Digital transformation

Artificial intelligence, big data, cloud computing, and virtual reality: thyssenkrupp is consistently backing digitization and new business models.

ENERGY
Global production and distribution of energy in 2050: Four Foresight scenarios

OCEANS
The autonomous submarine oXeanseeker aims to make fishing more sustainable in the future

INDUSTRY 4.0
The toii platform networks systems and devices at thyssenkrupp Materials Services
With just **SIX SENSOR SIGNALS**, carValoo can identify damage to an automobile and analyze the user’s driving style.

→ Further details are available on page 14

**THE NEURAL NETWORK OF THE OCEANSEEKER SUBMARINE WILL SOON BE ABLE TO IDENTIFY TEN SPECIES OF FISH.**

→ Find out more on page 18

**The planning process for a new stairlift now takes only one to two days, thanks to hoAliInc. Previously, it required three weeks.**

→ The report on this starts on page 26

**Some 300 machines are already connected to thyssenkrupp’s IoT platform, toii.**

→ The benefits of this are explained on page 30

More than 100 MEMBERS are working together in the International Data Space consortium, which aims to create a secure data space for companies.

→ You can find the article about this on page 44
Dear readers,

The best way to predict the future is to shape it. For this reason, at thyssenkrupp we are already making ever-increasing use of the quality and productivity advantages created by digital transformation. Our customers are at the heart of our strategy. Technologies such as augmented and virtual reality, analytics, artificial intelligence, and cloud computing are helping thyssenkrupp to develop novel solutions that generate additional customer benefit.

What we have learned in the course of thyssenkrupp’s digital development is that you can only shape digital transformation successfully if you can work together in a connected way. As part of this change, competition is moving away from quality and price toward the question of who is fastest at generating the best, most innovative ideas. The future belongs to agile teams of experts – people with a wide range of skills from different departments and companies who drive a project forward.

This is true of the way in which we at thyssenkrupp are collaborating across company and departmental boundaries. One example of this is the launch of the thyssenkrupp Garage, a start-up incubator that is making us much faster at coming up with new ideas and marketable products. We have also found new, creative ways of cooperating with external companies from sectors that are very different to our core businesses. One such case involves the Microsoft Corporation, whom we are collaborating with to revolutionize the maintenance of elevators and the planning of stairlifts.

Data-based cooperation with customers, suppliers, and external partners depends on new, efficient, and above all secure ways of exchanging data. For this reason, our Chief Technology Officer has assumed the chair of the International Data Spaces Association. This consortium of around 100 member companies and associations worldwide aims to create a secure data space where companies can work together in a digital network while retaining complete control over their own data, including contractual terms such as the period of use of data and charges for that use. In this way, we are overcoming another major barrier on the path to intelligent services and innovative business models and processes.

These and other projects by our company are covered in the latest techforum. One final feature I’d like to highlight is an article in our series on futurology, this time looking at the energy systems of the future.

I wish you an enjoyable read.

Dr. Donatus Kaufmann,
Member of the Executive Board of thyssenkrupp AG
Contents

06  Short Cuts
Carbon2Chem | Climate protection award | New logistics center | Research Unit for Elevators | AI cooperation with IBM

Cover story

08  The future of energy
Four scenarios for global production and distribution

Projects

14  Chronology of a vehicle’s life
The carValoo service records every meter that is driven

18  Submarine for greater sustainability
The “oXeanseeker” aims to reduce by-catch in fishing

22  Machine ears
Artificial intelligence identifies quality defects in production

26  Planning with HoloLens
Augmented reality speeds up the production of stairlifts

Open future: From wireless energy transmission to using volcanoes to generate electricity – looking ahead to energy provision in 2050

36  Steel by app:
Since October 2018, thyssenkrupp Schulte customers have been able to order by smartphone – thanks to the App Factory
Keeping watch on marine life: AI enables the autonomous submarine “oXeanseeker” to identify the most important fish species

Panorama

30 Intelligent data hub “toi” is bringing the digital transformation to materials trading

36 Non-stop production The App Factory creates mobile applications

40 Digital pioneers thyssenkrupp employees give free rein to their creativity at Berlin’s betahaus

44 Mutual trust on the internet International data spaces and the blockchain create a secure environment for the exchange of data

48 At home in the digital world A research team in Munich is driving the digital transformation

50 A search for meaning In the year 2030, human beings will have turned into algorithms

51 Imprint
Further recognition for climate protection

The nongovernmental organization CDP has, for the third time in succession, honored thyssenkrupp for being one of the world’s best companies in climate protection. The ranking evaluates whether companies formulate a coherent strategy for further reducing both their own carbon footprint and that of their customers and suppliers. thyssenkrupp was again given the highest rating and included in the Global A List. This covers about 130 companies worldwide, including only five that are listed on the DAX. The award was presented in Brussels on February 19. To progress climate protection efforts, thyssenkrupp is pursuing continuous improvements in efficiency, as well as long-term advances in innovation. With Oxyfuel, for example, the company has developed a solution that can very effectively capture CO₂ during cement production.

Ammonia and methanol from steel mill gases

Another step toward CO₂-free steel production: In a global first, thyssenkrupp has succeeded in producing ammonia and methanol from steel mill gases as part of the Carbon2Chem project. Steel mill gases are emitted during the steel production process and contain valuable chemical elements, such as carbon in the form of carbon monoxide and carbon dioxide (CO₂), nitrogen, and hydrogen. These are used to create synthesis gas, which in turn is a precursor for chemicals such as ammonia and methanol, as well as plastics and higher alcohols. Up to now, synthesis gases have been obtained from fossil fuels such as natural gas or coal – a process that generates carbon dioxide. When employed on an industrial scale, the Carbon2Chem technology can enable around 20 million metric tons of the German steel sector’s annual CO₂ emissions to be used commercially. It can also be deployed in other CO₂-intensive industries. The project is being supported by the German Ministry of Education and Research to the tune of around 60 million euros.
thyssenkrupp and IBM are working together on the future of autonomous driving. The two companies are pursuing a pilot project to investigate the best way of combining their respective strengths. thyssenkrupp is supplying its expertise in vehicle dynamics, while IBM is contributing “Watson,” a cloud platform that provides various types of artificial intelligence. In the course of the joint pilot project, data from the vehicle (such as speed or acceleration) is transmitted to Watson, which evaluates it using AI algorithms. In this way, the system learns how to meet specific requirements increasingly reliably. In the long term, this could result in solutions for autonomous driving using machine learning, for example, to be adapted more and more precisely to the user’s individual driving style.

Starting in summer 2019, thyssenkrupp Schulte is going to build a new logistics center in Rotenburg an der Wümme in Lower Saxony with storage space of up to 50,000 square meters, equivalent to seven soccer fields. Around 60 million euros are being invested in the state-of-the-art facility, which is due to go into operation in 2021 and hold more than 18,000 metric tons of materials such as aluminum, stainless and carbon steel. By storing every item in one location, thyssenkrupp Schulte will ensure the greatest possible availability of materials. State-of-the-art processing equipment and the digital integration of the site promise flexible, perfectly coordinated logistics processes and services.

Construction begins: The new test tower will be one of the tallest in the world

New research unit for elevators in Atlanta

Groundbreaking ceremony in the USA: thyssenkrupp Elevator is building the new Innovation and Qualification Center (IQC) in Atlanta. The centerpiece of the research unit is a 128-meter-tall tower for elevator tests. It is not just the tallest of its kind in the USA but also occupies one of the top positions in the world. The test tower’s 18 shafts will be used in the future to thoroughly examine new concepts and prototypes, including high-speed models and TWIN, thyssenkrupp’s unique elevator system with two cabs in one shaft. Testing will also focus on MULTI, the revolutionary, ropeless elevator system that can also move sideways. This facility will, of course, also perform all the tests that are necessary for approval in accordance with applicable safety standards.

Hands off the steering wheel: Autonomous vehicles will not work without artificial intelligence
A beam of energy keeps the helicopter airborne above New York.
How will the global energy system develop between now and 2050? Experts at thyssenkrupp have come up with four scenarios as part of the Foresight process. They could not be more different.

Carla Benedetti loved this view. From up here, 500 meters above the UN building on the Hudson River, Manhattan was, time and again, an experience that set her pulse racing. She had had the pleasure of enjoying this panorama many times before – as the Italian Minister of International Cooperation, she had already traveled to New York almost twenty times for meetings and negotiations. Today, though, was a very special day – after the international community had agreed on a global language ten years ago, the last UN interpreter had today been symbolically and ceremonially seen off into retirement. Now, most people were able to converse fluently not only in their mother tongue but also in Spachenglish, a combination of Spanish, Chinese, and English. To mark this special occasion, the UN had a documentary made about the history of the political unification process. In this film, Carla was to explain how the revolution in the energy sector had come about.

