

Reliability

WE LIVE CHEMICALS!



2/2015

WHO KEEPS THEIR WORD? **WHO** THINKS AHEAD?
WHO KEEPS US SAFE?
WHO REMAINS CRITICAL? **WHO** PAYS ATTENTION?
WHO EARNS OUR TRUST?



We make chickens big and strong.
And CO₂ emissions small.

Whether you're feeding chickens or pigs, amino acids from Evonik are not only good for animals but also for the climate. In concentrated feed, they make sure that farm animals grow healthy and strong. What's more, with amino acids far less CO₂ is produced than with conventional feedstuffs. Drawing on our creative ideas in specialty chemicals, we deliver solutions for tomorrow. And harness the power of our industrial group to meet the needs of world markets.

Evonik. Power to create.



EVONIK
INDUSTRIES

"A handshake means I keep my word; you can depend on me"



Klaus Engel, Chairman of the Executive Board of Evonik Industries AG

Dear readers,



For many generations now, merchants have sealed their business deals with a handshake. The handshake symbolizes the two parties' full agreement and is more important than even the most elaborately phrased paperwork. A firm handshake means "I keep my word; you can depend on me."

Anyone who has ever been let down by a partner knows that reliability is connected with very high expectations. They have to do with integrity and honor, as well as fair and open dealings with one's business partners. In essence, it's a question of trust.

Trust is formed when individuals or companies deliver on their promises and prove that they are reliable partners, day after day. As an internationally operating chemical company that works together with many partners, we know a lot about the importance of reliability. And that's why reliability is an integral part of Evonik's corporate identity.

Our customers depend on us to deliver our products on time and in the quantity and quality that was ordered. Our neighbors and employees also rely on us to manufacture these products in compliance with the strictest safety standards. Day after day, we work hard to become even better and safer. We communicate in an open and transparent way so that people know exactly where they stand as they deal with our company. That's how we keep and strengthen the trust our business partners have placed in us.

For Evonik, reliability means being aware of our social responsibility—as a business partner, as a good neighbor, and as an employer. You can rely on us—and we can shake on that!

In this issue of *Evonik Magazine* you can find stories about people and companies that take on responsibility—so that we can depend on one another. Pleasant reading!

Sincerely yours,

A handwritten signature in blue ink, appearing to read 'Klaus Engel', written in a cursive style.

Re|li|a|bil|i|ty

MASTHEAD

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Kommunikation
An der Alster 1
20099 Hamburg, Germany
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Printing

Neef+Stumme
premium printing
Wittingen

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ORIGIN Derived from the Scottish word “raliabil,” which in turn goes back to the Latin “religare” (fasten, bind fast).

TYPICAL ASSOCIATIONS Products and services, as well as people, can be called reliable.

SYNONYMS Dependability, stability, credibility, soundness

ANTONYMS Instability, inconsistency, unreliability, incalculability

USAGE

GENERAL: People, technical devices, and materials one can depend on

PHILOSOPHY: Reliability is a positive character trait.

LAW: Reliability needs to be officially determined, for example in the case of persons who drive a public conveyance, work in areas related to security or handle weapons.



“It’s all about mindfulness. A person who is mindful turns his or her attention around: from the pleasant to the unpleasant, from the certain to the uncertain”

Kathleen Sutcliffe has investigated the secrets behind the success of High Reliability Organizations (HROs): places where tiny details can trigger catastrophes. How do people safeguard security—in hospitals, within fire departments or, as above, on aircraft carriers?

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They pay attention and take on responsibility—for themselves, for others, and for their mission. We present five people who have taken it upon themselves in very different ways to make our world a bit more reliable



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Cid Jonas Gutenrath manned a telephone at an emergency call center. What’s it like to work in a situation when suddenly every second counts?

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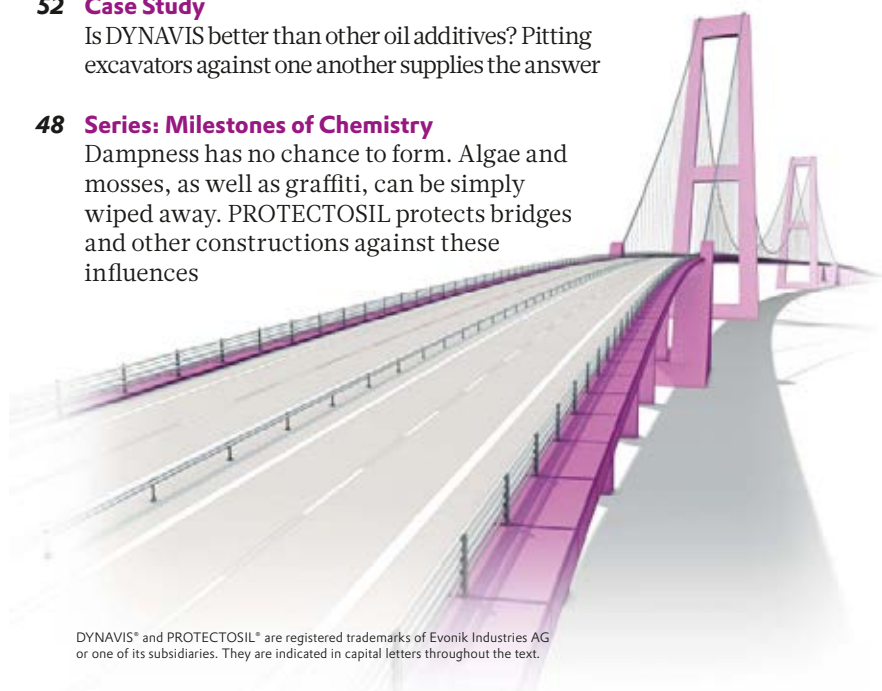
For centuries, ships ran aground, sank beneath the waves or landed far from their planned destination—until an eccentric Englishman built the most precise clock of his era

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Dampness has no chance to form. Algae and mosses, as well as graffiti, can be simply wiped away. PROTECTOSIL protects bridges and other constructions against these influences



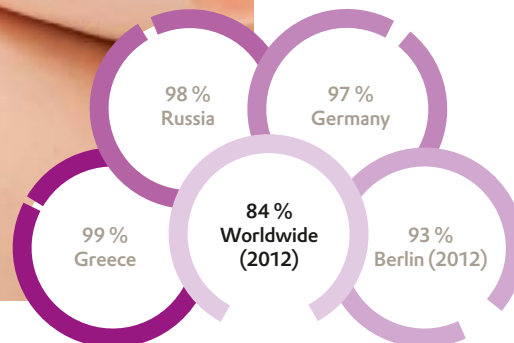
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Facts + Figures

*Little injection,
big controversy:
More and more
parents distrust
vaccinations*

The measles vaccination is considered a standard procedure. The danger of an epidemic rises when the vaccination rate falls below 95 percent

**Children vaccinated
against measles (2013)**



Source: OECD, WHO, Robert Koch-Institut

“Social Disease”: TDS— Trust Deficiency Syndrome

Trust is the glue that holds every society together. No political, economic or social system can function properly without trust. We trust the world around us, and we also trust our ancestors' achievements and their further development down through the generations. Trust is almost like an unwritten contract.

But what would happen if people began to withdraw from this contract? What happens when people begin to distrust more than they trust? Consider the current controversy over vaccinations. Those opposed to vaccinations benefit from their status as a minority. However, that benefit can quickly prove illusory, as was the

case in early 2015, when hundreds of people in Berlin caught the measles. Most of them had never been vaccinated. Experts are familiar with this tendency in the industrialized nations to forget past plagues and epidemics. Many of the same people who are willing to undergo cancer screenings have doubts about the (scientifically proven) effect of vaccinations. Perhaps we need a type of medical commemorative culture. Hardly anyone these days has experienced polio, diphtheria or smallpox, which was one of the oldest “scourges of humanity” until the WHO declared it eradicated in 1980. So, what should be done about the measles issue? The experts argue against forced vaccination, but they

advocate the introduction of a legal right to vaccination. Wolfram Hartmann, President of the Professional Association of Pediatricians, says that “when parents deny their children the right to protective vaccinations, that is an indefensible situation.”

Philipp Henneken, an infectiologist based in Freiburg, is also calling for a fundamental legal right to vaccination. “Vaccines are a fundamental achievement of modern medicine. They should be just as routine as wound disinfection and sterile surgical instruments,” he says.

PACEMAKER

42 Kilometers of Wind Shadow

Matthias Müller runs for other people—for example, Anna and Lisa Hahner, also known as the “Marathon Twins.” They like to finish in under two and a half hours, and to do this they need somebody who can keep up with their pace right down to the last kilometer. “I provide the rhythm that enables

top performance,” says Müller, a former competitive athlete himself who now works for Evonik in Worms. “The people I protect have to be sure we can keep up the pace.” Even if that means Müller must push himself to the limit. Müller also acts as a bodyguard—for example, when he keeps



Matthias Müller (right) only lets up at the end

the path ahead clear after a crowd forms at the start of a marathon. After that, he not only stubbornly maintains the agreed-upon pace but also helps out if one of the twins gets a cramp during the race. And he does all that just to be left in the dust in the end? That's not a problem, Müller says: “I do what I do out of friendship and because it's something special.”

PUNCTUALITY

Dinner at Eight?



China: 8:00 p.m.
A date is a date and should be kept. Five minutes is the maximum time someone will accept your being late



France: 8:12 p.m.
The “academic quarter-hour” is accepted here, as it is in Germany, so being 15 minutes late is all right



Spain: 8:33 p.m.
Apparently no one ever expects anyone to show up on time. Arriving half an hour late is definitely not a problem



India: 9:12 p.m.
Time is relative for Indians: They arrive whenever they arrive. However, they do expect Europeans to be punctual

3 QUESTIONS FOR

Wolfgang Krüger
"Unreliability
Is a Slow Poison"**1** What does reliability have to do with friendship?

A lot. Friendship also means being able to call someone in the middle of the night if you're having a personal crisis. We rely on our friends for security and stability, especially when we need help. This creates a foundation that endures in both good times and bad.

2 How does one stay a good friend?

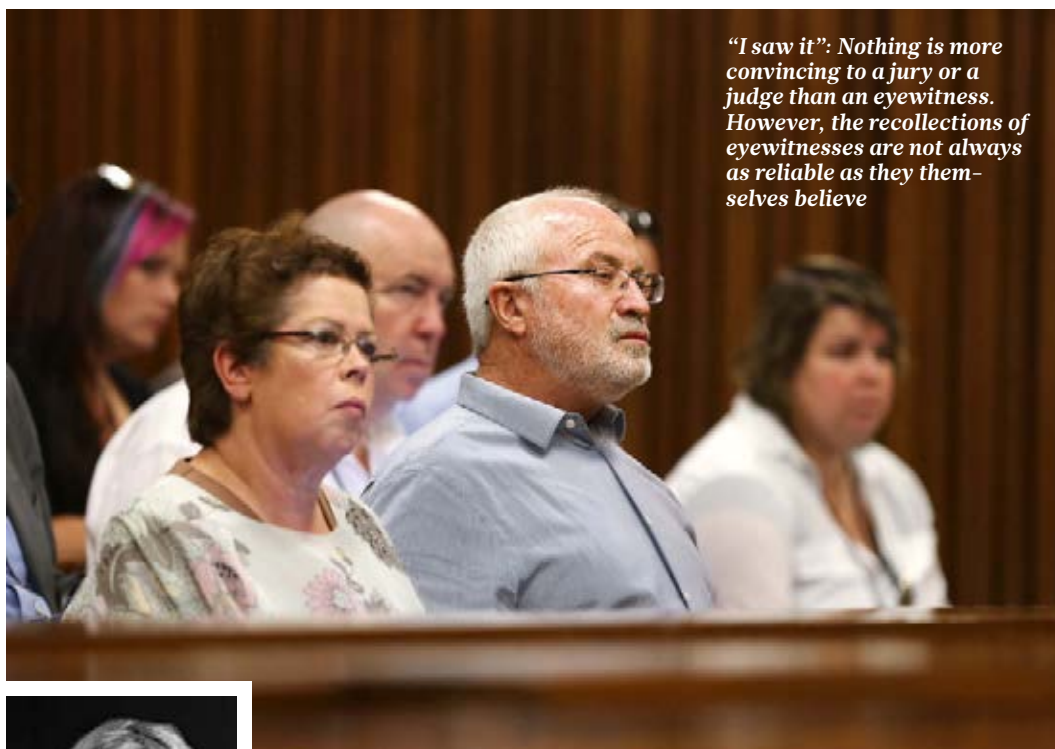
The relationship of trust needs to be maintained through contact. We should talk to our friends regularly and ask them how they're doing, and do this for a total of two hours a week. Personal encounters also remain important, even in this age of social media. Friends need to have common experiences that involve emotions.

3 What should we avoid at all costs?

Unreliability is a slow poison. Constantly breaking appointments, showing up late, or failing to keep secrets will destroy a friendship. Friends need to have the feeling that they can rely on one another unconditionally.

Wolfgang Krüger

is a psychologist who lives in Berlin. In his book *Wie man Freunde fürs Leben findet* (How to Find Friends for Life), he explains why friendship is vitally important



"I saw it": Nothing is more convincing to a jury or a judge than an eyewitness. However, the recollections of eyewitnesses are not always as reliable as they themselves believe



Elisabeth Brimacombe studies the reliability of witnesses. She knows that what we see and what we remember are two different things

IT WAS HIM! I'M SURE. OR MAYBE NOT?

I'm sure! He's the one who did it! A witness has identified a suspect in a lineup. The trial is sure to be short—that is until a DNA test proves that the witness must have made a mistake, despite the fact that he was one hundred percent certain.

"Unfortunately, such mistakes occur fairly often," says Elisabeth Brimacombe, a professor of social psychology at Victoria University in Canada. "Traces of memory are subject to many influences, which means they can become distorted or even be eliminated. A delusion then establishes itself as a real memory, and the consequences can be fatal." Brimacombe has been studying the reliability of eyewitnesses for many years and has demonstrated in various projects that people are capable of subconsciously manipulating what they observe.

One of her projects involved a robbery that Brimacombe staged in front of test subjects who were later presented with a series of photographs. Some of the witnesses identified a perpetrator—despite the fact that no photo of the person who actually "committed the crime" was included in the series. Even the use of certain words can alter memories. For example, after a police officer described a vehicle as being "totaled" following an accident, some witnesses suddenly recalled seeing broken glass, even

though there hadn't been any.

Witnesses' level of confidence is also no indication of their credibility. "Some people insisted they knew the color of the perpetrator's eyes, even though there was no way they could have seen them," says Brimacombe, whose studies are now being used by police, especially to help with interrogations and lineups.

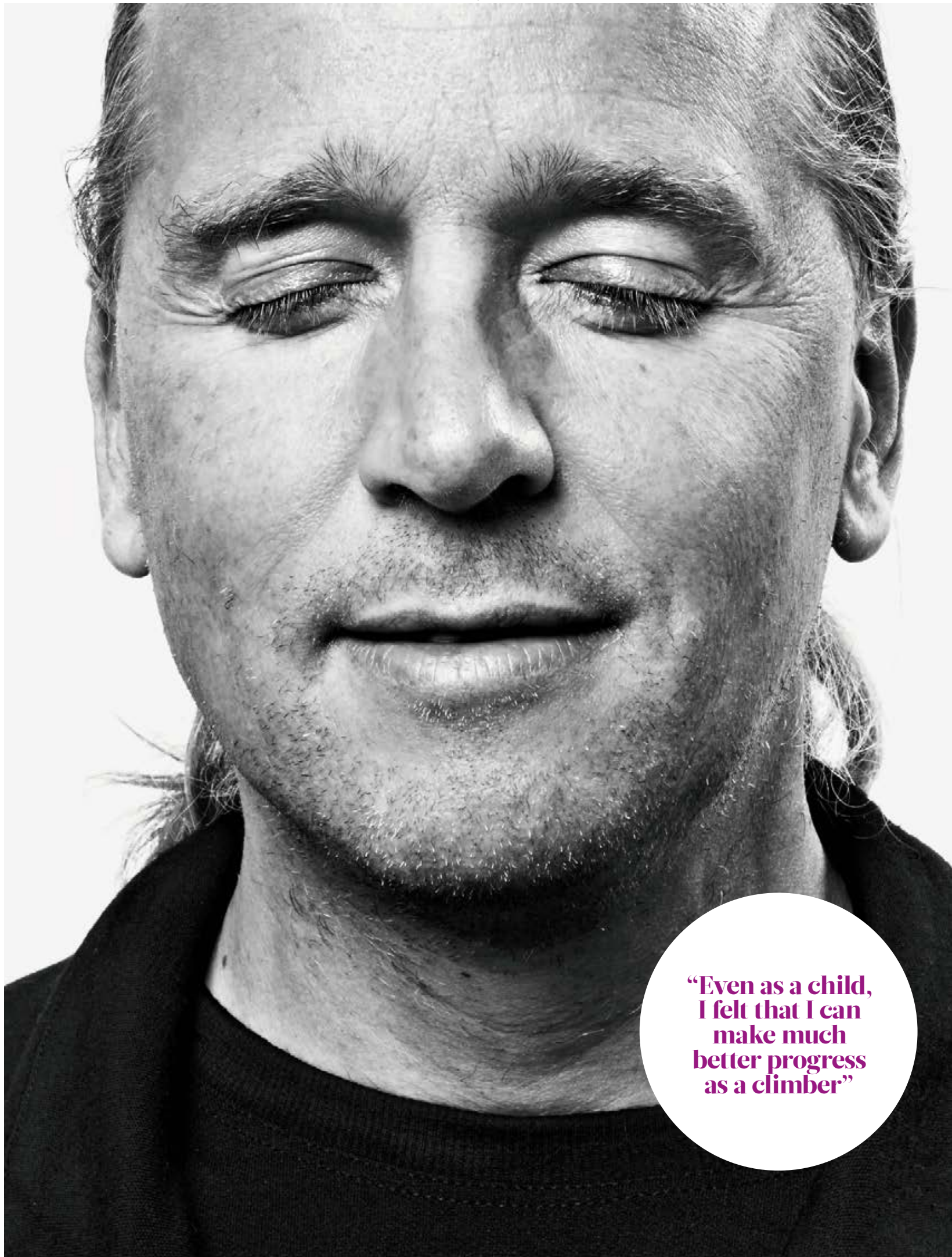
The independent "Innocence Project" initiative studied 329 wrongful convictions in the USA. The study's findings support what Brimacombe claims, as 75 percent of these verdicts were based on incorrect statements made by eyewitnesses.

