

INFORMER

KNORR-BREMSE GLOBAL CARE

An interview with Julia Thiele-Schürhoff

DESIGNED-IN CYBERSECURITY

Security for rail applications

IMPROVING BRAKING PERFORMANCE AND DYNAMICS

The latest CubeControl modular brake control system

EDITION
58

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Rail Vehicle Systems



KNORR-BREMSE

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As an industry, we’re currently seizing the opportunity to show just how innovative we can be in response to two key preoccupations of our time: the battle to resolve the climate crisis, and the future of sustainable mobility. A year ago, the industry launched a courageous project that responds to both issues, Europe’s Rail Joint Undertaking (ERJU), with the aim of developing products, systems and solutions that are both digital and green. Working together as partners, we have joined forces to facilitate a common European climate and transportation policy.

Not all ideas will prevail in the face of tough market competition. But I’m convinced that precisely this kind of courage is required to bring about a new era of rail mobility for transporting both people and goods. Under ERJU, ideas that previously seemed decades away are now unfolding apace, in the form of concrete development projects. Our Spotlight section (starting on page 12) includes a progress report on ERJU’s first year from Knorr-Bremse’s perspective.

This technology initiative’s focus on digitalization and automation highlights the importance of another Spotlight feature: the digital security of systems, products and applications. In an interview (on pages 24 and 25), Dr. Maximilian Eichhorn, our Vice President Digital Products & Services, discusses the difficulties involved in equipping today’s rail vehicles for threat scenarios that will only appear at some unknown point in the future. Sounds impossible? Dr. Eichhorn has good news: “Cybersecurity can be designed in”. We’ve named Knorr-Bremse’s approach “Security by Design” – a concept which we always tailor to the specific requirements of each individual product platform.

But at this time in particular, we shouldn’t just be focusing on ourselves and our own professional challenges – we should also be thinking about people in other parts of the world, who are facing very different problems. We discuss these issues in an interview with Julia Thiele-Schürhoff (starting on page 18), a member of the Supervisory Board of Knorr-Bremse AG and one of the founding members and current Chair of the Knorr-Bremse Global Care association. For almost 20 years, the aid organization has shown exceptional commitment and foresight in giving new hope and life prospects to those who find themselves in need through no fault of their own. How has Global Care been doing this? We show you, taking the examples of two ongoing aid projects in Brazil and Ghana.

As you may already have gathered from the industry media, there has been a change in the Knorr-Bremse Group’s senior management. With effect from October 1, I succeeded Dr. Jürgen Wilder as a member of the Executive Board of Knorr-Bremse AG. In this new role, I will be responsible for the Rail Vehicle Systems division worldwide, meaning I can very much look forward to continuing our excellent collaboration in the future!

I wish you and your families a very relaxing holiday season and a successful start to the New Year.

Warm regards,
Dr. Nicolas Lange

N. Lange



DR. NICOLAS LANGE,
Member of the Executive Board of Knorr-Bremse AG,
with global responsibility for the Rail Vehicle
Systems division

Information for
Knorr-Bremse’s customers
and business partners

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Innovative technologies and systems competence from a single source

Knorr-Bremse Rail Vehicle Systems offers an impressive variety of customized solutions for braking and onboard systems.

Braking Systems

Entrance Systems

Climate Control Systems

Power Electrics

Control Systems / TCMS

Digital Solutions

Lifecycle Management

Electrical Systems

Wiper / Wash Systems

Driver Assistance

Sanitary Systems

Coupling Systems

Signaling Systems



Tighter headway times

As part of the “U-Bahn100” project, Hamburger Hochbahn AG aims to run automated trains every 100 seconds on Hamburg’s U2 and U4 metro lines. Knorr-Bremse played a key role in adapting the main braking system and obtaining the necessary safety certification.

It all looks so simple. As soon as the doors close, the DT5 train automatically starts to move, accelerating up to as much as 80 km/h in a matter of seconds. And as it reaches the next station, the vehicle also brakes automatically, coming to a precise stop without any human intervention. By integrating suitable monitoring devices into the vehicle’s braking architecture, Knorr-Bremse has ensured that the braking system meets the necessary safety standards.

