers—manufacturers always face the same two challenges: they have to produce their substances in the purest form possible, and the entire effort should also be economically viable. But how can you optimize a synthesis?

With flonamic, Bayer Technology Services offers a whole set of tools to optimize every process quickly, individually and in a highly customized way. The spectrum ranges from evaluating the individual steps of chemical synthesis and determining the proper process parameters to scaling up to the specifically required production scale. The company’s connections to INVITE and its associated partner network as well as to the subsidiary Ehrfeld Mikrotechnik BTS have played a central role in providing this service. This has resulted in a unique infrastructure with extensive expertise and access to both innovative technologies and special hardware, including, among other things, the miniaturized facility module supplied by Ehrfeld Mikrotechnik BTS. With this technology it is possible to investigate planned processes with extremely small amounts of material that are still representative—for example, in terms of mixing procedures and heat transfers.

In the case of existing processes flonamic can help, for instance, when converting from a batch operation to continuous production. On the other hand, the requirements in the case of new processes can involve, for example, increasing the yields achieved until now on a laboratory scale, reducing the use of solvent or ascertaining the optimal reaction temperature. flonamic can set about this task either with theoretical calculations based on material data or with its own series of tests on a laboratory scale. In pilot plants experts can then determine the optimal parameters for a robust process on any scale.

flonamic also shows if an economically viable synthesis cannot be achieved. Clearly, this is important information to avoid a significantly bad investment as early as possible.
Microreactors prove that even smaller models are possible. The reaction components flow through mixing channels whose openings are in some cases narrower than a human hair. “And yet 25 liters can flow through such a reactor per hour, and one can produce 200 metric tons a year,” says Bieringer. This miniaturization offers big advantages because, for instance, the heat exchange occurs much faster than in larger reactors. Heating and cooling are also much faster. Smaller units are a lot safer to operate because, for example, they can be shut down much quicker and the hold-up of reacting materials is much smaller.

Continuous production (like a paternoster elevator) or in batches (press a button for an elevator)? Dr. Agathe Christine Mayer (left) and Dr. Andrea Vester from Bayer Technology Services look for answers.

And what if the production yield of a container is insufficient? Bieringer laughs. “It’s simple: you just install two, three or more containers parallel to each other.” This flexibility also allows producers to better handle fluctuations in demand.

**INVITE would also like to promote continuous processes** with its MoBiDiK project. The name derives from the German for modular bioproduction – disposable and continuous. “It involves a general concept for biologicals production, i.e. antibodies that are playing an ever greater role in medicine,” explains Dr. Andrea Vester, a Project Manager at Bayer Technology Services. They are usually produced from animal cells – until now almost exclusively in fed-batch processes. The product is first isolated and purified at the end of the process. With MoBiDiK, however, liquid is continuously extracted from the bioreactor in order to isolate the product. The remaining cells, together with fresh nutrient solution, are returned to the reactor – also continually.

Another important MoBiDiK aspect is that some parts, such as the reactor, filters and storage tanks, are made from plastic and can be quickly and easily disposed of after each batch. For the next production, they are replaced by new, clean and sterile elements. This allows more flexibility and saves purification costs as well as the associated proof of cleanliness.

**Chemical production of the future** is also going to have to change in terms of the starting materials. As fossil fuels further diminish, demand for alternative raw material concepts will continue to grow. The CO₂RECT initiative, in which INVITE is also involved, is pursuing this objective as well. A consortium under the leadership of Bayer Technology Services is now working on, among other ideas, the concept of utilizing CO₂ as a raw material for various base chemicals. In addition, the electricity required will stem from regenerative sources, including surpluses insufficiently used so far, such as those produced by wind turbines under certain weather conditions. So, there is a potential for a double advantage in terms of sustainability.

Indeed, sustainability in general plays a major role with INVITE and its associated projects. After all, production processes consume a lot of energy. In light of population growth and rising living standards, this expenditure will no doubt even increase in future. More efficient process concepts will thus continue to be in demand.

These are exciting times for Thomas Bieringer and his many colleagues, and you can clearly sense his enthusiasm for the targeted paradigm change. The head of INVITE once again fixes his gaze on the F³ container: “This concrete example of a two-step reaction is just the beginning. Many other companies participating in the F³ Factory project are also working on modular container solutions for specific production processes. In 2012 all these containers will be tested here at INVITE.” And also presented to many interested visitors, which is of course completely in line with the core idea behind INVITE: that is to be open.
What Affects the World

At first glance, the relatively small piece of thin, black fabric looks rather non-descript. But for foreman Roberto Warthe it is very special indeed. This modest-looking cloth is an oxygen depolarized cathode (ODC), which plays the central role in a highly innovative process developed for the production of chlorine. Bayer MaterialScience now uses this technology at its Brunsbüttel/Germany and Shanghai/China sites. Today, Bayer Technology Services manufactures a significant proportion of these cathodes.

The production of chlorine is one of the most energy-intensive processes in the chemical industry. For this reason, chlorine manufacturers around the world are constantly looking for more efficient methods of production. So far, an innovative electrolysis technology, jointly developed by Bayer MaterialScience and Bayer Technology Services, has delivered the best results. The third partner is the Italian company De Nora, a well-known supplier of electrodes and technology.

These oxygen depolarized cathodes, which function much like the cathodes in fuel cells, are the focal point of this process. They suppress the formation of hydrogen, thus reducing the electric voltage necessary to recover elementary chlorine from hydrochloric acid (HCl). Production facilities based on this ODC technology require 30 percent less electricity than conventional processes.

