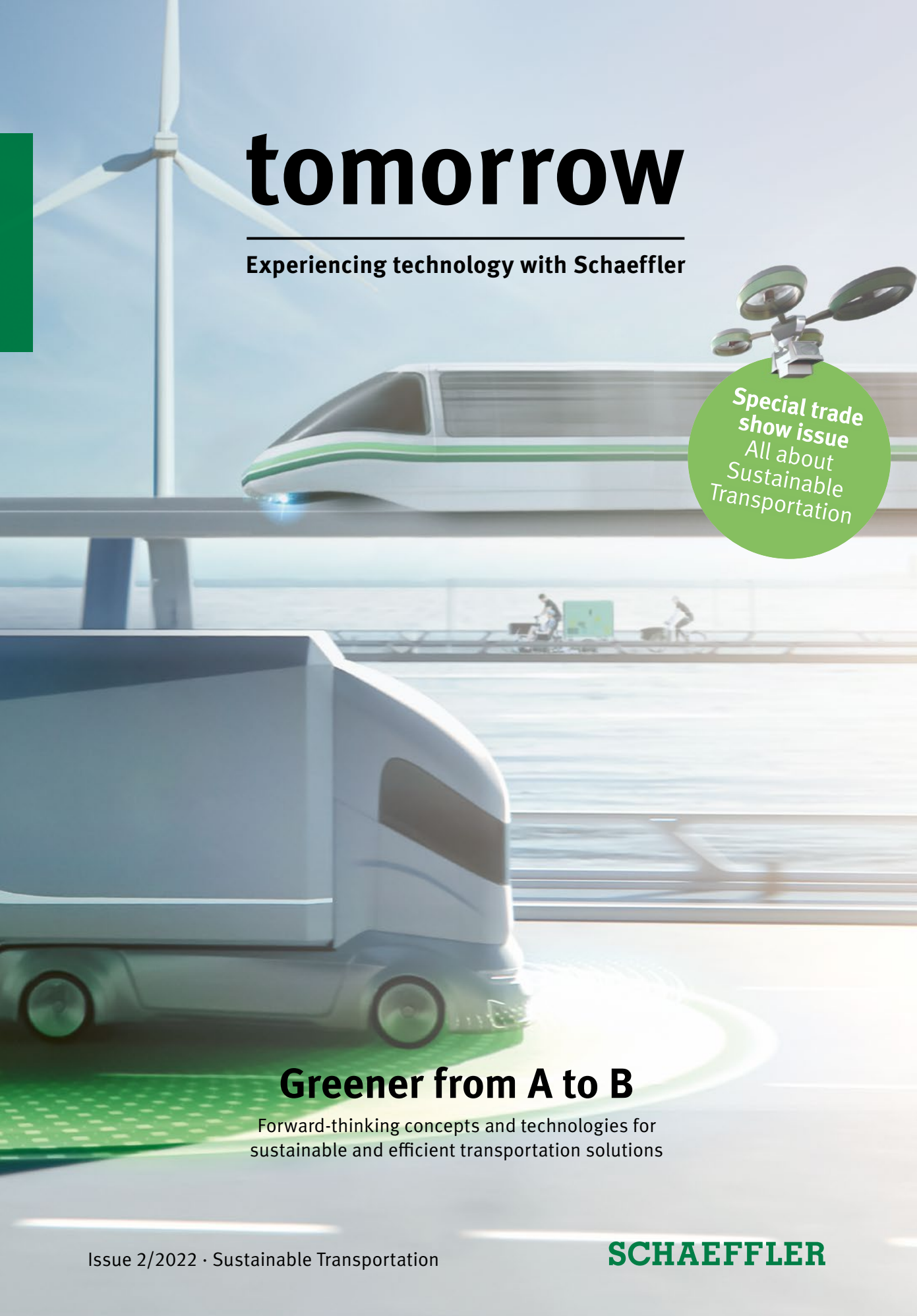
tomorrow

Experiencing technology with Schaeffler



Special trade show issue
All about Sustainable Transportation

Greener from A to B

Forward-thinking concepts and technologies for sustainable and efficient transportation solutions

Issue 2/2022 · Sustainable Transportation

SCHAEFFLER

Dear readers,

Progress of technology and civilization is decisively shaped by the movement of goods and by trade. Today, in a globalized world, that's more relevant than ever before. Transportation is an important engine of our collective existence. When it stalls, so does the world. We can currently see that in the stressed supply chains in many sectors. The transportation engine is still largely powered by fossil fuels – with the resulting impact on the environment. Roughly one fifth of all global CO_2 emissions are caused by hauling people and goods. That needs to change if we want to curb climate change. What new technologies can support this effort and with what innovations Schaeffler contributes to it are the topics of this special issue of our technology magazine "tomorrow" titled "Sustainable Transportation" to which I extend a warm welcome to you.

There are reasons why we publish a special issue for the first time in the eighth year of "tomorrow." In the middle of September, two globally leading trade shows will be looking at the future of transportation at the same time: InnoTrans in Berlin centered on rail transportation and, not even 300 kilometers (186 miles) away from Berlin, in Hanover, IAA Transportation focused on road transportation. Schaeffler will be represented at both trade shows with a whole host of innovations. The concurrence of these events and the relevance of the "Sustainable Transportation" theme in general provided the decisive impetus for this special issue.

Schaeffler's parallel presence in Berlin and Hanover shows the breadth and strength of our company's position in the transportation market, fueled by the collaboration between our Industrial and Automotive Technologies divisions. The range of new products showcased at both trade fairs encompasses means of transportation of diverse dimensions and performance classes – from cargo bikes to high-speed trains. Those products on display are also good examples of how we breathe new life into our slogan "We pioneer motion" daily. The internal technology transfer between the two divisions – which is another one of Schaeffler's strengths – acts as an important innovation accelerator in this regard.

On what tracks will trains be traveling toward the future and what will those trains look like? Dr. Michael Holzapfel, Senior Vice President Business Unit Rail at Schaeffler, provides answers. Starting on page 42, you can read about the technologies Schaeffler employs to enhance the performance and sustainability of today's rail transportation. As a treat in between, we invite you to join us on a reading journey of the world's most spectacular railroads, departing on page 34.

Let's turn from the tracks onto the road. Following Schaeffler's equally fast and successful rollout of components and systems for electrified passenger cars, the development of emission-reducing solutions for commercial vehicles and buses was the next logical move. We're showcasing the results at IAA Transportation – and here in our magazine, starting on page 18. In conjunction with that coverage, our Automotive CEO, Matthias Zink, looks at the trends and challenges of non-rail-bound passenger and freight transportation, going forward.

Andre Kranke looks at the transportation trends of the future from another angle, i.e., that of the user. He leads Trends and Technology Research at Dachser, a freight forwarder with worldwide operations. Starting on page 6, you'll be able to read about how his company tackles "Sustainable Transportation."

And now, delve into this very special issue of "tomorrow" and enjoy the journey.

Klaus Rosenfeld
Chief Executive Officer

Sustainable Transportation – the topics

Road

Rail

Sustainable Transportation

Road

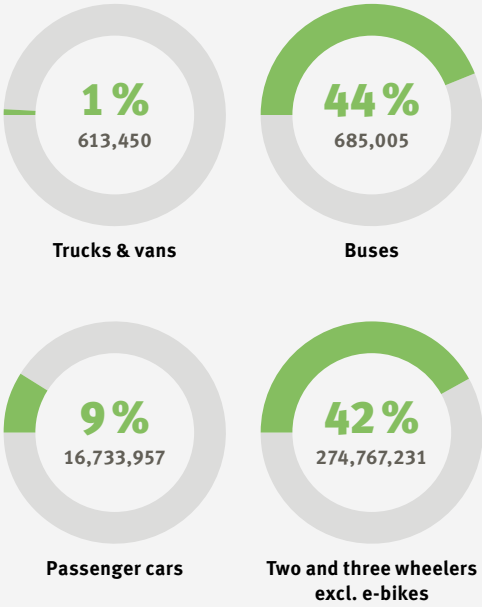
27 %

more electricity would be consumed worldwide if global road-bound hauling of goods and passengers were converted almost fully to all-electric powertrains by 2050 according to the net-zero scenario.

Source: BloombergNEF Electric Vehicle Outlook 2022

Trailblazers and trail followers

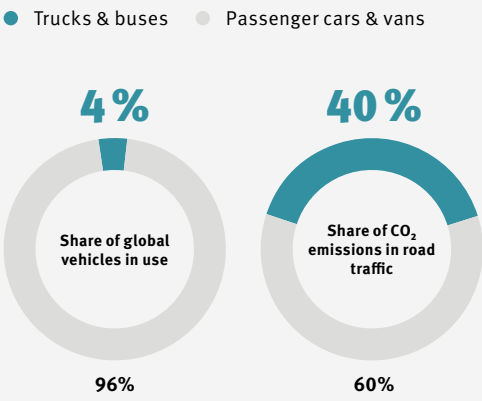
Current global number of electric vehicles in use and share of new registrations by categories (2021)



Source: BloombergNEF Electric Vehicle Outlook 2022

Few vehicles, lots of emissions

Share of vehicle categories in relation to vehicles in use and CO_2 emissions



Sources: IHS and IEA

More flow

Better integration of traffic systems can lead to a significant reduction of CO_2 emissions. Provided that the requisite investments are made in this area, global CO_2 emissions could be reduced by 205 million metric tons (226 million short tons) by as early as 2027, according to the "Smart Traffic Management – The End of Urban Congestion" study by Juniper Research. That would be twice as much as the emissions caused, for example, by domestic transportation in the UK in 2019. **The most important key to achieving the targets is smart intersections** at which vehicles communicate with each other and with infrastructure. Such intermodal communication would clearly reduce energy-intensive traffic jams and stop-and-go movements, say the researchers. Plus, they're seeing such smart city solutions making progress: by 2027, investments in smart intersections worldwide are expected to almost double to 10.2 billion U.S. dollars compared to today.

Fully focused

Half of the truck drivers on the road in Europe **focus on a small number of rest stops** when taking their breaks, i.e., on 300 in a total of 3,000 European truck pit stop facilities, as revealed by an analysis of the Fraunhofer Institute for Systems and Innovation Research (ISI) commissioned by the European Automobile Manufacturers' Association (ACEA). In view of those statistics, the ACEA calls for action **to ensure that those 300 hot spots be equipped with suitable charging infrastructure by 2027.**

“We need a real shift in powertrain technologies”

Transportation logisticians are key players across a sustainable supply chain. Without them, it will never be possible to push CO_2 emissions down to the intended net-zero level. In an interview, a manager of a leading logistics service provider explains how sustainability is put into action in the field and what else needs to happen so that the climate goals can be achieved.

Interview: Volker Paulun and Björn Carstens

This interview is focused on sustainability. In view of routine business being highly stressed as a result of strained supply chains, does Dachser even have any capacity left for decidedly dealing with sustainability?
The answer is a clear yes. Our sustainability activities, particularly in terms of climate protection, are continuing unaffected. Because sustainability simply cannot be put on the back burner. However, delays in implementing our climate protection actions do occur due to the strained supply chains and resulting bottlenecks, for instance, in deliveries of battery-electric trucks and company cars.

Talking about "alternative powertrains": What goals is Dachser pursuing?
We use the numbers provided by the automotive industry for guidance. They're assuming that in Europe, from 2030 onward, about half of all new registrations will be for zero-emission vehicles – in other words vehicles with a battery-electric or hydrogen fuel cell powertrain on board. But those are no doubt ambitious goals, considering the fact that the first production vehicles are only hitting the market now. Everything that's been deployed so far – including in our operations – has been within the scope of pilot projects.

When we're discussing alternative powertrains, what technology or technologies do you see as front runners in Dachser's routine business settings? Will it ultimately boil down to one or will various technologies establish themselves for diverse uses?
For ranges around 500 kilometers (311 miles), we regard battery-electric trucks as the more efficient and cost-effective solution in most cases. For longer distances, we consider hydrogen fuel cell technology to be a potential solution. That's also covered by statements from Daimler or Volvo. At the end of the day, we don't care which of those two technologies are going to handle what hauling volume. I think that the transportation sector is going to need both technologies and the specific use case will ultimately determine which technology will be the more efficient one. In air and maritime freight, synthetic or biobased fuels will be emphasized, especially in intercontinental shipping.

Especially when it comes to the practicality of hydrogen or battery-electric powertrains in long-distance road traffic a lot depends on the filling station and charging infrastructure. How do you assess developments in Europe in relation to those needs?
Charging is of vital importance. That puts the onus on the government as the provider of an infrastructural framework. I basically see the current trend in a positive light when it comes to planning a fast-charging infrastructure, for instance at highway rest areas. The same applies to hydrogen infrastructure. Now it will be crucial to put such plans into action as fast as possible. A clear and reliable roadmap for a viable European network is the most important aspect for all vehicle operators.

Are you noting that customers are willing to pay their fair share for sustainable transportation?
Yes, there are customers that lead the way in this regard, with whom we collaborate in sustainable logistics projects and who accept additional costs for the introduction of new technologies. However, when it comes to rolling them out across the board, obstacles in terms of costs do exist. The more cost-sensitive the markets the greater the obstacles. On the other hand, many companies have committed to not only being climate-neutral but "net-zero" by 2050 at the latest. That also includes indirect emissions along the supply chains, so-called Scope 3 emissions – in other words, those

As Head of Corporate Research and Development at international logistics service provider Dachser, Andre Kranke knows that there is no way around zero emissions for truck traffic. With around 31,800 employees at 376 locations worldwide, Dachser, as one of the world market leaders in system logistics, moved a total of 83.6 million shipments in 2021

that are produced by transportation. That will probably expand the costing-based scope for action.

