VOITH

ontrack

by Voith Turbo — N° 01.2018

Cleaner, smoother, more connected

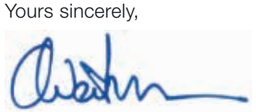
The multi-track road map for efficient and sustainable public and commercial transportation

Editorial

As more people choose to live in ever-expanding cities and towns, the pressure is on to find sustainable, cleaner transport. For the long term. We meet this challenge by offering a broad product portfolio, each option tailored to the specific needs of our customers. A multi-track approach is how Voith Turbo Mobility is driving this important shift to Drive New Ways. Our passion and expertise for smart, connected solutions using advanced engineering are at the core of this future. But the future is not only about public transport. Demands on commercial vehicles are increasing too. Whether on water or across rough terrain, we provide innovative, fuel- and cost-efficient solutions and services. With resounding success, as you can read in this issue of ontrack.

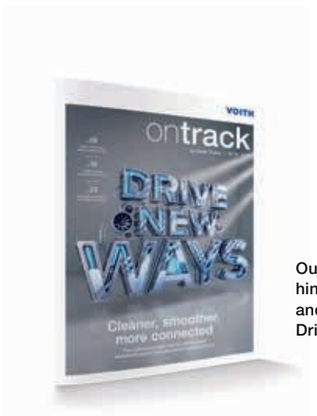
We hope you find our stories a source of inspiration to Drive New Ways with Voith!

Yours sincerely,

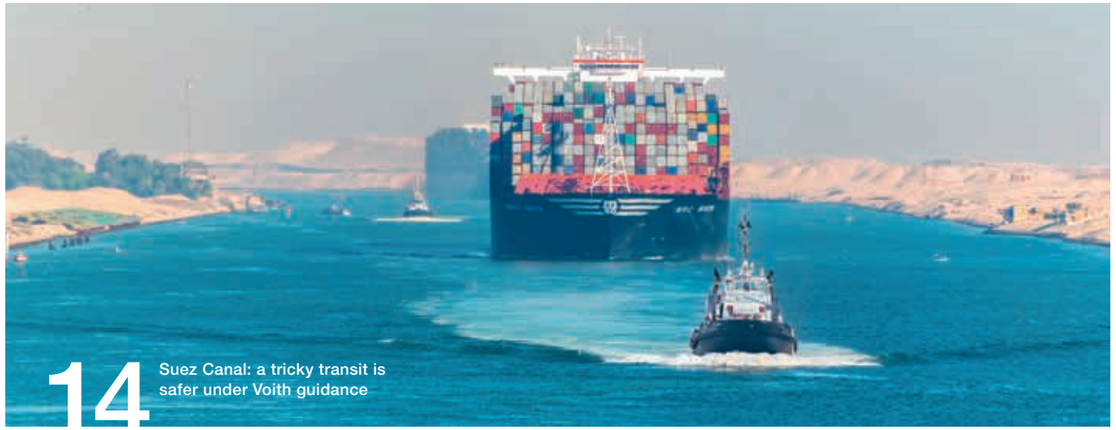


Cornelius Weitzmann
CEO, Voith Turbo Mobility

Content



Our intricate cover image hints at the level of design and technology required to Drive New Ways.

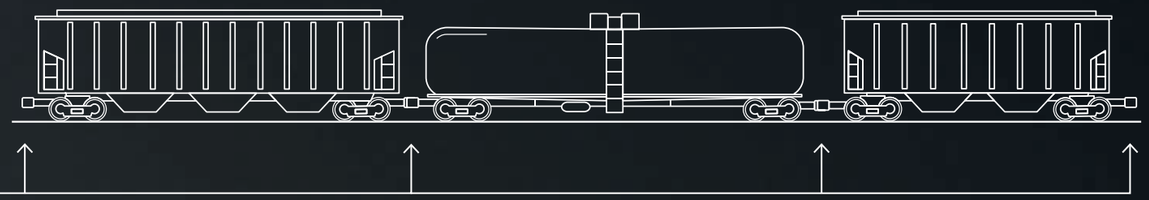


Freight couplers: finally automated

After 150 years, the time-consuming manual coupling of freight trains is coming to an end. Along with its inherent risks and downsides. The CargoFlex Type Scharfenberg by Voith changes the status quo. Since 2017, this automatic freight coupler has been undergoing its first long-term test run with SBB Cargo. Jessica Amberg, Project Manager 5L-Zug at the Swiss freight specialist, highlights the benefits: “Voith has implemented tried-and-tested design principles in their freight couplers, consciously avoiding maintenance-heavy screw connections on the load path,” she says. “Our completed trials so far promise a reliable operation for our freight rail transport during the four-year pilot phase.”

Safe, fast, efficient and digitalized

Seven new SBB freight wagons have been fitted with the half-automatic Voith CargoFlex Type Scharfenberg. This technology ensures greater safety, reliability, and a higher degree of automation in logistics and combined transport. The lightweight but robust modular system allows a flexible fitting of future upgrade components, for example for signal transmission or automatic uncoupling.



News

A quick round-up

Developed for the elements

Wherever in the world the RailPack from Voith travels, this drive system can withstand the most extreme environmental conditions and fluctuations in temperature. The newly designed RailPack with freely selectable power transmission types – diesel-mechanical, diesel-hydrodynamic or diesel-electric – accelerates for the long distance and helps ensure a long-lasting, wear-resistant, efficient rail vehicle.

Compared with today's RailPacks, the new technology is expected to pack a whole 23 % more performance in the same installation space. The result: a powerful, compact unit.

→ (For more information, see page 7.)

drive systems

diesel-mechanical, diesel-hydrodynamic or diesel-electric

↓

Voith Turbo: global excellence in production

Three cornerstones to success

1. Maximum customer focus.

2. Technological leadership.

3. World-class performance.

Top award: international integrated production network with state-of-the-art Centers of Competence

↑

"The vision of its future integrated production network is being implemented in a consistent, systematic and socially responsible manner."

Statement on Voith Turbo
Factory of the Year Competition Advisory Board

Effective, efficient and outstanding

Selected out of a field of 150 international competitors, Voith Turbo has won the prestigious "2017 Factory of the Year / Global Excellence in Operations" prize in the category "Outstanding Production Network," awarded by the business journal *Produktion* and the consultants A.T. Kearney. This award recognizes Voith's extensive digitalization and optimization measures that have connected more than 10 state-of-the-art plants and Centers of Competence (COC) to establish a tightly integrated production network on a global scale.

Three plants jointly received the award for Voith's advanced networked manufacturing capabilities: Crailsheim, the drive technology center; Garching, the center of automatic transmissions; and Salzgitter, the center of Scharfenberg couplers. Dr. Uwe Knotzer, CEO Voith Turbo, highlights the key to their success: "Consistent digitalization allows knowledge, machines and assembly capacities to be managed and distributed globally to further boost the effectiveness and efficiency of production as a whole."

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innovate

An insight into innovative ideas, solutions and the people behind them

Strong partners for low emissions

Ever-more-stringent emission regulations place increasing demands on rail system suppliers to innovate. Voith and Liebherr have entered into a cooperation with the mutual goal of delivering the most modern and future-oriented diesel engine for rail vehicles. To fulfill the European Emission Standard Stage V from 2021, Voith built an exhaust system, and Liebherr delivered the engines. Voith integrates the Voith Rail Engine in the drive system RailPack, creating low-emissions drive solutions for rail vehicle applications. "With our Voith Rail Engine and RailPack, we will provide clean and efficient solutions for our customers to fulfill the future European Emission Standard Stage V," confirms Dr. Andreas Wegmann, Senior Manager Engine Technology, Voith Turbo.

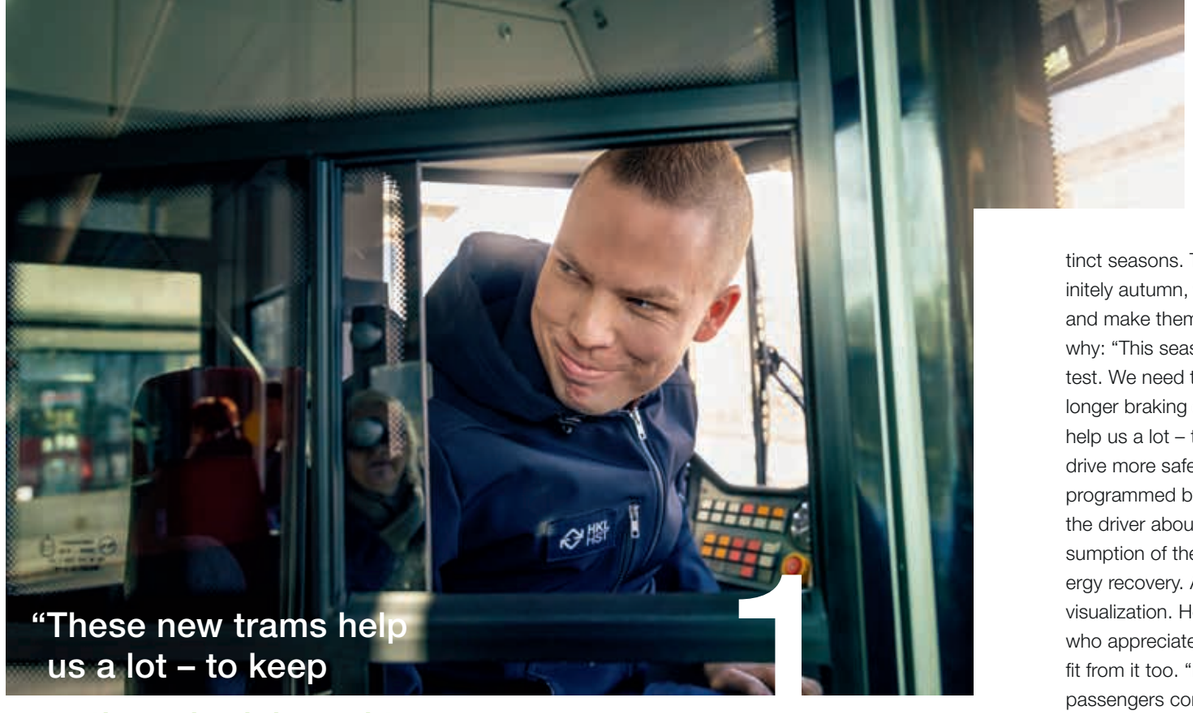
Most liveable, electrified Helsinki

Despite the short summers, harsh winters and long, dark nights, Helsinki is repeatedly ranked in the top 10 most liveable cities. Electrification of the city's transport network significantly contributes to the capital's enduring appeal.

