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Dear Shareholders,

There are a lot of positives to take from the 2018 fiscal year: Outstanding feedback from our customers at the InnoTrans trade fair, the continuation of our growth strategy through the acquisitions of Austrak and the rail milling business of STRABAG Rail GmbH, new strategic partnership with CN (Canadian National) in North America, the first distribution of a dividend since 2014 and a substantial increase in new orders, particularly in China, mean that we have a lot to look forward to in the future. From a financial perspective, the 2018 fiscal year was, as expected, marked primarily by a weaker business development for project-related reasons in the high-margin focus market of China. In accordance with expectations, we could not repeat the strong results of the 2017 fiscal year in both sales and EBIT. In this annual report, we would like to give an overview of the events of the past year and provide an insight into Vossloh's groundbreaking developments into future subjects. We also provide a preview of the key financial figures for the 2019 fiscal year and, for good reason, also exceptionally for 2020.

Group sales in 2018 totaled €865.0 million, 5.8 percent below the previous year's figure of €918.3 million. As expected, deliveries brought forward by customers in 2017 and comparatively low tendering activities in the China business of the Fastening Systems business unit at that time resulted in this weaker business development. Other units were only able to compensate for the lower sales and earnings contributions that resulted from this to a limited extent. In our most recent communications, we informed you that our sales expectations for 2018 would fall at

the lower end of the originally forecast range of €875 million to €950 million, and this is what occurred. Below the line, we achieved a Group EBIT of €54.2 million for 2018. The EBIT margin of the Vossloh Group thus amounted to 6.3 percent, which falls within the forecast range for 2018 of 6.0 to 7.0 percent. Negotiations regarding the sale of Vossloh Locomotives are nearly complete. As such, we are confident that we will soon find a good solution for the last remaining business unit of the Transportation division.

Orders received in the 2018 fiscal year developed favorably. At €979.2 million, orders received substantially exceeded the previous year's value of €867.2 million by 12.9 percent. This increase can primarily be attributed to positive development in the Core Components division. Among other things, we won three major orders for the delivery of rail fastening systems for the expansion of China's high-speed rail network with an overall volume of roughly €85 million. The majority of these deliveries are expected to begin in the 2020 fiscal year. This impressively underscores the Fastening Systems business unit's consistently strong market position in China's high-speed segment. We have also made a major step forward in the persistently challenging North America focus market. In 2018, we successfully concluded multiyear framework agreements with CN for the delivery of concrete ties and switch components. CN is one of the North American Class-I railroads that operates in the U.S. and Canada. CN is a strategically important partner for us, and it is a matter of decisive importance that we have established a long-term relationship with a further crucial Class-I operator in the North American rail industry with these agreements.



Left to right: **Volker Schenk** (Executive Board member), **Andreas Busemann** (CEO), **Oliver Schuster** (Executive Board member)

Let us look ahead now: "Grasping the future. Shaping the future." is the motto for our current annual report. With this in mind, we have established a wide range of new projects and processes at Vossloh that will allow us to act with greater agility. At present, Vossloh is a firmly established, focused global player in the rail infrastructure. Our customers see us as a strong and reliable provider of innovative products and rail services with a proven track record. We are also increasingly perceived, as a partner and trailblazer that develops and implements solutions for the goal of maximum track availability. At the biennial trade fair InnoTrans in Berlin, the resonance of our solutions with our customers and business partners was overwhelming. We made an outstanding impression with our future-oriented products and services that link the high quality and durability of tracks with the fulfillment of economic requirements. Our smart materials, such as the special CogX steel for switch frogs and an extremely resistant premium zinc coating for the tension clamps and screws of our rail fastening systems, were very well received. We were also able to reach a large audience with our *amalentic* tie, a highly innovative and extremely long-lasting tie made from composite materials developed in-house at Vossloh. In addition, we were able to present the compact Multi Purpose Milling machine, our newest product in the area of rail treatment machinery, to the public as a world premiere. In this context, it should be mentioned that by gradually outfitting rail treatment machinery with cutting-edge sensor technology, we are also creating a database for smart maintenance.

We also took major steps towards strengthening our core business through acquisitions and partnerships in the past fiscal year. In November, Vossloh successfully concluded the acquisition of the Australian concrete tie manufacturer Austrak. This acquisition serves to expand our product portfolio in the Australian concrete ties market, where we have already been very successful in the switches business. At the end of December, we were also able to successfully complete the takeover of the rail milling business of STRABAG Rail GmbH. The acquired sub-unit, which encompasses four milling machines and 30 employees, is being integrated into the Lifecycle Solutions division and represents a significant expansion of our existing milling business. In addition, we established a joint venture on rail monitoring in 2018. The joint venture, which operates under the name "Rhomberg Sersa Vossloh GmbH", specializes in the maintenance of switches and tracks, particularly switch servicing and diagnosis with the purpose of identifying appropriate maintenance measures.

We would now like to provide you with a somewhat more concrete overview of the near future: For the 2019 fiscal year, we are assuming a range of €900 million to €1 billion for Group sales. In the Core Components division, we anticipate substantially higher revenues in the Tie Technologies business unit than in 2018 due to the acquisition of Austrak. We also anticipate increased revenues in several regions for the Fastening Systems business unit, although not yet in China. We are currently assuming that sales in China for 2019 will remain at the same level as 2018. A significant increase in sales in China in comparison with the previous fiscal year is expected for 2020. This has prompted us to take the exceptional step of providing a forecast beyond the 2019 fiscal year. For the 2020 fiscal year, we are currently planning for Group sales between €950 million and €1.05 billion. Based on our current assumptions, this will not only result from the contributions of the China business. We also anticipate higher sales and earnings contributions in the North America focus market and growing milling business in the Lifecycle Solutions division. Under these conditions, we anticipate from our current perspective an EBIT in 2019 within a range of €50 million to €60 million, and forecast an increase to €65 million to €80 million for 2020.

Dear Shareholders, we want you to participate in the success of your Group appropriately. Due to the stable financial situation, we, the Executive Board of Vossloh AG, together with the Supervisory Board, propose the distribution of a dividend of €1.00 per share also for the 2018 fiscal year.

As publicly announced on March 4, 2019, Dr.-Ing. Kefer has resigned from his position as member and Chairman of the Supervisory Board for personal reasons. Together with the Supervisory Board, we would like to thank Dr.-Ing. Kefer for his good and trustworthy work.

All in all, Vossloh remains on track towards further growth and sustainably increasing its profitability in the future. We are continuously developing our core business and sounding out opportunities for cooperations and acquisitions in a targeted manner. We are well-prepared and purposefully continuing our constant advancement faced with a disruptive world on one hand and our industry's typically longer-term development processes on the other. You can count on us. We are grateful for your trust.

Yours sincerely,



Andreas Busemann, CEO

# Overview of the year 2018

## Q1 2018

The locomotive business based in Kiel, Germany, the last remaining business unit in the Transportation division, is reported under discontinued operations as of December 31, 2017.

In the meantime, two and a half years after the initial groundbreaking, production at Vossloh Locomotives is fully underway at the new plant. Covering a total area of 18,000 square meters, what is likely the most modern locomotive factory in Europe has been built in Kiel's Suchdorf district.

## Q2 2018

Vossloh wins a tender for the delivery of rail fastening systems in China. The order encompasses a volume of approximately €30 million. A subsection of the route from Zhengzhou, in eastern China, to Wanzhou, a district of the megacity Chongqing, is to be equipped.

The condition of the entire tram network of Le Havre will be assessed for the first time since the network went into operation six years ago. Vossloh will prepare a detailed description and assessment of the routes for the Compagnie des Transports de la Porte Océane. This will allow the operator to deploy their budgets in a more targeted manner as part of a holistic maintenance strategy while maximizing the service life of the infrastructure.