Beneath her, the Global Energies Inc. skyscraper rose up, completely covered with solar cells. This global company was responsible for the world’s energy supply, which had been based exclusively on electricity for around a decade. “Following spectacular breakthroughs in solar cells and artificial photosynthesis, the international community agreed back in 2030 to focus entirely on the conversion of sunlight into energy,” she says to camera. “Huge solar farms all over the globe were intended to produce electricity that would cost next to nothing and reach consumers through a worldwide network of power lines – including at night, of course.” Carla still had a precise memory of being present in Lisbon on behalf of the Italian government at the opening of the first trans-Atlantic high-voltage cable. Many more had followed, including the “Eurasian »
initially investigating a variety of technologies, the international community decided to focus entirely on solar power for supplying humankind with energy and to concentrate all developments on that source. "As a result of the mass-scale use of new solar technologies, the price of components has dropped dramatically, meaning that electricity can be produced at almost zero cost," Carla says. "Thanks to this and to our ultimate grid, high energy costs are no longer an issue, any more than global warming is." Also, because the experience in this area was so good, the global economy likewise was reorganized by artificial intelligence. Detractors initially called this the "Planned Economy 4.0," but they later had to accept that this centrally supported model was superior to the pure market.

This is what the world around the year 2050 may look like. Thanks to a shared social vision of the future, political common sense, and purposefully pursued innovations, it will have become a place fit for everyone to live in. Collaboration will have taken the place of competition. thyssenkrupp's experts call this scenario "www.wirelessenergy.4all," which emerged as part of the Foresight process on the theme of "Energy Systems and Greenhouse Gas Emissions." There is a simple reason

The global community has joined forces

All this had been made possible only because the international community had come together in the fight against climate change and launched a new world order under the motto, "Cooperation, not competition." The UN laid down a compulsory framework, which the individual regions then implemented according to their specific circumstances. This ambitious vision was rolled out under the heading "A stable and affordable energy supply as a basic right" – and, of course, it always had to be sustainable. After
New types of coal-fired power stations have outperformed wind and solar energy

why the company is looking decades into the future and developing a variety of scenarios: thyssenkrupp’s customers often come from industries with particularly high energy use and emissions, such as the cement, steel, or transportation sectors, which are responsible for almost one-third of global carbon dioxide emissions. If the company could use new technologies to reduce their carbon footprint, this would be a major contribution to environmental protection – and to its own long-term business success. However, the plans that need to be made now for the future depend on many factors, such as the development of global energy systems.

After all, it is far from guaranteed that the optimistic scenario will ever become a reality, even if the world does agree on central control of the energy system. Another possibility is a situation that the thyssenkrupp experts call, “Digital Energies: Much ado about nothing.” This future world, too, has a “UN for energy,” which sets goals and actually implements measures itself. Here, however, electricity comes not from the sun but from coal-fired power stations, which distribute their output through a global, digitized network.

Cheap coal-fired power from the “brown giant”

“We were able to increase efficiency levels significantly thanks to new types of power stations and to outperform all rivals, such as wind and solar energy – it is only thanks to this that your parents now have this ultra-cheap flat rate for electricity,” Chester McMurry, the UN Director for Global Energy Issues, reports to a school class in California. Like every year, he was again on a goodwill tour through the USA, during which he visited at least two high schools every day. He also had a pressing need for a little goodwill, as complaints from customers were growing louder and louder. Electricity production was no longer able to keep up with consumption, and so the “brown giant” – the nickname given to the “UN for energy” – now determined who should switch on their washing machine when or whose turn it was to recharge their electric automobile. This was not a popular decision, although nobody could actually complain about a low standard of living. Besides, McMurry had no real worries, for the energy market was so well protected that it was rare for new players to come along to compete with it.

“And what about climate change?” one school student asked. “Has it not caused whole countries to disappear under the sea?” This question came up in every class, and McMurry had, of course, had a long time to prepare his answer. “Come on, it’s just the Netherlands,” he joked, and today, the room laughed with him, yet again. Hardly any protests were
You can always find somebody willing to take part in a network, as long as a good deal is on offer

to be expected, for people had become accustomed to the limited impact of global warming, which had become a problem only on a very local scale. Besides, the people of the Netherlands had been given a very nice area of land in Kazakhstan in which to make their new homes. Indeed, many did wonder: “First we created this powerful ‘UN for energy,’ and then climate change was only half as bad as we had feared. Was it perhaps just much ado about nothing?”

This is also the view of many people in the “Competition of Opportunistic Deal-Makers” scenario. Here, competition has been taken to extremes, and in this all-embracing rivalry between politicians, companies, religions, and ideologies, everyone is focused on their own short-term benefit. One such person is Wen Zhao, who owns a number of coal-fired power stations in central China. This energy source is extremely cheap and offers high profits. The businessman does not care about the damage it does to the environment, for he has learned that the heat waves and storm surges that are now regular occurrences always affect others - some faraway islands or coastal regions that have warmed by four degrees Celsius. “Bad luck,” he thinks, with no pangs of guilt as he looks out of his office at the smoking chimneys of his power station.

On the contrary, farmers in his region are enjoying record harvests thanks to the high concentration of CO₂ in the air. Also, because the businessman saw this development coming, he bought land years ago and leased it out to those farmers. In this way, he is profiting twice over – first from the electricity and then from the rich yields on the leases. His latest project offers not just high profits but also spectacular sights. “Our artificial volcano,” he is at this moment explaining to his Supervisory Board, “will use the huge energy of the Earth’s crust. To put it simply, we shall throw large explosive charges into volcanoes and fissures. This will produce eruptions, the heat from which we shall use for electricity production. Or something along those lines – I am not a technical expert. The rest is all in the documentation in front of you.” In three years, everything will have been put into place, and already he is looking forward to the huge clouds of smoke that will overshadow even his biggest power stations.

He did not need to worry about much resistance from politicians. As everybody was fighting everybody else and nobody looked more than a few years ahead, he could forge new coalitions with officials, investors, and other companies for each individual project. This was also made especially easy by the fact that large corporations had ceased to exist long ago. What had developed in their place along all value chains was an extremely fragmented market of specialists. There, you could always find somebody willing to take part in a temporary network as long as a good deal was on offer. He had learned on his business trips that this was how things worked everywhere. “Consumer first” was the motto in all the world’s capitals – and why should Wen Zhao not join in this game?

Only tribal leaders and gang chiefs have smartphones

The world is anything but a game for Letizia Garcia. As the leader of a tribe of around 3,000 people on the outskirts of Sao Paolo, she fights every day for the survival of her people. Today, all the adults have gathered in the square outside the former administrative building of a bank that serves as the tribe’s headquarters. On its roof stand a few rusty antennae and a battered metal box, all of which are guarded around the clock. This decades-old technology is a relic of the mobile telephony system that used to connect every inhabitant of Sao Paolo with the whole world. Following the collapse of the telecommunications corporations ten years beforehand, ingenious amateurs had converted it so that neighboring tribes
could talk to each other using its ageing base stations. However, today there are only a small number of smartphones left – most of them more than 20 years old and guarded like gold dust. They are the exclusive property of tribal leaders and gang chiefs, who use them to forge coalitions with neighbors or issue demands to enemies.

“I have just spoken with our allies from the North,” Letizia calls to her assembled tribespeople. As she does so, she has to shout into the hot sandstorm that has been sweeping through the city for days and has followed straight after a period of torrential rain. These have been normal weather conditions since temperatures in Brazil rose by five degrees Celsius.

“They will help us to defend the forest, but in return they demand that we give them one-quarter of our timber harvest in future,” she adds. There is murmuring in the crowd – one-quarter is a lot, for the timber is used not only for heating, cooking, and very basic electricity production; it is also an important raw material for houses and the carts that the tribe use to bring in their vegetable harvest. “Do you agree to this?” Letizia asks the crowd. Hesitantly, most hands go up, and the decision is taken. Since the collapse of the central state, politics has once again reverted back to taking place on countless squares all over the country.

Nobody here engages any more with global issues such as climate change – it is simply present, and they have to live with it. Following the global economic crisis in 2032, people also had very different concerns – societies collapsed, the “survival of the fittest” principle prevailed, and everybody turned to their own local group for protection. Living standards plummeted on an unprecedented scale, and the focus was on day-to-day survival. This is a scenario straight out of an apocalyptic movie, which the thyssenkrupp experts have devised with the title, “Doomsday – The downward spiral,” and it is the complete antithesis of the optimistic assumptions used in the first vision of the future. Time will tell which scenario is closer to reality – but with smart planning today, we can make a contribution toward ensuring that the world around the year 2050 will still be a place worth living in.
Any experts are convinced that car ownership is a thing of the past, for digitization and connectivity mean that mobility will become mainly a service in tomorrow’s world. However, especially for automobiles with a lot of constantly changing drivers, damage often occurs that cannot be attributed retrospectively to one particular user. This applies especially to fleet operators such as car-sharing providers, car rental firms, or leasing companies. Their costs are substantial – for car-sharing vehicles, for example, the amount of damage per year is two to three times that for private automobiles.

Fitness tracker for cars

Especially with automobiles that have many users, damage is not always reported honestly. The new carValoo service aims to change this – using sensors and artificial intelligence...
In addition, not all damage is reported honestly.

This could change soon, for a team at thyssenkrupp has developed carValoo, a data-based service with a name derived from the words “car” and “value,” which records every meter driven and registers damage. Over time, it will help to create a complete vehicle history, digitally retrievable whenever it is needed, that records both aggressive driving behavior and to the last kilometer. The carValoo box is installed in an automobile, and it is easy to add it to an old vehicle. It has sensors that record acceleration and rotational movement by the vehicle precisely along the three spatial axes. These six signals enable users to make deductions about driving style and also provide information about damage. For example, if a user collides with another vehicle, the values measured will show characteristic amplitude and frequency patterns. In addition, a GPS receiver will record the location, making it possible to ascertain exactly where the damage occurred too.