Can the government or the EU support fleet conversions with financial incentives?
In the end, such a steering function will be essential, and it's already being implemented today, for instance, in the form of reduced toll fees for zero-emission trucks or by the taxation of vehicles or the propulsion energy. In vehicle costing, we always need to include total cost of ownership, or TCO for short, in other words, the total of purchasing and operating costs across a vehicle's entire service life. Since the purchasing costs for trucks with new powertrain technologies are clearly higher, at least for the foreseeable future, other costs for such vehicles must be clearly lower to achieve at least an equal TCO level.

Irrespective of the propulsion energy, where do you see additional potential for efficiency increases in haul-traffic?
Of course, digitization offers opportunities to optimize processes and to work more efficiently. The better the capacity utilization of trucks the fewer the number of trucks on the road traveling fewer kilometers and emitting less greenhouse gases. In addition, we emphasize the utilization of energy-saving technologies worldwide. In Germany, for instance, we switched completely to LED lighting. Since 2022 Dachser has been buying electricity exclusively from renewable sources, plus we're successively increasing our share of in-house production, are building clearly more photovoltaic systems and are planning to acquire an interest in wind farms. Such efficiency actions are important but will not lead us to zero emissions. We need a real shift in powertrain technologies and the energies they use. For example, that's why for air cargo, we promote the use of sustainable aviation fuels.

The new technologies also include autonomous driving. Dachser is already running initial tests with driverless vehicles. What are your experiences? When do you expect the first long-haul deployment of robo vehicles? And what are the major benefits?
We generally differentiate between three areas of autonomous driving: autonomous vehicles in our warehouses, on our plant premises and on public roads. In warehouse settings, we've made technological strides by deploying autonomous vehicles that, in mixed operations, assist people, for instance in hauling pallets. We're also dependent on that due to the shortage of skilled workers. To operate autonomous vehicles also on our company grounds, we're currently participating in a research project. For instance, automated machines can stage trailers. However, vehicles that are fit for use in the field that we can employ in interaction with people do not exist yet. In public road traffic, we're not active yet in terms of autonomous driving. Our guess is that that won't be relevant in Europe yet in this decade – unlike, presumably, on the long highways in the United States. Here we could imagine autonomous vehicles operating in Level 4 mode – in other words, vehicles in which humans no longer have any tasks to perform and could theoretically sleep.

What about partly autonomous driving? Like platooning where several trucks are integrated in a network and traveling in convoys.
Our analyses have shown that the benefit for drivers and the environment is very limited here. The tests of some commercial vehicle manufacturers have shown that too. For us, autonomous driving would be of interest starting with Level 4 but that's still a long way off.

Why is autonomous driving relevant anyhow?
Because, starting at that level, autonomous driving increases traffic safety, reduces costs and enhances efficiency. After all, we're struggling with demographic change that will exacerbate the problem of driver shortages. The deployment of autonomous Level 4 vehicles, at least between two storage halls in hub-to-hub traffic, might be a possible solution.

In its warehouses, Dachser deploys self-driving "assistants" to support human workers

From container ships to cargo bikes for emission-free delivery areas in the hearts of cities – Dachser operates nearly all vehicle classes

An area in which we do not see autonomous vehicles is delivery traffic. There, people will remain an important element in logistics in the long run. They're our face to the customer.

You haul goods with cargo bikes as well as on container ships, in other words using practically any vehicle category. What sustainability potential does better integration across the mobility mix hold?
I don't believe that that's an area in which major leverage can be achieved when it comes to climate protection. What we need is a powerful infrastructure that needs to be maintained as well. There's a lack of investments in that area. At the end of the day, the bottleneck is not caused by lack of integration in the mobility mix but by the reliability of the individual modes of transportation. Especially with the Trans-European railroads across several hundred kilometers I see a major need for action if rail cargo is to retain or even increase its share in the modal split. What good does it do our customers if a shipment is reloaded fast and smoothly from a truck onto a train but the train leaves or arrives late. That causes confusion in our customers' supply chains.

Let's turn to urban delivery traffic. How does a major freight carrier like Dachser plan to promote sustainability here?
We're in the process of establishing eleven zero-emission delivery areas in all of Europe this year. Stuttgart was our model region that we've applied or are still going to apply to other cities such as Madrid, Munich, Paris, Oslo and Copenhagen. What does that mean specifically? In a defined zip or postal code area downtown, we carry out emission-free deliveries as standard practice. Our branch offices are typically located outside of cities. From there we reload the goods onto battery-electric trucks that take them either directly to the recipient or to another micro-hub for distribution to cargo bikes for the last mile.

How do drivers feel about the new generation of zero-emission vehicles?
They're thrilled because these vehicles vibrate a loss less and it's much quieter inside the cabin. They also sense that the image of their job improves because now they're on the road in a way that's a lot more environmentally compatible.

In your view, aside from the established means of transportation, which new technology has the greatest potential of permanently enhancing the existing mobility mix also under sustainability aspects?
There are some really exciting projects. For instance, I'm thinking about the Hyperloop tube project as a solution for the last mile. Obviously, such an "XXL-size tube mail" would require extensive underground construction, which would make timely implementation difficult. Drones are a subject we're looking into at Dachser as well. However, we don't really see drones for mass hauling of millions of cargo units because flying is one of the most energy-intensive methods of transporting goods. Which is not to mean that there won't be drone shipments here and there, for instance, to remote regions or for urgent deliveries of goods.

Heavy-haul trucking …

Sustainable transportation solutions require sustainable energies. Although the requisite systems and components can be of mammoth proportions they need to be hauled on normal roads. That’s a Herculean logistical task for which manufacturers like world market leader Goldhofer develop highly specialized chassis.

To where the wind blows

Cargo
Towers and rotor blades for wind turbines.

General challenge
To maximize wind power harvesting, the size of the blades and towers of modern wind power systems keeps growing – and so does the complexity of hauling them.

Specific examples
Tower segments and rotor blades from Vestas Wind Systems had to be hauled inland across a roughly 100-kilometer (62-mile) distance from the Swedish port of Gävle to Hedemora (small pictures). In Madeira (large picture) elements for three large-scale wind turbines were hauled from Porto Caniçal across half the island to the hilly hinterland surrounding the town of Ribeira Brava.

Solutions
The extremely long blades (84 m/275 ft) and voluminous tower elements (diameter of 6.3 m/20.7 ft) required two different routes in Sweden, along which traffic circles had to be superstructed, high curbs banked up and traffic signs and lights removed. For the haul, the tower segment was fixed in place on the front and rear chassis using tube adapters, enabling the transportation of segments with a maximum weight of 110 metric tons (121 short tons) and diameters of up to 6.8 meters (22 feet). At the rear chassis, six steerable axle modules ensured high maneuverability.

For transporting the rotors, Goldhofer developed two systems. In Sweden, “Blades” was used. There the rotor blade base is fixed in place in a special swiveling mount installed on the tractor, while the rotor tip sits on a trailing dolly. For particularly winding roads, such as those that had to be mastered in Madeira, Goldhofer has a heavy-duty module called FTV on offer that even has self-propelling capabilities in very narrow sections. Its highlight: The module is designed for not only enabling freely suspended transportation of the rotor blade but also for lifting it by up to 60 degrees. As a result, the rotor tip just sweeps across obstacles if necessary. By the way, with a length of 67 meters (219 feet) the rotor blades hauled in Madeira were “small fry.” Lengths of more than 84 meters (275 feet) are possible, according to Goldhofer.

In Sweden, these mammoth wind turbine components were hauled across 100 kilometers (62 miles) on public roads – tons and tons of high-precision work

70-meter (230-foot) lindworm

Cargo
Three transformers for the substation of an offshore wind farm.

General challenge
The energy transition toward renewable sources entails a decentralization of the grid infrastructure. For that purpose, plants such as new substations have to be established around the globe.

Specific example
To make the energy generated by the 950-MW Moray East wind farm off the coast of Scotland available to consumers as 230-volt electricity, a substation with three transformers, each weighing more than 260 metric tons (286 short tons) and nearly twelve meters (39 feet) long, was built up-country near New Deer. The transformers had to be hauled across a 56-kilometer (35-mile) distance full of hills, corners and bridges from the port of Peterhead to New Deer.

Solution
The lateral beam bridge “Faktor 5.5” that was used can take up cargo with a width of up to six meters (20 feet), a length of 17 meters (56 feet) and a weight of up to 350 metric tons (385 short tons) and flexibly move it thanks to load leveling and 1.6 meters (5.2 feet) of hydraulic lift height. Since the transformers were 90 metric tons (99 short tons) below the maximum weight it was possible to use a configuration of “only” 10 axles per side at the front and rear. That made the 70-meter (230-foot) lindworm relatively agile.

Tons of cable

Cargo
Cable drums for building power lines.

Challenge
Transporting electric power generated by photovoltaic systems or wind turbines to where it’s needed requires cables – very long cables. Depending on the cable design and length (currently up to two kilometers/1.2 miles), the drums currently weigh 55 metric tons (61 short tons) – which may increase to 100 metric tons (110 short tons) in the future. Accordingly, the width of the drums of four to five meters (13 to 16 feet) today will increase to eight to twelve meters (26 to 39 feet). To make matters worse, the heavy-duty trailer (the picture shows a so-called vessel bridge hooked up between two heavy-duty modules that carries the cable drum) has to be suitable for difficult off-road conditions at construction sites. The use of self-propelled units is possible and increases the trailer’s flexibility.

Solution
To handle the increasingly voluminous cable cargo, Goldhofer’s experts are currently developing an optimized vessel bridge to accommodate an unwinding device for drums weighing up to 100 metric tons (110 short tons). Concurrently, concepts are being developed for motors with synchronized drive for jerk-free cable unwinding at the installation site.

Mega tank truck

Cargo
Overflow tanks for a solar farm.

General challenge
In 2005, Solarpark Bavaria in Germany with 10 megawatts (MW) was the world's largest solar farm. Today, the Mohammed bin Rashid Al Maktoum solar farm already has a capacity of 800 MW to be expanded 5,000 MW or 5 gigawatts in the final stage. To supply energy around the clock, solar power stations convert the energy of light not only into electric power but also store it in the form of heat, for instance by heating thermal oil. Huge overflow tanks are part of this complex heat cycle.

General challenge
A total of 30 tanks with a length of 52 meters (171 feet) and a weight of 235 metric tons (259 short tons) each had to be hauled from the port of Jebel Ali in the United Arab Emirates to the solar farm in the desert of Dubai. The greatest challenge was precise adherence to the tight completion schedule for the solar farm. For this, the route and loading times had to be optimally planned.

Texas: A self-propelled trailing dolly combination with 48 heavy-duty axle lines hauled this tank with a weight of 440 metric tons (485 short tons) and a length of 60.5 meters (198.5 feet) around a corner

Solution
One by one, the tanks were loaded onto 30 heavy-duty trucks that embarked on their journey in convoys of two. To pull the mammoth load of 235 metric tons (259 short tons) per truck through the desert sand, the weight was distributed to no fewer than 30 axle lines per side. After their journey, the tanks traveled another distance of about 100 meters (328 feet) on the hook of a 400-metric ton (441-short ton) crawler crane before being installed on previously prepared foundations. The advantage in the desert: There were no narrow bends to be mastered, so the tanks could be transported on a continuous heavy-duty module despite their length of 52 meters (171 feet). When the trucks have to go around corners, the situation gets trickier. But even that is possible as the picture above of a tank with a length of 60.5 meters (198.5 feet) being hauled in Texas shows.

“We can handle heavy-duty too”

Schaeffler exhibits at IAA Transportation for the first time: Automotive CEO Matthias Zink puts that premiere into perspective and provides insights into the reasons why Schaeffler’s innovative technologies and products are perfectly suited for pushing efficiency and sustainability forward in the transformation of the transportation and logistics sector.

Interview: Annett Fischer

The newly designed IAA Transportation trade fair is a platform and hub for transportation and logistics companies from all over the world. What makes this event so attractive?
That’s easy to answer – without the logistics industry it won’t be possible to achieve the global climate goals. Yet the industry is challenged to manage the balancing act between higher hauling capacity on the one hand and lower emissions on the other hand. That, in turn, calls for innovative technical solutions – especially from suppliers like Schaeffler. At IAA Transportation, all the players come together, showing how transportation will become safer, more efficient, and therefore more sustainable, going forward. Schaeffler will be an exhibitor for the first time and I’m very much looking forward to engaging in the exchange there.

So, it’s about time for that trade show presence …
You’re right. Many people associate Schaeffler’s Automotive division with powertrain solutions strictly for passenger cars. But we develop and manufacture systems for far more applications – including for light and heavy commercial vehicles. We can handle heavy-duty too. At the trade fair, we’re showcasing our answers to the pressing questions of the industry in the areas of powertrain and chassis.

What kinds of products provide positive answers to those questions?
We’re taking our solutions in the areas of electrification, emissions reduction, digitalization and automated driving to Hanover. My highlights are our electric motors for commercial vehicles, components for fuel cell drive systems and the SpaceDrive system – a key technology for autonomous driving. Of central importance for every system and every single component that we’re showing in Hanover is our comprehensive industrialization expertise. We have end-to-end capabilities at our plants up to and including forming and surface technology processes. As a result, we achieve decisive advantages over our competitors and for sustainable mobility. But we also want to listen and learn about the industry’s concerns and how we can get closer and closer to climate-neutral transportation with our products and services. That’s why I’m personally looking forward particularly to interesting dialogs with customers, partners and representatives

“The transportation sector will have to completely reinvent itself in the coming years – both in the urban environment and in long-distance hauling, with a focus on efficiency, sustainability and safety. Schaeffler is going to participate decisively in shaping this new mobility”

Matthias Zink,
Schaeffler CEO Automotive Technologies

of the transportation and logistics sector. We all need to pull together to master the great challenge of this sustainable transformation of the transportation and logistics sector.