This technology was launched as a pilot project at the Bayer site in Brunsbüttel at the end of 2003. But with this overwhelming success came the first concern: at the time there was only one ODC producer. What would happen if this supplier could no longer deliver? Without hesitation Bayer Technology Services offered to expand into the production as well – for emergencies and in case of increased demand. It was a decision with serious consequences. Senior Expert Ulrich Esser recalls: “When we accepted the task, we had no idea how complicated the actual production process is.”

The base material of an oxygen depolarized cathode is a delicate cloth. Several coatings are applied to this base with great care and then placed in a furnace, thus fusing the layers together. The next production step is to process the cloth to its final size. Each of these fabrication steps was unknown territory and posed a new challenge for Esser and his team. “Alone until we figured out how we should get the material to cope with the forces acting on it in the coating machine involved a great deal of work.” Even today, the mere recollection of this effort brought a deep furrow to his brow. In those days, practical solutions were in demand more than ever, and in the end, Roberto Warthe and his team were able to deliver. The production manager in charge at the time was in his early 30s – a young foreman who knew from experience that giving up was not an option.

Until then Warthe had pursued his professional path from chemical technician to industrial mechanic with great determination. He also obtained the equivalent of a high school diploma in evening classes as he had originally intended to go to university. But then Warthe was drafted into the German armed forces, where he realized that he did not need further studies. After all, he had all he wanted, including an interesting job in Central Research that he thoroughly enjoyed. But

Giving Up Is Not an Option

An innovative process for the production of chlorine from hydrochloric acid saves energy and significantly reduces CO₂ emissions. All this is possible thanks to oxygen depolarized cathode technology. Experts from Bayer Technology Services not only helped develop these electrodes; they now produce them with great success. But the path to this success was difficult, long and instructive.

“A Bayer Technology Services was instrumental in developing the oxygen depolarized cathodes, which is why we entrusted the company with the production.”

Andreas Amling, Senior VP Industrial Operations Basic Chemicals, Bayer MaterialScience
instead of sitting back and relaxing, he went on to complete his training as an industrial foreman – also at night school.

People with this career background offer the qualities needed for hard times: i.e. determination and the will to succeed. Sitting in the pilot plant in Leverkusen, Warthe makes no secret of the fact that he is pleased with his job decisions so far in life. Bayer Technology Services now delivers a significant number of the cathodes that Bayer MaterialScience uses in its processes. Even the very first order was a challenge. Production manager Warthe and the team specially set up for this task produced a large part of the cathodes for the initial fitting out of the HCl electrolysis at the plant in Shanghai.

**The entire production process takes about 12 weeks**, after which the colleagues take a break and return to their original workplaces. Warthe himself resumes his position as a laboratory foreman until a new run is required. The latest order was just completed. “We are very satisfied with the quality of the cathodes and the good collaboration with Bayer Technology Services, which is why we will rely on them and their competence for the replacement of the ODC in Shanghai,” says Andreas Amling, responsible for the global production of chlorine and other basic chemicals at Bayer MaterialScience.

Roberto Warthe is pleased, but not surprised. “After all, we supply a high-end product of the highest quality for a good price,” he says. And he is as proud of this achievement as he is of his team. “They are as top quality as our product!”
Our Next Top Model

In combination, theory and practice can achieve a lot. Making use of the appropriate experiments, experts are, for instance, now in a position to predict certain properties of a substance, before it even exists. That, in turn, helps the practice.
The redder, the more negative; the bluer, the more positive: modeling the charge distribution on molecule surfaces allows conclusions to be drawn about properties.
of the molecular interaction of possible drug candidates with the relevant target structures in the organism helps limit the number of experiments. The same applies to research in material sciences. “The more complex the substance composition, the more interesting the theoretical predictions of its properties,” says Diedrich. This allows developers to avoid some difficult syntheses that would ultimately turn out to be superfluous simply because the properties are not those desired.

Colleagues in Functional Films at Bayer MaterialScience are working on the development of this type of complex material compositions. Unlike conventional films, functional films are often combinations of various substances, and they usually achieve their intended function, such as a particular optical or mechanical property, through their interaction.

The Holographics Competence Center within Functional Films also deals with such material combination formulas. Adding suitable functional chemicals to the actual film material (matrix) turns conventional film into holographic film. This type of film is already used in a variety of applications, such as in identity cards and passports. Incorporating small holograms in such credentials is now a common way to make them safe from forgery. Anticipated uses of these films are highly diverse and currently include the application as light-diffusing components in screens.

Bayer MaterialScience is also developing holographic films for other applications. One person who is driving this research is Dr. Thomas Rölle. The title on his business card reads “Head of Chemistry & Photoactives”.

Photoactive substances play an important role in holographic films. Several functional chemicals generally interact with each other in a complex way, thus creating a functional film from a technical one. One constituent of the formula must be able to absorb light energy. This “light catcher” then passes on the energy to the other molecules, which triggers their polymerization. In this way it is possible to write the actual hologram into the film with a light beam.

Highly practical

Theoretical observations are helpful for practical use in many different ways – and not only when researchers are looking for suitable substances to be used in holographic films. Modeling experts at Bayer Technology Services can also offer a number of additional practice-oriented predictions. Modeling the spatial structure of individual molecules and the spatial allocation of the charge enables them to deduce very specific material data.

One example is pure steam pressure, which is a measure of a substance’s volatility. This information is important for researchers who want to market a new chemical. Depending on its volatility, they will have to produce the appropriate toxicological studies. However, the amount of the substance available in the lab is often insufficient to measure its pure steam pressure. This is where modeling can help. In addition, knowledge of the volatility and the solubility in various liquids is crucial for planning separation processes, such as distillation and extraction.

