

# Industry Journal

Topics, trends, and technologies for decision makers in manufacturing

## Competencies for the future of manufacturing

### The human factor


As production methods change, so do the demands made of the workforce – from employees to the CEO.

### Spanish miracle

The industrial enterprise Mondragón emphasizes high tech, codetermination, and consensus – with impressive results.

### Recycled energy

Process heat and kinetic energy are often lost in production. New technologies can change that.

A young man with dark hair, wearing a grey cardigan over a blue shirt, is looking thoughtfully to the left. He is holding several white papers in his hands. The background is a bright, slightly blurred indoor setting.

**»Our people's  
know-how and  
qualifications  
are key.«**

# Editor's note

Siegfried Russwurm  
CEO Siemens Industry



## Dear readers,

When people talk about the future of manufacturing, they usually mean the increasing digitization of production, networked product development and production processes, and the rising demands made of employees and management that result from those changes.

In discussions with customers, employees, and politicians alike, I find that they often have the same fear – that people will soon vanish from the factory floor and machines will take over. But in the production scenarios of tomorrow, employees will not play a smaller part – but rather a much larger role than today.

Today many executives already regard their employees as knowledge workers. For the future of an enterprise, the know-how and the qualifications of its people are what really matter. Anyone employed in manufacturing has to be able to deal with an increasingly wide range of responsibilities and greater complexity.

Qualification is becoming the dominant factor in success – for economies

and companies alike. And management will also have new tasks to deal with. The key will be to use new HR management methods to build a highly qualified workforce for the production of the future.

In addition, the digitization of production generates enormous volumes of data, on the basis of which the right decisions have to be made – under time pressure.

And, finally, most companies have more and more complex value and supply chains – not to mention the demanding management of volatile markets and the increasingly individual requirements of customers.

In this *Industry Journal* we put the focus on people and the importance of having a highly qualified workforce that is ready for the future.

I'm sure you'll find it an interesting read.

**Best regards,  
Siegfried Russwurm**



10

# Competencies for the future of manufacturing

## 10 The people are key

Highly networked, flexible, rapid, and individualized: this is what manufacturing will look like in the future. Advances in technology are raising the demands placed on employees and managers. Highly qualified employees and managers are becoming a key factor for success – and a locational advantage for economies with top-notch educational systems.

## 18 The next generation: Help wanted – lots of it, soon

Demographic change means that more expertise and experience than ever are being lost in industrialized countries. Generation Y should close this gap. But companies have to understand Generation Y to attract its members – and are finding that to be a real challenge.

## 06 Big picture

The Neumayer III research station is located in the Antarctic's eternal ice. Siemens Industry's technology enables polar and marine scientists to perform their challenging work.

## 08 Spotlights

Steel strip, gear units for coal-fired power plants, knee implants, employer rankings, hybrid airplanes, and software agents

## 46 What is the job of a ...

Condition Monitoring Expert?

22



# Management

## 22 Strategies for success in global competition

New customers and new competitors from emerging and developing countries call for new corporate strategies. An essay by Olaf Plötner, a professor at the European School of Management and Technology in Berlin.

## 26 Digital education

A new form of online learning is taking over the world: Millions of people are enrolling in high-quality, mostly free online courses offered by elite universities and enterprises. Skills 2.0 – a business model with a future.

# Contents

## 30 Company to watch: Mondragón

Democracy as a formula for success: The Spanish high-tech company is just as successful as it is unusual.

## 58 Company to watch: SpaceX

Founded by multimillionaire Elon Musk, this new U.S. corporation makes space rockets at low prices.

## 78 Bookshop

Books worth reading:

Power, Physics of the Future, Passion & Purpose, Ever since I was a young boy I've been drawing cars

## 80 Imprint



## Markets

### 36 Cars made in China

The Chinese car market is booming. Western manufacturers, in particular, are reaping the rewards, but Chinese manufacturers are catching up.

### 42 The flavor of success

Beer made by small, local breweries is taking the U.S. market by storm. Their recipe for success? Combining traditional craft brewing with the latest processing technology.

### 48 Resource-saving robots

Fluid motions can dramatically reduce energy consumption. New software is optimizing trajectories.

### 52 Investment program

Australia is providing businesses with lavish support as they retrofit to cleaner technologies – improving competitiveness and climate protection.

### 54 Good hope on the Cape

South Africa has the largest and most developed national economy in Africa. Its geographic situation and a middle class with open wallets make the country attractive to businesses.

## Innovation

### 64 Energy recycling

Industry loses the majority of energy used in production in the form of process heat and kinetic energy. New technologies aim to change this.

### 70 »Patents are assets«

An interview with Beat Weibel, the head of Intellectual Property at Siemens, about the challenges of protecting and exploiting innovations.

### 74 Graphene – a material that promises wonders

Ultra-light, extremely strong, flexible, and a superconductor – graphene is a new material that could revolutionize many industries.



# Big picture

## The knowledge that came out of the cold

The Neumayer III research station of the Alfred Wegener Institute Helmholtz Center for Polar and Marine Research is the primary German research facility in Antarctica. It is located on the Ekström shelf ice in the Weddell Sea and is one of the most advanced research platforms on the icy continent. Scientists conduct research here on a wide range of projects all year round. A variety of monitoring systems are available to them, including meteorological, geophysical, and air chemistry observatories. Polar researchers use these systems to seek answers to current questions: How is the global climate changing? Where is an earthquake happening right now on the planet? How much ozone is currently in the atmosphere?

In a land where the ice never melts, the availability of spare parts and service calls is limited. That's why the quality and reliability of the research station's building control technology is especially important. The central controller – a Simatic S7-313C PN/DP with remote access – is linked with all critical systems like the recooling plants, the emergency diesel generator unit, the snow melting unit, the fuel depot, and the climate-controlled container. Thanks to redundant networking using the Profinet Ethernet standard, additional subsystem controllers are not required.



# Spotlights



Arvedi ESP plant at the site of Siemens' partner Acciaieria Arvedi SpA.

## Endless steel strip

An extremely energy-efficient production process for steel strip will soon be launched in China. Siemens is supplying two Arvedi ESP (endless strip production) plants to a Chinese steel producer. The combined casting and rolling facility will produce up to 5.2 million tons of high-quality, ultra-thin, hot-rolled strip annually. The process uses up to 45 percent less energy than a con-

ventional plant with separate casting and rolling stages and also results in a substantial reduction in CO<sub>2</sub> emissions. The facilities will enable the steel producer to exploit new domestic and export markets for high-quality ultra-thin strip products. Commissioning is scheduled for 2015, with Italian company Acciaieria Arvedi SpA providing support with start-up and operations.

## Gear units for coal mills in India

Siemens will supply 60 Flender gear units for vertical coal grinding mills to Bharat Heavy Electricals (BHEL). The state-owned Indian utility headquartered in New Delhi is regarded as one of the country's leading builders of power plants and energy technology. BHEL has opted for reliable vertical mill gear units from Siemens for its planned construction and expansion of several coal-fired power plants. The optimal load distribution achieved through the combination of bevel gear stage and planetary gearing ensures a high torque for driving the vertical grinding mill. Coal grinding is the first stage of energy production in a coal-fired power plant. By supplying such a large number of gear units on short notice, Siemens is helping its client BHEL develop the electricity supply in India.



BHEL is counting on Siemens gear units to drive its vertical grinding mills.



Producing an artificial knee joint using a CNC machine.

## Personalized implants

Anyone needing an artificial knee joint generally has to resort to a standard product. To get a good fit, the surgeon has to modify the knee bone itself, not the implant. Until now – because Siemens Corporate Technology, in collaboration with Siemens Industry and Siemens Healthcare, has now completed a joint technology project that developed a method for manufacturing cost-effective, patient-friendly artificial knee joints. For the first time, the new process will allow the highly automated fabrication of personalized joints. In an end-to-end process, the patient data are

first used to produce a bone model and then a model of the prosthesis. Next, Siemens PLM Software NX CAM is used to compile the NC program for the CNC machine. The knee joint is then fabricated with pinpoint accuracy on the Sinumerik-controlled machine tool on the basis of a three-dimensional image of the patient's knee from a computer tomography or magnetic resonance imaging scanner. This means that the integrated solution can create an anatomically tailored implant in a matter of hours. Comparable manual construction would take up to two days of engineering manpower.





Women engineers appreciate the creative and dynamic work environment at Siemens.

## Most popular employer for female engineers

Siemens regularly enjoys very high scores in German and international employer rankings. In the latest such poll conducted by employer branding specialist Universum, young female professional engineers voted Siemens AG the most attractive employer in Germany in 2012. Among the reasons cited for their choice were competitive salaries, a creative and dynamic work environment, challenging work, job security, and the pros-

pect of a reasonable work/life balance. For many years, Siemens has been encouraging women to get interested in technical careers: for example, through its mentoring program Yolante (Young Ladies' Network of Technology) for female students with a passion for technology. Today every fourth Siemens employee is a woman and the proportion of female managers has almost doubled since 2002 to more than 15 percent.

## Collaborative agents

It's not just intelligence agencies that benefit from an extensive network of agents; so do modern production facilities. In the plant of the future, rapidly adaptable, distributed monitoring and control systems will be replacing centralized and hierarchical structures. These kinds of software agents allow plant operators to respond more flexibly than in the past to fluctuating market conditions and customer requirements.

As part of the EU-funded GRACE Project, Siemens has worked with partners from the industrial and scientific communities over the past three years to develop and successfully test a flexible control system for the production process. GRACE stands for »inteGration of pRocess and quAlity Control using multi-agEnt technology.« The individual components of the control and manufacturing technologies »communicate« with one another, exchanging information in complex dialogues and according to their assigned tasks. Household appliance manufacturer Whirlpool – also a GRACE partner – is now putting knowledge gained from the project into practice in an Italian washing-machine factory.

## Airplane with hybrid drive system

Today fuel accounts for about one-third of an airline's operating costs, with energy prices on the rise. In the future, energy-efficient electric propulsion systems could help cut fuel consumption while reducing pollutants and noise emissions.

With this in mind, Siemens, aerospace giant EADS, and Austrian light aircraft specialist Diamond Aircraft have entered a long-term research partnership with the goal of introducing hybrid propul-

sion systems for large aircraft and helicopters.

In the summer of 2013, the companies showcased their jointly developed second-generation DA36 E-Star 2 motor glider with serial hybrid electric drive unit.

Siemens developed an integrated drive train for the aircraft consisting of two main components: an electric drive and a generator powered by a small Wankel rotary engine.



Electric flight with integrated drive systems from Siemens.

# The people are key



People or machines – who's going to have the upper hand in the future? The answer is already clear for the production of tomorrow. New technologies will make production more efficient and flexible – and people will control the technologies. However, their responsibilities will change, and with them the qualifications they need to have.

**Production in the future: highly networked, flexible, individualized, and fast. That's impossible without IT – and without qualified workers. Around the world, the demands made of both management and employees are rising. Smart people are increasingly a factor of success.**

A factory of the future: quietly whirring conveyor belts bring workpieces to clinically clean production machines. Small, mobile transport robots zip through the corridors as if by magic, moving materials, transporting parts to storage, or taking care of maintenance work. Orange welding robots work at breakneck speed, but protective cages are no longer necessary because there are no people on the production floor.

A dozen engineers sitting in a raised, glassed-in control room control the machines – or rather, they watch over it all. The hard work is handled by high-performance computers that provide the monitors with a precise graphical representation of data prepared in real time to indicate changes in the production processes – triggered by machines and workpieces that communicate wirelessly with each other and organize themselves autonomously.

That is the picture of the world of production painted by the more apocalyptic prophets. They predict factories emptied of people, alienation, unemployment – but they are doubtless far off the mark. Of course, no one can predict exactly what factory floors will look like a few decades from now. But one

thing is clear: People will not have vanished from them – even though factories are expected to be full of autonomous robots and networked machines and products. »Even in the age of Industry 4.0, we won't have factories without people,« predicts Professor Wolfgang Wahlster, CEO of the German Research Center for Artificial Intelligence (DFKI).

However, the people working in production will have different jobs – less manual labor and more planning, coordination and decision making. That's because even the best computers and machines will never be able to relieve people of the most important thing they do: deciding on the best solution from a number of alternatives, managing unforeseeable events, or deriving new and creative ideas from experience – for products, shorter throughput times, smaller inventories, or quality management, for example.

### **Management's responsibilities**

Management will also have new and quite different responsibilities. More so than today, this will involve getting complexity under control, dealing with the constant flood of data, filtering and evaluating information,

deriving activities from that information, and coordinating the links of an ever more complex value chain. Many executives will have to give their organizations a new structure and introduce and use new leadership methods.

In light of the changes to job descriptions for people at all hierarchical levels, another fact is also becoming clear: The workforce of the future will need skills different from those it has today. »The jobs of traditional production workers and knowledge workers are growing together« is one finding of the study »Production work of the future – Industry 4.0« compiled by Fraunhofer IAO. It is based on a survey the Fraunhofer Institute did of 700 German companies and industry experts.

One of the reasons for the fundamental changes on the horizon is the convergence of virtual and real production, including overlapping processes in all production steps. At the same time, a quantum leap is expected in industrial production – driven by Cyber Physical Systems (CPS). These involve products equipped with processors, sensors, and wireless communications; they communicate with each other and with the production machines, orga-

»



In the intelligent, networked factory of the future, solid IT skills will be indispensable at all levels. Employees will also use tablet PCs to organize workflows and retrieve important information online.

nize themselves, and are partially self-optimizing. In this world, central controls are gradually being replaced by decentralized systems.

The complete implementation of digital production is a continuing process that will go on for decades. It promises to bring greater flexibility in production, increased productivity, and improved quality. Many experts see digital production as a prerequisite for keeping jobs in high-wage countries. That's because companies will not locate where wages are lowest and government subsidies highest in the future, but rather where they are best able to find suitable, highly qualified employees. »The availability of talented employees is becoming the single determining criterion for companies' success and wealth,« notes Deloitte Consulting in its study, »The Future of Manufacturing«.

This situation is made more serious by the fact that employees' responsibilities will change, moving from the job profile of someone who executes tasks to the greater responsibility of one who controls, operates, and plans. Many production processes will be Internet-based and operate under decentralized control, and all steps in the value chain will be networked with each other. It will be possible for workpieces to navigate independently through all the stations of the manufacturing process, for example – from the first supplier to final assembly in a plant that might be located hundreds or even thousands of kilometers away. And in addition to the factory of steel and concrete, a digital copy always exists in the computer as well, with which all products and production processes can be planned, simulated, and optimized in real time.

The consequence for employees: Traditional factory work will be less necessary in the future. Instead, retooling, maintaining, and repairing systems will play a greater role. »In Smart Factories, highly individualized products will be manufactured in small lots. One key task to be carried out by employees will be to manage the constant modification of production lines in the shortest possible time or to secure them by integrating new components via Plug and Produce,« says DFKI CEO Wolfgang Wahlster. That's why, in the future, almost every employee in production will have to know what the Internet Protocol (IP) is, how to operate a WLAN, and where new sensors should best be located.

### Information through data glasses

Employees will also have to deal with new user interfaces. Where today the status of a machine is often indicated by three lamps in the colors green, yellow, and red, ubiquitous sensors will soon provide a more detailed picture on the monitor of a smartphone or tablet PC – or display the information on the lenses of smart glasses. This information must be understood, assessed, and utilized. That means that employees in production will often have to satisfy much greater requirements.

The flood of data is not limited to individual machines: By networking all systems and steps in the value chain, the factory of the future will always have an up-to-date, overall picture of production. »Based on this data, computers can calculate the optimal value flow in real time,« says Wolfgang Dorst, area head for Industry 4.0 at BITKOM, Germany's IT industry association. »For employees in production, that means that they have to acquire system skills and understand what happens in such networked manufacturing processes.«

In the future, a simple adjustment made to one machine can have fundamental consequences for the overall process due to the tighter

mutual dependence of all production steps. Technology will also support employees on the production line: Simulations can display on monitors, tablet PCs, or smart glasses just what influence a planned change to a system will have and let you consider alternative scenarios.

Will industry primarily need a mix of trained workers and engineers in its future factories? The multinational human resource consulting company Manpower sees the age of »gray-collar workers« on the horizon.

Until now, production employees could be divided roughly into two groups: blue-collar workers, who operate the machines, and their white-collar colleagues – typically engineers or managers who take care of the planning and operation of entire factories.

### Gray-collar workers

This division is becoming obsolete. According to Manpower, more and more production jobs are being created for which workers on the production line must program and maintain networked machines and return them to operation if a fault occurs. In addition to programming skills, the new gray-collar workers must also be able to interpret complex data and work in teams with members of management.

The softening of this once rigorous division of labor is becoming more and more widespread – in a modern Chevrolet plant in Detroit, for example. »It's hard to say who is management and who's a worker – who works in production and who runs the plant,« says Diana Tremblay, Global Chief Manufacturing Officer at General Motors. »Everyone is involved in solving problems and drawing cause-and-effect diagrams. Just looking at them, you can't tell them apart.«

Constanze Kurz, who works for the Managing Board of the German labor union IG Metall and is responsible there for new technology trends, has made similar observations. »When I

see executives and workers standing together in production today, they talk as equals, and you can no longer tell them apart by looking at their clothes. That is a social and cultural change – not just a technical one.«

Of course, society and businesses still have some work to do to enable this change process on a broader basis. For the BITKOM expert Dorst, new job profiles such as that of the mechatronics engineer are a step in the right direction. »Here, existing vocations are linked with something overarching. For the Cyber Physical Systems of the future, however, we will need an even stronger emphasis on IT skills and the ability to work with the cloud – because that's where many processes will take place,« he notes.

The union official Kurz also sees the mechatronics engineer as an example of a qualification that matches the needs of Industry 4.0. »Integrated degree programs are a good way to combine vocational training with academic studies. Participants learn a core vocation, to which additional qualifications can be added.«

The German program for occupational training is now recognized internationally as a model to be emulated. In his State of the Union address in 2012, for example, U.S. President Barack Obama praised a Siemens program for the continuing qualification of the company's employees in North Carolina. In addition to Siemens, BMW has also set up training programs in South Carolina for demanding jobs in production.

And the need for training is considerable. In Germany, a country that already has an above-average level of qualification, the IAO study finds that more than eight in ten companies say they need to qualify their employees further to be able to meet the requirements for flexibility in five years.

There is a similar development world-wide. According to a study conducted by Manpower, for example, in 2011 more than 25 percent of the nearly 40,000 companies sur-

## 5 theses on the future of manufacturing

At the Hanover Fair in 2013, Siegfried Russwurm, CEO of Siemens Industry, and Thomas M. Döbler, Partner and Head of Manufacturing at the consultancy Deloitte Deutschland, presented five theses about the future of manufacturing. Together with the World Economic Forum, the researchers at Deloitte had compiled the report »Manufacturing for Growth – Strategies for Driving Growth and Employment.« For the report, CEOs in Germany, the U.S., Brazil, China, India, and Japan made concrete suggestions about how the political sphere can further the competitiveness of the manufacturing industry.

### Five key elements of the discussion:

- The manufacturing industry remains a central driver of growth and wealth. For Western industrialized nations, that implies a serious challenge, since high-quality products are increasingly also being produced in emerging countries.
- The middle class is growing, particularly in emerging nations. That is creating new centers of demand and renewed competition among production sites.
- The most important competitive factor will be employee-driven innovation – putting the topics of innovation culture and research resources into stronger focus.
- Employees are becoming the core factor of success. This includes the availability of researchers, engineers, and other skilled employees, the quality of schools and universities, as well as immigration policies that reflect current needs and are clear and focused.
- Tomorrow's customers expect profound product benefit, high speed of delivery, and professional service.



## People count

»How important will human work be for your production in five years?«



**Important/very important: 96 %**  
**Somewhat important: 3 %**  
**Unimportant: 1 %**

Source: Fraunhofer IAO 2013.  
 Survey of almost 700 German companies.

veyed in Europe, the Middle East, and Africa said they had problems filling open positions due to a scarcity of trained workers. In Japan, that figure even rose to 80 percent.

According to the study »Manufacturing the Future« done by the McKinsey Global Institute, by 2020 there will be more than 40 million openings for qualified employees in production. The regional availability of trained workers could turn into the biggest challenge faced by economies and businesses.

Politicians have a role to play here, too. In the UK, companies are currently going on the offensive on behalf of more training and education. In June 2013, an association of the largest manufacturers in the country, among them Siemens, the BIT Group, and BAE Systems, called for a Skill Strategy to get the country's education system ready for the needs of the future.

And in July 2013 the Australian government earmarked the equivalent of €32 million for a Skills Connect Fund, from which companies can finance qualification and continuing education measures to help their employees stay competitive.

### The C-level is adapting, too

It is not just the employees on the production line who have to adjust and learn new skills – the C-level has to do the same. »CEOs and CFOs have to learn to develop new models of collaboration with their partners – models that let everyone benefit,« says Udo Lange, vice president at the consultancy Capgemini. »In the future, companies will be integrated in larger networks that can change very quickly and flexibly from order to order.« According to a recent McKinsey study, two-thirds of executives around the world view changes in the value and supply chains as a growing risk in coming years.

New, closer models of collaboration with external partners require trust and openness – but also the ability to protect company secrets. Businesses

cannot depend on the judgment of individual top-level managers here – they have to use IT-based systems that enable knowledge sharing while also limiting openness in the right places.

### Channeling the flood of data

The networking and digitization of production offers great opportunities, but it may also prove to be a challenge – when the enormous amount of data comes to top management in real time from the sensors installed everywhere. To ensure that management does not drown in this flood of data, computers must filter and personalize the information. »Ideally, the analytical algorithms will deliver a recommendation for the next step,« notes Capgemini expert Lange. »In this way, for example, a computer could supply recommendations for new investments or market-related measures on the basis of market information.« However, even the best software cannot relieve management of the responsibility to evaluate this information and these recommendations and to make a decision about them.

A new type of manager could soon be responsible for that: the Chief Data Officer (CDO), who takes care of big data and analytics. The CDO has to create the right conditions in the company to ensure that other members of management are supplied with the right information at the right time. Recommendations made on the basis of old data could be disastrous.

### Versatile boss of data

The CDO does not need to be an IT specialist. »It is much more important that the CDO understands how to recognize trends on the basis of reliable information, draw conclusions, and derive recommendations,« says Lange. »I envision a manager with a background in business management who has additional qualifications in IT and trend research.«

But even perfectly prepared information is useless if executives ignore it or



U.S. President Barack Obama during a visit to a Siemens plant in Fort Madison, Iowa. In his State of the Union address, he later praised the Siemens program for further qualifying production employees (above). Flexibility, computer skills, and broad-based education and training are becoming increasingly important at all levels of the hierarchy. The stereotypical picture of workers in production and engineers in the office will soon be a thing of the past: The future belongs to the gray-collar worker, a symbiosis of trained workers and technicians (below).

do not use it for their decisions. »The fact is that many people – including managers – do not like to work with data,« says management professor Donald Marchand of the Institute for Management Development (IMD) in Lausanne (see interview on page 16). For that reason, they have to be forced »to depend more on a formal analysis of information and less on their gut feeling,« he points out.