The coming years will be fully focused on the transformation you mentioned. Where will the industry be in 2030 – and what milestones do you want to have achieved by then?
Looking at the current challenges, the transportation sector will have to completely reinvent itself in the coming years – both in the urban environment and in long-distance hauling, with a focus on efficiency, sustainability and safety. Schaeffler is going to participate decisively in shaping this new mobility. CO_2-efficient powertrains are a key topic for our automotive business. We understand the drive system, the requirements and the goals of our customers and on that basis develop powertrain solutions down to the level of individual components. Our product portfolio extends from systems for reducing consumption and CO_2 emissions in the powertrain to the electrification of commercial vehicles to components for fuel cell systems and powertrains using alternative fuels.

Investment in transformation: A new competence center for electrified mobility is being established at the headquarters of the Automotive Technologies division in Bühl

Then let’s briefly look back: What has been the major game changer in the logistics or transportation sector in the past ten years in your view?
The camera-monitor systems replacing the outside mirrors of trucks are definitely a game changer for me. The idea behind them is simple but brilliant. And it combines a lot of things: it improves the driver’s vision and reduces fuel consumption. For me, that’s a classic win-win development. Yet it’s a highly complex system requiring lots of system knowledge. I’d like to see more solutions like that.

And looking ahead: As a blueprint, what innovations are internationally pointing the way toward climate neutrality?
To answer that, I’d like to mention two areas. First, systematically thought-out electrification for commercial vehicles and hydrogen drive. Both of these solution strategies have enormous potential for the transportation and logistics sector on its pathway toward climate neutrality. On September 20, I’m going to talk about that with other guests at an IAA Conference panel that will take place as part of IAA Transportation.

IAA Conference brings decision makers, visionaries and experts together in important discussions: What are your expectations of that?
In my view, IAA Conference brings together what belongs together: incumbent industry giants and newcomers, OEMs and suppliers, political leaders and experts. This holistic look at the agenda appeals to me because we all need to act in concert, especially when it comes to topics that are so important at the moment. It's about massively reducing consumption and emissions, improving logistics chains and making life easier for drivers. Nobody can achieve that on their own. That's why I'm looking forward to that cross-industry dialog.

What trend are you currently tracking professionally with particular interest?
That again relates to the topics I've previously mentioned as crucial ones for IAA Transportation. I'm thrilled to see that awareness of the importance of sustainability and the reduction of emissions has now arrived across the board in industry. These areas are being pursued consistently and becoming a reality – from the production of energy to its efficient use. For instance, a few years ago, I wouldn't have thought that as an engineer, today, I'd be dealing so intensively with energy engineering for the next generation. There's still a lot of potential in that and I'd like to participate in tapping that potential.

Then let's lend you a helping hand by giving you superpowers that would be useful professionally: What would they be?
Wow, thank you! To answer that, I'll have to provide some brief context: We recently hosted the traditional Schaeffler-Kolloquium at Schaeffler, our biggest and most important customer event. Compared to our previous colloquium four years ago, we showcased more innovations, more new concepts and more prototypes in the fields of electrification, chassis applications and bearings than ever before at such an event. If I had superpowers, then I'd like to retain exactly that innovative spirit, that enthusiasm of the whole team and the courage to develop new technologies for mobility in times of change over and over, and carry it forward into the future.

Thank you very much for the interview!

About Matthias Zink

As **CEO Automotive Technologies,** Matthias Zink (born in 1969) has been responsible for the Engine and Transmission Systems, E-Mobility, Bearings, Chassis Systems and New Mobility business divisions since 2019 as well as for Research and Development of the Automotive Technologies division and Global Key Account Management.

Zink, who studied mechanical engineering with a major in automotive engineering and earned his degree at Karlsruhe University in 1994, calls himself a "car guy." Soon after starting his career at Schaeffler with LuK in 1994, Zink assumed leadership responsibility and served in various leadership roles of the company in the following years before assuming responsibility for the Clutch Systems business division in 2006. After leading the business division successfully for seven years, he became President of Schaeffler Automotive Asia/Pacific in China in 2012. In 2014, he returned to Germany.

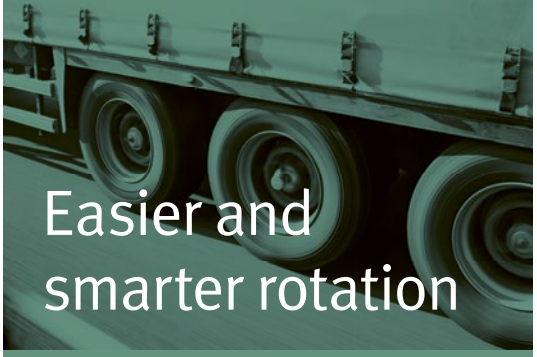
Green makes the difference

Whether mechanical, mechatronic, electrical or digital – Schaeffler offers a wide variety of technological solutions to make hauling of goods and passengers by trucks and buses more efficient and sustainable.

By Volker Paulun

By 2025, truck manufacturers in the European Union will have to reduce the CO_2 emissions of their fleets by 15 percent. For 2030, the CO_2 emission standards are supposed to be tightened once again. “Without the transportation and logistics sector it will not be possible to achieve the global climate goals,” says Matthias Zink, CEO Automotive Technologies at Schaeffler. Around 60 percent of the distances covered by trucks are shorter than 500 kilometers (311 miles) and thus within the range that battery-electric commercial vehicles can achieve on one charge. In addition, commercial EVs provide a solution for zero-emission and low-noise deliveries in cities. Another advantage of electric trucks over vehicles with IC engines is energy recuperation during deceleration events, particularly in stop-and-go traffic in urban areas.

Besides battery-electric powertrains, hydrogen and fuel cells are coming into focus, especially in long-distance haulage. Schaeffler develops efficient solutions for such powertrains as well. Even classic products such as bearings offer plenty of efficiency and innovation potential. They can reduce friction and thus noticeably lower the consumption of commercial vehicles. Upgraded with smart sensors, wheel bearings become an important element of automated driving and for digital services. At IAA Transportation 2022, Schaeffler is showcasing a wide variety of its innovations in the Truck & Bus sector. “tomorrow” presents them on the following pages.



Easier and smarter rotation

The future of the transportation and logistics sector is electrified, automated and digital, and bearings are a key component with which commercial vehicles are going to travel the roads even more efficiently and safely. Especially in heavy-duty haulage, bearings offer huge savings potential – in both conventional and electrified powertrains. Schaeffler has been developing specialty bearing solutions for light and heavy-duty trucks for 100 years. The current annual production for this segment amounts to more than 80 million bearings. Going forward, further developments will be focused on bearing solutions for electrified powertrains, automated driving and digitalization.

Smart wheel bearings

Challenge
With a **smart wheel bearing** Schaeffler is planning to help digitize trucks and accelerate the development of automated driving.

Innovation
Thanks to smart sensors the technical condition of the bearing and wheels can be monitored remotely. The **data gathered there can also be used for automated driving and digital services.**

Details
Defective tires or brakes are currently causing about 40 percent of vehicle downtimes – by means of conditioning monitoring **measuring wheel forces, braking forces, vibrations and temperatures at the wheel head within fractions of a second** that rate would massively drop. Additionally, using the data acquired in that way, shifted loads can be detected and road conditions be derived, for example.

Rotating air pump

Challenge
Tire inflation pressure has a crucial impact on the fuel consumption, tire wear, road holding ability and braking distances of trucks. However, **precisely adjusting tire pressure to changing conditions is laborious** and often neglected.

Innovation
Schaeffler has developed a wheel bearing with an integrated seal that helps to **optimally adjust tire inflation pressure to current conditions while the vehicle is traveling** on the road.

Details
The wheel bearing has a so-called compressed air feedthrough to the tire. Embedded in an OEM system, it **enables the pressure in the tires on all axles to be raised or lowered:** for instance, when high temperatures raise tire inflation pressure, which is not only bad for the tires but also leads to longer braking distances, or when traction is supposed to be enhanced in off-highway applications with low inflation pressures.

Friction minimizer

Challenge
Minimizing friction-induced power loss and thus reducing consumption and CO_2 emissions of commercial vehicles.

Innovation
Specifically for commercial vehicles, Schaeffler has developed a wheel bearing unit that once again clearly reduces friction.

Details
An innovative design, a novel type of thermal treatment and a modified sealing concept reduce friction by 56 percent, thus saving up to 600 watts of energy per 13 metric tons (14.3 short tons) of axle load. For a commercial electric vehicle with a 500-kilometer (311-mile) range, up to **11 kilowatt hours per charging event can be saved in this way.**

Future is spelled with an E

Going forward, electric powertrains will account for an increasingly larger share in the powertrain mix for light and heavy-duty trucks. Considering the special requirement of the industry, Schaeffler's new electric motor product family is not only scalable and efficient but also extremely robust.

"With our extensive expertise in electrified mobility, we are going to make a decisive contribution to the decarbonization of commercial vehicles"

Dr. Jochen Schröder,
President of Schaeffler's E-Mobility Business Division

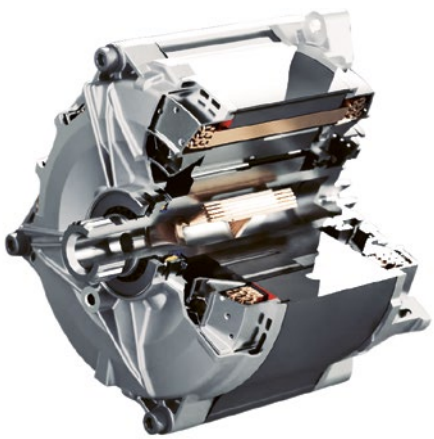
Versatile e-motor family

Challenge
Mastering the **balancing act between comparatively small production volumes of commercial vehicle powertrains and the high demands** made on output, efficiency and durability.

Innovation
Schaeffler develops **electric motors in scalable series in order to efficiently cover all performance classes.** They are used in on-road and off-road applications, in fully electric and hybrid-electric powertrains, in electric axles as well as serving as the central propulsion system.

Details
In the first stage starting in 2023, **Schaeffler will be delivering a product family of water-cooled 800-volt motors** with maximum permanent power output of 180 kilowatts and maximum torque of 950 Newton meters. The motors use so-called hairpin winding technology that Schaeffler can manufacture in-house.

The next development stage will be a series of high-performance **motors with efficiency of more than 97 percent and continuous propulsion power output of up to 300 kilowatts.** To enable such ratings, the company's experts have developed an innovative oil cooling solution. The bar wave winding of the stator is another special characteristic. That is a winding technology which only few companies have mastered worldwide. Schaeffler is one of them. It ensures particularly high power density of the electric motors.



The series of e-motors Schaeffler has developed are scalable in order to efficiently cover all performance classes

800-volt power electronics

Challenge
Electric powertrain systems with 800 volts and more make **exacting demands on power electronics –** to achieve fast charging times, for example.

Innovation
Schaeffler develops silicon carbide-based **power electronics specifically adapted to the requirements of commercial vehicles.** They are designed for voltages of up to 850 V and effective amperages of 600 A (peak) and 400 A (permanent).

Details
The electronics' silicon carbide technology enables higher switching frequencies and better cooling performance, both of which are important for high permanent performance in commercial vehicle applications. **With a volume of 12.4 liters (3.28 gallons) the silicon-carbide-based power electronics unit achieves space-saving power density of more than 40 kilowatts per liter (0.26 gallons).** Potential efficiency gain: for a battery-electric truck with a 500-kilometer (311-mile) range, the battery capacity can be reduced by 14 kilowatt hours thanks to this Schaeffler innovation. That, in turn, equates to a weight reduction by 84 kilograms (185 pounds) and significant cost savings due to the corresponding smaller size of the battery. By the way: via a 24-volt direct current connection the power electronics can be connected to the vehicle's regular on-board system.

Despite its compact design the new power electronics system for commercial vehicles delivers very high performance

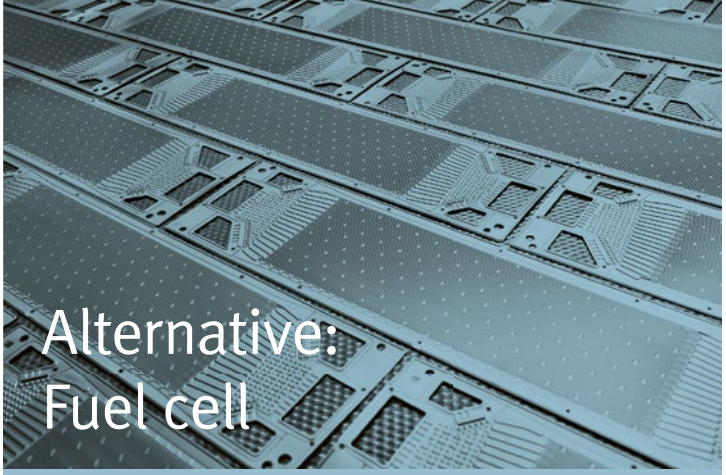
A smart valve for decentralized coolant control is a central element of Schaeffler's thermal management

A key competency: Thermal management

Challenge
Long charging times cost fleet operators a lot of money. For fast charging, a battery needs its "feel-good temperature."

Innovation
When it comes to enhancing charging efficiency and protecting the battery in high-power charging events thermal management becomes a key competency. **Schaeffler is a pioneer in intelligent thermal management, drawing on decades of know-how in this area.** Building on that expertise, Schaeffler has now developed efficient temperature conditioning of the powertrain and battery specifically for electrified commercial vehicles.