Modeling experts can also deduce the viscosity of a particular substance. In chemical processes this variable has a decisive effect on the design of pipes and pumps. This is why many engineers already want to know the viscosity of a mixture in a very specific composition before they begin constructing a specific facility. In this case too theoretical predictions are extremely useful. Sometimes this can influence whether a certain process will be pursued at all.
Rölle and his team are now working on new formulas. The current developments are concentrated on, for example, films that can redirect incident light or that can create visible images from the light. The interaction of all the functional chemicals included in the film matrix is a crucial element for the success. These substances must meet a number of requirements. For instance, the light catcher must show a specific absorption behavior, while the polymer-forming component must have a certain mobility in the matrix and be able to be integrated into a stable polymer.

Not unlike drug discovery research, countless substances may initially seem suitable for such requirements. This would be a Sisyphean task if you were to rely completely on lab work. Thousands of experiments would be necessary to find the optimal functional chemicals. Many candidates would have to be synthesized first before the actual test in the film – and this too is time-consuming and expensive.

Fortunately, the Bayer MaterialScience experts are well aware of the modeling competence of Bayer Technology Services, and this is how Christian Diedrich got involved. Using his modeling methods, he is able to make reliable predictions about the very properties that are so interesting for Rölle and his team, i.e. the light absorption, the mobility in the film, the reactivity in polymerization and also the optical properties of the resulting hologram.

For the latter task Diedrich called in his colleague, Dr. Thomas Mrziglod. The mathematician is an expert in artificial neural networks. For this work, he makes use of computer programs that do not perform calculations based on specific equations, but instead are capable of learning from existing data so that they can appropriately interpret additional data. This procedure is useful in situations in which several variables are involved and no exact equations are known. “We had experimental data for a number of formulas and as a result we were able to train our neural network,” Mrziglod explains. After that it was sufficient to feed in the data from Diedrich’s modeling. The “trained” neural network was then able to make predictions about the respective properties of the finished hologram.

With the help of these data, the colleagues at Bayer Technology Services calculated a number of formulas accessible to Rölle and his team by experiments. “Within a few days we were able to narrow down which of the substances look truly promising for practical application in holographic film with this virtual screening procedure,” Diedrich reports. As he says, it was an enormous advantage that with Thomas Mrziglod the additionally required expertise in terms of neural networks was available in his own company. “In view of the demands on the rapid development of materials and the additional costs involved, we would not have been able to produce and test all these substances in the lab,” says Rölle. The chemist is therefore all the more delighted that the “constructive cooperation with Bayer Technology Services has resulted in such promising new candidates”. In the meantime, Rölle has taken these candidates into the practical phase. “The lab tests have since confirmed that the chosen candidates are actually suitable,” Rölle reports.

This is not the first time that Diedrich has been involved in a successful product development. With modeling he helped with the development of Bayfol HX, a holographic film that is already available on the market. And in this case too it became readily apparent what theory and practice can achieve, when the two work hand in hand.
What Inspires Partners

Improving Processes Is Our Job

As soon as companies accept that a process is not running as efficiently as it should, they have already taken the first step towards improvement. However, they often lack the time and experience for the second step. In these cases the Process Technology Team is the ideal partner.

When Dr. Constantin Frerick drove to Muttenz for the first time, he knew immediately that he faced a considerable task. With its 17,000 inhabitants, the town located east of Basel in Switzerland is the site of a major Bayer CropScience production plant. Several thousand tons of three different active ingredients for crop protection products are manufactured here every year. "With such considerable amounts, you naturally ask yourself whether the production process cannot be made even more efficient," the chemical engineer says.

The 33-year-old German is a core member of the Process Technology Team (PTT) at Bayer Technology Services. In this particular case Frerick had the task of analyzing the production of trifloxystrobin, the active ingredient that has turned the crop protection product FLINT into an international success.

Frerick’s colleagues in Muttenz had already provided him with extensive information so that the Process Technology Team could thoroughly familiarize themselves with the subject matter in advance. He knows from experience what can happen: “In the worst case scenario you may end up having to deal with a molecule that you have never even heard of or with a stage of the synthesis process that is totally unknown to the team. And all this in a place you never even knew existed beforehand!”

Not that these circumstances can affect the ultimate success of the project, stresses Frerick. Fortunately, this predicament is the exception – and the exact opposite of his assignment in Muttenz. What impressed him the most about the job here was “The degree of commitment in the support we were shown by the customer Bayer CropScience.” In this case “we” means Frerick and another colleague – both of whom are experts in the total process approach.

Their first task was to analyze the situation at the Muttenz site, which required about a month of various meetings with the customer’s experts. “We obviously needed their input,” explains Unit Head Dr. Georg Ronge. Clearly, nobody knows the production facilities as well as the customer. And so why bother to engage external help in order to optimize the processes in the first place? “Because customers often do not have the time to devote to a systematic and detailed analysis of their processes,” says Ronge. In addition, the companies may also have no idea whether conceivable improvements would even function properly.

However, one thing is clear: throughout the entire process there is potential for improvement. But where exactly? And what can be done to rectify the problem? To answer these questions, the experts of the Process Technology Team investigate each individual step of the process. Are resources used unnecessarily? How many of them are discharged into the wastewater? Where are avoidable byproducts created? What costs are incurred as a result?

The Process Technology Team is a group of experts from Bayer Technology Services and Bayer CropScience who have only one goal, and that is to improve processes and facilities if and where it makes commercial sense. They are currently working on more than 30 projects around the world.
Although this may at first seem quite straightforward, it is actually a highly complicated investigative process. The experts from both sides gathered around the table some 15 times during this procedure. “All these meetings were very productive,” Frerick reports. An important interim result was a cost cascade that clearly mapped out the costs incurred in each particular process step. “This kind of cascade is definitely not some sort of magic,” Ronge says emphatically. “Instead, it reveals to many production operators where costs are actually incurred and which of them can be influenced by the process.” However, the work of the Process Technology Team did not stop here. For some investigations, the experts even went into the lab and analyzed whether the individual raw materials could be replaced by others without affecting the quality of the finished product.