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substances—from acrylamide to selenium, arsenic, and tritium—are examined daily at large waterworks to make sure their presence is within legal limits. **Drinking water** is thus one of the most monitored foodstuffs in Europe.



You can watch a presentation by Brimacombe on the unreliability of witnesses at: www.youtube.com/watch?v=rzpgyIKBS40



**“Even as a child,
I felt that I can
make much
better progress
as a climber”**

WORKING ON TRUST

They take on responsibility, sharpen their senses, are in the right place at the right time, and are always more sensitive, farsighted, and critical than others. Five people whose job is to make the world more reliable

The seer

➔ Andy Holzer is blind—and works as a mountain climber and mountain guide. When he's climbing, he relies on his hands, feet, nose, and ears.

"As soon as my hands touch the rock, I have an image of my surroundings," says the extreme climber Andy Holzer, 48. More than other climbers, he relies on his sense of touch, as well as on the sound of the scree under his feet and the

smells given off by granite or slate. Holzer, who grew up in the foothills of the Lienz Dolomites in East Tyrol, has been blind from birth. The mountains are more familiar to him than the world of daily life with all of its barriers. He trained as a

massage therapist, but he eventually gave up this career. Holzer has already climbed six of the Seven Summits—the highest mountains of the seven continents. The only one missing from the list is the highest one of all, Mount Everest. In

April, as he was making his second attempt to climb it, an earthquake shook Nepal. Local people died, and Holzer barely escaped with his life. Holzer passes along his experiences to others through presentations and management seminars,

and even as a mountain guide. His personal credo is "It may seem impossible, but you can do it." For the people he guides, it's an existential experience to rediscover their senses at the side of Andy Holzer—and, though seeing, to trust a blind man.

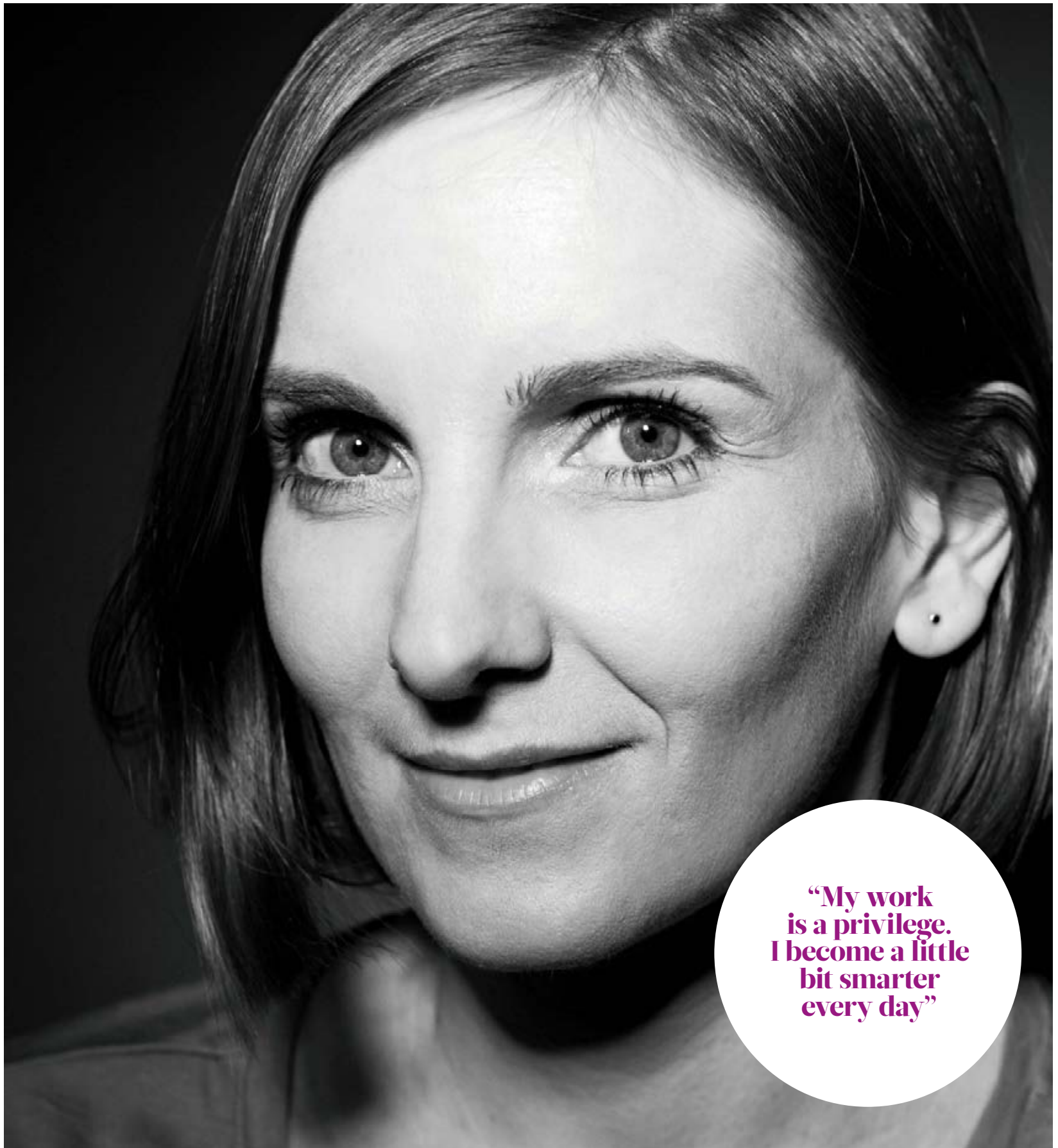


**“I translate
the craft of
a violin maker
back into
the trees”**

The listener

➔ Andreas Pahler is a dealer in wood for musical instruments. He finds trees from which to make violins and cellos that are meant to last for centuries.

Only one tree trunk in a hundred can be used to make a string instrument. Only this one tree can provide the wood for a violin that will produce an outstanding sound even centuries from now. Andreas Pahler, 42, is a man who knows how to choose this tree. “I have to have patience, look very carefully, and also listen to the wood. You need all of your senses in order to do this job,” he says. Of course he also needs knowledge. Pahler studied forestry and wood technology. He is a specialist musicians depend on. His knowledge and his experience are necessary in order to precisely register the structure and evenness of the wood, as well as the influence of the climate and the soil. Pahler’s work area is the spruce forests of his native Mittenwald region in the Bavarian Alps. The wood from these trees enjoys an excellent reputation among makers of stringed instruments all over the world. Once a tree trunk has been selected, it is left to dry for five years. It is turned almost every day, and Pahler evaluates it and listens to it regularly. To do that, he inserts a sound post into the wood and rubs it with a second sound post. “Through the vibrations I can feel the sound that the future instrument will make,” he says.



**“My work
is a privilege.
I become a little
bit smarter
every day”**

Photography: Antonina Gern

The critic

➔ Anika Zeller works for the newsmagazine *Der Spiegel*. She does research before the editors write their articles and also finds errors before the magazine goes to press. She's conscientious, painstaking,

and a stickler for details. When Zeller, 37, searches for mistakes in the editors' articles, she is unrelenting. And as a fact checker at *Der Spiegel*, she finds them every day. She originally studied Slavic languages and literatures, but today she sits side by side with

scholars from every area of knowledge: historians, jurists, economists, political scientists, specialists in Islamic studies. Depending on their qualification, they contribute their specialist knowledge to various departments. One might comment on an outdated

survey about Putin, another on the wrong year cited in an article on the history of Crimea, or the traditional name of a small town in Siberia, or some tricky transposed digits in an essay about negotiations on entry into the EU. Zeller's meticulousness safeguards

the newsmagazine's credibility. About 60 sharp-eyed fact checkers work in the editorial office. That's one for every three writers on the editorial staff. He or she checks all the facts and quotations in the finished text and also helps with the research before

and during the writing process. This system of expert assistance and final critical control is unique because of its (German) thoroughness. As Zeller says, "The editors appreciate our work, even though we sometimes really get on their nerves."

The scorer

→ Karl Malone is still known as one of the most reliable power forwards in the history of basketball.

In the USA, the men and women who deliver the mail are regarded as symbols of dependability. And during his career in basketball, Karl Malone made baskets

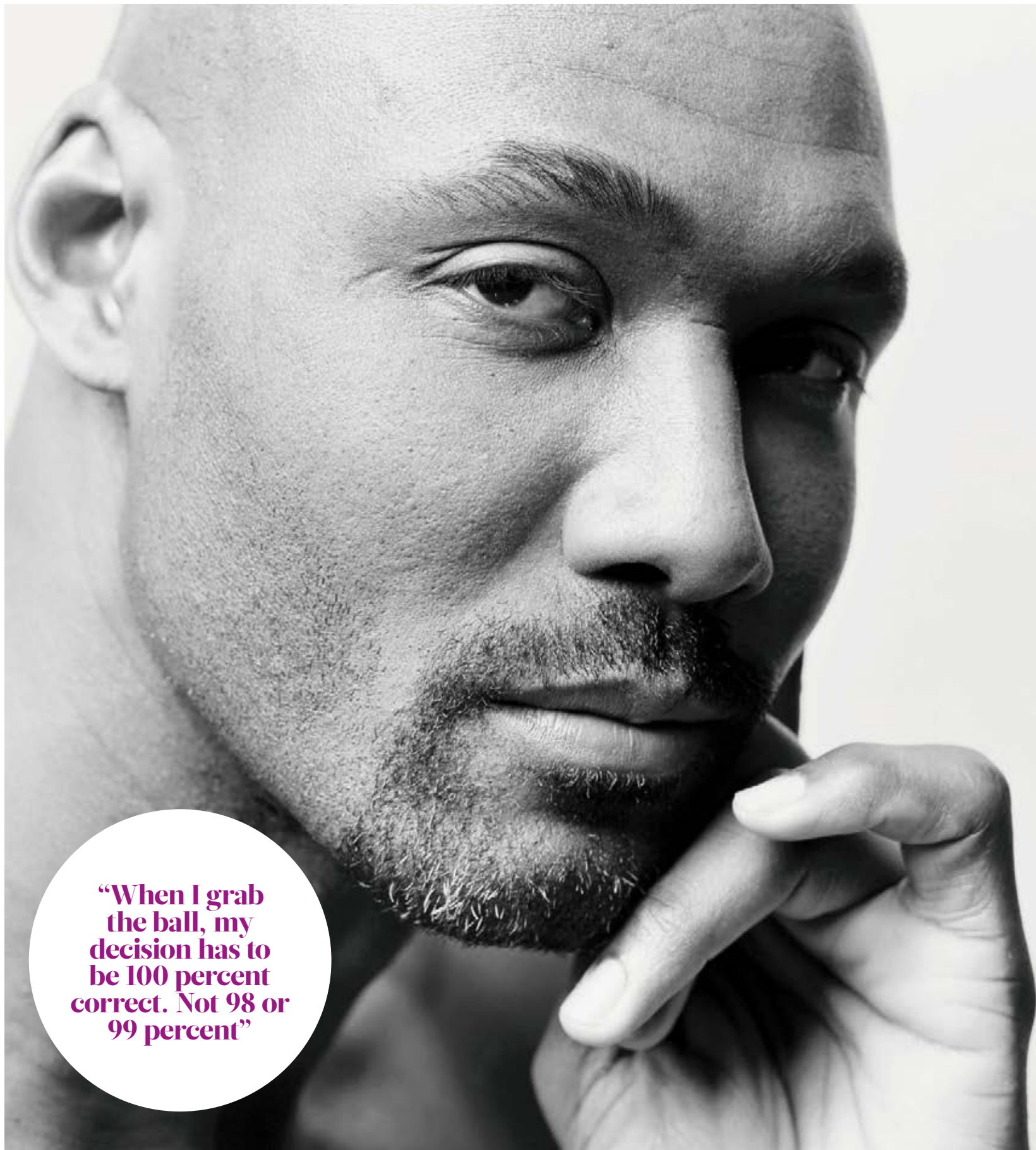
so reliably that he became known as "The Mailman." In the two decades that he played for his team, Utah Jazz, Malone, who is 2.06 meters tall, racked up almost 37,000 points.

Together with Magic Johnson and Michael Jordan, Malone was a member of the "Dream Team" whose precise passes in particular won them a gold medal at the Barcelona Olym-

pics in 1992. Malone, who is now 52, grew up in poverty in Louisiana. He eventually became one of the best power forwards in basketball, successfully shooting baskets from

the three-point line with unrivaled consistency. "I know where my physical prowess comes from," says Carl. "Other people didn't have to work as hard as I did in my childhood."

"When I grab the ball, my decision has to be 100 percent correct. Not 98 or 99 percent"





“The idea of sharing is leading to a fundamental democratization of every area of life”

The partner

→ Rachel Botsman is working to expand the “sharing economy,” whose central currency is trust.

“Would you trust me with your car? Or with your ice cream maker for my children’s birthday party?” The Englishwoman Rachel Botsman, 36, a Harvard graduate and corporate consultant, likes to ask such questions at the beginning of her presentations. They are very effective, not only because of her personal charm, but mainly because of her message. Botsman is an advocate of a new economy of sharing. From carsharing to swapping portals and new forms of neighborly assistance, ideas about sharing are flourishing. These sharing activities, for which Botsman has coined the term “collaborative consumption,” save money, save resources, and can launch tremendous economic and innovative potential. Examples include the global private-rental platform Airbnb and the ridesharing portal Lyft. “The most important currency in this new, self-organized economy of sharing is trust,” says Botsman, who acts as a consultant for governments, initiatives, and startups all over the world.

Why life should not degenerate into a lottery, or: On the credo of the social market economy

“Trust Is Based on Reliability”

Whom can I trust? Of course you can't trust just anyone. You have to reserve your trust for the people who demonstrate again and again that they deserve it. These are the people and companies that act openly and transparently and don't shy away even if we're taking a critical look at them. They are the people and companies who take responsibility and show that they can handle it. In their daily activities they prove that there's a difference between deeds and mere words. They are the ones we can rely on with confidence



Klaus Engel
has led Evonik Industries AG as the Chairman of its Executive Board since the beginning of 2009. He knows that his colleagues rely on his word—especially in turbulent times



In a complex industrial society that is characterized by the division of labor, the need for trust in one another's reliability is a key principle. Nothing works without trust, either in business or in politics. Reliability is the glue that keeps societies together. Germany's social market economy is the result of the successful historical attempt to create a new climate of trust between employees and employers after World War II in place of their hostile confrontation during the Weimar Republic. Since that time, the reliability of our social partnership has been a key pillar of our economic system. In the postwar period, Ludwig Erhard strengthened the West Germans' trust in their young democracy through his concept of a social market economy. The reliability of a stable currency and stable prices made Germany's "economic miracle" possible.

The virtue of prudence

Former German Chancellor Helmut Schmidt summed up the importance of reliability in politics as follows: "I must be able to depend on the fact that what a person tells me reflects his or her sense of the truth. I must be able to depend on the fact that a person who promises me something will do everything possible to keep that promise."

What does this mean in the realm of business? Reliability is a key requirement for business success in particular. We entrust leadership tasks to people who we believe have the power of judgment to make the right decisions and implement them through transparent strategies. In my opinion, entrepreneurial behavior requires not only reliability and strong decision-making but also the virtue of prudence. I expect people with leadership qualities to show mindfulness, respect,

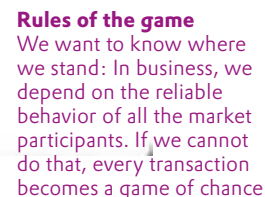
and loyalty toward their society. In recent years the financial crisis has taught us that people's trust in the reliability of market and state institutions can also be abused—even though in our business activities we are especially dependent on the reliable behavior of all market participants.

This brings us to a question: Does more regulation and control help to create trust? Yes and no. The policymakers of a social market economy must define a narrow framework for their rules in order to increase reliability. In return, the economy must be able to rely on the planning security of its long-term investments. State regulations and legislative processes should not arbitrarily change the rules of the game for the markets, as we are currently experiencing with regard to the energy transition, because that erodes trust in Germany as a business location.

I am convinced that both sides, the state and society, should once again place more trust in the market participants' sense of individual responsibility—even though some market participants still need to regain that trust in order to once again be regarded as reliable partners. There is no alternative to the market. Fair competition is the only way to release the productive forces of society.