Details
A central element of Schaeffler's thermal management is the so-called Single Smart Valve for decentralized coolant control. **It controls individual coolant flows of the battery, power electronics, motor or transmission.** The individual and decentralized arrangement provides manufacturers with freedoms in designing system architectures. In addition, it enables independent control strategies for the vehicle when it is in the states of fast charging, cold starting, urban traffic or hill-climb scenarios. In addition, Schaeffler offers system integration of all coolant functions for commercial vehicles. These systems include coolant control, electric water pumps, sensors and an intelligent control unit, providing manufacturers with the benefit of a compact, space-saving design.



Alternative: Fuel cell

Schaeffler also targets hydrogen technology for powering commercial vehicles, especially in long-distance hauling. The company develops innovative components for fuel cell systems and is preparing their industrialization.

“For Schaeffler, the fuel cell is a sensible complement to the powertrain mix of commercial vehicles”

Matthias Zink,
CEO Automotive Technologies
of Schaeffler AG

A letter loaded with energy: H

Challenge
How can commercial vehicles with hydrogen powertrains be developed as efficiently as possible to **create a further electrified alternative** for the truck fleets of the future?

Innovation
At IAA Transportation in Hanover, Schaeffler is displaying a demo vehicle that was assembled from the ground up based on an electric van and shows Schaeffler’s system expertise. **The vehicle is now propelled by a 3in1 e-axle and a fuel cell system with an interposed battery.** The electric axle, the fuel cell stack, the control technology of the system and energy management were developed by the automotive and industrial supplier’s experts. In the demo vehicle Schaeffler shows how optimum interaction between the electric drive, fuel cell system and lithium-ion battery works. “Fuel cell powertrains will initially gain traction primarily in heavy-duty trucks for long-distance hauling. But vans, for instance, that regularly cover longer distances can benefit from the advantages of hydrogen operation as well,” says Matthias Zink.

Schaeffler assembled this demo vehicle based on an electric van from the ground up to display its systems expertise in the area of fuel cell powertrains in real-world operations

Details
An individual fuel cell system contains a so-called stack consisting of **numerous bipolar plates stacked on top of each other with one membrane inserted between each of the plates.** In the process of "cold combustion," in which the chemical reaction energy of the continuously fed-in hydrogen and atmospheric oxygen is converted into electrical energy, the bipolar plates perform several tasks: electrical connection of the cells, gas distribution along the surface, gas separation between adjoining cells and external sealing as well as cooling. Although a single bipolar plate has a thickness of merely 50 to 100 micrometers (0.002 to 0.004 inches), as a composite it accounts for up to 80 percent of the stack's weight and up to 65 percent of its volume. That's why bipolar plates are of enormous importance for the power density of the system.

Schaeffler has been developing bipolar plates since 2017 and operates a pilot plant for manufacturing them at the Herzogenaurach location, leveraging the company's extensive expertise in manufacturing technologies such as cold forming, stamping, joining or surface treatment. "We use our high-precision forming and stamping technologies and innovative coating methods to produce plates with particularly high efficiency and performance capability," says Dr. Jochen Schröder, President of Schaeffler's E-Mobility business division. For instance, forming and coating even of very thin steel components such as bipolar plates is akin to manufacturing processes that Schaeffler has traditionally mastered in the production of engine and transmission components and adapted to the production of the plates.

In addition, based on its bearing know-how, **Schaeffler is developing various axial and radial air foil bearings for air supply to the fuel cell, nozzles for hydrogen circulation and key components for coolant management** such as a thermal management module and smart valves for centralized coolant control. Likewise, the company is continuously expanding its expertise in system control with respective software modules for fuel-cell-specific functions.

Joint venture for mass production of bipolar plates

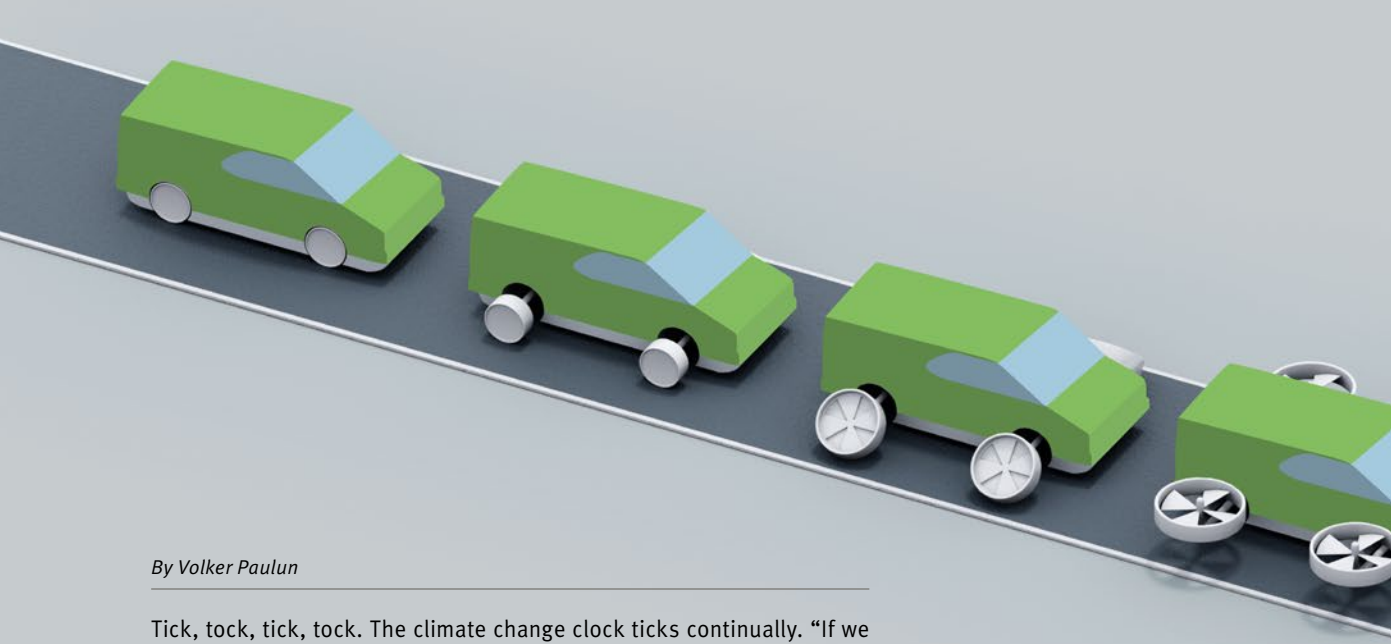
For large-scale deployment of fuel cell powertrains, systematic industrialization is intended to make the component and subsystem costs as economical as possible. This industrialization is central to Schaeffler's strategy. **Together with Symbio, a joint venture of Faurecia and Michelin for hydrogen technology, Schaeffler is planning to launch mass production of bipolar plates in early 2024.** The companies are targeting both mobile uses of the plates in mobility and in stationary applications. The joint production operation is planned to be established in Haguenau, France, where four million bipolar plates are initially planned per year, and some 50 million annually by 2030. "The joint production by Schaeffler and Symbio is aimed at achieving important economies of scale because that is a prerequisite for future cost-efficient production of the fuel cell stacks," says Jochen Schröder.

To demonstrate the industrialization feasibility of the bipolar plates developed by Schaeffler, the company installed a pilot manufacturing plant at the beginning of 2022. The plant is designed to include the production of bipolar plates with dimensions of 1,800 times 600 millimeters (70.9 times 23.6 inches) for electrolyzers. The individual process steps of the pilot plant that was conceptualized together with Schaeffler's in-house special-purpose machinery department are already fully automated. The pilot plant is embedded in a new hydrogen competence center at the Herzogenaurach location. It encompasses a large-scale test bed for electrolyzer technologies as well as for fuel cells on component, stack and total system level.

At the beginning of 2022, Schaeffler launched a pilot plant for manufacturing bipolar plates

Schaeffler's visionaries

How can the transportation sector become more sustainable? And how can Schaeffler accelerate that transformation? Those questions are among the ones that the specialists in Schaeffler's Advanced Innovation department address and explore.

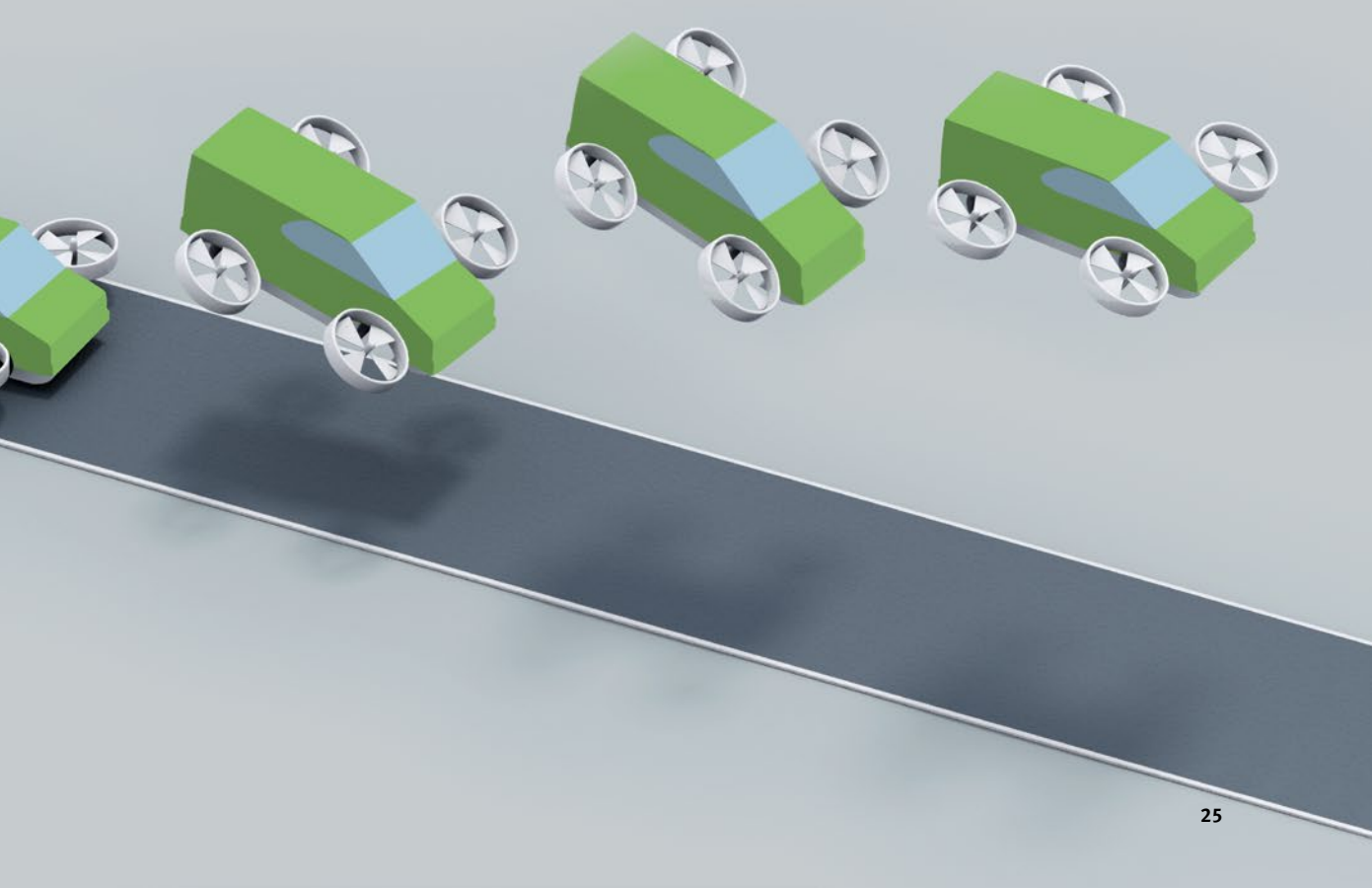


By Volker Paulun

Tick, tock, tick, tock. The climate change clock ticks continually. "If we want to achieve the established climate goals, we need to get the required innovations off the ground as soon as possible," urges Professor Tomas Smetana. The Doctor of Engineering has been leading the Advanced Innovation department at Schaeffler since September 1 – and is putting the pedal to the metal. "As the saying goes, the future begins today. When we're not talking about evolutionary but truly new, potentially disruptive technologies, we need to kick them off now if we want to use them in 2030. That's how long a development process takes from the initial idea to implementation to production and scaling for the markets."

To pick up speed in the development process as quickly as possible, Schaeffler concentrates its research and development competencies. “We don’t want to use a shotgun approach of kick-starting as many ideas as possible but focus on those that match market demands, problems that customers are facing as well as our areas of expertise,” says Smetana. That’s why the new Advanced Innovation unit that was established at the beginning of this year concentrates on six plus two focus fields: six in the area of Product and two in the area of Manufacturing. In the Product area, the range extends from applications in the fields of Energy, Robotics and Digitalization to Mobility Solutions and Electric Drive Systems to Material Solutions. Each of these teams conducts its research and development work as a self-sufficient entity. “Obviously, though, collaboration between colleagues from various divisions, functions and regions in joint project teams is a key to the success of an innovation,” emphasizes Smetana.

Tomas Smetana (center) and his colleagues in the Advanced Innovation department at Schaeffler are engaged in research and development of pioneering technologies for the future



Holistic approaches to thinking are important

As an example, Smetana, a 48-year-old Czech by birth who has been working at Schaeffler in various roles for 21 years, mentions a reduction gearbox that has found its way from internal combustion engines into robotics. Another case in point: drawing on traditional core competencies such as precision forming and thin-film coating, Schaeffler paved its way into the hydrogen economy a few years ago, where the company focuses on the production of bipolar plates for fuel cells and industrial-scale electrolyzers. Smetana: "The ability to combine product innovation and system understanding with material and manufacturing expertise as well as top quality is one of Schaeffler's great fortes. This concentration puts us in a position of developing ideas to market level within a short period of time. Clustering in focus fields establishes guidelines that additionally accelerate the processes."