_____ "We have a unique and beautiful city, but the winters can be tough. With spring, we get more light, more warmth, and the people just seem to brighten up," says Oskar Sjöholm, Tram Driver at Helsinki City Transport (HKL), with a charming smile. On this unusually sunny day, he's not the only one smiling in the capital. Helsinki recently landed the top spot in the 2018 UN World Happiness Report. The city is buzzing and prosperous. And there's a distinct sense of cheerfulness in the cool, salty air.

A highly efficient health care system, flexible working hours and generous parental leave make it easy to balance work and family life in Finland. The city's public institutions work efficiently – particularly public transport, which also meets the most stringent of environmental standards. The HKL system is completely electrified and, as it runs solely on renewable energy, also carbon neutral.

"As our city is growing fast and the density is getting higher, we need to increase the share of traffic modes that use space more efficiently," explains Ville Lehmuskoski, CEO and Managing Director at HKL. "This means a bigger role for walking, cycling and public transport as →



1
Oskar Sjöholm has been a tram driver in Helsinki for over three years.

2
Passengers are clearly impressed with the trams: the Voith technology ensures a smooth and much more comfortable ride.

3
The vibrant Senate Square in the clear: a popular spot for tourists, locals and businesses.

“These new trams help us a lot – to keep to the schedule and to drive more safely.”

Oskar Sjöholm
Tram Driver at HKL

Carbon neutral

Renewable energy powers the trams, buses and metro.

→ well, especially rail modes.” City trams are therefore an essential element of Helsinki’s public transport system. “The most important thing for us is to provide a good level of service to the citizens. In tram transportation, this means especially good reliability and increasing the average speed of the trams.”

Networked and powered for efficiency

By the end of 2019, 70 new Artic low-floor trams will successively supplement the current fleet. Manufactured by Transtech Ltd, a member of Škoda Transportation Group and a Finnish specialist manufacturer of low-floor trams, each new tram will be powered by Voith know-how and advanced technology. What’s more, they will also come with a tailor-made digital monitoring and diagnostic system from Voith.

More than 40 trams are currently in service, and Sjöholm is already convinced of the improvements they bring. “In Finland, we have four distinct seasons. The hardest for tram drivers is definitely autumn, when the leaves fall on the tracks and make them extremely slippery.” He explains why: “This season really puts our skills to the test. We need to be extra careful because of the longer braking distances. But these new trams help us a lot – to keep to the schedule and to drive more safely.” The vehicle control system, programmed by Voith Digital Solutions, informs the driver about faults on the tram, energy consumption of the different systems, as well as energy recovery. All in a user-friendly interface and visualization. However, it is not only the drivers who appreciate the difference. Passengers benefit from it too. “I get a lot of direct feedback as passengers come and thank me for the smooth and quiet ride,” adds Sjöholm. “They really seem to enjoy these trams.”

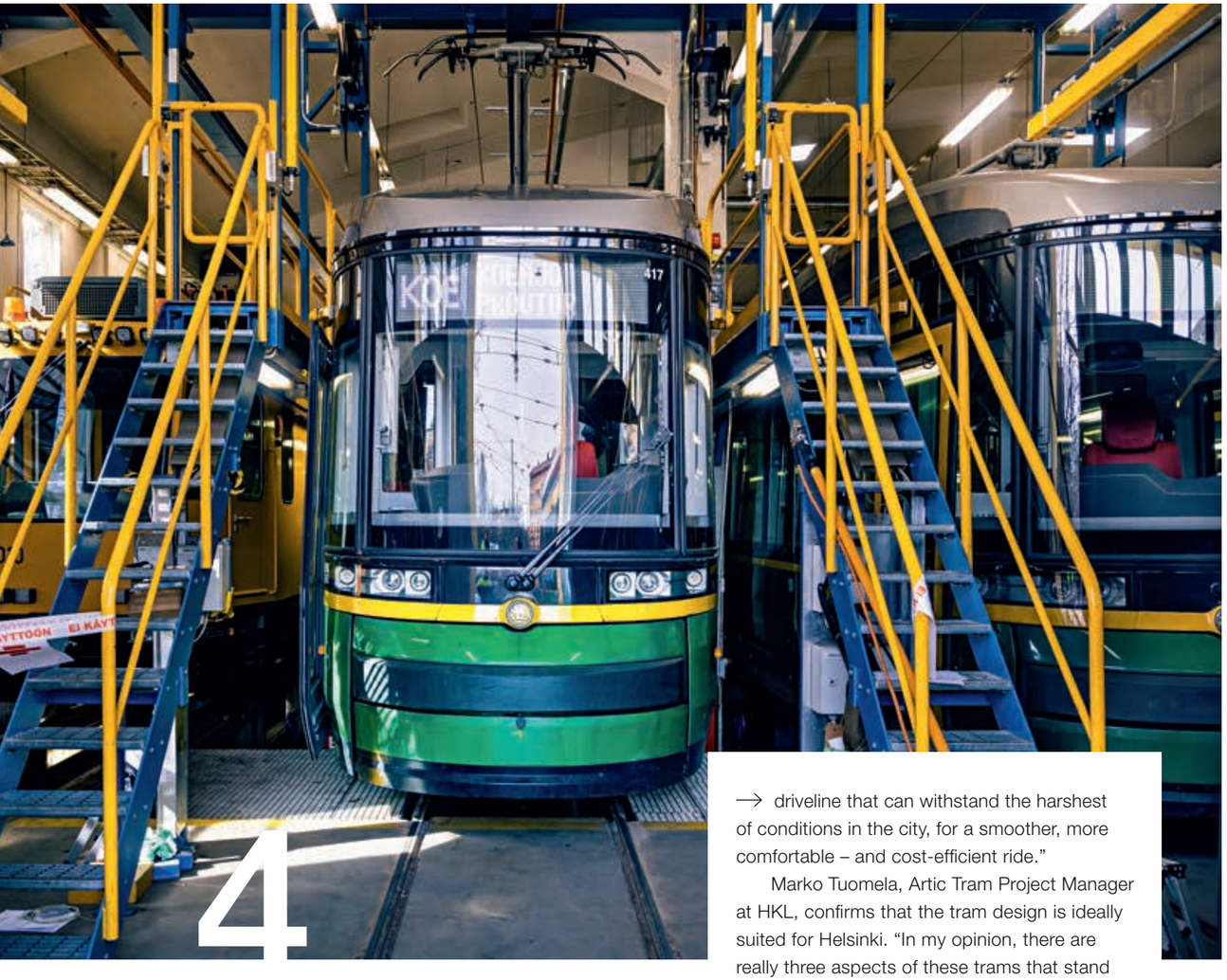
A most challenging of environments

The positive feedback doesn’t come as a surprise. “Helsinki is a busy, vibrant city on the Baltic Sea,” explains Alfred Gmeiner-Ghali, Head of Sales, Voith Digital Solutions Austria. “You get fluctuating temperatures, smog and dust. Combined with the high humidity, corrosive salt water and condensation, these all can have a detrimental effect on the electrical and mechanical components of trams,” he says. “So, we have developed this state-of-the-art electric →

2 million kilometers

Not a single serious fault has occurred over the more than 2 million kilometers already covered by the new trams.

The Transtech Artic Low-Floor Tram
Traditional freely turning, pivoting bogie design, with a modern low-floor body. Each of the bogies is powered independently. A separate motor-gear unit with a continuous output of 65 kW drives each of the eight axles. Their input power is from two EmCon Traction Inverters from Voith, with a continuous output of two times 180 kW.



Tough climate: –35°C to +35°C

Voith technology has been developed to withstand broad fluctuations in temperature.

→ driveline that can withstand the harshest of conditions in the city, for a smoother, more comfortable – and cost-efficient ride."

Marko Tuomela, Artic Tram Project Manager at HKL, confirms that the tram design is ideally suited for Helsinki. "In my opinion, there are really three aspects of these trams that stand out. Reliability, comfort of ride and energy consumption. All three are crucial after the contract has been completed. Overall, we are looking forward to a reduction in life-cycle costs and we expect to achieve this with the new trams that are fitted with Voith technology. On top of these benefits, our passengers are very happy, too."