Successful field trials were held in the summer – and did more than just set the scene for automated train operation (ATO). Hamburg’s transportation association, Hamburger Verkehrsverbund (hvv), is pursuing a clearly defined goal, referred to as “Hamburg timing” (Hamburg-Takt). In just a few years’ time, the aim is for metro trains to run every 100 seconds on the section of track shared by the U2 and U4 lines between Horner Rennbahn station and the city center. That would be six trains every ten minutes, meaning: no more lengthy waiting times on subway platforms.

According to Hamburger Hochbahn AG, this goal is only feasible because the guaranteed emergency brak-

ing distance has now made it possible to dispatch fully automated trains at shorter intervals. Otherwise, the regular headway time would still be 2.5 minutes (150 seconds). This automation is not intended to replace drivers, who will still be responsible for passengers boarding and alighting from trains, and is able to intervene if necessary (GoA2).

The key to 100-second intervals: same safety level, despite lower safety margin

To obtain the vital safety certifications, Knorr-Bremse applied the Monte Carlo method, using it to identify the need for a suitably designed monitoring device to be installed in the main braking system. The process involved calculating the statistical distribution of brake-related characteristics, such as the variance and failure probabilities of braking system components, and then producing a detailed summary of their impact on braking performance.

In the same way, the method was also able to quantify – in real-world terms – the extent to which the new monitoring device added by Knorr-Bremse would influence safety levels. For Hamburger Hochbahn AG, the advantage of calculating the braking curves in this way means that it will be possible to reduce the margin – i.e. distance – between two consecutive trains running in fully automated operation without compromising safety: an essential step toward achieving 100-second headway times.

Lightweight and flexible: a rail bus for rural areas

During rush hour, it is usually cost-effective for operators to run public transit services in rural areas. But buses and trains running at non-peak times only use a fraction of their capacity. This perennial conundrum is precisely what the two-axle FlexSbus-LR (Flexible Rail Bus for Rural Areas) is intended to solve. The vehicle is being developed by a consortium headed by RWTH Aachen University and the Laser Processing and Consulting Center (LBBZ) in Geilenkirchen, in Germany’s North Rhine-Westphalia region. Funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK), the team has already started to assemble the vehicle, which features comprehensive braking equipment supplied by Knorr-Bremse. Essentially, this consists of the FlexControl Lite brake control system, an air supply system complete with oil-free compressor, magnetic track brakes (MTBs), and Selectron’s Train Control and Management System (TCMS). Other components include a sanding system, pneumatic suspension and wheel slide protection.

The project aims to build a lightweight, flexible, self-powered, zero-emission rail bus with a compact motor powered by a high-performance electric battery. The planned demonstrator will be a conventional passenger

variant with sufficient capacity for around 80 people (32 seated, 48 standing). The vehicle will be 12 meters long, with a maximum gross weight of 28 tons.

At present, the plan is for the vehicle to run on the Düren-Heimbach line operated by Rurtalbahn GmbH.

But this only represents part of the concept – because the passenger module can easily be detached from the chassis, the rail bus could also be used to transport a freight container.



PROJECT STATUS FlexSbus-LR Aachen



MEETING OF THE CONSORTIUM developing the FlexSbus-LR at Knorr-Bremse’s Munich site

RailServices: new acquisition, new prospects

Because of their positive impact on availability and operability, advanced service models and customized support strategies have become an integral part of modern rail transportation. To further strengthen the company's position here, especially with respect to the electronic components that play such a key role, Knorr-Bremse has now acquired Italian engineering firm Alisea S.r.l., a well-established specialist in the obsolescence management, repair, refurbishment and reverse engineering of electronic

modules and circuit boards in rail vehicles. The firm is based in Taranto in southern Italy and will become part of Knorr-Bremse Rail Systems Italia.

The firm's Managing Director, Simone Mantero, clarifies the context: "Because RailServices replaces aging parts with state-of-the-art electronic components, we essentially give old rail vehicles a new lease of life." The acquisition of Alisea S.r.l., which was founded in 1895, puts RailServices in an even better position to offer modernization and life-cycle services for electronic rail systems that have already shown how much value they can add, especially in view of Europe's "Green Deal".