Acting freely—within a fixed framework

The reason why our social market economy works so well is that it is far more than a legal framework. It goes hand in hand with an open corporate culture and with normative "cultures of conduct" for all its participants. This configuration generates trust, predictability, acceptance, and the embedding of business activities in a context of social responsibility. What's more, a social market economy offers us the best orga-



The advocates of a pure market economy don't have any problem with that. The founder of this philosophy, Friedrich A. von Hayek, stressed from the very start his belief that in a market economy there can be no connection at all between personal

achievement and success. He claimed that successful competition in the market depends not on ability, effort, personal achievements, or even services to society as a whole. The only thing the market economy rewards is market success. And Hayek argued that market success is determined solely by random changes in the relationship between supply and demand.

Without these qualities, our economic system, our code of values, and our social system will not be able to survive in the long term. The economic and social existence of people and companies must not be allowed to degenerate into a lottery. In the future, this promise of a social market economy must continue to be the credo held by all of us. ●



Cid Jonas Gutenrath has been a martial arts expert, a bouncer, a navy diver, an elite soldier, and an undercover investigator. After working at the Berlin police emergency call center, he transferred to the K-9 police dog unit. He is pictured here with his German Shepherd, Teddy. In this interview, he talks about reliability, split-second decisions, and the world's most dangerous weapon: language

“I’ll Save the Next One!”

When Cid Jonas Gutenrath takes a call, it’s often a matter of life and death. How does he manage stressful situations in which he might be the only person the caller can depend on?

➔ **Mr. Gutenrath, you once said that in the course of your life you could have landed in prison just as easily as in a police department. What did you mean by that? Have you actually faced that risk?**

Cid Jonas Gutenrath: Let me put it this way: I didn’t have a very pleasant childhood. What saved me was the fact that in my teens I started to do competitive karate. The team mostly consisted of pimps, who had their own code of behavior. I don’t want to make this period of my life seem better than it was, but I was always the little one, the protégé. I could depend on my adopted family; there was a kind of honor among thieves there.

Did your past help you in your work at 110, the police emergency call center?

CJG: I had worked before as a bouncer, and I was always the shortest one there. I had an existential need, so to speak, to solve problems through language. I can express myself well, and when that’s combined with some insights into human nature it’s a valuable skill. What I’m talking about is every conversation with the police, whether it’s an emergency call or a talk on the street. Language makes it possible for everyone involved to get out of the situation in one piece. That’s not something I studied, it’s life experience.

How have your years in the police department shaped your attitude toward people?

CJG: I’m a pessimist about society, but I believe in individuals. If you find the right

tone and the right words, you can reach just about anybody. Then they let go of the cynicism and the delusions of grandeur that you’re often confronted with. No individual is basically bad, I still believe that.

Every call to a police emergency call center could be a matter of life and death. What qualities do you need in order to do this work?

CJG: You need the ability to make decisions and take responsibility for them. Having even a bad plan is better than having no plan at all.

What are your top priorities in this job?

CJG: When you’re working on the 110 hotline, the most important thing is to find out where the emergency happened, whether anyone’s been hurt and, if so, how seriously. Everyone who thinks he’s had a stressful day at work should spend two hours at the emergency call center. Somebody’s always shouting, whether it’s a caller or a colleague who’s simply lost it after being insulted for the tenth time. After all, we’re the point of contact—not

only for people who need help but also for folks who just want to blow off steam.

With all that stress around you, how do you deal with an individual caller?

CJG: If I don’t know what’s going on with a caller, or if he doesn’t want to tell me where he is, I have to talk. At that point I take on various roles in order to build up a relationship. Sometimes I’m a recovering alcoholic, sometimes a gambling addict who’s been through therapy or a deserted husband. Only if it’s a case of necrophilia or pedophilia do I give that up. But I simply know that sometimes I can only make progress if I put things on a personal level.

Can you give me an example?

CJG: For example, someone calls me up and asks if I’m religious. Of course at the emergency call center we often hear the phrase “an eye for an eye, a tooth for a tooth.” To one caller, I said, “I’m a Lutheran, but I’ve made my own deal with God. I pray every evening, because I have the feeling I have to thank Him. But I’ve also stood in St. Peter’s in Rome, and today I’m still ashamed of all the pomposity and wealth that could have been used to relieve so much pain and hunger. And now tell me why you’re calling!”

Does that work?

CJG: At that moment I don’t know whether it’s going to turn out well. But the main thing is that I’m gaining time and trust. Even if it doesn’t work, I won’t let anyone die without having tried everything. As it says in the Talmud, “When you save a life, you save the whole world.” ➔

“I won’t let anyone die without having tried everything. As it says in the Talmud, ‘When you save a life, you save the whole world’”

→ **At the other end of the line you've got people who are simply complaining about their neighbors, but you've also got murderers who confess to you what they've just done or what they're planning to do. Are there any tricks you use to find out where somebody's calling from?**

CJG: If I've only got the voice and the ambient noise to orient myself by, I close my eyes so that I can be more concentrated and focused than I would be if I were seeing a fluorescent light next to me or a colleague biting into a chocolate bar. We call this method "selective listening" and we train to develop it. The results are not always at the level of a Hollywood thriller, but if I hear a streetcar or a church bell in the background, that can be important.

What do you actually depend on while the callers who are in trouble are depending on you?

CJG: I depend on my gut feelings, and they've hardly ever let me down. Science tells us that the gut is practically a second brain. I'm not a logical person. I don't like electronics and numbers too much, but as soon as something has hair and flesh I can empathize with it. And besides, at the emergency call center there are of course prescribed processes that we stick to.

How do you deal with the psychic stress if, for example, someone who's planning to commit suicide actually does it while you're listening on the phone? Do you have to take the next call right away, as though you were on a hotline for technical services?

CJG: In a case like that, you can naturally go out for a smoke or knock off work that day. Everyone would understand that. But in my opinion, it's best to immediately take the next call. I've always told myself,

"The risk of making a false decision hangs over us all the time, like the sword of Damocles"

"Maybe I can save the next one, and maybe that will balance things out." If I take this approach, then I can go on.

At the same time, you always have to think about the legal consequences you may have to face if you don't proceed exactly according to the protocol.

CJG: That's a constant sword of Damocles. You can't even think about whether you might be risking your children's education because you'll eventually have to contribute to the disability pension of the person you want to help at this moment. Incidentally, that can happen faster than you might imagine.

Do you get angry about the lack of understanding you encounter in people who aren't familiar with such extreme situations?

CJG: If a decision turns out to be wrong, society tends to punish the person who made it. But what would've happened if nobody had made any decision at all? You have to avoid thinking about that risk, otherwise you're sure to do something wrong.

Are you saying that this sword of Damocles wasn't the reason why you switched to the K-9 police dog unit?

CJG: I wanted to work in the K-9 unit my whole life, but something always interfered. Either I had my eyes set on another target or we had a baby in the family, in which case having this kind of dog around wouldn't have been the best idea. Finally my wife put a call for applications for the K-9 unit on my desk. After that I had to sit in front of a commission, and they said to me, "Mr. Gutenrath, do you realize you're competing with candidates who are half as old as you?" But I'm a former Marine and a pretty tough guy.

Have you ever regretted taking this step from the desk to the street?

CJG: Not for a single day. I'm inspired by my dog. It's magical. In his brain he has a wisdom that's a thousand years old, which we humans can't even imagine. He's got 220 million olfactory cells, and he'd know if someone had drugs in his pocket the day before yesterday. And he senses things about a person, even whether he's got a cancerous tumor growing inside him. He's always in my range of vision, and I can already see from his body language what he thinks of a person and what I have to prepare myself for. Besides, he'd always defend me, even if there were no chance of winning against a superior opponent. That moves me.

"We constantly train our muscles, but empathy and the heart must be trained too so that we can experience inner growth"

You claim that the special thing about the way you work is that together with your dog you solve problems by de-escalating them and using a "soft" method. What does that mean?

CJG: Policemen wearing bullet-proof vests and dogs wearing muzzles look as though they were in Belfast during the civil war. Both of us have done that too, but we're actually softies, and we prefer to solve problems a different way if it's at all possible.

How, exactly?

CJG: For me, it's important to guide the dog in a modern way, without a leash. Normally the dog is on a leash and is trying to intimidate the other person. But maybe that's not necessary. That's why I make the dog roll over on his back, because that makes a completely different impression than if he were standing next to me gnashing his teeth. That defuses the situation and works very well with children and adults alike.

Has your "softy" approach ever failed?

CJG: My scars may suggest the contrary, but we've never shed blood, and I'm very proud of that. After all, I'm not a crackpot, I'm simply demonstrating that this model can be successful. However, the hardliners say I've spoiled this dog.

In other words, you're saying that a calm approach and quiet words can de-escalate conflicts.

CJG: That's right. Maybe police departments should focus more strongly on communication skills. Maybe they should hire older cops, or at least shift their perspective to other aspects of training. We constantly train our muscles, but empathy, the heart, and serenity must be trained too so that we can experience inner growth.



*A man listens:
People who
dialed 110 in
Berlin often
found them-
selves speaking
to Cid Jonas
Gutenrath*



Cid Jonas Gutenrath worked for years at the emergency call center of the Berlin police force. He has described his experiences in his books *110 – Ein Bulle hört zu* (A Cop Listens) and the sequel, *110 – Ein Bulle bleibt dran* (A Cop Stays on the Line). The book he published last spring, which is called *Teddy* after his German Shepherd, is about his work in a K-9 police dog unit. He's married with three children and lives on the outskirts of Berlin



Stefan Adrian is an author (*Bluffen* and *Der Gin des Lebens*) and a journalist who was born in Austria and lives today in Berlin. This talk with Cid Jonas Gutenrath was his first interview with a policeman

A close-up, high-resolution photograph of a person's face, focusing on the right eye and the bridge of the nose. The skin is fair and shows some texture. The eye is looking slightly downwards and to the left. A white circular graphic is overlaid on the lower-left portion of the face.

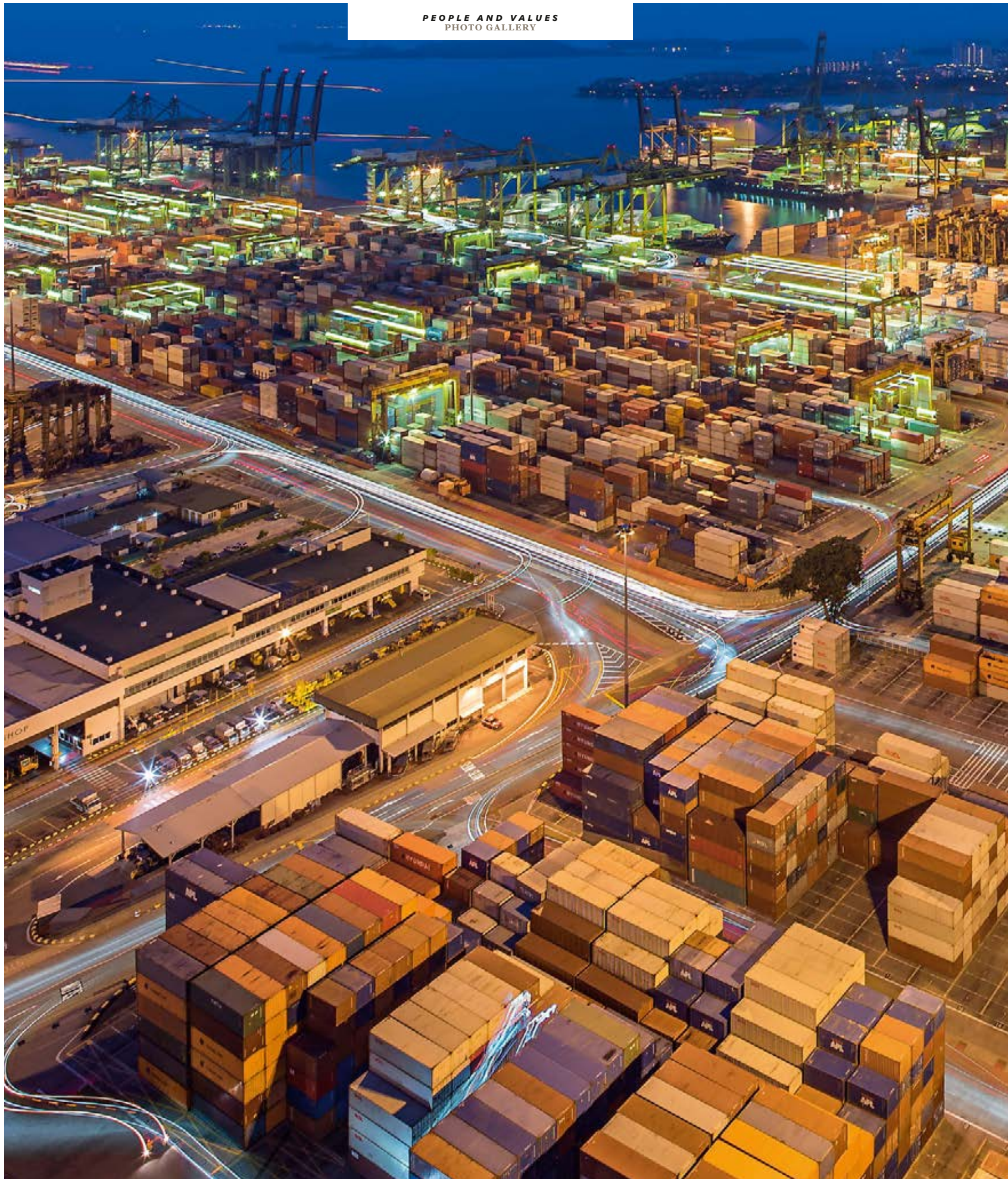
Watch Closely, Please!

Reliability requires repetition. Only after a handshake, a technology or a venture has led to good results again and again does trust start to grow. And if there's no trust, there won't be a future

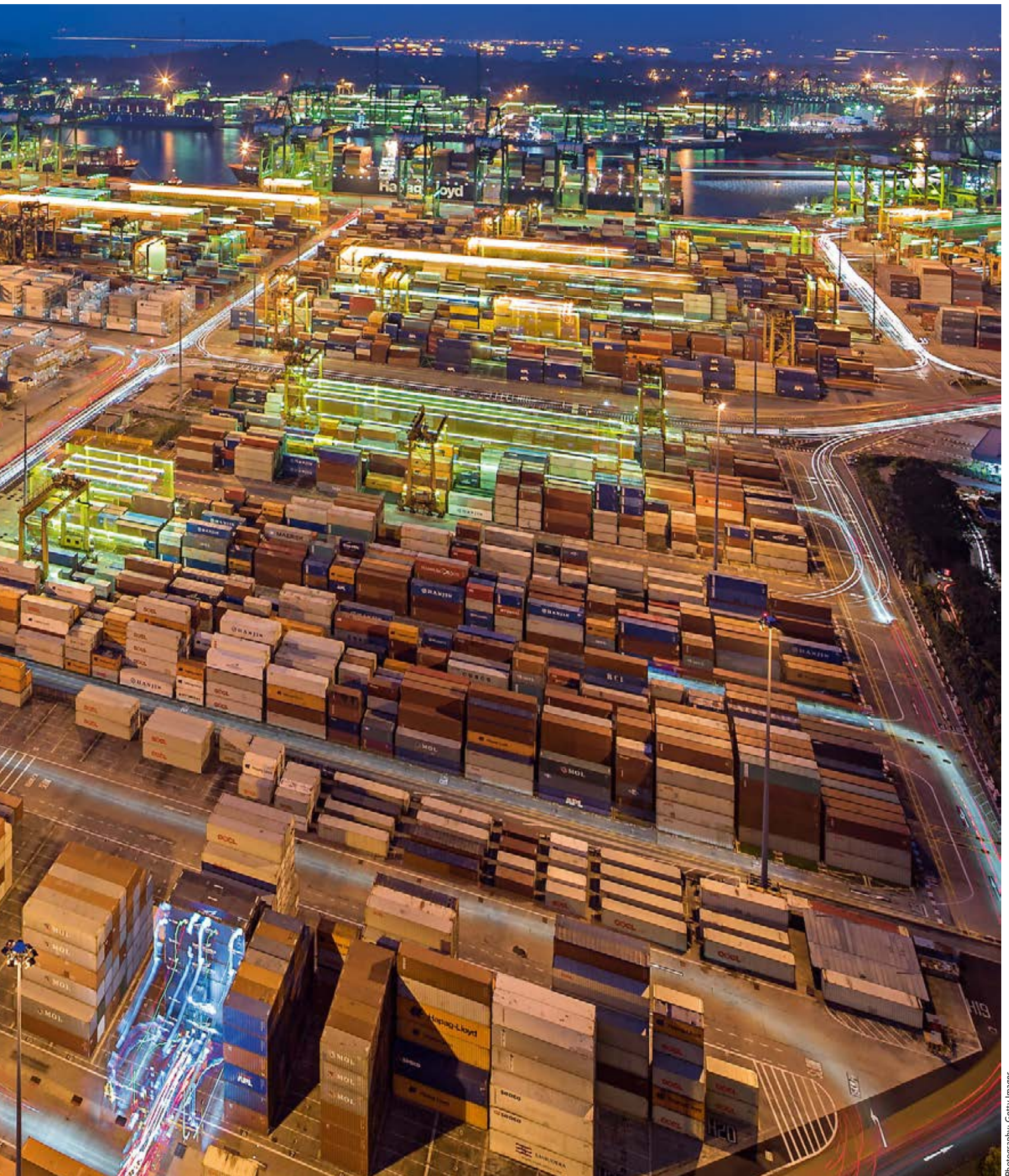


Photography: Denis Ballbouse/Reuters/Corbis

The phrase “with clockwork precision” is the highest praise for perfect work. And rightly so, because the watchmaker—a brilliant combination of an artist and a craftsman—is a pioneer of precision engineering. We can judge the quality of his work practically every second on our own wrists. But we don’t have to do that, because of course we know we won’t be disappointed



In this haystack, every needle can be found with ease. Hundreds of thousands of nearly identical containers are stored in the Port of Singapore before being conveyed to their precise destinations. The robustness of this logistics masterpiece is a foundation of global trade. Two thirds of the international trade in goods makes use of these standardized, easily transported containers



Photography: Getty Images





At the Diamond Club in Antwerp, dealers seal their transactions with a traditional handshake called the mazal, which means “good luck.” Antwerp is the oldest and still the most important trading center for these precious stones. Deals worth millions are closed here without a written contract, even in the digital age. This gesture is one of the most ancient in human history. It creates trust



The solitude of the diver under the eternal ice of the Antarctic—this idea fascinated Jules Verne’s Captain Nemo in 20,000 Miles under the Sea. It’s a state of total autonomy as well as complete dependence. The freedom that this researcher is experiencing at Cape Evans on Ross Island depends on his equipment and his certainty that his colleagues won’t let the exit hole freeze over



Photo: Science Source/mauritius images

Facts + Figures

Anna Kaiser (left) and Jana Tepe, co-founders of a job-sharing platform



JOB SHARING

Sharing Responsibility Doubles Reliability

If two people share one job, who should be responsible for ensuring that all tasks are completed, and not just pushed back and forth? Jana Tepe and Anna Kaiser are often faced with such questions. The two women offer job-sharers as complete packages.