With the increase in the amount of available data, it could also be possible in the future to create simulations of even very complex socioeconomic or technical systems and use them more intensively as the basis for management decisions. At the prestigious Swiss university ETH Zurich, for example, the project FuturICT is currently generating a kind of digital image of the world. Companies could use it as a sort of digital wind tunnel to test and optimize products and services at a low cost.

A further challenge for management is presented by more volatile markets, which require greater flexibility. »Customer demand will vary more strongly and at shorter intervals – not over weeks or months as in the past, but rather within days or weeks,« says Sebastian Schlund, one of the authors of the Fraunhofer study of production work in the future.

### Flexible personnel deployment

According to the study, about a fourth of all German companies are already dealing with strong fluctuations in their personnel needs. Some 48 percent anticipate that these fluctuations will be considerably stronger in the future. More and more often, companies are being forced to secure their ability to respond to market changes through the flexibility of their personnel deployment. »In addition to flexible automation, these companies also need flexible personnel,« says Schlund.

The surveyed managers agree – for 95 percent of them, the flexible deployment of production personnel is already important. And in five

»



# »Human cognitive abilities will always be indispensable«

**Professor Donald A. Marchand of the International Institute for Management Development (IMD) in Lausanne, Switzerland, collaborated with Professor Joe Peppard of Cranfield University in England on a study of more than 50 international companies. The study was aimed at finding out how organizations can make creative use of data from IT projects and how teams should be put together in the future. Our interview is a conversation about cognitive deficits, human cognitive abilities, and tax evasion.**

## **What skills will people need in the future to handle IT projects successfully?**

In the past 15 years, the focus for IT specialists was on the left side of the brain and its analytic abilities. It was all about knowledge in the areas of engineering, math, and computer science. That will remain important in the future. However, we will also need experts in human behavior who know how people learn and process information. This can be compared with the emergence of behavioral economics a few years ago: The Nobel laureate in economics Daniel Kahnemann made use of psychological and cognitive approaches to explain the behavior of people – and replaced the image of market participants who act on a strictly rational basis. We need to apply this approach to IT projects.

## **Why is that more important than in the past?**

Because today's IT projects are different from past ones. In traditional projects, for example the installation of a CRM or ERP system, the requirements and objectives were clearly defined going in, and the team implemented the solution step by step. In today's big data

projects, the objective is not set beforehand. No one knows up front with any reliability what decisions the new tools will support and what questions they will answer. That's why it is so critical to understand how people generate and use information.

## **What is important in practice?**

First, people have to ask the right questions and select the right data as the basis for evaluation. Moreover, results can be influenced by the expectations of the team members and those who commissioned the work. And finally, the corporate culture plays a major role: It's important that employees share their knowledge and derive solutions for their business processes from the information gathered.

## **So should IT project teams also include psychologists?**

In addition to the technical experts, we certainly also need team members who understand the mechanisms of human motivation and learning processes. These people can help their colleagues overcome ingrained ways of thinking. The idea here is to meet future challenges in a creative and exploring manner.

## **Could you name an example of a successful IT project?**

The British tax authority, HMRC, asked organizational psychologists to support their analysts in interpreting data. As a result, the HMRC was able to dramatically increase inheritance tax revenues. That's because the mixed teams developed a method of automatically identifying fraudulent tax returns. And it wasn't the technology that was critical – it was primarily a matter of understanding the psychological mechanisms typical of tax dodgers and taking the decision-making behavior of tax officials into account.



Donald A. Marchand

## **IT systems are also playing an increasingly important role in production. What significance do your findings have for manufacturing?**

In the future, workers will be confronted with massive amounts of data and very advanced technologies. That's why it is so important that they understand how their brain deals with this data and how they themselves formulate hypotheses about potential problem solutions. The challenges faced in production in the future will largely be data-driven, and it will only be possible to solve them by analyzing this data.

## **Wouldn't it be better to leave this analysis to the computers?**

Computers are unbeatable in analyzing large volumes of data. However, it is still important to ask the right questions, formulate hypotheses, and draw the right conclusions. That means that human cognitive abilities will remain an indispensable part of the process in the future, too. Even the most sophisticated algorithm can't replace it.



# Leading edge through education

No country in the world spends more for education than Korea, Norway, and the U.S. However, even among these three, expenditures come primarily from public sources only in Norway.

## Expenditures for education

Country	Total <sup>1</sup>	Tertiary area (universities, etc.) <sup>1</sup>	Share of public financing of tertiary area <sup>2</sup>
Korea	7.7	2.6	22
Norway	7.3	1.7	97
USA	7.2	2.7	37
Canada	6.0	2.5	59
France	6.0	1.4	82
<b>OECD average</b>	<b>5.9</b>	<b>1.5</b>	<b>69</b>
Mexico	5.8	1.2	70
UK	5.7	1.2	34
Brazil	5.3	0.8	No data
Australia	5.2	1.5	43
Spain	5.1	1.2	80
Japan	4.9	1.5	33
Germany	4.8	1.2	85
Italy	4.8	1.0	71
Russian Federation	4.7	1.5	63
China	4.3	No data	No data

<sup>1)</sup> In % of GDP 2008. (2) In % of total for tertiary area  
Source: OECD education report 2011

years, 98 percent believe it will be a key factor in their success.

Flexibility in the deployment of personnel requires employees who are ready and willing to adapt to the new requirements – which often mean changes that impact the way they plan their personal lives. Much like the situation in service industries and in management, the line between private life and work is becoming less distinct for employees in production as well.

At the same time, the more flexible deployment of employees requires fundamentally different forms of personnel planning. The more extensive use of temporary workforces will solve this problem only to a slight degree due to the high level of qualifications

required in the future. More important for ensuring greater flexibility will be having well-trained employees whom a company can quickly loan from one work area to another: »Loaning employees in this way is an instrument that makes it possible to quickly generate flexible capacity from within the core workforce,« notes the Fraunhofer IAO study.

### Broader-based qualifications

This flexibility requires that the workforce have broad-based qualifications. Only then are employees able to take on a series of different activities without long start-up times. Managers see this development coming, too: More than 73 percent say that in five years it

will frequently be necessary to deploy their production employees in response to needs in other organizational units than their regular work area.

In the future, HR departments will frequently have to deal with matters such as the flexible assignment of responsibilities and flexible structuring of working times.

Of course, the most perfect plans and models will not help if they have not been reliably negotiated for the long term with employees and other collective bargaining partners. Above all, however, the entire workforce must stand behind these agreements. And that suggests another central task for top management in the future – as communicators and motivators. ■

# The next generation: Help wanted – lots of it, soon

The demographics are merciless. In most industrialized countries, more managers than ever – along with their wealth of experience – are retiring every day, just when a solid knowledge base is increasingly important for production. Companies must now turn to designated successors from Generation Y. But they often have completely different ideas about work life than their predecessors.



Companies must develop a strategy so they can systematically manage valuable resources such as their knowledge, skills, and experience and pass them on to prospective managers from Generation Y.

Every day of the year, some 10,000 Americans born between 1946 and 1962 retire – and with those Baby Boomers goes a lot of knowledge and experience. Things don't look much better in other industrialized countries. The group of 50- to 64-year-olds makes up about 20 percent of the population in the European Union today.

The exodus of experienced employees from U.S. industry couldn't come at a worse time: The manufacturing industry is currently experiencing a comeback, and high-quality industrial products »made in the USA« are in great demand. More and more companies are making reshoring plans to bring outsourced production facilities home from low-wage countries.

### Loss of know-how

This industrial renaissance is now at risk as the change of generations threatens a serious loss of experience and knowledge. This combination of knowing what to do (know-how) and knowing facts (know-what) cannot be archived, and the conditions must be right in order for it to be passed on to successors. Companies fear

that this age-based loss could put the brakes on growth.

McKinsey & Company, a corporate and strategic consultant, predicts a worldwide shortage of 40 million skilled employees by 2020. This will affect aging societies in particular, including China. The need for manpower in developed countries will increase 0.7 percent annually – but the number of job candidates will decrease for demographic reasons.

According to a survey by Deloitte Consulting and The Manufacturing Institute, a U.S. think tank, some 67 percent of U.S. manufacturing companies were already complaining of a lack of qualified employees in 2011. More than half of these companies feared that the situation would worsen in coming years. Those concerns are reflected in the »Smart Manufacturing and Competitiveness« report by the American magazine *Industry Week* in collaboration with Siemens: Forty-one percent of managers consider recruiting and retaining qualified employees to be their greatest current challenge (see graphics on page 21).

This situation has led to a need for conversations and consulting all over the world. At the World Industry Forum in Orlando, Florida, USA, industry experts at the »Next Generation Workforce« workshop presented by the ARC Advisory Group held an intensive discussion on how companies can transmit know-how, a valuable resource, from generation to generation.

### Managing skills and abilities

Companies must have a knowledge- and skills-management strategy coupled with practical implementation, says Dick Hill, general manager and vice president of ARC. For practical implementation, he advises setting up centers of excellence that include networks from within the company and key contributors from outside. Inspired by leadership from the top, they will contribute to collecting and disseminating know-how among their peers. Hill says that individual learning styles must also be taken into account when training employees. He recommends using new experimental learning methods, and adds that mentoring programs have also made it easier for new, less



experienced employees to get started at companies.

## Filling the gaps

The members of Generation Y, born between 1981 and 2000, will play a key role in the companies of tomorrow. They are the new employees who will fill the gaps left as the Baby Boomers retire.

Boomers are considered to be particularly performance-oriented, career-minded, loyal, and consistent, while Generation Y has a completely different image. It is associated with attributes such as an orientation to leisure, the work-life balance, and self-determination. At the same time, Generation Y is very demanding where jobs are concerned. International studies show that professional challenges, opportunities for advanced training and development, reasonable compensation, and flexibility are very important to Millennials when choosing a career.

Companies are being forced to deal systematically with these expecta-

tions. Given the anticipated lack of skilled employees, members of Generation Y are in a strong negotiating position, which they defend confidently and often successfully. According to a study by the HR services company Robert Half International, three-quarters of 2,100 managers in 15 countries agreed with the statement that Millennials ask for higher pay than they are actually worth.

Millennials will quickly go elsewhere if their hopes for a job are not fulfilled. Three decades ago, new employees under age 30 in Germany stayed almost 27 months with their employers, but that time has now shrunk to only 18 months – one-third less – according to a study by IAB, the German Institute for Employment Research.

Naturally, the image of Generation Y also includes the use of new media. These digital natives grew up with the Internet, mobile phones, and MP3 players. In their eyes, smartphones, tablets, and social networking have an importance that many

companies find a bit odd. In addition to the distraction, company leaders primarily fear for the security of their data if employees use company IT systems for personal reasons – or, conversely, use personal communication technologies for their work.

## Using new media

However, a practical approach to the Millennials' enthusiasm for modern communication technologies is in order. Wise companies will leverage this skill set to modernize their own organization, says Valentijn de Leeuw, director of the ARC Advisory Group in Paris: »Like the Internet and e-mails at work, mobile devices in the hands of responsible, independent employees can absolutely be productive.« This means that management must be able to clearly define objectives and expectations, assess progress, and motivate employees, he says.

De Leeuw cites one positive example, oil and natural gas companies that use gaming technology to train operators and maintenance employees. Or a highway infrastructure company that uses smart devices to enable video conferencing with mobile employees. He says it is also worthwhile to consider making the functionalities, look, and feel of user interfaces in production facilities more similar to those of consumer devices. Things like this make an impression on Generation Y.

Industrial companies can also use Generation Y's fondness for technology to present themselves as attractive employers. This will require adapting management styles to the new generation, which is often unusually resistant to hierarchical management concepts and instructions. Millennials are much more likely to question the purpose of the tasks assigned to them than earlier generations were. ■

Modern communication technologies like smartphones and tablets are more than just a tool for Generation Y: They are part of a fundamental attitude to life, whether at work or at home.



## The greatest challenges for companies

(survey of 388 industry experts all over the world)

Attracting and retaining skilled employees	41 %
Knowledge transfer as employees retire/leave	29 %
Aging equipment/equipment modernization	28 %
Manufacturing productivity	27 %
Demand volatility	25 %
Time to market (of new products)	23 %
Supply chain complexity	21 %
Energy costs	10 %
Data management and analytics	6 %

Source: *Industry Week* in collaboration with Siemens: »Smart Manufacturing and Competitiveness,« 2013

## »Breaking down cultural barriers«



Matthew Pettigrew (left), Junior Partner at McKinsey & Company in London, and Ramesh Srinivasan, Director at McKinsey in New York

It is especially difficult for multinationals in emerging economies to find the right young professionals. Well-trained talent is scarce and hard to retain, and competition with local firms is getting tougher. *Industry Journal* spoke to McKinsey experts Ramesh Srinivasan and Matthew Pettigrew about personnel management, employers' brand equity, and the need to build relationships with talented families.

### What strategies should multinationals pursue in order to attract and retain promising talent in emerging markets?

*Matthew Pettigrew:* Global players should play to their strengths. It's tough to take on domestic firms – with their well-established local brands, deep pockets, and high growth rates – on their own terms. A big advantage that multinationals have over local competitors is their ability to offer recruits opportunities to work elsewhere in the world and bright perspectives for their career development. Multinational businesses need role models as living proof that these promises can be fulfilled. Therefore, global organizations should create opportunities for highfliers in emerging markets to lead, even if they haven't served long apprenticeships in a developed economy. And multinationals should also think creatively about the talent sourcing strategies that they pursue –

this could open up new opportunities and avoid the red-hot competition to grab the »usual suspects.«

### In fact, managers from emerging markets are the exception rather than the rule in the boardrooms of multinational organizations. What can companies do to change this situation?

*Ramesh Srinivasan:* There's no silver bullet for developing top talent in emerging markets. Each company has to find its own way. However, experience has shown that it is essential to break down cultural barriers. Many companies have started programs to improve cross-cultural cooperation and understanding, with significant success.

### How can multinationals enhance their brand as an employer in emerging markets?

*Srinivasan:* In any market, the basic ingredients of a strong employer brand will be competitive compensation; attractive working conditions; managers who develop, engage, and support their staff; good communication; and meaningful work. But some degree of local adaptation is often necessary if a company wants to be responsive to very diverse local needs. For example, in some markets, especially in Asia, global organizations are extending the awareness of their brand as an employer by building relationships with their employees' families.



# Strategies for success in global competition

An essay by Olaf Plötner

The competition situation for established technology companies is changing rapidly with the advent of new customers and competitors from the emerging and developing countries. This challenge calls for new strategies for products, prices, and services – not to mention the willingness of companies to transform their own organizations.

Whenever the globalization of markets comes up as a topic of conversation at the dinner table, in expert panel discussions, or in the press, the words *Asia* and *China* are inevitably spoken after just a few minutes. These days, every child knows that economic growth is to be found in the Far East, while the West stagnates.

From the perspective of globally active enterprises, it makes sense to examine two aspects of rising economic prosperity in the emerging and developing countries. First, the strongest growth in these countries is being generated in the low-price market segments. While it is true that sales of premium products are rising in these countries – as evidenced by the unit sales of German luxury automobiles, for example – the biggest demand growth is for automobiles that cost a lot less than a BMW or a Porsche. The same assessment applies to the B2B markets, where the unit sales of Chinese mechanical engineering firms have already overtaken those of German and U.S. companies, because the Chinese products are simpler and less expensive.

### New competitors

This development points to a second trend that established Western companies must learn to address. These new customer segments are producing new suppliers in their home markets, which are now growing in conjunction with their customer base. The new suppliers have extremely low cost structures, due in large part to the fact that they are simply imitating existing technologies. However, many of them are doing more than that: They are investing a high proportion of their revenues in research and development (R&D) in order to improve their performance in terms of quality and innovation to put themselves in a position to serve

the upper-level customer segments in the near future.

Huawei is one of the best examples of this phenomenon. Founded in the late 1980s, this company began to successfully conduct business with their first Western customers in the 1990s. By 2008, it was among the companies with the most patent applications, and in 2012 it invested more than 13 percent of its revenues in R&D. Today Huawei is one of the world's leading suppliers of telecommunications technology, along with Ericsson.

### Premium strategy

In responding to these trends, companies that have positioned themselves in the market as suppliers of high-quality products can choose from among three strategic options. First, they can continue to pursue their premium strategy – even if their relative market share would decline as a result of the growth in the low-end segments. They are placing their trust in their ability to defend their competitive advantages in terms of innovation and quality and are accepting the fact that they are no longer the largest suppliers in their respective industry, in absolute terms.

BMW is an example of this kind of strategic approach. On the scale of the global car market, this company is permanently losing market share, despite the fact that its unit sales are increasing. But BMW has no reason to worry, because the company is so well established in the global high-price segment that it can still earn handsome profits. Other companies that are pursuing this strategy of offering »advanced premium goods« are the optics and optical electronics firm Carl Zeiss, which has 24,000 employees, the technology company Körber AG, with roughly 10,000 employees, and a number of medium-

»New suppliers are growing in conjunction with their customers.«

## Olaf Plötner

Professor Olaf Plötner has directed the international management program »Bringing Technology to Market« at the European School of Management and Technology (ESMT) in Berlin, Germany, for more than ten years (see page 25). Prior to that position, he was a consultant with the Boston Consulting Group. His academic areas of specialization include customer relationship management and communications and marketing strategies in global B2B markets.



sized German enterprises. The many strong medium-sized enterprises are often cited these days as one of the reasons for Germany's economic strength in Europe.

### Low-price strategy

An established company that wants to capture a larger share of the growth in emerging and developing countries may choose the second strategy option of »no-frills technology.« In this approach, a company will add low-price products to its portfolio in order to satisfy the demand from new customer segments. Typically, such customers are looking for prices that are two-thirds less than the prices of similar premium products.

At these price levels, premium suppliers cannot become profitable simply by improving their cost efficiency. Instead, they must develop completely new products. In order to satisfy customer preferences, these

corporate headquarters can be called into question, as in the case of the U.S. telecom company Cisco, which opened a second corporate headquarters in the Indian city of Bangalore back in 2008.

### Service strategy

The third strategic alternative is to increase the offering of »complex service solutions,« meaning services that are highly customer-specific as well as highly complex. These services are of great economic importance to customers. For example, a supplier may design and implement a new IT architecture or plan a new production facility for its customer; or a management consulting firm may develop recommendations for the strategic orientation of a client company.

The problem with this approach is that customers who purchase these products cannot check out the product in advance. Consequently, the supplier's personnel must be all the more competent and trustworthy. In this business, customers are reluctant to accept new competitors, especially those hailing from emerging and developing countries, and that tendency represents an extremely high barrier to market entry. Prestigious, well-established technology companies find it easier to offer such services.

Despite the organizational and staffing challenges involved, Western companies are increasingly resorting to the strategic option of complex service solutions. Voith Paper, the world's largest manufacturer of papermaking machines, now offers consulting services aimed at optimizing the production processes of its customers, independently of its product business. TÜV Rheinland, Germany, is providing more procurement management consulting services to power plants. The French-German-Spanish aerospace company Astrium, which is part of the EADS Group, helps its customers interpret satellite images, in addition to selling satellites.

In addition to the high barriers to entry for new competitors, another

**»Premium suppliers must develop their products in those regions where the demand exists.«**

products should ideally be developed where the demand exists, meaning in the emerging and developing countries. That may sound easy and plausible, but it represents a great challenge because the ensuing global decentralization of development activity entails an organizational and cultural complexity that is hard to manage – and that is only one of the potential problems. Therefore, a company must establish hierarchically flexible, polycentric structures and break up long-entrenched processes. As a result, even the organization of





Making paper from fresh or recycled fibers (left) is a complex process. Voith Paper, the world's largest manufacturer of papermaking machines, is pursuing a comprehensive service strategy, including providing services for maintaining and optimizing the entire paper-making factory (right) – from raw materials to packed paper.

important reason why companies are pursuing this strategic option is the lucrative profit margins that can be earned through these kinds of consulting activities.

### Parallel pursuit of all strategies

Some companies today are attempting a competitive trifecta by pursuing all three options – advanced premium goods, no-frills, and complex service solutions – at the same time. This approach is very demanding, if only because these strategic options call for entirely different business cultures. Business divisions that offer advanced premium goods are primarily characterized by a culture of quality and technology development. Business divisions that pursue the no-frills technology strategy are mainly focused on cost considerations. As for complex service solutions, the chief success factor is a prominent customer orientation. These different approaches require different types of employees, compensation systems, and management methods.

These differences rarely make for simple coordination.

Despite these problems, the parallel approach also creates opportunities for identifying and exploiting synergies among a company's various divisions. For example, the ideas generated in the area of no-frills technology can also be useful in the area of premium products; the brand strength of premium products can influence the confidence that customers place in complex service solutions; and in the process of providing complex services, the company may obtain information about the customer that can be applied to the development of premium goods in order to create competitive advantages.

There are great opportunities for generating synergistic benefits with respect to costs, customer relationships, and technology development. Companies that can take advantage of these synergies will assume a global leadership role in their markets. ■

## ESMT

ESMT, the European School of Management and Technology, was founded in Berlin in 2002 by 25 global enterprises and associations, including Siemens. Today ESMT is among the leading business schools in Europe, offering not only English-language Executive MBA programs for full-time students and working professionals but also continuing education courses in management in both German and English. This international university is housed in the former State Council Building of the German Democratic Republic.



# Digital education

A new form of online learning is taking over the world: Millions of people are enrolling in an entirely new type of mostly free online courses offered by elite universities and enterprises – a business model that could someday benefit educational institutions, companies, and students around the world in equal measure.

The Khan Academy is considered a pioneer in free, global, online learning for all – and serves as a blueprint for programs at elite universities like Stanford and the Massachusetts Institute of Technology (MIT).

You have to be someone pretty special to be invited as a guest speaker in the forum of the venerable New York Public Library. Salman Khan seems more like an average citizen on this summer evening, with his purple checkered shirt and easy laugh. But this affable gentleman is involved in no less than a revolution in education.