At Vossloh AG's Annual General Meeting in Düsseldorf, Germany, shareholders approve the proposed dividend distribution of €1.00 per share. Prof. Dr. Anne Christine d'Arcy and Dr. Bernhard Düttmann are newly elected to the Supervisory Board as shareholder representatives.

## Q3 2018

After the conclusion of a multiyear framework supply contract for concrete ties in April, Vossloh announces the conclusion of a second multiyear framework agreement with CN (Canadian National) for the delivery of switch components in the North America focus market. CN is one of the North American Class-I rail companies that serves both the Canadian and U.S. markets.

At the InnoTrans trade fair for rail technology in Berlin, which takes place every two years, Vossloh presents its wide-ranging portfolio as a technologically leading specialist and value partner for rail infrastructure. Under the motto of "The Smart Rail Track by Vossloh," the Company presents the future of the intelligent railway. The trade fair is attended by around 161,000 industry visitors from 149 countries.



Vossloh and Rhomberg Sersa establish a joint venture. The joint venture, which operates under the name Rhomberg Sersa Vossloh GmbH, specializes in the maintenance of switches and tracks and offers a wide range of services for the value-conserving management of rail infrastructure.

The demolition excavator has made room for the factory of the future in Werdohl, Germany. The extensive conversion and construction work is being performed while production is ongoing and is expected to continue until 2021. In the meantime, a large portion of Vossloh AG has moved into a new quarter in Schalksmühle, Germany, 20 kilometers away. The transitional solution will remain in place until the end of construction period in Werdohl.

## Q4 2018

In order to maintain a consistently high level of rail quality in the Gotthard Base Tunnel, Vossloh's HSG grinding train has been used on a regular basis for just over two years. Grinding cycles took place for the fifth time in October 2018. High-speed grinding (HSG) is an integral element of track maintenance for Swiss Federal Railways.

The new foundry in Outreau, France, officially begins production. The location in northern France is one of the largest of its kind in Europe, and is a competence center for foundry technology for Vossloh. In 2020, the cutting-edge production facility will go into operation fully refurbished after the conclusion of the second phase.

Vossloh wins another tender for the delivery of rail fastening systems in China worth approximately €35 million for a section of the planned high-speed route between Ganzhou and Shenzhen in southeastern China.

Vossloh successfully concludes the acquisition of the Australian concrete tie manufacturer Austrak Pty Ltd. The contract was signed on August 3, 2018. This acquisition serves to expand the Company's product portfolio in the Australian concrete ties market and thus to increase vertical integration in the Australian rail infrastructure business.

Vossloh wins a major order for the delivery of rail fastening systems in China for the third time in 2018, this time worth approximately €20 million. Rail fastening systems will be delivered for the route between Weifang and Laixi in northeastern China.

Vossloh continues to expand the service business bundled in its Lifecycle Solutions division by acquiring the high performance milling business of STRABAG Rail GmbH. The acquisition further strengthens Vossloh's rail and switch processing business.

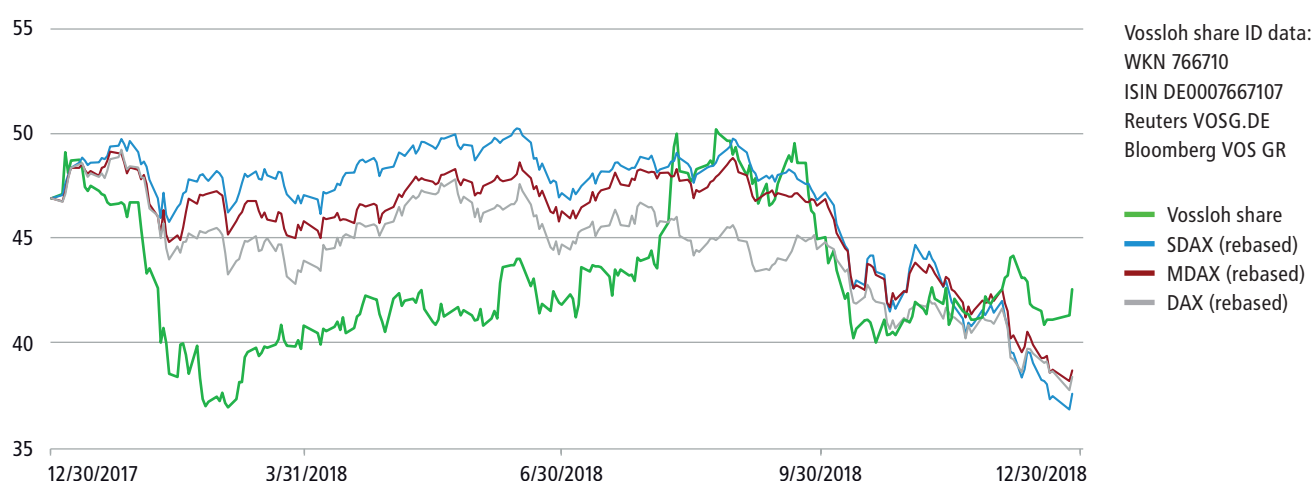
# Vossloh stock

The 2018 stock market year was generally disappointing. The introduction of U.S. tariffs on steel and aluminum, concerns surrounding an increasingly contractionary global monetary policy and weaker leading indicators in the eurozone led to depressed stock markets in the first quarter. In the second and third quarters of 2018, the mood was calmed in light of the ECB's announcement that it would initially leave interest rates unchanged. The consistently robust economic data from the U.S. as well as measures in China to loosen monetary and fiscal policy also contributed to a momentarily stable situation in capital markets. Negative factors won out again in the fourth quarter of 2018: Disappointing economic reports from China and Europe, concerns surrounding the intensification of the trade war between the USA and China, the ongoing uncertainty surrounding Brexit and profit warnings from some major U.S. and European companies caused share prices to tumble. Positive reports on holiday

season business and persistently strong labor market figures in the U.S. did little to change this. All major global stock market indices finished 2018 down from the beginning of the year, with the majority seeing downturns in the double digit percentage range.

Germany's leading index, the DAX, fell significantly, particularly in the fourth quarter of the year. It ended 2018 at a level of 10,559 points, 18.3 percent lower than at the end of 2017. The performance of the MDAX was similarly negative. It closed 2018 at 21,588 points, representing a twelve-month loss of 17.6 percent. The SDAX is the most significant index for Vossloh. The SDAX dropped immensely in the fourth quarter, losing 20.0 percent year-on-year, after remaining essentially stable for the previous nine months.

## Stock price trend from January 1, 2018, to December 30, 2018



Vossloh stock indicators		2018	2017
Earnings per share	€	1.14	(0.50)
Dividend per share	€	1.00 <sup>1</sup>	1.00
Annual average number of shares outstanding	thousand shares	15,967	15,967
Number of shares outstanding at year-end	thousand shares	15,967	15,967
Closing share price	€	42.45	46.80
High/low	€	50.40/36.55	63.99/44.10
Closing market capitalization	€ mill.	677.8	747.3
Trading volume	thousand shares	4,092	3,434
Average daily trading volume	thousand shares	16.3	13.6

<sup>1</sup> Dividend proposal subject to approval of the Annual General Meeting

At the beginning of 2018, the Vossloh share fell significantly in value while German stock markets still remained stable. The stock began to recover slowly in March 2018, and then registered a very strong increase in price in August which continued until September. The share was unable to escape the subsequent general bearish mood. Ultimately, despite price gains in November and December, the Vossloh share lost 9.3 percent year-on-year; however, the loss in value was significantly lower than the market as a whole. The share began the year with a price of €47.00 on January 2. It reached its highest point for 2018 of €50.40 during trading on August 24, and its lowest of €36.55 during trading on March 2. On December 28, 2018, the last trading day of the year, the stock's closing price stood at €42.45 (December 29, 2017: €46.80).