Digitalized for performance and comfort

"The technical quality of Voith's products has been high," confirms Lehmuskoski. "But also Voith's ability and attitude to take care of the success of the client has been respectable." In addition to the electric driveline, each tram is equipped with a Voith vehicle control system that includes a tailor-made monitoring and diagnostics system for the whole vehicle. As

4
The Vallila Depot in Helsinki: easier maintenance with digital tools.

5
Ville Lehmuskoski is convinced of the digital advantages.

6
Checking the Voith traction inverter: Tero Kämäläinen, Marko Tuomela.

Lehmuskoski explains, such digital tools are important for the future. "Digitalization has a big potential in the transport sector," he believes. "There is more and more data available and the technology related to robotization is getting more solid. In tram and metro transportation, different kinds of driver advisory systems will have a growing role, as it can help to improve energy efficiency and traffic safety."

It is not just the tram drivers and management who appreciate such tools. At the HKL Vallila Depot, the benefits of the Voith monitoring system come into play again. This is where Tero Kämäläinen, the local Project Engineer, takes care of the warranty maintenance of the trams for Voith. Today, Kämäläinen walks Tuomela through the performance checks on the DI 1000-5AR Voith traction inverter, cheerfully explaining the benefits of the technology.

Helsinki is repeatedly ranked in the top 10 of the annual Global Liveability Report, published by *The Economist*. According to the report, the Finnish capital is one of the least corrupt, most trustworthy and most liveable cities on the planet. No wonder people are happy. "And HKL is very happy with the partnership with Voith," notes Lehmuskoski.

"We need to increase the share of traffic modes that use space more efficiently."

Ville Lehmuskoski
CEO and Managing Director at HKL

70

By 2019, 70 new low-floor trams equipped with motor-gear units and traction system from Voith.

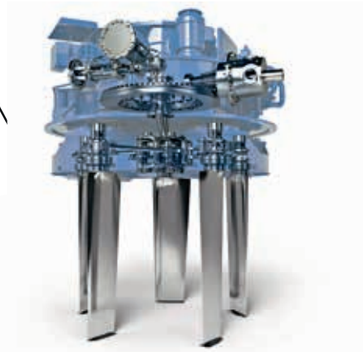
www.voith.com/
ontrack2-tractioninverter

Powerful dwarfs supporting giants

The iconic Suez Canal is a crucial maritime link between Africa and Asia. Massive tankers and container ships pass through its waters daily. Accompanied by the skillful crew on board the Voith Water Tractors (VWT), their safe and efficient passage is ensured.

Officially opened in 1869, the Suez Canal permanently altered the international shipping industry. By cutting out a treacherous 7,000-km trip around the southern tip of Africa, this channel created the shortest maritime link between the Mediterranean Sea and the Red Sea, and the Eastern and Western Worlds.

A more recent expansion, completed in August 2015, saw the widening and deepening of the canal, as well as the addition of the New Suez Canal, a 35-km canal running parallel to the original. Larger ships can now travel in two-directional traffic, and the transit time is expected to drop from around 18 hours to 11. The upgrade will double the canal's daily average →



Fitted with the Voith Schneider Propeller, the VWT offers convincing benefits.

Safety and precision of operation.

Ease of operation.

Low running, operating and life-cycle costs.

Safety first
The sensitive thrust control provided by the Voith Schneider Propulsion system ensures that ship-handling maneuvers can be performed far more safely, directly and smoothly.

Dwarfs VS Giants

Mosaheb 4	MSC Maya
Length: 36 m	Length: 395 m
Beam: 12.5 m	Beam: 59 m
Power: 5,280 kW	Power: 62,500 kW
Speed: 13 knots	Speed: 22.8 knots
Bollard pull: 70 tonnes	Capacity: 19,224 TEU

→ capacity to 97 vessels by 2023. Since the inauguration of the original, the ships passing through the canal have increased significantly in numbers, but also considerably in size.

Cargo colossus

For safety reasons, only Suezmax ships up to a beam of 77.5 m are permitted to pass through the 205-m-wide canal. This still means that giant cargo container ships, including the imposing Maersk Triple-E Vessel, which can carry 18,000 containers on board, can travel through.

Such vessels are unwieldy beasts, and therefore need expert guidance through the narrow waterway and shallow depths to ensure a safe transit. To this end, the Suez Canal Authority (SCA) operates 19 VWTs, and has recently placed an order for four more.

Entirely dwarfed by the oversized ships, these smaller, sophisticated vessels can nonetheless hold their own up against the colossal vessels. In their element, the tugs become the giants.

“Three or more tractors drive stand-by with the large vessels as they travel through the canal, ready to intervene if there are any issues,” explains Ralf Rocholl, Sales & Application Manager at Voith Turbo. “If they have an engine failure or rudder failure, a VWT is on hand immediately to help prevent a major incident or accident.” They need to be able to react rapidly in the event of a fire, for instance. A combination of agility, precision and efficiency is the key to their appeal.

“The Voith tugs perform all tasks in the Suez Canal to the full satisfaction of the SCA,” says Engineer Ahmed Shawky Mostafa, Member of the Board of the SCA, Director of Transit Department. “The tugs are an important element of the Suez Canal’s operations. The reliability of the propulsion system and overall performance of the tugs are key for the high productivity of the Suez Canal. The SCA confirms their satisfaction with the Voith tugs and highly recommends the VWT concept for complex operations in canals and ports.”

The precise maneuverability is guaranteed by the Voith Schneider Propeller – two are fitted in each VWT – which combines propulsion and steering in one robust unit. Easy handling makes the crew’s dangerous task much easier and safer. The man-machine interface is particularly user-friendly, so it doesn’t take long for the crew to adapt to the vessel.

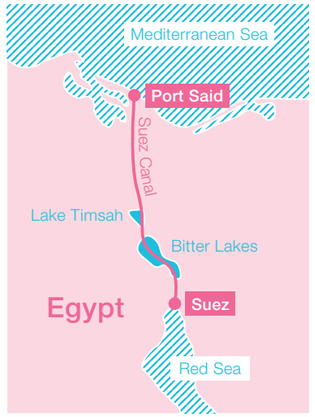
Training tailored to Suez

To ensure that the crew has mastered the maneuvers and can execute them with absolute confidence, Voith provides a tailored, enhanced training program for the crew members and pilots from the SCA. The training covers theory, plus maneuvers in the safe environment of the computer simulator at the Voith headquarters in Heidenheim, and also out at sea in northern Germany. A one-week intensive program on board the crew’s actual tug concludes the training.

For the port authorities, the program is viewed as an opportunity to increase the knowledge and skilled capabilities of the local crew. This translates into higher safety for the canal. Several tug crews and pilots participate in training, which also seeks to strengthen the interaction and collaboration between the pilots and the crews on the Suez Canal.

“When pilots and crew work seamlessly together, it really impacts the smooth and efficient running of the port,” explains Rocholl. “Our training is quite unique in the industry, but it is often an integral part of our service for our customers. One that they value. It’s how we help them to ensure the absolute safety and efficiency of their operations.”

Suez Canal



193 km
Length of the Suez Canal.

7,000 km
Distance saved by avoiding the journey around Africa, cutting the trip by around two weeks.

44%
Cutting the distance between Europe and Asia could reduce CO_2 emissions by up to 44%. For a large container ship (19,000 TEU), this would be around 12,000 metric tons.

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transform

The people and the technology shaping the industry

Space comes on board

Satellite technology has enormous potential for autonomous and remote-controlled shipping. A new generation of marine propulsion is in the pipeline to support such a shift: both the renowned Voith Schneider Propeller and the Voith Inline Thruster are now being upgraded. Lightweight and highly efficient, these new Voith propellers will deliver thrust for electric or hybrid vessels (with diesel or e-motors), achieving increased fuel efficiency and significantly reduced emissions levels – as well as an even more comfortable ride. With these propellers in charge of propulsion, Voith is participating in the development of autonomous vessels, in particular ferries and harbor tugs. Guaranteeing the highest degree of safety. Wherever the control systems are located.

Tough trucks

The Georg Müller GmbH is in the business of transporting heavy loads of various construction materials. A business that requires venturing into rough terrains. For economic and safe operation, the company relies on innovative Voith technology.

Power, strength and durability are attributes that immediately spring to mind to describe trucks that have to carry heavy loads of sand, gravel or timber. But sometimes the big muscles among the commercial vehicles are about something entirely different – a sensitivity that makes every inch count. Maneuvering in sand pits or on slippery dirt roads often requires sheer strength, but also highest precision. A fact that the drivers of the Georg Müller GmbH in the small town of Wilburgstetten, Germany, experience every day.

The family-run company quarries sand, transports logs and has a gravel plant. Eighty trucks make up the fleet, but for off-road operations owner Georg Müller and his wife, Bianca, rely on 10 Mercedes-Benz Arocs fitted with the Turbo Retarder Clutch VIAB (or simply VIAB for short) from Voith. The unique clutch technology combines hydrodynamic start-up and braking functions, which support the driver and preserve the drivetrain. The wear-free integrated start-up and braking system is an optional feature in the heavy-duty class of trucks at Mercedes-Benz. →

Inside: Turbo Retarder Clutch VIAB.
Designed for effortless, relaxed driving on tough, rough terrains and for heavy-duty tasks.

Martin Wunderlich drives a tipper fitted with a VIAB at Georg Müller GmbH, the family-run company. Even in the slippiest of conditions, the truck remains firmly under control.