Two months later, the investigation was completed, and the team was able to present the customer with a “highly satisfying result for both parties”, as Ronge describes it: “Some 10 million euros could be saved in Muttenz – alone in the production of trifloxystrobin.” That also surprised Dr. Wolfgang Bäcker, Site Manager of Bayer CropScience in Muttenz: “We supposed there was room for improvement in the process, but we had no idea how much. So, we really owe the experts of Bayer Technology Services a lot.”

Georg Ronge returns the praise: “The extent of our success also always depends on the input we receive, and in Muttenz the support was exemplary.” And he is sure that it is not the last success that the Process Technology Team can achieve at Bayer CropScience. In the meantime, the company has engaged 10 experts from Bayer Technology Services who do nothing other than to investigate the various processes. Considering this first experience, there may well be other areas where there is room for improvement. Georg Ronge: “You merely have to look and listen.”
Some fit into a single bathtub, while others occupy the space of several football fields. They come in different sizes, and all technical installations need them in order to function: pumps. “Without pumps, nothing works,” says Sergej Seifert: “I would say that they are the heart of every facility.” And who would dare to contradict him? After all, Seifert is a pump specialist.

The 29-year-old discovered his love of pumps a long time ago. Early in his career at Bayer Technology Services he spent a year working in the construction of static apparatuses, such as heat exchangers and tanks for the chemical industry. In 2008 his department began supporting the Ineos Group with engineering jobs. It was during this time that Seifert first came into contact with pumps and has been hooked ever since.

That this enthusiasm has led to true expertise is the consequence of Seifert’s determination to continue to educate and advance himself – and also that his employer, Bayer Technology Service, has supported him along the way in this qualification measure. “I wanted to broaden my professional horizons and further specialize,” says the mechanical engineer. His supervisor drew his attention to a new extraoccupational training course, offered by the so-called Pumpenfachingenieur GmbH in Graz, Austria. This is actually a pool of Austrian and German universities working together with a few engineering companies.

Sergej Seifert successfully completed the yearlong training in 2009, leading to his qualification as a pump specialist engineer. Bayer Technology Services financially supported him during this strength-sapping, but nevertheless worthwhile time. During the day Seifert worked as usual at Bayer Technology Services in Dormagen. But evenings, when his colleagues left work for the day, work continued for Seifert. On average every second week he received examination questions by phone or by internet, which he immediately answered and sent to Graz by email. To keep abreast of the necessary subject matter, he had to study every evening of the week, plus weekends.

Sergej Seifert no doubt benefited from the fact that it was not too long ago that his had finished his studies. “Unlike
some other colleagues, I was used to studying. They had a slightly harder time.” In any case, he did not regret the effort for his qualification for one second. “I have expanded my range of knowledge, which is a major benefit because I can actually see myself pursuing the expert career path.”

**Today, Seifert’s main duties involve** calculating and constructing pumps for newly created facilities or optimizing those in existing plants. In addition, he is responsible for failure analysis. “I used to sit at my computer all day, but now, I am included in the entire process, beginning with the planning of a pump. After that, I am directly involved in the project execution of a facility for the next two to three years. And ultimately, I am also there when the facility is commissioned. This job diversity is new – and great fun.”

Annegret Zandt has recently qualified as a certified foreman.}

**“Among other things qualifications have the goal to secure jobs for the long term.”**

Dr. Jürgen Kussl, Qualification Manager, Bayer Technology Services

Anticipating what others need is something the wife and mother of two children knows from home. In fact, Zandt is equally at home at Bayer, as she has worked for the Group for 25 years. She began her career at Bayer AG and then moved to Bayer Industry Services, which then became Currenta at the end of 2007. Ultimately, she transferred to the subsidiary Tectrion, before joining Bayer Technology Services three and a half years ago. Here she has recently accomplished a major career jump: In August 2011 she successfully completed her extraoccupational certification as a foreman – after three and a half years of intensive studies at night school.

“At Tectrion it was foreseeable that the workshop was going to be closed,” she recalls. “I didn’t want to be at risk of losing my job as a woman in a typically male-oriented profession.” So, she decided to attend night school in Leverkusen-Wiesdorf – with financial support from Bayer Technology Services. For three years she went to the Geschwister-Scholl School, the community business college for technology, home economics and social education – at first two, then three and eventually four evenings a week. Saturdays and Sundays were spent studying further at home. As of August 2011 Annegret Zandt now qualifies as a certified foreman in metalworking.

For the moment her everyday working life has not changed as a result of this qualification. However, she can now stand in for the workshop managers in all responsibilities – ranging from customer pitches and writing quotations to discussions with the apprentices.

**The distance from Annegret Zandt’s workshop to Serhat Kilic’s office is not far at all, but the 28-year-old works in completely different world.** In Internal Accounting Kilic is responsible for inventorying items of property that the company has purchased. This can comprise such simple things as IT laptops, multifunctional printers and office supplies, including tables, chairs, shelves and coffee machines. But it can also involve technical equipment such as machines, pumps and even entire facilities. As Kilic is quick to say, it is an exciting job. “Besides business subjects, I am also very interested in technology, and at Bayer Technology Services most of the newly procured items are of a technical nature.” He often has the opportunity to learn about interesting subject matter – for example, when he speaks to engineers about how a certain technical component should be inventoried.