In any case, developments for forward-thinking and sustainable mobility do not progress very far without holistic approaches to thinking. When it comes to sustainable transportation solutions for passengers and goods, energy sources as well as digital and automated applications play a role in which software is becoming increasingly important. Essentially, new concepts such as autonomous people and logistics movers are robotic vehicles. Vehicle-to-vehicle and vehicle-to-infrastructure communications are digital fields of application that are of major importance for autonomous driving as well as for smooth, emission-reducing traffic flow.

A playground for creativity and innovation

However, to ensure a high level of stringency, each innovation cluster has firmly defined project structures. "As a result, we have clearly defined development directions as well as responsibilities," says Smetana. New vehicle platforms such as people or logistics movers are located in the Mobility Solutions cluster, where teams from the Automotive division are active as well as the specialists from Schaeffler Paravan. Other sub-clusters there are the electrification of commercial vehicles as well as of aircraft, autonomous driving and, as an extended research field, infrastructure. E-Drive Solutions encompasses novel kinds of drive systems, propulsion electronics and sensors, transmissions and bearing systems. "These innovation clusters are our playground on which the creativity of our team members can develop freely," says Smetana.

However, innovation does not necessarily have to emerge from the company's own universe. "We also deliberately seek to collaborate with external innovation drivers," Smetana continues. That

Agile assistant

The **autonomous mobile robotic platform DEX** that has been recognized with the Red Dot Award is a good example of how Schaeffler drives innovations together with partners. DEX was visualized in close collaboration with Orcadesign Consultants Pte. Ltd. and the team of the Schaeffler Hub for Advanced Research (SHARE) at Nanyang Technical University (NTU) in Singapore. DEX can carry heavy loads of several hundred kilos and can be deployed, for instance, in urban delivery services. Other examples include autonomously moving beds in hospitals from A to B. Schaeffler itself is planning a research pilot run to deploy DEX for its production facilities and to optimize manufacturing workflows.

“The innovation clusters are our playground on which the creativity of our team members can develop freely”

Prof. Dr.-Ing. Tomas Smetana,
Head of Advanced Innovation at Schaeffler

area is called Open Innovation. “We systematically work together with startup platforms and are now also moving into the area of venture capital to accelerate our developments.” As cases in point Smetana mentions new forms of mobility, which he rates as particularly urgent innovation fields due to the increasingly apparent shortage of skilled staff. While Schaeffler is responsible for system development, individual components, for instance in the areas of sensors or digitalization, may well be supplied by an external source.

Innovation field: Sustainable Transportation

Regarding development projects in the area of Sustainable Transportation the informative tech talker says, “A key question we’re asking ourselves is: how can I design an electric motor electromagnetically to achieve high efficiency? That, no doubt, is an area with significant improvement potential. Another one is electronics. Here we’re asking ourselves why it looks the way it does. What can we achieve with a different architecture as well as with other materials and, of course, with software. What we’re seeing here is efficiency enhancement potential in the double-digit percentage range.”

It may sound surprising but Smetana wants to have the internal combustion engine mentioned as well in the context of Sustainable Transportation. “Obviously not in the passenger car segment,” he quickly adds to correct that statement. “However, in other vehicle categories such as ships, aircraft or in some heavy-duty applications it will take some time to replace it across the board. That makes it even more important to decarbonize its operation with green fuels like hydrogen or ammonia. Our enthusiasm for electric mobility notwithstanding, we’re working on that as well.”

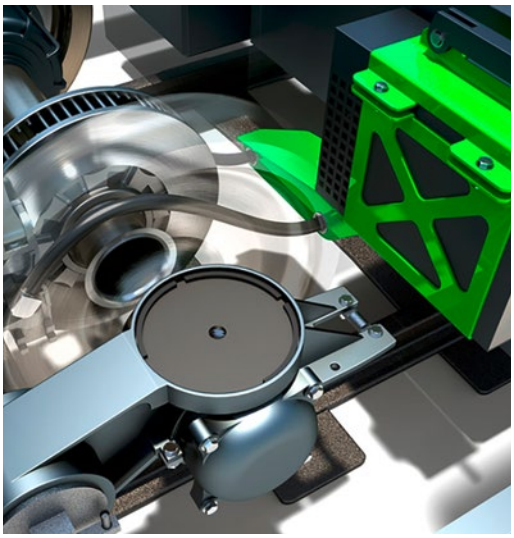
Sustainable Transportation

Rail

320,000

four-person households could be supplied with power for one year just by the electricity that the electric locomotives of Deutsche Bahn fed back into the grid through recuperation of braking energy in 2021. The technology, by the way, is anything but new. The Swiss Federal Railways (SBB) pioneered the utilization of the recuperation brake at the Gotthard as far back as in the 1920s – on the legendary Crocodile locomotive.

Source: Deutsche Bahn, SBB

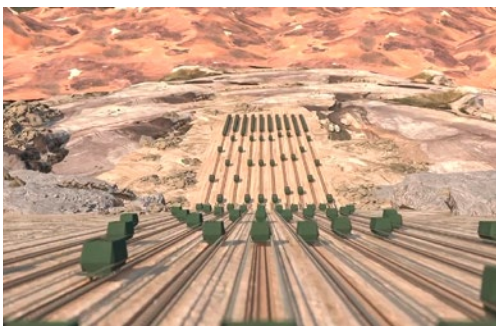


Putting the brakes on particulates

There's more to air pollution than just exhaust emissions. Especially in cities, **the fine dust emitted by passenger cars, buses, trucks and trams is a serious problem.** A major cause is abrasive wear during braking events when materials contact each other. Tallano Technologie based in France has addressed that problem and developed a kind of vacuum cleaner that collects the particulates directly on the braking system and stores them in a receptacle. According to the company, **up to 90 percent of the fine and ultra-fine particles** can be captured and partly recycled in this way. The system called Tamic is already in use at the Paris Metro and the subway systems of several big cities in Asia.

CO_2 aspirators

How can rail transportation that already leads the way in terms of sustainability become even more eco-friendly? US-based startup CO_2-Rail has come up with an idea: **CO_2 aspirators in the form of railcars.** While traveling on railroad tracks, they suck in air, absorb the climate gas using filters, liquefy it and thus prepare it for use in industrial processes, for example. The energy for the rolling CO_2 treatment is supposed to be provided by the recuperated braking energy. According to the developers' calculations, **every retrofitted railcar could filter 15 metric tons (16.6 short tons) of carbon dioxide from the air per day.** For comparison: combined, the direct air capture (DAC) plants currently operating around the world remove 10,000 metric tons (11,000 short tons) of CO_2 per year from the air, in other words just around twice the annual capacity of a single DAC railcar. However, to capture the annual CO_2 emissions of the world population currently amounting to some 36 billion metric tons (40 billion short tons), 6.5 million DAC railcars would have to be rolling on the planet's tracks – one million more than the total number of existing freight railcars.



50 megawatts

That's the capacity of the pilot plant of an unusual gravitation storage system that the American company ARES is building in Nevada. The idea behind it: Using surplus electricity from wind and solar powerplants, **electric mass cars on rails haul concrete blocks uphill.** When the grid requires power, the mass cars are deployed downhill again, delivering the energy with more than 90 percent efficiency. At the 50-MW pilot plant, 210 mass cars, each with its own motor-generator unit on board, move a total ballast of 75,000 metric tons (82,700 short tons) on 10 tracks. Such a facility is **scalable to a capacity of up to 1 gigawatt,** according to ARES.

“Freight shipments are becoming increasingly autonomous, compartmentalized and spontaneous”

Freight haulage offers plenty of potential for greater sustainability. In an interview, transportation expert Professor Gernot Liedtke explains what needs to be improved, what technologies lend themselves to such improvements and what role the government should play in that regard.

Interview: Lars Krone

What do you currently see as the major challenges in commercial transportation?

The challenges are massive and diverse. In particular, the working conditions of drivers and the serious accidents involving trucks come to mind. But the major problem is CO_2 emissions. It can be assumed that, in Germany for instance, about 40 percent of transportation-related CO_2 emissions, including transit traffic, emanate from road haulage. The big problem is that, at the moment, no one knows exactly what pathway should be pursued to reduce them. With trucks, for example, the outcome of the technology competition between the hydrogen fuel cell and battery-electric powertrains or perhaps even catenary systems is not yet in sight. Moreover, it's not clear what role biofuels, synthetic methane or so-called e-fuels from renewable electricity will play in the truck sector. Such uncertainties inhibit investments on the part of vehicle and component manufacturers as well as by providers and users of freight haulage services. Clear impetus from industry, which is already offering medium-sized battery-electric trucks for regional distribution today and planning 40-ton (44-short ton) trucks with battery-electric powertrains for long-distance haulage, can establish facts and thus point the way in the discourse.

Irrespective of the propulsion energy, do you see any potential for trucks to become more sustainable?

Test operations of trucks with a length of up to 25 meters (82 feet) – so-called longliners – in Germany have resulted in an efficiency gain of 15 to 25 percent, according to the Federal Ministry for Digital and Transport. Even more could be achieved by consistent aerodynamic optimization to reduce drag, for instance with a cabin that's similar to that of an ICE high-speed train, aerodynamically optimized vehicle trim and a sloping rear that reduces eddies.

How can Rail take away market share from truck haulage?

As far as the service characteristics are concerned trucks are currently simply the benchmark because they allow for easy and fast scheduling and can haul between one and 30 pallets – that's what most customers want. It will be difficult to re-educate customers and get them to use something that's less in line with their needs. That's why Rail needs to become more attractive in the areas I mentioned to capture market share – and, above all, do a better job of displaying its strengths. Take speed, for example. A truck is usually bound to one driver and therefore to rest periods. A train can travel through Europe day and night. Even at 80 km/h (50 miles) and more! Unfortunately, Rail is hampered by few, albeit decisive transportation hubs in metropolitan areas, where freight trains must yield priority to passenger trains. As a result, scheduled travel times are becoming longer and freight train delays accumulate.

Why does it always have to be Rail OR Truck? Wouldn't combined rail and road transportation be a particularly good solution?

Absolutely. But that would also presuppose fast reloading of cargo or loading units from one

The expert

Since 2014 **Gernot Liedtke** has been head of the Commercial Transport department at the DLR Institute of Transport Research and of the same-named department at the Institute of Land and Sea Transport Systems at Technical University Berlin. His research interests include multi-agent simulation of the freight transportation demand, spatial interaction models and infrastructure pricing. In these areas, he has published several articles in international scientific journals such as "Transportation," "Transportation Research" and "Journal of Transport Economics and Policy." In addition, he was involved in more than 15 research projects as a member or project leader.

Airships could be used to haul goods directly from ships to metropolitan areas

means of transportation to the other. There are long waiting and collection periods before a train can depart because, sequentially, one truck is dispatched after another. That's far too time- and cost-intensive.

Let's talk about digitalization: What potential does that offer for more sustainable movement of goods?
A look at developments in recent years shows that the systems, not least due to digitalization, have already become clearly more efficient and economical. However, most of the potential in that area has by now been fully exploited – especially in terms of long-distance hauling. We've generated statistics showing that the efficiency-related potential of today's systems – such as the share of empty runs or levels of capacity utilization – has remained constant. There is not a lot of room for improvement in that area anymore even though digitalization has developed further in recent years and is increasingly being used in freight hauling. Digitalization makes an important contribution but in and of itself will not be sufficient to reduce CO_2 emissions significantly.

What role are autonomous vehicles going to play in future freight hauling?
For one, they can counteract staff shortage. Plus, they can enable new ways of using trucks. Today, freight carriers looking for hauling contracts are often on the road with large trucks whose capacities are not fully utilized or that are even empty. Such trips will no longer be necessary because smaller, autonomous trucks can be waiting in industrial parks or at highway rest stops for hauling jobs to turn up and be activated as needed because no driver would have to receive continuing pay during such waits. That would also make it less expensive for companies to spontaneously request trucks because the need for long transfer trips is eliminated. In the future, companies will be able to reduce their planning windows and carry out shipments in more compartmentalized ways.

So far, we've primarily been talking about long-distance freight hauling. How can transportation develop more sustainably also on the last mile?
There are many ideas in that area as well. In my view, a multi-level distribution concept should be pursued that would always use the vehicle which in terms of its hauling volume is optimally suited for the respective level. Cargo bikes, for instance, can solve many but not all problems of urban transportation. They provide an answer to the density stress in cities and move from A to B without CO_2 emissions. They can circumvent traffic jams and are more agile, which enables faster delivery of goods to consumers than a van stopping 50 meters away from the recipient's doorstep with flashing warning lights. Plus, cargo bikes make speed-parcel and time-window-based deliveries possible because they operate in a radius of roughly one kilometer (0.62 miles) around a micro depot from where they can flexibly pick up new parcels for timely distribution. That meets the wishes particularly of digital consumers. By contrast, when using vans, dispatchers plan in the morning what the vehicles are supposed to deliver.

Speed-parcel deliveries cannot be achieved in that way. There's one problem, though, that cargo bikes cannot solve: the shortage of personnel because cargo bikes have to be operated too. In densely populated areas, automated deliveries or alternative vehicle concepts such as very large cargo bikes carrying small shipping containers might be conceivable. UPS, for instance, is already testing something like that in Munich. Aircraft, for instance, might be used in healthcare such as for express deliveries of medications or for deliveries of spare parts. In that area, small zeppelins are highly promising because they practically require no resources to generate lift and comparatively few for propulsion. By contrast, the energy efficiency of multicopters such as drones is relatively low.