The carValoo box sends all the data to a cloud platform for evaluation. “Every event has a kind of movement fingerprint,” explains Nico Schön, cofounder of carValoo. “Highway driving provides different measured values from city driving; a parking maneuver has a different digital fingerprint from the slamming of a door; and a left turn leads to different data from a hurried braking maneuver.” The carValoo algorithm has been trained by machine learning and has been taught by means of real measured values - for parking dents, for example - to break down a vehicle's movement patterns according to these specific fingerprints. This enables it to identify confidently parking accidents, bumps into curbs, or damage from vandalism. “carValoo guarantees full recording and evaluation of vehicle use, making it possible to track damage to a vehicle effectively, quickly, and reliably,” Schön says. “As a result, nothing can be concealed, because the digital logging»
of damage enables those who cause it to be identified unambiguously.” This means that costs will no longer have to be shared by all drivers in the future.

**Determining residual value objectively**

The automatic analysis of vehicle data can be used to produce movement profiles as well. “This also makes carValoo suitable for billing models that are based on individual driving behavior or vehicle wear,” Schöhn says. “We are in a position to make a qualitative evaluation of every kilometer driven.” For example, carValoo could provide greater transparency in the buying of used automobiles too, because the new technology enables a vehicle’s residual value to be determined individually on the basis of its digital usage history, and not just according to age and mileage. “Naturally, it is obvious that a highway vehicle with 100,000 kilometers on the clock is better than a vehicle with the same figure that has been used just for short trips,” Schöhn says. “Until now, however, buyers have not had an objective instrument to enable them to see this. carValoo allows us to change that.”

The carValoo users can install the sensors in a vehicle themselves. “Our solution is independent of the existing vehicle electronics and can be fitted in just ten minutes,” Schöhn says. “We can offer our customers individual installation training on request.” In addition, access to information is made as simple as possible for users – evaluations of movement profiles, damage, or unusual driver and vehicle behavior can be retrieved with an app, enabling carValoo users to check the status of vehicles at any time. The app can also help users to document instances of damage easily. A claims manager – at a car-sharing provider, for example – has an overview of all vehicles, and the app enables them to administer all cases of damage or to call up carValoo analyses. Technicians, meanwhile, can use the interface to store information about vehicles that have been inspected. The app thus covers the whole claims management process and enhances it with data-based evaluations.

**Data protection is guaranteed**

“Our technology is a fitness tracker for vehicles,” Schöhn explains, in a nutshell. “It offers substantial cost savings to fleet managers – for example, regarding deductibles in the event of damage.” At the same time, data protection is guaranteed. carValoo complies with the terms of the European General Data Protection Regulation (GDPR), which sets new requirements for the handling of personal data. “Data protection is very important to us,” Schöhn stresses. “As a matter of principle, we process and analyze only vehicle-related, not personal, data.” It is always sent in encrypted form to the thyssenkrupp cloud, the servers for which are located solely in Germany or other EU countries. In addition, carValoo customers are obligated to obtain vehicle users’ consent to the scope and the purpose of processing of the data recorded.

The carValoo project was born in 2016 as part of thyssenkrupp’s Innovation Garage. “The project began with the question of how we could develop new, data-based business models on the basis of vehicle data,” reports Sophie Wei, Chief Data Scientist in the carValoo team. Their investigations started with the new active chassis developed by thyssenkrupp. They capture and process numerous pieces of vehicle data to control the chassis in the

“We are in a position to make a qualitative evaluation of every kilometer driven.”

Nico Schöhn, Co-Founder Development & Testing, carValoo team
1. Teamwork: Felix Bömer, Sophie Wei, Nico Schön, Frederik Noll, and Ravi Sharma (from left to right) developed the idea of carValoo. An initial pilot project with one customer has been running since the end of 2018, and negotiations are currently in progress for another. It has already been demonstrated that carValoo makes it possible to identify objectively who is responsible for misuse of vehicles and instances of damage.

2. Update: Student trainee Felix Reese configures the carValoo box with new software for trials on the test track.

3. Keeping watch: The carValoo box is easy to add to an old vehicle, and it records acceleration and rotational movement along three axes. These patterns make it possible to identify, for example, whether the automobile has collided with another vehicle.

best possible way. "We examined other possible uses for this data that might be important for mobility in the present and the future," Wei says. However, in order to keep it independent from the sensors already included in the vehicle, the team opted for a separate box with its own measuring technology. This, ultimately, is how the carValoo idea emerged.

An initial pilot project with one customer has been running since the end of 2018, and negotiations are currently in progress for another. This cooperation with early users is enabling the carValoo team to gather valuable information in real-life operations – for instance, about mobile communications reception in multi-story and underground parking lots. In addition, the customers are providing anonymized information about the reported damage to their vehicles. "We are putting this feedback together with the data from the sensors and thus constantly improving our algorithms," Wei explains. "We have already shown in the pilot project that carValoo makes it possible to identify vehicle misuse and damage objectively. We also want to be able to evaluate driven kilometers qualitatively, to identify residual vehicle values dynamically, and to digitally enhance regular inspections and valuations."
An eye on the prey
The "oXeanseeker" as seen by herring, mackerel, cod, and the like.
Neural network for fishing

Fishermen still find a lot of fish in their nets that they had absolutely no intention of catching. The oXeanseeker aims to reduce this by-catch drastically - and to contribute toward the exploration of the oceans at the same time

Text: Christian Buck Photos: Mads Claus Rasmussen

On a dull, early March afternoon in Rungsted near Copenhagen, Marc Schiemann, Max Abilgaard, and Marc Bornefeld from thyssenkrupp and a handful of colleagues from the thyssenkrupp subsidiaries ATLAS MARIDAN and ATLAS ELEKTRONIK are standing on a footbridge by the Øresund strait. They are eagerly following the movements of a torpedo-shaped mini-submarine, orange at each end and with a shiny gold middle section. It has just been lowered into the sea on two red ropes and is about to show them what it can do. The four rear thrusters start turning, and the autonomous unmanned vehicle (AUV), one meter long and weighing ten kilograms, slowly descends below the surface – still connected to the team on land by a rope as a precaution. Everything goes according to plan, and ten minutes later the first test is over.

Next, the “oXeanseeker” has to prove that it can also operate reliably without a safety rope. A team member throws the now untethered mini-submarine from the bridge into the water, and immediately it begins to move in the Øresund, as intended. This is exactly what it will also be expected to do in the future - users are meant to be able to simply throw this vessel overboard to send it on its mission, which for example could be: “Analyze the composition of a shoal of fish near the ship.”

This will provide very valuable information for the deep-sea fishing industry, a sector that is under a lot of pressure. “By-catch,” in particular, is a big problem – despite sophisticated onboard technology and years of experience, captains can never be completely sure of the exact makeup of a shoal of fish near them. This means they still end up with large amounts of fish and other sea creatures in their nets that are not what they wanted to catch. However, they are not allowed to simply throw them back into the water, because the landing order requires the fish to be brought ashore and sold. As a rule, they are then used to make fishmeal, which makes very little money. However, they are counted toward the ships’ catch quotas, so every metric ton of by-catch costs valuable revenue.

Explore before you fish

If things go as the thyssenkrupp team plans, in the future, fishermen will put the oXeanseeker into the water before casting their nets and use it to ascertain first which fish are swimming in their vicinity. For this purpose, the mini-submarine’s
“The oXeanseeker will be the fishermen’s eyes in the water.”

Marc Schiemann, oXeanseeker project manager

1 Assembly: The team connects the sensor head to the new version of the oXeanseeker.
2 Ready to go: The oXeanseeker rests on the bridge, waiting for its first mission.
3 Water contact: The submarine is lowered into the water on ropes. On its maiden voyage, it remains connected to the team by a rope.
4 Teamwork: Max Abildgaard (with the oXeanseeker), Marc Schiemann (to the left of them), and Marc Bornfeld (left, beside Schiemann), plus colleagues from ATLAS MARIDAN and ATLAS ELEKTRONIK.

The bow is fitted with sensors that can be changed depending on the mission. Used to avoid by-catch, it will determine the shoal’s position with the multibeam sonar in the middle of the bow, enabling the oXeanseeker to move toward the fish independently. Once it has reached them, the light (on the left of the bow) will provide sufficient illumination to allow the camera (on the right) to film what is happening underwater. Next will come the crucial step – a neural network will identify the types of fish. At present, it is able to recognize the three most important European species – herring, mackerel, and cod. By the end of this year, it is set to learn more and then be able to identify the ten most significant species. The artificial intelligence needs five to ten days’ training per fish species to achieve 80-percent accuracy.

As soon as the submarine has analyzed the shoal’s composition, it surfaces and sends its results to the ship by Wi-Fi.
Oceans full of mysteries

However, the intention is that science will benefit from the oXeanseeker as well as fishermen – after all, more than two-thirds of the Earth’s surface is covered by water, and a lot of what lies in the depths of the world’s seas is still unexplored. So it is no wonder that these ecosystems, some of which are extreme, regularly yield headline-making discoveries of new life forms. To put it another way, the seas are home to the last great mysteries of our planet – and the little that we do know is well hidden. Although oil and gas companies, climate researchers, oceanographers, and meteorological services gather huge amounts of information, it is spread across numerous databases, usually hard to access, and in many cases not publicly available at all.