Multiple options

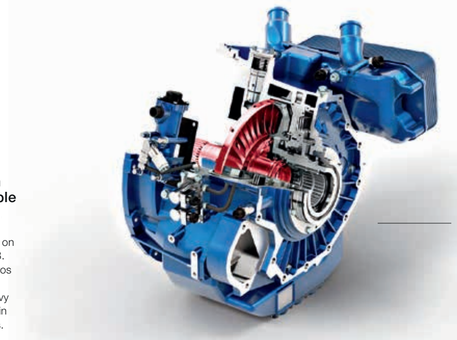
Designed for off-road terrain, the construction industry and also heavy haulage.

1. Tackles extreme inclines.
2. Copes with heavy loads.
3. Provides low-speed control.
4. Reduces fuel consumption.

Tried-and-tested with Mercedes-Benz, available for all manufacturers.

Mercedes-Benz relies exclusively on the Turbo Retarder Clutch VIAB. Optional with the Arocs and Actros series, it is a standard on the Mercedes-Benz Actros SLT heavy tractor, designed for a truck-train loads of up to **250 metric tons**.

The potential distance replacing brake pads: 600,000 km.



www.voith.com/ontrack2-VIAB

Turbo Retarder Clutch VIAB

→ Though the initial costs are higher, the Müllers expect to make savings in the long run.

For slippery, steep terrain

"We have difficult terrain in the woods, in quarries and on construction sites – and often have to start a fully loaded vehicle on slippery grounds or on steep slopes. That means a high wear on the clutch. The vehicles are in use for eight to 10 years. In that time frame, you would normally have to exchange the clutch at least twice," explains Georg Müller. "We chose to invest in the technology for economic reasons on the one hand, and also because it makes the work of our drivers easier and much safer," adds Bianca Müller. The VIAB enables both sensitive and wear-free starting as well as maneuvering at the lowest of speeds – both important in many areas of the Müllers' operation. Precise maneuvering with heavy loads is one example. "The VIAB was originally designed for Mercedes-Benz heavy haulage tractor units," says Hans-Günter Böhm, Senior Global Key Account Manager Truck OEMs, Voith Turbo. "Mercedes-Benz relies on this technology for its Arocs, Antos and Actros series of trucks. The Actros, for instance, has no difficulty starting at extreme inclines – even with a load of 250 metric tons. The combination of powerful engines with our retarder clutch enables a very spontaneous and dynamic start and quick response to acceleration – even at high total train weights."

Agility appreciated

This kind of agility is highly appreciated by the drivers. Responsible for driving timber transports all over Germany, Tobias Glatter, one of the truck drivers at Georg Müller GmbH, has to deal with loose, muddy and even icy roads all year round. Driving in such conditions is not only difficult but can be dangerous if the vehicle were to start slipping, for example. "The VIAB is especially helpful in maneuvering the truck on difficult underground. The system is very sensitive, precise and stable. The truck is easier to handle in every terrain," says Glatter. Martin Wunderlich, who drives a tipper for sand or gravel, agrees: "If you sink in a little on a construction site it is easier to get out again because the wheels don't start spinning immediately. Driving with the VIAB is so easy. You step on the gas and the truck just runs."

This is made possible by the unique design of the VIAB. The pump impeller and turbine wheel face each other in a non-contact configuration in the Turbo Retarder Clutch. The moving pump impeller is at the engine end, while the turbine wheel is installed at the transmission input. The power is transferred from the impeller and turbine without wear by automatic transmission fluid.

When the driver steps on the accelerator, compressed air pumps oil into the Turbo Retarder Clutch, establishing a non-frictional connection between engine and transmission input shaft. This form of power transmission offers the benefit of fast yet gentle and wear-free transmission at full engine torque.

Tough demands met

And the system is also easy on the brakes. During braking, the turbine wheel is locked in position and →

→ fluid is pumped into the housing once again – in this case it acts as an effective primary retarder. "With the wear-free braking system you can decelerate almost to a standstill. In any kind of difficult situation you always have full braking power because the service brake doesn't run hot. This means that, if driven carefully, the vehicles go for 500,000 to 600,000 kilometers without having to replace the brake pads. This is around three times more than brake pads usually last," says Georg Müller, and adds: "The demands we make on the vehicles are very high. They have to withstand stresses that are quite different to trucks that mainly transport goods on the highway. As a result, our demands on the technology are a little higher as well, and, so far, our experience has been very positive." –

"Driving with the VIAB is so easy. You step on the gas and the truck just runs."

Martin Wunderlich
Truck Driver at Georg Müller GmbH

Disconnecting to save

The next generation of the Secondary Water Retarder (SWR) from Voith – the ECO-SWR – takes the proven technology even further. Gunther Kraft, Vice President Truck OEMs, Voith Turbo, explains how.

What are the main features that distinguish the ECO-SWR?
The main innovation on the ECO-SWR is that it can be disconnected from the drivetrain in idle mode. Located in the drivetrain of a bus or a truck, the rotor of the SWR is rigidly connected to it via a step-up gear train. So while not in use for braking operation it still runs, and it runs against air resistance in the circuit. Though the resistance is small, it consumes energy nevertheless. With the ECO-SWR this constant resistance and consequential power use is eliminated by a coupling that disconnects the rotor from the drive shaft in idle mode.

What are the benefits for your customers? Apart from the yearly fuel savings, the new technology contributes to a reduction in CO_2 emissions. Not only is this beneficial to the environment, but it can also positively affect the CO_2 certification of the vehicles. As a result, both manufacturers and operators benefit. Manufacturers because they can optimize their overall CO_2 efficiency, on which tax subsidies are dependent. And the operators because they directly profit from the reduced fuel consumption, lower taxes and potentially toll charges.

And the driving experience? The ECO-SWR offers great driving comfort and safety. Just as with its predecessor it is integrated into the vehicle's brake management system. So the driver activates the continuous brake system as usual – either via the steering column or the brake pedal.

ECO-SWR

The safe, economical and sustainable solution for hydrodynamic continuous braking. Optimizing driving and protecting the environment.

Cornelius Weitzmann
CEO, Voith Turbo Mobility

“The Voith family has always thought in the long term. Just like the OEMs, we’re taking a multi-track approach.”

open

Driving electrification

As countries across the globe are aiming to reduce their emissions, policymakers are looking increasingly to electrified solutions for public transport. Cornelius Weitzmann, CEO for Voith Turbo Mobility, outlines how Voith is leading the transition to cleaner cities.

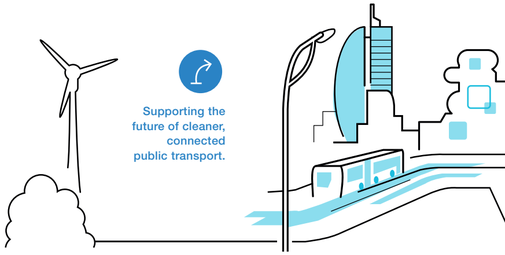
What are the main pressure points driving e-mobility in public transport? Next to population growth, it’s urbanization. The percentage of people living in cities is expected to increase to 60% by 2030. Which drastically changes public transport requirements. If we want clean cities in the future, we need to limit individual transport and, at the same time, increase sustainable public transport solutions. The pressure is on for policymakers to adopt cleaner transportation, in particular in Europe. And given that urban bus fleets are generally at least partly owned by the local municipalities, buses will be first to be electrified at a significant level.

Can we expect a complete switch to e-buses soon? The transition will take place at different speeds in different countries. China is already further ahead, and various European transport companies aim to completely switch to e-buses in the next eight to 10 years – when it comes to new acquisitions, that is. Overall, taihowever, there will still be a market for diesel and hybrid vehicles for the next 20 years or so.

What does this scenario mean for Voith? We believe in e-mobility in public transport and are planning accordingly. The classic transport segments are shrinking. We don’t exactly know how fast, as there are factors which we and even the OEMs cannot really influence – such as building the necessary infrastructure. Nevertheless, we will meet these changes by offering a broad product portfolio. We will see a mix of diesel, hybrid and e-buses for a while, and we will provide the very best solutions for all drive technologies. As well as developing an entirely new Voith electrical drive system, this also means improving our technologies for the classic segments. With the DIWA NXT transmission, for example, we will offer a mild-hybrid solution for reduced emissions. The Voith family has always thought in the long term. Just like the OEMs, we’re taking a multi-track approach. And this is not new territory for us.

60%

of the world’s population is expected to live in urban areas by 2030.



Supporting the future of cleaner, connected public transport.

Voith developed the very first hybrid solution for buses, the DIWAhybrid, over 10 years ago. Even back then we were conscious of where the market might be headed. So really what we’re doing now is in keeping with the Voith tradition. Essentially, we are building on the Voith legacy to provide the best solutions for e-buses. We are one of the top three suppliers for automatic transmissions for city buses worldwide, we have an established service network and close partnerships with major bus OEMs, as well as public transport operators. The best basis therefore to support our customers within these changing market conditions.

How exactly? At the moment, there really isn’t an optimal system – this is equally true for the e-bus drivetrains as it is for the entire infrastructure. We clearly differentiate ourselves in the market because the Voith electrical drive system is not an adaptation. We are designing an optimal system tailor-made for e-buses, which will lead to more e-buses on the roads.