The market capitalization of Vossloh AG, relative to the unchanged 15,967,437 shares outstanding, amounted to €677.8 million on December 28, 2018. Due to the share price being down year-on-year, this was below the market capitalization of €747.3 million at the time.

## Dividend

The Executive Board and Supervisory Board of Vossloh AG will propose a dividend payment of €1.00 per share also for the fiscal year 2018 to the shareholders at the Annual General Meeting scheduled for May 22, 2019. Based on the number of dividend-bearing shares, this equates to a dividend payout of almost €16 million in total.

## Shareholder structure

The largest shareholder of Vossloh AG remains Mr. Heinz Hermann Thiele, whose shareholding amounts to 44.73 percent of the capital stock (notification from December 30, 2016). Additional known shareholders of Vossloh AG with voting rights exceeding the legal reporting threshold of 3 percent are Franklin Mutual Advisers, LLC, Wilmington, Delaware, USA (5.05 percent, December 28, 2017), LBBW Asset Management Investmentgesellschaft mbH (3.09 percent, February 14, 2018), Franklin Mutual Series Funds (3.02 percent, October 15, 2018) and LAZARD FRERES GESTION S. A. S., Paris, France (3.01 percent, March 24, 2014). In accordance with the Deutsche Börse AG definition, the assets of the latter investors are not considered fixed shareholdings, but rather count toward the free float market capitalization. Accordingly, as of the end of December 2018, the free float of Vossloh AG's capital stock remained unchanged at 55.27 percent. The free available market capitalization according to this definition was determined on the basis of a volume-weighted average price over 20 trading days, and totaled around €373 million on the reporting date December 31, 2018.

## Analysts' ratings

As of the beginning of 2019, nine financial analysts covered Vossloh with regular commentaries and estimates. Six of these, the overwhelming majority, recommended holding the Vossloh share; two analysts gave the share a "sell" rating, and one gave a "buy" recommendation. The average price target for the Vossloh share was €43 based on the analysts' ratings made available up to the beginning of 2019. The lowest price target was €35 and the highest was €53.

## Sustainability

For many years, Vossloh AG has been deemed appropriate for investors with a sustainability focus. Vossloh has been listed in a number of sustainability rankings since 2008. The Vossloh share belongs to oekom research's investment universe, and is also part of the Global Challenges Index, which is made up of 50 companies worldwide which promote sustainable development through their product and service portfolios. Vossloh submitted a nonfinancial Group statement for the first time for the 2017 fiscal year, and has continued this practice in its reporting for the 2018 fiscal year.

## Capital market dialogue

The Vossloh Investor Relations team continued its intensive dialogue with institutional and private investors once again in the 2018 fiscal year. Over the course of the year, Vossloh AG took part in a number of capital market conferences and organized meetings with investors and analysts. Regular conference calls have also been a key element of Investor Relations for many years.

The Investor Relations team members were, and are, available to answer written or phone inquiries at any time. Additional information about the Vossloh company and the Vossloh share is available on the website [www.vossloh.com](http://www.vossloh.com). In addition to up-to-date financial reports, presentations and press releases, the website also provides information about creditor relations. Please send your questions to [investor.relations@vossloh.com](mailto:investor.relations@vossloh.com) or call us at +49 (0)2392/52-609.





# Grasping the future. Shaping the future.

In modern-day industrial societies – and particularly metropolitan areas worldwide – rail infrastructure is being used to almost full capacity. Every bottleneck and every malfunction results in delays and therefore in unpunctuality. At the same time, sustainability and especially the outstanding transport capacity clearly speak in favor of rail transport.

Here at Vossloh, we understand the physical fundamentals and technical interrelationships of railways, we know the needs of operators, and we have a clear vision for how we can and will shape the future of rail as a mode of transport.

With this in mind, Vossloh has taken the following pages to describe the main ways in which the world of rail might develop over the next two decades. At the same time, we also show – especially with our achievements in 2018 – that we are determined, well-prepared and well on our way towards this future scenario.

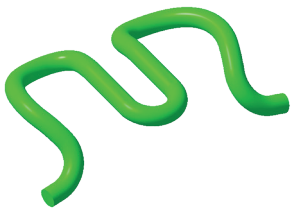
Not even the disruptive changes caused by digitalization can conceal the fact that profound and expansive changes to long-lasting and highly capital-intensive rail infrastructure can only be realized over long periods of time. Over the next twenty years, for example.

In our strategic areas of action – innovation, acquisitions and partnerships, operational excellence and linked-up work – we have clearly defined the way forward under the “One Vossloh” umbrella.

At this point last year, we presented what our vision of “The Smart Rail Track by Vossloh” means to us. By attending the InnoTrans 2018 trade fair, Vossloh was able to send the compelling message that we no longer stand just for our proven and innovative products and rail services. With our bundled expertise and a new sense of openness, we hope to set out on a journey together with our customers and partners where the goal is maximum track availability.

## Extremely durable

*The Skl 15 HF tension clamp for rail fastening, which was launched in 2018, is optimized for very high frequencies and can withstand speeds far beyond 300 km/h.*



*An overview of InnoTrans 2018 can be found at:  
[www.vossloh-innotrans.com](http://www.vossloh-innotrans.com)*

Cultural zeitgeist, political discourse, industry discussion – many things now hinge on the digital, and rightly so. However, the requirement for available railways, and therefore for punctual trains, remains the quality and durability of the tracks. This, and therefore the cost-efficiency of a product throughout its entire lifecycle, is already decided as early as the product design stage. For over 100 years, the development and production of safe and long-lasting components and systems have made up the core of Vossloh's expertise. For us, durability is an integral element of an intelligent railway.

### Smart materials

The materials used are a critical factor in ensuring that products are long-lasting and low-maintenance. Wear and tear is the highest at the frog of a switch. The unavoidable interruption of the driving surface always leads to shocks. Although modern designs minimize these, selecting the right steel for the frog remains an ongoing concern in switch construction. Vossloh cooperated with Arcelor Mittal Industeel to develop the special steel CogX and introduced it in 2018. The purpose of this material is to extend lifespans by at least 30 percent compared to traditional materials. CogX is extremely hard, homogeneous and tough, and is highly suitable for welding – crucial characteristics for steel used in switch construction.

The premium zinc coating for tension clamps and screws presented in 2018 is finer than a human hair, yet extremely robust. The coating provides long-lasting protection from corrosion, even in extreme environmental conditions. Its structure works like armor, and is even "self-healing" to a certain degree.

These longer lifespans do not come at the expense of sustainability. Environmentally harmful chemicals like chromium compounds are omitted, and resources are used efficiently thanks to the thin coating.