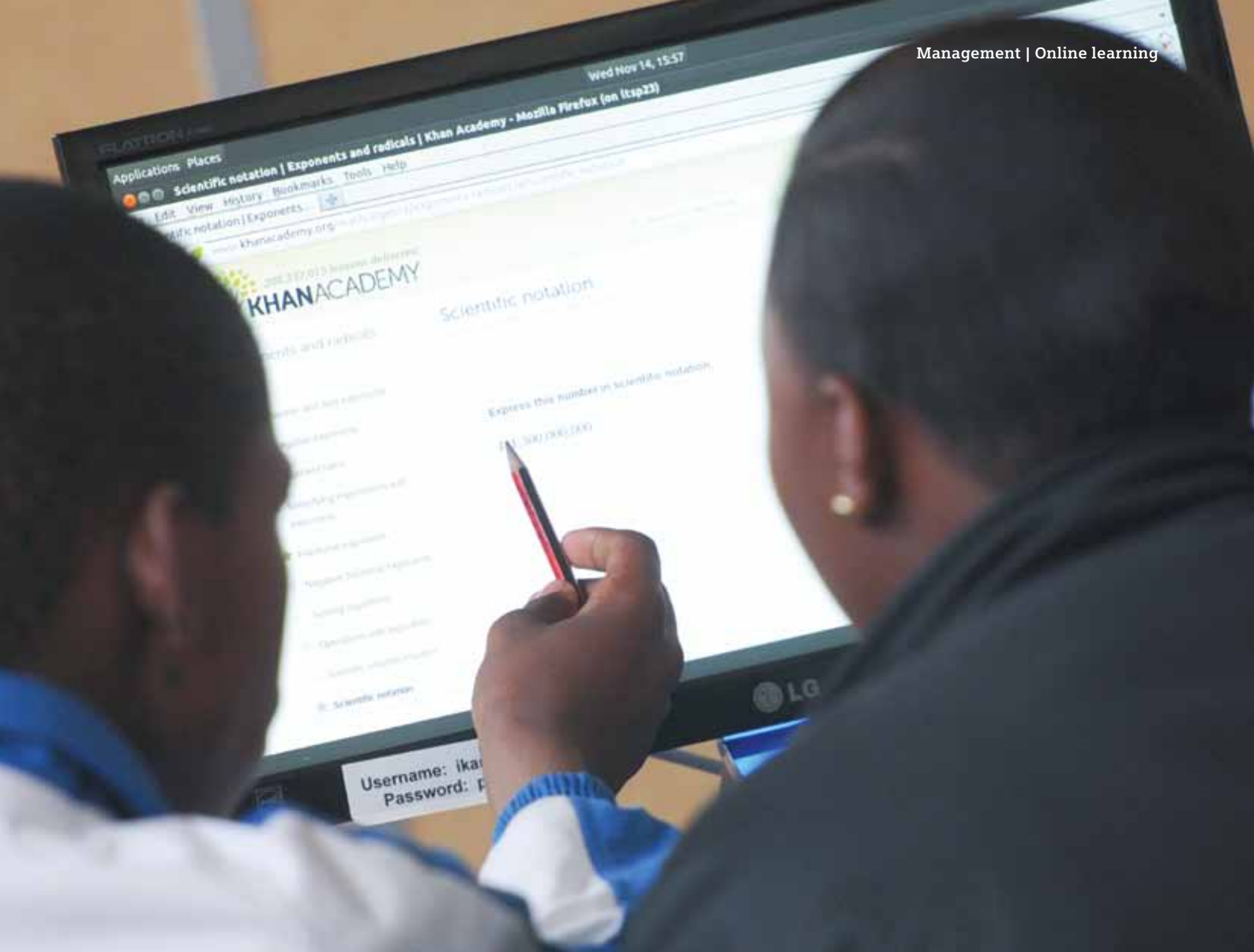
The 36-year-old is harnessing the power of the Internet with unprecedented determination to enable broad-based access to education. Khan has already uploaded more than 4,200 educational videos to YouTube, providing untold thousands with math, physics, and computer science instruction – for free.

»I've already reached more people than Harvard has in 400 years,« Khan remarks, eliciting enthusiastic applause.

The Khan Academy, which is supported by institutions including the Bill & Melinda Gates Foundation, is essentially the pioneer in online learning for all. Now the movement is driven by elite universities such as the Massachusetts Institute of Technology (MIT). And the trend has a name: massive open online courses (MOOCs). In less than two years, MOOCs have evolved from a fringe movement to a trend important enough to make the agenda of this year's World Economic Forum in Davos, Switzerland. In the United

States, colleges are beginning to integrate MOOCs into their curricula, and businesses are using them for continuing education.

Timo Kos, a Dutchman who works for Capgemini Consulting, is one of the first analysts to systematically study the new medium. »MOOCs will dramatically alter education as we know it,« predicts Kos. »Online education will become the new normal.« This means that for schools and universities, the online courses are both a threat and an opportunity. The trend can be a boon for businesses – if better access to education makes it easier to recruit trained specialists and continuing education becomes easier and more affordable.



## New business model

The technology for online learning has been around for at least 15 years in the form of interactive lessons and recorded university lectures. What's unique about MOOCs is not only the sheer number of participants – thousands, sometimes hundreds of thousands learning simultaneously – but the interconnectedness through social platforms: Students discuss among themselves and with the instructors and track their progress through interim goals. MOOCs are popular because they are free and sponsored by prestigious institutions. They are funded through partnerships with educational institutions and businesses. »MOOCs are not a tech-

»

» **Online education will become the new normal.**«

Timo Kos, Caggemini Consulting

# »Universities still often fail to teach the latest technologies.«

Clarissa Shen, Udacity

> 2

million students among the three market leaders

4,200

educational videos at Khan Academy

91

percent completion rate at San Jose State University

nological revolution, they are an innovative business model,« Kos notes.

The pioneer Khan, a former hedge fund analyst from New Orleans with family roots in Bangladesh and India, launched the academy that bears his name in 2006. The educational portal garnered a lot of praise as a philanthropic project but remained something of a niche for starry-eyed idealists. All that changed five years later when Stanford professor Sebastian Thrun, a German by birth, organized a seminar on the subject of artificial intelligence as an online course. The response was overwhelming: 160,000 people from around the world signed up.

## MIT and Harvard invest

Suddenly, the tremendous potential of combining education brands such as Stanford and Princeton with online learning technologies became clear. In January 2012, Thrun founded Udacity, a commercial enterprise dedicated to the production of MOOCs. This began a new wave of startups: Two months later, rival online educator Coursera was launched, a network that initially included four top colleges and has now grown to over 60. In May 2012, MIT and Harvard invested US\$60 million in a startup they christened edX.

About one year after their launch, these three educational portals now reach more than two million students around the world. New MOOC providers continue to enter the fray, such as Vanderbilt University in Nashville (Tennessee). The pioneers in Europe include the Hasso-Plattner Institute (HPI) in Potsdam, which is financed largely by the SAP founder of the same name (see interview, right). Ludwig-Maximilians-Universität (LMU) in Munich also began offering its first online courses this summer: Nearly 120,000 students registered for courses in business management, cellular biology, mathematical philosophy, and volcanology.

Currently, MOOCs still serve largely private interests: Those who enroll

typically seek to brush up on neglected school subjects, fill gaps in their knowledge, or simply pursue their personal interests. Education is no longer a standardized program. It is developing into a personalized commodity that can be shaped into an individualized curriculum – free, high-quality education from instructors who are recognized experts in their field.

But the integration of MOOCs into institutionalized education is already on the horizon. In the US, where the college dropout rate currently stands at around 40 percent, universities are already beginning to introduce MOOCs to streamline or enhance overbooked core curriculum classes. San Jose State University in California, for example, ran a pilot project early this year with basic math courses from Udacity. It has also partnered with edX since the fall 2012 semester to offer beginning electrical engineering courses. The result: 91 percent of students passed the final examination – a tremendous success rate compared to the 59 percent rate among those enrolled in the traditional classroom format. University President Mohammad Qayoumi is already predicting that in five to seven years, education as we know it will be transformed.

## MOOCs for continuing education

MOOCs are also making inroads in corporate continuing education. Udacity has partnered with Google, Autodesk, Microsoft, and others to teach programming languages to their employees. »Universities still often fail to teach the latest technologies,« says Clarissa Shen, Vice President of Strategic Business and Marketing at Udacity. »We can fill this gap.«

And that's just the beginning. In a pilot program at Georgia Institute of Technology (Georgia Tech), Udacity has partnered with telecommunications giant AT&T to develop a masters program for up to 10,000 computer scientists. »Our aim is to provide continuing education to our current employees

and recruit new employees,« explains Scott Smith, Senior Vice President of Human Resources at AT&T.

Many who participate in MOOCs allow the providers to analyze their learning data and sell it to companies or headhunters – with the possibility of receiving job offers down the road. For Udacity, Coursera, and their competitors, this provides a major revenue stream on the path toward eventual profitability.

This business model is a classic win-win-win situation: Businesses find new recruits, universities find new students, and students save a lot of money on their education: Georgia Tech plans to charge about US\$7,000 for its online masters program, about one-sixth of the usual tuition.

For this reason, many critics fear that politicians will misuse MOOCs to slash funding for public education. But this would be shortsighted, for practitioners agree that the potential of MOOCs is limited to a narrow slice of the educational spectrum. »E-learning is well suited for conveying knowledge. But when it comes to modifying behaviors, we achieve better results when students are physically present,« says Mark Braun, Head of Talent Acquisition & Learning Management at Siemens Industry.

Even the best video cannot replace direct, person-to-person contact. Perhaps that's one reason why MOOCs that do not offer an accredited certificate for completion suffer from an extremely high dropout rate. Many people enroll – it's free, after all – but only about 10 percent hang in to the end.

MOOCs offer the greatest potential benefit where traditional educational infrastructure is lacking: in the developing world. In the New York Public Library, Salman Khan talks about his dream of adapting his videos for mobile devices to reach millions more people – because even the very poor often have access to mobile phones. At present, Americans still account for two-thirds of his viewers. »But that will change,« Khan is certain. ■

## »Surprised by our own success«

**Professor Christoph Meinel, Director of the Hasso-Plattner Institute (HPI) at the University of Potsdam, talks about his experience with online learning, the potential for employee continuing education, and cheating on tests.**

**What advantages do MOOCs offer?**

They correct one of the original misconceptions of online learning: that all you need to do is put material online and give people access. MOOCs go much further, offering a fixed educational structure and creating a virtual classroom community in which students can interact with one another through a social networking platform. This goes much further to address the needs of most students.

**HPI has offered MOOCs for the past year, making it a pioneer in Europe. What has your experience been?**

We were surprised by our own success: Over 30,000 students enrolled in our first round of courses – four IT programs in German and English. Of that, 6,200 stayed until the end and received certification.

**Doesn't the anonymity on the Internet almost encourage cheating?**

There is an obvious problem here when it comes to formalized final examinations, since providers don't know who is behind a particular e-mail address. One possible solution is to require students to take the final examination in person.



Christoph Meinel

**You are also experimenting with corporate continuing education.**

SAP uses our platform and began offering its first class for »In-memory technology« in the spring. It was originally designed as an in-house training program but was then opened up to outsiders. Eventually, 5,000 SAP employees and 30,000 non-employees signed up. So businesses can use MOOCs to communicate their content to employees, customers, and consultants.

**Can the new form of online learning also be used to train specialists?**

That depends. You can't train a welder online. But we can train system administrators in a virtual lab. They can gain practical experience and an understanding of basic information.

MONDRAGON

HUMANITY  
AT WORK

GIZATASUNA  
LANEAN

»Humanity at work«  
The Mondragón  
conglomerate does a  
great deal to embody  
its motto.

Finance  
Industry  
Retail  
Knowledge

Finantzak  
Industria  
Banaketa  
Ezagutza

# Business as a democracy

Mondragón, a Spanish high-tech company with 80,000 employees worldwide, has its headquarters deep in the Spanish Basque country. The group, organized as a cooperative, is as successful as it is unusual. Its employees are also owners with co determination rights in the company. Employee-friendly, crisis-resistant, and expanding – how does this work?

Ainhoa Arregi's job is loud. And dangerous. Forklifts carry gigantic containers of molten aluminum heated to more than 600 degrees Celsius. Pressure-casting machines form the liquid metal into transmission cases. And robot arms dip the hot components into quenching vats.

Arregi is a process manager at the automotive parts supplier Fagor Ederlan, which makes components and systems for almost all of the major automakers with plants in the Spanish Basque country and at 15 other locations worldwide. A total of 3,500 people work for the company, whose latest annual revenue was nearly €700 million. Revenue is projected to be about €19 million lower at the end of 2013, but Arregi serenely accepts this. »We don't have to keep our shareholders happy,« she explains, standing near the pressure-casting machine. »We workers decide for ourselves what's good for the future of our company.« This also includes the current expansion strategy, she says.

### Elected by the shop floor

Arregi, a Basque, explains this while standing next to the managing director. Mikel Uribetxebarria, who wears a gray, somewhat wrinkled shirt and has an unassuming appearance, heads Fagor Ederlan, a company in the cooperative group Mondragón Corporación Cooperativa (MCC). Uribetxebarria was elected to a four-year term by the people on the shop floor, and he must ask his fellow employees for their votes again at the end of that term. This is because employees have owned the automotive supplier since it was created 50 years ago, and they decide who takes the helm.

Grassroots democracy in an industrial company is unusual. One result of this is that Fagor Ederlan is currently

managed by Uribetxebarria, a technician, along with Board members who are also bookkeepers or members of the sales force. »Conventional companies underestimate the fact that a mixed team that has sufficient information and a clear orientation can make very good business decisions,« says Uribetxebarria. When major decisions are on the table, the elected members of the Board meet with 50 employee representatives. They talk things over, weigh the possibilities, disagree – and finally make a decision. »Of course, you often have long discussions,« says Uribetxebarria, »but after that everyone marches to the same drummer.«

### Employee-owned

These principles also apply to other companies in the Basque Mondragón Corporación Cooperativa, the largest cooperative in the world, whose headquarters are in the mountainous region of northeastern Spain. Known as Mondragón for short, it is a global conglomerate with revenues of €12.9 billion in its industrial and retail divisions. It is the seventh-largest industrial company in Spain and, with total revenues of some €14 billion, the tenth-largest company in Spain. Like Fagor Ederlan, Mondragón belongs to its employees, who share in both management and profit and also have a voice in running the company.

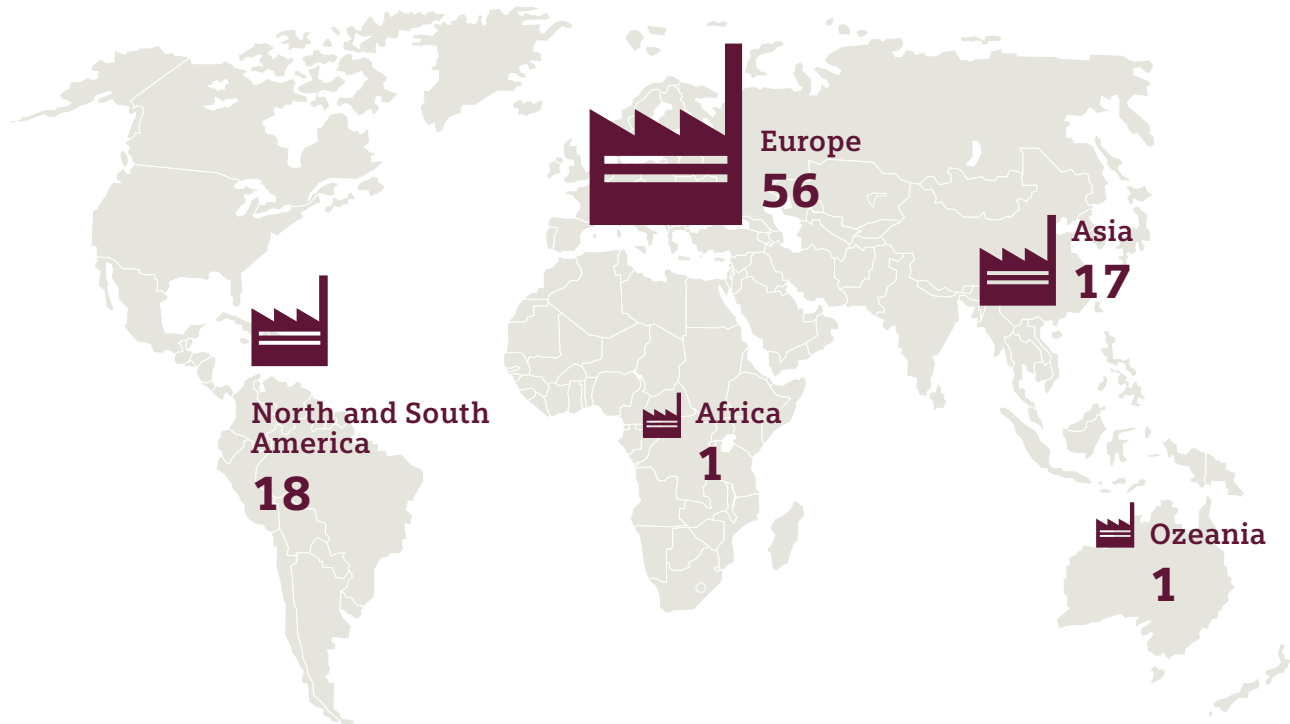
The name of the company comes from the small medieval town of Mondragón, located in the hills of the Basque country some 50 kilometers from the city of Bilbao. The drive to Mondragón leads through many tunnels and across vertiginous bridges. Farms climb the steep green meadows, often under a drizzling rain. The heart of the cooperative beats here in Mondragón.

This remote region has hosted many visitors recently: academics, students,



Ainhoa Arregi, process manager at the Mondragón factory Fagor Ederlan (above). The automotive industry supplier makes products like transmission cases from molten aluminum (below).





**Mondragón production sites**  
(2011)

managers, and journalists who seek to understand what makes Mondragón so successful during these tough economic times. Professions of respect come from all sides, not just liberals on the left. For example, the Chicago Manufacturing Renaissance Council (CMRC) has said that Mondragón is a company that others can learn from.

### Expansion into new markets

Most sales by the cooperative group – whose motto is «Humanity at Work» – have always been in the area of industrial production, which has proven to be extraordinarily resistant to past crises. In contrast to most other Spanish companies, Mondragón has not laid off any employees, even during the present crisis. In spite of a tight world economic situation, the company continues to expand and is investing in new products and markets. Mondragón employs more than 80,000 people all

over the world, 85 percent of them in industry. The proportion of women, at 43 percent, is relatively high.

Unlike a monolithic group, Mondragón is an association of many individual cooperatives. They are formally independent, but they share organizational units, offer mutual support, and usually pursue common market strategies. Just 60 people spend their time working on strategic planning and coordination and the company's image at the modest headquarters, which has a concrete façade, low ceilings, and brown seventies-style leather furniture. Employees manufacture many different products – from refrigerators and office furniture through forklifts and electric cars to pipelines for the oil industry and complete automation solutions – in the more than 250 cooperatives and other companies in the association. Most are very top-quality products and high-tech solutions. Members of the coopera-

tive run 15 research and development centers with 900 employees and invest nine percent of revenue in R&D to explore new business areas, such as renewable energies and healthcare technology.

### Its own social insurance

In addition to industrial companies, Mondragón also owns the Spanish supermarket chain Eroski with a total of 2,400 stores – including travel agencies, opticians, service stations, and cosmetics shops. The association also runs a bank with Caja Laboral and a private social insurance fund with Lagún Aro, which supplements state benefits like the sick pay and pensions.

The bank and the social insurance fund are supporting elements of the network, because all of the sub-cooperatives finance themselves through the bank. And they all use the network's pension and health





Mondragón – Employees constantly discuss business decisions in the cafés of Mondragón, a town of 20,000 in the hills of the Basque country, which is often covered by clouds (left). The entire valley is visible from company headquarters (right).

insurance, which requires them to pay into the joint educational and solidarity fund.

The sub-cooperatives also promise to assist sister companies if they get into trouble. For example, the cooperatives lend money to each other and take on employees for whom there may not be a job elsewhere.

The network flexibly cushions economic fluctuations with measures like these. Mondragón has never in its history laid off cooperative members for operational reasons, even though it is based in a country where the unemployment rate is about 25 percent.

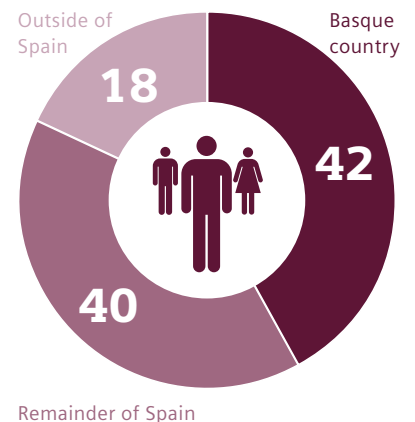
«The Basque country has a tradition of working cooperatively, which dates back more than 1,000 years,» says Javier Goienetxea, President of Konfekoop, the confederation of cooperatives in the Basque country. Work in the villages that dot the

inaccessible valleys of the Pyrenees has always been organized in a very cooperative manner. In addition, the discovery of iron ore there gave rise to an ancient industrial tradition.

The Catholic priest José Maria Arizmendiarieta built on this early history after being banished to the area in 1941 as an opponent of the Franco dictatorship. The Basque country was one of the poorest regions in Spain at the time. Arizmendiarieta combined Catholic social action with Basque traditions to stimulate the region. He first used money from donations and raffles to found a technical college, creating the Ulgor cooperative with five of its graduates in 1956 to manufacture kerosene stoves.

Three years later came the Caja Laboral credit union, which was intended to serve as the mainspring for creating more cooperatives

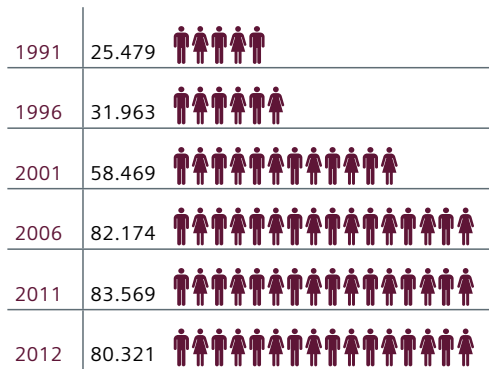
### Distribution of employees (in %, 2011)





Josu Ugarte (left), who is responsible for internationalization, sees the worldwide expansion of cooperatives as vital for survival. The company's headquarters (right) are as architecturally austere as its management is refreshingly unique and successful.

### Trend for employment figures



and increasing employment. That is how the cooperative network launched the exchange of jobs and loans among its members in the late 1970s, a time when blast furnaces, roller mills, and shipyards in the Basque country were being shut down on a massive scale. The cooperatives began to expand as the traditional companies around them were feeling pinched. Today the per capita income in the region is among the highest in Spain.

### Mandatory contribution €15,000

Anyone who wants to become a member of the Mondragón cooperative must first spend several years as a regular employee. A contribution of €15,000 is due at the end of the probationary period and confers full voting rights on the new member. The shares are personal and cannot be traded. Members receive no more than marginal dividends on their

investment, because most profit is reinvested.

However, Mondragón employees in the low wage range earn 13 percent more than is usual for the region. In contrast, mid-level and top management earn considerably less than in conventional companies. The pay gap, which is the difference between the highest and lowest wages and salaries in a company, is a specified requirement, with pay ratios averaging five to one, in some cases nine to one. As a comparison, it is not unusual for the highest paid employee of a major international corporation to receive 400 times as much as the lowest paid employee.

All Mondragón members are organized into a complex structure made up of several governing bodies, which is barely comprehensible to an outsider. This means lots of issues to discuss. According to a saying at the company, to find out what your

employer is planning, just drop by one of the cafés in the old town. That's where employees spend their time off, and that's where people like to talk. Decisions move upward from below – the conventional top-down approach doesn't work in cooperatives. Employees are unusually motivated and satisfied with their situation, as shown by regular surveys of the company. Absences are low, and productivity is relatively high.

### Not a paradise

But participation also entails obligations. For example, employees must think like entrepreneurs, not hired help, emphasizes Mikel Lezamiz. He is »director of cooperative dissemination« and as such is responsible for explaining and developing the cooperative idea. Says Lezamiz: »We don't offer a paradise and we're no angels, either. If we have to tighten our belts and cut wages, we will.«

Arriving at decisions like that may take a bit longer at Mondragón thanks to the prolonged discussions, Lezamiz concedes, »but then we can implement them faster because everyone stands behind them.« This means that the company has less need for corrective measures and improvements, he says.