Google of the world’s seas

The plan is to use the oXeanseeker to help create the world’s biggest real-time underwater database, “oXeapedia.” In the future, climate researchers, fishermen, and other interested parties could use it to find out about the current state of the oceans – for example, temperatures, pH values, oxygen and CO₂ levels, the distribution of plankton, and the topology of the seabed. The idea is to build up a “Google of the world’s seas,” as Schiemann succinctly puts it. Alongside their primary role in deep-sea fishing, these mini-submarines could in future gather additional data during their missions and feed them into oXeapedia.

The idea of oXeapedia and the oXeanseeker came about at the end of 2016 and received backing as part of tk Garage, the internal Group incubator that supports new talent with promising ideas. The interdisciplinary team includes colleagues from the Industrial Solutions, Marine Systems, and Components Technology business areas. “Our core team comprises six people, but in all we have around 30 colleagues from widely differing areas supporting the project,” Schiemann reports.

They have already met with a lot of interest in their conversations with fishermen and the fishing industry, and there is a big potential market for the autonomous submarine – worldwide, there are around 92,000 large fishing boats of more than 24 meters in length that could be interested in the oXeanseeker. If the project is successful, it could not just lead to greater sustainability in fishing, but also help uncover the sea’s remaining secrets.

Autonomous submarine

a) The camera provides images of the shoals of fish, which are analyzed by the neural network (species and size of fish).

b) The sonar ascertains the position of the shoals, enabling the mini-submarine to head toward them autonomously.

c) The light ensures that the camera has enough brightness for its photographs.

d) The hermetically sealed pressure hull contains the oXeanseeker’s electronics and batteries.

e) The handle contains the navigation light, as well as the antennae for Wi-Fi and GPS.

f) The drive consists of four propellers that can also be used to steer the submarine. As the oXeanseeker is lighter than water, the drive has to actively push it down below the surface of the water.

To this end, its stern is fitted with an antenna, beside which there is also a GPS receiver. “In the future, the oXeanseeker will be the fishermen’s eyes in the water,” says project manager Marc Schiemann from thyssenkrupp Marine Systems in Kiel. “It will help them to decide based on factual evidence whether or not to head toward a shoal, because they will then know in advance both its makeup and the size of the individual fish.” However, the identification process will require skill and judgement, for the oXeanseeker will have to adapt its speed and lighting to allow it to get as close as five meters from the creatures without scaring them away. “Herring, in particular, like to swim away,” Schiemann reports.
On the hunt for vibrations
Ball screws have a big impact on the acoustic behavior of steering gears. thyssenkrupp Presta has developed a new process that can determine their quality much more precisely than before. Neural networks identify complex connections as part of this process.

When talking about the acoustic experience of driving, the first thing most people think of is engine noise. But there is another element that has a major impact on the driving experience – the steering gear, which has a significant influence on background noise in the vehicle. One reason for this is that the steering gear transmits the movements of the wheels into the interior of the vehicle through vibrations. But noises that are deemed unpleasant are supposed to be as quiet as possible, whereas warning signals have to be heard by the driver.

So in the production process, completed steering gears are subjected to extensive final inspections, during which their acoustic properties are measured precisely. However, these gears are made up of dozens of moving and rigid parts, many of which impact the overall quality. One that is especially important here is the ball screw. It transmits the steering movement to the axle like a worm gear and makes a significant contribution to the vibro-acoustic properties of the whole system.

The properties of the ball screw are therefore examined first during the production process. It is rotated on a test stand and the resulting vibration frequencies measured. If their amplitude within specific areas of the observed spectrum exceeds the limits set by acoustics experts, the ball screw is classed as a reject. If, on the other hand, it passes the test, it can be fitted in the steering gear – which should then, ideally, also get through the acoustic test without a hitch.
But in practice this is not so simple, as a ball screw that tests “OK” can lead to a steering gear that fails the test. There are several reasons for this. First, it is hard to establish a correlation between the quality of the individual components and the steering gear as a whole, meaning that statistical methods have to be used for this. Moreover, the limits for the amplitude of the vibration frequencies are ascertained subjectively through test drives using pre-production components. And last, the final inspection is performed on the assumption that if a single acoustic limit is exceeded just once, this points to a substandard component. However, this can lead to “false rejects.”

**The neural network listens**

For this reason, the experts at thyssenkrupp Presta AG in Eschen, Liechtenstein, have developed a process whereby a neural network is trained to identify common patterns in the vibro-acoustic behavior of ball screws and steering gears and thus arrive at more reliable test results. This process examines not just individual parts of the frequency spectrum but all of them. In this way, the network is able to identify complex connections between the properties of the components. The insights gained as a result of this then help in testing the ball screw first, as usual, so as to draw conclusions about the quality of the subsequent steering gear.

The new process has proven successful. The neural network has been able to detect data that were not covered by the previous quality measurement procedure. It is these very data that have also yielded information about the quality of the ball screw, and this has enabled the focus on the test stand to be adjusted accordingly. The results of the learning process in the network were not abstract patterns but could be traced back to physical effects in the production process.

The new process is also very important to thyssenkrupp in business terms, for the company produces large numbers of ball screws every year at its Schönebeck site. From there, they are distributed to other sites in Europe and all over the world, where they are fitted in steering gears. It takes two to three days to transport them within Europe and six weeks to deliver them to Central America and Asia. This is why it is especially important that these components should not cause any problems when they are finally installed in the steering gears.

The neural network is still at the trial stage, but its positive impact can already be seen. Its use has led to greater reliability in the assessment of ball screws and, consequently, of the entire steering gear system. This has resulted in a significant cost saving. So it is no surprise that other areas are also running projects using neural networks, for their greater predictive power means neural networks can also be used, for example, to shorten the testing period for final inspections in industrial production.
techforum: What is the potential of artificial intelligence in optimizing automobile production?
Andreas Münster: The potential of data-based models in general and of AI methods in particular is huge. To put it simply, these methods enable us to address problems for which no physical model exists. Instead, AI methods use training data to learn a mathematical model that explains the problem and provides correct results, even with new, unfamiliar data. There is a wide range of conceivable cases where this could be used – they usually relate to complex quality issues in production chains that extend across several countries. The next quantum leap will happen when it becomes possible to gather data along the whole automobile production chain and then analyze them in conjunction with the field data that the vehicle generates constantly in everyday use.

techforum: What is thyssenkrupp doing in this field?
AM: This topic is, of course, of vital importance to thyssenkrupp. Here at thyssenkrupp Presta, in addition to the improvements in the production chain that I have already mentioned, we are tackling other types of challenges, such as autonomous driving. There are also a number of AI projects going on in the Group, such as carValoo.

techforum: When will AI methods leave the pilot stage and be used in production as a matter of course?
AM: There is no AI-specific answer to this question, because all other statistical data analysis methods have to be taken into account, too. For these processes to leave the pilot stage, it is necessary, first, to have an advanced hardware and software infrastructure that can capture data from machines and store it in analysis-friendly form centrally and in a way that makes it available to all analysts. Second, there needs to be an organizational infrastructure of experts who can use this data-capturing and evaluation pipeline to extract new insights from the data. In most cases these infrastructure requirements have not yet been fully met in the manufacturing industry. So the crucial question is: When will this infrastructure – both technological and organizational – have been completely developed and rolled out? Personally, I still think this will take several years.
Augmented reality: Data glasses allow building work to be visualized and evaluated beforehand.
Revolution on the staircase

Mixed reality combined with a cloud-based configurator: HoloLinc shortens the planning process for stairlifts dramatically and helps people regain mobility quickly.

Text: Axel Novak
Sometimes, things simply cannot happen quickly enough. One example is when people require help urgently – with a stairlift, for example. Those who need this sort of aid are often in a state of acute difficulty and want to regain their mobility as soon as possible. A stairlift provides quality of life, and people who need this should not have to wait too long to get it.

This view is shared by thyssenkrupp Elevator. With its global innovation, HoloLinc, the company is reducing the delivery period for a new stairlift from up to ten weeks at present to just two weeks – and revolutionizing the entire market in the process. “HoloLinc makes a completely digitized sales process possible in the stairlift sector,” explains Simon Feismann, who is responsible for the introduction of the new tool. “We are simplifying the measurement of staircases and offering our customers the unique service of being able to directly view an image of how the planned lift will look on their staircase.”

Each lift is adapted

The principle of a stairlift is simple – a chair moves by means of a toothed-wheel mechanism along a rail attached to the staircase. The user operates it with a remote control. Probably the most spectacular example of such an installation is the world’s highest stairlift in the Makkah Clock Tower in Saudi Arabia, at a height of 601 meters. It winds its way up the 27-meter-long rail on a staircase with a total of seven turns in just three minutes. Traditional solutions for private homes usually involve simpler installations from just one floor to another, but even this requires engineering skill, for each stairlift is adapted to the individual customer and their specific needs. The design process has to take account of not just the customer’s physical characteristics but also the structural properties of the staircase. Some manufacturers rely here on construction elements that are prefabricated in a modular manner, so as to enable their products to be installed as quickly as possible. However, this often means the journey is much less comfortable than it is on a custom-made lift.