Automatic obstacle detection in further field trials

ÖBB-Infrastruktur and Knorr-Bremse Austria installed the new RV2000 smart obstacle detection system on a 1063 Series locomotive for a whole week of field trials. The associated computer unit was installed in an adjoining passenger car. The electro-optical sensor system was devised by Israeli supplier Rail Vision, in which Knorr-Bremse holds a strategic stake. It detects potential obstacles such as vehicles or fallen trees at distances of up to two kilometers in all weathers – and even in pitch darkness. Manfred Stättner, Head of Operations Management for Rail Systems at ÖBB-Infrastruktur, sums up the results: "We conducted successful tests of Rail Vision's mainline system in various scenarios, both in daylight and at night. We'll continue to observe the fascinating technology used in this solution, and very probably include it in future research projects."



JOINT TRIALS: ÖBB-Infrastruktur and Knorr-Bremse with RailVision

Two modules, one objective

If you land at Stockholm's Arlanda Airport and decide to travel into town by local public transit, you'll generally find yourself sitting on the Arlanda Express. These silver high-speed trains, with their characteristic yellow livery, take just 20 minutes to whisk you into the nation's capital at speeds of up to 200 km/h. To ensure that the Express service remains totally reliable, the operator – A-Train AB – has signed a long-term service agreement with Knorr-Bremse, who will maintain the trains' brake control systems in perfect working order until at least the end of 2028.

The service contract comprises two modules. First, a refreshment service (for overhauls) that will extend the operating lifetime of the braking systems by reducing failure rates, and so help to deliver smooth, trouble-free train operation. And second, a proactive obsolescence management service through which RailServices will ensure the ongoing availability of electronic components. For the Arlanda Express,



A-TRAIN AB HAS CONTRACTED KNORR-BREMSE to service the brake control systems on the Arlanda Express, which runs between Arlanda Airport and Stockholm. | © A-Train AB

this is vitally important: The trains' braking systems have been in operation for over 20 years and are increasingly affected by the discontinuation of electronic components. A challenge which Knorr-Bremse's service package now overcomes as part of a holistic approach to rail vehicle life-cycle management.

Refurbishing compact brake equipment

So what does the much-vaunted customization of Knorr-Bremse service packages look like? A perfect example: Turkish freight car manufacturer Türasaş has asked Knorr-Bremse to overhaul compact brake equipment for 500 freight cars and adapt it to new technical specifications. The manufacturer already owns the brake equipment from an earlier order. Some of it was installed long ago, the rest put into storage.

Before the equipment is installed in an ongoing project for Turkish state railroad TCDD, it needs, first, to be completely refurbished, and second, to be partially converted and rebuilt for use in a new type of freight car. The original equipment was designed for a project involving a different vehicle configuration – the cars were shorter, for example. Now the converted equipment will be installed in the form of "as-new" components, complete with a full warranty.

For Knorr-Bremse's Turkish operation, which was substantially enlarged in 2019, this represents the biggest

service order to date. The project also reflects the advantages of having an on-site service infrastructure: Türasaş is not the only customer to benefit from fast deliveries and low transportation costs. The elimination of customs processes also speeds up throughput times, making the installation of equipment for the company's own export projects both fast and efficient.



BENEFITS OF KNORR-BREMSE'S ON-SITE SERVICE INFRASTRUCTURE: short distances, low transportation costs, zero customs processes

Going with the flow

The best way to develop shared ideas and visions is by meeting up in person and engaging in direct dialogue. Which is why Knorr-Bremse continued to welcome customers and partners to industry trade fairs around the world in 2023.

“Get into the flow!” was Knorr-Bremse’s slogan for our new trade fair presence, unveiled for the first time at InnoTrans 2022. Flow was very much the theme behind a wealth of solutions consisting of highly innovative products, systems and services capable of satisfying the most pressing needs of rail operators and vehicle manufacturers – solutions for optimizing eco-footprints, dynamizing traffic flow and streamlining train operations and maintenance.

Not to mention Smart Solutions, which – thanks to a broad selection of networkable subsystems, functions, services and applications – Knorr-Bremse can customize to the most specialized individual requirements. Customization was another theme that characterized Knorr-Bremse’s presence at trade fairs on every continent throughout 2023. We present a brief summary of some of the main events:

Eurasia Rail (Istanbul, Turkey, June 18-20): Positioned at the point where Europe merges into Asia, Turkey’s rail market has a special role to play. For Knorr-Bremse, the focus of the event was on presenting the local service operation and cultivating business relationships.



