Industry Journal

Topics, trends, and technologies for decision makers in manufacturing

Production goes to the customer
Off-shoring, re-shoring and next-shoring: Manufacturing companies are revolutionizing their logistics chains to achieve greater efficiency, be closer to their markets, and lower costs.

High-tech from China
The People’s Republic has huge potential: Increasingly, »Made in China« is becoming »Created in China« – not least thanks to massive government support.

Companies a target
Hackers and data thieves are a cause of concern to manufacturing companies around the world. Find out which measures provide the most effective protection from IT criminals.
Dear readers,

Siemens began its new fiscal year on October 1 with a fresh reorganization.

The aim is to serve you, our customers, with greater flexibility and in sync with the specific requirements of your industry and region. That’s why Siemens’ industrial portfolio will be catered for by two Divisions from now on.

The Digital Factory Division supports you on your path to becoming a digital enterprise. Integrated hardware and software coupled with technology-based services make your manufacturing processes more flexible and efficient and accelerate your time-to-market for new products. The use of software, the fusion of the real and virtual worlds of production, and the harnessing of rapidly growing data volumes are increasingly important as competitive factors – and not only in the manufacturing industry that is the focus of this Division.

The Process Industries & Drives Division will focus primarily on companies in the process industries. Division employees help our customers increase their efficiency and productivity while ensuring high levels of system security and availability. Our innovative, integrated technology spans the entire lifecycle and offers you a critical competitive edge.

Competitiveness is also front and center when you take advantage of our services to get the most out of your machinery and systems – but also when you turn to our proven platforms such as TIA or Sinamics.

Some of our Industry Journal readers have been with us since our first issue nearly seven years ago. During this time, we have explored many exciting topics, trends, and technologies from your industries and regions, offered portraits of many innovative companies, and presented the ideas of prestigious scientists and industry leaders.

We remain committed to this mission – and are now working on making our content even more relevant to you. We are eager to learn even more about your interests and the demands you place on us. Which challenges would you like us to help you overcome? What information do you need to remain competitive? We want to do the best we can to accompany you on your way into the future of manufacturing – and our Corporate Publishing is part of that effort.

Best regards,

Bettina Schoene

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Production goes to the customer

Multinational manufacturing companies are making radical changes to their logistics chains. Increasingly, they are replacing centralized production facilities with global production networks consisting of comparatively small sites from which they then supply local markets, particularly in emerging economies. This allows them to respond faster and more flexibly to market changes and be close to customers. It also reduces costs for transport, customs, and administering other export trade barriers. «Next-shoring» is a buzzword that holds the prospect of huge gains in efficiency for the manufacturing industry.

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As hardware and software increasingly converge in production processes, in the land of the IT techies there is growing interest in manufacturing. And industrial companies are opening their own facilities in the area south of San Francisco.

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The 86-year-old Chinese entrepreneur from Hong Kong is probably the richest person in Asia. He owns vast industrial holdings and has recently shown a great penchant for high-tech investments. Read the story of his fabulous rise from penniless migrant to one of the most successful managers in the world.
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Product pirates are no longer satisfied with merely counterfeiting consumer goods. They have now discovered a new and lucrative activity in copying complex plants and machines. Innovative concepts are crucial to avert this problem.

Factory for researchers
In an ultramodern research factory in Eastern Germany, researchers are working on the manufacturing of the future. Their goal is to make production processes more efficient and environmentally friendly and optimally coordinated with employee needs.

Indonesia: an economic giant in the making
In around ten years Indonesia will be one of the world’s ten largest economies. Government investment, modern production operations, and a young, fast-growing middle class offer great opportunities for businesses.

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The number of motor vehicles in the world is forecast to double by 2030. This will result in increased pollution, which in turn is boosting the market for electric drives.

58 »Computing emotions«
Soon, machines will be able to recognize the needs and moods of their users. This will fundamentally alter manufacturing practices, says IT Professor Elisabeth André from Augsburg. She explains in an interview how computers are beginning to understand us better and better, and the changes that this will bring.
Energy from the sea

The SeaGen tidal current turbine operated by Siemens subsidiary Marine Current Turbines (MCT) off the coast of Northern Ireland functions like a wind turbine that has been submerged in the ocean. The seawater flows through a strait in the bay of Strangford Lough at a rate of up to five meters per second, and the current drives two 16-meter adjustable-height rotors. With an output of 1.2 megawatts (MW), during peak times the power plant can supply more than 22 megawatt-hours of electricity per day and, on average, enough energy for a small city of 1,500 residents. In terms of power generation, SeaGen is the largest tidal current turbine project worldwide to date. The potential for energy generation from tidal power plants amounts to as much as 4 percent of global electricity requirements.
Adidas, the sportswear maker from Herzogenaurach, Germany, is looking hard at its global production strategy. A large worldwide network of small factories in individual markets might replace the present small number of large production centers. Then it might even be possible to produce soccer shoes for Brazil right in the country.
Bring production back to high-wage countries. Or take it to new customers in upcoming emerging economies. What’s the right strategy for industrial multinationals? »Both ... and,« is the answer. One thing is sure: There will be fewer giant centralized production sites for the world market. Being close to customers and to skilled workers is what is especially prompting companies to relocate. The result: global production networks that can respond fast and flexibly.
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Rhenish-Westphalian Technical University (RWTH Aachen). By 2016, the group first plans to study whether and how shoe production can be relocated to minifactories. »Now, I don’t know what the results will look like. But I think there’s immense potential,« Manz says.

The project is receiving German government support as part of the »Industrie 4.0« project. Part of that government project is the »Autonomics for Industrie 4.0« technology program, a set of twelve projects. And Speedfactory is one of them.

The dawn of a new production era

The government’s technology program is based on the assumption that a new production era is dawning, when production processes will increasingly be influenced by innovative information and communications (I&C) technology. The latest I&C technologies, for example, are to be used to reduce energy consumption in production, and at the same time to design processes to use less material. To take due account of the need for customized products, another point of emphasis is highly flexible production infrastructures that have intelligent, autonomous functions.

Thus Adidas’ Speedfactory strategy is revealing the company to be a potential pioneer in an impending paradigm change in industrial production. In many industries, centralized production sites that supply the world market may soon reach the end of their service lives. Instead,

»Our aim is to produce flexibly, locally, and in a very small space.«

Gerd Manz, Vice President Technology Innovation at Adidas

Whether Brazil or the USA, Russia or China – if Gerd Manz is right, practically every important market for sporting goods maker Adidas could have its own little Adidas factory in the neighborhood. The company, based in the Franconian town of Herzogenaurach, has most of its athletic shoes, balls, and sportswear made at giant plants in Asia. The products from there are then delivered to customers all over the world.

But that could soon change. Just recently, Adidas launched its »Speedfactory« product, under which employees headed by Gerd Manz, Adidas Vice President for Technology Innovation, will give the company’s global production strategy a thorough review. They will look at whether Adidas should set up a global network of minifactories. The company now generates 95 percent of its revenue outside Germany, and the move would bring it closer to its customers and their preferences.

Responding flexibly to changing demand

For example, if demand for a certain kind of shoe suddenly soars somewhere in the world, the company could react faster and more flexibly. Centralized, very large production sites are able to do things like that only with limitations.

»Our aim is to produce flexibly, locally, and in a very small space« is how Manz explains Speedfactory. To do that, he has joined forces with allies like automotive supplier Johnson Controls and researchers from the Textile Technology Institute at the

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much of the production of the future would be carried out near or even within future sales markets – in movable production networks of small factories distributed all over the world.

Industry would see two parallel currents as a consequence. One would be »re-shoring« – the return of production from low-wage countries to Western industrialized nations. The other would be the establishment of ultramodern production facilities in rising new markets. The result would be a decentralized reorientation of global production structures, with a focus on regional demand.

The next development stage

The key question is not whether companies should produce in one market for another, but how they can customize products for each of those markets, and how they can apply the latest production know-how and digital expertise to meet local needs, says corporate consultant McKinsey & Company in its analysis, »Next-shoring: A CEO’s Guide.« And thus they created a new buzzword. »Next« means both »near to markets« and the »next stage of development.«

»Next-shoring asks how industrial production might develop, rather than always looking only at labor costs or similar factors, when a decision has to be made about production sites,« says McKinsey director Katy George.

She expects that greater proximity to two factors in particular might lead companies to decentralize their production: to selling markets and to innovative suppliers and skilled personnel. Both are essential in a world where rising demand in new markets is challenging companies to adjust their products to different regions, while at the same time emerging technologies are making new supplier ecosystems possible as a unique selling point, according to George and her colleagues.

No one-size-fits-all recipe for success

The specifics would look different for every region in the world. Western industrialized nations differ in this regard from developing and emerging nations. The result is that companies in traditionally industrialized countries will concentrate mainly on »re-shoring.« That’s because, first of all, the cost of labor in the formerly cheap workplaces of the world is rising. The Chinese Five Year Plan of 2011, for example, calls for
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Customers want a production machine tailored specifically to their own requirements. Fragmented proximity to the customer in the automotive industry, for example, has caused model diversity to increase by half in the past few years. Fast-growing demand for different product variants, features, and additional service is also making shorter delivery chains a necessity, George says.

Rising demand in emerging economies

Producing in the rising markets is especially worthwhile because that’s where demand is rising. McKinsey estimates that as early as 2025, two-thirds of all goods traded globally may be intended for upcoming emerging and developing economies. The figure in 2008 was still 40 percent.

Companies worldwide are rethinking their production strategy, and are moving their production facilities toward the markets where the demand is.

the minimum wage to rise 13 percent a year. And second, it will enable manufacturers to respond faster and more flexibly to quickly changing demand in developed markets – as well as to reduce their logistics costs.

»Most industries today require a larger number of product variants, or even custom products,« says George. Private consumers want an athletic shoe in a specific size with a specific color; business customers want a production machine tailored specifically to their own requirements.

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It’s true that Western companies are also still building new production sites in China and India. But they’re no longer doing it to make goods for their home markets — they’re doing it to have a direct access to the growing local markets and their rising buying power. »Made in China« is becoming »Created in China« (see »Made in China – the next generation« page 16). And here too, they must adapt their products to changing local requirements — and they must be able to act fast to do it.

But it’s not just that regionally distributed, decentralized production sites can increase flexibility. They can also impose effective limits on the rising cost of transporting raw materials and finished products. They would eliminate many foreign-exchange risks, as well as the expense for customs, administration for international exports, and other trade barriers. And these networks are also more resistant to natural disasters and war, because such events always shut down only parts, never the whole production system (see »Supplier risk under control,« page 42).

**Digital networking, a basic requirement**

»Successful production in networks is based on using data streams for better communication, coordination, and control,« explains Aviva Freudmann, a project manager at the independent English research institute Economist Intelligence Unit 2. To generate those data streams, companies must first connect all parts of the production chain to each other digitally.

»It’s a matter of building up a structure through which machines, people, and even products can then communicate with each other,« explains Markus Lutz, an expert on production, development, and design at the German Engineering Association (VDMA). That includes information that flows between machines over the Internet, and data with which a product »informs« a tool how it wants to be processed. This structure, known as »Industrie 4.0,« will make it possible for the first time to monitor foreign production sites adequately, and control them directly.

Two features of the production chain will make it possible for companies to operate a decentralized network of factories. First, increasingly economical automation solutions will make it worthwhile to produce again in high-wage countries, and will make it possible to make quality products for the first time in emerging and developing countries. Modern robots in particular are increasingly easy to program, more flexible to use, and can perform more and more precise tasks. A working production system is easier than ever to copy today, and to set up identically in other countries, yet with regional adjustments.

**3D printers make decentralization easier**

Second, new »additive« production methods, now often called 3D printing, may soon make it possible for a company to produce even the smallest quantities of products with consistent quality, even at far distant locations. Factories worldwide will be fed the same data set via the Internet, and can make products on location as needed.

Even today, machines are already replacing an increasing number of conventional production methods. For example, Boeing uses high-power 3D printers to build 200 different components for ten aircraft platforms. Small U.S. carmaker Local Motors has even made the entire body for an open two-seater using digital 3D design data, by depositing materials in layers. This 3D printed component will then be supplemented with standard components. Lower prices, larger machines for bulky products, and the ability to work even materials like titanium or even human cartilage, may make these techniques more and more worthwhile.

**Return to inner cities**

A production plant halfway between home and the supermarket: Joachim Lentes dreams of factories in the middle of town. He’s the head of the Urban Production research team at the Fraunhofer IAO institute for labor economics and organization. Here companies and researchers are exploring what would be needed to let companies produce in the midst of metropolitan regions.

In contrast to the early years of industrialization, when such arrangements already existed, today’s urban factories can’t emit harmful exhaust gases or generate a lot of noise. But thanks to modern production facilities, noise insulation, and closed combined heat and power systems, they can now in fact be clean, quiet, and compact enough to return to the inner cities. »Production can have many advantages for all involved – for companies and the city, as well as employees and residents,« says Lentes.

For example, companies can set up their production in the immediate vicinity of their sales markets, or near the homes of creative, well-trained employees — a significant competitive factor in light of increasing urbanization worldwide.

Short distances also make both suppliers and manufacturers more flexible if demand shifts. What’s more, companies create jobs and increase buying power, as well as a city’s attractiveness as a place to live,« Lentes points out.

For example, medium-sized mechatronics maker Wittenstein Bastian GmbH recently set up a new plant right next door to a residential district in Fellbach, a part of the Stuttgart metropolitan area. Employees are happy about the short commute, and neighboring residents can make use of a company-owned biotope and an electric car recharging station.
If users supplement these components with alternative forms of energy – for example, using renewable energy sources, combined heat and power plants, or high-performance lithium-ion batteries – the ultimate result will be highly flexible, largely autonomous global production networks.