Where is sustainability currently positioned in the logistics requirements ranking between costs, speed and reliability?

There's a strange asymmetry in that regard. Actually, almost all major manufacturing companies have CO_2 reduction programs, CO_2 audits or internal incentives for saving energy. These companies by now are in a really good position for reducing their environmental footprint on a strategic level, which also includes freight hauling. There's a clear correlation here: the larger the company the more it has embarked on that journey. There are several reasons for that. It's a question of resources, strategic corporate management as well as of the company's reputation and preparation for future frameworks. Such large corporations need to brace themselves for rising energy costs or CO_2 taxation early on. Because such companies are like huge tankers, they must change tack in time. On the other hand, we've found out that the smaller the company the lower its strategic approach to dealing with sustainability. Small manufacturing companies, as well as most transportation companies, have no market power with their suppliers. For instance, a freight carrier with, say, 20 vehicles cannot simply go to a truck manufacturer saying that it would like to have a totally different truck.

What role should the government assume in order to enhance sustainability in freight hauling, in other words, to specify a framework, use subsidies or improve infrastructure?

When you're dealing with innovations it's always good to have an unbiased view of technologies because that allows the best technology to win out. However, once it becomes apparent which technology is going to win the race an unbiased view of technology is no longer helpful. That's when the government has to support the development of the favored technology by establishing guard rails and provide all the players with planning certainty. Specific developments should occur in parallel in that regard. For instance, it doesn't make sense if power companies establish charging stations but no electric cars are being produced and vice versa. It's important to develop joint strategies and the government can assist by establishing frameworks or by acting as a moderator.

Tesla has announced a range of up to 800 kilometers (500 miles) for its new electric truck. Will it disrupt the market in the same way as Tesla passenger cars did?

Amazing trains

For almost 200 years passengers and goods have been hauled on tracks. Trains, trams and subways are time-tested and popular means of transportation. They travel at highest elevations, through thickest jungles and even through residential buildings. Here's a look at seven of the most remarkable trains, tracks and stops around the world.

Inter-city rail on the roof of the world

Where
Lhasa Express in the Himalayas

Wow!
Its route between Lhasa in Tibet and Xining, the capital of Qinghai province in China, holds as many as three world records: highest railroad (up to 5.072 meters/16,640 feet), highest train station (Tanggula, 5,068 meters/16.627 feet) and highest tunnel (Fenghuoshan, 4,905 meters/16,092 feet). Nearly 90 percent of the 1,956 kilometers (1,215 miles) through the Trans-Himalaya Mountain Range are at an elevation of more than 4,000 meters (13,123 feet).

Other interesting facts
The railroad that was opened in 2006 is Tibet's main traffic artery. A train ride from Lhasa to Xining takes 17 hours. The route is electrified only in some sections. At the highest elevations, it takes up to three diesel locomotives to pull the 16 railcars. That's the only way to compensate for the power loss of the IC engines caused by the lower oxygen content of the air at such altitudes. In addition, the permafrost ground on 550 kilometers (342 miles) of the mountain railroad required a special technical solution. Steel tubes filled with ammonia were driven deep into the ground to prevent thawing and to permanently stabilize the track system. Rough grids of stone to the left and right of the tracks prevent an accumulation of sand from huge wandering dunes.

Zigzag course around the “Devil’s Nose”

Where
Trans-Andean Railway in Ecuador

Wow!
The topography at the “Devil’s Nose” calls for spectacular shunting. To route the tracks around a sharp, dizzyingly steep bluff called “Nariz del Diablo,” they’d actually have to be laid in serpentines – but then no train could run on them. The solution was to route the train around the cliff on a zig-zag course. And this is how it works: The train traveling uphill or downhill coasts at walking speed into a “dead-end track” at every hairpin turn. The switch at the entrance to the turn is changed to reverse the diesel locomotive’s direction of travel before the train moves on to the next “bend.”

Other interesting facts
The “Devil’s Nose,” whose name derives from the large number of railroad workers who died during its construction (1899–1908), is a twelve-kilometer (7.5-mile) section of the train service between Ecuador’s capital Quito in the north and Guayaquil on the west coast. The spectacular train is very popular with (rail) tourists and can be taken as a day trip.

Climbing tour without cables or cogs

Where
Pöstlingbergbahn in Linz (Austria)

Wow!
Although it has to handle uphill and downhill gradients of up to 11.2 percent the electrical energy that drives it is transferred to the steel tracks strictly via the steel wheels of the multiple unit (MU). Additional cable or cog drives that are typical for mountain railways are not used in this case. Such an adhesion railway featuring a drive concept normally used for regular trains can climb a theoretical maximum of 13 percent. There’s hardly another train or tram that comes as close to this limit as the one at Pöstlingberg in Linz.

Other interesting facts
The construction of the nearly three-kilometer (1.9-mile) Pöstlingbergbahn between 1888 and 1898 was mainly motivated by the visitors flocking to the St. Mary’s Pilgrimage Church atop Linz’ local mountain. In 2008, the single-track railroad was regauged from 1,000 (3 ft 3/8 in) to 900 millimeters (2 ft 11 7/16 in) enabling its connection to the city’s tram network. Four new accessible MUs with an optimized braking system have been standard since then. As before, no other railcars are connected to the MUs due to the steep downward gradient. Top speed: uphill 12 km/h (7.5 mph), downhill 13.5 km/h (8 mph).

Train traffic at the limit

Where
Chemin de fer Congo-Océan in Congo

Wow!
The 502-kilometer (312-mile) railroad between the capital Brazzaville in the southeast of the Republic of Congo and the Atlantic port city of Pointe-Noire is regarded as the country's "lifeline," albeit a lifeline whose construction (1921–1934) claimed the lives of more than 17,000 forced laborers. The section through the mountainous Mayombe Forest is a special challenge – that was true during its construction and still is for its maintenance (many landslides!) and the ride. From the coast, the trains initially overcome a swampy valley before traveling uphill. Three locomotives have a lot of schlepping to do especially when hauling heavily laden freight trains uphill.

Other interesting facts
The 1,067-millimeter (3 ft 6 in) narrow gauge that was selected due to the difficult topography is also a reason for the many accidents on the route. In the impenetrable Mayombe jungle, derailed cars are left to nature's whims – as rusty warnings to the trains rumbling past them day in day out.

A stop in the middle of a high-rise

Where
Chongqing Train in China

Wow!
Line 2 in Chongqing, a city with a population of 31 million, cuts through the full length of a 19-story residential building. What's more, the building also accommodates the Liziba Station that extends across three levels.

Other interesting facts
With the "stop inside the high-rise," one of the largest urban areas on Earth solves two problems at the same time: The train service to the center of the city neither required any architectural changes in the surroundings nor was a lot of urgently needed housing space lost. The residents of the high-rise were in favor of the project as well. Due to the train station directly in their building, their way from home to the train is extremely short – an advantage that also increased the value of the apartments, especially since the unconventional penetration of the building by the train tracks causes neither vibrations nor noise disturbances. Thanks to special insulation, the noise emissions from the train service do not rise above 60 decibels, a level that equates to a normal conversation.

A 12-hour scenic ride

Where
Alaska Railroad in the USA

Wow!
After construction started in 1903, the Alaska Railroad was continuously extended further inland. Today, 750 kilometers (466 miles) connect the ports of Seeward and Whittier with Alaska's biggest city, Anchorage, in the interior. There's no connection to another train network. "Every mile of this legendary railroad was hard earned through grit, bravery, faith and lots of sweat," it says on the website. A look at the schedule shows how tricky the trip is even in summer: it takes the express train twelve hours to travel the 580 kilometers (360 miles) between Anchorage and Fairbanks – ample time for passengers to marvel at the majestic landscape.

Other interesting facts
Good roads cannot be taken for granted in Alaska, so pickups and cargo hauling trucks also frequently use the tracks of the Alaska Railroad. For that purpose, the highway-railroad vehicles have two bare-steel rail-wheels each on the front and rear that can be raised or lowered. In winter, roaming moose like to use the cleared tracks as well – often with fatal consequences for these heavyweight members of the deer family.

Sophisticated steel giant

Where
Rendsburg High Bridge (Germany)

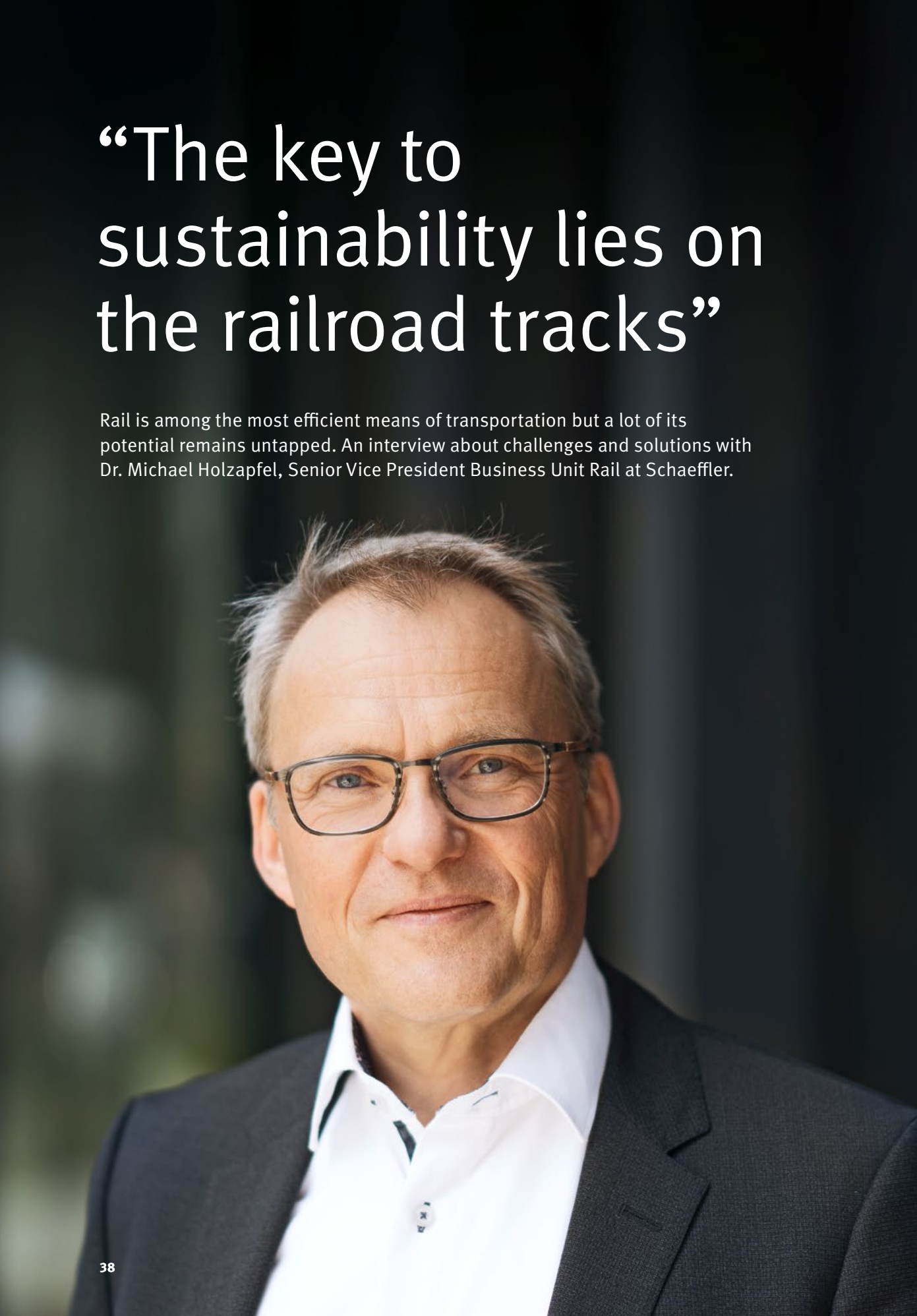
Wow!
This railroad bridge across the Kiel Canal is a masterpiece of engineering – assembled between 1911 and 1913 from 17,350 metric tons (19,125 short tons) of steel that are held together by 3.2 million riveted bolts.

Although the main bridge is only 295 meters (968 feet) long the entire structure measures 7.5 kilometers (4.7 miles). To link the Rendsburg train station located near the bridge to the important north-south connection, the railroad is routed through a four-kilometer (2.5-mile) loop on the north bank of the canal and subsequently spirals down in a tight space from a height of 42 meters (138 feet) (required for ship traffic).

Other interesting facts
At the bottom of the high bridge, one of the eight suspension ferries still operating in the world travels back and forth between the banks of the canal. That, too, makes this bridge a very special rail structure.

“The key to sustainability lies on the railroad tracks”

Rail is among the most efficient means of transportation but a lot of its potential remains untapped. An interview about challenges and solutions with Dr. Michael Holzapfel, Senior Vice President Business Unit Rail at Schaeffler.