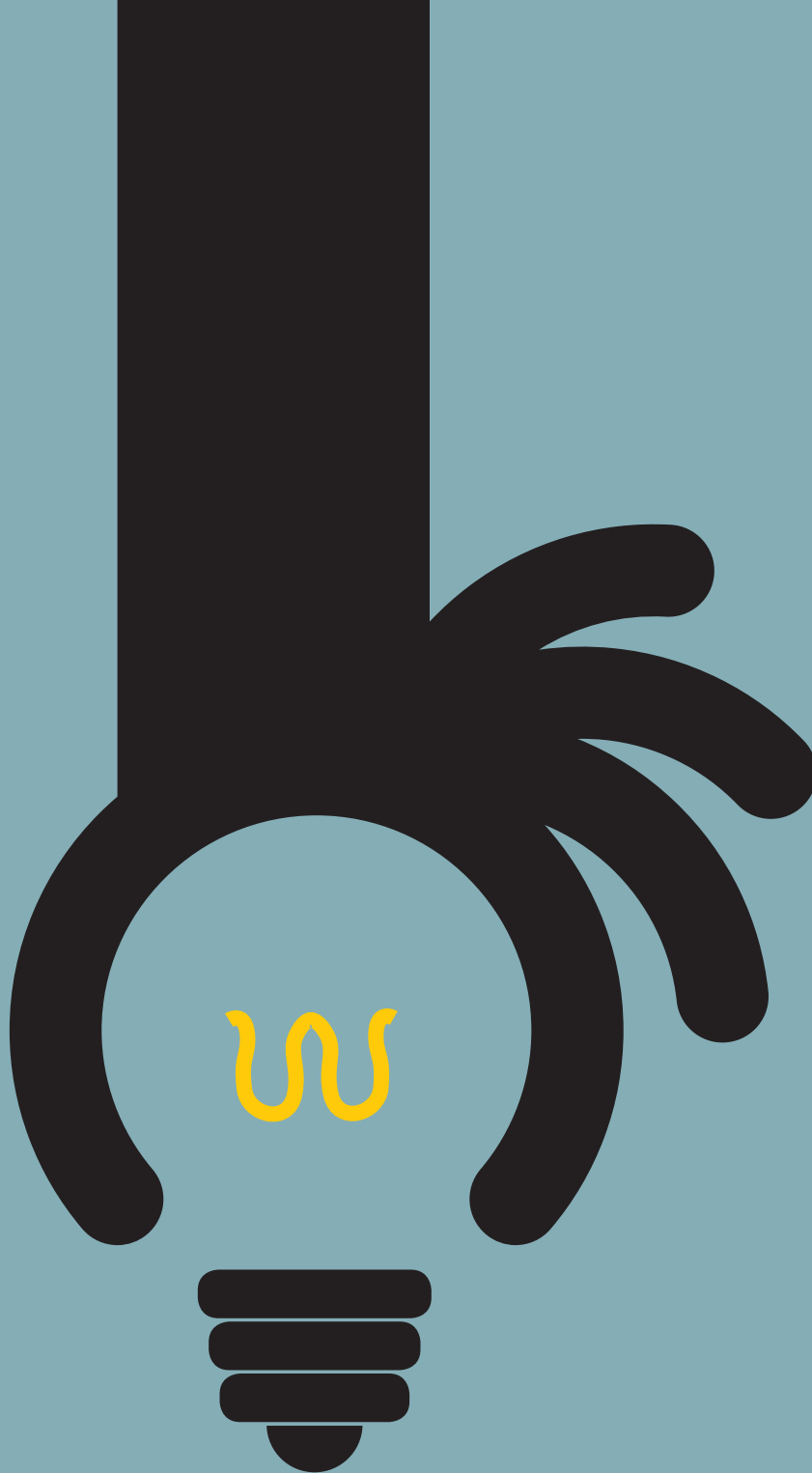
With *amalentic*, Vossloh introduced InnoTrans 2018 visitors to an innovative material with special properties for its own composite ties. The *amalentic* tie is especially suitable as a replacement for wooden ties. Wooden ties are increasingly facing restrictions on their use due to the potential health and environmental hazards posed by the waterproofing materials they contain. The *amalentic* tie can last for at least 50 years, roughly twice the lifespan of a wooden tie. It is robust, recyclable, and, depending on the design, can even do without individual fastening components. All of these qualities together makes the *amalentic* tie a perfect complement to Vossloh's concrete ties.

### Polished simulation expertise

The rail fastening system is a crucial element of the spring-mass system of the railway. Vossloh possesses industry-leading expertise in this area, and uses a complex simulation model that analyses both material qualities and the dynamic vehicle-track interaction as a whole. This is not only good for the lifespan of products, but also reduces the amount of time to market. This is why Vossloh was able to have the innovative Skl 15 HF tension clamp ready for approval within one year. Vossloh also uses the simulation model to develop safer and longer-lasting switches. The proprietary DYNADeV platform is capable of simulating the effect of moving rail vehicles on a switch and its components in real-time.



*Durability makes the difference:  
Rail tracks must be more  
efficient to use in the future.*



*Innovation cycles in the railway industry will accelerate significantly over the next decade.*

## Learn. Share. Grow.

Innovation requires a culture of sharing, cooperation and learning. For this reason, we remain dedicated to working on international and cross-divisional development opportunities for young talent and managers. 2018 saw Vossloh establish a new online learning environment. It focuses on tailoring sessions to individuals whenever possible – with maximum learning success. The Vossloh Learning Platform supports this approach and offers numerous learning opportunities. In addition to internal and external in-person training, there is also digital learning formats with carefully selected tutorials, online courses and specialist lectures. The details: The learning platform has been implemented by an international and cross-divisional project team in accordance with the priorities and concerns of Vossloh employees. The guiding principle of the platform is continuous learning, sharing, and growth (Learn. Share. Grow.). Vossloh is of the firm belief that business growth is only possible by fostering people's skills and improving employee satisfaction as a result. The Vossloh Learning Platform supports the One Vossloh concept by promoting knowledge exchange, cooperation and joined-up thinking. Learning and working are seamlessly integrated in day-to-day business. For this reason, the learning platform also provides orientation for freely accessible digital learning content.

## New agile approaches and methods

Vossloh paid a great deal of attention to processes in 2018 in order to fully develop the organization's existing potential. The new Group-wide innovation management process took center stage. This process primarily serves to answer the question of whether an idea is relevant for particular customers and markets. Ideas need to go through multiple stages, exciting expert colleagues and decision-makers and convincing them of their potential along the way. Initial feedback from the market or customers is just as obligatory as a business plan. The innovation process is supported by in-person events and an online platform.

In order to create space for ideas and enable more agile working, Vossloh has also maintained teams outside of the conventional structures since 2018. These provide suitable experts from all Vossloh divisions with the opportunity to concentrate exclusively on a single urgent customer topic with a large degree of freedom for a limited time. When starting out, early validation is more important than depth of detail. Heavy specifications books are done without; instead, an initial viable product idea that can easily be adjusted later is created in short, dynamic steps before being developed until it is ready to launch. During the project, the team is permitted to disengage from their normal day-to-day responsibilities.

In 2018, we created the role of a Chief Digital Officer who advances and holds responsibility for the implementation of digital innovations for Vossloh's business or new business models in close coordination with our customers. The Chief Digital Officer reports directly to the CEO.



## Truly networked

*One Vossloh has been the guiding principle of the integrated Group since 2014. Five years on, people are working together in a truly networked fashion under the One Vossloh umbrella. It was natural for managers and experts at all levels to discuss and share knowledge across all divisional boundaries in 2018. Up-and-coming talent appreciates the advantages of the flat structure of the Vossloh Group: early responsibility, short decision-making processes and interdisciplinary projects, and at the same time international and intercultural.*

## Strategic partners

*Vossloh engineers know which physical parameters are relevant and which sensors must be used to capture these measurements with which level of precision in order to record the condition of railways. Vossloh also works together with strategic partners to prepare relevant information for operators and use artificial intelligence. One example from 2018 is our joint venture with Rhomberg Sersa. With software established in the market, the new company possesses professional inspection and monitoring expertise, with a focus on recording, assessing and evaluating the condition of infrastructure and identifying suitable maintenance measures.*