If such complex systems are to be able to produce smoothly, with high quality, at distant locations, users must plan and control them carefully. Siemens offers solutions for that purpose all along the value chain. For manufacturing: in areas like product design, production planning and engineering, or production itself, together with global after-sales service. And for the process industry: in plant design, process planning and plant engineering, production, and services. These are digitized, fully integrated solutions for a product or plant’s entire lifecycle, and for efficient production control. »That portfolio enables our customers to develop, configure, produce, and deliver custom products – and all for the cost of mass-produced articles,« says Gerhard Volkwein, director of digital enterprise architecture at Siemens.

**Multiple countries and teams**

Siemens itself operates more than 250 production sites all over the world – and to that extent, has plenty of firsthand experience when it comes to linking up efficiently operating production networks. The portfolio it applies begins with the PLM solutions NX, Teamcenter, and Tecnomatix, along with Simatic IT Preactor for production planning and scheduling. Teamcenter links the product designers and suppliers, engineers, and service teams involved in a project all along the value chain. And it lets them cooperate as though they were sitting in the same office together.

To design work processes reliably at far distant locations, users can also create virtual versions of entire factories. For example, employees in the processing industry can use the COMOS Walkinside software to take a virtual tour of their plants, so as to detect potential dangers and optimize processes.

Similarly, U.S. car manufacturer Ford is using Siemens IntoSite software in a pilot operation to image its factories virtually. That enables employees to attach suggestions for changes to the right points in the simulation – and even to check their effects on working processes. Ford is also using the pilot software to standardize production at various plants all over the world.

**Complexity is rising in the automotive industry**

»The value chain will get more and more complex in the automotive industry especially,« says Stefan Bihler, director of digital enterprise

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**Immense regional markets in emerging economies**

At the moment, emerging economies are often treated as a monolithic group, and enormous countries like China or even entire continents like Africa are lumped together in a single breath. Yet in fact, they have an extremely broad range of regional, ethnic, and income segments. Some of these regional markets are bigger than the entire national markets in some industrialized countries.

Since the number of countries that want industrially produced goods continues to rise worldwide, manufacturers will have to offer more and more variants of their products. After all, a vast range of tastes, national laws, and local customs prevail around the world. »So manufacturers will increasingly have to tailor their products to their customers’ requirements,« says Florian Gülndner, director of research at ARC Advisory Group technology consultants. »Bottom line, that often results in an incredible number of variants.«

Manufacturers still produce individually or regionally customized products, especially for industrialized countries. But rising markets are also beginning to want customized products of their own. And that’s not just a question of consumer goods to match local tastes – it also means things like leaner, more robust machines to be used in their markets, where the production conditions are often entirely different from elsewhere.

»But those requirements should no longer pose a problem to manufacturers today,« says ARC expert Gülndner. After all, modern, data-based, automated production methods often offer the ability to make even one-of-a-kind consumer products cost-effectively. Which would enable producers to serve any market segment, no matter how small, whether in China or Ghana, Indonesia or India, Brazil or Russia.
The automotive industry is a pioneer in the global trend toward building local production facilities. High levels of automation, the latest IT, and energy-saving production methods – for example, using especially energy-efficient robots – make it relatively easy to copy working production facilities and build them elsewhere.

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Architecture at Siemens. After all, most carmakers make and sell their products all over the world – and at the same time, must very particularly respond to local demand. But that has been the case for many years now. No wonder this industry is a pioneer in building production networks. German manufacturers and suppliers, for example, have their own production facilities in every important market all over the world – and increasingly in rising emerging economies as well.

“In 2013, the German automotive industry made 14.1 million cars worldwide, more than 8.6 million of them at foreign locations,” calculates Matthias Wissmann, president of the German Association of the Automotive Industry (VDA). Look at the configurator of a German carmaker, he says, and you’ll see that customers for a new car can get their cars more customized than ever before.

Centralized control and decentralized flexibility, together with individual responsibility, are the setscrews that make successful production possible,“ Wissmann says.

Process industry relies on modular solutions

Following the example of the automotive industry, other industries might soon convert to decentralized production networks. For example, more than 20 companies and organizations in the chemical and pharmaceutical industry from nine European countries recently looked into how chemicals or medications might be made faster and more flexibly through decentralization. That team includes major industry players like Bayer, BASF and AstraZeneca. Together they have invested €30 million in researching modular factors in the »F³ Factory« project – the »Flexible, Fast, and Future Factory.«

The investigators were able to house several chemical plants in standard containers that users can combine to make »plug and produce« factories. The modules are easy to ship, set up, and commission when markets anywhere in the world demand a certain chemical or pharmaceutical product. If demand rises, you simply add more of the standardized containers. The F³ Factory concept has cut operating costs one-fifth compared to conventional plants, reduced investment by as much as 40 percent, and cut environmental impact in half – for example, because users can save on transportation distances for input materials and finished products.

“Decentralized organization and high levels of autonomy in value-added networks supply the synergy to become and stay highly flexible and adaptable,” says Thomas Bauernhansl, director of the Fraunhofer IPA institute for production technology and automation.

“We all feel that we’re living in an era of change. Many developments are moving much faster than we imagined. This isn’t just expectations – you can already see the changes.”
The People’s Republic is still tarred with the reputation of a cut-rate producer: cheap clothes, counterfeit brand products, simple electronics, inferior quality. Yet China is now conceiving and developing highly complex products, and making them with the latest processes and innovative methods. »Made in China« has become »Created in China.«
Carsten Dilling wants to make one point absolutely clear: The decision by Danish telecommunications group TDC to use Chinese vendor Huawei to update its infrastructure, instead of its former supplier Ericsson, had nothing at all to do with Chinese prices, the Danish company's CEO explained last fall. It was purely a matter of technical expertise. Huawei was »in fact, rather expensive.«

With 150,000 employees around the world, including 45 percent in research and development (R&D), Huawei is a familiar name to industry insiders. The corporation, headquartered in the southern Chinese city of Shenzhen, was initially scorned as a cheap provider of infrastructure solutions for telecommunications.

But now Huawei is working with almost every major telecommunications corporation in the world. It has increased its revenue by two-thirds over the past five years, to US$39.5 billion, and it is catching up with market leader Ericsson – and has left rivals like Nokia and Alcatel-Lucent far behind.

**New focus on innovation**

Huawei’s growth was due in particular to its focus on innovation. And the company’s been willing to pay for it. From 2004 to 2013, R&D spending grew by a factor of 14, to US$5.5 billion. The company’s Shanghai research center alone has 10,000 engineers, many of them IT specialists. They’re the foundation of Huawei’s strength – improving infrastructure software, rather than replacing hardware.

But word of these successes hasn’t really gotten around yet. »Name me one innovative project, one innovative change, one innovative product that has come out of China,« said U.S. Vice-President Joe Biden in late May 2014.

But Huawei’s race to catch up isn’t a unique case. The days when China was the world’s extended workbench – where low-wage, untrained workers churned out low-grade sneakers, batteries, and plastic toys for the West – are long gone. Chinese companies are more and more among the frontrunners in the technology world. Their spectrum of expertise ranges from genetic engineering to communications technology, Internet applications, electric drives, pharmaceuticals, and solar technology.

Unlike a few years ago, more and more Chinese corporations have been spending immense amounts on research and development. According to a study conducted late in 2013 by the innovation researchers at the Battelle Institute in the U.S., China’s research expenditures for the current year will amount to US$284 billion. That’s 22 percent more than in 2012. Growth in the U.S. for the same period is estimated at just 4 percent – albeit from a base of US$465 billion, which is still substantially more than China’s.

**Government encourages research spending**

The new emphasis on R&D is at the explicit urging of the government, which is aiming to professionalize the economic system and move it away from light industry and construction – the growth drivers of the past – into sectors that provide more demanding jobs. »Innovation as a driver of economic development« is how Premier Li Keqiang describes the strategy.

»China’s companies have come to understand that in the long run it won’t be enough to be positioned as a low-price manufacturer or a cheap alternative to established brands,« explains Benjamin Cavender, an analyst with the China Market Research Group consulting firm. »Instead, they’re investing heavily in marketing, branding, and research and development. Quality and service have improved substantially.«

That’s the approach taken by Xiaomi Tech, founded in 2010. Even given the country’s extremely competitive mobile communications market, entrepreneur Lei Jun’s company has been able to establish itself as a trendy new provider. Xiaomi’s most important invention is its business model. Lei’s strategy: listening to consumers and including them in product development. The smartphone interface is updated week by week – using MIUI, Xiaomi’s proprietary firmware.

**New beta versions every week**

The company releases a new beta version every Tuesday. Then people like 32-year-old Yang Zhilin help find bugs and improve the software. »I like playing with systems, and finding a bug is always exciting,« says Yang, who earns his living as a manager for a catering company, but enthusiastically tests MIUI versions in his time off. Hundreds of Xiaomi fans regularly register to work with the updates.

And the products are not short on innovation, either. For example, the company was the first manufacturer in the world to install the latest, fastest processor from U.S. chipmaker NVIDIA, the Tegra K1, which was used in Xiaomi’s Mi Pad tablet in 2014. The battery promises an impressive standby time of 54 days. »Fast. Xiaomi does everything very fast,« writes NVIDIA corporate blogger Will Park. The influential »Fast Company« magazine from the U.S. put Xiaomi at Number 3 on its list of the world’s most innovative companies in 2014.

Another unusual feature for Chinese products is that Lei has been able to generate some real passion from his customers. When the 44-year-old billionaire lists Xiaomi’s successes up on stage, young Chinese cheer him frantically. The media often compare him to Apple’s Steve Jobs. There are also parallels to the big U.S. competitor with the apple logo in the Chinese company’s name – Xiaomi means »little rice.«

**Selling only over the Internet**

But CEO Lei goes his own way in sales and marketing. He does without dealers and sells his devices only in limited quantities, and only over the Internet. The 100,000 units of the
first version of the Mi3 smartphone sold out in 86 seconds. When sales of the first tablet, the Mi Pad, started in mid-2014, the initial production run was only 50,000 units – and they sold out in four minutes. The industry calls it »hunger marketing« – creating scarcity to spur consumer desire.

Last year, Xiaomi sold 18.7 million units and generated revenues of US$5 billion. In the first half of 2014, it had already sold 26.1 million telephones. The company was already the Chinese market leader in 2013, leading Samsung with a 22 percent market share compared with the Korean firm’s 19 percent. Xiaomi currently ranks Number 6 in the global mobile phone market.

Many young talents

Xiaomi and Huawei are just two examples of a new generation of Chinese companies that would have counted for little in terms of innovation potential just a few years ago. That’s partly the result of the educational system, which so far prioritizes learned information over creative problem-solving. But it would be mistaken to think that a single requirement could be solely responsible for keeping a diverse, ambitious nation from being innovative,» says Christian Neuner, an expert in Operations Strategy at consulting company Roland Berger in Shanghai. At any rate, one-third of the bachelor’s degrees generated by Chinese universities are in engineering and science. The figure for the U.S. is only five percent.

Four thousand of these Chinese scientists work for BGI, a genetic research institute in Shenzhen. One thousand of them are bioinformaticians. The company cafeteria could be at a university – the average age of the staff is around 25. BGI was founded at the end of 1999 by a group of scientists headed by today’s company president, Wang Jian, to make sure the People’s Republic had a place in the Human Genome Project – the DNA decryption effort that was dominated at the time by Western industrialized nations. Today the institute is far and away the biggest gene sequencer in the world.

More than 150 ultramodern machines offer more capacity than all the major U.S. universities combined. Some of the more recent milestones in BGI’s research have been the DNA of pandas, chickens, and silkworms, and sequencing the coronavirus that causes the serious lung disease SARS.

Unlike many specialized institutes in North America and Europe, BGI will use its fleet of machines to sequence anything that’s requested – whether for human medicine or agricultural scientists. The institute just recently decrypted the genetic code of 90 different varieties of chickpeas.

Zhang Yong, one of the institute’s research directors, expects the cost of identifying human DNA to fall to between US$200 and US$300 within a few years, and he believes that BGI will then help to organize all the biological information in the world.

Competitors for Western Internet corporations

China’s companies have also made significant inroads on the Internet. Though firms like Alibaba and Tencent are still often dismissed in the West as Chinese clones of Western ideas, it’s nevertheless also true that there’s plenty of copycatting on the Internet in Europe and the U.S. What’s more, the claim is unfair in many ways. With QQ, for example, Chinese online service provider
The headquarters of Chinese high-tech corporation Huawei in Shenzhen. The company invests about US$5.5 billion a year in research and development.

Tencent introduced a chat app long before WhatsApp became popular. And QQ’s next generation, Weixin – known abroad as WeChat – was the first app capable of transmitting voice messages.

Online giant Alibaba not only operates its successful B2B platform of the same name, it also has Asia’s largest online auction and trading platforms, Tmall and Taobao Marketplace, as well as a successful payment service, Alipay. That makes Alibaba the Chinese answer to Amazon, eBay, and PayPal – but with a trading volume of nearly US$250 billion in 2013, it’s bigger than Amazon and eBay together. In September 2014 Alibaba celebrated the biggest IPO ever on Wall Street.

**Copy first, then innovate**

The accusation that China is a perpetual copier is premature, Berger consultant Neuner explains. Those Chinese companies, especially the ones that operate outside the country’s boundaries, »Often start out with a ‘me-too’ product, and exploit their advantages on the cost end before going on to apply product and process innovations to stay competitive.« The German Engineering Association (VDMA) also warns against underestimating Chinese competitors and assuming they operate only in the lowest-priced market segments. German vendors shouldn’t allow themselves to be pushed off the top of the technology pyramid by competitors that are slowly getting better and better at what they do, warns association president Reinhold Festge. »The market up there is too small. If we don’t adequately serve the medium-level technology segment, we’ll gradually lose market share.«

In spite of their gigantic home market, sooner or later increasing numbers of innovative Chinese companies will begin operating beyond China’s borders, says analyst and China expert Cavender. »They’ll be fighting for position in their own market, and at the same time trying to penetrate into the U.S. and other international markets.«

In the process, they’ll often be counting on innovation expertise from the West. As Xiaomi has done, for example: In 2013, the company recruited Hugo Barra, former head of Android product management at Google. Now he’s in charge of the Chinese company’s international business. Brazil, Mexico, Russia, Turkey, India, and a handful of Southeast Asian countries head the agenda, and that’s just the first step. It’s not unlikely that Xiaomi products will also soon be available in the U.S. and Europe via Amazon, eBay, etc. – or through a potential Western outpost of Alibaba.■
Danger from the Web: In 2013, 181 security vulnerabilities in industrial control systems were reported to the U.S. Department of Homeland Security – 20 percent more than in previous years. The risk is rising in Europe, too.