Why is Voith the preferred partner for this shift? Our components are critical for an efficient bus operation. Today, the DIWA transmission is the most complex part in a diesel bus. It effectively determines fuel consumption. The same goes for the Voith electrical drive system with regard to energy efficiency. The intelligence is built into the DIWA transmission. But this is not just about individual parts – we are also looking at the bigger picture. Using design thinking, we are identifying the exact needs not only of our customers, but of end-users, too. Many operators are unsure about how to implement e-mobility. From electrical infrastructure in the depot to the right fleet management system – these are problems they are facing. And we are looking into ways we can offer support across them all.

What role will digitalization play? It is as relevant here as it is to all of our business. That is the reason why Voith established the Group Division Digital Solutions a few years ago. We will offer a digital package with the Voith electrical drive system that OEMs can use or integrate into their own digital solutions. As for maintenance, we have intelligent digital solutions for the repair shops, with our SmartMaintenance, for instance, so that operators can easily work with our built-in components. As manufacturers, we know our products, we know the needs of our customers. We have them all covered.

The success is in the mix, believes Voith Turbo Mobility CEO Cornelius Weitzmann.

“We are building on the Voith legacy to provide the best solutions for e-mobility.”

All options covered

With its extensive experience and expertise in drive systems, Voith is playing a leading role in defining solutions for the world of transport.

A digital future for all

Fully networked via the Voith Cloud, these drive systems will offer additional digital functionality to help operators optimize public transport. Supported by Voith domain knowledge and connected to standard public transport telematics systems, the next generation of drivelines will contribute to the data and insight required for operators to achieve excellence and efficiency in fleet management, operation, service and maintenance.

System monitoring and truly predictive maintenance.

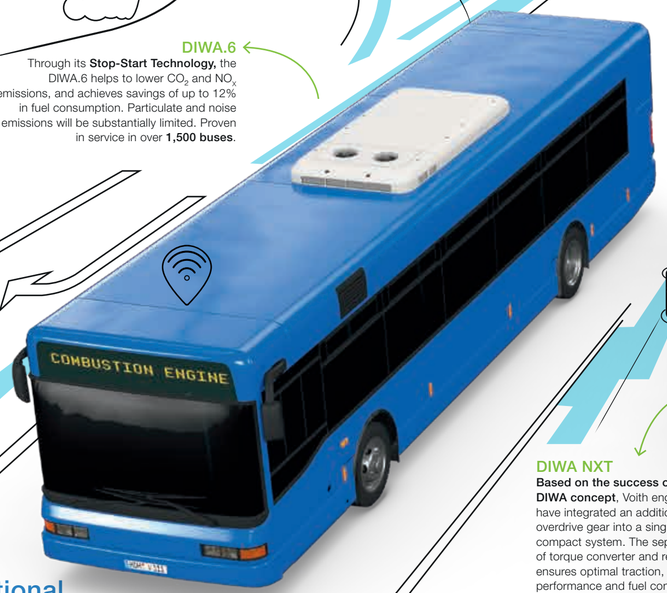
Optimum layout of routes thanks to power and energy prediction.

Tailor-made monitoring assistance systems.

Demand-driven energy management.

DIWA.6

Through its **Stop-Start Technology,** the DIWA.6 helps to lower CO_2 and NO_x emissions, and achieves savings of up to 12% in fuel consumption. Particulate and noise emissions will be substantially limited. Proven in service in over **1,500 buses**.

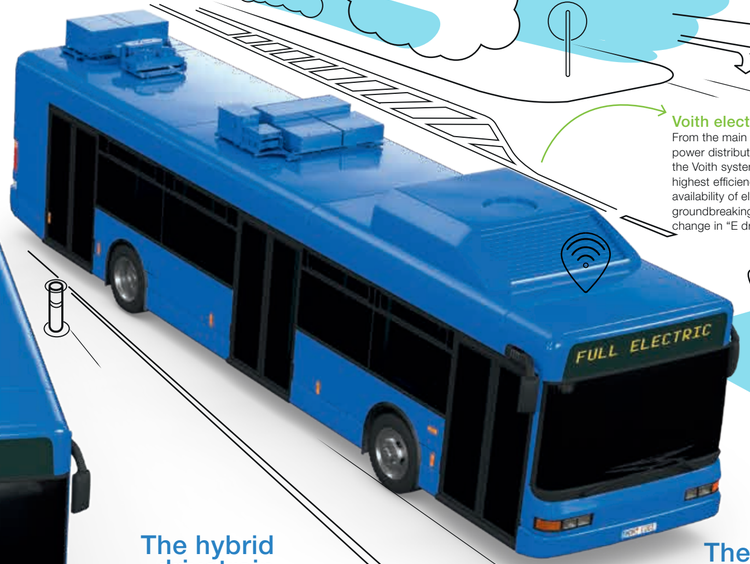


DIWA NXT

Based on the success of the DIWA concept, Voith engineers have integrated an additional overdrive gear into a single compact system. The separation of torque converter and retarder ensures optimal traction, retarder performance and fuel consumption. The wider transmission spread offers flexibility in driveline design – also for intercity buses and coaches.

Voith electrical drive system

From the main drivetrain to auxiliary handling, power distribution and energy management – the Voith system covers them all. This ensures highest efficiency, range of operation and availability of electric buses. Discover how this groundbreaking technology is already driving change in “E drive” (pages 29-30).



The conventional drivetrain

Today, there are more than **160,000 buses** operating with DIWA transmissions throughout the world, and over **320,000 transmissions** in total have been sold. For combustion engines, whether powered by diesel or by compressed natural gas, the **DIWA automatic transmission** offers tailored solutions for all kinds of city and intercity applications.

Fuel savings:

DIWA.6

– 7%

DIWA NXT

– 16%

DIWA NXT (–7%) + CRU (–9%)

The hybrid drivetrain

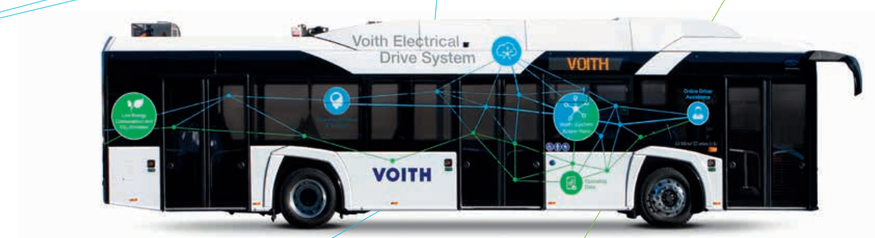
In areas where a pure electric solution is not feasible, **a mild-hybrid drivetrain** will offer an optimal alternative. In the future, the **DIWA NXT** automatic transmission will offer the option of an **integrated central recuperation unit** (CRU). For easy maintenance, this mild-hybrid system is based on 48 V technology, with a continuous power of 25 kW and a peak power of 35 kW. The highly efficient electric motor will support the combustion engine during demanding routes and supply power to other components, such as the air conditioning, via the vehicle’s electric system, and requires almost no additional installation space due to its compact design.

The pure electric drivetrain

To reduce air and noise emissions in urban areas, operators have started to electrify their fleets. Voith is committed to providing a tailored **plug-and-play solution,** with optimized interfaces, that is easy to integrate. The **Voith electrical drive system** is a fully electric powertrain suitable even for articulated buses and challenging topographies. Best in class for efficiency and reliability. The advanced design of the motor ensures highest efficiency. Due to the high power density, the Voith electrical drive system motor has a very compact design.

www.voith.com/ontrack2-E-Bus

drive



3,100 Nm torque

300 kW output

Compact, reliable and technologically superior, the Voith electrical drive system has convinced forward-thinking public transport operators to make the shift to electric vehicles. E-buses fitted with the new drive system will be on the road within the year.

The vision of a sustainable network of electric buses is already taking shape as part of two pilot projects in two German cities, Schwäbisch Hall and Heidenheim. Developed for Transdev GmbH, the leading private operator of passenger buses and trains in Germany, and fitted with the Voith electrical drive system, these electric buses will help satisfy the ever-increasing demand for low-carbon urban mobility solutions.

The commitment for this engagement was very important for us as a mobility provider. We are aware of our responsibilities, as Michael Dalhof, CEO of Stadtbus Schwäbisch Hall GmbH and Heidenheimer Verkehrsgesellschaft mbH – subsidiaries of Transdev GmbH and transport operators in the two cities involved in the e-bus pilot projects – is keen to emphasize: “As an international provider of public transport we have a responsibility to support CO_2-friendly transportation,” he says. “We can also draw on the extensive experience in e-mobility of our Group.” →

Innovative drive system

Low weight, low noise, maximum efficiency.

Compact, reliable and available for all types of buses.

300

300 kW ensure not only outstanding driving dynamics, but also high efficiency.

550

For each bus that covers 50,000 km over a period of 12 years, the savings in CO_2 emissions total 550 metric tons.

Local backing, global expertise

In both cities, the shift has the backing of the local government and the locals. In Heidenheim, where three e-buses will operate from November 2019, Mayor Bernhard Ilg explains why: “The investment in e-mobility is a crucial step to a climate-friendly city, and is widely supported by politicians and the public.”

In Schwäbisch Hall, three e-buses will be on the roads by April 2019. The mayor, Hermann-Josef Pelgrim, is convinced of the need to electrify the bus network: “The electric buses are part of a key pilot project that the city of Schwäbisch Hall is keen to support so that we can firmly push ahead with e-mobility as part of the scope of our overall climate protection project.”

Compact, clean and quiet

The compact, innovative Voith electrical drive system ensures an efficient and reliable e-bus operation for both cities. Tailor-made for inner-city applications, it includes a reliable traction system with maximum efficiency and auxiliary handling that is rounded off with an intelligent energy-management system.