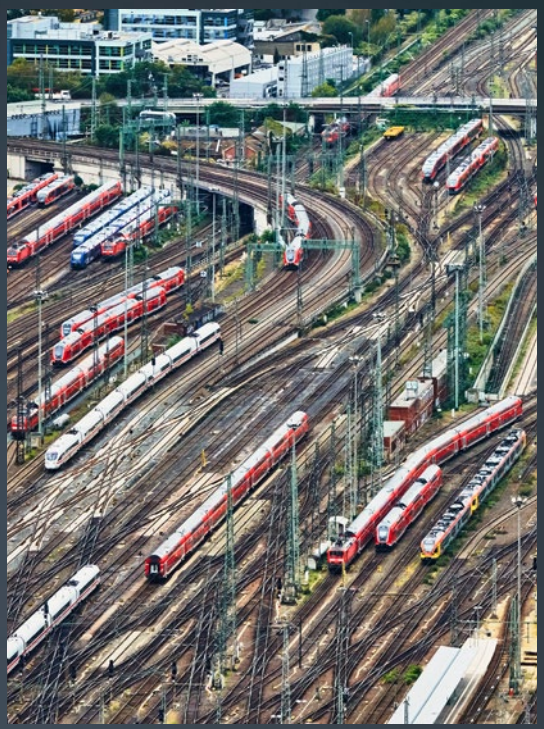


Interview: Volker Paulun

In a metaphorical sense, you're Schaeffler's train driver. As a child, did you want to become a train driver like so many other kids?
Even if it may surprise you, the answer is no. The job of a train driver struck me as being too specialized because back then as well as today I've always been interested in the railroad system as a whole: the interaction of tracks, switches, signals, trains and stations, plus the people and goods that are hauled on trains. Consequently, in the same vein as the wide variety of our systems and components in the Rail sector, I don't see myself as a train driver but more as a rail traffic controller.

Schaeffler attributes a key role for mobility of the future to the Rail sector, especially when it comes to achieving the global climate goals. However, to do so, more passengers and goods need to be shifted to Rail, particularly in Europe. How much growth can the current European system handle? And what are areas in which improvements are needed?
The track network is divided into so-called blocks that define the distances between trains. At the moment, they're very large. That's partially due to the signal systems, some of which date back to the imperial era and are showing their age. Although the systems are still safe, they're not efficient. A shift toward Europe-wide, digitized and more vehicle-bound signal systems enables a dynamic division of the blocks. For instance, by using such a European Train Control System, or ETCS for short, a lot more freight trains could have the total length of 740 meters (2,428 feet) that's possible in Europe. At the moment, only one in ten trains is that long. The average freight train in Europe has 25 to 30 cars instead of the 35 that are possible. That alone shows improvement potential of more than 20 percent. And, of course, passenger transportation and the transportation mix of passenger and freight trains could also be organized more efficiently with ETCS.

Where else do you see improvement potential?
Both in hauling goods and in passenger transportation the trains that exist actually need to be deployed. That's a very important issue. Technical failures must be reduced to a minimum. The same applies to maintenance. Schaeffler focuses on both of these areas: with innovative maintenance concepts, systems for condition monitoring and for more reliability.



Fewer downtimes, modernization of signal systems, autonomous trains – there are many approaches to improving the capacity utilization of existing track networks

When freight trains become longer do they require more locomotives to pull them?
740 meters (2,428 feet) is not really long yet. Transcontinental trains in the United States have a near-endless length of seven kilometers (4.3 miles). A 740-meter (2,428-ft) train with a normal payload can easily be pulled by one locomotive while hauling as much cargo as 52 trucks. That makes the whole system of Rail so efficient and, ultimately, fascinating too.

In countries such as China, Australia and the United States you just mentioned, Rail accounts for 40 or 50 percent of cargo transportation; in the European mix, it doesn't even account for 20 percent. How can Europe catch up?
Catching up with the countries you mentioned, and I'd like to highlight India in this respect as well, requires major changes as well as investments. In

those regions, rail freight is run on dedicated corridors providing it with totally different opportunities – including financial ones. Especially in the United States, rail freight corporations like BNSF or Union Pacific are extremely profitable. In the area of separation, China is exemplary: high-speed trains, short-haul passenger transportation and freight trains have dedicated tracks, enabling totally different capacities to be handled than in Europe.

Are there any plans to establish such corridors for freight trains in Europe?
In isolated cases. For instance, there's a freight train corridor from the Rotterdam port to the German border that's now supposed to be extended to the Ruhr region. To shift more cargo to Rail, more projects like these would no doubt make sense.

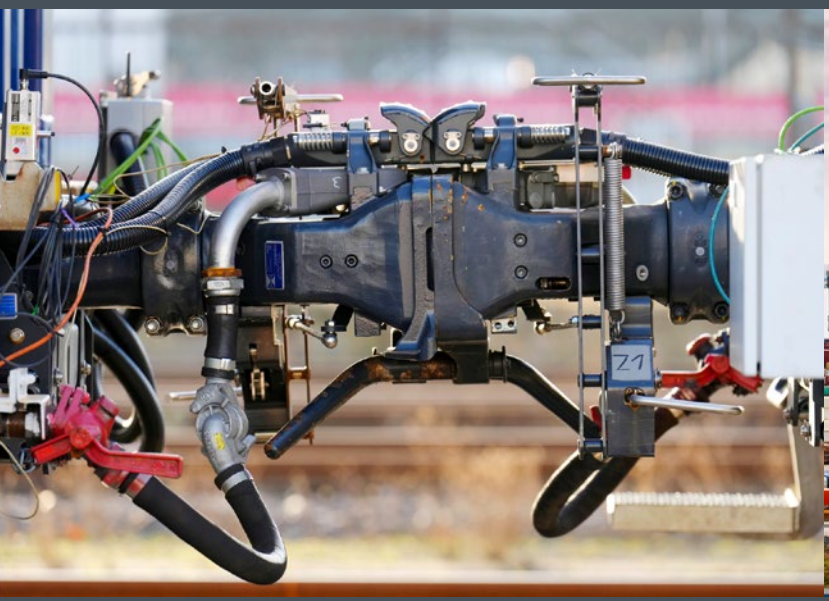
Especially when looking at freight trains, it's obvious that there are still many diesel locomotives in service around the globe. How can they become "clean?" Hydrogen, batteries, synfuels?
Well, first of all, it needs to be said that the energy consumed by a diesel locomotive per metric ton (1.1 short ton) hauled is around 80 percent lower than that consumed by a truck. The hard train wheels are simply running on tracks with a lot less friction than a truck tire does on asphalt. In addition, the close coupling of cargo railcars reduces train resistances. Consequently, trains per se operate with much higher efficiency. So, the decarbonization challenge is much less pressing there than it is with other transportation systems – but it does exist, as do ideas of how to achieve improvements. Looking at Europe, the issue, clearly, is electrification. Here, Germany, with a current electrification rate of the track network of less than 61 percent, is one of the countries that needs to up the ante. One reason why the electrification of locomotives is so attractive is the fact that the braking energy that's lost in the case of a diesel locomotive can be recuperated and used. In the United States, for instance, our customer Wabtec is running a pilot project with a battery-electric and diesel locomotive hybrid consist, in other words an efficient mix of both types of drive technology that can be used anywhere.

... that works in which way?
As previously mentioned, freight trains in the United States are clearly longer and powered by several locomotives. The idea now is to include a battery-electric locomotive in that type of consist. With its 7 MW it assists in acceleration events or on inclines where the need for power is the greatest. While the train is coasting the electric locomotive shuts down and recharges its batteries while braking. As a result, even on long distances, it's always ready to help push the train.

And what about hydrogen?
Especially in the area of long-distance cargo hauling, that's not a truly viable solution, technically or economically, because the required amount of hydrogen cannot be hauled in reasonable ways at the moment. In regional transportation settings, where the routes are shorter and more frequent refueling is possible, the situation is different. In August, service of the world's first network with hydrogen passenger trains started in Lower Saxony. By the end of the year, the deployment of 14 Alstom hydrogen trains is planned there – by the way, also with Schaeffler technology on board.

What's your take on the Hyperloop hype?
Because the further development of a vehicle is always easier than the further development of infrastructure the track or road has always been simple and the lion's share of the technological evolution has occurred on the vehicle throughout the history of mobility. That's different in the case of the Hyperloop with its complex vacuum tubes. And that's exactly why I tend to have a critical view of that technology. For me, the classic wheel/rail system is the gold standard. According to a popular saying among engineers, a system is always good if it's so simple that there's nothing left to be omitted from it. And that exactly applies to Rail and the wheelsets rolling on the tracks. It's hard to top that interaction with a new technology, especially since there's no physical reason why rail vehicles should not travel exactly as fast as a maglev train, for instance, or some other technology.

Going forward, what trends have the potential to evolutionize or even revolutionize rail transportation?
Of course, there's always something that can be improved; otherwise, Schaeffler wouldn't pursue the further development of its Rail portfolio. But talking about a revolution, the first thing that comes to my mind is the screw-type coupling for railcars. Here in Europe – unlike in other regions – technology from the century before last is still being used, requiring many manual, and even some hazardous,



Especially in Europe, there are many opportunities for making better use of the potential of rail-bound freight hauling, for instance with automatic couplings and efficient intermodal transshipment hubs

procedures. To finally arrive in the 21st century in this area, the EU is working on the introduction of a standardized Digital Automatic Coupling, or DAC for short, that could massively accelerate European rail freight hauling and, as a result, significantly increase its competitiveness.

Without such automatic couplings autonomous train traffic would be impossible as well …
Exactly. And that takes us to another important trend, going forward. Humans and their tendency to make mistakes are a major obstacle when it comes to enhancing the capacity utilization of the track network and putting more trains – and thus more hauling capacity – on railroads. Fully automated systems would clearly increase the efficiency of railroad operations. In addition, they could eliminate the problem of personnel shortages that the Rail sector is struggling with as well. That's why I find it all the more surprising that so little is happening in that area.

Would better integration of the transportation systems help shift cargo to Rail?
It definitely would. From the departure points of the major European ports that's already working pretty well. But in the case of intermodal movements in the range of 250-kilometer (155-mile) distances, Rail quickly loses out because the reloading times are simply too long or there just aren't enough transshipment stations. Switzerland is exemplary in this regard. More than ten years ago, the country started establishing a freight train network with fixed schedules so that freight haulers can reliably plan intermodal routes. The network of transshipment sites is close-meshed and efficient too. We need such a close-meshed network of modern hubs across Europe so that combined transportation becomes competitive.

What are Schaeffler's focal areas in the Rail business, with passenger or cargo transportation?
For us, both areas are important, but there are differences between them. In our case, passenger transportation is largely project-related business. That means that together with our customers we develop tailored solutions for specific types of vehicles. By contrast, in the freight train business, the emphasis is on standard products. Of course, that doesn't mean that there are no developments in that area, which is also reflected in our innovations showcased at InnoTrans. (More on that on the following pages.)

Setting the course for the future

The role of Rail is crucial if the transportation sector wants to achieve its climate goals – because Rail is already an efficiency champion today. Which doesn't mean that there's no room for improvement with locomotive & company. For instance, with innovative products from Schaeffler for higher reliability, sustainability and planning certainty.

By Björn Carstens

All signals are on green for intensifying the effort of shifting haulage traffic to rail-bound transportation. According to the International Energy Agency (IEA), around eight percent of worldwide passenger and around nine percent of freight haulage is handled by trains while trains account for only three percent of the energy consumption in the transportation sector. On the one hand, this comparison shows how efficient Rail as a system already is today. On the other hand, the fact that the percentage of passengers and goods hauled worldwide is not even in the double-digit range illustrates that there's still a lot of potential for shifting more transportation capacity to Rail. For that to happen, the reliability and capability of trains as a means of transportation needs to be enhanced. That, of course, applies to sustainability as well: good is not good enough.

For Schaeffler as one of the world's leading automotive and industrial suppliers, this means that components, systems and services need to become even more sustainable and durable to enable even more intensive operation. At InnoTrans 2022 (see info box on page 47) Schaeffler is showing how the company intends to serve those market needs in its trade show display billed as "Reliable, predictable, sustainable – Schaeffler Solutions for Innovations in Rail."

“Predictable” – Solutions for digital lifecycle management

It’s annoying when a train doesn’t depart on time. But when important shipments are delayed as a result companies can incur enormous costs. One cause of delays is unforeseen maintenance work that is time-, labor- and cost-intensive. In the past, maintenance work was typically scheduled after a specific number of months – irrespective of factors such as material wear and weather conditions. Today, the magic word is predictive maintenance. Digital and sensor-based systems from Schaeffler make manufacturing and railroad operations more sustainable.

Data Matrix Code

The Data Matrix Code (DMC) is combined with the GS1 EPCIS interface standard to enable end-end-to information exchange between the component supplier, vehicle manufacturer (OEM) and railroad operator.

Innovation
Schaeffler provides manufactured components with an individual product marking called DMC. It is a kind of digital birth certificate that becomes a digital twin by being fed with current maintenance data about the condition and wear of the component. New is the utilization of the internationally recognized, manufacturer-independent **GS1 EPCIS interface standard enabling transparent electronic data exchange between Schaeffler, the vehicle manufacturer and the railroad operator for planning and optimizing predictive maintenance and service intervals.**

Facts
The digital twin of a bearing can be fed with information about which wheelset, truck (bogie) and railcar the bearing was installed in by the OEM. **After delivery, real-time data from the train’s operational history can be continuously added,** including mileage or stationary temperature or vibration measurements along the route, among other information.

Railway Condition Monitoring System

The Railway Condition Monitoring System (RCMS) enhances operational reliability and safety by means of predictive maintenance.

Innovation
The sensor-based RCMS enables digital monitoring of individual wheelsets, full wheelsets as well as powered and trailer bogies in rail vehicles. The data pertaining to acceleration, rotational speed and temperature are analyzed and prepared by special software. **Due to the analysis of vibration signals, railroad operators are provided with information about the components’ exposure to mechanical loads and their condition.** At InnoTrans 2022, Schaeffler is presenting the benefits of web-based RCMS monitoring of a wheelset bearing.