Hacking, data theft, and sabotage: Industrial companies are more and more frequently the target of attacks on their production facilities. But a multilayer defense concept and the latest automation solutions with built-in IT security functions offer protection.
Sometimes all it takes is a single event to alert the whole world to a threat – as happened in June 2010. That was when the Stuxnet computer virus made headlines for targeting Iranian nuclear enrichment plants. The virus manipulated the control of frequency converters and destroyed centrifuges used for uranium enrichment. At a single stroke, the general public was confronted with an unsettling fact: Even industrial automation systems and critical infrastructure like power plants are vulnerable to hacker attacks.

Since then, maintaining cybersecurity to protect production facilities against sabotage and espionage has become a matter of greater concern to industry. »Stuxnet was a wake-up call for the entire automation sector,« recalls David Heinze, marketing manager for Industrial Security at Siemens.

The digital virus wasn’t an isolated case. In 2011, security experts discovered two more invaders: The Duqu worm gathered information to make attacks, while the Nitro Trojan virus spied selectively on companies in the chemical industry. And Web forums and special search engines like Shodan now deliver potential targets right to the hackers’ front doors.

Statistics confirm threat

The statistics confirm the growing threat. In 2013, the Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) at the U.S. Department of Homeland Security received 181 reports of security vulnerabilities in industrial control systems – over 20 percent more than in 2012 and 2011.

And the significant dangers aren’t limited to the U.S. »The situation in Europe is entirely comparable to what they have in the U.S.,« says Thomas Menze, a senior consultant at the ARC Advisory Group. »We too are facing attacks like these, which could not only cause serious financial damage but could actually endanger people and the environment – for example, if hackers manipulate the controls of a drinking water purification system.«

The fact that attacks like these are possible at all is linked with the technical trends of the past few years. Today’s production facilities are more and more extensively networked – with each other, with the rest of a company’s IT system, and with the Internet.

Open standards offer loopholes for attack

To create these networks, companies rely on open worldwide standards like the Ethernet and the TCP/IP protocol that is well known from the Internet, as well as standardized hardware from IT sources. »These systems enable companies to seamlessly connect all levels of their organization – from production to top management,« Heinze explains. »Which means, for example, that data can be fed directly from production to the company’s ERP system.«

It’s common for large corporations in particular to even network multiple locations via the Internet. On top of that, add far-flung installations that are generally connected with their home base by means of mobile networks. The smooth flow of data speeds up production, provides a better overview of all processes, and cuts the cost of development and production.

But there’s a downside. Open, end-to-end systems are an ideal target for hackers, because their weak points are known worldwide and represent potential gateways for attacks and espionage.

Systematic defense

Siemens has responded to these developments, and is already taking into account these threats from attackers and malware in developing its new automation solutions. To improve its products’ security, for example, in 2011 the company launched the Industrial Security Process Improvement (ISPI) project: After an evaluation phase, experts defined improvements in Product Lifecycle Management (PLM), Supply Change Management (SCM), and Customer Relationship Management (CRM), as well as in Siemens’ internal organization.

To avoid security vulnerabilities, fundamental programming guidelines have been established for all Siemens developers and external vendors. Potential gateways for
attack are shut down by the pro-
gramming code itself, and it is also
possible to avoid other weak points
like passwords implemented within
the code.

Before a new product reaches the
market, automatic testing tools like
Achilles and Nessus detect potential
points of attack. »Hardening« of
automation solutions also plays an
important role, by selectively disabling
unnecessary interfaces so they can no
longer be used for hacking.

And if security vulnerabilities do arise,
Siemens can respond within a few
hours, notify customers, and provide
them with updates or security patches.
»Today Stuxnet couldn’t work the way
it did in 2010,« Heinze says. »Auto-
mation products are considerably
more secure now.«

Comprehensive protection

Using up-to-date automation solutions is just one part of industrial security. The best possible security only comes from multiple layers of defense that protect a production system from all sides and bottom to top. Here Siemens relies on the Defense in Depth concept. Multiple mutually complementary measures help keep the entire system and its network secure and protect the system’s integrity.

Plant security includes physical protective measures like fences, turnstiles, cameras, and card readers as well as organizational measures like a security management process.

Network security ensures that automation networks are shielded from unauthorized access. »One potential
gateway from outside is the remote access points that equipment manu-
facturers use to maintain their machi-
nery remotely,« ARC expert Menze warns. »Anyone who gains access through these points can do things like switch drives on or off, or selec-
tively overload them.« So firewalls are an important defensive tool that monitors data traffic and bars access to hackers.

Multiple firewalls for each automation network

Even greater security comes from segmenting the automation network: The network is divided up into cells, with firewalls controlling the borders between them.

This applies even to general corporate IT, which is also a popular target for
hackers. For wireless communications in particular, experts recommend using virtual private networks (VPNs). With their completely encrypted data transmission, they offer hackers little or no chance to gain access or grab information. Siemens products like SCALANCE S not only offer a firewall, they also provide VPN access combined with access authorization linked to individual users.

The third component of the Defense in Depth concept is the integrity of automation systems and protection of intellectual property. That includes protecting automation systems, control components, and HMI (human-machine interface) systems — in other words, the interfaces over which people communicate with machines. This component is primarily concerned with safeguarding the expertise contained in automation components. Siemens offers integrated security functions for this purpose that are easy for automation engineers to apply.

Whitelist for computer programs

Virus scanners are also used to protect against hackers in production by detecting malware within the system. One addition to these is whitelisting software, a digital list that defines the processes and programs that a computer is allowed to run, to the exclusion of all others.

In all of the above, it’s important to make sure that costs and benefits are kept in proportion, and that maximum security measures don’t end up making products unnecessarily complex. »The main idea at Siemens is that security has to remain manageable, and the customer shouldn’t incur any added expense to use these functions,« Heinze says.

But no matter what technical countermeasures you apply, security can never be airtight. »Companies can only try to make the barriers to hackers as high as possible, and always keep their defensive measures current,« ARC consultant Menze says. »It’s also essential that not just management but the entire staff develop an awareness of the dangers.«

Siemens supports its customers in this process by offering Managed Security Services as an all-around protection — with analysis, implementation of defensive measures, and continuous system monitoring (see box). After all, the threat from hackers mustn’t keep companies from implementing important developments like digitalization simply for fear of cyber attacks. Otherwise, the hackers would still get just what they want — to do serious harm to businesses — only in this case, by going the long way around.

Managed Security Services from Siemens

Assessment, implementation, and continuous monitoring — these are the three building blocks of Managed Security Services from Siemens. »First, a team of security experts assesses a customer’s current situation,« explains Stefan Woronka, business development manager at Siemens Industrial Security Services. »That includes hardware and software, processes, and the level of training of employees in production.«

In the next step, Siemens sets up a comprehensive security architecture. In addition to firewalls and antivirus software, this also includes clear rules for accessing a system’s various components.

»We also introduce new processes for critical situations — for example, when there’s a malfunction,« Woronka explains. »In those cases, it has to be clear who’s supposed to do what, and who needs to be informed.«

Employee training plays a key role. Staff members have to learn to recognize threats — for example, from external service providers on the plant grounds — and to respond appropriately.

As soon as these measures have been put into action, Siemens also provides continuous monitoring for the system. IT experts at the company’s own computer centers keep an eye on system access points and the usage of all components. »They also watch the global security situation, and take immediate countermeasures if there’s an attack,« Woronka says. »The uppermost goal is to keep production running.« This around-the-clock monitoring is provided centrally from Germany and the U.S.

siemens.com/industrial-security-services
Luxury watches from Switzerland, major-brand clothing from the U.S., top-notch wines from France – no consumer good is safe from product pirates. They’re especially fond of copying high-margin premium and big-brand products. But counterfeiters branched out beyond consumer products long ago. They’re increasingly attacking capital goods, from motors to robots to complex machine tools. »It’s not just individual components – they’re copying whole machines and systems,« says David Heinze, marketing manager for Industrial Security at Siemens.

Product piracy of capital goods has increased ominously, according to sources like the regular surveys by the German Engineering Association (VDMA). In the latest study from 2012, two-thirds of machine builders said they had been victimized by technology theft at least once. The VDMA estimates that the thefts cost German companies roughly €8 billion in lost revenue in 2011. That’s a 24 percent increase in just two years. And the trend is on the rise.

Product piracy doesn’t just affect manufacturers – it harms society. If the machine builders had made the counterfeited products themselves, it would have protected 37,000 jobs in Germany alone.

Technological progress makes copying easier

»Most companies have no idea how easily their products can be copied,« says Bartol Filipovic, head of the Product Protection and Industrial Security Department at the Fraunhofer Institute for Applied and Integrated Security (AISEC) in Garching, near Munich. Technological progress has made counterfeiters’ work incomparably easier. In today’s globalized machine construction, individual components are largely standardized goods. So if the individual parts that product pirates need for larger systems are too demanding or expensive for the counterfeiters to make themselves, they have no trouble finding them on the market.

In most machines and systems, the exclusive and often crucial expertise is buried in the electronic controls and software. These are the innovative product characteristics and performance features that determine a machine’s success or failure on the market – which is why cybersecurity is becoming an increasingly crucial topic all over the world (see »Companies a target,« page 20).

So it’s important to protect the software that controls machinery against unauthorized copying. »That function
Product counterfeiters have gone far beyond targeting only consumer goods like expensive brand watches.

is already integrated into the latest generation of our Simatic S7-1500 and Simatic S7-1200 family of controls,» Heinze says. »The program code can be linked to the hardware, which makes it impossible to copy.«

If security precautions are absent or deficient, a plagiarist can illegally copy programs from original machines. »Unprotected software is relatively easy to download – in the simplest case, with a USB flash drive,« warns Fraunhofer expert Filipovic. »You can already get the tools to download and analyze software for €5,000 on the Web.«

Serving plagiarists legally

For more complicated cases, there are highly specialized companies that offer their services. They’ll download the software for the plagiarists, use it to reconstruct how

Approximately €8 billion

is the total amount of damage German enterprises suffered from lost sales due to technology theft in 2011, the VDMA estimates.
Markets | Product piracy

are working on inventive solutions for stopping product piracy.

There are certainly many standard solutions in industrial security nowadays. But the most promising option is not to rely on just one of them, but to combine a variety of methods instead.

Holograms offer limited protection

One relatively cheap solution involves gluing holograms onto the machines. These can show, for example, whether the provider has legally acquired a license for the equipment software. Siemens uses this method to display a valid software license. «But holograms are of only marginal importance, because they’re relatively easy to imitate,« says security expert Heinze.

But how can companies protect themselves against increasingly sophisticated product pirates? Most machine builders are small to medium-sized businesses. They have neither the knowledge nor the resources to track down counterfeiters and prosecute them successfully. So they have to keep their technology from being copied in the first place.

Many companies all over the world – from technology corporations to startups in nanotechnology –

the machine works, and then deliver complete blueprints. This morally questionable service, called »reverse engineering,« isn’t even illegal. The counterfeiting business doesn’t become open to legal challenge until the plagiarist uses the delivered information to build and sell imitation machines.

Controllers like the Simatic S7-1500 use not only anti-copying protection but also authentication mechanisms to prevent manipulation.
One indispensable security measure is to use passwords to safeguard access to a machine. Of course, far too many companies make the same mistake here as many private computer users: They use a password that’s too easy for hackers to guess or work out. Also, they often use no «brute force» protection, which automatically locks a user out after too many failed attempts to input a password.

But most importantly, the password has to be stored somewhere that can’t be hacked into. That means it can’t be stored openly in the program code, which outsiders can access relatively easily. »There are easily accessible tools that make it possible to guess passwords or make them visible in the program code,« Heinze warns. Digital signatures, a kind of electronic fingerprint, work similarly to passwords, authenticating access so machines can be serviced, maintained, or repaired.

**Protective films for controls**

Counterfeiters quickly react to new security technologies and find ways to evade them. To make their job harder, the Fraunhofer Institute has recently been investigating an innovative physical protective measure, as opposed to virtual approaches. Its scientists are currently developing protective films to wrap the electronic controls of machines and systems. »If the film is cut, perforated, or otherwise damaged, the software in the controls automatically becomes useless,« says Filipovic. That impedes access to the stored data. Machines that have already been installed can be retrofitted with the film. »The technology is likely to be ready for practical use in about two years.«

One significant drawback of intellectual property rights is the disclosure obligation. If you want to apply for a patent, you have to describe the invention in detail. That gives plagiarists crucial information about how to imitate the innovation. For that reason, many companies avoid patenting, especially in countries where counterfeiters are especially active.

But that practically drops their innovations right into the product pirates’ laps. The counterfeiters can often imitate a new machine within a few months and then apply for a patent on it themselves in their own country – and the company that developed the innovation can no longer sell it in that market.
Factory for researchers

In the virtual reality applications laboratory at the Fraunhofer Institute for Machine Tools and Forming Technology (IWU) in Chemnitz, visitors can take a virtual tour of the research factory.
Looming behind protective glass walls are four orange robots, ready to manufacture vehicle bodies. But this is not an automaker’s production bay. Rather, it’s a bodywork construction unit at the Fraunhofer Institute for Machine Tools and Forming Technology (IWU) in Chemnitz, in the German state of Saxony. The short production line is equipped with the latest manufacturing technology. With only a few exceptions, these are the same machines as those used to produce millions of units of the Volkswagen Golf.