A recent major corporate decision was the global expansion that the cooperative group has been pursuing for several years. The foreign revenue of its industrial arm now accounts for more than two-thirds of its total revenue. The 105 production facilities and their 14,000 employees in nine countries also contribute to this scenario. »We are trying to convince our cooperatives to go abroad,« explains Josu Ugarte, who has responsibility at headquarters for the group's foreign operations.

Ugarte and his fellow employees also advise small and medium-sized cooperatives and offer them financial support for internationalization. For example, Mondragón buys real

estate in China and India as a location for its companies. The foreign subsidiaries that Mondragón also operates in low-wage countries like Thailand and Romania are generally not organized as cooperatives. This has brought accusations that the group is betraying its own ideals.

Employees of the foreign subsidiaries are usually paid more than the

local market average. And in Ugarte's view, there is no alternative to greater involvement outside of Spain. Not just because the high-tech group must follow its business partners, which operate all over the world: He believes that expansion into international markets also offers insurance against economic shock waves. »If we don't go abroad,« says Ugarte, »then we won't survive.« ■

## Academic powerhouse for the cooperatives

The roots of the Mondragón association date back to a technical college founded some 60 years ago. The college merged with others in the area in 1997. Today Mondragón Unibertsitatea (Basque for »university«) has 4,000 students and serves as an academic powerhouse for the Mondragón cooperatives. It offers training for entry-level positions as well as advanced training for all employees in the association, and it gets R&D projects up and running. Some 9,000 people currently receive beginning and advanced training from Mondragón.

The emphasis is on engineering and management, but other specialties like education and audiovisual communication are also on offer. A Department of Culinary Sciences has been training chefs and restaurant managers since 2011.

Like the industrial cooperatives, the University's employees, including faculty, own the institution. It costs more to study here than at the state universities of Spain, but less than at private universities. »It's important for us to be accessible to the sons and daughters of our employees,« says Jon Altuna, Vice Chancellor of the University.

Like the entire group, the University is also expanding worldwide. It has opened branches in Madrid and Barcelona as well as in the Netherlands and Colombia. Others in Germany and Great Britain will follow soon. Mondragón University has entered into cooperative agreements with universities in Mexico and Chile, and hopes to convert them progressively into cooperatives.

# Cars made in China

A Volkswagen vehicle leaves the production line in Shanghai. The company has already supplied 14 million locally manufactured vehicles to Chinese customers.

The Chinese car market is booming. Many Western manufacturers and suppliers are also profiting from this development by entering into joint ventures with Chinese companies and massively expanding their production capacities in China. German makers are setting the pace, primarily in the premium segment – but Chinese manufacturers are catching up and are increasingly focused on both production and product quality.

If you climb into a taxi in Shanghai, there's a good chance you will be riding in a Volkswagen Santana – and yet you'll be riding in a traditional Chinese car. The Santana is a four-door sedan originally developed in Wolfsburg, but many different models have been produced in China for decades, with 3.7 million sold so far.

About 35 years ago, Volkswagen was the first Western automaker to put out feelers in China. Its early involvement in that promising market has paid off, and China has long been one of Volkswagen's most important markets.

From the time it entered the market to mid-2012, Volkswagen delivered some 14 million locally produced cars to its customers in China. Volkswagen Group China reported that it sold 2.81 million vehicles in 2012, a new record.

### Twenty-five percent growth

The group enhanced its leadership position in the passenger-car market with growth of almost 25 percent over the previous year. And there's no end in sight: VW anticipates more double-digit growth rates and is currently expanding its production facilities in China – as are General Motors, BMW, Daimler, Nissan, and Hyundai.

The Chinese car market is one of the most dynamic in the world. Some German automakers have been operating there for decades and are now intensifying their expansion in the region. They are in an extremely strong position, especially in the premium segment, which they now want to defend and expand. The country's increasing prosperity and rapid growth of the middle and elite classes are playing right into their hands.

### Few car owners

Statistically, only one in 20 people in China currently own a car. By comparison, in Germany that rate is one in two. »People in China want to be as mobile as we Europeans. Mobility is now very strong in the eastern part of the country, but the remaining 80 percent still get around with donkey carts and horse-drawn vehicles,« said Group Head Martin Winterkorn in an interview with the German weekly *Die Zeit*.

The reason for the great potential that Western automakers see in China is the development of the enormous country over the past few years. China has had the world's largest national economy since 2010 and is running neck-and-neck with the United States for the position of top trading nation. The Chinese economy now faces the challenge

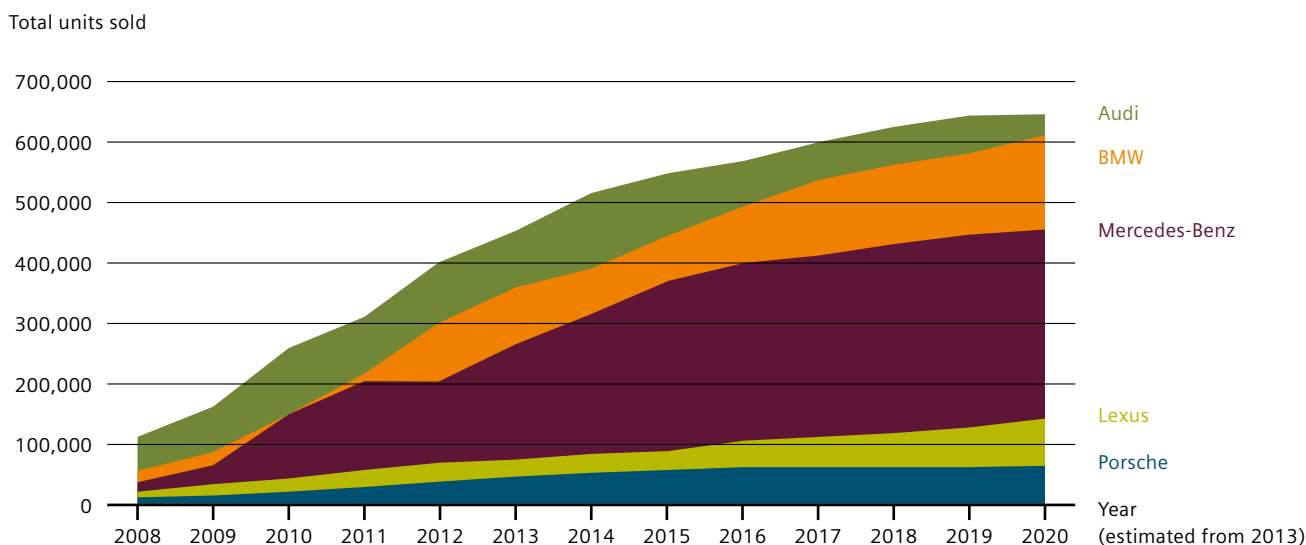


VW Santana used as a taxi in China: The notchback sedan first developed in Wolfsburg, Germany, has been produced in various versions in China for decades.



## Demand for premium models increasing

Source: IHS Inc., Siemens, 2013



of stabilizing its growth. This will require ongoing modernization and profound reforms.

Therefore the Chinese government's current five-year plan aims to transform the economy – away from an emphasis on exports and toward innovations and a greater focus on the internal market. The percentage of what are known as »new strategic industries« in the gross domestic product (GDP) will be increased. One of those industries is alternative vehicle drive technologies.

The investment conditions for foreign automakers have improved considerably since China joined the World Trade Organization (WTO) in 2001. But large parts of the economy are still under strict government control, making market access difficult for foreign companies. China has not yet acceded to the WTO Government Procurement Agreement.

### Favorable market environment

However, the market environment for automakers remains favorable – and not just due to the gigantic potential in areas that have rising incomes, a high savings rate, and

hardly any transportation technology at all. The Chinese government is also planning to ratchet up internal demand, which has weakened somewhat: for example, by offering another scrapping premium.

### World's largest premium market

By 2020, China will also outstrip the U.S. as the world's largest car market in the premium segment. Management consultancy McKinsey estimates that auto sales will increase by about 12 percent annually, reaching three million cars by 2020 – about 50 percent stronger than the market as a whole, for which McKinsey forecasts 8 percent growth.

By 2020, some 23 million urban households in China will earn enough to allow them to buy a premium car. This target group is currently distributed over only about 100 cities in the country, but by 2020 this potential class of buyers will be drawn from 300 cities.

Foreign makes enjoy a good reputation among the Chinese. Even when they are manufactured in China, they are seen as being of higher quality than brands from Chinese manufac-

turers. The fast-growing elite class wants primarily premium models.

For example, almost half of BMW's world sales of its 7 Series luxury-class models are sold in China. It's no different for its direct competitors, Mercedes and Audi. However, »the German premium manufacturers will have to consider changing their distribution strategies and adjusting their marketing concepts for their Chinese business,« says Detlev Mohr, head of European automobile consulting at McKinsey. He says that the buyer structure poses completely new challenges for national coverage and distribution.

### Owning a car is very prestigious

The McKinsey study »Upward Mobility: The Future of China's Premium Car Market« also shows the high status of owning one's own wheels in China. Respondents accorded the same priority to buying a car as to buying an apartment and paying for their children's education.

Compared to buyers in other countries, buyers in China are more prepared to decide in favor of a premium car at a lower level of



Premium models, like the 5 and 7 Series BMW sedans (above), are in demand in China. BMW has built one of the world's most modern car factories in Shenyang in a joint venture with the Chinese company Brilliance (center). The joint venture is also manufacturing the compact SUV model BMW X1 at the plant (below).



income due to their optimistic outlook for their continued economic development. »However, these new customer classes pay more attention to price than premium manufacturers are used to from their traditional client base,« says Mohr.

He adds that the McKinsey analysis also shows that the brand loyalty of Chinese buyers will continue to increase: »It is strategically important for manufacturers to work now to gain the loyalty of tomorrow's customers.«

### Joint ventures are necessary

German automakers are allowed to manufacture cars in China only as part of joint ventures with Chinese companies in which the local partner holds at least 51 percent. This model has been used many times, with VW collaborating with state companies FAW Group and SAIC Group, BMW with Brilliance Group, and Mercedes with BAIC Group.

»Collaboration with entities of this kind has certainly become simpler for foreign automakers over the years,« reports Thomas Schott, head of Factory Automation at Siemens. »But the special conditions in China are still being felt even as we participate in the current construction of the Daimler plant in Beijing.« One requirement, for example, was to cooperate with a Chinese production plant builder.

### Step-by-step approach

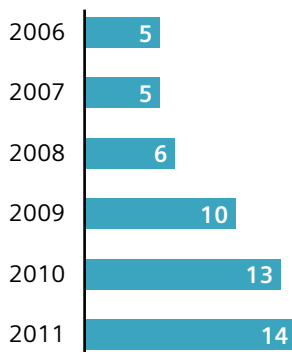
Most German manufacturers get started in local production by supplying parts that are assembled in China. The final assembly is followed by more investments in individual plants until a complete production process is realized.

These investments pay off, as shown by record sales by manufacturers



## Passenger car registrations in China

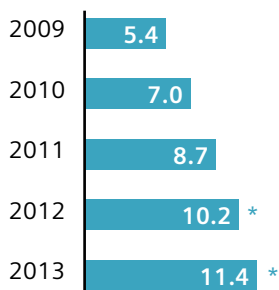
(in millions)



Source: Ministry of Transportation China

## Car production by foreign automotive manufacturers in joint ventures in China

(in millions of units)



\*estimated  
Source: Statista 2013

such as VW, BMW, and Daimler. Sales in China by BMW rose eleven percent in April 2013, while Audi increased its sales by more than six percent to more than 137,000 cars, thanks to the high demand in China and the U.S. And VW increased its car sales in China by more than 18 percent between January and May 2013, and now earns about one-third of its total revenue there.

BMW is also making money in China. In 2012, sales of its BMW, Mini, and Rolls-Royce models increased by about 40 percent, to almost 330,000 cars, almost 18 percent of total sales for the BMW Group. One symbol of the Group's expansion strategy in China is the plant in Shenyang it opened with its joint-venture partner Brilliance in May 2012. It is one of the most modern production facilities in the world and is considered to be the most sustainable automotive plant in China.

### Transferring value creation

Along with this second production plant, BMW is also significantly expanding its local purchasing and shifting value creation even more into China – a strategy that also hedges currency risks and can be seen throughout the industry.

At the opening of the new plant, Norbert Reithofer, Chairman of the Board at BMW, stated, »By building our second plant in Shenyang we are increasing our capacities in China to 200,000 vehicles. In addition, we and our partner Brilliance will invest another €500 million in China, thereby fulfilling the requirement for further growth.« The flexible plant structures will allow BMW to produce up to 400,000 vehicles locally, allowing it to respond to potential increases in demand, according to Reithofer.

Automaker Audi has also seen China develop into one of its most important markets, accounting for a quarter of its global vehicle sales. Audi is building a new production site in Foshan in southern China.

The Chairman of the Board of Audi AG, Rupert Stadler, told this year's annual shareholders' meeting, »We again clearly increased our competitive edge in 2012. Audi gained more new Chinese customers within one year than ever before. And we are the first premium supplier in China to exceed the magic number of 400,000 deliveries.« Audi achieved that level worldwide in 1995 – and now it has done so in China alone.

Stadler explained why a presence in China is so important when he spoke at an event organized by VDA, the German Association of the Automotive Industry in spring 2013: »If you want to operate internationally, you also have to produce internationally. For the first time, in 2014 we will produce more cars outside of Germany than here at home.«

### Suppliers have to play along

However, manufacturers must rely on their suppliers to play along, and that can be an Achilles heel. Says Stadler, »Where global expansion is concerned, I see a considerable need for the supplier industry to catch up. If you believe the pure statistics, their sales are still strongly dominated by domestic sales. That means that further internationalization offers major opportunities for them.«

Because it has operated in China for 120 years, Siemens is among the suppliers that have long understood this global logic. Based on the country's enormous growth, Siemens



# China's manufacturers are catching up

One goal of the government's twelfth five-year plan is to increase the sales share of Chinese car models in the overall auto market to 50 percent by 2015. (The figure is currently 40 percent.) To achieve this target, manufacturers are focusing more closely on quality and a consistent design concept to create brands with an independent recognition factor. In addition to their economical products, they are now developing not only elegant and sporty sedans but also hybrid and electric vehicles to reduce the air pollution caused by traffic in megacities like Beijing and Shanghai.

To fulfill these objectives, Chinese companies are investing in purchasing expertise and using attractive offers to entice experienced managers, designers, and production experts from Western industrial nations to work for them. The Chinese car manufacturer Chery poached world-class designers Hakan Saracoglu from Porsche and James Hope from General Motors in 2012. And Qoros Automotive Corporation signed up Gert Hildebrandt, the designer of the BMW Mini – as well as retired VW senior manager Volker Steinwascher, BMW's production expert Alexander Wortberg, head of

development at Jaguar Land Rover Peter Matkin, and Saab's technical safety expert Roger Malkusson.

It is obvious to the Chinese: In addition to modern design and interiors, the future in the eyes of potential buyers lies increasingly in the elements of quality and security. And not just in China. »In our view, this development is reflected in the emerging demand from Chinese manufacturers for our solutions,« explains Thomas Schott, Director of Factory Automation at Siemens. »Initially, manufacturers pursued primarily simple concepts with a comparably low level of automation in production. Today they have recognized that the results are not good enough for the world market,« he says.

»To date, Chinese cars have been sold primarily outside the country in emerging markets with less demanding customers,« says Jürgen Nolde, Director of Vertical Automotive at Siemens. This group included Turkey and Russia. In the next phase, the quality and safety offensive is intended to make access to Western markets easier. So far, the export business has been growing primarily due to the increasing demand for budget vehicles in the developing world.

has systematically expanded its team in China in the area of automotive components.

»There is also the issue in the region of deepening the awareness of the latest innovations in automation and propulsion technology,« says Jürgen Nolde, Director of Vertical Automotive at Siemens. »With our high level of automation skills and growing automotive expertise, we are ensuring that the car manufacturers' new production plants in China will quickly attain the desired production output.«

The high demand in China is not just the outcome of the premium approach that German car manufacturers continue to follow when manufacturing abroad. »Our philosophy also includes transferring high standards in automation technology to the Chinese factories,« says Nolde.

Today the team has been based in Shanghai for over 15 years and is headed by the Automotive Director for China, Xia Wei, who oversees the local and international car manufacturers and offers them an extensive range of products, solutions, and services.

Siemens' business also includes building final assemblies as well as the associated subassemblies, which the company performs as a general contractor for German automotive companies in China.

## Factories on greenfield sites

»China is our most important end-customer market,« states Nolde. »All car manufacturers are currently investing in »greenfield factories« to fulfill the increasing demand for vehicles and to ensure their market share for the future.« ■

Approximately 23 million people live in the Shanghai commuter belt. License plates are dispensed via auctions for several thousand euros in order to regulate traffic density. Nevertheless, the volume of traffic and the desire for car ownership in the city remain extremely high.



In the United States, 225 million hectoliters of beer are produced every year. That corresponds to the water volume of almost 100 Olympic-sized swimming pools. Craft breweries are already producing one-tenth of that.

# The flavor of success

In the United States, small local breweries are in demand. They rely on creating a nostalgic setting – and state-of-the-art technologies. Thanks to double-digit increases in revenue, nationwide they hold a market share of approximately ten percent.

Gleaming steel brew kettles fill the old brick factory building. Pipes are visible everywhere, and the sound of hissing steam fills the room. The history is fascinating: In Stratford, Connecticut, Baird is a company that used to produce machinery, but the good old days are now 50 years in the past. The building stood empty and abandoned for decades, a relic of the company's former industrial heyday. Production started up again about a year ago – this time, of beer, not machinery.

Two Roads Brewing Company is typical of the craft breweries that have recently come into vogue in the United States. These small breweries employ artisan production methods and rely on customer proximity, creative marketing ideas, a nostalgic setting, and regional sales. At Two Roads, for example, visitors can observe the brewing process and enjoy a beer tasting outside in the beer garden.

In an era when the majority of beer is industrially produced by a handful of major international companies, the Americans are turning to an old

art form. Only 30 breweries existed in the United States in 1980; today, that number has grown to more than 2,400 – many of which are small local breweries. »People enjoy experimenting and discovering new tastes,« remarks Brad Hittle, the founder of Two Roads. »We are not just a flash in the pan – this is a trend.«

Yet none of this would be economically feasible without state-of-the-art technology – technology that often includes Siemens Braumat automation systems that help master brewers with their work. Siemens has already delivered dozens of these systems to craft breweries in the United States, and concrete discussions are already taking place with other interested parties. In the U.S. market for brewery technologies, Siemens commands a market share of approximately 20 percent. Sales to large breweries like Anheuser-Busch InBev account for most of that market share.

On the rise, however, are breweries that are experiencing strong growth despite being unknown internationally, such as Stone Brewing in San Diego, California, Bell's Brewery in

Kalamazoo, Michigan, Lagunitas Brewing in Petaluma, California, and Yazoo Brewing in Nashville, Tennessee. In the summer of 2012, Siemens delivered the Braumat Compact system to Two Roads and the brewery began using it for production in September 2012.

## Quality is key

»The most important factor for success is a consistently high-quality beer,« says Hittle, who has extensive experience in consumer goods and the beer business. The name Two Roads comes from a poem by U.S. poet Robert Frost, and illustrates Hittle's philosophy of life – to always take the road less traveled. True to this motto, he quit his secure job as the head of marketing at Pabst Blue Ribbon, the traditional beer brand of Pabst Brewing Company, to establish Two Roads Brewing Company.

Hittle is pursuing a two-pronged strategy for economic success: First of all, he wants to establish an independent beer brand. But for economic reasons he also needs to fully exploit his brewing capacities –

»

## Proven technology for the process industry

Braumat technology from Siemens has been available since 1977. Braumat is the first SPS-based, recipe-controlled automation system for breweries. The centerpiece of this process control system is the Simatic PCS 7 controller. The process control system is scalable and used in numerous process industries.

Viewed from the outside, the turn-key Braumat Compact consists of a stainless steel cabinet with a touch panel for operation that is tailored specifically to the requirements of

smaller breweries. The inside of the cabinet contains switching elements that perform various functions, such as setting up the motor for pumping and opening and closing valves. Braumat has integrated libraries that offer off-the-shelf solutions for the production processes of smaller breweries – brewing, fermentation, storage, and filtration.

The control functions for heating and cooling are energy-optimized to keep operating costs low. A production planner organizes brews and cleaning, and also offers features like the monitoring and recording of process data. The process instrumentation – sensors, motors, and valves – is connected via the Profibus universal field bus system.

[www.siemens.com/braumat](http://www.siemens.com/braumat)



The entire Braumat production process at a glance: brewing, fermentation, storage, filtration. The centerpiece of the technology is the Simatic PCS 7 process control system, which is also used in other process industries.

something that is currently not supported by Two Roads' sales figures. For this reason, his brewery operates concurrently as a contract manufacturer for other breweries experiencing production bottlenecks.

»Having the best state-of-the-art facilities is the key factor in securing these kinds of orders and having the flexibility to manage them,« says Hittle. A »sight for sore eyes« is how he refers to his gleaming brewing equipment, which he had built by Rolec, a German specialist located on Lake Chiemsee. Rolec also drew his attention to the control systems from Siemens. It was a decision that was easy to make, because other breweries he works with had also recommended the Braumat solution.

Just six months after its opening, Two Roads was handling twice as many outside orders as had originally been anticipated. The list of customers

includes ten companies that commission Hittle to brew 40 different kinds of beer. But Two Roads' own beer production is also outstanding: Sales are twice as high as projected in the business plan. In the state of Connecticut alone, more than 850 businesses sell beer from Two Roads.

Two Roads markets ten different types of beer. The variety of recipes would bring a master brewer with no control software to the brink of despair. With Braumat technology, however, variety is not a problem. Braumat can be used to produce a nearly limitless number of beer types – the number is limited only by the performance of the computer to which it is connected.

### 20 percent growth

Quantitatively, a relatively small number of large breweries define the beer business in the United States. The market for beers from craft breweries currently accounts for less than ten percent. However, in the last ten years, the demand has risen by an average of 20 percent annually, while the consumption of industrially produced beer has decreased slightly.

During the economic crisis, the demand for beers from small breweries actually increased. In the past, beer in the United States was sold primarily through television advertising. Advertisements focused solely upon emotions to create brand loyalty; taste was considered to be secondary. In the United States, most beers from large breweries have a similar taste: light, refreshing, but also rather bland. Beer drinkers are now increasingly looking for individuality and distinctive flavors.

»Siemens has played an active role in the brewing industry for more than 100 years; for over thirty years, it has worked on automation with major players in the beer industry,« says Rüdiger Selig, Siemens' expert in brewery automation. »Seven years ago, we came up with the idea of supporting craft breweries by offering

our control technology in the form of a Braumat Compact turnkey solution to smaller breweries.« It is clear that this has been a thoroughly successful approach.

Braumat is a system used to control the brewing process, and is similar to automation systems Siemens supplies to other sectors of the process industry. In the past, Siemens automation was usually delivered by German machine manufacturers along with the production plant itself. For smaller breweries, however, this package was often too large. With Braumat Compact, the entry-level costs for brewery automation have dropped to less than US\$50,000 – an amount that even start-ups can shoulder. The investment pays for itself starting with an annual production volume of approximately 5,000 hectoliters.