Tandemploy is the name of their online platform. Qualified individuals looking to share a job can connect at the platform and find companies offering such jobs with corresponding working-time models. "Having

two people work the same job gives employers access to greater expertise with regard to language skills and organizational and analytical capabilities," says Tepe. Around 15 percent of all companies already offer tandem positions—in management as well.

Nevertheless, it's all still very new, so it's important to spread the word about good experiences and to allay concerns. "When one person arrives at the office on Monday, he or she needs to know what happened

on Friday," Tepe explains. "The job-sharers themselves make sure that this is the case." Reliability is the key: Power struggles and territorial thinking have no place here.

Job-sharers need to get along if everything is to function properly. That's all it takes, and according to Tepe, those looking to share a job already tend to display a great sense of responsibility. They know they will be watched—not least by the human resources department.

3 QUESTIONS FOR

Matthias Schäfer "The Trend in Spying Is to Focus More and More on People"



1 You're the Head of Corporate Security at Evonik. What issues do you deal with?

We're examining the impact unrest in Ukraine and the Middle East is having on Evonik, as well as plagiarism in China, industrial espionage, and other topics. Our job is to safeguard Evonik's corporate values, and our tasks are as varied as the threats we face. Measures here include everything from the construction of eavesdrop-proof conference rooms to the shrouding of facilities to keep them from being photographed.

2 How do you organize your work?

We ask ourselves what our competitors might be interested in. Where are we in the lead? What's our special expertise? Who and what do we need to protect? Depending on the region and the location in question,

the answers can be extremely different. That's why the measures our security people take on site are always specific to the situation.

3 What role does cybercrime play here?

Defending against digital attacks is not something we and our IT Security department only began doing after the NSA scandals broke or the "Sony Hack" was revealed. Still, at the moment we are seeing a type of espionage "trend toward people." Employees are being directly approached and attempts are being made to listen in on their conversations at trade shows, conferences, and even on the phone.

Matthias Schäfer is the Head of Corporate Security at Evonik Industries in Essen.

5 S

for reliability
in the job and
in daily life

1
Sorting: Get rid of all devices, tools, and papers you don't need. Be brutal in your analysis: Only keep those things you really need.

2
System: What's left must be organized. This makes daily access easier. Guidance systems help in stores and factories, shelves in offices. At home? You decide—but use a system.

3
Simplicity: Workplaces should be clean and tidy. This ensures safety, clarity, and an overview. Clever ideas and great projects seldom originate from chaos.

4
Standards: Internalize Steps 1–3. Develop standardized processes and automatic sequences for all activities that are repeated frequently. This will free up your brain.

5
Self-discipline: Be strict with yourself. Always return tools, documents, and materials to the same place after you use them. That's the only way to maintain your system.

Chatting devices:
Who will check
their identities?



WAITING FOR TRUST 4.0?

In the Internet of Things, refrigerators will talk to smartphones, doors, and delivery drones. Experts are working hard to develop systems for securely identifying such devices



Interesting discussion in the USA about "license plates" for drones:
<http://bit.ly/1KqXk3V>

First computers, then people, and now objects are getting connected. Today's smartphones can already be used to operate garage doors, baby monitors, stereos, and heat and lighting systems. Combined heat and power plants, gas

storage tanks, waterworks, and wind and solar power facilities now form smart grids and networks that will soon also include batteries and electric cars.

Similar networks will be established in the banking, public administration, logistics, and retail sectors as well. The more autonomously these networked helpers operate and self-organize, the more important it will

be to establish their identities. "These days, 90 percent of cybercrimes are committed by criminal organizations," says Ulrich Hamann, CEO of the company Bundesdruckerei, which produces ID cards for German citizens and ID systems for companies and facilities. "Expenditure on security technology in the USA alone rose by 24 percent last year, from US\$68 billion to US\$84 billion. Secure

identities are the key issue of the 21st century." Indeed, it won't take much to go from machine-readable ID cards to IDs for drones.

Cryptographers, IT specialists, and mobile communication experts are now developing systems for device IDs. After all, the world of computer viruses will soon yield impostor drones—and the hackers who program them.

TRAVEL

Reliable Places



Do you like things hot? Then take a trip to **Ahvaz**, Iran, where the average temperature in the summer is 46.8 degrees Celsius



Do you enjoy rain? **Mawsynram**, India, gets 20 times more of it than Berlin—11,812 millimeters per square meter to be exact



Do you prefer the cold? Then go to **Oymyakon** in Siberia, where the average temperature in January is -50 degrees Celsius



How about sameness? Then head to **St. Martin's Theatre** in **London**, where "The Mousetrap" has been running continuously since 1952

SUBMERSIBLES

Invisible under High Pressure

Two under pressure: Kirsten and Joachim Jakobsen are using a high-resolution camera to study the deep

ocean off the Azores. When conducting their research at depths of up to 1,000 meters, they need to be sure that the



viewing dome on their diving vessel can reliably withstand a pressure of 1,000 tons per square meter. That isn't all, however, since the dome also needs to be more or less invisible to enable the brilliant images the couple are seeking to

capture. Evonik Industries solved both issues by developing a dome made of PLEXIGLAS for the Lula1000 research submersible. The dome has a diameter of 1.4 meters, is 14 centimeters thick at its thinnest point, and is highly transparent.

Takehisa Abe in his Kiryu Seisen Shoji factory. The high-quality fabrics he produces have attracted Chanel, Armani, and Etro as customers

CITY OF MAKERS

Whatever they do, they do it right. And when they do something, it always leads to a new product. They call this *monozukuri*, which means "making things." Whether it's slot machines, clutches, silk fabrics or industrial machines—if they're made in Kiryu, they're the best in the world



The key to the city's development: The surrounding mountains. Abe and Kiryu Mayor Toyofumi Kameyama have a talk and a cup of tea



The roof of the Kiryu Performing Arts Center is designed like a silk cocoon as a reminder of how the city got its start

→ This story begins in the eighth century—in the mountains above a village that lies below in a valley where two rivers meet. The soft mist from the rivers rises up into the mountains, whose slopes block the wind—ideal conditions for silkworms to thrive in. The breeding of silkworms that began back then still shapes everything that happens in Kiryu today. Those who manufacture silk must be attentive, precise, and reliable. Even the tiniest mistakes can jeopardize entire harvests.

These days, Kiryu is a site for the manufacturing of electromagnetic clutches and the popular *pachinko* gambling machines, as well as research into liquid crystal films and, of course, the production of large amounts of silk. The care and precision that goes into these process has made Kiryu the world market leader in these sectors. Etro, Chanel, Armani, and Issey Miyake use silk from Kiryu for their finest collections. Liquid crystal films are utilized in solar cells, iPads, iPhones, wind turbines, satellites, and airplanes. The production machines for this (with a world market share of 40 percent) are built in Kiryu—by a company that was dyeing silk as recently as 20 years ago.

If you Google “reliability” in Japan, your first hits will always be located in Kiryu, where a large share of Japanese automotive suppliers are also based. Ogu-
ra Clutch, the world market leader for electromagnetic clutches and brakes, was named the best supplier in Japan last year by Mitsubishi Heavy Industries. Decades before General Motors, Porsche, and Volkswagen discovered Japanese management methods such as kaizen

(continuous improvement process) and began offering a globally competitive level of quality, an engineer at Kiryu University by the name of Genichi Taguchi was studying whether quality could be managed, and if so, how. As early as the late 1940s, Taguchi was interested in making products and processes more reliable and resistant to external disruptions. He also wanted to reduce costs for manufacturing companies and for society as a whole.

His “Taguchi method” ended up becoming world-famous. It now forms one of the foundations for the type of quality management systems taught at business schools around the world. It is used in six sigma as well—a famous management philosophy that has also been the subject of some controversy. Some American success stories can be traced back to Taguchi, as he also began advising companies such as Ford, Boeing, and Xerox in the 1960s.

Spectacularly unspectacular

A story can be told in Kiryu about how complex processes in the textile industry taught a region the value of cooperation in the early days of industrialization. It is a story about industrial transformation, people and factories, families and inventors, industrialists, engineers, and hidden champions, as the countless relatively unknown quality and brand leaders are called. A similar story could be told about the Swabia and Westphalia regions of Germany. Stuttgart, Bielefeld, Kiryu—these places can be referred to as centers of high quality, where one might also ask the people who live there exactly what it is that they do right. →

**“Here
in Kiryu
we love
to make
things”**

Toyofumi Kameyama
Mayor of Kiryu



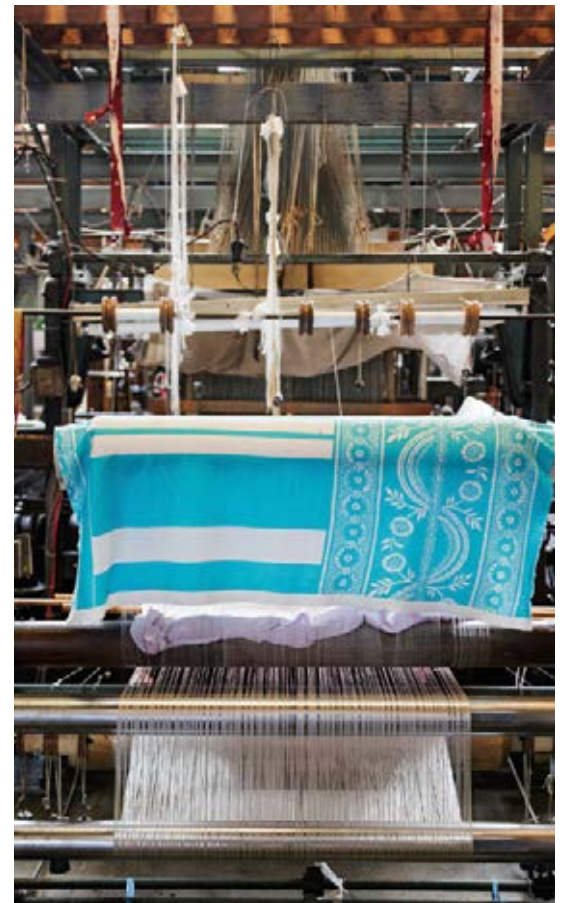
Nishi Industry uses its textile industry expertise to build machines for the production of fine films



The old weaving mill recalls the origin of Kiryu's successful development



Takehisa Abe admires the LCD polarizing films for laptops that Nishi Industry manufactures



Only connect: Kiryuvians learned how to do this from weaving

“Our capital is the fact that we never stop learning”

Tetsuya Abe
Son of the owner and manager at the Abe factory in Kiryu

➔ With its population of 120,000, Kiryu is a very unspectacular city located about two hours from Tokyo by train. Aside from a station for electric buses, there's not much in the way of modern technology to admire here. The city center is quiet, and a few brownfields can be found on the outskirts. However, as you move further out and up along the hills, you'll find modern industrial buildings that are as unspectacular as the city below.

Takehisa Abe sits at a desk behind the gray facade of one of these buildings. Abe owns a textile plant. He's also the chairman of the local business association and a manufacturer of silks that are in great demand around the world. An hour ago, he finished a telephone conversation with Veronica Etro, the Chief Designer of the Italian fashion company Etro and the granddaughter of its founder. Etro ordered ten different fabrics—materials that even a non-professional can tell immediately are works of art just by touching them. They are delicate and extremely thin, almost without substance, yet they are also surprisingly robust.

Abe inherited the business from his father, who had taken it over from his father. Abe's oldest son, Tetsuya, also works at the company. Tetsuya, 43, studied in Australia, speaks perfect English, and assists his father, whom he calls “boss,” during evening telephone negotiations with customers in Paris and Milan. Abe's youngest son, Shinya, lives in London, where he established his Relax Garden fashion label in 2004. He sells his creations to young women in London, including actresses, and has “even had Keira Knightley as a customer,” as Abe senior proudly explains.

Naturally, Abe's son in London uses fabrics from his father's company. The fabrics are manufactured using looms from the 1920s. However, the process of turning yarn into textiles is only one small part of the work conducted here. Patterns also have to be carefully coded and

the textiles have to be properly dyed and finished. In order to be able to manufacture such exceptional products, Abe has to “do research and experiment.” He repeatedly studies his materials, pushes them to the limit, and observes what happens as a result. He sometimes stamps his shoes on a wet piece of fabric for 40 minutes, watches what happens, and then stops and makes notes. He incorporates the results of these tests into production processes. This is only possible in Kiryu, he says—where spinners, dyers, printers, weavers, toolmakers, and mechanical engineers are never far apart.

But where are the fashion designers and photographers? “Oh, we don't really have any of those here,” Abe says politely, adding that Kiryu is not about creativity but instead *monozukuri*—making things. The entire town focuses on one thing: manufacturing. So why is the quality so good? Abe points to the mountains. “If not for the mountains and rivers, we would never have become what we are,” he says. Abe also explains that Kiryu means “rising dragon” in old Japanese and that dragons represent the element of water in Japan. “My grandparents had a silkworm farm up in the mountains,” he explains. “It was almost frightening to hear the silkworms nibbling on the leaves at night. We children used to feast on mulberries and had purple lips all summer long.”

Tenmangu: The god of learning

At the other end of Kiryu, in the northwest, is the city's most important shrine, says Abe. The citizens of Kiryu built it in the 17th century. After the building was completed, Tenmangu—the god of learning—moved in. The people of Kiryu pledged to worship the god at the shrine. “The town has maintained it ever since,” Abe explains. Back when Abe's father died, he called his son and grandchildren to his side and made them promise at his deathbed that they would pray at the shrine once every month.

The word *monozukuri* also tends to come up in conversations with Toyofumi Kameyama, the mayor of Kiryu. “The challenge we face is to continue making things, creating jobs, and preserving our cultural heritage,” says Kameyama when we meet with him in the Business Club, a Spanish colonial-style building built by the local business association in 1918. “If there’s anything that makes Kiryu special besides all the nature here, then it’s this building,” Kameyama says. This is where the town’s future is discussed by the “makers of things,” who meet here every week. This is the place from which the makers of old sent “scouts” out to Liverpool and New York in the early 20th century to learn. It’s also where the decision was made to build a hydroelectric plant—Japan’s first. It’s where changes are agreed upon when the time is right.

For the benefit of everyone

“The decisions have to be good for everyone,” Kameyama explains. For example, back in the 18th century, when the city was officially established, the houses of the high-class samurai dotted the mountainside. However, it soon became clear that this area was much more suitable for manufacturing fabrics than the town center. What happened next would have been impossible in any other Japanese city: The samurai moved away for the benefit of the community. Abe’s factory is also in the hills, but he lives in the city. “It’s been said that the people of Kiryu have the character of bamboo, which you can split without making splinters,” says Kameyama.

In other words, Kiryuvians can change without losing their identity. This principle explains how the textile-roller producer Teizo Nishi was able to transform himself into a high-tech manufacturer of cell phones, laptops, satellites, and solar cells. Nishi started out designing machines for washing and dyeing silk. The engineer’s technology was very clean and reliable, as it left no spots or creases. Today his company builds machines for coating films with fine liquid crystals using the original textile technology as a basis. These machines are sold in India, Taiwan, China, and the U.S.—40 percent of all such liquid crystal films worldwide are produced with Nishi’s machines.

It’s an impressive achievement, says Abe, who is friends with Nishi. Nishi himself is more modest. If he’s proud of anything, he says, it’s the fact that his 35 employees were recently honored for having worked 2,100 days without an accident. That has motivated everyone to try and make it ten years. How does Nishi do it? “I teach my people to be attentive,” he explains. For example, he makes an announcement every morning: “I point out the weather, the time of year. If it’s cold and rainy, I tell them to dress warmly, and when I return from a trip I tell them about the new things I’ve learned—things like that.”

So, attentiveness and an inquiring mind are his recipes for success? Nishi laughs. “Well, yes—but I also believe in having fun.” What kind of fun, we ask. “*Monozukuri*,” he says, and then his eyes get big. “*Monozukuri*,” he repeats. “Making things!”