Serhat Kilic is ambitious. He completed his education as an industrial clerk in just two years, instead of the usual three. And thanks to his excellent performance he made the
high-score list of the German Chamber of Industry and Commerce. But since his early youth he has had the big dream to study business administration. In 2006 he approached his supervisor at Bayer Technology Services about gaining a degree: “I wanted to assume greater responsibility. I was also excited by the prospect of dealing with tasks from a broader perspective.” His strengths and abilities were discussed during this conversation, and it quickly became clear to his boss: “We’ll let you study business administration!”

The three years of studies at the University of Applied Sciences for Economics and Management (FOM) in Cologne were extremely stressful. After work Kilic attended lectures beginning at 6 p.m. and spent Saturdays from 9 a.m. to 4 p.m. at the university. Added to this were the hours of studying at home. This is no easy task for someone who is equally ambitious in pursuing his hobbies. Kilic played football in a club for a long time, and he is also a jogger and a swimmer. “All this fell by the wayside during my studies, but it was absolutely worth it!” He soaked up the material like a sponge, was completely fascinated by the new perspectives and different points of view in tackling problems. He perceived the company’s continuing interest as support and not as pressure.

During his studies, Kilic was very grateful for the fact that the company repeatedly asked him what he felt he could contribute already at this stage. In July 2010 Kilic earned his business degree and its effects have been noticeable. “I already carry more responsibility than before my studies and now deal with more and more exciting tasks.” For example, he is currently working on a project that will allow the company to invoice customers for certain orders faster than in the past.

“Doesn’t he now have enough time for playing football, jogging and swimming?” “Hobbies are a thing of the past!” says Kilic with a smile. “I’m married now!”

What does qualification mean at Bayer Technology Services?

Bayer Technology Services has been offering qualification measures to secure jobs for the long term since 2005. Employees are able to advance themselves in a demand-oriented way – and intentionally outside their current area of responsibility. Specifically, there are three possibilities: training in new areas of work through seminars, extraoccupational training and extraoccupational studies. So far a total of 106 employees have taken advantage of these possibilities as part of the agreement with the Employee Committee. Each qualification measure was worked out according to the individual needs and wishes of the employee, approved by employee representatives in line with the joint committee on equal opportunities and supported during implementation. At the same time there is the “perspective” career model, which is an effective personnel development program offering employees individual advancement and career opportunities (see also technology solutions 1/2011).

What is the main advantage of these measures?

Securing one’s own job through a qualification that not only serves the interests of the company, but is also of direct use to the employee.

How would you describe the distinctive characteristics of people who pursue further qualifications?

They are people who are very committed. They give a great deal of thought to themselves and to their situation in life – and they are willing to invest in themselves.

What is the dropout rate?

It is very low. These people are extremely motivated. In a sense, the selection of appropriate candidates takes place before qualification process begins.

Are there qualification requests you would refuse?

There has to be a win-win situation. That is why qualification measures are agreed in consultation with the respective department. Generally speaking, it is an opportunity for each individual to turn his or her personal strengths and abilities into success factors for his or her professional advancement. However, the qualification must also be compatible with the interests of the company.
Hector Rodriguez has worked for 26 years, and half of this time he has been with Bayer. Over the years, the electrical engineer has been involved in numerous projects for many different customers. It goes without saying that Rodriguez does everything he can to satisfy his customers, but when he talks about one company in particular, his voice noticeably softens. One senses immediately that the Senior Project Manager at Bayer Technology Services in Mexico associates something very special with this client: the pharmaceutical company Chinoin. “It is difficult to explain, but I always get quite emotional when it comes to Chinoin,” says Rodriguez. His feelings have a great deal to do with the beginning of a certain collaboration to which Rodriguez attaches a very particular significance.

It was 2003, and Bayer Technology Services had just started to market its services outside the Bayer Group. Rodriguez, who worked in Engineering Healthcare at Bayer Technology Services in Mexico, immediately began searching for potential customers who might be interested in the service range of his company. He also checked with colleagues at other Bayer sub-groups. Someone at Bayer HealthCare gave him the tip about Chinoin. At the time the major local pharmaceutical corporation already worked as a toll manufacturer for Bayer HealthCare. This existing cooperation was no doubt an important door opener. As a result, Rodriguez was able to present his offer directly to Chinoin’s management team: President Eric Hagsater, General Manager Estela Hernandez and Chief Financial Officer Eduardo Rodriguez. Even today Hector Rodriguez still raves about the extremely congenial initial meeting. “We sensed immediately that we speak the same language in terms of pharmaceutical technology and that we would be able to establish a stable and fluid communication,” Eric Hagsater also recalls.

A further presentation for Chinoin managers soon followed. “And then we invited them to the Bayer plant in Lerma,” says Rodriguez. Just a few years earlier his team had overseen the construction of the ultramodern world-scale facility for the production of OTC drugs at the Lerma plant. “This is where we could show what we can do,” explains Rodriguez. The visitors were particularly impressed that Bayer Technology Services was so well versed in the special concerns of the pharmaceutical industry. For Rodriguez and his team it was completely routine to factor in the standards of Good Manufacturing Practice (GMP). Chinoin President Eric Hagsater was delighted. “It was important for Chinoin to be fully in the picture in terms of GMP thinking, teamwork capacity and the implementation strategy of the planned technical solutions.” Hagsater is passionate about quality and intrinsic value – in his company, one of the largest in Mexico, and in his private life. Hagsater is a highly respected orchid expert and maintains his own wine growing operations. His quality consciousness perfectly suited what Rodriguez had to offer. After all, Bayer also stands for quality! This reputation is perhaps even more pronounced in Mexico than it is in some other countries. So, Chinoin became the first external customer of the Engineering team of Bayer Technology Services in Mexico. Rodriguez was thrilled! The first joint project was initiated that very same year. Chinoin was in the process of relocating some parts of production from Mexico City to its Aguascalientes site some 500 kilometers away. So, Bayer Technology Services was commissioned to plan and construct a new facility for the production of drugs administered by injection, called parenterals. At a total sum of more than 16 million euros, it was a comparatively large investment. But before work on the facility commenced, some
“We immediately sensed that we speak the same language.”
Eric Hagsater, President, Chinoin