Facts
In addition to early fault analysis to avoid accident risks, **the system optimizes maintenance processes and increases mileage.**

At InnoTrans 2022, Schaeffler is presenting the Data Matrix Code (DMC), an individual product marking for continuous acquisition of data and maintenance information

“Reliable” – New products for safe and efficient train operations

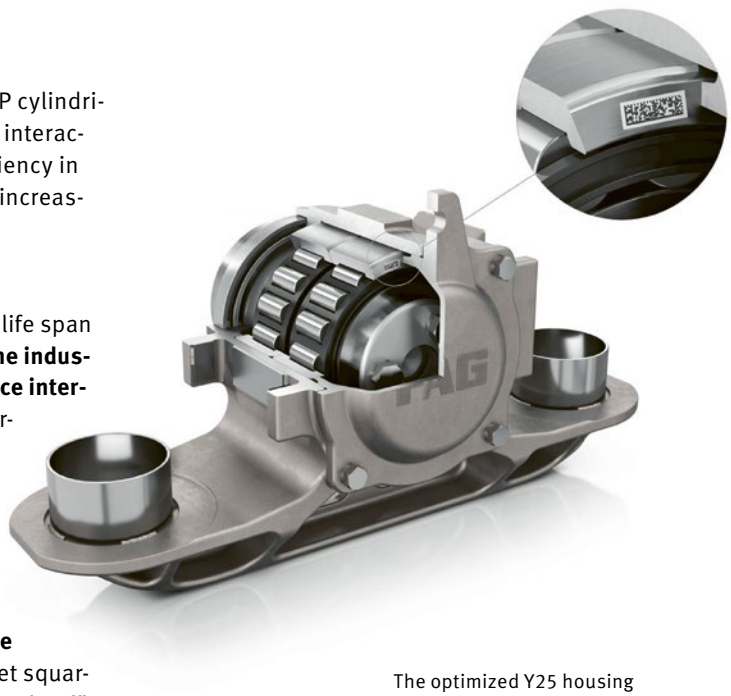
Lack of reliability is one of the biggest concerns when it comes to shifting haulage traffic to the rail sector. Careful product design and high-quality manufacturing provide manufacturers and operators with assurance that their trains will not have to stop due to a defective component that will cause enormous costs along the supply chain. Bearings and system solutions from Schaeffler help make trains fit for the future in a dynamic world.

Y25 housing

The improved Y25 housing including WJ/WJP cylindrical roller bearings in the form of a digitized interactive freight wheelset enhances energy efficiency in cargo hauling and, thanks to lower weight, increases payload.

Innovation
Despite higher service output the bearing’s life span is longer. **As a result, Schaeffler supports the industry’s central demands for longer maintenance intervals and CO_2 reduction.** In addition, the bearings are marked with a so-called Data Matrix Code (see “Predictable”) for predictive maintenance.

Facts
The maximal axle load can be 25 metric tons (27.6 short tons) without damage to the wheelset. That is tantamount to the wheelset squaring a circle because despite the higher load Schaeffler managed to reduce its unladen weight by 14 percent compared to its predecessor. That equally reduces CO_2 emissions in the manufacturing process of the housing.



The optimized Y25 housing for wheelset bearings and new bearings with DMC markings extend maintenance intervals and reduce CO_2 emissions in freight haulage

Rolling bearings

New rolling bearings for internally mounted drive wheelsets of high-speed trains result in clearly more economical train operations.

Innovation
Due to the inner bearings, a smaller outer profile on the vehicles and reduced vehicle weight is achieved. **Rail operators benefit from longer service life and operational reliability of the bearings as well as reduced track wear.**

Facts
Designed for use with maximum vibrational and impact loads, **the rolling bearings impress with higher power density and minimal wear.**

“As long as trains run on tracks there will be rolling bearings”

Dr. Michael Holzapfel, Senior Vice President Business Unit Rail at Schaeffler

Insert bearings

Robust insert bearings for wheelsets in streetcars enable resource-saving tram operations.

Innovation
The inner rings of the tapered roller bearing pair are manufactured with such precision **that after their installation into the wheel unit the specified preloading perfectly occurs automatically.** That simplifies installation and ensures optimal load distribution with maximum reliability.

Facts
The compact design and use of robust and low-wear materials saves resources and ensures clearly longer service life as well as sustainable CO_2 reduction.

The new insert bearings are required for the wheelsets fitted with independent wheels in low-floor streetcars

“Sustainable” – Optimized circular economy for sustainable train operations

Statistics put facts in a nutshell. Compared to the production of new wheelset bearings for train operations, the reconditioning of wheelset bearings for a freight train with 80 cars, two locomotives and thus a total of 1,296 wheelset bearings can result in reductions of 133 metric tons (147 short tons) of CO_2, 481 MWh of energy and 1,767 cubic meters (62,401 cubic feet) of water. Sparing use of resources, optimized service life of components and maximized train mileage – Schaeffler’s products and service concepts meet all of these objectives.

With the TwinTandem bearing, Schaeffler announces an innovation leap in rail-bound transportation, unleashing new performance potential with significant impact on operations and maintenance

TwinTandem

Balls instead of rollers: Schaeffler presents the novel TwinTandem wheelset bearing for high-speed transportation.

Innovation
The central innovation of the TwinTandem design features the use of ball bearings with clearly reduced friction. **As a result, low temperatures are maintained even at high rotational speeds,** which in turn leads to a sustainable extension of the service life of the lubricants used and thus the entire wheelset bearing.

Facts
The expected service life of a TwinTandem wheelset bearing **is 3 million kilometers** (1.9 million miles).

20 percent
less is what a TwinTandem bearing weighs compared to a classic tapered roller bearing.

55 percent
friction reduction is achieved by the geometry.

1.1 metric tons
(1.21 short tons) less CO_2 emissions per million kilometers (0.6 million miles) and bearing is what Schaeffler expects to achieve due to the use of a TwinTandem bearing compared to an inner bearing with rollers.

Reconditioning

Schaeffler's Reconditioning combined with 100-percent return service ensures sustainable maintenance scheduling.

Innovation
When using the 100-percent return service customers receive a fully functional reconditioned or new bearing in return for any wheelset bearing, irrespective of its condition, that Schaeffler includes in its professional reconditioning process as part of maintenance. Customers can choose between two service models. **In both models, the manufacturing, installation, operation and maintenance data of the DMC-addressed digital twin support fast, plannable and particularly resource-saving maintenance.**

- *Model 1 provides for the bearings sent to Schaeffler to be returned after reconditioning. Defective bearings are replaced by new ones. That eliminates the need for customers to stock spare bearings.*
- *Model 2 provides for customers to immediately receive a shipment of the same number of reconditioned or new bearings from a pool of rolling bearings.*

Facts
93 % energy, 96 % CO_2 and 97 % water are saved by reconditioning a wheelset compared to producing a new one. Thanks to this Schaeffler service, train bearings can achieve a multiple of their nominal service life – without sacrificing operational reliability.

The Data Matrix Code assists in collecting data for the digital twin

Leading trade fair for transportation technology

InnoTrans (September 20–23, 2022) is the leading international trade fair for transportation technology. It is held in Berlin every two years – due to the coronavirus pandemic, most recently in 2018 with more than 3,000 exhibitors from 60 countries. Divided into the five trade fair segments: Railway Technology, Railway Infrastructure, Public Transport, Interiors and Tunnel Construction, InnoTrans occupies all 42 halls of the Berlin trade fair grounds. InnoTrans' unique selling proposition is a track and outdoor area featuring 3,500 running meters (11,500 feet) of tracks on which everything is represented, from a tank car to a high-speed train.

Logistic Rubik's Cube

43,252,003,274,489,856,000 – that's the number of possible turns to solve the famous Rubik's Cube. The options of the global logistics network are similarly diverse. A maze that will surely cause one to get lost without comprehensive data use and analysis. At Schaeffler, the Transportation Data Cube (TDC) developed in-house takes care of that.

By Björn Carstens

The supply chains of the global economy are currently affected by exceptional circumstances. The international survey "Interos Annual Global Supply Chain Report" has revealed that global supply chain disruptions cost large companies 184 million dollars per year on average. "We can no longer cleanly separate digital and physical supply chains, which is driving a need for greater transparency into hidden supply chain risks, relationships and reliances," says Interos CEO Jennifer Bisceglie.

For companies, that means no analysis, no improvement, no routine business without specific data. Schaeffler as a group with global operations has to handle data volumes of astronomical proportions. Every year, the company dispatches hundreds of thousands of shipments on vessels, trains, aircraft and trucks around the globe. 121 countries are part of its transportation network. In 2021, Schaeffler shipped 18,500 standard containers – equating to a whole freighter of the currently largest class. Each of these shipments generates a huge volume of data pertaining to prices, transit times and more – a massive amount that needs to be prepared and analyzed in complex processes.

Since 2021, the Transportation Data Cube (TDC) – a smart, digital program that Schaeffler developed in-house – has been facilitating those tasks. On

the one hand, the TDC enables complex freight cost data management and on the other hand, it makes finding the cargo routes with the lowest costs as easy as booking a tourist flight on the internet. The TDC runs automatic searches for the world's most favorably priced, reliable and fastest transportation routes on water, rail and in the air.

Transportation Data Cube – what are its capabilities and uses?

The automated analyses of the TDC serve as the database for a number of other interfaces (see infographic) and increase the speed of responding to market changes and disruptions in transportation networks. The data gained by the TDC provide the basis for numerous features including a detailed CO_2 calculation (see info box) and a digital image of all the logistics routes used by Schaeffler. Via an intuitive intranet tool, the TDC delivers complex analyses and manages all data preparation processes transparently and centrally.

More data means more green

While costs, transit times and accessibilities used to be the key parameters in logistics until recently, the level of CO_2 emissions is now becoming an increasingly important assessment factor – also at Schaeffler. **Schaeffler's objective was to establish a centralized solution functioning as a CO_2 calculator and enabling the calculation of standard values from transportation logistics.** The Transportation Data Cube (TDC) provides the database for that task so that employees no longer need to calculate distances in a complex process. The CO_2 levels can subsequently be queried using a web tool.

How digital transportation logistics works at Schaeffler

20 different logistics service providers ...

... furnish raw data ...

TRANSPORTATION DATA CUBE

... that the TDC analyzes for subsequent systems.

Transportation and logistics experts in the regions work with the data and services from the TDC.

TMS@Schaeffler

The planned Transport Management System (TMS) is intended to organize shipments in a way that minimizes transportation costs and delivery periods.

iTrack

Schaeffler uses the iTrack system to track ocean freight with pinpoint accuracy.

The different divisions and corporate departments at Schaeffler use various services of the TDC, including a tool for invoice verification and network planning, among other things.

The CO_2 dashboard uses CO_2 accounting to assess the emissions caused by transportation logistics.

everstream ANALYTICS

External service provider Everstream matches global warnings with Schaeffler's logistics network to enable the fast resolution of potential problems.

Masthead

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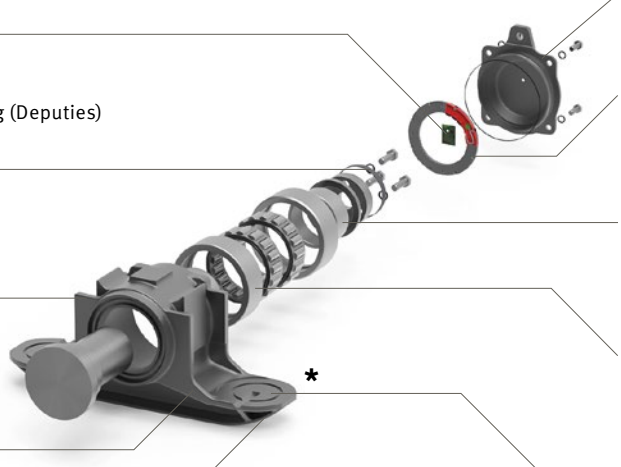

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* Schaeffler has a decade-long track record of systematically extending mechanical components into mechatronic modules in the Rail sector. These modules add considerable value in the field of freight transportation. For instance, with wheelset generators like the one depicted here, reliable, self-sustaining electric power supply can be achieved for many Rail applications, including digital ones.

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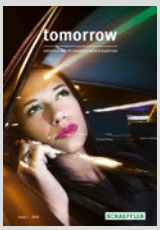
tomorrow All previous issues



01/2015
Mobility for tomorrow

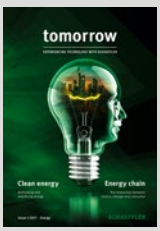
02/2015
Productivity

03/2015
On the move

01/2016
Innovation

02/2016
Sustainability

03/2016
Digitalization



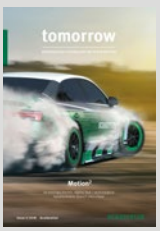
01/2017
Energy

02/2017
Motion

03/2017
Machines

01/2018
Transformation

02/2018
Urbanization



03/2018
Acceleration

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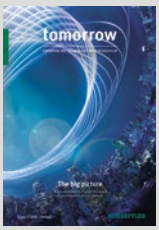
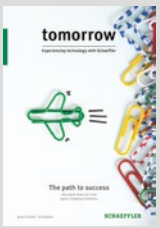
Challenges



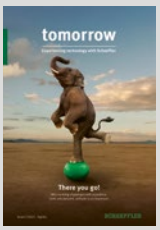
02/2019
Holism

03/2019
Work

01/2020
Opportunities



02/2020
Innovation



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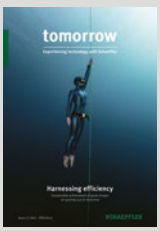
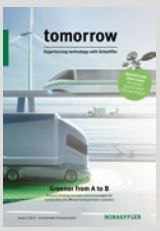
Agility



02/2021
Efficiency

03/2021
Pioneering spirit

01/2022
Reduction



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