Michaela Wieser studied Japanology and Asian art history in London and Japan. In her bestseller, *Tee mit Buddha*, she describes the time she spent as the first Western woman to live in a Buddhist monastery in Japan.



Takehisa Abe settles down for a dinner served to him by his daughter-in-law. Under one roof: The Abe family at the entrance of their house

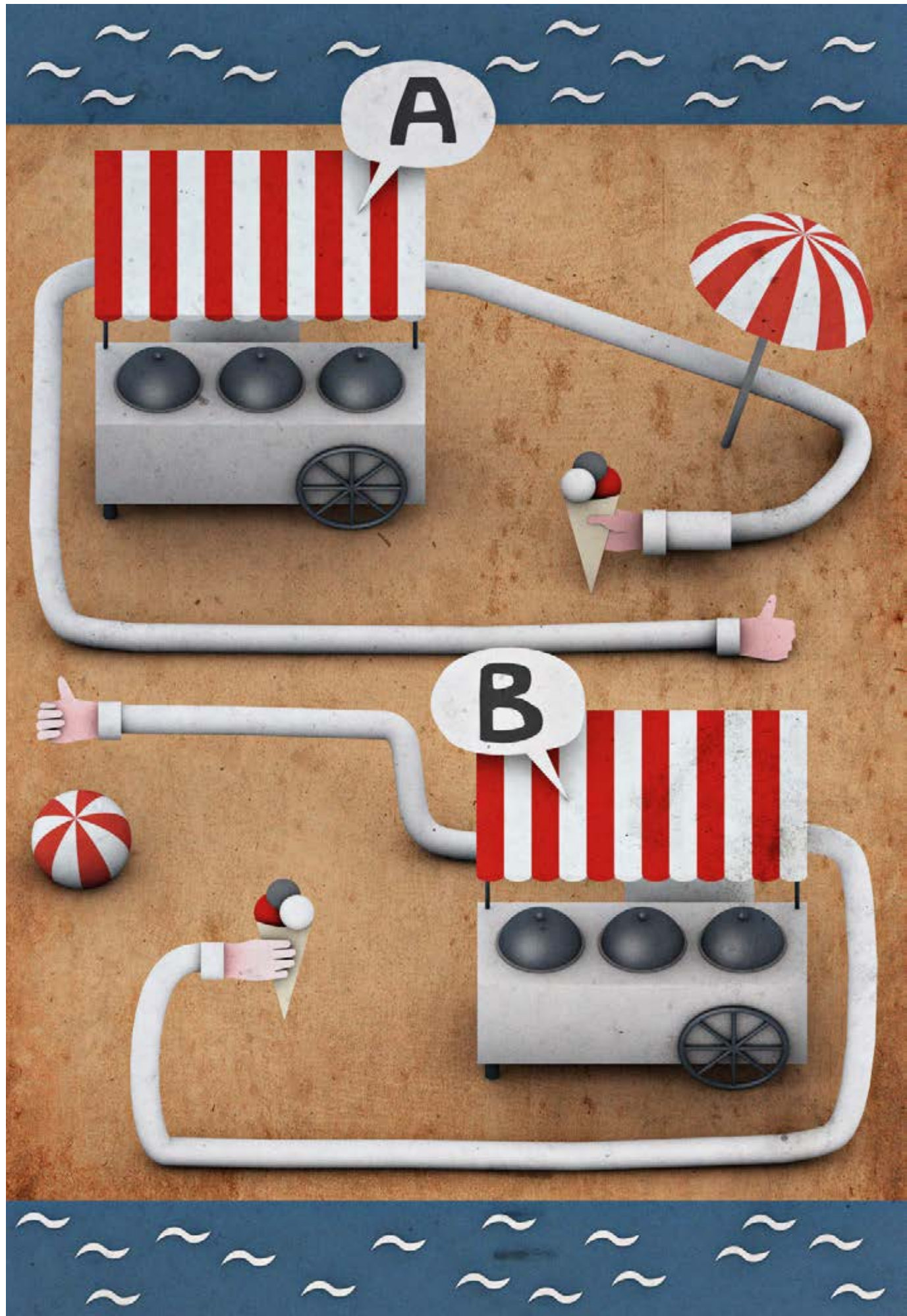


The next generation of Abes prays every evening with Takehisa Abe at their home shrine

Ice Cream on the Beach

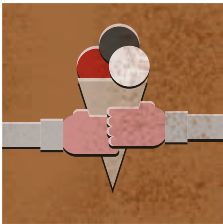
→ The classic model for markets and competition shows that close proximity is bad for everyone's business

Imagine a beach one kilometer long that's divided into two equal halves. Then imagine an ice cream stand in the middle of each half. In other words, the sellers have equally divided the beach (market), and no matter where you sit down, it's easy to get to one of the two ice cream stands. Now imagine that one of the ice cream dealers moves toward the other one. What will the other one do? He will also move toward the middle of the beach. This will go on until both stands are next to each other and more and more people also crowd into the middle to get closer to the ice cream. The U.S. economist Harold Hotelling described this phenomenon in 1929 as the "principle of minimum differentiation." It can still be seen around the world. For example, instead of focusing on their specific fields, manufacturers copy their competitors. Retailers also often move into the direct vicinity of one another. This leads to lower prices and margins and similar—even interchangeable—products. Some market players therefore make arrangements to divide the market. That's a violation of antitrust law, however. The way out of this situation is through innovation and open markets. This allows new players to position themselves differently and invigorate the market.



GAME THEORY 101

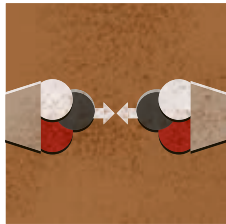
Negotiating, sharing, trusting: What happens when we make decisions but our fate nevertheless depends on others? Welcome to the world of auctions, markets, and collective bargaining negotiations—the world of behavioral economics and game theory. The models used here make irrational behavior predictable, whether in the sandbox or on the stock market



Prisoner's Dilemma

→ UMTS auction and honor among thieves: When mutually dependent individuals make blind decisions

Two burglars are interrogated separately. If they both say nothing, they will each get three years for violating parole. If both confess, they will be given the average sentence for the crime: five years. If only one confesses, he will get only one year as a reward for betraying the other, and the one who doesn't confess will get the maximum sentence of eight years. In most cases, both will opt for the average sentence—honor among thieves. Those who bid on German UMTS licenses faced the same dilemma. There were different license bundles (of 2 or 3 frequency blocks) and communication between bidders was prohibited. After one bidder quit and all the others could get 2-block licenses, they kept bidding and doubled their costs. Each was hoping to get a 3-block license.



Chicken

→ Those who yell loud enough often get their way—because the other person is smarter

How it works: Two cars race toward each other. Both drivers are risking their lives, but whoever veers away is considered a coward and loses the game. If neither "blinks," they both die. If one driver—or both—veers away, a so-called Nash equilibrium is established (named after Nobel laureate John Nash). If you think this doesn't happen in real life, think again. It's quite common in international politics especially. Just consider this quote from a European head of government in reference to a current dispute: "Despite all the difficulties, there's a high probability that we will emerge from the negotiations as the winner. We should just avoid panicking. Whoever gets scared will lose the game."



Battle of the Sexes

→ Anticipating what your partner will do in order to plan your own actions

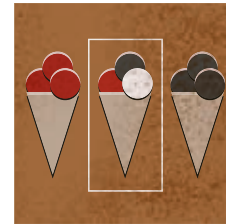
The military-sounding title is somewhat misleading because this is really a "coordination game with a distributional conflict." Consider a couple. He loves soccer, she adores the opera. The two are supposed to meet one evening, but they forgot to decide on where. There are no cell phones in this scenario. If he goes to the soccer stadium, he'll probably end up spending the evening alone. The same could happen if he goes to the opera—if she has decided to go to the stadium for his sake. This model is generally applied negatively in everything from the rock-paper-scissors game to tennis matches and penalty kicks in soccer, where the shooter and the goalie have to make lightning-fast decisions (assuming they're prepared for one another): Should I play my game or the game of my opponent?

"People obey the same rules, regardless whether they're playing games or making business decisions"

John Nash, (1928–2015)
Nobel laureate in economics. His formulas shaped economic science and his life was the subject of the movie *A Beautiful Mind*.



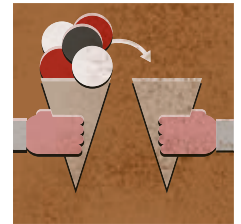
Uwe Killing The former Editor in Chief of *MAX* magazine lives in Berlin and writes for the *Wirtschaftswoche* business magazine and the *Berliner Zeitung* newspaper



Beauty Contest

→ Stocks and innovations: Success occurs when many people think they're doing something others like

A car is to be raffled off among the jury for a "Miss" contest, but only those who voted for the winner are eligible. Such a situation would cause jury members to ignore their own convictions and vote for a woman who they believe most of the others would vote for. Stockbrokers are familiar with this phenomenon. Prices of certain stocks rise because investors are buying them in the belief that others are doing the same. Knowing this, professionals enter the fray and then get out before prices fall again. Or consider video cassettes. In the early days, there were three systems: Video 2000, VHS, and Betamax. The system that eventually became the standard was not the one with the best technology but rather the one that consumers could tell early on was becoming the most popular. This impression was manipulated through sales pressure and advertising.



Ultimatum Game

→ Those who underestimate their negotiating partner's sense of fairness will fail

This model pits selfishness and altruism against each other. Person A is to receive 100 euros and to offer Person B a part of it. However, if B rejects the amount offered, A will get nothing. Although every euro is a gift for B, he keeps rejecting the offers for as long as they consider them to be cheap or disrespectful. Hardly anyone accepts an offer of 20 euros; when the offer reaches 40, most people accept it as fair. Knowledge of the ultimatum game is used in all different types of price negotiations—from company acquisitions to collective bargaining agreements and even divorces. Those who make an offer considered to be too low will offend their negotiating partner and significantly decrease the chances of concluding a successful negotiation.



*Kathleen M. Sutcliffe
is a professor at the
Johns Hopkins School of
Medicine and the Johns
Hopkins Carey Business
School in Baltimore*



Look carefully!

→ Aircraft carrier crews have to search the deck for loose objects several times a day

Even a tiny screw can lead to disaster if it's sucked into a jet engine. Everyone takes part in this act of collective mindfulness, no matter what their rank

THE POWER OF MINDFULNESS

Hospitals, power plants, aircraft carriers, and fire departments are places where serious mistakes must be avoided. The American sociologist Kathleen M. Sutcliffe studies how people under stress in such environments are still able to maintain safety. Her research focuses on high-reliability organizations (HROs), where, no matter what happens, reliability is always a must



“Something always goes wrong,” says Kathleen Sutcliffe. She knows what she’s talking about.

After all, in her younger days she worked on a fishing cutter in the Bering Sea—complete with ice floes, storms and high waves, and 35-hour shifts. Her job was to put bait into large metal crab baskets that were then lowered into the sea on cranes. Working on a fishing cutter is still considered one of the most dangerous jobs in Alaska.

Back then, Sutcliffe learned that inattentiveness can be fatal. Today, she’s a professor at both the School of Medicine and the Carey Business School at Johns Hopkins University in Baltimore, and she also advises executives. Her expertise is mainly founded in what she learned in the harsh environment of the Bering Sea: Successful management is all about paying attention.

“The power of a mindful approach,” says Sutcliffe, “lies in the fact that it causes you to divert your attention from what’s expected to what is seemingly irrelevant,

“We all need to learn to pay attention to seemingly irrelevant things”

Kathleen Sutcliffe, knows how important details can be. She has been studying risk behavior at companies for more than 20 years

from things that confirm what you’re thinking to those that contradict it, from the pleasant to the unpleasant, and from things that are certain to those that are uncertain.” This doesn’t sound like an easy thing to do—and it isn’t. “People tend to look for confirmation and tune out things that contradict their point of view,” Sutcliffe explains. Those who want to establish an atmosphere of attentiveness and mindfulness must fight this tendency.

Expecting the unexpected

Sutcliffe and her research colleague Karl Weick have studied how this is done at high-reliability organizations (HROs), including special firefighting units, nuclear power plants, intensive care units, and aircraft carriers. People who work in HROs must be extremely reliable because they have to deal with major risks: Accidents can mean injury or even death. By looking at HROs we can learn how to sharpen an ability to recognize deviations and irregularities, even during routine tasks. →



Watch out!

→ Such an approach is often considered undesirable, however. Instead, many believe that too many details, especially unpleasant ones, cause people to lose sight of their goals. In their book *Managing the Unexpected*, Sutcliffe and Weick use the Union Pacific (UP) railroad company in the USA as an example of how such an attitude can drive a company into the ground.

In 1996 UP merged with the Southern Pacific rail freight company. UP's managers were pursuing a growth strategy. Two years prior to the merger, UP had acquired Chicago North Western Railroad. The growth led to organizational problems. There was a shortage of locomotives and personnel, hundreds of rail cars that had been taken out of service clogged sidetracks and stations, delays kept getting worse, and the average speed traveled by the trains declined from 30 km/h to 19 km/h. Serious train collisions also led to the deaths of nine employees in 1997.

The managers denied any responsibility for all of this, claiming that snowstorms, slow customs procedures, unexpected track work, sudden floods, and derailments were at fault for all the problems. In any case, it wasn't them. Government safety inspectors came to a different

→ **Is the wind changing? Is the fire moving faster than we thought? Where are the hot spots?**

Firefighters have well-trained senses: They see and feel changes in the way a fire progresses. Fire unit commanders trust the intuition of the firefighters on the ground and maintain constant contact with them

conclusion. They found that the company had been laying off people too quickly and forcing train crews to work longer than legally permitted. Crews were often tired out as a result. The officials also discovered that equipment and locomotives were poorly maintained, and that train dispatchers were sent to work in regions they were unfamiliar with. Basically, the company was infected with a culture of command and obedience. Employees who attempted to solve problems on their own were accused of high-handedness. When they tried to report the problems on the tracks and at stations, no one at the executive level listened. "UP came to be viewed as the epitome of arrogance and hubris," says Sutcliffe. The managers had outsmarted themselves with their own rhetoric. They stuck to inflexible rules, took isolated decisions at the highest levels, and were in denial regarding their failures. In other words, they violated what Sutcliffe calls the five HRO processes. These are:

- Sensitivity to operations
- Preoccupation with failure.
- Reluctance to simplify interpretations
- Deference to expertise
- Commitment to resilience

Organizations that are exposed to high risks must internalize these processes, otherwise they will fail continually. Firefighters, for example, always pay attention to the direction of the wind, patterns of smoke, potential fire sources, and hot spots.

After all, the lives of others, and their own lives, are on the line.

Sutcliffe found that in the best fire departments, commanders on the scene maintain constant contact with everyone in order to stay updated. They encourage their people to pay attention to details and gut feelings. They interpret details on the basis of their overall knowledge and relate their interpretations to the firefighters on the scene. When in doubt, they make decisions based on intuition.

One screw away from disaster

The situation is similar on aircraft carriers. If a sailor informs an officer that he's misplaced a wrench, all take-offs and landings are immediately suspended. The entire crew, regardless of rank, then searches every inch of the deck. Even a screw can lead to disaster, because a jet engine can explode if it sucks one in. Sailors who misplace tools are therefore not scolded but rather praised by their superiors for reporting the loss.

Officers who transmit instructions to pilots during landings are sensitive to the slightest irregularities. To outsiders, it sounds as though they're chatting about nothing when they talk to the pilots, but in reality they're trying to detect changes in a pilot's mood. Even experienced pilots can panic at night if they become unable to distinguish between dark water and the dark sky. Landing signal officers pay attention to signs of tension and try to keep pilots calm. If necessary, they may take emergency measures.

This approach to accident prevention also includes filming every landing, showing the films on the ship, and issuing grades. Bad landings are discussed within an hour of their occurrence. All planes must be inspected repeatedly before they are permitted to take off. "The people who work on an aircraft carrier leave nothing to chance," says Sutcliffe.

Ambition destroys mindfulness

This was also the prevailing attitude at Toyota for a long time. The solidity and reliability of the automaker's vehicles were praised around the world. Toyota's employees paid attention to the tiniest details, and the company's philosophy regarding quality was considered →

"Keep in mind that things never turn out the way we want them to"

Kathleen Sutcliffe cautions companies to avoid relying too much on their own plans

Mindfulness on the Film Set "In Contact with Everyone"

Annette Gebauer is a consultant for high-reliability organizations. She studies movie sets and knows that even minor glitches can ruin everything

What can industry executives learn from film crews?

Business managers and film producers have many things in common. For example, both want to produce an outstanding product and must therefore ensure that they deliver reliable top performance. Both are under enormous pressure because mistakes can have devastating consequences.