Keeping their cards close to their vest is part of the job for the researchers at IWU: They are working here with Volkswagen and other partners in industry to develop the manufacturing of the future. This innovative project is known as E³ Research Factory for Research-Efficient Production. In German, the three E’s stand for energy and resource savings, an emissions-neutral factory, and integration of humans into the manufacturing process.

Humans in the factory of the future

“We want to adopt a comprehensive approach to determine, for example, how we can better plan, implement, and control flows of materials, energy, and information in emissions-neutral factories in the future,” says Matthias Putz, head of the Fraunhofer IWU. “At the same time, we are thinking about new approaches to integrate humans into the manufacturing processes of the future.”

The researchers in Chemnitz are seeking answers to key global trends: Raw materials are becoming scarcer and more costly. The transition to a new energy mix is also making the supply of electricity more volatile. And shorter and shorter product lifecycles demand extremely flexible manufacturing. In addition, demographic change and the integration of information and communications technology into manufacturing are changing the work environment. Companies must thus create working conditions that are suitable for older employees, while also remaining appealing and meaningful for the younger generations that have grown up with tablets and smartphones.

A leading project for the Fraunhofer Society

Because these topics are important to all of Germany as an industry location, the Fraunhofer Society has made E³ production one of its four leading projects. Work on these projects always involves several Fraunhofer Institutes, each with different skills, seeking solutions to challenges that affect society as a whole. By 2016, three other locations should have demonstrators and pilot...
applications in place that are similar to those in Chemnitz: the Fraunhofer Institutes for Manufacturing, Engineering, and Automation (IPA) in Stuttgart, Material Flow and Logistics (IML) in Dortmund, and Production Systems and Design Technology (IPK) in Berlin.

The state of Saxony, the German Ministry of Education and Research (BMBF), and the EU have invested a total of about €20 million in the research factory in Chemnitz. Partners from industry were also involved in providing equipment. Between June 2011 and November 2013, a hall measuring more than 1,600 square meters took shape, with a state-of-the-art fleet of machinery and its own power supply, including a cogeneration unit and a photovoltaic system.

Sensors measure resource consumption

The building contains many sensors that measure how the plant handles resources – for example, power and compressed air. Key components in the building management system, such as the cogeneration unit, photovoltaic system, and main electricity feed, also supply data for the central information system in the research factory.

“This is where we can test how machines and processes will need to be structured for the resource-efficient manufacturing of the future – all during ongoing production," said Fraunhofer President Reimund Neugebauer at the opening in May 2014. “A paradigm shift will be needed to make sure that manufacturing remains in Germany in the future: Instead of thinking about deriving maximum profit with minimum capital investment, we will need to start thinking about obtaining maximum added value with minimum use of resources.”

One focus in Saxony is on new solutions and procedures for the automobile industry – which is hardly surprising in a state that is not only home to three major automakers and 750 suppliers, but was also where pioneers such as Auto Union made automotive history many decades ago.

Research cluster for the automobile industry

Currently, more than 70,000 people are employed in the automobile industry in Saxony. Research in this area is also strong, as can be seen from IWU’s immediate neighbors: The Institute is flanked by buildings of its research partner, the Technical University of Chemnitz. And diagonally opposite is where the cornerstone has just been laid for Europe’s largest lightweight construction research center. Access to experts in other automotive technologies could not be any more convenient.

The four-story hall of the research factory is where the Fraunhofer experts work in three key areas, representing the core competencies of the Institute. On one side, the focus is on new machines and procedures for the resource-efficient manufacture of drive train components. One of the projects, for instance, deals with new process chains for the manufacture of splined gear sleeve shafts that should decrease material requirements, shorten production times, and reduce energy consumption.

Forming instead of machining

A poster showing the goals of the research program reads »Process chains for power train components based on forming.« Today, components are created by following the processing stages of forging, turning, and drilling, gear hobbing, honing, heat treatment, shot peening, and polishing the shaft and splines. If the IWU researchers’ plans work out, the material- and cost-intensive machining processes will no longer be needed and will be replaced by resource-efficient forming processes instead.

The basic idea is that machining processes such as deep-hole drilling and spline hobbing will be replaced with alternatives such as spin extrusion and spline rolling, which will mean no waste in the form of chips that require subsequent high-energy recycling. This does more than reduce energy consumption: Material consumption falls by about 30 percent, processing times are expected to fall by 40 percent, and component properties such as strength, wear, and resilience will be substantially improved.

This example makes particularly clear what the researchers at Chemnitz mean in terms of »saving energy and resources. « They also want to develop alternative process chains like those for the splined gear sleeve shafts for other parts of the drive train – for engine components, for instance. In this connection, the experts at IWU do more than combine existing procedures – they are also developing new process stages and working with the manufacturers to improve production procedures used in automobile manufacturing, mechanical engineering, and the aviation industry.

Improve energy efficiency, reduce emissions

In addition to the individual process chains, the researchers at IWU also want to operate the entire manufacturing facility with minimal emissions. »That’s why we not only constructed the building to the highest building technology standards, but also used advanced energy supply and management strategies, « explains Andreas Schlegel, head of the Business Management Department, who is responsible for the Power Management 2.0 competence area.

This includes, in addition to the use of renewable energy sources such as photovoltaics, production planning aligned with current power supplies, a production control system that operates all equipment with minimum power consumption, and the most complete possible use of lost energy, for example for heating of buildings.
A key role in this regard is played by the virtual commissioning of power control solutions: Based on the Siemens Plant Simulation software, the researchers have developed the eniBRIC simulation tool, which enables them to evaluate and optimize the power and resource consumption of the entire system of manufacturing equipment, supply infrastructure, and logistics, as well as the higher-level factory control systems.

**Transparent, individual status monitoring**

New information systems also ensure maximum transparency relative to the current status of the machines and processes on which Ariel Firlej, IT specialist and research assistant in the Information Management group, works. He stands alongside a monitor that encourages him to »Take what you need!« Firlej scans a QR code on the screen with his iPad, which allows him to transfer the status information that he requires, such as power consumption or operating times, onto his tablet computer.

»The state-of-the-art dashboard enables me to move from machine to machine and put together my own personal menu of measurement values,« says Firlej. And these measurement values are constantly updated via WLAN. »The roles that each individual plays are very important in this regard,« says Firlej. »After all, a maintenance technician needs different information than a machine operator.«

Firlej’s system still needs the QR code to identify which machine he is dealing with at any given time. Thanks to the WLAN routers, which are installed throughout, the research factory also has an in-house navigation system that is accurate to about 20 centimeters. »In the future, we could use those to automatically determine user locations,« explains Firlej. »Then it will be possible to show on the screen the data for the machine that the individual is dealing with at the time – and coordinated with the person’s role within the company.« At that point, too, the information would not necessarily need to be displayed on a tablet computer – smart glasses could also be a practical alternative in the future.

**Time savings of 50 percent**

A few meters from the monitor showing the machine information is the research factory’s body construction plant. This is where the orange robots assemble automobile doors from individual components by welding, gluing, and seaming. Today’s factories still lose a lot of time when switching over to a new automobile model – it takes about six months to set the plants up for production. During this time, the manufacturing experts are busy reconfiguring elements such as the fixing devices that hold the components during manufacture. The new engineering approaches being created at Chemnitz enable these run-up times to be cut by about half.

This means that, over the medium term, they could speed up model changeovers significantly within the manufacturing environment. Over the longer term, however, faster conversion could also open up entirely new opportunities. In the future, automakers want to be able to produce different models on the same line, continuously and flexibly. To do this, information for the robots’ fixing systems, for instance, would have to be updated in mere seconds, to enable a medium-segment sedan to be built immediately after a compact model. This is still a long way off – but after all, the research factory’s goal is to develop production methods appropriate for the 21st century.
Indonesia: an economic giant in the making

The Indonesian capital, Jakarta, with a population of more than nine million, is the country’s largest city. And its metropolitan region, with 30 million residents, is the second-largest megalopolis in the world.
Untouched jungle, endless mangrove swamps, aboriginal people who still live almost as they did 1,000 years ago – a trek through the Indonesian province of West Papua on the island of New Guinea is an adventure even today. Of the more than eight-million international tourists who visit Indonesia each year, few come to explore the mountainous island in the Pacific, the eastern half of which has been the independent country of Papua New Guinea since 1975.

Nevertheless, visitors from all over the world do come, though not as tourists but as business travelers – because West Papua is especially rich in natural resources. That’s why many international corporations have important production facilities in the midst of this tropical wilderness. For example, U.S. mining group Freeport McMoRan has the Grasberg Mine at an elevation of more than 4,000 meters, and it’s one of the richest gold and copper mines in the world. And British petroleum giant BP’s Tangguh Project in isolated Bintuni Bay is tapping into one of the world’s largest known natural gas deposits. The gas has been pumped up offshore since 2009, then brought onshore by pipelines to be liquefied and carried off in tanker ships.

**LNG a major export**

Liquefied natural gas, or LNG, is an important energy source for industry in Japan, China, and South Korea as well as the U.S. The Asian countries are currently among the main customers for the gas from Tangguh and other Indonesian sources.

To ensure their natural gas supply, Chinese, Japanese, and South Korean energy corporations have also invested in the gas production joint venture that BP heads. By 2019, Tangguh’s production capacity will be expanded by about another third – because gas demand is growing not just in other countries, but now in Indonesia itself.

**Transformation to an industrialized nation**

So as to be less dependent economically on fluctuating exports of raw materials, and at the same time to keep a larger share of value added within the country, the Indonesian government plans to strengthen the country’s industry over the next few years. According to the Master Plan for Acceleration and Expansion of Indonesia’s Economic Development released in 2011, Asia’s fifth-largest economy aims to join the world’s Top 10 by 2025. It’s not an unrealistic goal. A 2012 study by the McKinsey consulting firm found that Indonesia has the potential to become one of the world’s largest economies by 2030, overtaking Germany and the United Kingdom.

But that will call for substantial capital expenditures. Because of its rapid economic growth of about six percent per year, combined with its fast population growth, Indonesia has to invest in improving its infrastructure, says Josef Winter, CEO of Siemens Indonesia. For example, nationwide electricity consumption is likely to soar by ten percent a year until 2030. State energy utility PLN estimates that it will have to add about 6,000 MW of new capacity every year to the grid in order to keep up. And the grid itself needs to be expanded. Nearly 70 million Indonesians have no access to electricity from the national grid.

Indonesia has some 17,000 islands within its territory. Though the country has large reserves of natural gas and coal, this means there are also market opportunities for decentralized power generation from renewable sources like the sun, wind, and biomass. To advance economic growth still further, it will also be necessary to expand roads, seaports, rail networks, and airports.

**Investment opportunities**

The government has also recognized the need for investment, and is opening up opportunities for international companies to invest in the country. That’s especially so for the construction and energy industries, but machine and plant construction also have
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Important opportunities – including for the requisite control technology. The 2011 Master Plan, which was adopted under former president Susilo Bambang Yudhoyono, calls for investing the equivalent of about US$400 billion in infrastructure and the energy supply. There’s been an explicit call for public-private partnerships, and companies that can bring new technologies into the country or set up labor-intensive production operations can get tax breaks.

President fights corruption

The Indonesians elected a new president in July 2014: Incumbent Yudhoyono was ineligible to run again after two terms. Experts on the country expect his successor, Joko Widodo, to make structural reforms and provide positive impetus for business. The administration under Joko Widodo is going to continue with parts of the Masterplan for Acceleration and Expansion of Economic Development. The plan focusses on the neglected maritime sector and seaports, public transport, and underdeveloped provinces such as Papua. Realization of the masterplan faced delays mainly caused by bottle-necks in regulatory issues and land acquisition. The 53-year-old president is a former governor of the capital, Jakarta, and is considered a man of the people who has pledged to make reforms and fight corruption.

Indonesia is ranked as Number 120 out of 185 countries in the World Bank’s 2013 Doing Business Report. Widodo, always known by his nickname Jokowi in Indonesia, ran on a platform of strengthening the anti-corruption authorities, inviting more foreign investors, and expanding infrastructure, especially in the country’s less-developed eastern regions.

The new president strongly welcomes foreign capital and expertise to support this effort. With a population of nearly 250 million, Indonesia may be the most populous country in Southeast Asia and the fourth most populous in the world. But well-trained skilled workers are in short supply.

In addition, neither the Indonesian government nor local companies invest much in research and development. «Those expenditures come to just 0.1 percent of the gross domestic product,» says Roland Rohde, who works at the Jakarta office of the German government’s foreign trade agency, Germany Trade & Invest GTAI.

So it’s also no wonder that despite the vigorous economic growth of the past few years, Indonesia still lags well behind neighboring countries like Malaysia and Singapore. Average per capita income in 2013 was less than US$4,000 per year. «And the economic structure still lacks many of the characteristics of a rising emerging economy,» says GTAI correspondent Rohde. Exports of goods in 2013 came to barely US$183 billion – only about one-fifth of the Indonesian gross domestic product, and one of the lowest export ratios in Asia.

In contrast to other Asian countries, the manufacturing sector has had a rather minor share of the gross domestic product so far, about 22 percent. To date, Indonesian exports have been driven primarily by commodities. The principal exports, besides coal and natural gas, have been unprocessed mineral ores. China’s booming automotive industry, for example, needs vast amounts of iron ore and bauxite for steel and aluminum production. Indonesian nickel, gold, and copper are processed by the IT and electronics industry in China, Japan, and South Korea.

Process raw materials, don’t export them

The first sign of the desired economic transformation came in January 2014, with an extensive ban on exports of unprocessed ores. International mine operators in particular will be forced de facto to build up in-country processing capacity in the years to come, which will extend the value chain in Indonesia. »Indonesia will benefit a lot from this law, because the country will no longer be selling raw materials for little money,» stated the Mining Committee of the Indonesian Parliament at the beginning of this year.