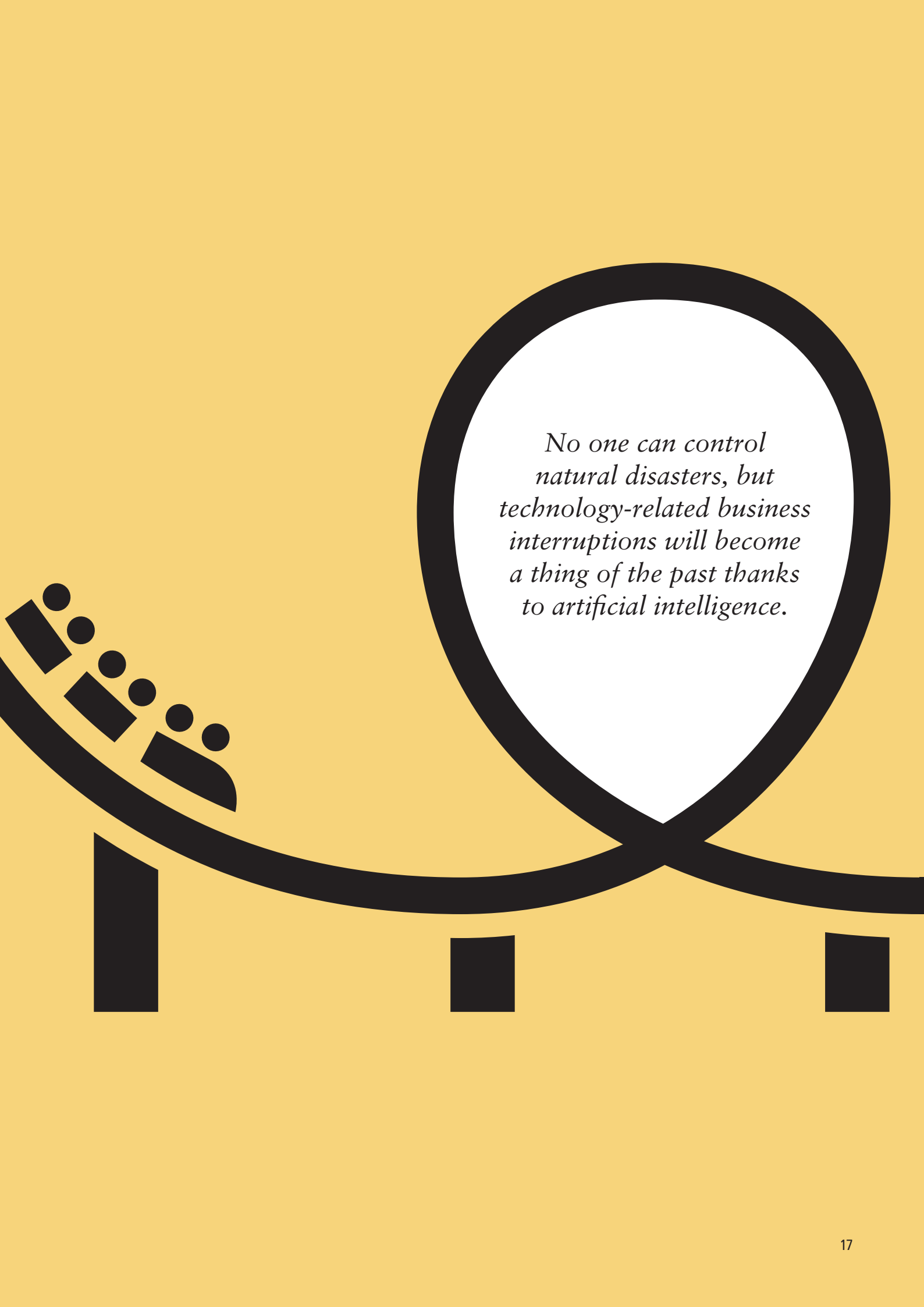
## Success factor: digital expertise

The availability of tracks, while simultaneously considering the associated costs, is becoming increasingly critical for rail operators. Rail traffic is increasing, along with the cost of maintenance and repairs, which make up the majority of costs over the entire lifecycle. This is the central pain point for operators, as every disruption costs a great deal of money and trains running late damage their reputation. In an ideal world, the operator could make use of its infrastructure reliably and with a high level of quality. In the best case scenario, there would be no more component failures and thus no more route closures. Operators would not need to carry out work at fixed intervals or according to the "scattershot" principle, and there would be no "surprises" leading to unexpected work. They would be so familiar with the condition of their network that they would be able to make long-term plans, and only carry out work that is actually necessary based on the actual condition of their network. This ideal world is possible in principle – with the opportunities provided by digitalization.

Solutions for monitoring track conditions have been used in the field for many years. It is only now, however, that the limiting factors for the storage and, in particular, the prompt analysis and interpretation of large quantities of data are beginning to be addressed. Whoever can understand and interpret data about the current condition of tracks and switches will become an indispensable partner for the owner of the infrastructure – especially as expertise improves with increasing quantities of data.

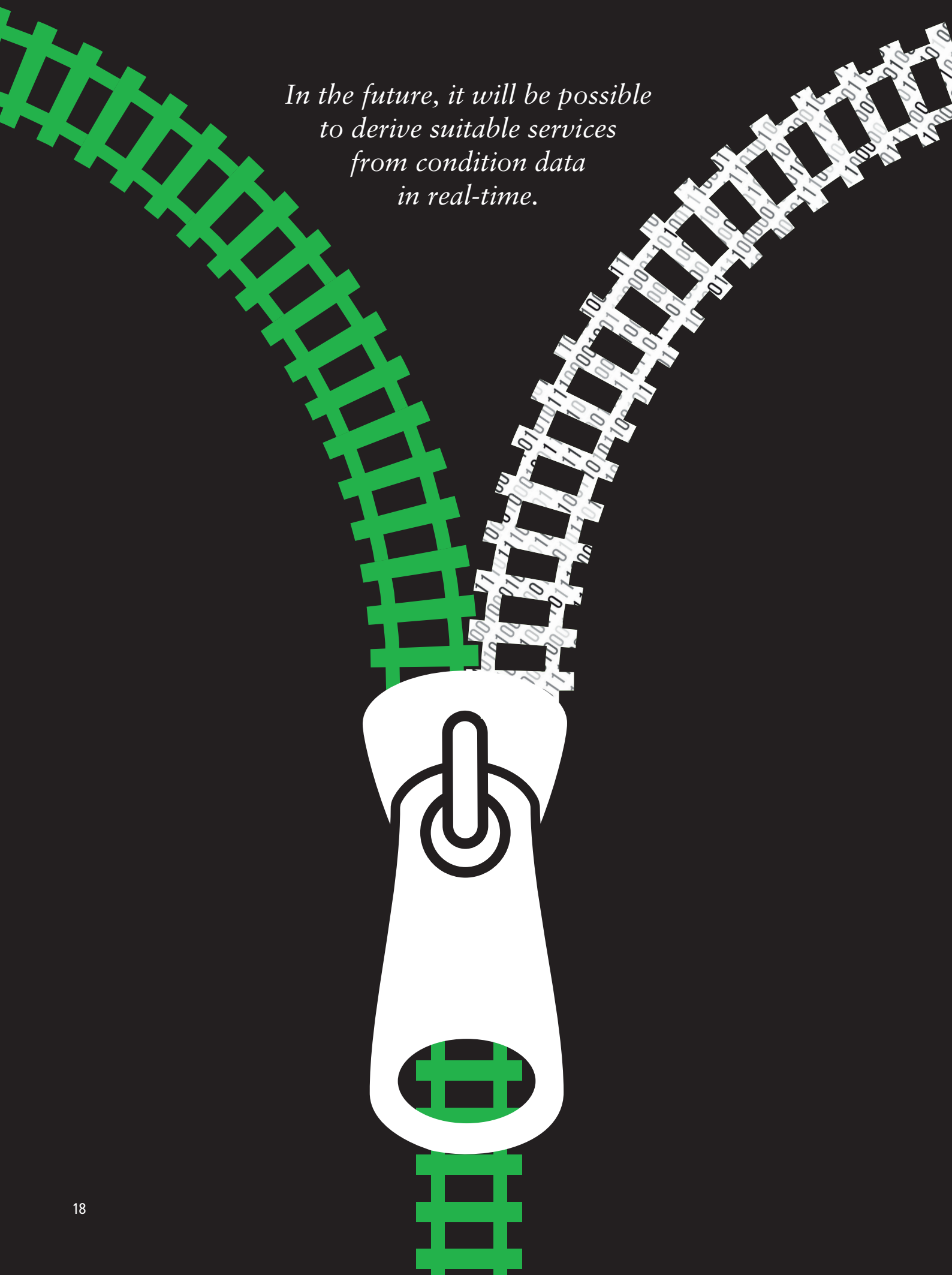
Vossloh wants to provide open systems and integrate mainstream technologies in order to increase acceptance within the market and achieve a competitive time to market. The software of our joint venture company Rhomberg Sersa Vossloh takes a comprehensive approach to optimizing lifecycle management for rail infrastructure. The joint venture specializes in the maintenance of switches and tracks and offers a wide range of services for the management of rail infrastructure. "MR.pro" is the digital tool for the technical maintenance management of entire rail infrastructures. The software provides comprehensive numerical and graphical analysis tools for evaluating and visualizing the condition and substance of track infrastructure. Bi directional interfaces ensure connections to business systems for maintenance management and planning. The system is open to all data sources and all manufacturers. MR.pro is in some ways a system memory. Changes in product models and condition information for tracks over time can therefore be accurately depicted in the system. Useful life can be predicted and tracked at all times.