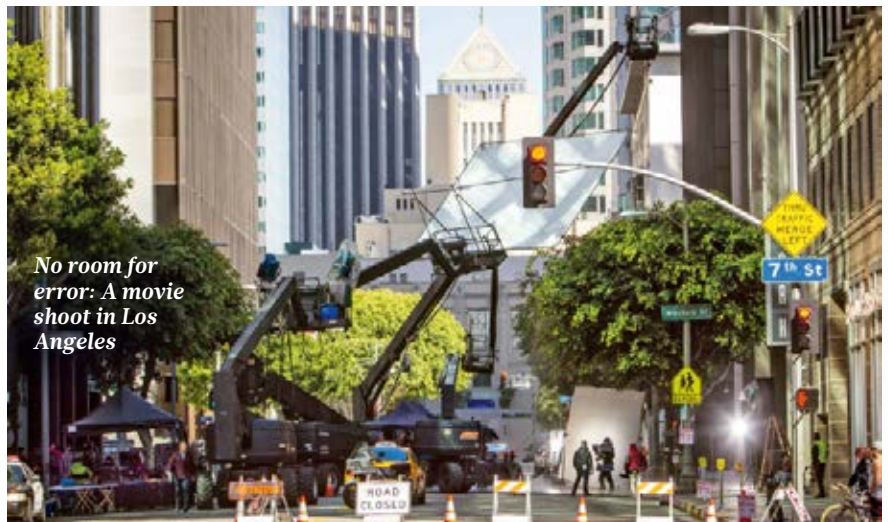
Design mistakes in the automotive industry or the power plant sector can cause serious accidents, but what can happen at a movie shoot?

Lighting technicians, stagehands, and camera teams work with heavy equipment and high voltages, and movie sets also have cranes, trucks,

scaffolding, and cars. One shouldn't underestimate the risks here. Most of the time only minor problems occur, but these can quickly grow and ruin the entire movie.

Can you give us an example?

There once was a movie crew that spent two hours setting up a swimming scene in a lake. The lead actor then called and said he wasn't going to swim in cold water because he had caught a cold. Sometimes a sunny scene is ruined because it suddenly starts raining. Or an actor gets stuck in traffic. In such situations, you can't just say, "OK, we'll continue tomorrow." Every day of shooting is expensive, and even one retake of a scene can easily cost hundreds of thousands.



How do film producers deal with this uncertainty?

By quickly rewriting the script if something happens, or else through redundancy. For example, you can keep an interior set, such as the hero's apartment, on permanent standby and use it whenever exterior scenes can't be shot. You can also keep three copies of each wardrobe piece, since something always happens to clothing.

Film crews often include many freelancers who have not worked to-

gether previously. How can one ensure reliability in this case?

Through mutual unconditional trust, attentiveness, openness, flexibility, and a lot of communication. The director shakes hands with everyone every morning, asks if there's anything bothering them, and if there's anything they need. The director's assistant is always available via radio to talk to about any problems. Every evening, the director, camera team, and the heads of scenery and costume design meet to talk about problems and unexpected events that

day. They also try to predict what might go wrong in the next few days.

They focus on mistakes and doubts rather than on sticking to the schedule.

How important is the director as a manager?

The director must stay in contact with everyone and communicate to them his vision of the film. He or she needs to retain a clear concept of the fundamentals of the story without getting bogged down in details. This enables permanent change without anyone losing sight of the overriding goal.

→ exemplary. Revenues rose, and by 2007 Toyota was at the top of its game, selling more cars than any other automaker. Things then turned bad when it was discovered that gas pedals were getting stuck in floor mats or just simply getting stuck. More than six million cars had to be recalled for servicing. Production fell by more than 20 percent and Toyota began recording losses for the first time in its history.

The company has since recovered and its management has learned from past mistakes. The biggest mistake, according to Sutcliffe, was probably too much ambition—at some point the company began focusing solely on becoming number one. That was the plan and it did in fact work, but only temporarily and at the price of quality.

Probably the biggest challenge associated with mindful management is how managers should deal with plans. “Plans are important,” says Sutcliffe. “They help us define our goals and determine which direction we want to head in, but they can also be dangerous because they imply that the world will develop in the way we imagine at a certain moment.”

High-reliability organizations (HROs) are aware of this danger. They don’t succumb to wishful thinking that “everything will go according to plan,” but in-

stead pay heed the actual experiences of employees—i.e. “things always turn out differently than you think they will.” Most managers believe you have to be careful not to lose sight of the forest for all the trees. Managers at HROs would agree but would add that it also makes sense to inspect each tree trunk, because one tree could be sick and pose a danger to the others.

HROs don’t confuse plans, expectations, and reality; they simply compare them with one another. Landing signal officers on aircraft carriers expect pilots to approach the ship in a focused and relaxed manner. If this is not the case, an officer will immediately “change the plan” by taking appropriate action. Fire department commanders also update their plan after every unexpected event.

Making reality fit the plan

The worst thing you can do is to make reality fit the plan. In such a situation, deviations are redefined as a type of “expanded normality.” This is what led to the *Challenger* space shuttle disaster. NASA technicians had previously discovered erosion of the O-ring seals in shuttle rocket boosters. They concluded that this had been caused by contact with hot combustion gases. Instead of calling a

Keep talking!

→ Because every medical operation is different, complications and irregularities are a given

Patients get well faster in hospitals where teams talk about unexpected events, possible mistakes, and potential solutions—both before and after operations

Mindfulness at Evonik “A Sharp Eye on Things”

Thomas Jostmann is the Head of the corporate division Environment, Safety, Health, and Quality (ESHQ) at Evonik. He believes that thinking ahead is more important than obeying rules

Mr. Jostmann, what makes Evonik a high-reliability organization?

We operate very complex facilities that frequently use hazardous materials. Our safety precautions are therefore sophisticated and varied.

The public at large and your neighbors at your locations depend on you for this...

Not just at our locations, because chemicals are also transported by truck, by train, and by ship. We therefore plan for and ensure safety even in the most remote regions.

What role does mindfulness play here?

It plays an extremely important role. There’s no such thing as one hundred percent safety. Instead, you have to try to anticipate

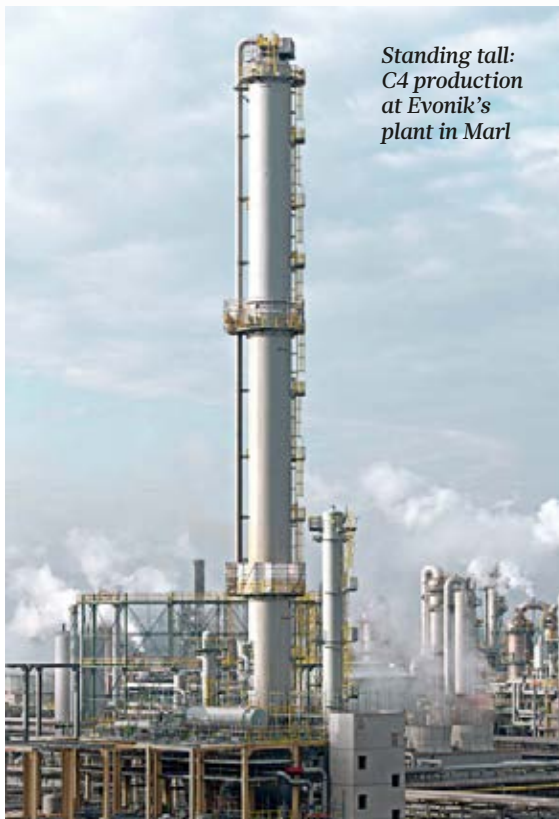
problems as much as possible and be prepared to react to the unexpected. This can be planned to a certain extent, but the important thing is that our employees act correctly and flexibly if things get serious.

What about the “human error” that everyone’s always talking about?

It’s true that human behavior always poses a risk. That’s why instructions, checklists, and rules are so important. Still, the idea should never be to simply monitor employees. Mindfulness has to do with thinking and thinking ahead, and not simply obeying orders.

How do you get people to think like that?

Employees need to understand what is going on—not just what the rules are. Jobs must be designed in a way



Standing tall: C4 production at Evonik’s plant in Marl

that challenges employees. Someone who does the same dull job eight hours a day won’t necessarily immediately spring into action when a dangerous situation occurs. We also need to nurture a culture that encourages unconventional thinking and considers the possibility of mistakes.

Are you saying mistakes should be possible?

I’m not talking about carelessness here, I’m talking about a climate in which people prefer to acknowledge their mistakes rather than hide them. After all, we want to learn from our mistakes. That’s why we also closely analyze near

accidents. The real danger is when employees would rather play by the rules than point out problems or express their own ideas. That’s why I like programs for suggestions for improvements—or idea management, as it’s often referred to today.

Why is that important?

Because it shows that we reward and therefore honor people who really think about what’s going on, people who say things like “This process doesn’t work so well,” or “It’s not as safe as it could be.” Being mindful means keeping a sharp eye on things that have become routine.

How does being mindful work in practice?

Everything is getting faster, so mindfulness involves taking time to ask yourself whether you’re fully aware of what you’re doing and have properly assessed all the risks. Are you paying enough attention to your task, or have you overlooked something? It’s really the only approach you can take in a system as complex as a chemical facility.



halt to the shuttle flights, those responsible simply expanded the definition of an “acceptable risk.” In other words, erosion of the O-rings was now considered “normal.” This opened a door which just kept on opening. Soon, the material fatigue of the rings was also seen as acceptable. The heat was also causing erosion of the secondary rings, but when this was discovered, it too was deemed “acceptable.” On January 28, 1986, *Challenger* exploded shortly after launch. It was later determined that O-ring failure had caused the explosion.

How does one get people to talk about deviations and mistakes, including their own? “Such honesty requires courage,” says Sutcliffe, “as well as self-respect, trust, and openness toward one’s colleagues.” Still, it’s not the responsibility of individual employees to develop such qualities. Instead, companies must promote them by introducing new rituals and procedures, for example. These don’t take up much time, but they are highly effective.

In well-managed hospitals, surgeons and nurses meet before every operation. They greet each other and discuss the procedure in question, as well as possible complications and the patient’s details. All this takes around two minutes—and it’s typical for any organization that needs to operate reliably because lives depend on it.

Sutcliffe recommends that all companies adopt such approaches, regardless of what business sector they’re in. Interestingly enough, open communication does not reduce the number of complications that occur. However, regular discussions make it easier to identify and eliminate complications in their early stages.

Doctors and nurses at all hospitals have to deal with a similarly high number of unexpected events, as Sutcliffe discovered. However, fewer patients die in those hospitals that follow the principles of mindfulness.

This concentration on mistakes that have occurred and those that might occur is not something everybody likes, says Sutcliffe. Many managers believe this will lead to a gloomy, pessimistic attitude that will make it extremely difficult to achieve defined objectives. However, this is not the case. Instead, mindful organizations create an atmosphere of honesty. Fears are addressed, positive energy is freed up, and a desire to solve problems develops.

The difference here can best be illustrated with a fire-fighting analogy: “Whereas most managers complain about how much time they have to spend ‘putting out fires,’ managers at HROs are proud to be ‘good firefighters,’” Sutcliffe explains.



Carsten Jasner knows about mindfulness. Jasner, who writes for *Geo* magazine, is also the author of a book about risk and security

Facts + Figures



3 QUESTIONS FOR Peter Berthold “Migratory Birds Are Adapting to Climate Change”

1 Migratory birds used to return home on a set date. Why has that changed?

More and more migratory birds have become resident birds over the last 50 years. These birds are more than capable of adjusting their habits to external influences such as global warming.

2 So the birds just stay where they are?

Yes, like blackbirds, which were migratory as recently as 200 years ago. Or else they come back earlier than they used to. Many migratory birds that once returned from the south on a certain

day now come back earlier and also brood at different times. This adaptation functions smoothly because both migratory and resident behaviors are genetically ingrained in all birds.

3 What's your prediction for the future?

As climate change continues, so too will the evolutionary restructuring of the range of species. In a few years, we'll probably see only resident birds in Central Europe.

Peter Berthold, professor emeritus at the University of Konstanz, is the author of the standard work *Vogelzug* (Bird Migration).

EUDRAGIT doesn't look futuristic—but its effect is guaranteed to be

The Chemical Taxi En Route with EUDRAGIT

The taxi knows where it is. The pH value has risen above 6.0, so it must be in the small intestine, which means it has arrived at its destination. Now it's time to open the door and let the active substance out—here, where it will have the desired effect.

The “taxi company” is called EUDRAGIT. For 60 years now, Evonik Industries' pharmaceutical polymers with this brand name have been chauffeuring different kinds of pills through human

bodies. The “taxi” is more than just a protective covering, however, as EUDRAGIT uses pH values to determine whether it should dissolve and release its active substance in the stomach or later on in the intestines. It even knows how much time it has, because controlled-delivery formulations ensure the drug is not released at once but instead uniformly over a predefined period of time.

It took years of research to achieve such precision, one

reason being that the film coating could not be more than a few micrometers thick. The original premise was simple, however. The idea was for the coating to shield the active substance from light and moisture and, if necessary, mask an unpleasant or bitter taste.

Sweet covers bitter: That's how the combination of drug and coating got its name—from dragées. Originally created in medieval France, these were almonds coated with sugar or honey.

A screw made of RESOMER degrades completely inside the body in just a few weeks



BIOTECHNOLOGY

Disappearing Medical Supplies?

Yes, it's true. The familiar technologies used in stitches and bandages that keep surgery wounds closed and then simply degrade after a while are now also being applied inside the body, in some case helping to avoid operations as well. This is the idea behind the biodegradable nails, screws, and plates from Evonik Industries that are implanted in the body to help mend broken bones. Unlike steel or titanium, these pharmaceutical polymers, which are marketed under the RESOMER brand name and are used to set bones, degrade completely—without leaving any residues—after a few months, once they've also helped bones grow back together.

High-tech stents function in a similar manner. They ensure a sufficient supply of blood to coronary vessels and then degrade completely after around two years. During this time, they release a drug that prevents the blood vessels from narrowing again. In other words, they make themselves redundant.

MATERIALS SCIENCE

Almost
Indestructible**Kevlar**

It's been 50 years since the invention of Kevlar. The gold-yellow aramid fiber can stop bullets and is resistant to acids, bases, fire, and heat. Kevlar can be found in protective vests and helmets and in armored vehicles. Firemen also use it to protect themselves when battling blazes

**Aluminum**

Kevlar withstands temperatures of up to 400 °C, which is not good enough in the event of an airplane or gas-pipeline fire. Along with normal protective clothing, firemen therefore also wear a heat-resistant suit with a substrate coated with aluminum that can withstand temperatures of up to 1,000 °C

**Sapphire glass**

Cracked cell-phone displays are annoying. Apple has therefore been using sapphire glass since 2014, as the material is (fairly) robust. Chemically speaking, sapphire glass isn't really glass at all but rather a colorless synthetic sapphire made from molten aluminum oxide

Designers can gain important knowledge for their planning activities in the "Elbe Dom" in Magdeburg



CYBER CHECK

Will this even work? Designers use animated virtual worlds to test how feasible their ideas for new industrial facilities are in reality. The VDTC offers the necessary technology

Minimizing risk:

Whether you're building a container port, a natural gas production facility, or a production line at a chemical plant—design errors in such complex industrial facilities can be extremely expensive, and not just if they inadvertently lead to safety violations. Knowledge gained from virtual testing can go a long way toward minimizing such risks.

1:1 simulation: The Virtual Development and Training Center

3

reasons

for virtually testing industrial facilities

1

Optimization: Virtual reality precisely simulates processes and helps identify errors and deficiencies.

2

Safety: Planning errors can have fatal consequences in terms of occupational safety. Tests conducted under realistic conditions can reduce risks here.

3

Cost-efficiency: Timely corrections help avoid the costs associated with replacement parts or reworking.

(VDTC) operated by the Fraunhofer Institute in Magdeburg is a pioneering large-scale digital engineering lab. The centerpiece of the lab and the institute, which has close ties to the University of Magdeburg, is a cylindrical structure 16 meters wide and seven meters high known as the "Elbe Dom." The facility enables 1:1 simulations—even of cranes, excavators, and airplane cockpits.

Virtual harbor: Both large corporations and medium-sized businesses send their planners to Magdeburg to develop solutions that can be applied in practice—or to identify previously undiscovered

problems. This turned out to be the case for the operator of a port of transshipment. The company commissioned a simulation of a virtual port and a virtual crane operator who entered a simulated cabin in order to check all the possible transport paths and stacking methods for virtual 3D containers. The simulation revealed that the location that had been planned on a drawing board had a "blind spot" that would have caused big problems during operations and also increased the risk of accidents.

Virtual engineering: The VDTC not only shares its expertise in such tests; it also offers training courses.



Further information on virtual reality in action:
www.vdtec.de/en.html

*Holding the key to
determining longitude
at sea: John Harrison's
marine chronometer
saved countless sailors
from shipwreck*





Starting in 1760, the precision of this watch made it possible to determine longitude. This innovation first transformed seafaring, then the world

IN TIME WITH DISCOVERERS

The oceans can be cruel. For centuries, entire fleets ran aground because navigators had lost their orientation—until an eccentric Englishman built the most precise clock of his era. His invention ushered in the age of global trade and expeditions

➔ In the fall of 1707, a British fleet commanded by Admiral Cloudesley Shovell set sail from the Mediterranean back to Great Britain. Storms gathered in the Atlantic, and the squadron pitched for three weeks in heavy seas. Finally, Shovell and his captains believed they were safely in the English Channel. In reality, they had sailed too far to the west. On the evening of October 22, 1707, four of the five ships ran aground on the rocky reefs of the Isles of Scilly off the southwestern tip of England and sank. Shovell and almost 2,000 of his men drowned.

The admiral and his men lost their lives because they were unable to reliably determine the position of their ships. Like thousands of seamen before them, they died because the problem of determining longitude at sea had not yet been solved.

Ever since antiquity, geographers had covered their maps with the well-known network of vertical and horizontal lines. This network gradually developed into a system consisting of 360 degrees of longitude and 360 degrees of latitude. The lines of longitude ran from pole to pole, whereas the lines of latitude were parallel circles lying north or south of the equator. These reference values could be used to define the position of any object on the earth.