Quality control at Chinoin, one of the biggest pharmaceutical companies in Mexico. The portfolio also includes veterinary products.

questions had to be clarified. Rodriguez quickly carried out a business case analysis. “Based on the sales expectancy, we optimized the entire machine set up and its capacity,” he recalls. A new model making use of rotating shifts was also drafted to improve the efficiency of the facility.

After presenting the details to the Board of Management and predicting an amortization period of just two and a half years, Rodriguez heard Hagsater say: “Hector, you’ve got the job. You can begin tomorrow.” Rodriguez could hardly believe his ears. It usually takes weeks before a customer makes a final decision.

The construction of this unit for parenterals marked the beginning of an intensive and long-term cooperation. Since then, they have worked together on 10 further projects. Experts from Bayer Technology Services redesigned the heating and air-conditioning technology of one facility. Further projects included a laboratory for quality control, a unit for cooling water and an installation for the production of vaccines.

Rodriguez particularly recalls an experience in 2006. Chinoin had just completed the new manufacturing facility for the cortisone preparation Alin, at its Aguascalientes site. An audit carried out by the Mexican certification authorities awarded the facility the sensational grade of 598 of 600 possible points. Chinoin immediately received an order for more than nine million Alin ampoules from the national health insurance. The company had to hire additional workers. “We helped organize a training program for the new employees,” says Rodriguez. The eleventh project is now underway: a production facility for ointments, which is set for commissioning in the first half of 2012. Since their first cooperation in 2003, the joint projects have added up to a total investment of over 40 million euros. Some 20 percent of this volume has been allotted to engineering and other support services from Bayer Technology Services.

Rodriguez has not been directly involved in the project work for a long time now. Pablo Bolaños became Head of Customer & Product Management of Bayer Technology Services in Mexico in 2008. The engineer for control systems was already acquainted with Chinoin, as he had been involved in their projects from the start. He even worked at the customer’s Aguascalientes site from 2004-2006. But Rodriguez has never lost touch with his first customer, and this strong attachment is mutual. When Chinoin is planning a new engineering project, Rodriguez’s advice is always welcome. And these good relations are shared among all the people involved in both companies. “It is a good feeling to be able to exchange information with the Bayer team,” says Eric Hagsater.

Engineering now works for a wide variety of external companies in Mexico, but for Hector Rodriguez Chinoin will always be special. And then his voice softens again. It is rather like the first love. “Although you may marry another woman, you never forget your first love. She always remains special in your life.”
What Success Creates

PLANNING FOR SUCCESS

Wrested from the sea: Bayer constructed its state-of-the-art plant on this just under 40 square kilometers of the Shanghai Chemical Industry Park. The terrain was still swampy at the time of this lower photo. The top photos show the site today. Bayer MaterialScience has produced raw materials here since 2003 – now at an annual capacity of some 850,000 tons.
Site master planners have an important function in a company. They are the experts who optimize existing sites once these have reached their limits or design new plants on greenfield sites. For this work they can rely on more than 100 years of experience.
It is a particular noise that Henner Schlieper will never forget: it went “squish, squish”, under his feet as he stepped on the ground for the first time. The sound reminded him of his childhood days – traipsing through the mud in rubber boots. But this occasion was not child’s play. At the beginning of 2000, Schlieper inspected the site at the Shanghai Chemical Industry Park (SCIP) for the first time. Bayer planned the largest investment of the company’s history here.

His shoes slowly filled with water as his eyes critically swept the terrain. “At that moment I knew it was not going to be easy,” the Head of Engineering Infrastructure at Bayer Technology Services recalls. His reaction was entirely understandable when you scan the huge area, the full dimensions of which only become completely visible from the air. In next to no time, the operators of the Chemical Park wrested a total of some 4,000 hectares, i.e. 40 square kilometers or just under 10,000 acres, from the sea for industrial settlement with the help of man-made land reclamation. Some 150 hectares of this expanse were designated for Bayer.

After the first contact, Schlieper knew that this land near Shanghai offered a unique opportunity. Clearly, every expert in site master planning dreams of planning and constructing a new site of this magnitude. And the colleagues involved in Site Master Planning at Bayer Technology Services are no exception. For their work at Bayer they can draw from a wealth of experience – not least thanks to a man who influenced the history of the company and its site planning more than anyone else: Dr. Carl Duisberg.

In 1895 the first General Director of the Farbenfabriken vorm. Fried. Bayer & Co presented a detailed plan for the new plant on the River Rhine in his “Memorandum on the Design and Organization of the Dyestuffs Factory in Leverkusen”. It remains a work of genius – even today. “For every plan, a terrain should be reserved for which it will presumably not be necessary in the next 50 years to think about relocating a factory or building a second analogous plant at some distance away...”

Dr. Reinald Wüstefeld has considerable respect for this exceptional foresight: “In those days Duisberg was way ahead of his time with his planning.” Sustainability is the modern term for such ideas. And it also influences the work of the Head of Site Master Planning at Bayer Technology Services and his team. Ulf Stopka, Michael Eberle and Otto Spelter are the experts who are mainly responsible for conceptual planning and layout engineering of Bayer sites around the world.