Measuring with HoloLens

The HoloLinc technology means thyssenkrupp Elevator can produce its equipment not only quickly but also on a tailored basis and without sacrificing quality. “Holo” here stands for the data glasses known as “HoloLens,” and “Linc” for the fact that they are linked to intelligent planning software. HoloLinc enables a sales representative to use the data glasses to measure the customer’s staircase on a single visit. The results are very precise and take account of even small, seemingly difficult details. The data is then sent to Microsoft’s cloud platform Azure and can be presented visually on two devices – the spectacles or a tablet.

This visualization shows the customer what the proposed lift will look like later in their home. The presentation in augmented reality helps many potential buyers to overcome their fear of having a stairlift installed. “The technology used here is not just unique – it is also like playing with a toy,” Feismann says. “Even sales representatives with little experience can gather the necessary information quickly and skillfully, and customers are truly amazed when they are able to sit in their own home and see what the lift will look like on their staircase and how it will work.” The lift can also be adapted quickly and easily to individual preferences, and, finally, the customer can also be given a quotation there and then.

“We have managed to reduce the original three-week planning process for a lift to one to two days.”

Simon Feismann, thyssenkrupp Elevator

Visualization: Customers can see what the stairlift will look like
offer. If the customer accepted this, it was followed by a time-consuming exercise to measure the staircase with the help of a camera system. This often required a second visit. Only once the measurement data was available could the order – many elements of which were still prepared by hand – be processed, and it was only after this had been done that the actual feasibility check by the engineers at the Krimpen stairlift plant in the Netherlands could take place. The fact that the lift is custom-built means that further small changes are frequently made to the design before it goes into production, and before the introduction of HoloLinc, this meant that time-consuming coordination work between the plant, sales representatives, and customers was often necessary before the final design was eventually agreed. As a result, customers would lose precious time in their difficult personal situation.

For this reason, three years ago thyssenkrupp Elevator’s engineers started to consider how the ordering process for the custom-made guide tube could be automated and accelerated. Working with Microsoft and Zühlike Engineering GmbH, they began combining mixed-reality technology with a cloud-based configurator.

30,000 stairlifts are sold by thyssenkrupp Elevator in Europe every year. Demographic changes mean that this figure is likely to continue to rise.

Microsoft is the partner for measurement technology and provides the communications infrastructure for the data flow, while Zühlike is the implementation partner for linking the various systems together logically and efficiently. The partners are planning to push digitization further and further, because thyssenkrupp Elevator wants to use HoloLinc to digitize more than just one production step. The goal is a completely digitized production chain, from initial measurement through to assembly. Artificial intelligence and additional automated processes – for example, in the design of the stairlifts – could make processes even more efficient and faster in the future.

Following a successful pilot project in the Netherlands, thyssenkrupp Elevator has now introduced the system in Germany, the UK, Belgium, France, Italy, Spain, and Norway. Japan is set to follow later. thyssenkrupp Elevator has to take account of the differences between these markets. In the Netherlands, for example, staircases are high and narrow, for historical reasons. As a result, very tight spiral staircases make considerable demands on the design of a stairlift.

Fast-growing market
The HoloLinc solution is helping thyssenkrupp Elevator to serve a fast-growing market. The company sells and installs around 30,000 stairlifts in Europe every year, and this figure will probably continue to rise. With an aging population, in the year 2060 Germany will have 65 people aged 65 and over for every 100 of working age – the present number is only 37. For those people, independence and mobility at home will be crucial to their quality of life. thyssenkrupp Elevator has been active in this sector for 60 years and is a market leader in custom-made installation projects on tight, difficult, and winding staircases. “We have the best product on the market, we can meet all customer requests perfectly – and if we plan and produce even more quickly, this will give us an additional competitive advantage,” Simon Feismann observes.
One language for all

At thyssenkrupp Materials Services machines, workpieces, and logistics communicate with each other via the specially developed “toii” platform. This connectedness opens up huge potential

Text: Mirko Heinemann
The robust metal saw dates back to the 1960s. Immediately beside it stand modern longitudinal slitting lines. They unwind material from the coil, cut it into narrower strips, and measure the result entirely automatically. In other production areas, metal sheets are cut by laser or plasma arc into various shapes in line with customer specifications. One step further, a mechanic has to get involved to drill a hole as specified in the customer order. The item then needs to be given a special coating before being delivered.

At thyssenkrupp Materials Services, different types of tasks are performed by a variety of machines. The Materials Services team supplies raw and processed materials to industrial customers. Processing is done according to customer specification, and includes slitting, cutting to length, cutting, sawing, drilling, milling, and coating. Sophisticated logistics ensure the materials get to their destinations all over the world “just in time”. Most customers come from the metalworking industry and many from the automotive sector.

Materials Services is currently undergoing a digital transformation. The aim is to achieve more efficient, automated processes, higher quality, and even greater logistics integration. A quick look at its machine pool illustrates how hard it is to digitize the entire value chain. The machines not only vary in age, they also come from different manufacturers. In addition to machine tools, there are assets such as cranes, forklifts, warehouses, and other production facilities. There are also a large number of parts – the Materials Services product portfolio covers around 150,000 items.

Axel Berger, Head of Digital Transformation, who manages the company’s
IT professionals from Germany, India, and the USA, has accepted this challenge. Together with his team, he has developed a dedicated digital platform called “toii.” This name spells the acronym “IIoT” backwards, which stands for “Industrial Internet of Things,” and alludes to the word “toy” – the idea being that machines should be integrated and industrial processes controlled in a manner that is almost child’s play. The software architecture is based on the interplay between data from sensors and machine and movement data, which can be linked to warehouse data, order processes, and customer orders. This enables more and more processes to be automated.

**Modules for specific tasks**

This digital connectedness opens up huge potential for Materials Services. However, the road is paved with numerous challenges. The very first is that there is no standard interface and no uniform protocol that is “understood” by all machine types from different eras. To achieve end-to-end digitization, Berger’s team had to find a digital language in which all assets could communicate. Off-the-shelf products were no use here. A dedicated protocol had to be developed along with a separate communications infrastructure, the heart of which is the “toii” platform.

Various interfaces or modules are docked onto the platform. For example, “toii.Collect” pulls together the data from the machines and returns it to the platform; “toii.Control” is a control module for the machines; and “toii.Fusion” is a visualization module for the operator, presenting productivity and capacity curves or data from third-party systems, such as an ERP system.

The ERP system can, for example, link order data to the machines’ capacity data. It can calculate how the machines can be used efficiently or when an order will have been completed. Intralogistics is integrated, too. Procurement tells the driver of a forklift where in the warehouse they should place which item for storage. When this has been done, the information is sent back to the ERP system. In this way, people always know what the situation in the warehouse is, and ordering and order picking can be handled automatically.

At Materials Processing Europe in Mannheim, for instance, “toii” controls a highly complex cut-to-length line that cuts sheets from wide strip coils. The platform transmits work orders from the SAP system directly to the machine and controls its settings – size, weight, quantity. At the same time, operating data from the machine is fed back into SAP. This means the status of production and of the finished product can be seen at any time. What was pro-
duced when, and in what quantity? What additional materials need to be delivered? The system answers all of these and many other questions by not only gathering data but also analyzing it. The results are available at the click of a mouse, clearly presented and easy to understand.

Precise predictions
“toii.Think,” a module connected to the platform, provides added value. Here, special algorithms help to generate new insights from the incoming data. For example, in the future it can be used for predictive maintenance. Where and how quickly is a problem developing? When will the machine need to be serviced, and when may it actually need to be replaced? The more data that are gathered over time, the more precise such predictions will be. “toii.Think” has created an option for future smart data applications with almost unlimited potential for expansion.

But what if not all the data is available digitally – from an analog band saw, for example? “Then the platform will not know which order is being handled at a particular moment or what material is on the saw,” Berger admits. This is where the machine’s operator will come in. They will have to scan the order using a barcode or enter it on a PC. Then it will become part of the machine’s data set and be included in the subsequent digital handling of the job. Another simple analog-digital interface comes from “toii.Lights,” a smart idea inspired by the Japanese Andon method: Light signals indicate the current status of an analog machine and convert this into digital data.

Digital transformation at the core
There is great pride in the new platform. “We have created a comprehensive solution that is not merely tailored precisely to our own requirements but is actually geared to the diverse needs of small and medium-sized industrial companies,” Axel Berger explains. “It enables us to push forward automation in production quickly and makes our processes much more efficient. As a result, we are now also bringing the digital transformation into the core of our business – our factory floors, our machine pool, and our materials. This will naturally benefit our customers, but it will also be good for us.”

Some 300 machines are already connected to the platform, including 60 band saws, numerous slitters and cut-to-length lines, slitting lines for slabs, packaging units, measuring systems, and 18 high-bay warehouses – as well as numerous cranes, forklifts, and other vehicles, such as almost 100 wheel loaders. In all, there are many thousands of “things,” including sensors, actuators, or manual measuring instruments. Soon, there will also be a huge, global, virtual materials warehouse, with more than 150,000 products and services. There is already digital access to 3.5 million square meters of storage space at 271 international locations.