To distinguish their beers from the uniform beer produced by large competitors, craft breweries focus their attention primarily on the ingredients and the authenticity of the product and less on a process that operates with maximum efficiency. »Owning a Braumat system does not mean that you simply press a button, leave, and then have finished beer after 20 days,« says Edward Montgomery, the person at Siemens responsible for business with U.S. breweries. In his experience, breweries that decide to go with Braumat continue to do many tasks manually. That is no problem for the technology. »Braumat can accommodate work that is done manually, which enables customers to retain the artisanal aspects of their brewery. For that reason, we have not yet encountered any reservations about too much automation.«

Many craft breweries begin as the proverbial garage operation, where the brewing process is still performed manually in large vats. Water and malt are added by hand and mixed into a mash. The mixture has to be heated five times followed by a rest period to activate the enzymes that

### Largest beer producers in the world

(Output in millions of hectoliters)

China	<b>490</b>
U.S.	<b>225</b>
Brazil	<b>133</b>
Russia	<b>98</b>
Germany	<b>96</b>
Mexico	<b>82</b>
Japan	<b>56</b>
United Kingdom	<b>46</b>
Poland	<b>38</b>
Spain	<b>34</b>

Source: Barth-Haas Group, 2011



The mashing process is complicated: The mash has to be heated five times, but the temperature must never exceed 78 degrees Celsius (left). Two Roads Brewing Company (right) has relied on the Braumat Compact system from Siemens since September 2012.

will later convert starch into sugar. During this process the temperature must never exceed 78 degrees Celsius. During fermentation, the temperature must be constantly monitored in order to identify the right moment to separate the wort and undissolved parts of the mash, also referred to as lautering, and begin the pumping process. After boiling the wort, it is transferred via the beer cooler to the fermentation and storage tanks, where the beer ages for three to five weeks until it is bottled.

If a brewery increases its production at a later time, it not only needs more tanks for the aging process: It also frequently needs to start a new batch of beer. »Transfer processes between the fermentation and storage tanks occasionally occur in the middle of the night,« says Selig. For small operations with manual production, that is anything but a desirable time. It is even worse if, for instance, cooling fails to occur in the fermentation and storage tanks. In

these cases, Braumat in conjunction with an alarm control system automatically sends a warning message to the master brewer's cell phone; whereas breweries that are manually controlled run the risk that an entire batch of beer will be ruined. »That represents a tremendous financial risk,« says Montgomery. »Initially some craft breweries decide to buy our system simply to monitor their brewing process.«

### Turnkey product

Braumat is a turnkey product. In contrast, competitors in the U.S. market typically only supply individual components that the breweries have to assemble themselves. »Braumat Compact is a standard product with uniform quality regulations, support, a training hotline, and a product lifecycle – in other words, the usual standard found in all our products,« says Montgomery. One weakness of individually assembled systems is often the maintenance, because it can only be provided by the specific

plant builder. »Siemens, on the other hand, offers superior hardware as well as incomparable customer service,« says Montgomery.

Another benefit is that Braumat Compact helps when it comes to trying out new recipes. »Experimentation is very user-friendly, because Braumat Compact records every step and makes it reproducible,« says Hittle.

At Two Roads, Hittle has already exceeded his growth plan at an unexpectedly early stage, so he is thinking about expansion. As a first step, in early 2014 he plans to expand sales from Connecticut to Massachusetts and New York: »We are located just a stone's throw from Interstate 95 – a freeway that extends from Maine to Florida,« says Hittle. He already regards the entire East Coast of the United States as a market for his beers. As a result, he is thinking about expanding not only sales but also his production capacities: »In five or six more years, we'll need another brewery.« ■



What is the job of a ...

# Condition Monitoring Expert?

Downtime is expensive – especially in production. That's why successful industrial enterprises rely not only on innovative technologies and efficient manufacturing processes but also optimized maintenance. Condition Monitoring experts use continuous monitoring to help businesses optimize how they use their equipment and systems.

It is 7,562 kilometers to Brazil, 8,968 kilometers to China, 9,285 kilometers to Mexico – some of the international clients of Schwäbische Werkzeugmaschinen GmbH (SW) are very far away from the headquarters of this medium-sized German company in Waldmössingen, south of Stuttgart.

In Waldmössingen SW produces multi-spindle machining centers and manufacturing systems used around the world in the automotive, hydraulics, and aerospace industries. The client list includes names such as BMW, Delphi, Hyundai, and VW – discriminating customers that expect high-precision machine tools and prompt service. »As a highly specialized SME with some 300 employees, we naturally don't have enough service technicians to provide on-site support to all our customers around the world,« explains Johannes

Zuckschwerdt, who is responsible for developing new services at SW.

But the company has not abandoned its faraway customers: Thanks to a partnership with Siemens, the machine tool manufacturer can provide its customers with quick and efficient support from the headquarters in Germany. Since 2002, SW has relied on Fleet Management Service, an online service offered by Siemens, to manage its products. »We manufacture machinery. Machine technology is our focus – not software development,« says Zuckschwerdt, explaining his decision to partner with Siemens rather than developing an in-house solution.

## Core component

A core component of the service developed and implemented with

Siemens is Condition Monitoring – ongoing monitoring of the status of the machinery and components.

»We use Condition Monitoring to help our customers optimize how they use their systems. This helps minimize downtime,« explains Jochen Heinz, who is responsible for developing Condition Monitoring and Reliability Services at Siemens.

The principle: The control technology of modern machinery provides a steady stream of useful data about the condition of the equipment. Increased power consumption may be an indication of wear, for example. Minor accidental collisions by equipment operators don't usually result directly in reduced product quality, but they often create increased wear that reduces the lifespan of the affected components.

However, the only way to draw reliable conclusions is to analyze a lot of data over an extended period of time. For this reason, the Condition Monitoring Service collects machine data and transmits it over an encrypted connection to the Siemens data center, where it can be analyzed centrally.

This enables seamless automatic monitoring of the condition of all machinery components. A visualization of the results in reports and graphics is part of the service. When a defined threshold is exceeded, the relevant employees are automatically notified by e-mail or text message, sparing them the task of painstakingly troubleshooting the problem on the shop floor.

This comprehensive database makes it possible to plan and optimize maintenance activities so as to minimize downtime and avoid conflicts with shipping deadlines. An optimized and preventive approach to maintenance also minimizes equipment outages – and the unplanned downtime that results. And if a piece of equipment does fail, the error can usually be quickly diagnosed online with the help of all the recorded data from the long-term Condition Monitoring.

This not only benefits the companies that use the monitored equipment in their production halls, it also benefits the original equipment manufacturer (OEM). At SW today, all the machine tools deployed throughout the world are connected 24/7 with their developers at company headquarters in Germany. This saves personnel and travel expenses, since SW can thoroughly prepare its service technicians before sending out exactly the right expert to the customer site equipped with all the required tools and spare parts. This eliminates unnecessary trips and lengthy troubleshooting at the customer site. The result is that even an occasional trip to Brazil or China is within the budget of a medium-sized business like SW. ■

## »We're looking for well-rounded professionals.«



Jochen Heinz

**Interview with Jochen Heinz, Head of Business Development, Condition Monitoring, and Reliability at Siemens**

### **How does Condition Monitoring benefit the customer?**

Condition Monitoring gives customers an entirely new level of transparency in production: Minor user interface errors, increased power consumption, a short-term

load increase – all these phenomena are pieces of a puzzle that reveal a clear picture only when combined. Condition Monitoring (CM) gathers this data centrally and analyzes it using algorithms. This makes it possible to identify potential malfunctions before they occur and avoid downtime. Creating a comprehensive database makes it possible to conduct proactive, condition-based maintenance.

### **What is your job when this type of system is implemented?**

Technically, it's relatively simple: The customers actually have everything they need already on board. The control unit already provides a lot of key data. During the implementation, we offer our customers a »comprehensive, worry-free« package to extract this data from the equipment. We take care of the network connection and centralized data analysis.

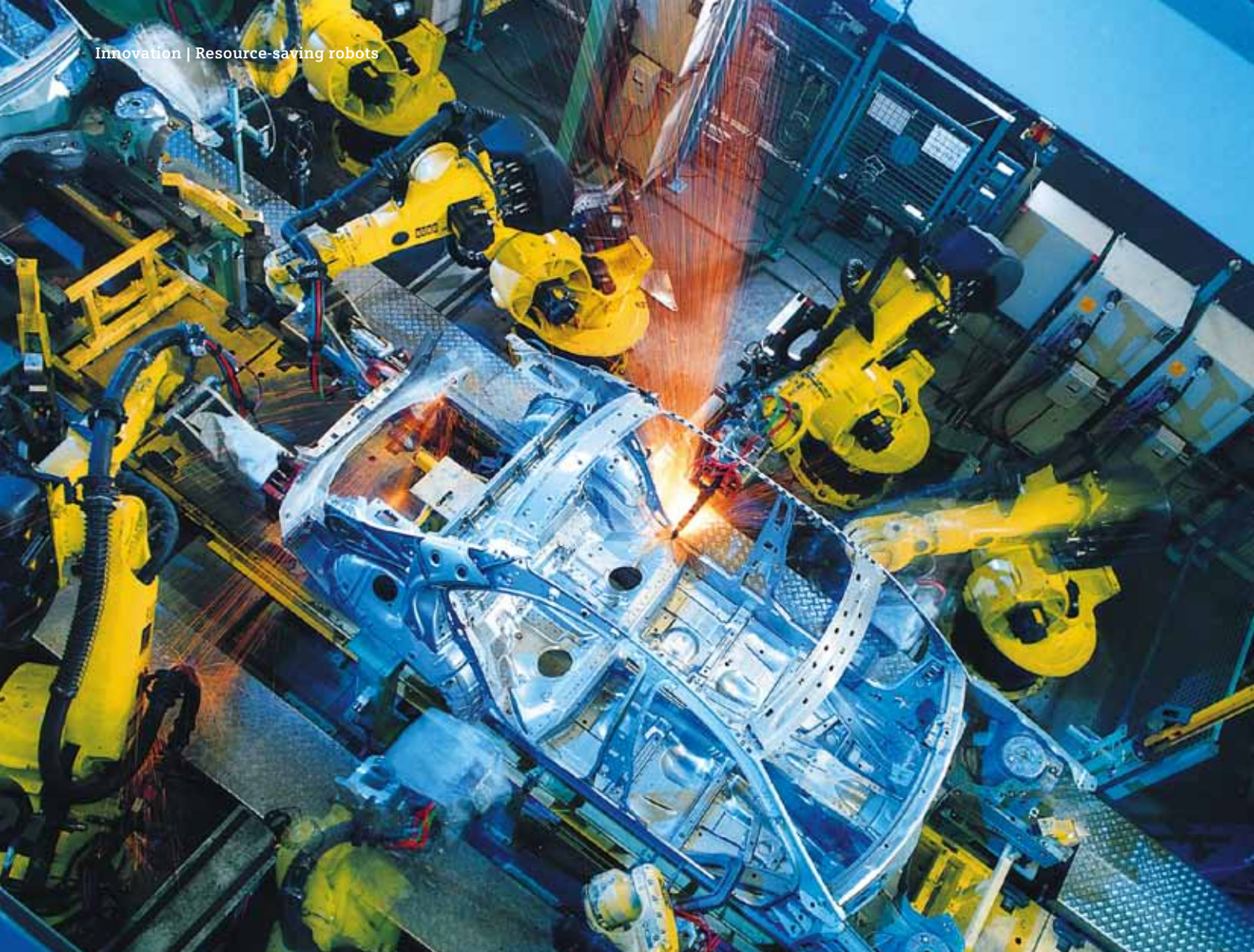
### **So it's all very simple?**

Basically yes, but the simplicity on the technical side stands in contrast to the complex organizational component of Condition Monitoring. We support the customers here as well. For example, we work with the customer to analyze which equipment is a potential production bottleneck – where downtime would have the most negative impact. Or take our maintenance strategy: Various user groups within the company benefit from the transparency that CM offers – from the company management to production, the maintenance technicians, the CM experts, and the equipment operators. All of these roles must be taken into account.

### **What skills does a Condition Monitoring expert need?**

We're looking for well-rounded professionals. To provide our customers with the best possible service, our experts need to have a detailed understanding of the machinery and how it is operated. But they also need to know about networks and IT applications. The consultants also need to understand the customer's processes in order to interact effectively. A talent for communication is also a big plus.

[www.siemens.com/condition-monitoring](http://www.siemens.com/condition-monitoring)



# Digital back training for robots

Industrial robots in the car factory: Optimized sequences of motions can help save energy.

Industrial robots consume a huge amount of energy in production – in fact, in automotive body-in-white assembly it is not unusual for them to account for more than half of the total energy consumption . In a joint project, Siemens, Volkswagen, and the Fraunhofer-Gesellschaft have developed technologies aimed at significantly increasing the energy efficiency of robots.



First lesson in back care: »Sink down into a squat position, lift the water-bottle crate, and straighten the body in a smooth, fluid motion.« Unlike lifting with jerking movements from a standing position, this method uses less force and is gentle on the joints. The same basic procedure also works for industrial robots – even though what they are moving are components rather than beverage crates. What sounds simple and logical in theory poses a practical question: How can industrial robots perform sequences of motions with minimum force in order to save energy and resources?

A pioneering research project of the Green Carbody Technologies (InnoCaT) innovation alliance, under the lead management of Volkswagen, Siemens, and the Fraunhofer-Gesellschaft, has addressed this issue. For example, it investigated the impact on energy consumption of the distance between robot and production object, changes of speed, and switching off the robot during breaks and on weekends.

### Fluid motions

The project participants focused in particular on optimizing sequences of the robots' motions in areas where they believed there would be savings potential. »At present, most robots move jerkily because before they change direction they first brake and then accelerate again,« notes Siemens Integration Manager Matthias Frische. »That costs a lot of starting energy that can be saved with smooth movements.« Today hardly any industrial robots operate with optimal motion, and therefore

they cause peaks in energy consumption and also over-stress their mechanical components due to their abrupt movements.

### 50 percent less energy

One of the results of the three-year research and development project is that the trajectories describing the motion path of the typically jerky robot movements in the future will be reprogrammed by an innovative software program into smooth sequences with no abrupt changes

of direction. Continuous acceleration and curvature are two important attributes of the trajectories. This, according to Frische, would enable energy consumption to be reduced by as much as 50 percent. The partners in the alliance were surprised by the magnitude of the potential savings. In addition, a rounder motion reduces wear and tear, thereby cutting maintenance and service costs as well as downtimes. These promising laboratory results motivated the researchers to develop elaborate tests to assess



»Save Energy. Now«: The sequence of movements of robot arms can be made more energy-efficient and resource-saving by planning with intelligent control software. This topic attracted considerable interest at the Siemens booth at the 2013 Hanover Fair.

the practicality of the models in actual automotive production. The prime objective was energy efficiency and conservation of resources, although maintaining cycle times was also an essential requirement.

### Exactly like humans

In their result brochure, the InnoCaT research partners drew the following conclusion: »By analogy with human ergonomics, the kinetic optimization of robots has the effect of optimizing their positioning and the sequence of motions.« In short, it's the same principle used in lifting the water-bottle crate, with the difference that humans decide on the rational use of their limited resources themselves, either intuitively or through learning. In the case of the robot, a programmable software module will perform this function. While programming a robot's trajectory, pressing the »Save Energy« button will start a

complex calculation that takes into account the physical and kinetic laws governing its movements. For example, an energy-consuming angular movement will be reprogrammed into resource-saving harmonic motion. Siemens is working to integrate an application in the Tecnomatix planning software (see interview, right).

### No drop in performance

The software application simulates and optimizes robot motions to produce energy savings without making any concessions in terms of process time, let alone production output. The normal robotics performance is retained in full – with significantly reduced energy consumption. This has been confirmed by the scientists at the Fraunhofer Institute for Machine Tools and Forming Technology IWU in Chemnitz after conducting numerous test series

with a typical robot from the automotive industry. They analyzed various sequences of motions in a straightforward handling task and determined the energy-saving potential. Fraunhofer IWU project manager Sören Lorenz has no doubt whatsoever: »The robot programmer will make a substantial contribution to greater energy efficiency in the future.«

Alexander Spiller, project manager in the area of robot and assistance systems at the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA), explains how this will function. »A special measuring device records the robot's energy consumption. The robot's movements are recorded in parallel to their energy consumption via an interface. The data acquired flows into a simulation model that determines the expected energy consumption. This is followed

## The InnoCaT innovation project

Increasing the energy efficiency of industrial robots through specific software simulations was only one of the objectives of the Green Carbody Technologies (InnoCaT) research project. From 2010 to 2012, a total of 60 partners in five joint projects and 30 subprojects – coordinated by Volkswagen and the Fraunhofer Manufacturing Engineering Institutes in Chemnitz, Aachen, and Stuttgart, Germany – sought solutions for resource-efficient production.

### Focus on body-in-white

The research focused on the production of car bodies, although this was not considered in isolation. On the contrary, all relevant subsidiary areas, including tool making, the press

shop, body-in-white, and painting, were investigated with the goal of acquiring knowledge about optimization potentials throughout the entire process chain.

### Same output with less energy input

The benchmark for the project participants was to find ways to implement future production processes with considerably lower energy input and consumption of resources for the same production output, to allow the methods to be assessed, and to make them plannable. In addition to approaches for technical solutions for new technologies and production controls, an attempt was made to resolve resource efficiency issues early on during the planning stage.

### Virtual reference factory

Each subproject presented its results in the form of actual demonstration models and components. Information on the energy- and material-saving effects and reduction in CO<sub>2</sub> emissions has been compiled and transferred to a virtual reference factory. This data is now available to the automakers involved in the project as a benchmark for one reference vehicle each, independent of manufacturer. This makes it possible for the first time to individually mirror and scale the savings potentials achievable when introducing new technology concepts and implementing improved manufacturing engineering and enhanced planning tools.

[www.greencarbody.com](http://www.greencarbody.com)

by the optimization process, in which various simulation parameters are varied until an effective setting is found for the minimum energy consumption.« With this kind of intelligent planning and control of energy consumers, IPA calculates that energy savings of up to 45 percent are possible.

### Paradigm shift required

Matthias Putz, chief coordinator of the Green Carbody Technologies innovation alliance (InnoCaT) and department head at the Fraunhofer IWU, summarizes as follows: »The energy-saving potential the project has demonstrated highlights the fact that a paradigm shift in production engineering is not only necessary but is also feasible. Resource-efficient robotics will very clearly play a role in the digital production planning of the future.« ■

»The robot programmer will make a substantial contribution to greater energy efficiency in the future.«

Sören Lorenz, Fraunhofer IWU Project Manager

## A groundbreaking new tool



Matthias Frische

**The team under Siemens Integration Manager Matthias Frische teaches industrial robots resource-saving movements.**

### How much interest is there in the new trajectory programming systems for robots?

At the 2013 Hanover Fair, a large number of decision makers from the automation sector and the automotive industry looked at our model system for the virtual simulation and optimization of robot movements and expressed great interest in the details.

### Had you expected this response?

The robotics sector is picking up speed. For 2013, for example, the German Engineering Federation VDMA posted a new sales record in the area of robotics and automation. At the same time, manufacturers are looking for resource-saving production solutions. Designing robots that use less energy is a huge issue in the manufacturing sector. In this respect, I was not surprised at the great interest shown.

### But the first robust results from the software testing surprised you?

Yes, indeed. The high energy-saving potential resulting from the application of trajectory programming impressed us enormously. A reduction in energy consumption of up to 50 percent through optimized motion control – we certainly didn't have this order of magnitude in mind when we started development work.

### When can manufacturers start reaping the benefits?

We're planning to be able to launch a software expansion of the Siemens Tecnomatix planning software for the energy-efficient programming of industrial robots as early as 2014.

[www.siemens.com/tecnomatix](http://www.siemens.com/tecnomatix)

New record temperatures are repeatedly being measured, and not just in Australia. Climate researchers warn about the consequences of climate change.

## Australia: billions for competition and climate protection

Australia is one of the world's biggest climate offenders. Now, with lavishly endowed funds, the government is supporting companies' efforts to convert to clean technologies – very much in the best interest of a country that is more and more often plagued by natural disasters.

The village of Colignan (population 200) in the Australian state of Victoria has neither a supermarket nor a gas station. The post office was closed over two decades ago. But this little place, in the midst of wine country and fruit farms, is the headquarters of Australian Tartaric Products (ATP), Australia's largest manufacturer of natural tartaric acid for wine production. Until now, ATP's production ran on propane that was delivered over long distances in tank trucks.

An expensive solution, and one that's bad for the climate. ATP's latest energy bill was AU\$3.4 million (about €2.5 million) and was threatening to run even higher – in part because Australian companies will soon have to pay for their CO<sub>2</sub> emissions. »We needed a solution to cut our energy costs and reduce CO<sub>2</sub> emissions at

the same time,« says ATP General Manager Sam Testa.

### Lower energy costs

That's why, with support from the Australian government, the company launched its own private energy turnaround in 2012. A biomass boiler will soon be generating the steam for energy production from grape residues left over from tartaric acid production. Surplus steam will also be used via a thermodynamic process (an organic Rankine cycle) to generate nearly two-thirds of the electricity the company needs. Bottom line: ATP expects to reduce both its emissions and its energy costs by about 75 percent.

To finance the project, which will cost the equivalent of approximately

€5.6 million, ATP received roughly €1.3 million from the Australian government's new Clean Technology Food and Foundries Investment Program. This assistance program is part of a broad investment plan established in 2012 to encourage private companies to invest in climate protection. In all, over the next few years the Australian government will be providing about €900 million to promote energy-efficient and clean technologies, processes, and products.

A change of attitude seems to be the essential ingredient. In per-capita CO<sub>2</sub> emissions, Australia is currently among the foremost of the world's major climate offenders. Chief to blame are the nation's antiquated coal-fired power plants, which generate more than three-quarters of the country's electricity. The electric, gas,

and water sector alone is responsible for 36 percent of all emissions.

Australia itself already appears to be suffering severe consequences from global climate change. Over the past few years, massive floods have alternated with periods of extreme heat and drought. Just recently, Australian weather maps introduced a new color, dark purple, for temperatures of 50 degrees Celsius (122 degrees Fahrenheit) and above. So the Labor government currently in power has set ambitious goals. Australian CO<sub>2</sub> emissions will be cut by 159 million tons by 2020. That's a five percent reduction compared to the turn of the millennium. By 2050, emissions are to be cut by a full 80 percent compared with levels in the year 2000 – even though the country's population is expected to nearly double by then.

To get businesses to take action, in 2015 Australia will launch emissions trading based on the European model, at which point the price of carbon will be tied to the carbon price in the European Emission Trading System (ETS). Since July 2012, the country's 500 biggest air polluters have already had to pay an emissions tax the equivalent of €17 per metric ton of CO<sub>2</sub>. That price will rise about five percent per year until 2015. The revenue will go to domestic businesses that invest in climate protection by way of the clean technology programs.

## 220 projects financed

Since these programs began in February 2012, the government has helped finance more than 220 projects, encouraging investments in energy efficiency to the tune of more than €250 million. The recipient companies have already collectively saved more than €22 million in costs per year. About one in every four companies have been able to cut their emissions intensity – CO<sub>2</sub> per unit of output – in half. The government's plan appears to be panning out. »These projects

are good for business and good for the environment,« according to the Ministry for Climate Change, Industry, and Innovation.