The company has conducted systematic site master planning for more than 40 years. Under the supervision of Wüstefeld, the team is currently looking after some 200 large and small production sites of the Bayer Group worldwide. Among the highlights of their work during this time was no doubt the construction of new sites, such as Antwerp/Belgium, Brunsbüttel/Germany, Baytown/United States and Bitterfeld/Germany. Since 2001 the most recent project has been the Bayer Integrated Site Shanghai (BISS) at SCIP in China.

With one glance at the plan for the most recent site, it is clear that Duisberg’s memorandum has lost none of its topicality after more than 110 years! Everything is still standardized; the facilities are divided into blocks; roads and sites are geared for expansion. But if you take a closer look, you will see that modern planners have added a further aspect to their site designs. “Site master planning is now a lot more than just arranging a block structure in a particular area. It is based on a comprehensive understanding of processes and includes the entire infrastructure to encompass the supply and disposal of raw materials and goods, energy and wastes, as well as the site management,” says Wüstefeld.

Today’s site planners are able to draw from a full scope of expertise. Wüstefeld: “Our many years of experience and our knowledge of production and logistical processes enable us to be a provider who would be hard to match these days.” There are certainly a number of experienced engineering firms with qualified staff and good designs, but they usually lack...
The Bergkamen plant (right) went on stream in 1962 and is now (below) one of Bayer’s largest pharmaceutical production sites. This plant will be prepared for the future with the help of a new site master plan.

The understanding of processes and the view of the “bigger picture”. “In addition to our conceptual strengths, our chemical and pharmaceutical operational know-how is a huge advantage,” says Wüstefeld. “If you take this together with our many years of experience, we not only have suitable answers to many questions, but our design concepts extend far into the future.”

In concrete terms, this means that the site master planning team always has the whole operation of the new site in its sights – especially if it is supposed to be part of a much larger system, as is the case with the industrial park in Shanghai. Just like many other integrated production networks of its kind, it is characterized by countless interfaces. With a view to these interfaces, the experts begin searching for the answers to a number of questions long before the first ground is broken: Who manages the Chemical Park? Who carries the responsibility for shared features such as the site entrances, supply and disposal facilities, logistical areas, etc.? But Bayer
What Success Creates

Technology Services does not only have the technical know-how at its disposal; the company’s site planners can boast a further valuable asset: their proven business expertise. This is particularly effective when it comes to the decision “make or buy” – in other words, should they take responsibility for waste management themselves or would it be better to purchase this service?

Until the construction of the Bitterfeld plant, which went on stream in 1994, Bayer had always treated its effluents in the company’s own waste treatment facilities. In Bitterfeld this method changed for the first time, when the waste disposal was outsourced to an external company. “It was a completely new concept in those days,” says Wüstefeld. However, purchasing external supply and waste management services has now become almost commonplace.

External companies also trust in the extensive know-how of Wüstefeld’s team. One example is the world’s largest manufacturer of phenol and acetone: Ineos Phenol. The company wanted to transfer an existing process complete with a new facility to a new site in China. On a recommendation the decision makers went to Bayer Technology Services with their own site master plan to seek advice. “As a global team with colleagues in Shanghai, we were able to introduce our experience from Shanghai and then to optimize the plan for regional implementation,” says Schlieper. The customer was satisfied.

Experts from Bayer Technology Services are also in demand more and more frequently when companies would like to expand, but they would prefer not to shout it from the rooftops. Such moves often have a lighthouse effect. If, for example, someone is searching for a site in Asia, it is always going to be seen in the market as a signal. In the initial phase many companies would rather keep this information to themselves for strategic reasons.

**This is why companies approach the Wüstefeld group,** who propose the appropriate concepts – ideally, with all the important interfaces and oriented to the needs anticipated in the next 50 years. Clearly, this is a crucial strategic aid for decision making in investment projects.

A good example for this foresight leads back to Shanghai Chemical Industry Park. For now the truck traffic is still booming there, but the Bayer experts know that it is only a matter of time before this heavy transport by road will reach its limits. In fact, they have already provided for this day thanks to concrete plans for rail transport.

Bayer has invested 2.1 billion euros in its site in China so far, and the company intends to invest a further billion in expansion in the near future. Here, too, the site master planning team is involved. Indeed, it is work that has now become part of daily business and that Otto Spelter has professionally carried out on site since 2008.

However, there is also a recent example for preparing existing sites in the best way possible for the future: the Bayer HealthCare site in Bergkamen, Germany. For more than 50 years, the company has produced active pharmaceutical ingredients such as hormones and contrast agents here. Located next to a former mining area, the site is so large that it offers more than just sufficient space for the further development of the company’s own concepts. In addition to established logistics and infrastructure, the site also has plenty of undeveloped areas that might make it attractive for investors.

The company therefore commissioned Wüstefeld’s team to develop a site master plan that incorporates the coming 50

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**“It was important for us that someone would tackle the view of a site in a structured way and with the right questions. This is exactly what Bayer Technology Services did.”**

Ralf Mechelhoff, VP Infrastructure Bergkamen, Bayer HealthCare

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**The grid design works in India too**

The government of Andhra Pradesh (India) and GIZ (the acronym for the German Organization for International Cooperation) also trusted in the company’s experience in designing 200 plant sites, when they commissioned the master planners from Leverkusen for the development of an industrial site in Visakhapatnam on the Bay of Bengal. The idea is for industry and small businesses to locate here on an area of some 40 km².