Initially developed for one prototype electric bus, a Solaris Urbino Bus, the Voith electrical drive system is designed so it can be integrated into vehicles from other manufacturers without restrictions. In total, it took less than three years to go from concept to prototype to market.

With a torque of 3,100 Nm and an output of 300 kW, the liquid-cooled permanent magnet motor with high-efficiency inverter and smart energy management system provides outstanding driving performance and does not require a separate transmission. The system can efficiently operate heavy articulated buses. Due to the high power of the system, an outstanding recuperation rate can be achieved, which increases the operating mileage. All components are cooled with water, which increases the reliability and performance and allows for noise reduction during operation.

The vision of low-carbon urban mobility requires decisive action and commitment. Forward-looking decision-makers have already signed up to low-carbon urban mobility solutions. Cornelius Weitzmann, CEO of Voith Turbo Mobility, confirms: “Especially for the bus fleets of municipal transport services, the time for electro mobility has definitely arrived.”

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reflect

Key trends, new developments and industry-insider opinions

Welcoming Panda, our sensitive cobot

Cobots, short for “collaborative robots,” work hand-in-hand with their human colleagues. This is especially true of Panda, the interconnected, quick-learner cobot with ultra-rapid reaction times from Voith Robotics, a joint venture between Voith and Franka Emika that combines pioneers in automated production processes with intelligent robotics. Because of Panda’s sensitivity to touch, safe reflex system and human-like dexterity, this cobot easily masters intricate movements and performs finely controlled repetitive tasks, even in dangerous production settings. Martin Scherrer, CEO Voith Robotics, explains: “Based on our in-depth domain knowledge and cutting-edge robotic know-how, we now offer tailor-made automation solutions for all production needs. Making Panda a welcome, and affordable, addition to any team.”

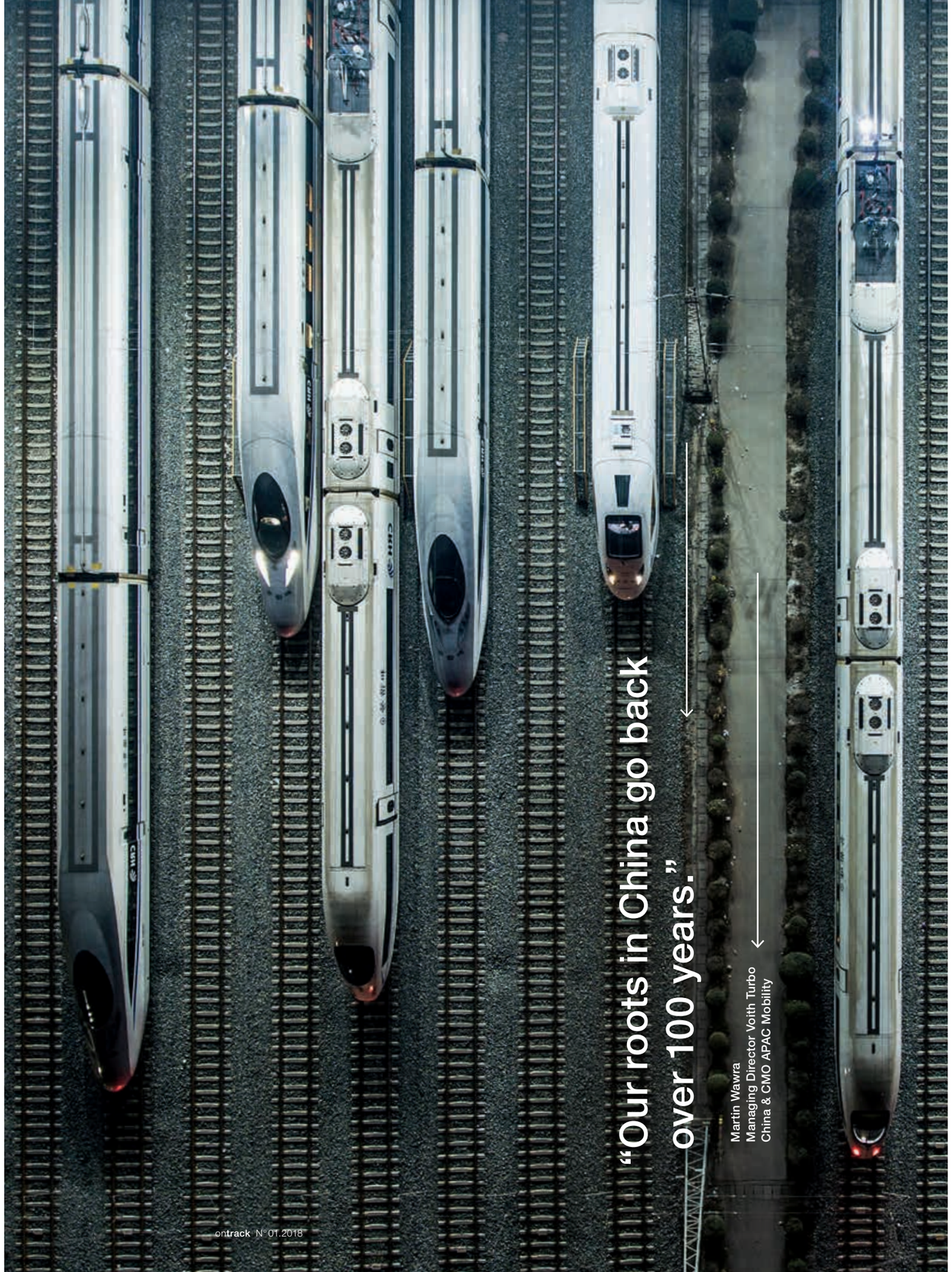
High-speed gains

The modern revival of the ancient Silk Road is underway. Voith is expecting to help meet the increased global demand for high-quality, high-speed passenger and freight trains, and for sophisticated rail components.

Under the “One Belt, One Road” (OBOR) initiative, China is driving the revival of the ancient Silk Road. A whole series of infrastructure projects is expected to spur economic development, transform local economies, and forge closer ties to and across a network of almost 70 countries. Germany included.

Much like the original Silk Road, the OBOR is a broad logistics network. It includes oil and gas pipelines, as well as new maritime hubs and routes. Central to the project – which is more formally known as “The Silk Road Economic Belt and the 21st Century Maritime Silk Road” and was officially launched in 2013 by Chinese President Xi Jinping – are three modern rail corridors. This “Iron Silk Road” travels overland across the Eurasian continent and much of the original ancient routes, but is light years away from the caravans and camels that connected communities and cultures for over a thousand years.

Today, high-speed trains cross deserts, plains and cities in days, rather than months. In the future, the over 10,000-km rail journey from China to Germany is expected to take around seven days for passenger trains and 15 days for freight. This opens up a convenient and, more crucially, a cost-efficient third logistics option, located somewhere between the ultra-fast, costly airfreight and the six-week sea routes.



5,000 new high-speed trains will be sold in China by 2030, 1,200 in the next three years alone.

40,000 km will be covered by the Chinese rail network by 2030. Currently it stands at 22,000 km.

Old ties, modern results

Such an extensive rail network is expected to lead to an increase in the market for more modern trains. And not exclusively for the freight trains on the Iron Silk Road, either. At the same time, passenger trains for international and domestic routes are also expected to increase.

“One Belt, One Road will bring a massive expansion of China’s railway infrastructure,” says Martin Wawra, Managing Director Voith Turbo China & CMO APAC Mobility. Construction of the first high-speed line, from Beijing to Shanghai, started in time for the 2008 Beijing Olympics. The line was 1,138 km long and took three years to build. Ten years later, the network stretches over 22,000 km. And it has gained a reputation for its world-class, high-speed trains, the most modern of which operate at top speeds of 350 km/h.

“Our roots in China go back over 100 years, so Voith has a close connection to the Chinese culture and economy,” adds Wawra, who is based at the Voith Turbo headquarters in the Minhang District of Shanghai. “These are exciting times for China, and a time of interesting opportunities for Voith.”

Bordeaux, a city thriving on traditions and the most modern of smart public transport.

Smarten up the city

Keeping transport in Bordeaux clean, connected and economical: a dedicated smart bus network equipped with Voith technology.

The city center of Bordeaux is a UNESCO World Heritage Site, but progress has far from passed it by. Medieval street names lead to neoclassical architecture. Cobbled, narrow passages end at brand-new, gleaming tram lines. Gothic churches contrast with modern offices. Bordeaux is clearly a city that has always embraced its past and made plans for the future. The iconic design of La Cité du Vin, the city's interactive museum of wine that opened in 2016, is a symbol of this joie de vivre. The city keeps its history alive, and also thrives on modern connections.

A thoroughly contemporary transport system connects the different quarters and suburbs to the historic center. Traveling through the city today, it's hard to believe that it was, until fairly recently, pretty scarred by traffic congestion and air pollution. The French are good at long-term rejuvenation projects, however, and they have done it in style in Bordeaux. Over the last 20 years, the city has undergone a major transformation. A motorway made way for a green promenade along the Garonne River. Streets have been pedestrianized, tram lines laid. And an extensive bus network is playing a central role in this modernization push.

What makes this network particularly special are its fast connections and reliable service. Extremely reliable. Keolis, the city's transport →

"At least once a year our team is trained on the latest technology."