The Smart Maintenance app was developed in-house by Vossloh: Simple and intuitive to use, it is designed to serve as the cornerstone of the maintenance cycle. The software interprets measurement data and derives maintenance scenarios while taking costs and route closure times into consideration. The operator then has the option of choosing a recommended maintenance scenario or having alternatives prepared.



*No one can control  
natural disasters, but  
technology-related business  
interruptions will become  
a thing of the past thanks  
to artificial intelligence.*

*In the future, it will be possible  
to derive suitable services  
from condition data  
in real-time.*





### **A virtually emulated network, a step ahead of reality**

The intelligent railway of tomorrow will not be a standardized solution. Customer requirements differ – and solutions for intelligent railways will follow the most pressing requirements and change to reflect customer needs over time. The use of digital technology is also always a learning process. Better data and knowledge about the infrastructure must be interpreted in a real-world environment. In view of the possibilities of digital technology, we can imagine an infrastructure that is so smart and knows its own condition so well that it automatically plans maintenance activities in order to achieve defined availability targets. This system would give recommendations about which maintenance measures should be performed and when these should be carried out in order to prevent travel disruptions, based on the available resources and the time available on the tracks. It is also conceivable that the network would have a virtual twin on a computer that would use AI to make predictions on the basis of data on usage and wear and tear, as well as condition information.

#### **Switches as an innovation driver**

As a safety-critical infrastructure element, switches are constantly at the center of the maintenance strategy of network operators.

By definition, a switch fault always affects multiple routes, which can lead to far-reaching operating restrictions within the route network and disrupted vehicle circulation. Issues with switches are responsible for the majority of delays. Switches are also an ideal starting point for the continuous collection of condition data with sensors. This is because switches represent a meeting point not only for tracks, but also for signal and control systems. This means that the data gathered at these points is extremely useful. In addition, data-based maintenance solutions for switches have a significant effect very quickly. For this reason, point machines are one of the first application cases for Vossloh's IoT sensor. This sensor can be configured freely and can collect a wide range of parameters from inside a compact housing. The data is pre-processed directly by the embedded micro-processor. The data is then sent to a central cloud, and can be prepared and visualized using Vossloh's V-MON platform.

The decisive step towards truly predictive maintenance then requires the use of self-learning systems. Once the artificial intelligence has identified all of the significant patterns that play a role in the occurrence of disruptions, it can then implement these – in conjunction with live measurement data – in the form of reliable forecasts for each individual switch.

### *Intuitive data cockpit*

*The Vossloh monitoring platform, V-MON, introduced in 2018, compares the anticipated physical behavior of switch components with measurement data. This can include data such as current flow, vibrations, hydraulic pressure, position of the switch device, or even environmental parameters like temperature, humidity and precipitation. By using threshold values and disruption patterns, predictions of maintenance needs become more and more reliable over time.*

## Smart Maintenance

*With Vossloh's Digital Twin app, maintaining a point machine is virtually child's play. By holding a mobile device over the switch components, the technician receives an extremely precise virtual depiction of the real components and is led step-by-step through the maintenance process in real-time in the form of animated instructions. The technician can order replacement parts in the app, if necessary, and effortlessly receive access to production and function data on-site. This "digital twin" allows railway specialists to resolve disruptions quickly without the need for time-consuming preparation.*



## Technology makes people's work easier

Fatigue damage significantly impairs the lifespan of the railway, and by extension passenger safety. Switch disruptions can trigger domino effects throughout the entire network. Vossloh applications set new standards in the areas of working speed and quality of results. The applications introduced in 2018 combine measurement and evaluation data, provide a quick overview of the condition of routes and suggest suitable measures or enable maintenance technicians to identify damage and carry out repairs without further preparation.

## Services of the future: rapid and digitally enhanced

With innovative ideas, Vossloh combines the best of the analog and digital worlds to offer customers the 100 percent track availability. One key to this is service which not only arrives on-site quickly, but also takes place either during the timetable or during rest periods.

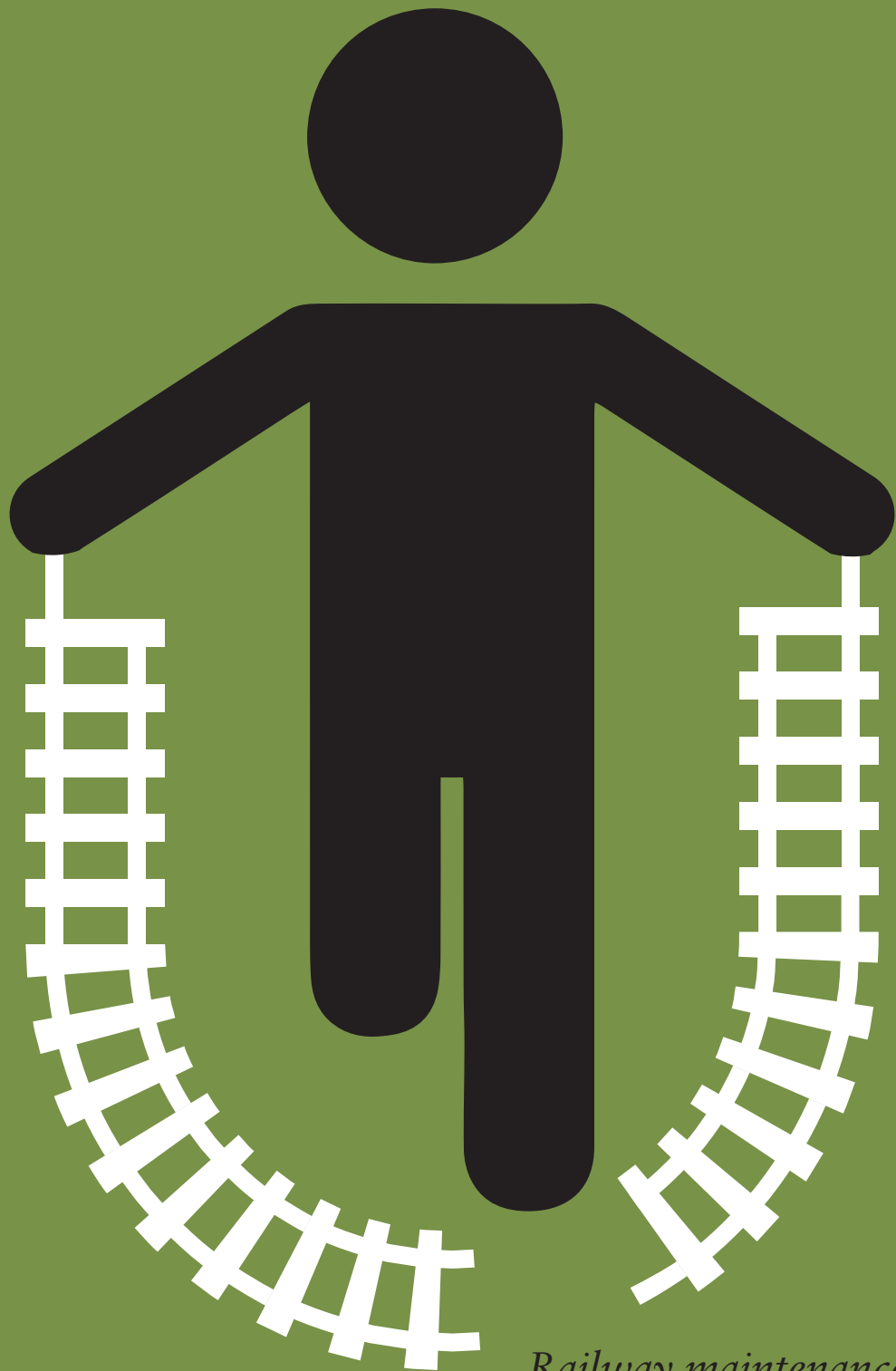
In the case of high-speed grinding, the vehicles are so fast that they can keep up with regular traffic. Vossloh can also help if rail replacement work is needed – a fact proven at truly critical locations such as the Channel Tunnel or the highly frequented 300 km/h route between Cologne and Frankfurt.