The beauty of the idea is that once “toii” has been installed, numbers and sizes will no longer matter. The platform is very scalable, which means it can grow as needed. Why not go a step further and also offer “toii” to external customers? “We did indeed build the platform not as a project but as a product,” Berger says. This means it will also be installed in other business areas. Theoretically, it is also capable of being used outside of thyssenkrupp. At present, however, such a step is not yet planned, says the head of digitization.
The toii platform was developed to connect technological systems and devices at thyssenkrupp Materials Services efficiently. It enables digital communication between the various machines as well as with the ERP system, intralogistics, and production control.

**Platform for Industry 4.0**

**Machine integration**
Old as well as network-compatible and IoT-capable machines made by various manufacturers can all be integrated. Light signals indicate the status of analogue machines and convert this into digital data.

**Integration of assets**
Vehicles such as forklifts, dumper trucks, or containers are integrated through the IoT network and can thus be deployed more efficiently.

**Artificial intelligence**
Machine data gathered over a long period of time are analyzed. Machine learning enables process optimization and predictive maintenance.

**Measurement and quality control**
Measurement data – including from manual measurements with micrometers or calipers – reach the platform via a Wi-Fi connection and are compared there with the nominal values from the ERP system. Discrepancies are notified to the operator immediately and escalated automatically as required.
**toii® modules**

The individual modules are connected to the platform. They perform many functions in the digital factory, from data collection to control and visualization.

- **toii®.Collect**  
  This module collects data from the machines - ranging from simple devices without programmable logic controllers, or older machines with custom interfaces, to modern, IoT-capable machines.

- **toii®.Lights**  
  Uses the principle of the Japanese Andon method – light signals indicate the status of an analogue machine and convert it into digital data. The status of all machines can be seen in a web browser. This is a simple, effective, low-cost, entry-level solution.

- **toii®.Fusion**  
  Interprets and visualizes machine data transmitted by toii.Collect, toii.Control, or toii.Lights. The data are combined with external data and make production output visible on dashboards. All relevant data can be displayed on a desktop.

- **toii®.Control**  
  The integration module for the automation and control of all machines. Machines are connected bidirectionally, processes are automated, and data streams in the factory are controlled. The operator is kept informed by means of modern user interface technology.

- **toii®.Think**  
  Option for future smart data applications with unlimited potential for expansion. Here, algorithms can foresee the machines’ maintenance requirements through predictive maintenance, optimize production efficiency, develop customized processes, or generate new business models.

- **toii®.PDC**  
  The platform’s mobile module. Data from portable devices are transmitted by toii.PDC to the platform for further processing.

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**Intralogistics management**  
Procurement and warehousing are connected to each other and to the ERP system. This means that ordering and order-picking can be handled automatically.

**Integration of the ERP system**  
A connected ERP system links order and capacity data together. It can determine order times and perform efficiency calculations. Productivity and capacity curves or data from third-party systems are presented visually on a desktop.

**Just-in-time delivery**  
The exact calculation of the order time also optimizes just-in-time logistics. Supply flows can be adjusted even better to meet customer needs.
Things are looking serious. Oil is leaking from the excavator undercarriage – from a roller that holds the chain in position. If the leak is not stopped, the construction vehicle will wear out more quickly or fail completely. This means urgent action is called for. In the past, that required an employee of the construction firm to contact the undercarriage manufacturer (Berco) by email to describe the problem. Berco’s service team would then get in touch and ask for the part number and details of where it was being used and how long it had been in operation. The customer, in turn, would send those details back – and so on and so forth.

However, the days of those back-and-forward email exchanges are over. For a while now, the construction company has been able to report problems quickly and easily using a mobile app. All the customer has to do is open the “easy support app”...
and answer a few simple questions. After that, they can also attach a photo of the damage – and that is all. “This gives us, in a structured form, all the data we need to be able to decide whether it is potentially suitable for repair under guarantee,” explains Dr. Tobias Posner, head of the US spare parts business at Berco, a thyssenkrupp subsidiary. Thanks to the app, the customer receives a response within a week – it sometimes took much longer than that in the past. “This saves a huge amount of time both for customers and for Berco,” says Posner, who came up with the idea of the “easy support app.” It was also put into practice very quickly – in less than six months the idea had been turned into a finished app that Berco’s customers can download free of charge.

All-inclusive package
It was made possible by the App Factory, a new team within thyssenkrupp Materials Services GmbH that specializes in helping mobile apps become a reality. “We look after every step, right up to go-live and beyond,” says Daniel Schorzmann, the head of the in-house app maker. Any thyssenkrupp employee from any business area who has an idea for an app can approach the team and will be supported in putting it into practice. The App Factory helps with planning the project and refining the concept, and the digital experts also manage the development of the software and handle the necessary tests. “We offer an
“It is all about sensing needs before customers even articulate them.”

Andreas Kellermann, head of thyssenkrupp Schulte’s Munich site

all-inclusive package,” Schorzmann says, summing it up. What emerges at the end is a finished app that can be downloaded in the normal way through the Play Store (for Android) or the App Store (for iOS).

Of course, the idea of mobile apps is nothing new at thyssenkrupp. Some business areas are already using apps, but these are individual cases, where each area has driven its own applications forward with the help of outside service providers. This means expertise in mobile apps has indeed been developed, but it has happened only in individual business units.

Furthermore, the various app projects in the group have often known nothing of each other. “So there was no transfer of expertise,” Schorzmann reports. The creation of the App Factory means there is now a central contact point that not only turns out mobile apps quickly but also pools the relevant knowledge so that it is available throughout the Group.

The mobile app makers’ first customers included thyssenkrupp Schulte, a leading service provider for steel, stainless steel, and nonferrous metals. The company supplies metalworking companies, for example, with materials such as bars or tubes. Customers have traditionally submitted their enquiries by telephone, email, or fax. At the end of 2017, the idea came up within the company of offering an additional, simpler way of making contact – a mobile app. “This attracted a lot of interest from customers,” recalls Andreas Kellermann, head of the Munich site. And so, they got in touch with the App Factory. A rough concept was worked out, and after just a few months, a first version was ready. “We then went to one of our customers and presented it to them,” Kellermann continues. The business partners were excited there and then, but they also wanted to be able to do more – not just submit enquiries but also place orders at the same time. In collaboration with the team from the App Factory, this wish came true. The finished “easy supply app” has been available for

Bull’s-eye: Andreas Kellermann immediately attracted a lot of interest from customers with his new app
download from the app stores for iOS and Android devices since October 2018. The small program makes buying steel beams as easy as ordering shoes online – maybe even easier. It is based on the QR codes that are found on every product. Customers can, for example, attach the code directly to the shelf where the relevant parts are kept. If it is empty and needs to be restocked, all an employee has to do is launch the app, scan the QR code, and enter the required quantity. The order is then automatically transmitted to thyssenkrupp Schulte and processed. Fundamentally, therefore, the app performs the function that used to be handled with kanban cards. “The key advantage for our customers is that they can now send us their requirements around the clock,” Kellermann says.

Focus on what is practicable

With the “easy supply app,” the App Factory has shown that the concept of using digital technology to bring ideas to life works. However, this “interface work,” as Schorzmann describes it, is not always straightforward. On one side you have the app inventors, from whom ideas simply pour out and who come up with something new every day for which their program could be used. On the other you have the App Factory team, who have to focus on what is practicable – questions such as what can actually be programmed, whether it complies with data protection rules, and whether it observes IT security requirements. “Sometimes the inventors expect us to perform magic,” Schorzmann says with a grin.

The core work involved in creating an app – the actual programming – is performed by the thyssenkrupp subsidiary GSS IT India. This company is home to ten developers, who are responsible for activities including the development of mobile apps. The “easy support app” and the “easy supply app” were also their doing. The Berco executive, Posner, is enthusiastic about the ease with which his company cooperates with its Indian colleagues using an electronic project schedule. “You can submit tasks and immediately see them being worked on,” he says. However, even the development of apps does not happen entirely without any conversations. “I am on the telephone to India every day,” Schorzmann reports. What is more, their colleagues on the subcontinent work on German time in order to make coordination easier.

Just as important as contact with the developers is contact with customers. “We involved users from the very beginning,” reports Kellermann, the man behind the “easy supply app.” With every new test version, his team went out to customers and collected feedback on every detail, however small. “We spent a long time talking about the design of the data entry fields to enable employees to get through the app quickly,” Kellermann says, citing one example. This is a dialogue that continues even after the program has gone live. After all, a good app is never finished. Kellermann is continuing to talk to customers about mobile possibilities, and additional functions are already being worked on. “It is all about sensing needs before customers even articulate them,” he explains.
thyssenkrupp wants to accelerate the digital transformation. To do this, the Group is sending “smart steel pioneers” to Berlin. Their mission is to find new solutions to everyday challenges

Finding the right person to fill a vacancy is no easy task: Applications have to be examined, relevant specialist departments involved, and interviews carried out. If this process could be shortened, it would be a considerable help to both applicants and HR managers. This was also the view of Timo Kissmer from HR Development at thyssenkrupp Steel Europe (tkSE). “Face-to-face impressions are extremely important in a job application process,” says Kissmer, a 25-year-old business economist. “For this reason, I looked for a way to capture this first impression of a candidate without taking up a lot of time for either party – perhaps by using a video.”