On a swaying ship, sailors could calculate their latitude to within a few miles by observing the position of the sun at its zenith at noon—or, if they were in the northern hemisphere at night, the position of the North Star. How-

ever, they could only guess at their longitude by estimating how far they had sailed eastward or westward.

A fall from the rigging

Over and over again, ships were wrecked because navigators had lost their orientation because of storms, fog or sleet or because they had wrongly estimated their longitude. During their ships' long wanderings, sailors would die of scurvy or fall from the rigging through sheer exhaustion. And the European trading companies lost valuable freight in the process.

Starting in 1567, naval powers such as Spain, Portugal, and the Netherlands offered huge amounts of money to anyone who could solve the longitude problem. Astronomers and mathematicians, including famous scholars such as Galileo Galilei, tried to solve the problem—and failed.

Captains therefore sailed within sight of land, navigated carefully from island to island or sailed “widthways”—that is, they didn’t steer directly toward their destination, but instead first sailed to the degree of latitude on which it lay and then used a compass to sail in a straight line eastward or westward.

This method lost much precious time. And because almost all trading ships sailed along the few well-known routes, they became easy prey for pirates, who benefited in their own way from the growth of long-distance trade on the high seas. In 1685 alone, the British East India ➔

“Longitude at sea cannot be determined with a clock alone”

Isaac Newton in 1725, just before his death. 35 years later, a carpenter from Yorkshire proved him wrong.



New Zealand looks shrunken on this world map from 1778. With the help of chronometers, entire continents would soon be remapped



“This clock has exceeded all of our expectations”

James Cook while rounding the Cape of Good Hope on the return trip from his second South Sea voyage

→ Company imported tea, coffee, spices, and porcelain worth 600,000 pounds (the equivalent of €70 million today) from Asia. Every ship that sank or was captured meant a tremendous loss.

After the shipwreck off the Isles of Scilly, trading companies and the British Navy urged the British government to also offer an award for the solution of the longitude problem. In 1714, Parliament passed the Longitude Act, which promised an award of 20,000 pounds (worth about €2.3 million today) to the person who could find a foolproof process for determining longitude at sea to an accuracy of half a degree. The solution was known in theory, because the geographic longitude of a point can be determined using the time of day at that location. These two measurements are directly related. Because the earth turns on its axis, an observer on the earth perceives the sun as moving in the sky from east to west. During the 24 hours of a day, the sun passes over all 360 lines of longitude on the globe, at a rate of 15 degrees of longitude every hour.

If the sun has reached its zenith above London at 12 noon, it will require exactly three hours to reach its zenith above another location that lies 45 degrees of longitude west of the British capital. With this knowledge, an officer could easily determine the longitude of his ship's position. When he left the Port of London (whose longitude is indicated on maps), he would only have to take along a clock that would continue to indicate local London time even while he was sailing in the Atlantic. Then he would have to determine the local time at his current location with the help of nautical instruments. By calculating the difference between the two times he could find out his ship's longitude.

The problem was theoretically solved, but this solution failed in practice because the timepieces of that era lacked the necessary precision. The first pocket watches lost half an hour per day. Pendulum clocks, which were the most

precise timepieces around 1700, gained or lost at least one minute every 24 hours. This was not acceptable, because on a long sea journey such imprecision would quickly add up to an error of many degrees of longitude—the distance between continents.

Competing over seconds

In 1726 John Harrison, a 33-year-old carpenter from Yorkshire, heard about the longitude award. A brilliant self-taught scholar who had never attended school, he had already constructed on his own a pendulum clock that lost or gained only one second per month and thus fulfilled the requirements of the Longitude Act. The only problem was that on a rolling ship the pendulum would quickly be thrown out of kilter.

In 1730 Harrison retreated into his workshop to try to build a clock that would be immune to such shocks. Five years later, his first marine chronometer—a huge brass apparatus weighing 34 kilograms—was finished. When he presented it to the experts from London on a ship in the English Channel, they were impressed, but the chronometer was still not ready for an official test voyage.

With financial support from the Board of Longitude, Harrison started to work on a successor model. But in this competition over seconds, he seems to have lost his sense of time. He built and tinkered with two more clocks for almost a quarter of a century, but neither of them ever ran with the desired degree of accuracy.

Harrison started all over again and decided that his marine chronometer should be a watch, even though back then watches were generally considered unreliable. Unusually for that era, Harrison equipped his fourth timepiece with an especially fast movement. For many of the bearings of the gear train, he used small gems in order to minimize friction. He even cut small diamonds to act as

1780

marked the birth of the first “chronometer.”

The clockmaker John Arnold, who refined Harrison's last model, first used this term to advertise the precision of his clocks. His successful campaign made this new word standard.

1787

was the year the *Bounty* went to sea, with a chronometer on board. Two years later its crew mutinied in the South Pacific and cast off the captain and 18 sailors in a dinghy with an octant and a compass—but without the chronometer.

hooks in the teeth of the gear train. How Harrison managed to shape these high-precision components is still a mystery today. In 1760 Harrison presented his masterpiece for the first time to the Board of Longitude. The initial test voyage ended in a dispute. The Board of Longitude declared the results unusable and demanded a repeat performance.

In 1764 Harrison was ready. After a 46-day voyage from Portsmouth to the Caribbean, the chronometer was allowed to show a deviation of 120 seconds. On Barbados, comparative astronomical measurements revealed that Harrison's chronometer had lost only 39.12 seconds. It was three times more precise than the Longitude Act required!

The carpenter from Yorkshire had solved the calculation problem of the century.

New Zealand rediscovered

John Harrison had virtually nothing more to do with the practical use of his invention, which was an extremely expensive unique model (see the box on the right). English horologists created simpler versions of his fantastic chronometer and thus brought the prices down.

The Board of Longitude equipped state-financed naval expeditions with these initial imitations of Harrison's marine chronometer. For example, in 1774 the explorer James Cook took three marine chronometers along on his voyage to the South Sea. He was enthusiastic about the precision of these instruments and used them to map islands in the Pacific Ocean and correct the position of New Zealand on the maps. British researchers traveled with their chronometers to the Arctic Ocean to search for a northwest passage between the Atlantic and the Pacific and revised existing maps of the coasts of North America, Australia, and Africa.

Starting in 1810, the East India Company equipped its ships with marine chronometers; eight years later, the Royal Navy followed suit. Other nations also adopted Harrison's invention. His marine chronometer promoted global exploration, boosted maritime trade, and ultimately facilitated the conquests made by the imperial powers. Along the way, it saved the lives of countless seamen. ●



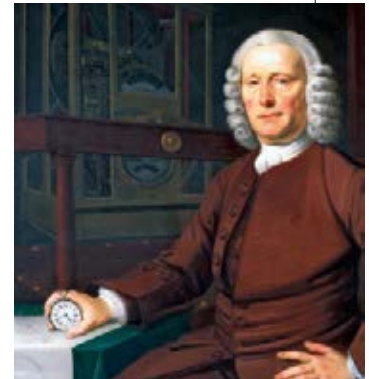
Ralf Berhorst likes to sail (without a chronometer) on the Wannsee in Berlin and writes for *GEO Epoche* and *National Geographic*

John Harrison The Unlucky Inventor

He solved one of the greatest technological problems of his era, but wasn't rewarded with happiness or fame during his lifetime

John Harrison invented a marine chronometer that solved the problem of how to determine longitude at sea, but his achievement was not recognized by scientists. After a successful test voyage in 1764, the Board of Longitude acknowledged its results but refused to pay Harrison the prize money of 20,000 pounds. The Board pointed to a clause of the Longitude Act that required the winning method to be "practicable and useful." Could Harrison's expensive (it cost the equivalent of €40,000 today) and complicated timepiece be produced in large numbers at affordable prices?

In the course of his work, Harrison made two discoveries. One of them was the bimetallic strip, a flat piece of metal consisting of brass and steel riveted together that bends in response to changes of temperature. This movement compensates for reactions to heat or cold inside a clock. In addition, he constructed a predecessor of the ball bearing that enabled parts of the clock movement to run with almost no friction and require no lubricants. Harrison was asked to take apart his chronometer in front of scientists, explain it, and hand it over to the Board. He was a mistrustful man with an almost paranoid fear of imitators, but he reluctantly agreed to do so. As a result, he was granted half of the award money, amounting to 10,000 pounds (minus a previously paid advance of 2,500 pounds). In exchange for the rest of the prize money, Harrison was expected to build two



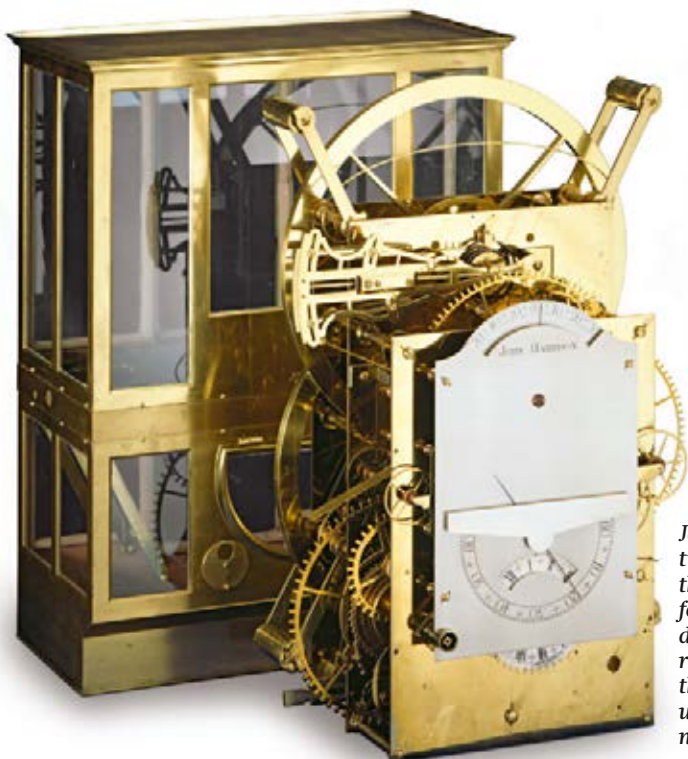
John Harrison required royal help to receive his long-overdue recognition

copies of his chronometer—without having the original chronometer as a model.

Six years later Harrison, now 79 years old and plagued by gout, was finished with the first copy. The Board insisted on receiving the second copy as well.

The clockmaker, who by now was embroiled in a private feud with the experts in London, decided to take his protest to the king. After receiving Harrison's son William in an audience, King George III declared, "By God, I will ensure that you receive justice." In 1773, the British Parliament ordered the Board to pay the remaining 8,500 pounds to the inventor.

The total amount paid to Harrison was 23,065 pounds—more than the actual prize money. But he never received the official prize of the Board of Longitude or its official recognition for having solved what was probably the most difficult technical problem of his era. John Harrison died in London in 1776 at the age of 83, a rich and bitter man.



John Harrison tinkered with this model for two decades before realizing that it was unfortunately not practicable

Power and endurance are what counts: In the future, the performance of big hydraulic excavators will be even more reliable



NONSTOP DIGGING!

When hydraulic oil gets too hot, the excavator and its driver have to take a break in order to cool off. But thanks to DYNAVIS, the oil no longer overheats. This boosts productivity, reduces fuel, and lowers stress on the transmission. Does all this sound too good to be true? To convince the skeptics, Evonik Industries regularly pits excavators against one another



“It just got weak in the knees,” says Dieter Pukowski. He’s talking about the machine he works on, a 16-ton banana-yellow excavator. Pukowski notices right away when the excavator’s hydraulics falter, its reactions slow down, and the movements of the shovel get shaky. He normally moves this powerful steel colossus precisely, down to the centimeter, across the construction site with the flowing motions of a dancer. However, when the hydraulic oil gets overheated in the afternoon, all that is over. The machines’ afternoon slumps and the resulting forced pauses are common occurrences everywhere, not only here at Pukowski’s workplace in the Swabian Alps in southern Germany. When hydraulic oil gets too hot, it gets thin and can no longer be pumped under high pressure. As a result, the pump also overheats. In such a situation, amateurs give even more gas until the machine gives up altogether. Professionals take a break to cool off. And Pukowski doesn’t have this problem any longer.

That’s because his employer relies on a technology that is new in the field of hydraulics. The key word is DYNAVIS, which stands for a mix of additives for hydraulic oil and a new standard for performance.

It all began in the modest low-rise building in Darmstadt that houses the Performance Test Lab of Evonik Industries. This is where Thorsten Bartels and his team run punishing endurance tests on pumps, transmissions, gear wheels, roller bearings, and all kinds of other metal components. Behind thick doors and sound-insulated windows, they simulate the final effects of years of work. At the end of the process, many of these components only have scrap value, but they yield columns of figures that are much more valuable. When these numbers are plotted on curves, they tell a professional tester just what the right oil means for the good performance and long service life of engines, transmissions, and hydraulic systems.

The challenge is pretty much the same in all cases. Wherever oil is used, it should have the optimal viscosity. If it’s too thick, it slows the machine down; if it’s too thin, it flows too easily through pumps and interstices, doesn’t lubricate, and doesn’t transmit any power. Improving viscosity is the business of Evonik. Oil also changes its viscosity with the temperature, just like butter and honey on a breakfast table in the summer. Materials that flow when it’s hot tend to thicken or harden when it gets colder. The art of improving viscosity lies in keeping oils at exactly the right degree of viscosity over as wide a temperature range as possible. →

“When I show customers how much they can save by switching to a different hydraulic oil, they turn pale.”

Rolf Fianke,
Aftermarket Support
Manager DYNAVIS,
estimates the performance spectrum of the additive.

“The cheapest oils have been the most popular. But that’s changing.”

Thorsten Bartels
from Evonik’s
Performance Test
Lab in Darmstadt

350

bars of operating pressure is generated by the hydraulic pumps of big excavators. This power is transmitted through cylinders to the arm and the shovel so that the excavator digs easily, even through rock.

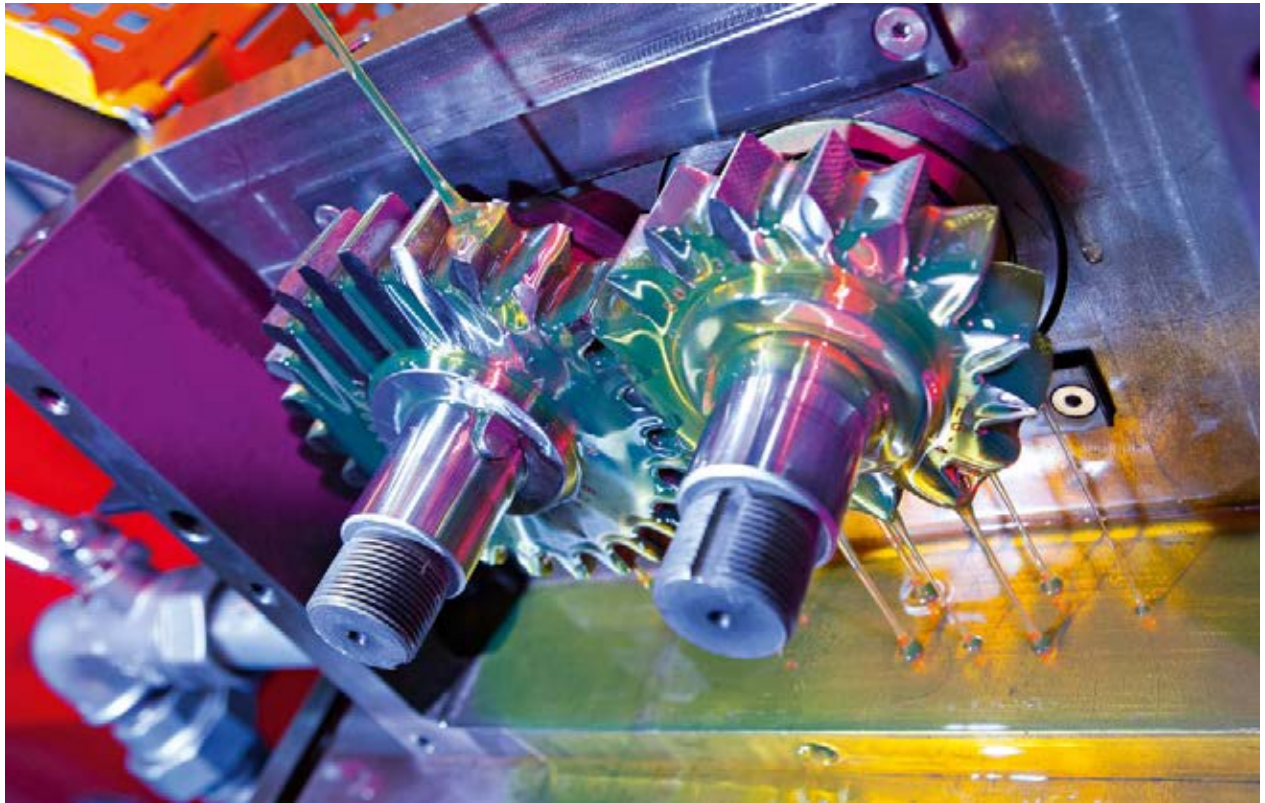
4,000

operating hours is how long an excavator can operate before its hydraulic oil has to be replaced, thanks to DYNAVIS. With normal oils, it can manage only about 2,500 hours of operation.