The Clean Energy Map, continuously updated on the Internet, provides an overview of the diversity of projects nationwide. For example, pharmaceutical maker Baxter in the state of Victoria swapped out the lighting in its production halls – a simple step that has saved this mid-sized company (100 employees) as much as €12,000 per year and cut CO<sub>2</sub> emissions eleven percent.

Soft-drink corporation Coca-Cola invested nearly a million euros from the Clean Technology Investment Program at its plant in Richland, in the state of Queensland, where it will

be producing the lightest-weight PET bottles in the entire company. The savings on weight are expected to lower CO<sub>2</sub> emissions from the mixing and bottling plant by 32 percent, while the energy bill should drop as much as 40 percent – equivalent to a savings of €210,000 a year.

According to Eduardo Sugay, responsible for Industrial Energy and Environmental Services at Siemens Australia, many plants spend as much as 50 percent of their operating costs on energy. »Energy efficiency is one of the best starting points for industrial clients to improve their margins, and to produce sustainably in both economic and ecological terms,« says Sugay. »In many cases, we can cut our customers' energy consumption in half.« ■

## Climate protection programs

The Clean Technology Investment Program enables Australian production companies to apply for grants for energy efficiency projects until 2017. Companies with annual revenues of less than €71 million can get assistance of up to 50 percent and just under €360,000; the maximum for larger companies is 25 to 33 percent. The government is providing about €560 million, in several phases. About €260 million will be made available between July 2014 and June 2015.

Assistance is available for replacing and modifying existing equipment or processes and for converting to alternative energy sources, including the costs of consulting and audits.

The cash is awarded by a neutral commission, or by the Cabinet in the case of large projects. Applicants must prove how much energy and CO<sub>2</sub> the planned projects will save, how the project will improve their competitiveness, and that they possess the necessary expertise and capacity.

For the food industry and metal foundries, the Clean Technology Food and Foundries Investment Program will provide another €143 million on the same terms until 2016. Private-sector research projects on renewable energy sources and energy efficiency are also being supported under the Clean Technology Innovation Program (total: €143 million) up to 50 percent and a maximum of €3.6 million.

View of Cape Town from the Table Mountain Aerial Cableway: Siemens electrified this still-popular attraction in 1927.

# Good hope on the Cape

South Africa has the largest and most developed national economy in Africa. Its geographic situation is ideal for trade with neighboring countries – some very dynamic – as well as for international trade. South Africa also has an aspiring black middle class that is eager and willing to consume.

The head of state wore a high-visibility vest over his suit and was in a great mood. Jacob Zuma, head of the government of the Republic of South Africa, opened the Ngqura deepwater port near the city of Port Elizabeth in March 2012. A state-owned logistics company had invested the equivalent of more than €600 million in the area. »The port is a key strategic infrastructure project for our country, the continent, and the world,« said Zuma at the official launch. One of Ngqura's beneficiaries will be South Africa's automotive industry, which has set up shop around Port Elizabeth. Many international automakers such as VW, Ford, and General Motors, along with numerous suppliers to the auto industry, make their products there. Port Elizabeth, home to one million people, is known as the Detroit of South Africa.

Along with automakers in other parts of the country, the cluster in Port Elizabeth has caused South Africa to develop into a worldwide hub for the automotive industry. Manufacturers profit above all from its geographic location on the southern tip of the African continent. Asia, Australia, and South America are easily reached by sea, as are neighboring countries in southern Africa. The industry has become one of South Africa's main employers.

The automotive industry – like other industrial sectors – is using South

Africa as a gateway to one of the last nearly untapped markets in the world: sub-Saharan Africa, with a population of 250 million (see interview on page 57). The group of BRIC countries – Brazil, Russia, India, and China – added South Africa to their circle in December 2010 due to its strategic importance. South Africa has participated in the annual meetings of the group, now known as BRICS, since that time.

### Largest national economy

Thanks to a gross national product (GDP) of around US\$400 billion, the new BRICS country is the largest national economy in Africa, ahead of Nigeria and Egypt. South Africa is the only G-20 country in Africa, and it alone is responsible for about one-quarter of the economic output of the entire continent. It has well-developed financial, legal, and communications systems, most of which are at the level of those in Europe. »South Africa is one of the few success stories on the African continent,« according to an analysis by the Bertelsmann Stiftung, a private nonprofit foundation. Its economy grew on average 4.2 percent per year between 2005 and 2010. South Africa's Finance Minister, Pravin Gordhan, still expects growth of 2.7 percent in 2013.

South Africa's economy is broad-based, unlike those of many other

sub-Saharan countries, which rely primarily on commodities. The mining industry is another of the largest sectors in South Africa. The country is the world's largest producer of chromium and platinum, with more than 700 mines. But other major sectors, including the automotive industry, textiles and leather, the financial industry, telecommunications, and tourism, are also making vital contributions to the national economy. Cape Town, a city of five million people with a Mediterranean climate, is the most popular tourist destination in all of Africa.

Most companies are located in the Johannesburg metropolitan area, which has a population of 11 million. This includes the Midrand district, where many international conglomerates are represented: Canon, Sony, and of course Siemens (see page 56).

South African companies like the mobile telephone provider MTN are active throughout the continent. The SABMiller group, the product of a 2002 merger between South African Breweries and Miller Brewing Company, is the second-largest brewery group in the world, with headquarters in Great Britain. South African industrial companies contribute almost one-third of the GDP and one-quarter of all jobs. The industrial sector is more developed there than in any other African country.





The automotive, food, and textile industries (left) are important pillars of the economy – along with service-based industries like tourism (center). Some 700 mines like this ore mine (right) also make South Africa a major world commodity producer.

## Siemens in South Africa

Werner von Siemens had the first telegraph connection in South Africa installed between Cape Town and nearby Simon's Town in 1860.

Siemens opened its first office in Johannesburg in 1898. Numerous contracts and prestigious projects followed. For example, Siemens electrified the Table Mountain Aerial Cableway, which carries passengers 1,000 meters to the summit of the mountain, in 1927.

Siemens provided all of the telephone equipment for the Election Commission during South Africa's first free elections, in 1994. And Siemens participated in the 2010 FIFA World Cup with infrastructure projects valued at €1 billion.

Today Siemens employs 2,000 people in South Africa at five large production and service locations. Most of them are in the greater Johannesburg area, including Siemens Southern Africa based in the Midrand district.

[www.siemens.com/africa](http://www.siemens.com/africa)

### Modern industrialized country

The economic success of South Africa – also known as the Rainbow Nation because of the number of skin colors and cultures among its inhabitants – could not have been predicted when apartheid ended in 1994. True, South Africa had swiftly developed from an agrarian country into a modern industrial nation after the Second World War. But Nelson Mandela, the first black president, inherited an economy that was not internationally competitive. It had been slowed by decades of sanctions and embargoes imposed by the international community due to the country's policy of apartheid. Still, it had well-functioning road and rail networks.

The government is still using that infrastructure today, along with smart – in sub-Saharan terms – financial policies to move the South African economy forward. These initiatives have had positive effects on domestic consumption. South Africans are responsible for some of the highest per capita consumer spending in Africa, second only to the people of Mauritius. South Africa's per capita income is about the same as that of Turkey.

According to a study by McKinsey («Lions on the move – The progress and potential of African economies»), more than two-thirds of all South Africans have access to formal retailing. In comparison, only 38 percent of the Eastern European transforma-

tion countries, on average, have access to boutiques, shopping centers, and supermarkets. In a retailing study, Deloitte Consulting called South Africa one of the »hidden heroes,« along with countries like Pakistan and Vietnam.

Thanks to a redistribution program that uses quotas to bring greater prosperity and influence to black and »colored« South Africans, the country now has a very prosperous black upper class and a new middle class that is eager to consume. A study by the University of Cape Town indicates that there are 4.2 million of these »Black Diamonds« – 2.5 times as many as in 2004 – and their purchasing power now outstrips that of the white middle class.

South Africa still has some problems that hamper its economic development, primarily corruption and nepotism. The Corruption Perceptions Index of Transparency International ranks South Africa among the countries in last place in Africa. A bloated state apparatus, dirigisme, and red tape all act to slow direct foreign investment. Other aggravating factors are frequent strikes initiated by unions and a high rate of HIV in the population.

High unemployment also exacerbates the problems. About one-quarter of the population is officially unemployed, but unofficial estimates put the rate at closer to 40 percent, because many people are no longer looking for work and are therefore not included in the



statistics. This social predicament means that South Africa has one of the highest crime rates in the world.

One major challenge is the need for a rapid expansion of the education system. The government has recognized this and is investing almost one-fifth of its budget in teaching the relatively young population – average age 26. However, the need for qualified employees is still far from being met. The South African economy,

which is in the midst of the transition to producing complex products, is desperately seeking enough qualified blue- and white-collar workers.

Despite all of the difficulties and the tasks ahead, the World Bank considers South Africa to be one of the most business-friendly company locations on the continent. The Bank's Ease-of-Doing-Business Index shows that among African countries, South Africa is second only to the island country of

Mauritius. South Africa will no doubt become more attractive to international companies as a result of its geographic location. Experts assume that the southern shipping route between China and Brazil will gain importance over the long term – making South Africa a place for transshipment along the way. According to President Zuma, »this development indicates that South Africa and the region will be well positioned to lead the establishment of a key trade corridor.« ■

## South Africa in figures

### Area:

1.2 million square kilometers

### Population:

52 million

### Unemployment rate:

25% (official), 40% (estimated)

### Gross domestic product (GDP):

US\$402 billion (2013, estimated)

### GDP growth:

3% (2013, estimated)

### Industry's share (total) of GDP:

31% (2011)

### Services' share of GDP:

67% (2011)

### National debt:\*

43% (2013, estimated)

### Export volume:

US\$62 billion (2011)

### Main export countries (percentage of total exports, 2011):

China (13%), U.S. (9%), Japan (8%), Germany (6%)

### Import volume:

US\$122 billion (2011)

### Main import countries (percentage of total imports, 2011):

China (14%), Germany (11%), U.S. (8%), Japan (5%)

\* In relation to GDP

Sources: CIA, IWF, IMF, Statistics South Africa, World Bank World Development Indicators, WTO

## »On the brink of an economic takeoff«



Raymond Padayachee

**Raymond Padayachee, Senior Vice President Industry Africa and Middle East at Siemens, Johannesburg, South Africa, on Africa's up-and-coming markets.**

### How do you judge Africa's potential?

»Africa is rising« is a fitting slogan used by the African Union, given the vast economic, social, and political transformation the continent is undergoing. Macroeconomic conditions are improving. Governments across Africa are taking action to end wars, corruption, and enhance political stability. The World Bank, for example, reports that Africa could be on the brink of an economic takeoff – much like China 30 years ago and India 20 years ago.

### What products will these markets need now?

Many African countries require access to reliable energy generation and distribution, public transportation, water, and affordable healthcare, along with a functioning industrial sector. Siemens is well prepared to meet these expectations.

### What is Siemens doing for its customers?

Siemens has been operating in Africa for over 150 years, and we are fully equipped for dealing with these growth markets. Currently, Siemens has six regional companies: Algeria, Angola, Morocco, Nigeria, South Africa, and Tunisia, as well as six branches: Kenya, Tanzania, Zambia, Mozambique, Ghana, and the Democratic Republic of Congo. Siemens' focus is on solutions for sustainable urban infrastructure development, accessible healthcare solutions, renewable energy, and environmentally friendly products and services for industry.

# Shooting star

Elon Musk knew next to nothing about space travel when he started SpaceX in 2002 with some three dozen employees. But he had a vision: to colonize Mars. Today the high-tech company has more than 3,000 employees and makes rockets for NASA and other customers.

SpaceX's Dragon spacecraft is contracted by NASA to resupply the International Space Station.

Vanilla and chocolate ice cream are among the earthly pleasures that astronauts usually have to do without. Not the crew of the International Space Station (ISS), however: They were able to enjoy an ice-cold treat right after their resupply delivery in October 2012. But the real sensation wasn't the ice cream, it was the fact that a private company was officially resupplying the space station for the first time.

Now in 2013, deliveries to the orbiting outpost have become routine – much to the delight of Elon Musk, founder, CEO and Chief Designer

of SpaceX, which is based in Hawthorne, California. His rocket and spacecraft took the ice cream and 450 kilograms of other cargo to the ISS and returned to Earth with scientific samples and worn-out parts and equipment.

SpaceX is the only company in the world that has ever delivered an unmanned transporter to its destination in space and safely brought it back to Earth. Founded in 2002, SpaceX will operate ten more unmanned flights to the ISS under the US\$1.6 billion Cargo Resupply Services contract (CRS). >>



## History of SpaceX and space travel

The CRS program provides for the regular resupply of the ISS by commercial companies. This official contract for services was awarded to SpaceX by NASA. CRS followed the Commercial Orbital Transportation Services program (COTS), created by NASA in 2006 to encourage private companies to develop commercial spaceflight capabilities with technical and financial support from NASA.

### Replacing the Space Shuttle

The COTS program was developed because NASA urgently needed a replacement for the Space Shuttle. The expensive Space Shuttle program became a target of criticism after the Columbia disaster in 2003, when the shuttle disintegrated during reentry into the Earth's atmosphere. The last three shuttles made their final flights to museums in 2011.

The ISS is still in orbit, however, and it still needs to be resupplied. NASA

created COTS to avoid leaving this task to Russia and its Soyuz spacecraft. Only one company other than SpaceX was awarded a CRS contract to resupply the ISS. Orbital Science Corporation, based in Dulles, Virginia, specializes in the manufacture and launch of satellites, has decades of experience, and employs 2,700 people.

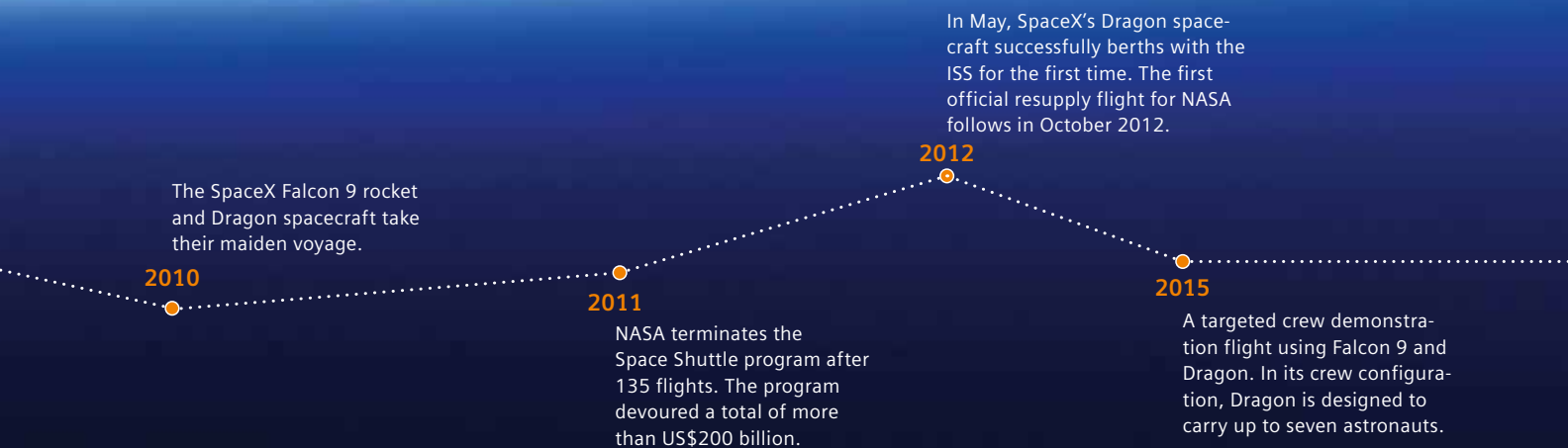


The SpaceX headquarters in Hawthorne, California, USA.

### From the Internet to Mars

It's pretty unusual for a newcomer to pull ahead of the competition after only ten years in a high-tech industry like private space travel. The capital needed to get the operation off the ground, so to speak, came primarily from Musk. He was a cofounder of PayPal, which allows payments and money transfers to be made through the Internet. PayPal went public in 2001, after which Musk sold his shares to eBay, becoming a multi-millionaire at the age of 31.

Looking for new challenges and having always been interested in space exploration, he turned to nothing less than the colonization of Mars. In 2002 he came up with a plan to send a miniature greenhouse packed with seeds and dehydrated nutrient gel to Mars to prove that his vision could be realized. His thinking was that the experiment, if successful, could result in a photograph of



the first life on Mars, reigniting public interest in space.

### Inexpensive rockets

Musk needed suitable transportation for his own private Mars mission, but the results of his search were pretty disappointing back in 2002. The price tag on the cheapest rocket was US\$65 million.

The Russian government made a more attractive offer: two redundant inter-continental ballistic missiles for about US\$15 to 20 million each. And after that? Musk realized he would never be able to find adequate replacements for them at a comparable price anywhere in the world.

At that point Musk, a native South African, changed his plan and decided to simply build his own rockets. He recently told the technology magazine *Wired* that it had become clear that »rocket technology had not materially

improved since the 1960s – arguably, it had gone backward!« According to Musk, this is due to »the incredible aversion to risk within big aerospace firms. Even if better technology is available, they're still using legacy components,« often from the early years of space flight.

Other factors, says Musk, are the tendency to outsource everything and excessive bureaucracy. He calculates that the materials cost of a rocket is about two percent of the typical price, and he calls this »a crazy ratio« compared with other high-tech products like cars – which he also knows something about as CEO of Tesla Motors, maker of electric sports cars.

SpaceX has proven in record time that things can work differently. Its Falcon 1 rocket was launched from an atoll in the Pacific Ocean in 2008, just six years after the company was founded. The price was a fraction of that of the surplus ICBM mis-



SpaceX builds complete rockets, from propulsion units to software, including large tanks.

siles offered by the Russians. Today SpaceX uses a more powerful successor, Falcon 9, for its missions to resupply the ISS for NASA. SpaceX also makes the Dragon spacecraft, which launches atop the Falcon 9 to deliver supplies to the ISS.

### Vertical integration of more than 70 percent

Musk doesn't say much about his formula for success, because the international competition – China



# Rocket design with Siemens PLM software

The aim of SpaceX was clear: to build the world's most reliable vehicles at a fraction of historical costs in order to further space exploration. This requires new, highly efficient processes. SpaceX relies on Siemens PLM software solutions for design, development, simulation, testing, and assembly.

The PLM NX software is able to load even extremely complex subassemblies containing more than 25,000 parts within ten minutes. This allows developers to design multiple components in context and immediately coordinate them. Rocket engineers can simulate movements, allowing them to check the effects of rocket stage separation on individual components.

NX data is also used to produce models and videos for marketing purposes. In addition, NX models are helpful for production employees, because they can see the virtual paths of wires, cables, and lines.

The use of Siemens PLM Teamcenter software as a central data archive creates a consistent development environment in which all development documents – including calculations and test results of CNC programs – are managed together with the rocket components. This facilitates collaboration among the development teams in different departments who are working on propulsion, structure, and avionics as well as subsequent modifications.

[www.siemens.com/nx](http://www.siemens.com/nx)

Test launch of the Falcon 9 rocket, almost 70 meters long, at Cape Canaveral, Florida.



in particular – is much too eager to find out more. However, some fundamental parameters are known, including a vertical integration of more than 70 percent based on the value and mass of the rocket. And novel design, development, and production methods using Siemens PLM software (see box, left).

»SpaceX relies on the value and capabilities offered by modern information technologies,« says Timothy Nichols, Vice President Global Marketing for the aerospace industry at Siemens. According to Nichols, the company digitally simulates many steps in a mission before production begins. This allows many potential risks to be identified and prevented at an early phase, which is more cost-effective.

Nichols describes a corporate culture distinguished by an innovative and entrepreneurial spirit and fully dedicated to maximum productivity as another success factor. He cites the absence of entrenched structures, technologies, and processes that could curb the company's quest for innovation as another crucial competitive advantage for SpaceX.

SpaceX has opened up existing markets and tapped new markets through innovation in both design and manufacturing that ultimately result in highly reliable vehicles at less cost. In addition to NASA, commercial satellite operators also have their communication and TV satellites launched by Musk. »There are a lot of applications for satellites that suddenly begin to make sense if the transportation costs are low,« he says.

The company has grown significantly since it was founded in 2002 – from just 30 employees to more than 3,000. SpaceX's career page invites all recruits to help the company change the future of human space exploration.

Musk is still aiming at his original objective – Mars. He has received official orders from NASA to continue to pursue manned space flight, so SpaceX is working on upgrades to the Dragon spacecraft that will be able to carry astronauts to and from the ISS and other orbiting destinations.

According to Musk, the real breakthrough will be fully and rapidly reusable rockets. »America would never have been colonized if ships weren't reusable,« he says. This has never been seen in the history of space travel. The Space Shuttle was reusable, but needed massive refurbishment, which was both expensive and time-consuming.