Thanks to highly refined Vossloh logistics, switch replacements within eight hours have also become the new standard in Sweden.

If the rail is already too severely damaged, rail milling is the method of choice. This not only reduces noise emission and increases rail safety, but also significantly increases the life of the tracks. For this reason, Vossloh strengthened its service business during the reporting year by acquiring the rail milling business of STRABAG Rail GmbH.

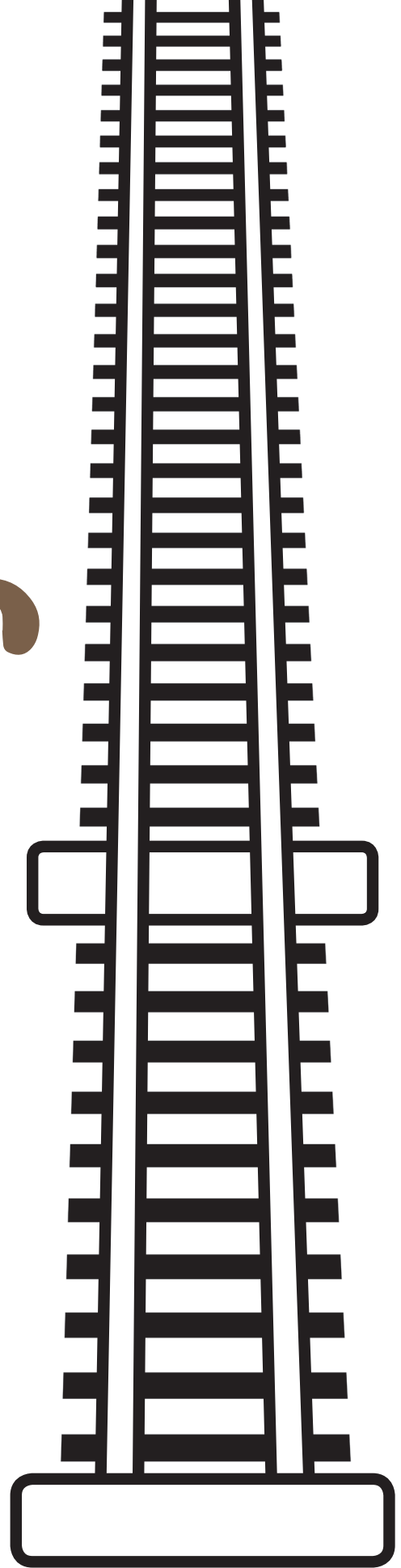
The lightweight MPM milling machine can be brought to the deployment site by road or by rail in the shortest possible time. Despite its size, the MPM is a powerhouse that can remove up to two millimeters per pass. Touch-free rail scanning using laser technology even enables comprehensive, condition-oriented switch processing. Another factor critical for use during night hours is that the milling procedure itself is extremely quiet. With sound levels of less than 78 dB(A), local residents will hardly notice anything.

The Smart Maintenance app supplements digitalized processes: Vossloh processing machines are used as diagnostic vehicles in order to survey rail conditions during the ongoing timetable without closures. The diagnostic data is supplied directly to the app; with each maintenance cycle, the database for processing recommendations gets larger. Rail services can be ordered directly from the app.



*Railway maintenance  
is becoming very easy  
and intuitive.*

*For the residents  
of the future, passing trains  
will be quieter than  
a vacuum cleaner.*



## Noise reduction requires a profound understanding of railways

Noise and vibrations are a particular inconvenience for people in dense urban areas and overshadow the generally outstanding environmental credentials of rail as a means of transportation. For this reason, the pursuit of maximum availability for rail infrastructure will always involve a concerted struggle against noise. This is because noise restricts route usage and route expansion, causes sickness and drives up costs.

Vossloh's solutions for noise and vibration go straight to the source: the track itself. The frequencies generated by rail traffic fall within a relatively low frequency range. This means that humans also perceive them physically to a certain extent – a phenomenon many will be familiar with from listening to a subwoofer. Rail fasteners perform a critical function in dampening structural noise. The elastic tension clamps, and particularly the intermediate layers made of the Vossloh material *cellentic*, dampen vibrations effectively. *cellentic* is a highly flexible elastomer manufactured by Vossloh that is also distinguished by its outstanding temperature, aging and weathering behavior. In urban networks, Vossloh can use DFF 336-type dampening fasteners. The newest generation has a system framework made of plastic which improves dampening with polymer-coated base plates. The noise level can be reduced further through the use of sleeper pads and by dampening the rail web.

Beginning with the Shanghai Metro, Chinese scientists have confirmed that Vossloh's "whisper switches" significantly reduce vibrations. The whisper switches are also embedded with specially-designed frogs that minimize shocks when driven over. In cities, filler block elements for rail bearings also come into play. These primarily serve to electrically insulate the rails. A welcome side-effect: the rails are also insulated acoustically.

The better rails and wheels are maintained, the less noise and vibrations are generated by the rail-wheel contact itself. Vossloh's high-speed grinding also makes it possible to achieve an effective acoustic grind. This reduces rail noise by up to ten decibels. The human ear perceives this as a halving in volume! With the increasing use of sensors in railways, it will be possible in the future to effectively evaluate and document whether the rail vehicles in use have well-maintained wheels.

The fight against noise and vibrations was one of the points of emphasis of the Vossloh presentation at InnoTrans 2018, and could even be physically experienced there under the "sound shower." On the tracks, Vossloh's highly elastic rail fastening systems and intermediate layers made of *cellentic* minimize vibrations and structural noise directly at the source. The passage of a train with smooth, well-maintained wheels on a rail with an acoustic grind now no longer needs to be any louder than about 75 decibels. This is equivalent to the passage of a car, the noise of a food court or a washing machine during a spin cycle.