Kissmer used this idea in his application for the “smart steel pioneer program,” which tkSE developed in 2016. The aim is to accelerate the digital transformation of Germany’s biggest steel group. The program seeks to appeal to everybody in the group, and not just those who are already familiar with digitization topics. So far, employees from Controlling, Sales, and Research and Development have also taken part. In addition, age is not a factor – in the first two years, the spectrum ranged from early 20s to mid-40s, but the program is also open to applications from people in their mid-50s.

“Our pioneers try to use new technologies, methods, and business models to find solutions to everyday challenges,” explains Kerstin Dähne, Head of People Development. The idea is that they should give free rein to their creativity without fixed structures, working hours, targets, and hierarchies, work independently, and learn to think in an entrepreneurial way, just like in young start-ups. This works...
best in places where the winds of start-up change are particularly noticeable. For this reason, they opted for Berlin and the betahaus. On average, there are six pioneers working there in start-up conditions. They all sit together, which means they are not alone as they each advance their own projects. Every three months, three of them are replaced. In this way, the aim is to keep everything in a constant state of flux.

Timo Kissmer, too, has been working on his idea at the betahaus since last October, after persuading the Digital Acceleration Office (DAO), the top steering committee for all digital issues at tkSE, of its merits. He quickly turned his first idea into reality there. “As soon as somebody applies for a position, they receive a link that they can use to carry out their first video interview – whenever and wherever they like, for there is no need to schedule an appointment,” Kissmer explains. “Similarly, the recruiter can watch the video whenever they want.” However, he then found out during his market research that there are already a number of providers of such online-based video interviews; and so, he changed his objective, just as young founders of start-ups do when they get stuck at a particular point. His new aim was to find the best provider, contact them, and work together to develop adjustments to match the specific needs of tkSE.

Six months in Berlin
Like all the other pioneers, Kissmer has moved to Berlin for a six-month period. At the betahaus, he can gradually and independently put flesh on the bones of his idea. Every six weeks, he has to present the progress he has made to the DAO – and also indicate what financial resources he needs for the next development step.”
and what they will be spent on. In other words, Kissmer has to sell his project to an interested but critical audience, just like in the real world.

It was the same story for Anika Cornelius. She had the idea of developing an app for maintaining machines: when one breaks down, the app shows the service technician on their smartphone precisely which functions have failed and what parts they need to get the machinery going again. It uses augmented reality in this process, so the technician sees a particular part in its actual setting. “It is a little like the smartphone game Pokémon Go,” says the 31-year-old business mathematician, who worked at the betahaus from April through September 2018. There, she first established what the app should be able to do. Then she went looking for somebody to program the app. In Berlin, she met with people from different companies, invited offers, and finally commissioned a start-up to turn it into reality. The prototype was then trialed with customers. Under the pioneer program, these “customers” are departments within the group that might benefit from the innovation.

The group’s maintenance department found the prototype so promising that it is now being developed further by a dedicated project team. Cornelius is still involved in the project; this is not

“My project manager wants me to bring the agile Berlin way of working to the team.”

Anika Cornelius, Smart Steel Pioneer
actually part of the program, but the project manager in Duisburg was emphatic about having her on board. “He wants me to bring the agile Berlin way of working to the team, so that everything moves more quickly,” Cornelius says. Kissmer’s project, too, is being turned into reality – he is currently working with the tkSE HR Department to put his video applications into practice.

Failure is allowed

However, not all pioneer projects end up being implemented by the Group. Some are terminated when it becomes evident that they are unfeasible. Others are shelved once the pioneer project is over. However, those in charge at the DAO do not regard this as a problem. On the contrary, one of the program’s mottos is “failure is allowed,” which picks up on a mantra from the start-up world. “By failing, you gain experience in identifying something and taking measures against it. This is an important learning process. We are very consciously seeking to promote new ways of thinking and acting,” Dähne says.

Nevertheless, it is not always easy to simply disengage from a department, current projects, and operational business for six months. “Of course, line managers are always very hesitant about letting their best people go for half a year. However, we get very positive feedback from those that do agree to it. They say that when the employees come back they think and act differently,” Dähne reports. Many heads of department have actually taken the trouble themselves to encourage promising employees to apply for places on the pioneer program. When they come back – the calculation goes – the experience they have gained and their unconventional way of working will make them role models for their colleagues.

For those temporary entrepreneurs, however, the process of coming back is not so easy. Many do appreciate the security that the structure of a big group provides, but they also miss the freedom that they now have to give up again. In Berlin, they could work whenever they wanted, at night or on Sundays if they wished, and then go for a walk in the park during the week. They could make appointments without coordinating with anybody else, and they could make decisions. They had no boss to tell them what to do. “Reacclimatizing to Duisburg is a major adjustment. In Berlin, everything happens much faster,” Cornelius says. Nevertheless, it was clear to her and all the others that they would have to go back. However, they also enjoy acting as role models and finding that they can make something happen through the experience they have gained. “The Pioneer program is driving cultural change in the company,” Kissmer agrees. “The people who come back from Berlin work differently, and they have developed a different feel for things. This enables us to break up entrenched structures and unleash new potential.”

Start-up incubator: The betahaus is close to Checkpoint Charlie in central Berlin.

“The people who come back from Berlin work differently, and they have developed a different feel for things.”

Timo Kissmer, Smart Steel Pioneer
Companies are wary of moving into 3D printing because they do not want to disclose their design data. Two new technologies now offer greater security: International Data Spaces and blockchain.

Text: Constantin Gilles

Secure data hub
Here is what tomorrow’s manufacturing world could look like: toolmaker X dreams of a new, revolutionary product. They want to bring a drill head with internal coolant channels onto the market. This would make it possible to achieve much greater speeds and longer continuous operation. However, this drill head with integrated channels can only be produced by additive manufacturing and has to be redesigned accordingly. Toolmaker X has no experience of either of these things, so they send their design data to thyssenkrupp’s TechCenter Additive Manufacturing, where engineers add the coolant channels and pass the data on to a 3D printing service provider. That, at least, is the vision. In practice, however, many companies are hesitant about handing over their data – and this means they are missing out on the additive manufacturing revolution.

Thyssenkrupp has now removed this barrier with the aid of an IT solution that lets manufacturers retain control over their data and exchange for companies. “In this way, it is possible not only to transmit design data securely but also, for example, to receive information about quality from the printing service provider,” explains Frederik Noll from thyssenkrupp’s Innovation Strategy and Projects department. The secure environment for the transfer of data was created in collaboration with IBM and the Fraunhofer Institute for Software and Systems Engineering (ISST) in Dortmund. What is special about this is that data transmitted via the IDS are additionally protected against manipulation by a blockchain. Blockchain as an electronic log

Known as the backbone of the digital currency, bitcoin, a blockchain operates essentially like an electronic log. It runs in parallel on all parties’ computers and captures all transactions, such as the transmission of design data or the start of production by the 3D printing service. Any change is recorded in all copies of the log (also known as the “distributed ledger”) in such a way that it cannot subsequently be altered again. “Blockchain technology provides transparency and traceability – a perfect complement to the IDS with its secure transmission routes,” says Sarah Wiederkehr, a consultant at IBM.

International Data Spaces and blockchain are intended to create trust – and this is precisely what Industry 4.0 needs urgently, for companies will only join networks if they can be confident of keeping control of their data. It is this realization that gave birth to the IDS four years ago. Forty companies and twelve Fraunhofer Institutes came together in 2015 to create the protected data platform initially known as the Industrial Data Space. The consortium has now grown to comprise more than 100 members.
clearly what is happening to your data, you will be more willing to share them,” the thyssenkrupp innovation strategist Dr. Joachim Stumpfe explains. thyssenkrupp is currently pursuing another pilot project to explore how the IDS can simplify this sharing. The Industrial Solutions business area is working on ideas that will enable cement production plants to be connected to the IDS. This involves complete factories made up, for example, of silos, mills, and drying facilities. All these components gather data around the clock that are theoretically very valuable. They can be used, for example, to identify technical irregularities at an early stage, enabling a maintenance engineer to intervene before problems occur (predictive maintenance). However, little use is being made of this potential at present because plant operators are wary of sharing their data with the manufacturer. There is a lack of trust. International Data Spaces is designed to create precisely that: thyssenkrupp is looking to use the IDS together and regulate the sharing of data by means of simple contract clauses.

**Equal rights for all**

Of course, companies are already handling business electronically even without the IDS, but this often works only on a bilateral basis – company X connecting with company Y. If more companies are to be included, a lot of work is often required because there are no universal standards. In addition, in digital exchanges it is usually the company with the greatest market power that calls the shots. International Data Spaces is different – here, all users have equal rights, and they establish the rules together. Furthermore, there is no central server with an all-powerful operator behind it. The IDS is built on the peer-to-peer principle. This means that the data are held on the users’ computers, which access the network through special software (known as the “connector”).

The great advantage of the International Data Space is that users retain control over their data at all times. They can specify in exact terms who is allowed to see and use which information. They can also sell data packets in accordance with simple rules, such as “if you want to view my machine data, it will cost two cents per day.” Very different rules apply in the world of private internet users: if you upload your data to Google’s or Microsoft’s clouds, you have little or no way of seeing what is happening to it and who can access it. This uncertainty is exactly the sort of thing that the IDS prevents.