International mining concerns, including Russia’s United Company, China’s Beijing Shuangzhongli and Bosai Mineral Group, and Korea’s POSCO Group, have responded to the new law by announcing the construction of smelting plants.

Attractive domestic market

But the country’s gigantic domestic market is also attractive to foreign investors. Indonesia is a young country: More than half of its population of nearly 250 million is under the age of 29. The population is considered to be very optimistic and willing to consume. The minimum wage that the unions have been able to negotiate increases every year, though in the Jakarta metropolitan region it’s still only around US$2,000 a year. Over the past few years a very brand-aware middle and upper class has also grown up, now numbering about 40 million customers and expected to more than treble by 2030, provided economic growth continues.

That means major market opportunities for industries like construction. Builders’ order books in the major metropolitan areas are filled with numerous new apartment buildings, office complexes, and shopping centers. The pharmaceutical industry is profiting from general health insurance, introduced in January of this year. And consumption of cosmetics and toiletries is also growing at double-digit rates.

Things have also been steeply on the rise for the automotive industry for several years. From 2010 to 2013, the number of new vehicle licenses rose 60 percent to more than 1.2 million per year. The figure is expected to grow to 1.3 million
this year. The lion’s share of the cars have been from Japanese makers. International automotive corporations like Nissan, Honda, and General Motors are currently building and expanding production capacity in Indonesia to be better able to supply the Southeast Asia region from here. That’s because the AEC – the Asean Economic Community – is expected to create a gigantic liberalized economic zone with a population of more than 600 million starting in 2015.

The economic integration of members of ASEAN (Association of South East Asian Nations) is expected to promote the free travel of goods and services, which will strengthen those countries’ own competitiveness even more. One more reason for the Indonesian government to narrow the technology lead still held by its economically powerful neighbors, and attract foreign expertise into the country. That will benefit international companies who can quickly set up their own locations in-country and offer capable customer service.

Siemens in Indonesia

Siemens’s history in Indonesia goes back as far as 1855, eight years after Werner von Siemens founded the company in Germany. The company has carried out many infrastructure projects since then – starting with the first telegraphs, turbines that generate a total capacity of more than 5,000 MW, and now the delivery of the latest control technology for industry. «Our integrated automation technology helps increase productivity and competitiveness in a variety of industries, including mining, paper, cement, steel, and many more,« says Josef Winter, CEO of Siemens in Indonesia.

For example, Indocement Tunggal Prakarsa, a cement maker listed on the stock exchange, ordered an upgrade solution for its factories in 2013. A major part of the project was to migrate the old process instrumentation and control system, made by a competitor, onto the Simatic PCS 7-based Cemat system.

The construction boom is also having its effect: Siemens is supplying ThyssenKrupp Industrial Solutions with an integrated drive system for the expansion of their Holcim cement factory on Java.

Over the past 20 years, Siemens in Indonesia has invested more than €200 million in expanding and modernizing its production facilities in Indonesia and in the development of its workforce. «Indonesia is an important market for us, and offers major growth opportunities in many sectors like energy, industry, transportation, and health,« says Winter. The company now has 1,800 employees at four production establishments. Revenues for fiscal 2013 amounted to about €214 million. New orders came to €291 million.

siemens.co.id
Industry discovers Silicon Valley

For many years, the area south of San Francisco was viewed as a zone that had nothing to offer to old-style, traditional industry. Silicon Valley was home to the best software developers in the world. Young, hip, unconventional. But as hardware and software have coalesced in production, these programmers too have begun taking an interest in manufacturing. And in the other direction, industrial companies have been discovering the Valley’s potential – and are opening their own locations there.
Back in California’s pioneer days, the brick building at 35 South Market Street in San Jose was a hotel, the Metropole. Today the picturesque red building is like something from another age — the vast majority of downtown San Jose is mirror-windowed skyscrapers. But the former hotel is actually making history: It’s the corporate headquarters of Electric Cloud.

Walk in the door and you’re in for a surprise. The whole ground floor has been remodeled as a contemporary work loft, with roughly finished walls and exposed ceiling fixtures. The software company — founded in 2002 — moved in just a few months ago, explains CEO Steve Brodie, an affable man in a blue-checked shirt. Electric Cloud is growing fast — 69 percent in the second half of 2013 alone.

The company’s roughly 100 employees produce programs to automate and accelerate the testing of new software solutions. But the biggest surprise is the customers, many of whom are in industry. Automotive suppliers like Delphi and Hella, SpaceX (aerospace), Lockheed Martin (defense industry), and Siemens — not just as a customer but also as a financial backer through its own venture capital unit (see box on page 38: »Siemens invests in startups«). Brodie sees it as the trend of the times. »Every company is a software company, or should be,« he says. »Our orders reflect what’s going on in products.«

Software is in everything

A new age has begun. Experts call it by names like the Fourth Industrial Revolution, »Industrie 4.0,« Machine-to-Machine, or the Internet of Things. More and more traditional industrial products incorporate mini-computers — packed with software and connected wirelessly with each other and the Cloud. At the same time, a new generation of platforms has emerged, with future applications that can scarcely be guessed at today, and they too need highly complex software. Robots are doing more than we could have even imagined just a few years ago. The bifurcation of business into software and hardware, digital and real, is evaporating.

One unexpected consequence: In Silicon Valley — once synonymous with IT, software, and social media — the emphasis is very gradually shifting toward manufacturing. Investors, scientists, and young entrepreneurs are getting interested in hardware again. At the same time, companies have been moving in that were rarely associated with the Valley. For instance, almost every major automotive producer has a branch here now: laboratories for developing the vehicles of tomorrow.

Engineering moves in

Back in late 2012, San Jose organized a Silicon Valley Manufacturing Roundtable that was intended to expand the growing presence of modern production technology. Stanford University, the nucleus of innovation and the incubator for the Valley’s next generation of innovators, has been beefing up its engineering school and promoting careers in industry — or founding related start-ups. Medium-sized companies like Altierre and ETwater have even begun shifting their production back from China to the Valley (see box on the right: »Hardware made in Silicon Valley«).

A lot of factors have contributed to this revolution. Like President Barack Obama, who has provided massive backing for the modernization of U.S. manufacturing. Rising labor costs in Asia, the Cloud, which facilitates decentralized computing and robot applications. It’s a new class of tools and solutions driven by the low cost of hardware and the Cloud infrastructure, according to a report from Silicon Valley Bank.

»Silicon Valley’s Hardware Renaissance,« ran the headline in the New York Times. Whether for utilitarian equipment like thermostats that are being reinvented in new, smart forms or production machines that communicate with one another. »Investors have begun pushing hard on topics
like automation and B2B, « says Daniel Kellmreit, CEO of the Detecon consulting firm in San Francisco and author of The Silent Intelligence – The Internet of Things.

Thousands of industrial firms on location

Just as in the days of the dot-com revolution, managers, engineers, and investors are gravitating to Silicon Valley. Kellmreit estimates that thousands of industrial firms already have a presence here. Some maintain a small office of trend-watchers; others have set up research locations and gradually expanded them.

Take Bosch, for example. The Stuttgart company has a Research and Technology center in Palo Alto that explores avant-garde technologies for sensors, batteries, security systems, and robots. It’s headed by Jiri Marek, an electrical engineer trained in Stuttgart and at Stanford. The laboratories are located in the Foothill Research Center, a massive complex of buildings on the slope overlooking Stanford University, which also owns the site.

Or Nissan. Until recently, the carmaker had only a small trend-spotting office in Mountain View. Then in February 2013 it moved into a big property in Sunnyvale, complete with research laboratory. As many as 60 researchers are at work there on a forward-looking topic that was formerly housed at corporate headquarters in Japan: driverless cars.

A hub for the automotive industry

Silicon Valley has very quietly been evolving into a hub of the automotive industry. They’ve all moved into the Valley in recent years – Toyota, General Motors, Chrysler, Volvo, Kia, and Honda. Three German makers, VW, BMW, and Mercedes-Benz, have actually been there for 15 years, with a steadily expanding presence. Today the BMW Group Technology Office in Mountain View has about 35 employees doing research, and the Volkswagen Electronic Research
Laboratory has about 150. Mercedes-Benz is even in the process of expanding its Research & Development Center in Sunnyvale to a workforce of 200.

Away from mechanisms and toward electronics and software – few products reflect the transformation of industrial goods as visibly as the automobile. An average car today is controlled by 60 microprocessors. Ten years ago, it was only 15, according to a study by the Center for Automotive Research (CAR) in Detroit. About software: »In the 1970s, a car had a couple of hundred lines of code. Today it’s more than a hundred million,« says Electric Cloud’s Brodie. It’s likely that cars are going to become fully networked consumer goods – a blueprint for the Internet of Things.

That’s why VW and Mercedes are now developing their apps to maturity in California for production. And BMW is organizing hackathons – a kind of programming competition popular in Silicon Valley – to find out about new trends. Collaborations with big-time Valley players like Apple, Google, and Facebook are going well, the carmakers say. »They’ve understood that the next big deal will be the car,« says Herbert Kohler, head of corporate research and sustainability at Daimler AG.

When competitors cooperate

As ever in Silicon Valley, communication is open. Amid this legendary, dynamic environment, even competitors cooperate in institutes and associations, and it’s not even uncommon for them to invest together in start-ups. They call it «coopetition» here, and it’s a basic principle behind the region’s innovative spirit. »The mentality here is to do things differently,« says Brodie.

But in the new world of collaboration between hardware and software experts, industrial experts and IT nerds, new partners often have to learn how to understand one another
An interview with Richard Dasher, Director of the Center for Integrated Systems (CIS) and the US-Asia Technology Management Center at Stanford University in Palo Alto

How is the Internet of Things changing your work at Stanford?
A few years ago we started working with analyzing big word packages – what’s known as Big Data today. Now our research is shifting toward visual data. Taken together, these areas represent the foundation of the Internet of Things, because this kind of information will play an increasingly important role in machine-to-machine communication. Those systems will have to have their own automated data management.

What does that mean in specific terms?
Take a car, for example. Electronics are already doing a lot of tasks today, like checking tire pressure. Drivers don’t have to deal with that until the system tells them, watch out, you’re about to get a flat. The Internet of Things will be an expansion of things like that. And that goes just as much for the B2B sector – say, supply chains. There too, people will be relying much more heavily than today on automated inputs: for example, information about how many components have to be made.

Where do you foresee the biggest challenge?
Connectivity. And for hardware, sensor technology has to be developed even further. It’s a fascinating job, controlling and analyzing the quantities of data that the sensors bring in. Just think of the complex jobs that robots might do someday.

Isn’t that why Silicon Valley has been turning more and more toward hardware lately?
You can’t separate hardware and software so clearly any more. Look, for example, at new types of hardware platforms like wearables – biometric armbands. 3-D printing is also an interesting development. But to take advantage of the opportunities that come from that, you need to know something about hardware.

How deeply are companies exploring these areas?
It’s still very early days. Commercial applications often aren’t clear yet. It’s hard for large corporations to make resources available that aren’t allocated to a specific business purpose. Often it’s better to just watch the start-up scene and invest in interesting companies. That’s a portfolio approach, where not every project has to be a success.

Are young talents even willing to deal with hardware?
Young people are interested in anything new. Stanford is working very hard to arouse interest in engineering programs, and offers wonderful opportunities for beginners in the laboratory. They need to get an early experience of the delight that comes from a practical application – otherwise they aren’t motivated to work their way through the basic levels of study. Technical development moves so fast today that an ever-widening gap is opening up between basic knowledge and cutting-edge innovations. One way out is to teach knowledge in less breadth, and instead to teach more specialized skills and cooperate with other specialists.

Who are the new stars among new companies?
I haven’t seen the next Google yet. But if you look at the history of Silicon Valley, every seven or eight years there’s a big new wave with one or two companies that become world leaders.

»You need to know something about hardware.«
»In the 1970s, a car had a couple of hundred lines of code. Today it’s more than a hundred million.«

Steve Brodie, CEO Electric Cloud

first. »A medium-sized machine builder is focused on its industrial processes, and views software as a means of supporting production,« says Rene van den Hoevel, managing director of the German-American Chamber of Commerce in San Francisco. »Companies like Google are all about software. And if they need production capability, they just buy it.«

Early in 2014, at a price of US$3.2 billion, Google acquired Nest Labs, a maker of smart home appliances with more than 400 employees that was founded in 2010 by Apple engineers Tony Fadell and Matt Rogers. It makes smoke detectors and thermostats that can be controlled by an app and that learn their users’ habits. Just half a year later, Nest in its turn bought Dropcam, a San Francisco maker of Web-linked video cameras with 77 employees. The price: US$555 million. These amounts alone show that this isn’t just about technology. It’s about power in the market of the future. »It’s the next big wave,« says consultant Kellmereit. And Ralf Schnell, CEO of the Venture Capital Unit of Siemens, adds: »Silicon Valley is going to get considerably more important when it comes to topics like industrial automation and industrial processes.«

Yet in many cases, we can barely guess what kind of a revolution is on its way. After all, part of the reason terms like the Internet of Things, Advanced Manufacturing, and »Industrie 4.0« are so fuzzy is that the thing they’re describing is only just coming into being – and it’s changing daily.

Start-up technology for robots

Richard Avenue is in an outlying area of Santa Clara, just a few minutes by car from the university and San José International Airport. Places like this also exist in Silicon Valley: an unlovely industrial district with low utilitarian buildings and front yards paved with concrete, and obscure companies with names like Diamond Glass and Sincere Home Decor. But it’s a good place for start-ups looking for authenticity and cheap rent. That’s why Grabit is here, in a pale-yellow concrete building decorated halfway up with a blue horizontal stripe, like a birthday present without a bow.