Georges Nave
Maintenance Director at Keolis Bordeaux

Smart savings

The potential savings from implementing predictive maintenance could be substantial for each avoided failure, particularly when factoring in possible penalties, towing costs and, equally as important, any reputational damage.

Johannes Ilg
Vice President Service Product Management,
Voith Turbo

Interview

GAME ON
for smarter drivers

Johannes Ilg, Smart Services is a proven state-of-the-art toolbox for achieving environmentally friendlier transport systems. Can you reveal the next step? Data analysis can go even further than creating tailor-made maintenance schedules. Intelligent monitoring can help improve driving skills and performance, which has the knock-on effect of reducing fuel consumption.

Could you explain? During intensive and extensive real-life trials, we developed OnEfficiency.DriverAssist, the latest tool in our Smart Services portfolio. It is a tool that presents drivers with a mission. Their goal is to drive in the most efficient way, and they are rewarded when they do.

How exactly? With points and by moving up different levels, much as you would in a fun video game. But there is a serious upside. The tool captures accelerator pedal position. Using our algorithms in the Voith Cloud, we are able to use such data to uncover potential for optimization. Using OnEfficiency.DriverAssist, the improvements in driving can lead to a potential 10% reduction in fuel consumption. The tool is about helping to visualize personal success and ways to build on that success. The players are not up against other drivers, just monitoring themselves and using the analysis of their performance to improve their own driving style.

And the bus operators? We provide clear aggregated management reports that help identify areas where drivers could benefit from more training and reveal potential room for improvement. We help provide an environment that recognizes and rewards success, and motivates the drivers to improve. OnEfficiency.DriverAssist taps into our natural competitive streak, but in a positive way and within clear boundaries. The focus is on a safe, economical driving style. That is welcomed by operators and drivers alike.

Our Service – Part of Your Business.

OnEfficiency. DriverAssist
Capturing and analyzing driver behavior to improve driving style.

→ company, was very forward-thinking in its modernization strategy and set several ambitious goals, including the drastic reduction of unscheduled and scheduled standstill times. “Our current fleet consists of 398 buses, 90% of which are equipped with Voith transmissions,” explains Georges Nave, Maintenance Director at Keolis Bordeaux. Currently, 200 buses are powered by compressed natural gas and equipped with SmartMaintenance, which permits extensive data monitoring and analysis of the DIWA automatic transmissions. The difference this tailored serviced has made is remarkable.

SmartMaintenance
Monitoring the DIWA transmission for automated analysis and predictive maintenance, based on over 150 years of Voith expertise and experience.

Highly effective

“In the past few years, none of the Keolis buses in Bordeaux equipped with SmartMaintenance have been out of service due to transmission problems,” highlights Hervé Robin, Customer Service Manager, Voith Turbo France. A sure sign that permanent transmission monitoring via SmartMaintenance is highly effective. According to Nave, the close cooperation with Voith is a key factor for the effective utilization of the system when it comes to evaluating the data.

The optimal interplay of data, training and technology: buses on schedule, fully cost-efficient and available on demand.

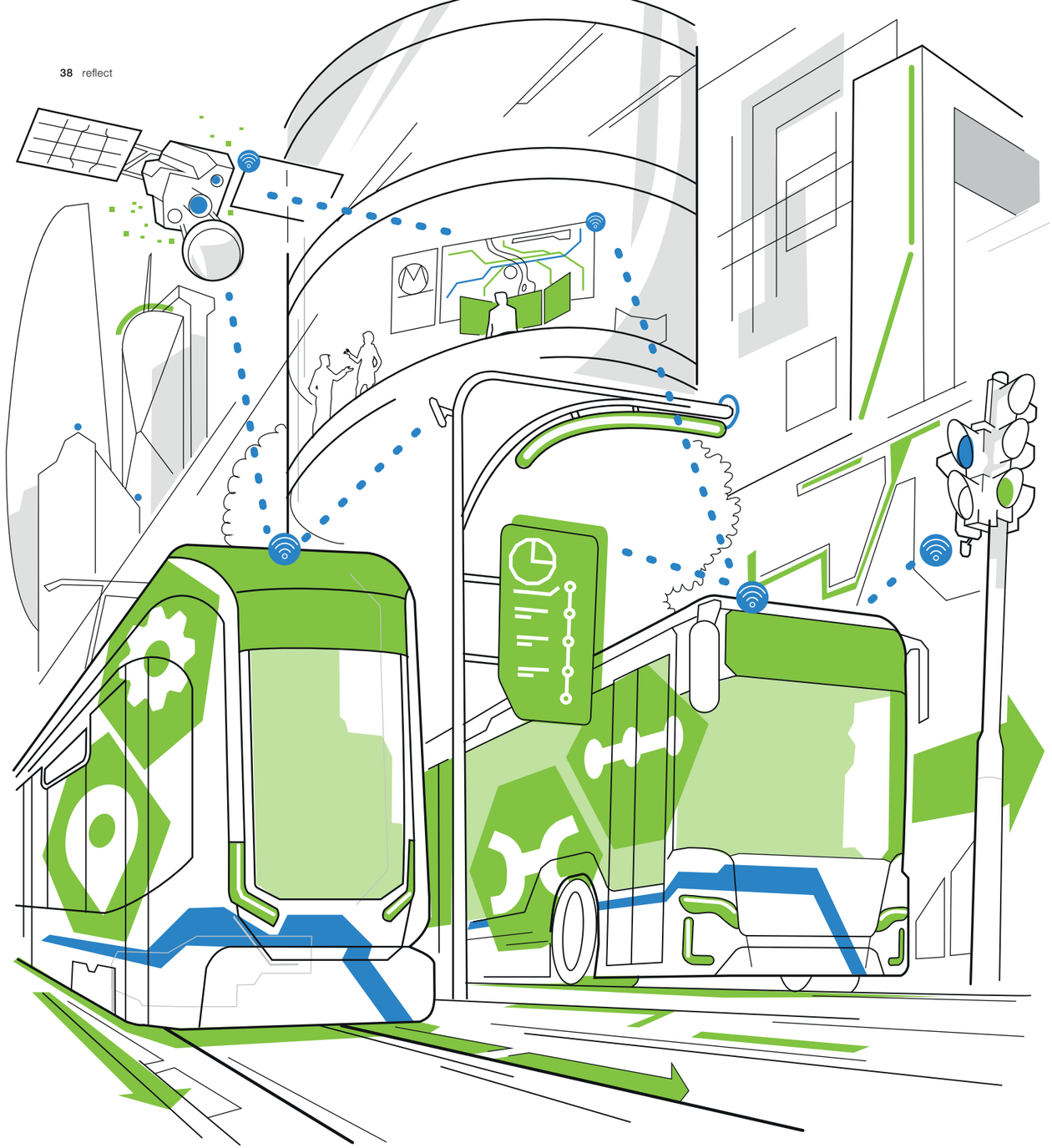
Voith has been collecting data for analytical purposes from the buses in Bordeaux for over seven years. What started out as a fairly laborious manual process has been developed together with Voith Digital Solutions to the industrial-grade level of Smart Services. The data analysis has been automated, and each week a visual report is supplied to Keolis, so the company can understand the situation at a glance and put predictive maintenance into action. The cooperation with Voith includes regular training of the Keolis maintenance team at the dedicated service center to ensure the success of the program. “At least once a year our team is trained on the latest technology,” adds Nave.

“The aim is to keep total life-cycle costs as low as possible, while ensuring maximum availability of the buses,” explains Johannes Ilg, Vice President Service Product Management, Voith Turbo. The data, the analysis and the expert training result in perfectly maintained transmissions, and buses that operate on time, with full efficiency and increased availability. This maximizes profitability for the bus operator. And also heightens the attractiveness of a ride on public transport. Which is probably the reason why a total of 141 million passengers catch the bus in Bordeaux each year.

Smart Services
Reducing the largest segment of costs for public transport operators: fuel and maintenance.

Control Unit
Capturing data as ECU files for detailed data analysis.

Voith Cloud
Providing data algorithms for performance calculation and optimization advice.



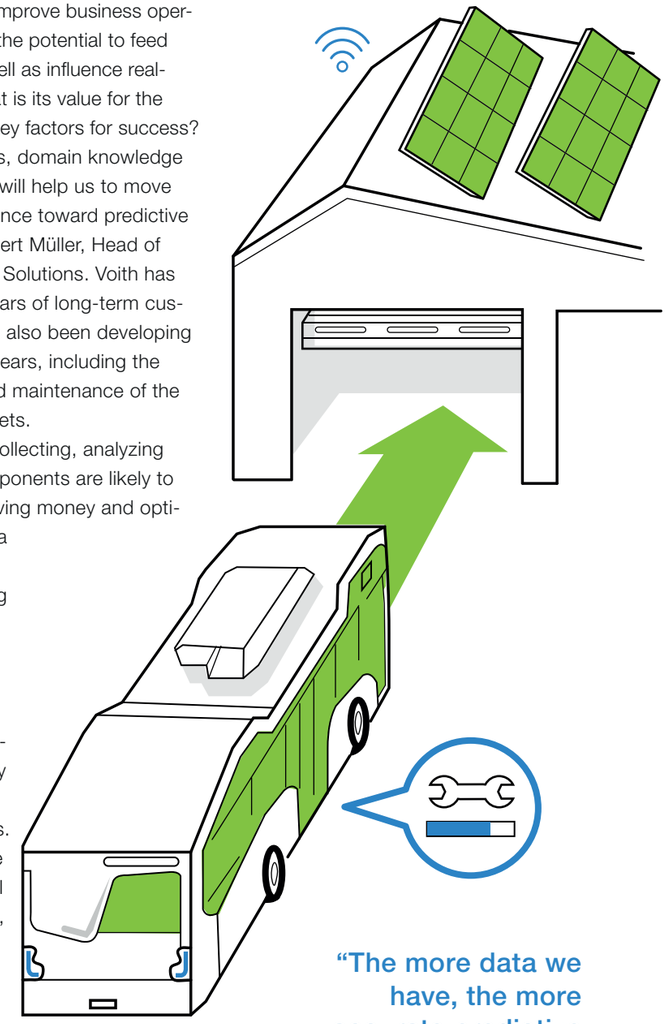
Data-driven insights

Efficient and targeted data generation, storage, management and analysis are crucial in today's digital landscape. With Voith support and expertise, companies derive real insights from big data — and convert domain knowledge into action.