### Precision landing

SpaceX hopes to change this. The company is currently testing the technologies needed to return a rocket back to earth intact with a 10-story vertical takeoff, vertical landing (VTVL) vehicle called Grasshopper. While most rockets are designed to burn up on reentry, SpaceX rockets are being designed not only to withstand reentry but even to return to the launch pad for a vertical landing. If SpaceX succeeds in its efforts to develop fully and rapidly reusable rockets, there may someday be commercial rocket flights – and perhaps they'll even serve ice cream. ■

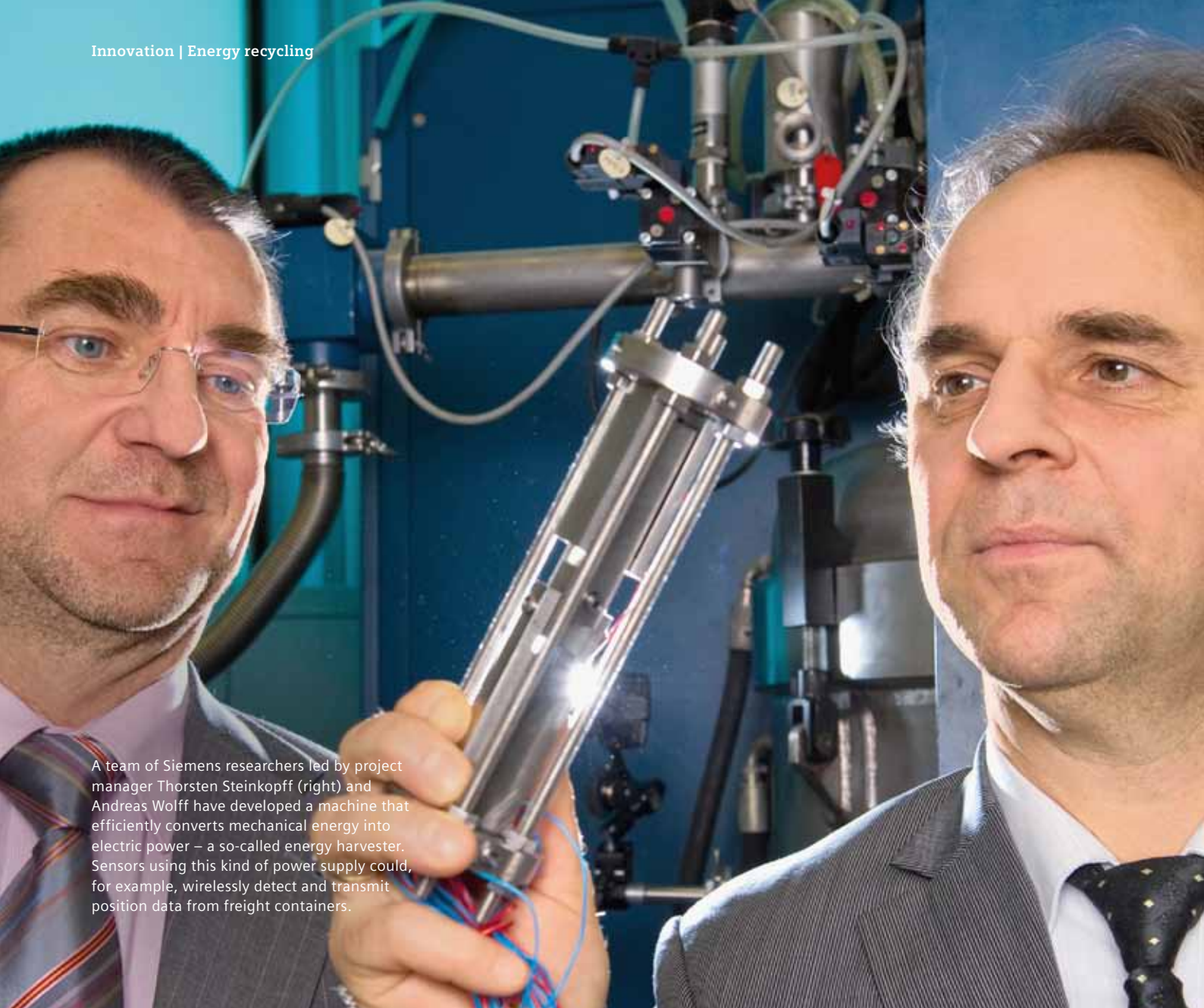
## Elon Musk

Elon Musk, CEO and founder of SpaceX, was born in South Africa in 1971, emigrated to Canada at the age of 17, and studied physics and economics at the University of Pennsylvania. He was 24 when he and his brother founded Zip2, his first online company. Four years later, the computer manufacturer Compaq paid US\$307 million for it.

Musk then launched an online payment system that today has become part of the largest Internet payment service in the world: PayPal. eBay acquired PayPal in 2002, paying almost US\$200 million for Musk's shares.

Musk is also the cofounder and CEO of the automaker Tesla Motors. The company, which has more than 2,000 employees, builds electric sports cars.





A team of Siemens researchers led by project manager Thorsten Steinkopff (right) and Andreas Wolff have developed a machine that efficiently converts mechanical energy into electric power – a so-called energy harvester. Sensors using this kind of power supply could, for example, wirelessly detect and transmit position data from freight containers.

# Chasing valuable treasure

Approximately half of the energy used in manufacturing is lost in the production process in the form of heat and kinetic energy. Research and development departments around the world are working overtime to put an end to this waste through energy recycling.



This is a fascinating concept for vehicle manufacturers: Small thermoelectric generators absorb free energy from the area surrounding an automotive engine and convert it into onboard power, which contributes to reducing fuel consumption as well as CO<sub>2</sub> emissions. From the perspective of physics, this is really old hat: The concept is based on the Seebeck effect. In 1820 the German physicist Thomas Johann Seebeck discovered that voltage can be generated in an electrical circuit made from two different conductors if there is a temperature difference between the contact points.

Now, almost two hundred years later, Seebeck's discovery is once again being put to practical use in industrial innovation research projects. In the future, carbon-neutral electricity will be produced by thermoelectric generators (TEGs) that rely on the Seebeck effect: for example, utilizing vehicle exhaust heat.

### Power from exhaust heat

This was the subject of a European Union (EU) research project called HeatReCar. The Fraunhofer Institute for Physical Measurement Technology (IPM), Siemens, and other industrial enterprises participated in the project. TEGs in the form of semiconductors were developed that generate electricity from the temperature difference between a vehicle's combustion engine and its surrounding environment. A TEG installed in a test vehicle on a test stand has been able to extract 500 watts of electrical energy from exhaust gas. Fuel sav-

ings of almost four percent as well as a CO<sub>2</sub> reduction of 9.6 grams per kilometer were measured. TEGs of this type will be used in the future in small trucks to generate up to three kilowatts of power.

Exhaust heat is also utilized by waste heat recovery systems (WHRs) to generate environmentally friendly power on container ships. Containers are transported primarily by sea, so they are responsible for a large percentage of the global freight traffic. Small energy savings during transport can translate into a significant competitive advantage for shipping companies. The WHR system collects engine exhaust gases and uses them to drive a combined exhaust-gas steam turbine that generates power from the thermal energy of the gases. This can reduce fuel consumption by up to ten percent and CO<sub>2</sub> emissions by about twelve percent.

The new 400-meter-long container ships operated by the Danish company Maersk, the largest container ship company in the world, were not only equipped with WHR systems but also with environmentally friendly drive and power generation systems from Siemens.

The recovery of wasted energy – which often occurs in the form of waste heat or kinetic energy from cars, trains, ships, and industrial plants, and which often goes unutilized – now ranks very high on the agenda of industrial research and development departments. This is the result of rising energy prices as well as the need to reduce emissions

»This technology is able to significantly improve the efficiency of large industrial plants.«

Stefan Lampenscherf,  
thermoelectric expert at  
Siemens Corporate Technology

»

# »Runs with no effort«

**Philip Howell of Siemens Corporate Technology coordinates the European NEXTEC project (Next Generation Nano-Engineered Thermoelectric Converters). Thermoelectric generators (TEGs) are being developed that in the future may be able to optimize waste heat recovery in industry.**

## **Does industry already use thermoelectric systems for exhaust gas recovery?**

Apart from a small number of prototypes, there are currently no TEGs for generating carbon-neutral power from waste heat suitable for industrial application. Modules are required that are able to withstand application temperatures between 400 and 700 degrees Celsius, which occur, for example, in gas turbines, oil refineries, and the exhaust systems of diesel engines.

## **Will this change anytime soon?**

Most certainly. NEXTEC is working successfully on innovative materials and technologies for TEGs suitable for industry. At Siemens we are currently developing a prototype with the long-term goal of using it as the central unit in a new, integrated energy recycling system for large industrial plants.

## **What will be the benefits?**

To achieve increased and optimized energy recovery. The advantage is that the waste heat temperatures and the mass flow of exhaust gases in an industrial plant fluctuate very little. It is therefore relatively simple to optimize TEG systems for such constant conditions. A TEG used in an industrial plant will run with no effort, because we expect that the maintenance effort and the operating costs will be low.



Philip Howell

and make components like sensors more independent from the power supply.

## **Miniature generators**

Waste heat recovery systems and the development of thermoelectric generators are just two of many possibilities. Stefan Lampenscherf, a thermoelectric expert at Siemens Corporate Technology, says, »A current flows in thermoelectric materials if there is a temperature difference, for example, between a hot and a cold surface. TEGs are installed in an exhaust duct or pipe in such a way that one surface remains cool, and power can be generated through this arrangement.« Thermoelectric components are cost-effective and can be mass-manufactured. They are also solid-state units with short start-up

times. They can therefore become operational very quickly so as to process heat that occurs even for short periods of time.

»For example, this may be of interest to power stations that in the future will be required to compensate for brief supply fluctuations due to renewable energy infeeds,« says Lampenscherf. »The continued development of this technology will also significantly improve the efficiency of large industrial plants.«

One obstacle to the practical application of thermoelectric generators in industry is the development of materials for thermoelectric modules that work efficiently at temperatures of several hundred degrees. In addition, new joining methods must be found because conventional solder

joints are not suitable for high temperatures and where temperature fluctuations occur. Siemens, in conjunction with universities and partners in industry, is following up these questions within the scope of the NEXTEC research project. Siemens is also currently building a laboratory demo unit (see interview, above).

## **Low temperatures are sufficient**

There is nothing new about the fact that industry and energy companies are utilizing waste heat and process heat in high-temperature areas. For example, gas-fueled power stations use the waste gas from the gas turbine to generate steam to drive the steam turbine. The chemical industry uses waste heat from



Piezoelectric systems are a perfect solution for rain or light sensors that are wirelessly attached to the windshields of cars, where the car body vibration is sufficient to generate power

## The boom in sensor technology, and therefore for energy harvesting, is expected to arrive with Industry 4.0

reaction products for subsequent production processes. However, in production environments where the waste heat temperature is low, there are few utilization concepts that are economically viable and technically advanced. Siemens Corporate Technology is currently working intensively on the so-called ORC technology (organic Rankine cycle), which is used to reclaim energy from low-temperature waste heat.

In partnership with the Moscow Power Engineering Institute and Moscow State University, scientists have been working since 2011 on efficient generators. Unlike the classic steam power cycle, with OCR technology it is not water that circulates but an organic medium comprised of carbon, fluorine, and oxygen. This process is highly effi-

cient, particularly with low-temperature waste heat, and the generator design is compact. Unlike water, this medium converts to steam at 49 degrees Celsius at normal pressure.

While ORC and NEXTEC technologies essentially utilize the flow of heat (waste heat and mass flow), Andreas Wolff, a developer at Siemens Corporate Technology, is concentrating on the utilization of the piezoelectric effect to generate power. The term »piezo« is derived from a Greek verb that means »to press.« This physical phenomenon converts mechanical movement into electrical energy. The objective with this form of energy production is to »harvest« comparatively small quantities of energy from the environment to generate power.

»

# Energy harvest for sensors

Energy harvesting generates electric power from movement, pressure, and waste heat. With this power it is possible to operate sensors and other devices. Energy harvesters can be small generators like thermoelements that produce voltage when encountering temperature differences. Others include electrodynamic converters that generate voltage through a coil or magnet as soon as mechanical pressure is applied, and elements containing special piezoelectric crystals that release electrical energy when mechanically deformed.

Power generated in these ways is sufficient to supply wireless sensors with power without the need for batteries. Systems of this kind are currently used mainly for control systems in buildings. Sensors measure temperature, air, and light conditions in rooms and transmit the data to the heating, air-conditioning, and light control systems.

The power required for sensing and transmitting the data is obtained from the voltage generated through the temperature difference between a heating radiator and the air in the room, for example.

The biggest advantage compared to wired or battery-operated sensors is the low maintenance and installation effort required: no change of batteries, no wiring checks. This means that building maintenance is significantly simplified. One example is the

building automation solution created by the energy harvesting specialist and Siemens partner EnOcean for one of Europe's most spectacular high-rise buildings: The Squire at the Frankfurt airport, Germany. The entire concept is based on a decentralized control system with battery-free, wireless sensor technology. Lighting, heating, and shading of the rooms in The Squire are accomplished using 18,000 switches and temperature sensors.

The EnOcean building concept for The Squire was awarded »Best energy harvesting application« by the U.S.-based market research and consulting company IDTechEx. With this award the jury acknowledged the great installation flexibility of the battery-free, wireless sensor technology and the low-maintenance and energy-saving features of the system.

Energy harvesting for sensors has enormous future potential for monitoring industrial plants. The wireless sensors are supplied with power generated from vibrations or waste heat emitted by the machinery they are monitoring.

The IDTechEx analysts estimate that there will be a worldwide boom in the energy harvesting sector in the next ten years. The market for small systems utilizing ambient energy is predicted to increase from the current US\$660 million to \$4.4 billion.

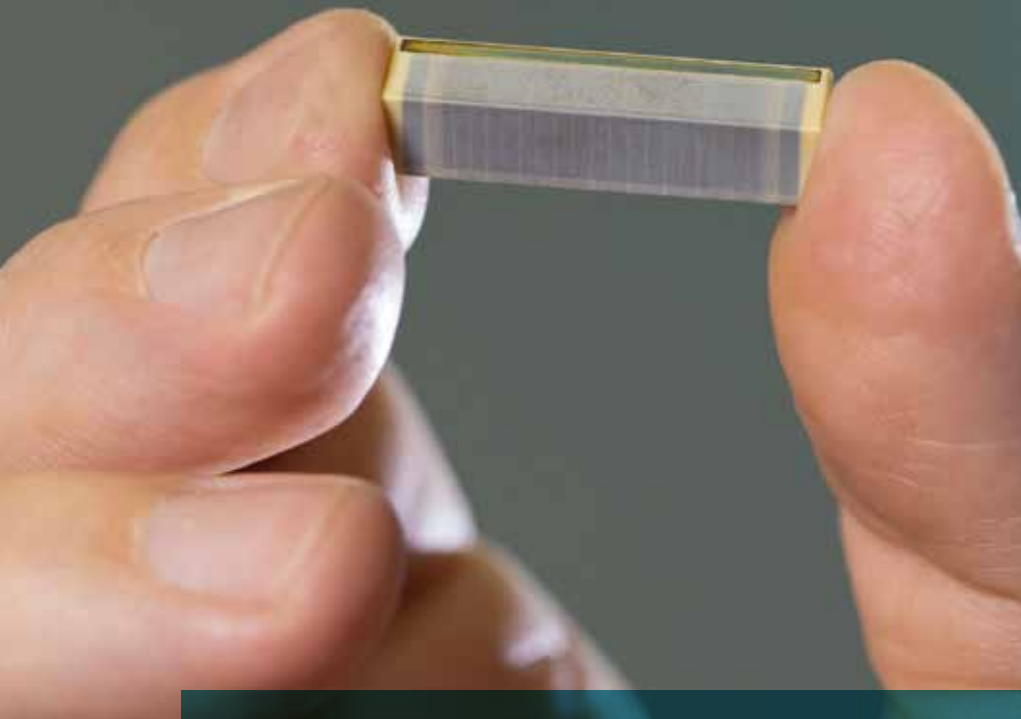
One significant advantage of piezoelectric systems is that they do not require wiring or batteries. This makes them ideal as power supplies for sensors, including rain or light sensors that are attached to the windshield of a vehicle without wires, utilizing the car body vibrations to harvest energy. The boom in sensor technology, and so for energy harvesting, is expected to come with Industry 4.0.

Wolff has developed an energy harvester on the basis of a spring-mass system that converts movements such as vibrations and oscillations of varying frequencies and amplitudes into electrical energy. »We can use this to utilize mechanical energy in the environment far more effectively than ever before,« says the scientist. »To date, this method has worked only under very limited conditions and in very narrow oscillation bandwidths.«

It is now possible to more effectively utilize the unavoidable vibrations and oscillations of an engine: for example, to generate power in the milliwatt range, which is often sufficient to drive a sensor.

To research this process, developers at Siemens use an especially stable piezoelectric converter with great rigidity, which Siemens already developed in the 1990s for use in fuel injection systems. »This makes it possible to adjust the natural frequency of the spring-mass system through automatic stiffening to the variable frequency of the ambient movement,« as Wolff explains the physics principle being utilized.

»This has two advantages in practical application«, says Thorsten Steinkopff, who is responsible for the development project. »First of all, even very small movements can be converted into energy. Secondly, the applied reinforcing prevents the harvester from flexing too much, which protects it from damage through impact or vibration.«



Miniature power station for sensors: These energy harvesters for sensors generate power from movement, pressure, and heat (left). A system for utilizing exhaust gas heat results in fuel savings of up to ten percent for Danish shipper Maersk's container ships (top right). By using thermoelectric generators attached to vehicles' exhaust systems, power for onboard use can be generated from the temperature difference between the exhaust gases and the surrounding atmosphere (bottom right).

This renders the piezoelectric harvesting device extremely suitable for application in freight and transport systems, for example. The generated power can be used to wirelessly collect and transmit the position and status data of containers. Piezoelectric converters can also quite easily be mass-produced for a large number of applications.

### Energy through dedusting

Another approach to increasing a plant's energy efficiency is to prevent energy loss caused by temperature fluctuations and pressure losses in the first place. The Turkish steel-maker Kardemir will achieve this goal at its Karabük plant in the Black Sea region using a Merim dry-type dedusting plant. Merim stands for

maximized emission reduction and energy recovery in ironmaking.

In contrast to the common wet-type dedusting plants in the iron processing industry, the pressure and temperature losses with the Merim technology are significantly lower. This makes it possible to increase energy recovery in a blast furnace gas turbine by 25 percent.

In addition, 90 percent of the dust collected from scrubbing the gases is separated into usable and non-usable components. The usable, iron-containing dust component is available for use in a sinter plant. The completed Turkish plant, designed and installed by Siemens, will be commissioned by the end of this year. ■

## Wasted potential

Much more than half of Europe's industrial process heat is wasted.

Temperature (in °C)	Unused energy (in %)
> 400	57
100-400	73
< 100	70

Source: Euroheat & Power, 2011

Beat Weibel,  
Head of Intellectual  
Property at Siemens



# » Patents are assets «

Siemens files patents for just under 5,000 inventions every year. The company's Intellectual Property department employs about 430 specialists to protect their intellectual property. *Industry Journal* spoke with Beat Weibel, who heads the department, about the challenge of identifying and protecting valuable inventions as well as exploiting them economically.

**Mr. Weibel, innovative ideas are the most important resource for technology companies that invest heavily in research and development. How does Siemens protect its inventions with patents?**

When the research and development (R&D) departments of individual Sectors or the Technology Fields of Siemens' Research & Technology Center (CT RTC) develop new products or processes, they disclose the inventions internally to Intellectual Property (CT IP), the central patent department. Last year, employees in R&D submitted a total of 8,900 invention disclosures. Our patent attorneys then work together with representatives of the Business Units to determine whether these innovations can be patented. If they reach a positive conclusion, they prepare a patent application that includes a comprehensible description of the invention as well as legal claims. It is very important that the patent claims defining the scope of protection are worded neither too narrowly nor too broadly. We file the patent application with the appropriate international patent offices along with a patent request.

**How many of the inventions disclosed internally are ultimately submitted as patent applications?**

In 2012, we filed patents for 4,600 inventions, which is more than half of the invention disclosures received. Overall, this is seven percent more patent applications than in the previous year. Siemens currently has a worldwide inventory of 60,200 patent grants.

**Inventions are part of the job for development engineers – but are these engineers also familiar with patent law?**

When R&D employees submit invention disclosures, they first need to be aware of the importance of patent protection for technology companies like Siemens. This is why they receive systematic training so that they can identify the inventions that may be patentable among the new products and technologies they are currently working on.





Experienced patent attorneys are needed to effectively protect intellectual property throughout the world.

### What form does this training take?

We offer regular and systematic workshops that are held in the R&D departments. We also offer advice and support during the development process and organize joint conferences with employees from the patent department and R&D in order to discuss inventions and establish patent protection. CT IP must get involved when certain milestones in the development process have been reached, in particular when significant progress is made toward creating new products or technologies. At this point, we can usually more accurately determine whether patentable inventions are being created. Finally, we conduct extensive searches in patent databases to determine where there is still room for patenting inventions in the range of existing industrial property rights. We then give the R&D departments targeted advice on the fields in which new patents can be successfully filed or where third-party patents present obstacles.

### What motivates your engineers to submit internal invention disclosures?

High on the list is the professional curiosity that drives researchers and developers. They naturally want to strive to find innovative solutions to the challenges that they face. If the engineers are successful after months or even years of work, this success drives them to greater

accomplishments. A successful patent application is extra validation for any inventor. We encourage this kind of motivation by presenting the »Inventor of the Year« award, which we have been handing out to the company's researchers and developers every year since 1995.

### Surely there are also financial incentives?

Siemens greatly values its employees' power of innovation. In addition to the inventor compensation to which an employee is entitled under the law, we also pay an incentive for invention disclosures.

### It can often take years for a patent to be granted, and a company usually cannot wait that long. Roughly three-quarters of the products that Siemens sells today were developed just in the last five years. Are the patent offices overtaxed by today's rapid technological progress?

A patent request is made, in principle, before the innovative product to be protected against imitation comes onto the market. In Germany, it usually takes three to five years before a patent is granted. However, the applicant receives preliminary protection until the patent offices have decided on the intellectual property rights. In certain cases, it is advisable to request a utility model instead of a patent for products with a short lifecycle. Although the protection period is much shorter,

utility models are registered faster without requiring a material examination of the invention.

### Siemens cannot use all patents for its own technologies. What happens with these kinds of inventions?

Our company is no longer active in communications technology, for example. The patents that Siemens holds in this business area have been combined into a so-called Corporate Asset Portfolio. These are extremely valuable assets, because communications technology has a very high patent density. We systematically exploit these rights, often with a great deal of success.

### Many innovations today involve software. Are such inventions patentable?

Indeed, many new technological methods are in the form of computer programs. Where control technology is concerned – like motors, CT scanners, and other imaging technologies – the inventions worthy of protection ultimately involve information processing. This is as true in our business areas as it is in the fields of chemicals and pharmaceuticals. In Europe, however, the reproduction of information and programs for data processing systems is, in principle, not patentable in and of itself. A technological effect must also exist. This would be the case, for example, if an X-ray machine were controlled by a new computer program in order to speed up the imaging process or reduce the radiation dosage. Intellectual property rights may also be requested if a computer-implemented invention influences, measures, or analyzes physical or chemical variables. Patent law does not protect the software but rather the underlying technological process.

### So software itself cannot be protected by IP rights?

Yes, it can be. The source code is protected by the copyright that



forms the basis for issuing software licenses. However, the copyright can be circumvented more easily than the patent protection – the source code only has to be modified.

**American and Asian electronics firms regularly wage spectacular legal battles over alleged patent violations, often involving figures in the hundreds of millions. How does Siemens protect itself against this kind of legal dispute?**

We take this issue very seriously. Before Siemens places new products on the market, we very thoroughly determine whether they could violate third-party rights. Most of our more than 200 patent attorneys deal with these so-called product clearings.

**How do you feel about accusations levied at countries like China, stating that they systematically copy innovations in violation of the law?**

The widespread view that the emerging industrial nations do not respect the protection of intellectual property rights is no longer true. This trend has undergone a radical change in recent years. China, India, and other emerging nations have now discovered the economic importance of patents and other intellectual property rights. After all, the companies in these countries have long since stopped imitating the inventions of their Western competitors. Instead, they are producing their own inventions in increasing numbers, using them to distinguish themselves from the competition. For example, China registered more than two million intellectual property rights in 2012. Although the majority of them are utility models and designs, which are registered without an examination, the number of genuine patents on inventions in China has also grown rapidly over the past five years. The Chinese government and business community are now just as interested as Western companies in protecting their innovations against imitation

and are adhering to the international rules. This is also apparent in the fact that China plans to focus more on the quality of its inventions in its new five-year plan.

**Do Chinese companies use the same methods to defend their rights?**

Indeed, they do. China has even become a decidedly litigious country when it comes to protecting intellectual property. Around 8,000 patent disputes are argued before Chinese courts each year, more than in any other country on earth. For example, a small Chinese firm recently sued Apple in Shanghai.

**Does this mean that protecting intellectual property in China is not a problem anymore?**

The problems have less to do with patents and more to do with the abuse of trademarks, logos, and designs and in the failure to respect business secrets. Siemens has also been affected by this trend. Registered designs don't just protect the design of consumer goods. Intellectual property rights of this type can also be granted for machines and equipment including electric motors, transformers, and wind turbines. We report about 50 to 100 violations of our designs and trademark rights in China every year. Counterfeits of our low-voltage switches are particularly popular.