Grabit emerged in 2011 from SRI International, a Menlo Park research institute that originally belonged to Stanford. Today Grabit has 25 employees. If companies like Electric Cloud and their software technologies represent one end of the Internet of Things, Grabit stands for the other: ultramodern production methods for the factory floors of the future. Grabit’s technology helps robots pick things up.

CEO Charlie Duncheon sails through the laboratories, an industry veteran with combed-back hair. He explains the process known as electronic adhesion. Surfaces are charged with static electricity, and the effect is like a magnet, but it works with any material – even cloth and cardboard. Robots can use it to pick up practically anything – even thin, fragile, circuit boards and different-shape containers. Duncheon demonstrates a prototype that first picks up an apple and then a can of food. »We’re getting closer to a human hand,« he says.

Grabit believes in the increasing use of robots in production – which is why Duncheon says they’re in exactly the right place in Santa Clara. After all, thanks in part to Stanford, Silicon Valley is a center of robot research. »And once venture capitalists really discover this topic, its development here will accelerate,« he adds.

But there’s also another reason. In the longer term, Grabit plans to offer the industrial robots themselves, and they will need to be programmed. And for that, the company will need software – the Valley’s core competence.
Supplier risk under control

Many companies’ success and stability depend on a crisis-proof supply chain. As relationships with suppliers grow more complex and globalized, the emphasis in purchasing is shifting from saving on costs to risk management.
Dear Valued Customers: In order to protect our employees, equipment, and facilities, we've temporarily suspended production at our two factories in Thailand, which have been inundated by floodwater – that was the bad news that international computer makers faced on Western Digital's website in October 2011. The California-based American company is one of the world's largest makers of hard disks, and the clientele it serves includes Acer, Apple, Dell, and Lenovo. Some 60 percent of its production normally comes from Thailand, where Western Digital has 37,000 employees.

Granted, heavy rain and flooding are nothing unusual there between May and October. But in the fall of 2011, an exceptionally heavy monsoon caused the worst floods in decades, bringing production at numerous factories to a halt. The flooding affected not just Western Digital's own plants north of Bangkok, but also its Thai suppliers like the manufacturers of hard disk motors and suspension assemblies for read/write heads. The consequences: massive losses in production and earnings for the hard disk maker, supply bottlenecks for its customers, and rising prices for buyers of computers all over the world.

Like the devastating tsunami in Japan in the same year, the Thailand flood is a trenchant example of the risks involved in today's complex, worldwide supply chains. If a single link snaps anywhere in the world, the result can be distortions in production and difficulties with deliveries.

According to the Institute for Supply Management (ISM) in the U.S., suppliers already account for about 50 to 65 percent of a company's value added in many sectors. »Disruptions of the supply chain are one of the main causes of business volatility,« affirms Achim Hillgraf, Vice President of Germany Operations at FM Global, one of the world's leading industrial insurers. Among its lines, the company – headquartered in the American state of Rhode Island – provides coverage for what are known as interdependency losses. These include business interruptions and other losses caused by supplier dropouts.

The sources of risk are very diverse. Natural disasters, political unrest, economic crises, and a lack of global security rules and standards as well as mismanagement can disrupt the supply chain and seriously interfere with business operations at the affected companies, jeopardize their competitiveness, and do lasting damage to their reputations.

Risks affect all industries

The risk is by no means limited to specific sectors. Take the case of Thailand. The 100-year flood of 2011...
Management | Supplier Risk Management

Suppliers.

eral inspections and better manage-

in the Thai supply chain.

90 percent of the respondents invest-

expend considerable effort on moni-

service sector are also setting up risk

flows like Canon, Nikon, Sony, and Sharp – all of which saw rev-

were knocked out, as well as technol-

also had a tremendous impact on

Damaged more than just hard disk

makers like Western Digital, Seagate, and Toshiba and their customers. It

companies like car makers Toyota and

also has an average of up to 20,000

suppliers, with just as many contracts.

In the EY survey as well, half the com-

panies said they worked with more

than 10,000 suppliers. Yet in their

internal risk management, the major-

ity of those surveyed concentrated

on 1,000 up to a maximum of 3,000

suppliers. More than 80 percent of all

companies also kept a list of critical

suppliers that were watched with spe-

cial attention. As a rule, this list had

no more than 60 names, selected on

the basis of criteria like risk of business

interruption, information security, or

the supplier’s strategic importance

(see chart on page 45).

Looking at country-specific risks also

helps in the systematic search for

weak spots in the supply chain. One

support that is available for orien-

tation and decision making in this

regard is the FM Global Resilience

Index, introduced in June 2014. The

insurance company’s risk experts

examined key risk factors like politi-
cal stability, a country’s dependence

on oil imports, and the risk of natural

disasters for 130 different countries

(see box, »The world’s riskiest loca-
tions,« page 43).

Each country earns an index score

between zero and 100, with 100

being the greatest resistance to risk.

Low index scores, on the other hand,

show that companies in that part of

the world are especially vulnerable.

The riskiest locations include places

like the Philippines (117th place):

Typhoon Haiyan at the end of 2013

provided a dramatic demonstration

that the island nation is too weak
economically – and has neither ade-
quate crisis management nor a suffi-
ciently stable infrastructure – to deal
effectively with the substantial risk

of a serious typhoon. Thailand is in

62nd place for 2014 – in other words,
in the middle of the pack. Although

the analysts at FM Global accord the

Southeast Asian kingdom credit for
good risk management for fire and

natural disasters, the index score

was pushed down by low per capita
income, political risk, and rather

weak control of corruption.

FM Global views the new index as a

data-based tool for strategically pri-
oritizing risk management and invest-

ments in the supply chain. The ranking

and index scores reveal more than just

potential weak points in the supply

chain. Purchasing managers can also

use the index in the reverse direction,
to see which countries have improved,

and therefore to identify attractive

new locations for future suppliers. The

biggest upward leap in 2014, by 19

places, was made by Bosnia-Herze-
govina. Other rising candidates are

Armenia, Kazakhstan, and Jordan.

The focus goes to the most important suppliers

Yet most companies would hardly be able
to uniformly monitor all of their

many suppliers. According to a work-
ing paper from IBM, a company on the

Fortune 1,000 List (a list of the 1,000

U.S. companies with the highest rev-

enues) has an average of up to 20,000

suppliers, with just as many contracts.

More and more companies in the

service sector are also setting up risk

management programs. For example,
a survey of 35 global companies in

the financial sector by the auditing

and consulting firm Ernst & Young

(EY) found that here too, a rising

number of purchasing departments

expend considerable effort on moni-
toring supplier-related risks. Almost

90 percent of the respondents invest-
ed in on-site inspections in 2013, and

three-quarters invested in gen-

eral inspections and better manage-

ment of their collaborations with

suppliers.

Disasters like those of 2011 in Thai-

land and Japan, as well as the terrible

factory accident in Bangladesh in

2013, have frightened even com-

panies that were not themselves

affected. The awareness is spreading

through all industries that supplier

relationships must be managed more
carefully than ever. »Companies that

know their supply chains and sup-

plier businesses very well, and stra-
tegically counteract the associated

risks, suffer interdependency losses

significantly less often and to a lesser
degree,« says FM Global manager

Hillgraf. That’s why the industrial

insurer actively supports its custom-
ers in risk management with some

62nd place for 2014 – in other words,
in the middle of the pack. Although

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places, was made by Bosnia-Herze-
govina. Other rising candidates are

Armenia, Kazakhstan, and Jordan.
Controlling risks through regional spreading

The experts hold that an early search for alternative suppliers at a variety of locations is always a part of risk-based supplier management. Purchasing decisions are a matter not just of price, but also of important risk aspects. Companies should not put all their eggs in one basket, but rather set up parallel emergency suppliers from the very start, advises (among others) Sean Correll, head of the consulting business at Emptoris in Boston, Massachusetts (U.S.). The company, which has been owned by IBM since 2012, offers consulting and analytical software for procurement systems. »A resilient supplier management program with alternative suppliers approved in advance in a variety of geographic regions is a sound foundation for managing volatility,« says Correll. It’s a strategy that Western Digital has been following since the 2011 flood: To mitigate the risk of future production downtime, it has set up new supplier capacity in Malaysia.

Supply chain management at Siemens

Purchasing volume at Siemens AG in fiscal 2013 amounted to about €38 billion – equivalent to roughly half the company’s total sales revenues. Supply chain management undergoes constant optimization, with uniform processes applied to quality, logistics, and production, pooled negotiating power, and a focused supplier base. A Siemens Procurement Council reports directly to the member of the Managing Board in charge.

This is how companies distinguish critical suppliers from noncritical ones

<table>
<thead>
<tr>
<th>These criteria make a supplier critical</th>
<th>in %*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of business interruptions</td>
<td>90%</td>
</tr>
<tr>
<td>Information security risk</td>
<td>83%</td>
</tr>
<tr>
<td>Regulatory risk</td>
<td>72%</td>
</tr>
<tr>
<td>Strategic importance</td>
<td>72%</td>
</tr>
<tr>
<td>Contribution perceptible to customers</td>
<td>72%</td>
</tr>
</tbody>
</table>

*Multiple mentions possible
Source: EY Financial Services Supplier Risk Management Survey
Modest, gentle, interested – and extremely successful.

He’s been one of the world’s super-rich for a quarter of a century: Li Ka-Shing of Hong Kong. An immense industrial conglomerate – from port facilities to supermarkets and real estate to telecommunications – has made him very wealthy indeed. But the 86-year-old wouldn’t dream of retiring. He’s currently showing an increasing penchant for high-tech investments.
Josh Tetrick, the founder of biotech start-up Hampton Creek Foods, served him scrambled eggs a few weeks ago. The last time this young entrepreneur was in Hong Kong, the aging billionaire wanted to find out for himself how close Tetrick’s company has come to its research goal of completely replacing eggs with plant products for culinary uses.

Li has invested US$15.5 million in Hampton Creek Foods through his technology investment platform Horizons Ventures. The development project’s aim: to bypass costly, plant-eating chickens and offer the world an economical, totally plant-based alternative to eggs. But Tetrick himself isn’t satisfied yet – the product is too dry and tastes too much like plants. Back to the laboratory.

A foundation in industry and real estate

That’s hardly likely to affect Li’s appetite for technology. Admired for decades in his home town of Hong Kong for his unerring business instincts, the billionaire made his fortune in class industrial ventures. Plastic production, port transshipment, energy companies, and retail were among his major investments – and over and over again, real estate. The Hurun Report, a Chinese analog to the Forbes list of the richest people in the world, most recently put his fortune at US$33 billion.

That places Li 12th in the world – ahead of people like the heirs of the U.S. Walmart retail empire and Facebook founder Mark Zuckerberg. It also makes him the richest man in Asia. But he doesn’t see his mature age and massive fortune as any reason to sit back and rest. Instead, for the past several years he’s been investing in a portfolio of newly established technology firms – and with considerable success.

An early investor in Facebook

It took him only a few minutes late in 2007 to decide to invest in Facebook, Li mentions offhandedly. Though the social network was still making almost no revenue, its rising user numbers and its usability on mobile phones were instantly interesting to him. He considered the bet worth US$120 million up front, which he then added to over subsequent months. And when the company went public for billions in 2012, he raked in a mighty profit.

Li invested in the Siri voice recognition system long before Apple took the company over; he invested in loss-making voice-over-Internet provider Skype before eBay made its move; and in news-reading summary app Summly – the creation of founder Nick D’Aloisio, barely 15 years old – before Yahoo bought in. Music streaming service Spotify, the Maze navigation system, the online comic Bitstrips – Li was in on them all.

Learning more important than earning

»Making a business from these investments is secondary,« said Li in one of his very rare interviews, explaining the motivation behind his tech investments. »It is much more important that we are learning so much.« An area that Li is especially interested in at the moment is replacing animal products so as to conserve raw materials and protect the environment – while at the same time getting supplies to more consumers thanks to cheaper prices. A few weeks after he bought into Hampton Creek Foods, he acquired a stake in Modern Meadow, a U.S. start-up that is making leather and meat in the laboratory.

But Li is concerned about more than just understanding technology better in order to stay in the vanguard of innovation and expand his fortune. He has a deep interest in education and continuing education. For decades, the tycoon has been spending a substantial chunk of his fortune on projects in education and health. Through the Li Ka-Shing Foundation, which also receives the profits from Horizons Ventures, he has funded projects worth €1.4 billion since the charity was founded 30 years ago.

You can see how much the foundation and its goals mean to him from the fact that he likes to call it »my third son« – alongside Victor and Richard. One of its major projects is Shantou University in the southern Chinese province of Guangdong, near his native town Chaozhou. Though he never finished school himself, he has provided generous support for medical research and libraries at universities from Cambridge to Berkeley to Singapore. And he has often spontaneously donated millions after natural disasters like the southeast Asian tsunami of 2004 and the severe Sichuan earthquake of 2008.

The difficulties of life barred the way to that kind of education for the billionaire when he was young. Like a good many of his fellow tycoons in Hong Kong, young Li
arrived in the former British Crown Colony as a refugee. His father, the director of an elementary school in Guangdong, was trying to keep the family safe from advancing Japanese troops in the early 1940s. The Japanese overran Hong Kong less than two years later. Li’s father fell ill with tuberculosis, and by that time the family was so poor they had no money for doctors or medicine. His father died. »The worst experience of my childhood,« Li recalls.

The burden of poverty and the bitter experience of helplessness left him permanently asking the questions that still drive him today: Can you rewrite your own fate? Can meticulous preparation increase your chances for success?

In any case, Li knows how to make the most of an opportunity. His rise from a penniless immigrant to a top businessman is like something out of a fairy tale. After leaving school at 14, he joined an uncle’s business in plastic production. In 1950, with very little capital, he founded a company of his own. He named it Cheung Kong, the Cantonese name for the Yangtze, China’s longest river, whose many tributaries and arms are a symbol of the importance of business partnerships.