## Quiet rails

*The Multi-Purpose Milling (MPM) milling machine celebrated its world premiere at InnoTrans 2018. Tailored to the needs of regional transportation, it is also suitable for flexible hot-spot processing on mainline routes. With its compact dimensions and low weight of only 16 metric tons, it can be used for a wide variety of applications. It can be quickly transported to the deployment site by truck or flatcar. A well-maintained, MPM-processed rail is also a quiet rail.*



## Smart factory

*In 2018, the green light was given to the factory of the future in Werdohl, Germany, an ultramodern production plant for rail fastening systems. Production is being automated further, and throughput time for tension clamps reduced by 50 percent. Lead times will also be reduced because additional components will be sourced from Vossloh's own manufacturing. With the "factory of the future", Vossloh customers will benefit from an entirely new and excellent service level thanks to digitalized processes.*

## Good climate

With two landmark projects, Vossloh is currently bringing the factory of the future to life – at the main plant for rail fasteners in Werdohl, Germany, as well as the foundry for crossing frogs in Outreau, France. The first of two subsections at Outreau was officially launched in 2018. Creating modern workplaces that meet the highest standards for occupational health and safety is at the very top of the agenda. In the interest of more sustainable production, a focus has been placed on both increasing energy efficiency and using alternative energy sources more intensively. The Werdohl location has set a goal for itself: Within 20 years, the manufacturing process for every tension clamp will be carbon-neutral. A comprehensive set of measures are already in use: the most efficient burner technology, the best possible insulation of furnace systems, optimal waste heat utilization, lifecycle analysis, CO<sub>2</sub> monitoring as well as the active participation of the employees at the site. The next goal for the period from 2017 to 2020: to reduce CO<sub>2</sub> by 30 percent.

## Top industrial performance

Researchers anticipate that the increasing use of robots and artificial intelligence in production could increase productivity to the point of balancing out the cost advantages of manufacturing in "low-wage" countries. Manufacturing in the factory of the future in Werdohl will be optimized by 2021 with linear processes, new technologies and a substantially higher degree of automation for tension clamp production.

Continued processing by the customer is also accelerated by means of improvements made at Vossloh, which in turn contributes to an improvement of their profitability. Along with the traditional manufacturing of tension clamps, plastic components and *cellentic* components for the rail fasteners will also be manufactured at this location in the future. In addition, new and innovative products and concepts are constantly being developed at Vossloh headquarters. This makes it possible for us to create new opportunities for our highly qualified workforce over the long term, provide them with professional development and keep them in the Company.

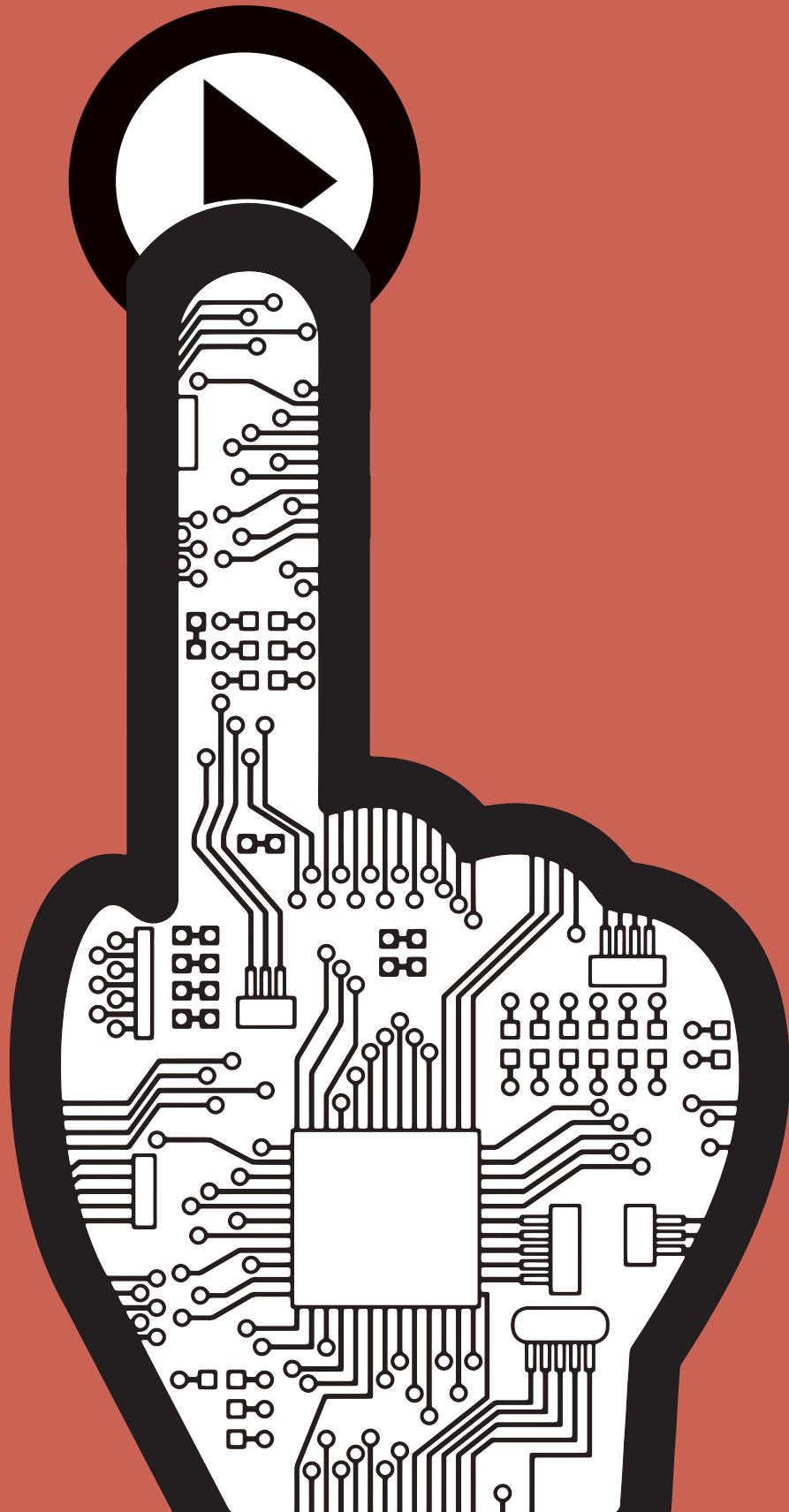
The factory of the future in Werdohl stands next to the technology center we inaugurated in 2011. This close proximity will lead to innovative technologies being developed that can then be multiplied in a second step so that they can be used at other locations worldwide.

This increased vertical integration substantially shortens the supply chain and speeds up response times in projects. The renovation will be accompanied by the introduction of digital processes: E-commerce, process control, automation technology, traceability including online delivery of quality data. Ultimately, data and analyses from infrastructure condition monitoring will provide crucial momentum for the development of new product ideas and designs in the future, as well as future functional expansions.



*Our production processes of the future  
are close to the customer, deliver quickly  
and protect the climate.*

Project Future.





## **Grasping the future. Shaping the future.**

Expanding infrastructure costs a great deal of time and money. There is, however, no way around the rail as sustainable means of transportation. The advantages in transport capacity in relation to the area required are immense. In light of this, it is all the more important to ensure that existing routes remain 100 percent available – at reasonable costs. The interaction between long-lasting and low-maintenance components and the possibilities of digitalization has already created numerous opportunities to gradually permeate the necessary areas and ultimately achieve the objective for the long term. Preventative rail maintenance, modern sensors for railway monitoring, supporting and learning applications, highly mobile networked maintenance machinery and many other technologies are available. Even though the rail industry only started building up its trove of data a few years ago, this critical process of ensuring indispensable condition monitoring and diagnostics has already rapidly picked up speed.

With the increasing amount of condition data, identifying relevant information in this flood of data is becoming a matter of decisive importance.

The key is knowledge about rail as a mode of transport. Reflected in the diversity of its range of products and services, Vossloh possesses uniquely broad knowledge of all components of the railway – under a single roof. This capability is what makes us the first port of call for network operators. With our business model, we are able to meet the needs of operators, from A to Z, with tailor-made solutions: from long-lasting, low-maintenance products and solutions to the supply, understanding and evaluation of data, and onwards to the recommendation and actual implementation of maintenance measures.

“The Smart Rail Track by Vossloh” is our detailed vision for the intelligent railway that enables disruption-free operation and increases the lifespan of infrastructure. Unimpeded travel, punctual trains, safe and quiet operation – this is how we see the future that we are already shaping today.