**What do you do in these situations?**

First of all, we have to find out about the counterfeits. We rely on our local colleagues and send them to trade shows and other events where counterfeit Siemens products are likely to be sold. Then we resolve the situation with the company out of court, or else we take legal action. Hopefully, the respect that China and other emerging nations have for the rights to trademarks, logos, and designs will come to match their strong affinity for Western brand-name products in the future. ■

## Beat Weibel

The Swiss native has headed Intellectual Property (CT IP) at Siemens – one of the world's largest IP departments – since early 2013. CT IP's about 430 employees worldwide assist Siemens researchers and developers in registering, asserting, and exploiting intellectual property rights.

Born in 1966, Weibel studied electrical engineering at ETH Zurich, Switzerland. With the equivalent of a Master's degree in engineering, he qualified as a European patent attorney in 1995 and earned the degree Master of Laws. After beginning his career with the ABB technology group and the Swiss industrial company Georg Fischer, he headed ABB's IP department from 2000 to 2012.



# A material that promises wonders

Scientists say that the new material graphene will have a brilliant future. It is ultra-light, extremely strong, flexible, and a superconductor – and could soon revolutionize many different industries. The European Union (EU) plans to spend €1 billion on research into this carbon-based miracle material over the next ten years.



Flexible, stable, conductive – potential applications for graphene abound.



Examples of possible applications: batteries for electric cars, light construction material for aircraft, electrodes for solar cells, touchscreens, and windshields.

More powerful batteries for electric vehicles; lighter, more fuel-efficient planes; rollup e-readers – these are among the many innovations that may be possible thanks to graphene, a new material that is fascinating physicists, chemists, and engineers all over the world. The material is made out of ordinary carbon, but its atoms are chained into enormous web-like molecules.

»Graphene has numerous outstanding properties and the potential for quantum leaps – not just in science but also in applications,« says Klaus von Klitzing, a German Nobel laureate in physics. He is a member of the Scientific Advisory Committee of the EU's Graphene Flagship Project, which seeks to fund research into graphene with a total of €1 billion over the next decade.

The range of potential applications is enormous, and scientists wax eloquent on the subject. »Graphene exhibits an extraordinary combination of physical-chemical properties,« says physicist Jurgen Smet of the Max Planck Institute for Solid State Research in Stuttgart. Graphene is the thinnest known material and yet it is 300 times stronger than steel. It can also be easily bent. Its optical proper-

ties and heat conductivity are excellent, and it also conducts electricity better than copper. »The mobility of electrons in graphene is 100 times greater than in silicon,« says Smet.

This revolutionary material, for which there are such high hopes, can already be found in a very ordinary product: graphite pencil lead. Graphite is made of individual sliding layers of graphene that can rub off when writing. The fantastic properties of graphene were discovered about ten years ago by Andre Geim and Konstantin Novoselov of the University of Manchester in Great Britain. The two scientists were awarded the Nobel Prize in physics for their discovery in 2010.

### 126 research teams in the EU

Geim and Novoselov sit with Klitzing on the Advisory Committee of the Graphene Flagship Project, which coordinates research activities by science and industry. A total of 126 research teams from 17 European countries are being funded as part of the EU program. In contrast to many other future technologies, with graphene Europe has very good chances of defending its leadership position against Asia and the United States, because materials research is consid-

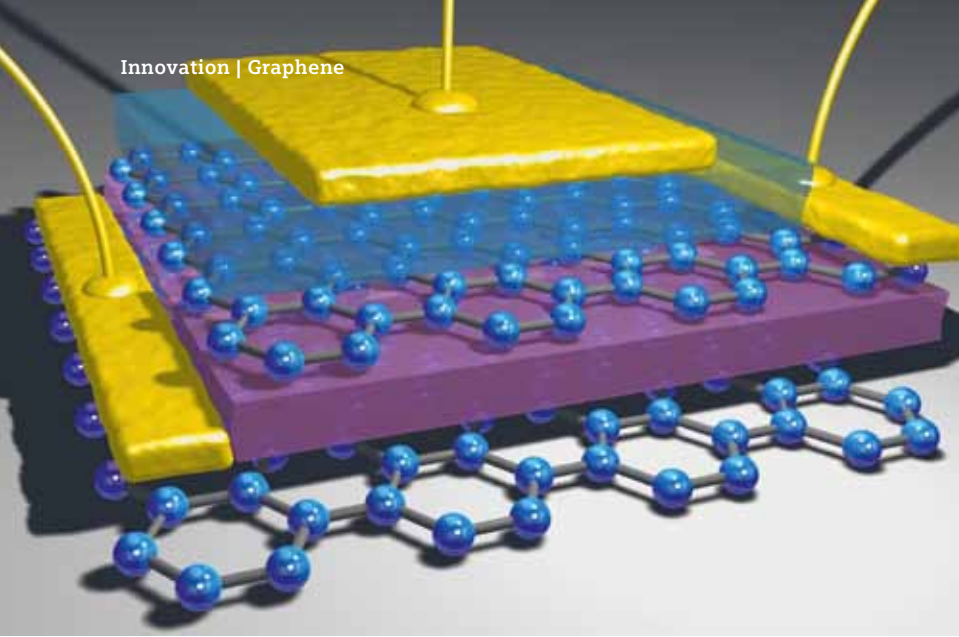
ered to be the strength of European science.

There is a risk, however, that Europeans could lag behind their competitors in applying the research results. Leading electronics companies in Japan and Korea, for example, are already working on displays and touchscreens that – thanks to the use of graphene – bend so well that they can be rolled up. These flexible displays can also be applied to an irregular substrate, like the windshield of a car, where drivers could then view warnings about traffic jams and other current information.

Another prospective application for graphene is transparent electrodes for thin-layer solar cells, in which graphene could replace the usual indium tin oxide. Indium is a very scarce element, and world reserves may be exhausted in the next decade. In contrast, carbon is available in almost unlimited quantities. In addition, using graphene increases the efficiency of solar cells, because the material also converts the infrared spectrum of sunlight into electricity.

Graphene will also be used to develop efficient new energy storage units. Two properties – excellent electrical





Vertical graphene structures for powerful transistors (top). Graphene can increase the efficiency of solar cells because it utilizes the infrared spectrum of sunlight (bottom).

conductivity and very low density – make graphene ideal for this application. Graphene batteries could theoretically store far more electricity in the same volume, considerably increasing the range of electric cars, for example.

The aviation industry is also interested. Aircraft builders are always trying to reduce weight so they can cut fuel consumption. The outer skin of the A350, the most recent Airbus model, is made primarily of carbon fibers, which are lighter than aluminum. It's possible that using graphene could reduce the weight of aircraft even more without undermining their stability.

However, it could be years or even decades before the new miracle material makes its commercial breakthrough. That is because graphene is far too expensive for commercial applications.

An example: The Material Research Center at the University of Freiburg,

**» Graphene has the potential for quantum leaps – not just in science but also in applications.«**

Germany, has successfully incorporated small amounts of graphene into rubber tires, making them almost gas-tight. Reinforced tires hold air longer, and can also be thinner because of their greater strength, thereby saving fuel. But graphene today costs up to a thousand times more than the conventional additives currently used to produce tires.

### Cost-effective manufacturing

The Material Research Center in Freiburg is working on new manufacturing methods for cost-effectively obtaining graphene on an industrial scale. The »Scotch Tape method« was developed by Geim and Novoselov and tested in laboratories. The two Nobel laureates simply stuck Scotch Tape to graphite and then carefully removed it. They repeated that process until they obtained small particles of ultra-thin graphene.

Scientists all over the world are working on an alternative production method known as chemical vapor deposition (CVD). It uses a substrate made of metal, such as copper, as a catalyst to break down carbon compounds at temperatures of 1,000 degrees Celsius. The hydrogen they contain vaporizes, while the remaining carbon is deposited on the metal, where the carbon atoms spontaneously combine into web-shaped graphene. The material obtained in this way must then be removed from the metal and transferred to the target object.

»This problem has not yet been satisfactorily solved in technical terms,« says physicist Smet. The metal is often completely etched away, with the catalyst being lost. The acid that is used must also be disposed of or reprocessed. As an alternative,

researchers are now attempting to separate the metal and the graphene electrochemically, retaining the catalyst, which can then be reused. »In spite of the existing problems, this method is currently the most promising,« says Smet. »There have already been initial attempts to use the CVD method on a large scale.«

### Health risks unclear

However, using graphene commercially will first require determining whether it could pose health hazards. Graphene is sometimes used in the form of extremely tiny particles that are only a few millionths of a millimeter (nanometers) in size. These nanoparticles could react with cells in the human body and cause lung disorders when inhaled, for example. BAM, the German Federal Institute for Materials Research and Testing in Berlin, is working with partners in various projects to test whether nanoparticles cause health problems.

Nanoparticles are generally only processed in closed systems to ensure that no particles are released. However, the risks that might be involved in weathering, disposal, or later processing of materials that contain graphene have not yet been researched. »It's possible that sawing, filing, and sanding could release nanoparticles that could pose a risk to human health,« says BAM scientist Bernhard Schartel.

The production, use, and disposal of nanoparticles in Europe is governed by the EU regulation on chemicals and their safe use (REACH). However, strict requirements like this are certainly not in force in every country that will use graphene in the future. ■

## Billions for research

The European Union (EU) launched the largest research competition in its history with the FET Flagship Projects. FET, which stands for »Future and Emerging Technologies in Europe,« received 21 proposals after the launch, six of which were chosen as finalists. The EU announced the winners on January 28, 2013. The other winner besides the »Graphene Flagship Project« was the »Human Brain Project« on modeling and simulating the brain. HBP researchers hope to gain a better understanding of human learning, as well as new insights into conditions like Alzheimer's disease and Parkinsonism.

The four other finalists included the »FuturICT Knowledge Accelerator and Crisis-Relief System,« whose initiators want to build a powerful computer that can better forecast natural disasters. The »Robot Companions« project hopes to develop robots to support people in their daily lives. Similarly, the »Guardian Angels« are intended to provide assistance from infancy through old age. The »IT Future of Medicine« project supports the development of personalized medicine, because vast amounts of individual patient data must be collected and evaluated if genomics are to be used to develop personalized drugs and treatments for different patients.

# Bookshop

*Industry Journal* browsed the market of management literature and presents books worth reading.

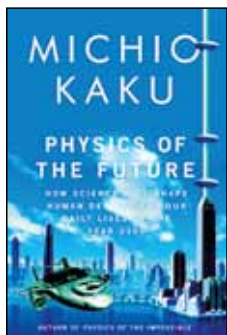
## Brave new world

### *Physics of the Future*

How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100

Michio Kaku\*  
English, 480 pages, US\$15.95

Let's say you're an engineer at a U.S. construction company in 2100. A day in your life might look something like this: Even though it's your day off, your digital housekeeper wakes you with the news that you're urgently needed at the office. As you perform your morning ablutions, protein and DNA sensors in your mirror and the drain analyze your health status. Your contact lenses flash current headlines to your retinas as you eat breakfast (»First-generation fusion power plants to be retired after 50 years in operation«). And then you float off to the office in a magnetic car.



At the conference room at work, a number of direct reports are already waiting – or at least, their holograms are. The reason for the meeting: The dam that keeps Manhattan from being submerged below the rising sea has developed a crack. That needs to be repaired with telepathically

controlled robots – a real success product that you helped to develop. That evening, you find out from your family-doctor software that the DNA sensors have discovered cancer in your pancreas – a disease that is as easy to cure now as a cold was 100 years ago. Instead of worrying, you use programmable materials to redecorate your apartment for the guests you're expecting.

This might read like science fiction, but it's based on projections by well-known scientists. For his detailed and highly readable scenario of the future, star physicist Michio Kaku asked more than 300 famous experts from fields like energy, space travel, medicine, IT, and nanotechnology about how technology and society would develop over the next 100 years.

Kaku also analyzed the predictions from the past 100 years that have become a reality (and the ones that haven't). The upshot: Scientists who started with existing technology and projected it forward into the future turned out to be right most often.

\*Best-selling author Michio Kaku (born in the U.S. in 1947) is one of the world's most famous physicists. He teaches and works as a professor of theoretical physics at the City University of New York.

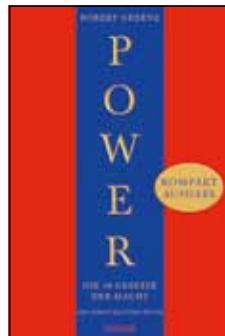
## Who gets kicked, who does the kicking

### *Power*

The 48 Laws of Power

Robert Greene\*  
English, 452 pages, US\$23.00

»Never outshine the master« is the first law in Robert Greene's international best seller, *The 48 Laws of Power*. Those above you must always feel superior – otherwise, their fear and insecurity might sour them on their former favorite. The advice – don't steal the show from higher-ups – is followed by a catalog of recommendations about how to deal with the »foot soldiers« and build your own power. The rules are often morally dubious, but they are relentlessly honest. They include such counsel as »Let others do the work for you, but always take the credit.« Or »Pose as a friend, work as a spy.« And »Avoid the unhappy and unlucky.«



Because of its aggressive, provocative advice, *The 48 Laws of Power* has also been called a »psychopath's bible.« At any rate, it has little time for such virtues as teamwork, positive thinking, trust, or fairness.

Nevertheless, with more than 200,000 copies sold, the book is a worldwide contender. It has been translated into 24 languages since it appeared in 1998, and a condensed German version appeared early in 2013. The author is used to defending his work: He says he's not evil, just a realist. »I believe I described a reality that no other book tried to describe,« he said in an interview with the British newspaper *The Guardian* late in 2012.

Using a long list of tales from the lives of famous powerful people, as well as fables and examples from the Bible, the author explains the structures and rules of the power game – not just in business and the military, but also in the art and culture business, where Greene has experience of his own with power structures and manipulative personalities. Very much worth reading, as a counterweight to classic purveyors of advice on success and management.

\*Robert Greene (born in the U.S. in 1959) studied classics and comparative literature in college. He works as a filmscript writer, dramatist, essayist, and translator in Los Angeles.

## A picture book full of inspiration

### *Ever Since I Was a Young Boy I've Been Drawing Cars*

The World's Best Car Designers: What They Are, and How They Got That Way.

Bart Lenaerts, Lies De Mol\*  
English, 252 pages, €59.90

»I've learned that innovation is a very fine thread. You mustn't pull too hard on it.« Wise quotations like this from Fiat chief designer Lorenzo Ramaciotti; frank, interesting life stories from world-renowned automotive designers, told in the first person; a lavish, large-format layout and lots of pretty pictures (including some unpublished sketches, drawings, and design studies) – all of these ingredients make this book an exciting read, and not just for car fans and industry experts.



Belgian automotive journalist Bart Lenaerts has interviewed today's most influential automotive designers, including such iconic figures as Walter de Silva (VW), Gordon Wagener (Daimler), J Mays (Ford), Adrian van Hooydonk (BMW), and Jean-Pierre Ploué (PSA). All of them loved drawing cars, even when they were kids. Now they decide on the look of most of the cars on the world's roads.

In personal conversations, they tell about their careers, their visions, their favorite designs – and of course their favorite cars. As you leaf through and read, you get a look behind the scenes at the big automotive corporations and learn a lot about successful design – and how it negotiates a balance between cost pressures, function, innovation, and tradition.

The many quotes strewn through the text provide material for conversation; and the reader gets to guess which designer they're from. For example: »I don't like classic luxury cars. I prefer cheap, simple, industrially designed cars.« The answer? Walter de Silva.

\*Belgian Bart Lenaerts wanted to become a car designer when he was a boy, and works as an automotive journalist today. He and his wife, photographer Lies De Mol, have written several books on car culture together.

## The CEOs of tomorrow

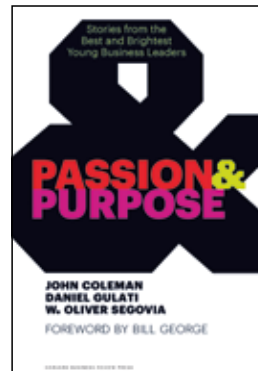
### *Passion & Purpose*

Stories from the Best and Brightest Young Business Leaders

John Coleman,\* Daniel Gulati, W. Oliver Segovia  
English, 296 pages, US\$25.95

They're no longer interns and trainees – the members of Generation Y are now reaching the end of their twenties, and so have been in the professional world for several years. An up-and-coming generation who find out about world events from Facebook, who blog and tweet, and tend to be more partnered than drilled by their parents and teachers, are filling today's classrooms at the major business schools and will be gradually taking over the driver's seat.

Will these young MBAs change business? How will they lead in the future? Author John Coleman, Harvard Business School MBA 2010, and his coauthors try to offer firsthand answers to these questions. In *Passion and Purpose*, 26 young MBAs tell their personal success stories. They talk about founding schools in Pakistan, or the difficulties of getting into an Indian family business. About debating clubs in the Middle East, about coming out on the job, and about interviewing for a job while pregnant. About innovative business ideas on the Internet, and about their learning experiences as fundraisers.



The stories are organized into six chapters that the authors believe define the environment where young executives will operate in the future: increasing convergence between the private sector, the public sector, and nonprofits, as well as globalization, diversity in the workplace, lifelong learning, technology, and sustainability.

Interviews with experienced, respected executives and the results of a survey of 500 MBA students and graduates from well-known business schools round out the book. Recommended reading for HR developers and senior managers who want to understand the next generation.

\*American John Coleman is a management consultant at McKinsey & Company in Atlanta, Georgia. He earned an MBA with high distinction from the Harvard Business School.

# Imprint

## Industry Journal

Topics, trends, and technologies for decision makers in manufacturing

## Published by

Siemens AG  
Industry Sector  
Communications  
Werner-von-Siemens-Str. 50  
91052 Erlangen, Germany  
journal.industry@siemens.com

## Responsible for the content

Gerald Odoj (V.i.S.d.P.)

## Editor-in-chief

Bettina Schoene

## Concept

Stephen Rose

## Editorial staff

das AMT GmbH & Co. KG  
Andreas Jung (CEO)  
Tiessenkai 10  
24159 Kiel, Germany  
www.das-amt.net

## Contributors to this issue

Christian Buck, Kirstin von Elm,  
Christiane Engelhardt, Günter Heismann,  
Nele Husmann, Christine Mattauch,  
Mirjam Müller, Professor Olaf Plötner,  
Florian Sievers, Andrea Wiedemann

## Creation

feedback communication GmbH  
Hendrik Leyendecker (CEO)  
Hannah Egelseer (project management)  
Mario Kienel (art direction)  
Bartholomäusstraße 26 c  
90489 Nuremberg, Germany  
www.feedback-communication.de

## Print

NovaConcept Schorsch GmbH  
An der Weinbrücke 11  
95326 Kulmbach, Germany  
www.novaconcept.de

## Copyright

© Siemens AG 2013


All rights reserved. Reproduction of this publication and use of its content are subject to prior consent. Technical details are subject to change. All information provided in this document refers to general technical possibilities and characteristics that do not always apply as described in every individual case.

## Photo credits

Getty Images: p. 2, p. 10  
Thinkstock: p. 12, p. 15 bottom, p. 18,  
p. 19, p. 20, p. 42, p. 45 left, p. 52, p. 54,  
p. 56 left, p. 56 center, p. 56 right,  
pp. 60/61 top, p. 67, p. 69 bottom right,  
p. 76 bottom, pp. 78/79 top  
© Image: Thomas Steuer, source: Alfred-  
Wegener-Institut für Polar- und Meeresfor-  
schung: pp. 6/7  
© Donald A. Marchand: p. 16  
© Matthew Pattigrew, McKinsey & Company:  
p. 21 left  
© Ramesh Srinivasan, McKinsey & Company:  
p. 21 right  
© Olaf Plötner: p. 22, p. 23  
© 2012 Voith GmbH: p. 25 top left,  
p. 25 top right  
© European School of Management and  
Technology: p. 25 bottom  
© 2013 Kahn Academy: p. 27  
© Hasso-Plattner Institute,  
Foto: HPI/Kay Herschelmann: p. 29  
© BMW AG 2013: p. 39 top, p. 39 center  
© 2012 Two Roads Brewing Company:  
p. 45 right  
© 2013 Space Exploration Technologies  
Corp.: pp. 58/59, p. 60 bottom,  
p. 61 bottom, p. 62, p. 63  
© Simon Burchett (www.channelphotogra-  
phy.co.uk): p. 69 top right  
© Bendable Smart Window/U of Cambridge:  
p. 73  
© Tunneling transistor/U of Manchester: p. 74

All other images: © Siemens AG

 Siemens Industry: [www.siemens.com/industry](http://www.siemens.com/industry)


 Read and subscribe to *Industry Journal*: [www.siemens.com/industryjournal](http://www.siemens.com/industryjournal)

 Siemens Industry customer magazines: [www.siemens.com/industry-magazines](http://www.siemens.com/industry-magazines)

 Siemens Industry Newsletter: [www.industry.siemens.com/newsletter](http://www.industry.siemens.com/newsletter)

 Blog *Competitive Industries*: <https://blogs.siemens.com/competitive-industries>

 Siemens Industry on Twitter [@siemensindustry](https://twitter.com/siemensindustry)

 If you would like to unsubscribe to delivery of *Industry Journal*, please send an e-mail with your address to [journal.industry@siemens.com](mailto:journal.industry@siemens.com)





Interview  
with our  
condition  
monitoring  
expert



# Prevent machine and plant downtime with condition monitoring

Unleash potential – with Industry Services

## Industry Services

Teresa Martinez-Roca is one of our condition monitoring experts. She knows many manufacturing companies inside and out, which is why she fully understands the importance of comprehensive condition monitoring for today's plants, machines, and networks. »Condition monitoring is based on the precise collection, processing, and transmission of measurement data. Our technology enables us to detect machine and plant malfunctions at an early stage and automatically initiate countermeasures as needed. Minor faults are corrected proactively before they can lead to major damage. This type of preventive maintenance reduces our customers' maintenance costs while at the same time increasing the availability and productivity of their machines and plants.«

With services such as condition monitoring, Siemens provides worldwide support throughout the entire lifecycle of your machines and plants. The comprehensive product knowledge and industry expertise of the Siemens experts can help you measurably improve the performance of your machines and plants and reduce lifecycle costs – important factors on the road to the future of manufacturing and more nimble, flexible, and intelligent production for a lasting competitive edge.

**Unleash hidden potential with condition monitoring:**  
[siemens.com/industry/cmr](https://www.siemens.com/industry/cmr)

**Answers for industry.**



The information provided in this magazine contains merely general descriptions or characteristics of performance which in case of actual use may not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of contract.

All product designations may be trademarks or product names of Siemens AG or supplier companies whose use by third parties for their own purposes could violate the rights of the owners.

Siemens AG  
Industry Sector  
Communications  
Werner-von-Siemens-Str. 50  
91052 ERLANGEN  
GERMANY

[www.siemens.com](http://www.siemens.com)

Subject to change without prior notice  
Order No.: E20001-A200-S100-X7600  
DISPO 06330  
Printed in Germany  
© Siemens AG 2013