**Plastic flowers build a worldwide corporation**

Li quickly had Cheung Kong specialize as a maker of plastic flowers for export. The flowers were a success, and Li became one of the biggest vendors in the world. A few years later, when his landlord raised the rent, Li had more than enough profits to buy the production facilities. It was the beginning of a successful career as a real estate developer, which is the source of many large fortunes in the Chinese Special Administrative Region.

In past decades, Li has always been alert to good moments for new business – whether during the riots incited by Maoists in the 1960s or when investor confidence collapsed during the negotiations for the city’s return to China 20 years later.

**Economic and social triumph**

In 1979 he achieved what amounted to an economic and social triumph: He acquired a substantial interest in Hong Kong conglomerate Hutchison Whampoa, making him the first Chinese investor in one of the great »hongs,« the city’s old, established commercial firms. With Cheung Kong and Hutchison Whampoa, he soon came to control two of the city’s biggest business empires. On top of that, he had investments in port operations, retail, the hotel business, and telecommunications, which he expanded with more investments year after year. The principle of concentrating on a core business – to which Western companies so often declare their loyalty – has not been much in evidence so far among the great business dynasties of the Far East.

While Li uses Horizons Ventures as a vehicle for his investments in technology, Hutchison Whampoa and Cheung Kong focus on classic segments of industry and trade. Early in 2014 Li negotiated a takeover of Australia’s Envestra pipeline corporation for US$2.2 billion. A large operator of parking lots in Canada was worth US$320 million to him.

These acquisitions are part of the infrastructure emphasis that Li has been pursuing in Europe for some time now. In 2010 he bought British electric utility UK Power Networks for US$9.1 billion. In the next two years he acquired English drinking-water and sewage specialist Northumbrian Water and the third-largest mobile phone service in Austria.

Li benefited in grand style when the People’s Republic began to open up economically under Deng Xiaoping in the 1980s and noteworthy numbers of foreign investors were allowed into the country for the first time. Step by step, he expanded his sphere of influence into Hong Kong’s vast hinterlands: He now has trading firms, real estate, and port facilities there as well. But even in those days, he’d already been at the top for some time. When Forbes magazine published its first list of the super-rich in 1987, Li was already on it.

**Modest, disciplined, and hard-working**

Despite his billions, Li is considered modest. He views himself as hard-working, frugal, steadfast, and willing to learn. »He hasn’t changed his trademark boxy black-framed style of glasses in years. He often wears a simple Seiko wristwatch. His favorite dish is beef noodle soup. And he stands foursquare in the midst of life, working with iron discipline even today, according to acquaintances and employees. He gets up at dawn, plays a round of golf near his home in the southern part of Hong Kong Island, breakfasts on a bowl of rice gruel with vegetables, and then heads off to the office to study the international press.

Reading is essential: His thirst for knowledge seems insatiable, as though he wanted to make up for the lost education of his youth. He tries to read books on science, business, politics, and philosophy every day, he says. And when he takes one of his rare vacations, he spends the day reading.

His fairy-tale success story, his hunger for knowledge, his sixth sense for business – all of these may well have contributed to the fact that he has long enjoyed unreserved respect at home in Hong Kong.
## Heavy hitters
### The richest people in Asia

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<th>World rank</th>
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Jack Ma Yun, founder of the Chinese online enterprise Alibaba. His current assets are estimated to be worth US$25 billion since the Alibaba IPO in September 2014
The Cheung Kong Holdings web of investments at a glance

Source: Cheung Kong (Holdings) Limited Annual Report 2013
He’s admiringly called »Superman.« His word – and even more, his investment decisions – have always carried weight in a city where investments are one of the most popular hobbies. Hong Kong residents trusted his judgment so fully that a decade ago, the IPO of Tom.com, an Internet company held by Li’s conglomerate, triggered fistfights among competing investors in front of bank branches. Despite major questions about the company’s strategy and assets, its stock gained more than 300 percent on the first day of trading – and then slumped to less than one-tenth of its original value. Nevertheless, for investors there was no question: If Li is in the game, it will be a triumph.

Enthusiasm for Li wanes

And so criticism of Li has grown. The city’s residents grumble that five cents out of every dollar they spend goes straight into Li’s pockets. Last spring, when a group of port workers went on strike for a week (an extremely rare event in Hong Kong) to protest a decade with no wage increases, regular long overtime hours, and a shortage of bathroom breaks, Li became a target of anger. Demonstrators carried his effigy on protest marches through the city, complete with devil’s horns and the Chinese character for »shameless« painted on his forehead. The port workers were employees of Hutchison International Terminals, a terminal operator in Li’s empire.

Yet despite all the criticism, everyone in Hong Kong continues to watch Li’s steps closely. His opinion still carries weight. When he announced that he would be withdrawing from a number of investments in the city over the last few months, it was immediately interpreted as a signal that Li no longer believes in his home town, that the overheated real estate market was about to crash, that Hong Kong would soon become just another big Chinese city. The tycoon gave assurances that he would keep investing in the city as usual; He just expected to be investing even more elsewhere.

Son runs the day-to-day business

Officially, Li has largely withdrawn from the day-to-day business. His son Victor Li Tzar-Kuo, 50, runs affairs. Younger son Richard Li Tzar-Kai, 47, does hold shares of the family fortune, but has also built a small empire of his own: He’s primarily interested in telecommunications and Internet companies. At the moment, through his Pacific Century Group investment company, he’s building up the insurance company FWD in Southeast Asia.

But Li’s sons’ positions in management and their business activities are no indication that he is getting ready to retire. He continues to sit on the boards of Cheung Kong, Hutchison Whampoa, and his foundation, pulling strings behind the scene. And presumably to fore-stall rumors, he regularly emphasizes how fit, healthy, and eager to work he is. In part thanks to his successes with Horizons Ventures, »If you invest in technology, you feel younger,« he says with a smile.
Electricity, not smog

Charge 'er up: Recharging opportunities for electric vehicles are still in short supply in many areas. Germany, for example, has only about 4,500 recharging stations nationwide so far, compared to more than 14,000 filling stations.
The world’s count of motor vehicles is expected to double by 2030. Which is giving a lift to the market for clean alternative drives.

When Jörg Grotendorst has to go to Beijing on business, he can see what his work is aiming to fix even before the plane lands. The graduate engineer heads the eCar Powertrain Systems Business Unit at Siemens, developing drives for electric and hybrid vehicles. »The Chinese capital is always covered by the same drab yellow blanket of smog,« he says. »Even from the air, you can see it’s one of the most urgent problems of the city and of our whole era – air pollution.«

One of the main causes for the smog is cars and delivery trucks. About 95 percent of today’s traffic depends on fossil fuels. The resulting emissions are contributing more and more toward air pollution all over the world. Today, there are already nearly a billion motor vehicles, and about 70 percent of them are passenger cars. Experts expect the figure to double by no later than 2030.

The numbers show how urgent it is to find alternative drives. Government and manufacturing in many countries are investing immense sums in developing electric drives, batteries and infrastructure solutions. For example, Germany’s government is aiming to get at least a million electric cars on the country’s streets by 2020. They’re intended not just to make traffic quieter and reduce emissions, but also to serve as mobile electricity storage, making better use of the fluctuating supply of renewable energy from wind and sunshine.

China powers up

Other countries are also pushing the idea. In May 2014, eight states in the USA agreed to reach a target of 3.3 million licensed »zero emission« cars by 2025. At the Auto China trade show in Beijing, the electric car was one of the featured themes in 2014. The Chinese government is promoting electromobility with subsidies and by restricting licenses for conventionally powered cars in many cities.
Zetsche thinks vendors like Tesla can become an »additional nail in the coffin« of auto companies that don’t invest heavily enough in alternative drives.

Premium segment leads the way

One interesting wrinkle in Tesla’s strategy is that even though co-founder and CEO Elon Musk is known for his desire for change, he’s still been taking the automotive industry’s time-tested path to market penetration. Innovations are first introduced in expensive cars, production is optimized, and cost is lowered. Only then are lower-priced models offered for the mass market.

But contrary to their usual practice, the established automotive corporations have so far been approaching electromobility primarily through small cars and the compact class. Since buyers in this segment are fairly price-sensitive, that leaves the makers less financial leeway for development, and makes it harder to innovate.

Infrastructure is the stumbling block

But in any case, successful electromobility concepts include far more than replacing internal combustion engines with battery drives. The real obstacle to market development is the problem of infrastructure. In addition to long recharging times, many buyers are still frightened off by the wide variety of plugs and payment systems, and the scarce supply of recharging opportunities.

Take Germany, for example. According to the German Association of the
Smog is a constant problem in China. Exhaust gases are adding more and more air pollution around the world.
Innovation | electric car

The world’s largest carmaker thinks the fuel cell car is the most sensible e-car option for the mass market. The cable-free fuel cell vehicle (FCV) generates the electricity it runs on from a reaction between hydrogen and oxygen, and will go into series production in April 2015, initially for Japan, but starting that summer for the European and U.S. markets as well.

Hydrogen as a new power source

It’s true that making a hydrogen infrastructure available and raising customer awareness are still a big challenge, concedes Karl Schlicht, executive vice president of Toyota Motor Europe. But thanks to successful hybrid cars, he thinks, we now have the necessary experience to establish a new technology on the market. In Europe, fuel cell vehicles are to be introduced step by step at first in selected markets. I’m very confident that hydrogen will be a popular drive option for future vehicles, he says.

These and similar plans at carmakers like Honda, Nissan, Ford, BMW, and Daimler are due not least of all to the fact that increasingly rigorous limits on pollutants and CO₂ can be expected in the years to come – and will refer to the average figures for each manufacturer’s entire fleet. It’s not likely that the targets can be met by conventionally driven fleets alone.

Smog in metropolitan areas is likely to result more and more often in prohibitions on gasoline or diesel engines all over the world. If makers and governments are devoting a lot of attention and cash to alternative drives, that’s also due in part to the fact that conventional internal combustion engines will get more and more expensive if they are going to meet the general demand for lower consumption, says Siemens manager Grotendorst. For example, by 2020, carmakers in the EU must lower the CO₂ emissions of the vehicles they sell to 95 grams per kilometer driven.

Although a lot of questions still remain to be answered, experts agree that the global market for electric cars will continue to grow. There’s no way around alternative drives, Grotendorst thinks. For most consumers the entry will be through hybrid vehicles: They’re a good way of getting to know the potential of electric drives.
I firmly believe in electromobility.«

Jörg Grotendorst, CEO of Siemens eCar Powertrain Systems, explains how Siemens is getting positioned in a market of the future.

What’s your estimation of how the market for electric cars will develop?
I firmly believe in electromobility. The reasons for it to expand are compelling, whether we’re talking about the finite supply of fossil resources or air pollution and the global CO2 problem. The crucial impetus for this market is going to come from government – it was no different for such things as safety belts, three-way catalysts, and soot filters. The mass market won’t develop until legislators make the technology a requirement. Relying on consumers’ voluntary willingness to help reduce environmental pollution won’t be enough. If you have a choice between wider tires or an electric motor, you’ll often make your choice based on looks and your own pleasure in driving.

And what are the market opportunities for Siemens?
For our company, the electromobility market is an exciting, important field – because of its immense growth potential, the high pressure on costs and quality, and the rapid speed of innovation in the automotive industry. And we also can benefit from our experience in this fast-moving, highly competitive segment when we do business in other industries – such as industrial drives for large machinery.

How is Siemens positioning itself in this market?
Along with the infrastructure business, we’re counting primarily on electric drives. There we can contribute a century’s worth of experience in drive technology. And for the time being, we don’t view electric drives as a competitor with the internal combustion engine. Even if most people use their cars mainly for short trips, they don’t want to give up the option of sometimes driving off on vacation. As is so often the case, people want to have their cake and eat it too: a car that has both a fast engine and a long range. Here hybrid cars are a good solution – not least of all in overcoming consumers’ reservations about electric drives.

What specific solutions are you offering?
In addition to electric recharging stations and what are sometimes called »wall boxes,« which can upgrade a home carport to a private recharging station, we make converters, rechargers, and high-performance electronic motors for the automotive industry. We’re constantly at work developing those products further in close cooperation with our customers. For example, we’ve developed prototypes for inductively charging electric cars – a solution that we already have in series production for buses and automatic fork lifts.

How important are corporate partners for Siemens in electromobility?
We approach our commitment with a systematic strategy that focuses on partnership. That’s evident from the various stages of the partnership we initiated with Volvo in 2011 to develop electric cars – from the acquisition of Semikron subsidiary VePOINT, which develops innovative high-performance electronic solutions for hybrid and electric automotive drives, to our recently launched joint venture with the Chinese automotive corporation BAIC. We want to pursue the path toward the e-car in the future as well, as a significant supplier. Our strategic cooperation with Volvo, for example, will yield the first series production of electronic drives for Volvo’s C30 line. And Siemens is a principal supplier for the electric drive train in Volvo’s new SPA drive platform. That hybrid drive concept will be installed for the first time in the new Volvo XC 90, which will come out at the end of this year.
Computers can recognize emotions.«

Machines that respond to users’ needs and moods will bring about a fundamental change in production and consumption, according to IT professor Elisabeth André. She explains in an interview how computers are beginning to understand us better and better.

Robot dogs are both toys and a topic of research. What’s of interest is the technology behind them, which may also be usable in industry.
People immediately perceive someone else’s feelings. Can a computer do that?
Very probably, yes. Some time ago, Berlin Technical University had professional actors say the same sentences inflected with seven different emotions. Our computer program identified the emotions with a success rate of nearly 80 percent. A human being doesn’t do any better. But this high recognition level also has to do with the actors, who are able to express their emotional states with special clarity. Recognizing emotions in a real everyday situation is an incomparably more difficult task.