Tom Rademacher secretly hoped he’d get to drive an excavator in the course of this research. He didn’t. Instead, he’s still working as a freelance journalist based in Cologne

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Stress tests in Darmstadt: When steel clashes against steel, high-powered lubricants show what they can do

→ This can be done especially well by the comb polymers recently developed by Evonik. “These are long chains of molecules with many side arms just like the teeth of a comb,” explains Stephan Fengler, the Head of Innovation Management for oil additives. He is responsible for the chemistry behind the product. “When these polymers are dissolved in oil, they react in completely the opposite way. When they’re dissolved in cold oil, they contract into small clusters. When the oil gets hot, the clusters untangle themselves, spread out, and thus thicken the oil.”

It sounds simple, but it really isn’t. That’s because the polymers have to stand up to tremendous pressures. “Inferior additives that are meant to improve viscosity are simply ground up in transmissions or pumps,” Bartels says. “But that doesn’t happen to our highly shear-resistant polymers.” The figures and curves from the test lab document this claim. But because only experts understand what the figures mean, Bartels regularly pits excavators against one another. Sometimes they compete in sprints under officially predefined conditions or swing their arms back and forth until onlookers almost get dizzy. The performance parameters Bartels derives from these tests can be understood by everyone on the construction site. The excavators dig more shovelfuls per hour and consume less fuel. That’s good news for Pukowski’s boss, the civil engineering contractor Rainer Schrodde. By using the right hydraulic oil, he saves about €6,000 per excavator per year on diesel fuel alone. And that’s not even counting the increased productivity of each machine. In his field tests, Bartels has proved that using the right oil saves up to 20 percent of fuel. Meanwhile, Evonik promises only very conservative savings of five to ten percent on the market. But because promises don’t count for very much on a construction site, Evonik also does a bit more.

This is where Rolf Fianke enters the picture. He’s the man who speaks the language of excavator drivers, fleet operators, and machine manufacturers, and “sells” the usefulness of high-quality hydraulic oils directly at the

construction site. He has just returned from a visit to Turkey’s biggest coal mining operator, whose excavators consume between 80 and 100 liters of fuel per hour. Fianke reports that the company spends €40 million a year for diesel fuel alone. “When I showed the managers how much they could save just by switching to a different hydraulic oil, they turned pale,” he says. The Turkish managers are now checking whether Fianke’s promise was realistic—not under lab conditions but in their open-pit mining operations. Evonik is only delivering the oil for the test. Fianke is confident about the results, thanks to Bartels and his watertight calculations. “If I didn’t have those, the customers would simply call me a fast-talking salesman,” he says. So far he has never had to be anxious about a test result, whether it was in Germany, Lithuania, Belgium, Italy or China.

It’s not really obvious why Fianke has had to deal with Turkish mine operators, Swabian excavator drivers or Chinese machine rental companies. “After all, we’re not selling them anything at all,” he says. End customers buy their hydraulic oil from oil companies such as Total in France or small specialist suppliers such as the family-owned company Schaeffer’s Specialized Lubricants in St. Louis, Missouri. Thanks to the diligent fieldwork of Fianke and his colleagues, both of these companies are noticing a long-overdue rethinking process among their customers. Because the machines work with just about any oil, “the cheapest oils have been the most popular,” says Bartels. But word has gotten around that DYNAVIS demonstrably ensures better performance and lower fuel consumption—so customers are asking for it more and more often. And that’s the whole point of the campaign. Evonik wants to establish this brand as the industry standard. “Just like Intel Inside on a laptop or Gore-Tex on an outdoor jacket, we want DYNAVIS on an oil barrel to immediately make it clear to everyone just what they can expect,” he says. In this case, it’s “that extra bit of reliability when the going gets tough.”

HOW IDEAS GROW

Innovations flourish at Evonik Industries. But which innovations deserve large-scale production? After all, production plants have to operate 24 hours a day, 365 days a year, with an output of thousands of tons—reliably, with high purity, and absolutely safely.

That requires testing, testing, and more testing

Developing an idea

The first question is: Can the desired product be manufactured at all? Through experience and specialist literature, the researchers find a chemical equation that describes which starting materials, reaction conditions, and catalysts could lead to the desired result. Now this procedure has to be tested.

Proving feasibility in the lab

A few grams of the product are produced in the lab by hand. The yield is often low. The researchers slowly make their way forward. Is the reaction stable? Can it be managed and reliably repeated?

Only a few out of 100 ideas overcome this obstacle. Not every chemical reaction is cost-effective.

Testing production in the technical center

A 100-liter tank cannot be as easily stirred and evenly heated as a beaker. Which reactor is the right one for the process? In the technical center all stages of production are tested at once and over a long period of time. Risks and by-products that were unimportant in the lab now reveal whether they are going to become problematic. Sometimes this stage also provides product samples for customers.

Improving cost efficiency in the test reactor

Lots of waste, high energy consumption or stringent safety requirements make production processes unprofitable. That's why it's important to answer certain questions early on and on a small scale. Which catalysts are appropriate? Are the pressure and the temperature right? There are almost endless combinations of all the parameters. Special software and test processes help to limit the field.

The costs of refining the reaction itself can quickly add up to a six-digit figure. It's important to protect the resulting valuable knowhow

Real production in the pilot plant

Processes that work well on the technical center-scale don't necessarily function for large-scale production. A reactor built on a scale of cubic meters also behaves differently. And the investment risk is huge. That's why it's often worthwhile to build a mini-plant or a pilot plant that will produce for the market for one or more years under conditions that are as true to life as possible.

Building a large-scale production plant

If the process is mature and the market is ready, it's worthwhile to build a large-scale plant. Experience and comprehensive knowhow are important because the Group will invest tens or hundreds of millions of euros all over the world at this stage as engineering and process development interlock.

Only one idea out of a hundred successfully reaches this point. That's no surprise, considering that technical center-scale tests can cost €1 million or more.

Pilot plants are generally built to operate for two to three years. Depending on the product, they can already have an output of up to 100 tons per year.

Large-scale production plants have an annual output of up to tens of thousands of tons. If they are continually optimized, they can run for decades.

PROTECTOSIL

PROTECTOSIL has been protecting concrete, sandstone, granite, and plaster against water, salts, pollutants, dirt, oil, and exhaust particles for the past 25 years. As is the case with breathable waterproof jackets, the coating causes moisture to simply roll off and creates a dry and healthy climate inside. Mold, algae, and moss can be quickly removed without any residue from PROTECTOSIL-treated surfaces, as can graffiti. PROTECTOSIL can also prevent and stop corrosion



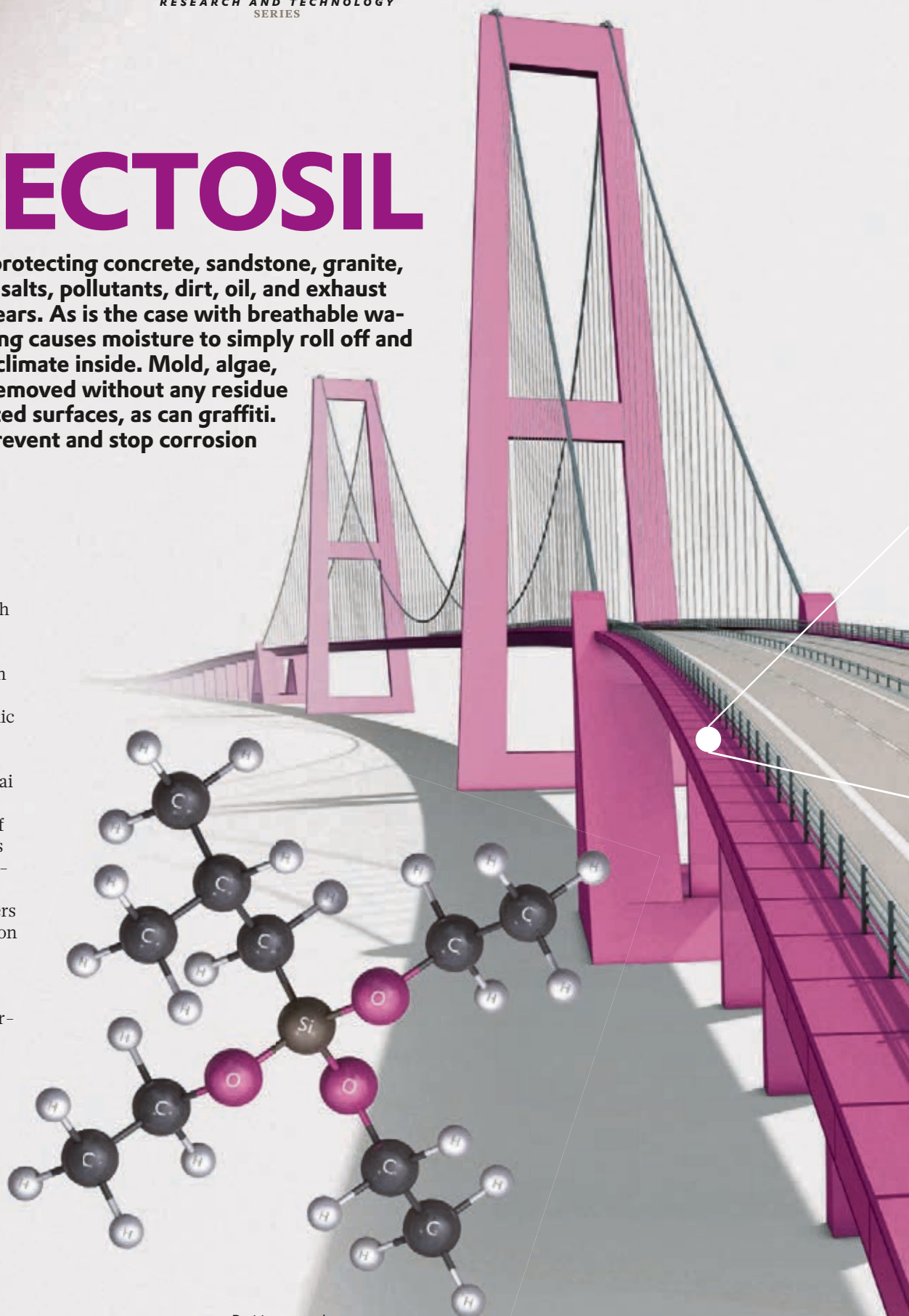
Planners and builders demonstrate their farsightedness if they protect structures with

PROTECTOSIL instead of having to renovate or repair them at great cost. This is especially the case with bridges and roads that are constructed and maintained with public money. Even such huge structures as the almost 36-kilometer-long Hangzhou Bay Bridge near Shanghai would be unprotected against the long-term effects of the elements if they weren't treated in time. That's why the planners used PROTECTOSIL CIT to treat the bridge's 7,000 pillars, each of which rises 70 meters above its firmly anchored foundation in the seafloor.

The specialty chemical penetrates deeply into the concrete, where it forms a colorless, water-vapor-permeable seal and reacts with the surface of the stabilizing rebar.



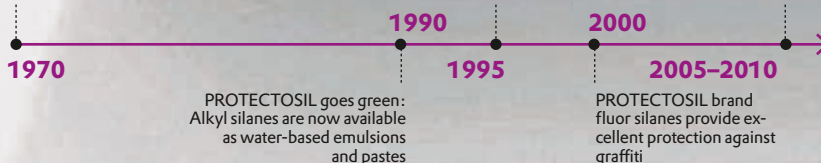
You can find additional milestones of chemistry at: geschichte.evonik.de/sites/geschichte/en/inventions



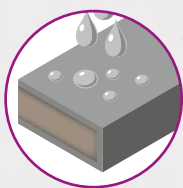
Decisive step on the way to PROTECTOSIL: Silanes are patented as protective agents for concrete. The alkyl silanes repel pollutants and water. Chemists talk about hydrophobizing impregnation

New silane systems prevent corrosion and stop it in bridges which are already rusting

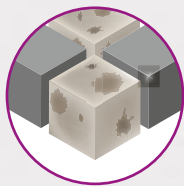
PROTECTOSIL is now also available as a powder. This makes surfaces even easier to clean



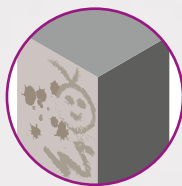
Hydrophobized
surfaces repel
water



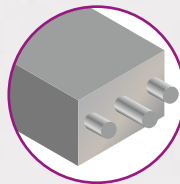
Easy-to-clean
surfaces aren't fazed
by persistent dirt



**Graffiti pro-
tection** stops
sprayers right
from the start



**Corrosion pre-
vention** reduces
renovation and
repair costs



Claus-Dietrich Seiler now has a relaxed attitude toward walls

The Wall Expert

Claus-Dietrich Seiler and his family fled to West Germany 16 days before the Berlin Wall was built. In an ironic twist of fate, the chemist then worked on ways to protect walls. After getting a job as an application engineer in Rheinfelden, he began to develop new products from trichlorosilane in May 1965. "Do something with it!" he was told. In 1970 Seiler submitted a patent application for a wall-impregnation agent based on silicon-containing organic compounds. This makes him the inventor of today's PROTECTOSIL. What made this first-ever depth impregnation agent groundbreaking was that it didn't agglutinate and that it let the concrete breathe in both directions.

Protected by PROTECTOSIL:



Staatstheater Darmstadt

The facade isn't suited for use as a stage, because it has been protected against graffiti since 2011



Containerterminal Zeebrugge

According to a study, the protection lengthened the quay wall's service life by 100 years



Transamerica Pyramid Center

The windows of the 48-story building show no trace of the protective agent



Sydney Opera House
A protective coating prevents moisture from affecting the building, which is located right next to the harbor



Princeton University

Amazon founder Jeff Bezos and First Lady Michelle Obama studied in a protected sandstone building

Stefan Ertler,
Head of R&D at
Paratec, Europe's
leading manufacturer
of parachutes

“We Are Self-taught”

Parachutes were first used for military aims, then for thrills, and today for sports ranging from parachute jumping to skydiving. Stefan Ertler, the founder of Paratec, has played a key role in this development. Thanks to his parachutes, jumping through the clouds is still exciting. But these jumps have also become much safer

Mr. Ertler, can you still remember your first parachute jump?

Of course. It was from a Transall plane of the German Air Force in the winter of 1981. I was a trainee, and back then I jumped from 400 meters with a round cap parachute. This became a hobby, and later it became my career.

How do you make sure your parachutes remain safe?

We've been developing and producing parachutes for three decades, as a self-taught company. You could compare this with the surfing scene, where an experienced surfer wearing shorts and a Hawaiian shirt might design a new board—nowadays of course with a 3D design and simulation programs. When we make new models, we improve the details—for example, if our suppliers have refined their materials or if new trends appear, such as swooping with small high-performance parachutes that make a long gliding flight possible.

And then you simply sell them, right?

It's not that simple! We are inspected and audited on a regular basis. The European Aviation Safety Agency (EASA) is responsible for personnel parachutes, the German Parachute Association for sport parachutes, and the German Aerospace Center (DLR) in Cologne for parachutes used by the German

armed forces. Before a new development can go into series production, a model is tested to see whether it meets the relevant standards. And of course, subsequently every serial number of the approved model must be released for use after an individual inspection by our trained professionals. This is a precisely defined procedure that is required of every manufacturer.

What has changed in parachute technology since you made your first jump?

Round cap parachutes were standard until the end of the 1970s. After that, sport jumpers gradually came to prefer rectangular parachutes, which look like oversized flying mattresses. That was the last really big change. Since then we've been fine-tuning the details through our innovations. Our commitment to safety dictates conservative improvements and no experiments. Every type of parachute, whether it's square or round, has its own production processes.

What kinds of parachutes are there?

Rescue parachutes that are used in emergencies, for example in a situation of distress involving a glider. A sport parachute has a built-in rescue parachute, but it's only a reserve apparatus for the main parachute. To use such a parachute, you need a license. There are also military and supply parachutes.

Who guarantees that a parachute that has been lying in a corner for five years can still function?

A parachute can be used for about 20 years, but sport jumpers replace their apparatus more often than that. In order to find out whether there has been wear and tear, the parachutes are submitted to an annual airworthiness examination. So from a technology perspective, this is an absolutely safe situation. However, when you're jumping you have to obey the rules of the game.

What are these rules?

For one thing, you have to act at the altitude known as the “decision height.” The main parachute has to be opened at a height of 1,000 meters, the reserve parachute at 500 meters. In addition, you have to be healthy and fit and strictly comply with the ban on drugs and alcohol.

Now that you've made so many jumps, do you still feel any fear or excitement?

It's more like a healthy respect for jumping and a sense of happy anticipation for what I'm about to do.

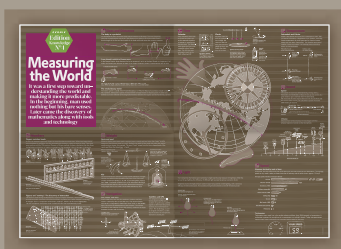
EVONIK

Edition Knowledge Nº 4

Comparison leads to understanding. The history of civilization is also a history of observation and mapping. The process of measuring the earth and the cosmos marked the birth of the natural sciences—and of our scientific understanding, research, and discoveries. The Evonik Edition Knowledge poster in this issue relates the history of meters and miles, Celsius and Fahrenheit, kilos and pounds. There's a wealth of information worth knowing about the never-ending efforts to measure our world—and thus to make it more reliable.



WHAT THE FRENCH REVOLUTION HAS TO DO WITH OUR METER.





PROTECTOSIL® protects bridges against water and prevents corrosion of the reinforcing steel.

You can read more about how to repel pollutants and decisively extend bridges' lifetimes on pages 52 and 53.