The weak points were the existing conditions: a public road intersects the site on which numerous villages are also located. In addition, it would be necessary to include the already existing factory sites. The team of experts from Leverkusen designed a site master plan and helped put together the details of the concepts over a period of 12 months, until the plan was eventually approved by the government authorities.
years. Phase 1 – the documentation and analysis of the status quo – has now been completed. Phase 2 of the company’s biggest pharmaceutical site, which encompasses the development of the site master plan, is currently underway. It is as important for the company itself as it is for investors because it will determine how the site will be developed in the coming decades. For external companies, this vision of the future is the basis for important strategic decisions. “They need the assurance that their investments will pay off because they will still have ample space for increasing their capacity in the years to come,” says Müßefeld.

The example of Bergkamen clearly shows the core task of site master planning: the phase by phase development of a site. Sustainability, or a vision incorporating the next 50 years, is still one of the most important aspects of the concept. However, today’s experts face a lot more challenges than the father of all site master plans more than 110 years ago. For one thing sites are becoming more and more diverse. Ever since, for example, biosciences companies have been among the customers, the development of sites for greenhouses has also been part of the range of services offered by the site master planners. And since many customers, including Bayer, are increasingly opening their sites to external companies, Reinhard Müßefeld, Ulf Stopka, Michael Eberle and Otto Spelter are providing long-term prospects for modern sites. There is now a trend towards plants that group together raw material suppliers, producers and users.

This new form of cooperation also follows clearly defined specifications and responsibilities, which means that the experts from Bayer Technology Services are translating the ideas put forth by Carl Duisberg perfectly in line with present times. And that would have pleased him immensely.
Would You Believe It?

**5000 times bigger than in a conventional stirrer tank:** that is the ratio of the surface to volume in a microreactor. The main reason for this difference is the structural design of the microreactors (right: a cross section of the parallel flow channels). As the speed of the heat transfer increases with a higher the surface-to-volume ratio, the liquids in the microreactors can be heated and cooled considerably faster. Microreactors therefore save time – and allow for a more efficient and better controlled processing with the aim to ensure more reasonable manufacturing costs. Furthermore, they are able to perform reactions and processes that cannot be managed in classical batch reactors because of the higher release of heat.

**60000 tons less CO₂ are emitted from the new TDI production facility operated by Bayer MaterialScience in Shanghai.** A new technology, which Bayer MaterialScience has developed with the help of Bayer Technology Services (see also technology solutions 1/2011, p. 26 f.), has contributed to this significant reduction compared with existing facilities. The reaction components are combined in the gas phase in the final step of synthesis, while in conventional processes this reaction takes place in a liquid solvent, which then has to be separated in an energy-intensive process. Up to 60 percent of the energy formerly required can now be saved. The corresponding amount of CO₂ is equivalent to the combustion of 26 million liters of gasoline or 300 million kilometers by car.

**50000 euros in sales can be lost in a single hour when production is interrupted.** This loss is calculated on the basis of a world-scale facility with an annual capacity of 200,000 tons and a kilogram price of two euros, which is the current price for the polyurethane raw materials MDI and TDI. The annual capacity is usually computed on the basis of an assumed availability of 8,000 hours per year. According to this calculation, a full day of plant downtime would therefore lead to a loss of revenue of 1.2 million euros. With the Inspection and Plant Downtime Management offered by Bayer Technology Services, these production interruptions can be kept as short and efficient as possible.
1. **BELGIUM: ANTWERP**  
   Markets: Benelux countries  
   Regional Head: Johan Vanden Eynde  
   Phone: +32 3 540 7744  
   Email: benelux@bayertechnology.com

2. **BRAZIL: BELFORD ROXO**  
   Markets: Brazil  
   Regional Head: Roberto Salvador  
   Phone: +55 21 2189 0464  
   Email: btsbrasil@bayer.com

3. **CHINA: BEIJING, SHANGHAI**  
   Markets: China and East Asia as a whole  
   Regional Head: Dr. Martin Franke  
   Phone: +86 21 61465100  
   Email: btsasia@bayertechnology.com

4. **GERMANY: BERGKAMEN, BERLIN, DORMAGEN, KREFELD, LEVERKUSEN*, WENDELSEHEIM, WUPPERTAL**  
   Markets: Europe and Africa  
   Managing Director: Dr. Dirk Van Meirvenne  
   Phone: +49 214 301, Email: info@bayertechnology.com

5. **INDIA: MUMBAI**  
   Markets: India, South Asia as a whole  
   Regional Head: Matthias Rauck  
   Phone: +91 22 2531 1949  
   Email: btsindia@bayertechnology.com

6. **MEXICO: MEXICO CITY**  
   Markets: Mexico, Central America as a whole  
   Regional Head: Dr. Jan-Thomas Leu  
   Phone: +52 55 5728 3016  
   Email: btsmexico@bayertechnology.com

7. **RUSSIA: MOSCOW**  
   Markets: CIS  
   Regional Head: Dr. Evgeny Belov  
   Phone: +7 495 234 2000  
   Email: btsrussia@bayertechnology.com

8. **SINGAPORE**  
   Markets: Southeast Asia, Australia, New Zealand  
   Regional Head: Dr. Olaf Stange  
   Phone: +65 6496 1888  
   Email: btssea@bayertechnology.com

9. **USA: BAYTOWN, BERKELEY, NEW MARTINSVILLE, PITTSBURGH**  
   Markets: United States, Canada  
   Regional Head: Jim Stephanou, Phone: +1 281 383 6000  
   E-Mail: btsamericas@bayertechnology.com

10. **UNITED ARAB EMIRATES: DUBAI**  
    Markets: Middle East  
    Regional Head: Dr. Ulrich Wenzel  
    Phone: +971 4 887 1112 Ext. 212  
    Email: info@bayertechnology.com

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Bayer Technology Services
51368 Leverkusen, Germany · EPI-Info@bayertechnology.com