This branch of research is known as »affective computing.« It’s about computers detecting and interpreting emotions and human conduct and responding to them.
Why are you working in that area?
Someday in the future, a computer might be able to make fundamental changes in certain processes, both at work and at home. Today we often don’t think of a computer as just a machine, but rather we expect it to understand us and respond to us to some degree. People react to computers, and especially to robots, in ways similar to how we act when we’re dealing with a living thing. Let’s say I ask someone to hit a robot that can express pain – whether by whimpering or distorting its face. Most people will refuse to go along with the request.

Why is that? After all, they know it’s only a machine.
When we interact with computers and machines, we also appear to unconsciously attribute a social role to them. It can get to the point that we maintain standards of politeness toward computers and transfer cultural prejudices to them – even gender stereotypes. My colleague Clifford Nass at Stanford University has noticed that people are better able to assess a computer program that concerns social topics if the content is conveyed in a woman’s voice. People automatically attribute a gender to these computers.

What’s the prerequisite for a computer to be able to interact with us in what could be called a »human« way?
It has to evolve as far as possible in three areas. First, its sensors have to be able to detect what its interlocutor is doing, and how. So if I smile or speak in a cheerful tone of voice, the information about my tone and facial expressions should also be conveyed to the computer, for example, via a camera and a microphone.

In a second step, the computer needs to be able to interpret that information. A somewhat higher pitch, with the corners of the mouth turned upward, for example, can be interpreted as cheerfulness. Maybe the computer would draw on other data, too – like the fact that someone had made a joke shortly before. That gathering and interpretation of data and information represents the first steps toward a kind of emotional intelligence for machines.

And finally – and this is the third step – the computer has to be able to respond. In other words, ideally it has
to be able to express itself, or send its own signals, so that two-way communication can develop.

Has the field already advanced far enough to provide computers with adequate communication skills?
Technology is evolving fast in that direction. Just sensor capabilities alone have improved immensely in the past few years. Take camera prices, which have dropped significantly. A few years ago, for example, an »eye tracker« – a camera that follows where we’re looking – still cost more than €20,000. But now you can get high-performance models for less than €150. Robust gesture-detectors, which likewise still cost thousands of euros several years ago, are now standard equipment on many everyday game consoles. There are also a lot of sensors that a computer can rely on, so to speak, as sensory organs: microphones, pressure sensors, pulse meters, thermometers, and of course cameras. But the software supporting them – for example, for reading emotions from a tone of voice – has also improved a lot in the recent past.

Unfortunately, I didn’t come across any of that when I called a hotline just lately. The computer didn’t understand me for several repetitions – and at some point I just ran out of patience. That certainly must have been evident in my voice, but the computer didn’t react.

That could be different in just a year from now. Most developments are still being tested in the laboratory, but they have only a short way to go before they go into broad application. Detecting emotional language is now so far advanced that it’s possible to use it at call centers. For example, if the computer identifies especially excited and angry customers, it could put them through directly to a human employee. Detecting extreme emotions like anger or rage works pretty well by now.

How well?
That depends in part on the level of detail with which the computer can assess the person it’s talking to. If there are four clearly distinguishable emotional categories like cheerful, sad, angry, and neutral, the computer can often get it right 80 percent of the time. But if you have, say, eight more finely differentiated categories, the computer is wrong most of the time. To create an application that can work successfully in practice, it’s important to appraise a computer’s abilities realistically, and make the best use of them.

What would such practical applications be like?
Affective computing methods might be used in the near future for things like safety in road traffic. We’re already not far from using onboard computers that can find out what the driver’s mood is, or whether they’re tired. That might use an eye tracker, for example, that watches where the driver is looking, or a voice analysis. And pressure sensors in the driver’s seat can already detect the driver’s level of physical tension. Likewise, pressure and temperature sensors in the steering wheel can tell how tightly or loosely the wheel is being held. If anything suggests fatigue, the onboard computer can ask a question, or simply turn up the music, or maybe change the kind of music that’s playing.

Computers are now also playing an increasingly central role in production. Can the findings of affective computing be used here too?
Absolutely. Of course, you could also conceivably apply the findings in the office or factory. How are we sitting at our desk? Straight, or slouched? How badly is a worker at a production line stressing their back with their poor posture? Would it be possible to take the pressure off by raising the conveyor belt a little higher? Machines on the production...
floor of the future will be able to tell how we’re feeling at the moment. Of course, this is very private information that’s being collected: So special attention has to be given here to privacy and data protection. In part, too, because the role of machines is likely to change even more in the future than we can guess today.

**In what sense?**
Machines will adapt more to people. It used to be the other way around. Machines used to only be involved in production performance and safety. As long as the arm of the loading crane couldn’t slam a worker in the back, everything was fine. But now people are working on fine-tuning the interactions between people and machines. Humans and machines are supposed to be able to cooperate better. It’s conceivable that in the future, machines will be able to tell when an office worker is tired or exhausted, overstressed, or bored: Then, for example, they could change the temperature and the light intensity accordingly. Overall, machines will get more sensitive, and they’ll provide continuous feedback. So ideally, people will come to perceive machines more as a kind of colleague.

**How might a simple gripping arm, for example, be humanized?**
A type of arm has recently been developed that’s as mobile as an elephant’s trunk. It’s much more flexible than a classic gripping arm, so it poses next to no threat of injury. The arm’s dynamics also permit expressive capabilities that can convey the impression that you’re dealing with a social being.

**What barriers have to be overcome to make machines more ... let’s call it »socially compatible«?**
It’s true that computers are getting better and better at detecting humans’ emotional states. But they still can’t adjust their behavior to that recognition. When we talk to each other, we attune our behavior to each other. For example, people who know each other well, in particular, adjust their nonverbal behavior to each other – like the way they move their heads when they nod, without even thinking about it – and that builds a mutual sense of trust. A humanoid robot can’t do that yet. The big challenge at the moment is to make this continuous, nuanced emotional interaction more fluent.

**Can’t computers learn that over time from their human interlocutors, and improve their behavior?**
That’s exactly what researchers all over the world are working on right now. One starting point might be a computer-based tutor that recognizes when students are frustrated because they did badly in their classwork. The tutor can then either encourage the students to keep going, and offer easier tasks as an incentive – or it could give them a good talking-to and encourage them to prepare better. But we can also conceive an electronic tutor that tries out multiple methods and can learn independently through a reward system to determine which one works better. If students do better the next time, the computer has achieved its goal, and the method it tried with them will be used more frequently in similar cases. Of course, the prerequisite for all that is that the computer must have a certain repertoire of modes of behavior.

**How many emotions can a computer or a machine display today?**
Quite a few. In therapy for Alzheimer’s, for example, stuffed toy seals are being used that can show emotions very credibly – like pleasure when they’re petted. And a colleague of mine in Belgium recently taught computers to laugh, and I don’t think it sounds bad at all. People are also working on entirely new forms of expression. At one research institute in France, for instance, they’ve just studied the emotional effect of air streams that a computer intentionally generates. A stream that expresses anger is violent and irregular. One that expresses pleasure is gentle, like petting. It sounds a bit esoteric, but who knows? Maybe someday a computer will teach us whole new forms of human communication.

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**Elisabeth André**

Elisabeth André is a professor at the University of Augsburg, where she heads the Department of Multimodal Human-Technology Interaction at the Institute for Information Technology. Under her guidance, the department’s scientists are researching device-based topics using mobile hardware, eye-tracking systems, contact-sensitive surfaces, biosensors, and robots as well as software-based concepts like behavioral and group simulations, game development, learning systems, and virtual agents.
Industry Journal has been looking at current international books on management and has found some interesting new titles.

**Six Simple Rules**
*How to Manage Complexity without Getting Complicated*
Yves Morieux, Peter Tollman
English, 240 pages, from about US$20

Companies and their managers are finding the world more and more complex. They have to meet higher and higher expectations for performance, which often conflict with one another – for example, offering uniform services worldwide while meeting local needs, or producing high-quality brand products at low cost. Don’t despair, says author and corporate consultant Yves Morieux. After all, complexity also brings opportunities, provided a company remains fast and agile enough to take advantage of them.

According to Morieux, the real curse is not external complexity but the complexity that businesses create internally for themselves. This develops when managers attempt to address an increasingly complicated environment with cumbersome organizational structures, sprawling volumes of rules, and rigid procedures – in other words, with outdated, inefficient, and irrelevant management attitudes and practices.

Morieux has six simple rules for frustrated managers who feel like they’re spending too much time on unproductive reports and meetings. The goal: to strengthen autonomy and cooperation among the team. Both of these qualities are essential in a complex world so that employees can perform their work as independently as possible, and willingly support and complement one another. Of course, much that looks simple and obvious on paper can be hard to put into practice, but numerous specific tips and examples from this consultant’s practice make the book worth reading. At the very least, Morieux’s observation that many companies create their own problems for themselves offers important food for thought.

* Yves Morieux is a partner at the Boston Consulting Group in Washington, D.C., and heads the BCG Institute for Organization. The Complexity Index he helped develop shows how complicated everyday work is for management today.

**The Silk Road Rediscovered**
*How Indian and Chinese Companies Are Becoming Globally Stronger by Winning in Each Other’s Markets*
Anil K. Gupta, Girija Pande, Haiyan Wang
English, 304 pages, from about US$25

More than 2,000 years ago, the Silk Road was already a heavily traveled trade route. It linked China and India, then as now two of the world’s most important economic and cultural areas. Professor of management and globalization strategist Anil K. Gupta chose the title of his latest book to remind us of the historical importance of that legendary channel between East and West – because he believes that soon the economic relations between China and India will again become one of the world’s most important bilateral connections. By 2025, these two emerging Asian markets could well join Japan and the U.S. as the four biggest economies in the world.

Together with his well-known co-authors Girija Pande from India’s Apex Avalon Consulting firm and Haiyan Wang from the China India Institute, Gupta analyzes the expanding business relationships between Chinese and Indian companies. He presents cases of well-known companies as readily understandable examples of how Indian companies have developed successful strategies for the Chinese market in recent years – including Indian tractor maker Mahindra, now one of the top five in its sector in China. Or Jaguar Land Rover: The luxury brand from India’s Tata Group is likely to generate more revenue in China in 2014 than at home – or in Europe or the U.S.

Conversely, Chinese corporations like Huawei, Shanghai Electric, Lenovo, and Xinxing Heavy Machinery have recently been investing more in joint ventures, factories, and research centers in India, and are now beginning to reap the rewards of their commitment.

Summary: Worthwhile reading not just for managers at Indian and Chinese companies, but for anyone who appreciates a practical insight into multinational corporate strategy.

* Anil K. Gupta was born in India and teaches strategy and entrepreneurship at the Smith School of Business, University of Maryland (U.S.). He is considered one of the world’s leading experts and advanced management thinkers on matters of globalization, and regularly presents at the World Economic Forum.
In the era of globalization, intercultural competence has become a key qualification, and the market is well equipped with consultants on the topic – which does not make Erin Meyer’s new book any less worthwhile. The U.S. author has extensive professional and private experience in the field: She, her French husband, and their sons live in Paris, where she teaches the next generation of managers and executives from all over the world at the INSEAD international business school. And she’s led intercultural teams herself as a former manager in the pharmaceutical industry, in addition to training executives for an international personnel consulting firm to handle foreign assignments, international negotiations, and work with multinational teams.

In a relaxed, entertaining, but always knowledgeable style, Meyer draws on numerous examples from her experiences to explain how to detect the invisible barriers in the global business world – and how to get past them. The first step is self-knowledge: We’re all culturally conditioned, Meyer says. Not until we identify what’s typical of our own culture, and what distinguishes it from other cultures, can we open up, communicate, learn, and understand.

Meyer’s «Culture Map» also offers the reader a handy analytical tool. She has eight scales of culturally defining factors – including styles of communication (plain-spoken vs. elliptical), giving feedback (direct vs. indirect), handling disagreements (confrontational vs. nonconfrontational), and setting and keeping deadlines (linear vs. flexible scheduling).

The changing values on these scales yield a different profile for every culture. It’s a convenient way of working out culturally conditioned differences and commonalities between countries.

Based on numerous interviews, Meyer has situated about 30 countries on her eight scales, providing a useful aid for orientation.

* Erin Meyer teaches Organisational Behavior at the INSEAD international business school, where her duties include heading the training programs in Managing Global Virtual Teams and Management Skills for International Business.

Kelsey Young is an energetic young woman who is paying her way through business school by working at Ferguson’s – a discount where satisfied customers are in short supply. When she takes an impressive course on service quality at her university, she decides to put her discoveries from the discount into practice. Her goal: to defend the company from a powerful competitor and create a secure and exciting job for herself.

Kelsey Young and her crisis-ridden employer are fictional, but the course on service quality is real. Best-selling author and management consultant Ken Blanchard has been offering trainings for companies for more than 30 years. The Ken Blanchard Companies now have locations on every continent.

The Legendary Service management seminar has long been one of his biggest sellers, and is now available as a book. Blanchard’s core message: Employees are what make the difference between excellent service and a mediocre performance – and how employees treat customers is highly dependent on how companies treat their employees.

Successful managers understand that connection. Less successful ones can discover it in this easy-to-read, entertainingly written manual and can adjust their practices accordingly. Because – as Kelsey Young ultimately discovers – success depends on everyone.

* Ken Blanchard is much in demand as a speaker and coach, and not just in the U.S. His The One Minute Manager advice book has sold 13 million copies to date and has been translated into 37 languages.
We don’t know what the car of the future looks like. But we know how it will be built.


To ensure long-term success in the automotive market, production has to react flexibly to its changing needs. Nowadays it is about more than just the mere manufacturing process – product design, production planning, and service performance are also key factors.

Volkswagen has already collaborated with Siemens to make production more intelligent. In the future, machines will learn to communicate independently and to optimize production steps. The goal is to simplify the manufacturing of different car models. The benefits include greater flexibility, increased efficiency, and improved global competitiveness.

The answers for the future of manufacturing exist. And now is the time to make things right. Because the world of tomorrow needs answers that last today.

siemens.com/future-of-manufacturing
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