_____ Generating real-time data from machines and vehicles is one thing – but leveraging it to improve business operations is quite another. Such data has the potential to feed into strategic business decisions, as well as influence real-time operational decision-making. What is its value for the transport industry – and what are the key factors for success?

"Combined with intelligent analysis, domain knowledge is what makes all the difference. Data will help us to move forward from former reactive maintenance toward predictive maintenance strategies," says Dr. Robert Müller, Head of Business Development at Voith Digital Solutions. Voith has acquired such knowledge over 150 years of long-term customer relationships. The company has also been developing digital solutions in this area for many years, including the DIWA SmartNet service for service and maintenance of the automatic transmissions in city bus fleets.

That started out as a system for collecting, analyzing and sharing data to detect which components are likely to fail and replace them in good time, saving money and optimizing bus availability. Today, high-quality data comes from a variety of different sources, such as existing sensors throughout the bus, on doors and tires for instance, enabling truly predictive maintenance that tells the operator what needs to be done in six months' – or even in a year's time.



A richer data pool

"The more data we have, the more accurate predictive maintenance will be," adds Müller. Fuel consumption is also a key point here. If a bus fleet can reduce fuel consumption, even by a few percentage points, it will achieve significant savings. "This is where data collection and analysis provide real value beyond predictive maintenance." Intelligent data analysis will compare all the variables – passenger load, traffic situations, weather and time of day, as well as fuel.

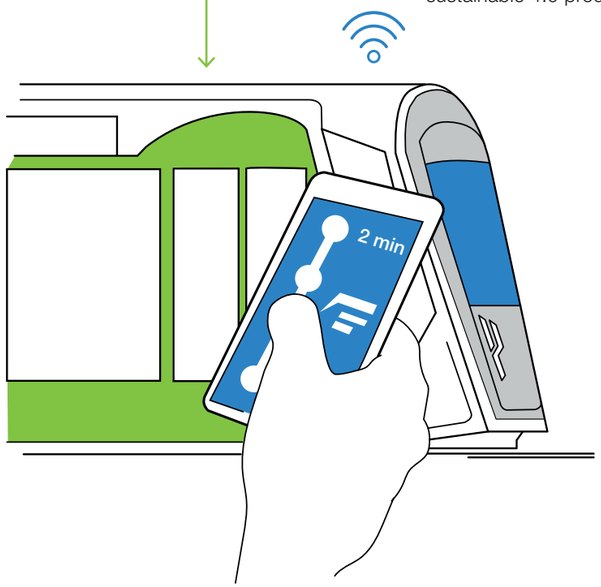
However, bus operations are not the same everywhere, even if the buses are similar. A bus in, say, Dubai will need more frequent maintenance than one in Munich. Again, this is where domain knowledge – coupled with the intelligent analysis of big data – makes the difference, compared with a "one-size-fits-all" approach. →

"The more data we have, the more accurate predictive maintenance will be."

Dr. Robert Müller
Head of Business Development, Voith Digital Solutions

Key factors for success

Build an ecosystem for customer needs.
|
Protect data privacy and capture high-quality data.
|
Create actionable insight based on domain knowledge and data.
|
Focus on user experience, relationships and the future.



“High-quality data insight can improve city transportation and create a more complete and efficient offering for residents.”

Dr. Benedikt Hofmann
Executive Vice President Service & Upgrades, Voith Digital Solutions

Experience, privacy and security

The data interface is important to the users, such as the bus driver, garage mechanic doing the repairs, or the operator’s management, too. “We’ve taken this a step further by partnering with Ray Sono, a leading digital agency specializing in usability and user experience,” says Dr. Benedikt Hofmann, Executive Vice President Service & Upgrades at Voith Digital Solutions.

Improving user experience is key to the successful implementation of data-driven strategies. “If a bus driver or mechanic is being asked to enter data on a screen, the interface must be as appealing and intuitive as possible,” continues Hofmann. Appealing systems with high business impact – with short payback for customers – will result in sustainable 4.0 products.

For users to have confidence in transmitting such sensitive data, data privacy and security is indispensable. “That’s why we have strict data-protection rules in place and a firm commitment to keeping our customers’ business and fleet data private too,” confirms Müller. “This is another area where domain knowledge comes into play, because bus operators need support from specialists like Voith who have the ‘big picture’ of how to work with and protect data.”

What the future holds

“We’re looking at a few ‘hot’ areas for further development at the moment,” notes Hofmann. “Operational data is collected and will be leveraged in conjunction with domain expertise, for instance for electric bus development.” Data analysis and domain knowledge will help to optimize battery usage, and system efficiency solutions may well be available in the next few years. “Other opportunities include intermodal transport in cities. Data could be generated from – and networked between – buses, trains and taxis. Such high-quality data insight can improve city transportation and create a more complete and efficient offering for residents,” adds Hofmann.

Managing digitalization efficiently helps new ideas and functions to emerge. This is especially true for companies like Voith, which combines decades of domain knowledge with engineering expertise. The result will take efficient transport operation to the next level – and that benefits us all. ____

IMPRINT Publisher: Voith GmbH & Co. KGaA, St. Pöltener Str. 43, 89522 Heidenheim, Germany **Responsible for the content:** Kristine Adams **Editor-in-chief:** Susanne Speiser **Editorial Board:** Sebastian Busch, Deborah Fischer **In cooperation with:** C3 Creative Code and Content GmbH, Heiligegeistkirchplatz 1, 10178 Berlin, Germany. www.c3.co **Content Director:** Klaus-Peter Hilger **Freelance Editors & Authors:** Deborah Capras (responsible), Liz Fletcher, Kirti Letsch **Freelance Copy Editor:** Asa Tomash **Project Management:** Marlene Freiberger **Design:** Michael Helble (Creative Director), Regina Fichtner (Art Director) **Photo Editor:** Elke Latinovic **Printer:** C. Maurer GmbH & Co. KG, Schubartstraße 21, 73312 Geislingen/Steige **Copyright:** No part of this publication may be copied, reproduced or otherwise disseminated, nor may any of the content in it be used in part or in whole in other works in any form whatsoever, without express written permission of the editor. **Photos:** Cover: Mohamed Reda, p. 4-5, 7: C3 Visual Lab, p. 8-13: Matti Immonen/FOTOGLORIA, p. 15: Shutterstock, Thomas Kohnle [M], p. 17: Shutterstock/Johan Swanepoel, p. 18-22: Bernhard Huber, p. 23-25: Dominik Gigler, p. 25-28, 38-40: Florian Sänger, p. 32: Imagine China/Wang Shutian, p. 34: Arnaud Fevrier/MAN Truck & Bus, p. 41: John Deere PR. All other photos are from Voith

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questions and answers

Does the future of agriculture lie in increased automation? Ralf Lenge of John Deere, the leading manufacturer of heavy agricultural equipment, outlines the benefits of autonomous innovations.

_____ Is autonomous agricultural machinery as far advanced as it is for cars? John Deere has been developing autonomous drive systems for several years now. We started by introducing the AutoTrac GPS parallel tracking system that guides machines along each field row with a pass-to-pass accuracy rate of +/-2cm. After that, we developed the headland management systems, which enable tractors – with or without implements attached – to turn around automatically while also controlling tractor and implement functions at the end of the field. In a further development, a lead vehicle – such as a harvester – controls a tractor moving alongside it, while harvesting and loading the produce onto the tractor’s trailers. We’re already testing fully autonomous driving today, but security is one challenge. Also, a driver still needs to be on site to top up seeds or fertilizer.

_____ What are the benefits for farmers? Farmers find the equipment much easier to operate. They often have to use several functions and implements, making errors and driver fatigue more likely. Automation lightens their workload significantly – and the machines always work at optimal capacity. This helps farmers avoid overlaps and gaps when spreading pesticides and fertilizer, by placing them exactly where they’re needed. That uses less product, increases productivity and protects the environment.

_____ What do you see as the next steps on the road to precision farming? There are two different approaches to increasing agricultural automation. The first is based on swarm technology, using swarms of autonomous or semi-autonomous vehicles on the field, running on electricity and controlled as a group, which uses less energy. With the second approach, conventional farm machines become autonomous vehicles. Driverless tractors, harvesters and implements could all be controlled by one person on the field, reducing costs. And the machines wouldn’t need a comfortable cabin, which is a large part of their purchase price. Another benefit is that all machine data can be captured by telemetry and used for future planning, helping to optimize costs and profits while protecting the environment. _____


“
The best way
to predict
your future is
to create it.
Peter F. Drucker
”
VOITH
Inspiring Technology
for Generations