Retaining control over data is, of course, not an end in itself. “If you can see

**Basis of new business models**

International Data Spaces does not just foster trust between companies, it also makes completely new types of business possible. “Dispersed data marketplaces could create a lot of added value in the future,” says innovation expert Noll. For example, manufacturing companies could sell data from their plants to third parties, who could then use them to train self-learning computer programs (machine learning). The Düsseldorf-based start-up Advanceo has already established one such market. In this way, companies could generate additional revenue from digital information that would otherwise be lying around on servers unused.

So there is no shortage of good ideas for how to use the IDS. However, it is not
yet completely established as standard. One reason for this is the democratic structure of the consortium. "The difficulty lies in reconciling the interests of all those involved," explains Dr. Bernhard Holtkamp, deputy head of department at the Fraunhofer ISST. The thyssenkrupp expert Noll sees another challenge. "The number of partners is simply not yet high enough," he says. To put it another way, a new standard in B2B data exchange is being thwarted by the classic chicken-and-egg problem - potential participants are waiting for other companies to sign up, but those companies too are waiting for others to move. However, the pioneers believe that a breakthrough will come, not least as a result of the new combination of IDS and blockchain. "This could provide a boost," the Fraunhofer researcher Holtkamp says confidently.

"If you can see clearly what is happening to your data, you will be more willing to share them."

Joachim Stumpfe, innovation strategist at thyssenkrupp

Cement plants could transmit production data via IDS to help them identify technical problems at an early the future
Inspirational diversity

Mechatronics, simulation, and data analytics: The thyssenkrupp team at the TechCenter Control Technology in Munich is developing innovative system solutions and using all the elements of the digital world.

Text: Barbel Brockmann

If you are designing a new product, you need to get it simulated digitally first to see whether your idea is practicable and what adjustments need to be made in order for the whole thing to work in the end. When anyone in the thyssenkrupp Group wants to check an idea’s feasibility in this way, they turn to the research team at the TechCenter Control Technology in Munich. Their current project is Carbon2Chem, which is investigating the feasibility of using mill gases from the steel production process as a raw material for chemical products, so as to reduce carbon dioxide emissions – a megaproject being conducted under thyssenkrupp’s leadership and involving numerous partners from industry such as BASF, Linde, and Siemens, as well as research institutions.

Carbon2Chem requires a very wide range of plant sections to be brought together – a steel melt shop, a power station, a gas purification system, chemical facilities, an electrolysis plant, and many more. Researchers at the TechCenter are in the process of developing a simulation framework for this cross-company network. “This will enable us to bring the various plant section models together in a large-scale simulation of the whole plant network,” explains Jonas Grundler, a mechanical engineer. Along with two colleagues – one a mechanical engineer like him, the other a mathematician – he is part of the simulation team and has been working for two years on this project, which will run up to 2020.

The work of Grundler and his colleagues is a good example of digital transformation, which is currently the subject of much discussion. It stands for the connection of universally accessible data, mathematical models, and self-learning algorithms.

Checks: Janos Jung testing software using hardware-in-the-loop

Simulation: Jonas Grundler and Andreas Diekmann (left to right) discuss the energy flow in the Carbon2Chem plant network
The aim here is to have several elevator cabs operating online in English. The team in Munich is responsible for the Multi’s drive technology, sensors, and movement control. “We are working on the specific requirements of the motor and the related power electronics, which makes sense because we used to work on the technology for the Transrapid maglev train. Like the Transrapid, the Multi elevator uses a linear motor,” says Janos Jung, an electrical engineer who has been supporting the project from the outset. However, his colleagues and he are also keeping an eye on the latest technologies in power and process electronics. “We must always be completely up to date with the latest research in order to be able to propose solutions to difficult issues,” Jung comments.

The 20-odd researchers at the TechCenter Control Technology work in a modern, light-flooded office building in the north of Munich. When the skies are clear, you can see all the way to the Alps. The team covers all the relevant specialist areas: engineering, physics, mathematics, and information technology – plus an inspiring level of diversity. They work across different locations and continents, and they are also happy to operate online in English.
Human beings as algorithms

Digitalization is the dominant paradigm of the 21st century – and Google now performs miracles

The 20th century was the age of the automobile, a time when human beings practically turned into such vehicles. When strolling along a sidewalk, they would walk on the right, overtake on the left, and stop at pedestrian lights – sometimes, at least. In the 21st century, digitalization is the dominant paradigm. However, the automobile was still so influential as a model of technological progress that the internet was also known as the information superhighway in its early years. Those days are over now.

At present, in 2030, human beings adapt themselves to the digital world. For example, searching has become the new source of meaningful content in their lives. More and more people do not simply see just a search engine at work but a deus ex machina – a god from the machine, who anticipates every human intention and shows where the future lies. This entity is considered capable of things that used to belong to the realms of religion. The cofounder of Google, Sergey Brin, was once asked when his search engine had actually become a modern icon. He told the story of someone who was said to have saved the life of a relative suffering a heart attack by carrying out a Google search to find out what to do. In other words, Google now performs miracles!

Meanwhile, the digital world has turned itself inside-out. Its elusive insides are now on the outside and have colonized the physical world. Human beings are no longer turning into mechanical systems but into algorithms – in some cases consciously, as happens when the police take their lead from a piece of crime-prevention software, but sometimes almost unnoticeably, when secret criteria are used to control the results of searches or even the composition of an individual’s personal circle of acquaintances on the internet.

The increasing digitalization of the economy is changing the nature of globalization. Nowadays, there are no longer bricks-and-mortar factories where a workforce produces things, but instead, more and more services that are offered across national frontiers – for example, translation software that does not require human employees anymore. Is there actually still any point in learning a foreign language?

The Internet of Things plays a big part in this latest phase of digitalization. We are surrounded by networked sensors that are almost as common as oxygen molecules – they are present in autonomous vehicles and foodstuffs, and in screws and materials. What is more, they produce data on an enormous scale. The concept of data protection has changed, for now the key question is how to protect yourself from data.

Artists use these mountains of data as quarries from which they extract the ultra-modern material that they need for their work – gigantic puzzles. In the past, works of art could sometimes be a little hard to understand, but now mystery is their fundamental principle. It is possible to draw an interesting line tracing developments from the analog block of marble to the digital blockchain. It is a line associated with a technology from the early days of computing – the technology of cryptography. For example, long before public-key cryptography became a familiar concept, railroad embankments and the walls of buildings were adorned with graffiti that looked to the untrained eye like an intricate form of decoration. In fact, however, they were legible, artistically encrypted messages – there for all to see but, nevertheless, accessible only to those in the know. Present-day artists are trying to establish a kind of balance between information overload and the antithesis of information – mystery.

Peter Glaser is an author and journalist. He writes for publications including the "Neue Zürcher Zeitung" and "Technology Review." He won the Ingeborg Bachmann Prize in 2002.
The energy market of the future

In its “Outlook for Energy,” the oil corporation ExxonMobil takes a look far into the future and provides lots of figures on major global trends and the energy market in 2040. It deals with both the future fuel mix in the field of mobility and the global electricity system 20 years from now. Energy will remain a key issue in the coming decades, as in the period up to 2040 alone, global consumption is expected to grow by another 25 percent as against 2015 levels.

2017 Outlook for Energy: A View to 2040
ExxonMobil
http://tinyurl.com/techforum23

New thinking

The future belongs to renewable energies. Not only are they environmentally friendly – they are also becoming increasingly competitive. In this study, the International Renewable Energy Agency (IRENA) has looked at how energy sectors in many countries around the world are currently changing. Its conclusion is that the accelerated expansion of renewable energies is leading to more growth, creating new jobs, improving people’s lives, and contributing to a sustainable future.

REthinking Energy 2017
IRENA
http://tinyurl.com/techforum24

AI: Turbocharger for productivity

Artificial intelligence is going to change the automotive industry profoundly, and not just through innovative driving functions: AI is also opening up new opportunities in vehicle production – for example, in supply chain management, quality assurance, and marketing. In the years to come, process improvements could lead to improved productivity and in so doing, free up resources for the development of autonomous driving.

Artificial Intelligence – Automotive’s New Value-Creating Engine
McKinsey
http://tinyurl.com/techforum25

Mixed feelings

What do people in the USA and Germany think about digitization and its impact on their lives? PwC questioned groups from the two countries and found that the participants had mixed feelings about a lot of things – on the one hand, digital technologies are accelerating many processes; but on the other, their omnipresence is leading to stress. People also draw distinctions in the medical field – there is greater acceptance of digital medical records than of “robot doctors.”

Digitisation: A Quantitative and Qualitative Market Research Elicitation
PwC
http://tinyurl.com/techforum26
Digitization is not an end in itself. It has to create lasting value for our company – for example, through lower costs, higher efficiency, or new business models. This is exactly what we are achieving with toii – higher productivity as a result of more transparency, greater automation, and less downtime. We can also offer the service externally and thus establish a business model that is new for us.

Axel Berger is Head of Digital Transformation at thyssenkrupp Materials Services. A mechanical engineer and MBA, he has been contributing significantly to the company’s development for three years in this post. What appeals to him the most about his role is that he has the opportunity to engage with new technologies such as artificial intelligence, e-commerce, and blockchain and make extensive use of them where it makes sense to do so. Page 30