RailLog (Busan, South Korea, June 14-17): RailLog, held in Busan, South Korea, is the country’s only rail industry trade fair focusing as much on the logistics sector as on traditional product presentations. Knorr-Bremse highlighted energy-efficient solutions at the event.

Expo Ferroviaria (Milan, Italy, October 3-5): This is the only B2B trade fair on Italian soil devoted exclusively to the rail industry. Knorr-Bremse showcased the entire extensive portfolio, including solutions for the most recently implemented Italian rail projects such as “La Dolce Vita”.



APTA EXPO (Orlando, USA, October 9-11): In the U.S. federal state of Florida, rail transportation is resurgent, with brand-new lines under construction. Knorr-Bremse presented a full panoply of solutions for tomorrow’s mobility in the Convention Center.



TRAKO (Gdańsk, Poland, September 19-22): This is the fifteenth time that TRAKO, on Poland’s Baltic coast, has acted as Eastern Europe’s most important rail industry trade fair. Knorr-Bremse presented the Digital Automatic Coupler (DAC) on the open-air fairground.



Other major trade fair appearances by Knorr-Bremse: IREE in New Delhi, India (October 12-14); Mass-Trans Innovation (MIT) Japan in the country’s capital, Tokyo (November 8-10); AusRAIL PLUS in Sydney, Australia (November 13-16); and Modern Railways in Beijing, China (November 14-16).

Faster to market: first agile n.XBRAKE development



n.XBRAKE: Taking the next generation of train brake control systems into the future

It all started with an Innovation Cell™ workshop. Now Knorr-Bremse has a new n.XBRAKE unit focused on the further development of the next generation of brake control systems for trains. A key priority is full product digitization, as well as seamless integration with the rail vehicle ecosystem so that software updates and releases can be brought to market much faster than is currently possible, thereby continuously adding value for customers.

By using a new, agile collaboration model, n.XBRAKE is attempting to cut existing development times by half – and this model will be used as a template for hugely accelerating the time to market of complex systems in the future. For the first time, the Rail division is uniting agile working methods and dedicated cross-functional expertise in a major, market-driven systems development function. Mechatronics and electronics engineers, software developers, and cybersecurity and safety experts are all working together in multiple close-knit

teams based in Munich, Germany and Lyss, Switzerland, in regular consultation with various customer representatives. Each team is working on intermediate goals broken down into three-month phases. At the end of the process, the individual parts will be combined to form a fully integrated system.

Digitalized product development is another key enabler. This involves combining an entirely virtual, model-based engineering toolchain (the “digital thread”) with an agile working approach. This makes it possible to create powerful digital system models (“digital twins”) and – virtually – integrate them into the customer’s product models at an early stage via a series of high-speed iteration and feedback (learning) cycles.

Expansion of Technology Center India (TCI) in Pune



TCI provides Knorr-Bremse Group sites worldwide with development, engineering and IT support. | © Knorr-Bremse

Jobs for a prospective 1,300 or so experts, plus new research and development capacity, plus a Green Building standard that will cut production-related carbon emissions by 75 percent compared with base-line year 2018 – these are the key features of the new building complex at the Knorr-Bremse Technology Center India (TCI), which was officially inaugurated in mid-September. As a major cross-divisional resource covering product development, engineering, hardware and software, simulations and virtual tests, TCI will support Knorr-Bremse sites around the world in driving forward the Group’s core innovation and development projects – such as the next generation of braking systems for trains and commercial vehicles.

The complex is located close to the existing development center, in Pune’s modern Hinjewadi business district. Thanks to intensive planning and rapid implementation, the new construction project – launched in May 2023 – was completed in a matter of months.

Fast delivery for a fast metro

Chengdu is one of China’s major business centers, and the new Line 13 will provide the city with an exceptionally high-speed metro link to Tianfu International airport. Ordered from the world’s largest train manufacturer, CRRC (China Railway Rolling Stock Corporation), the line’s 36 new trains will run at up to 140 kilometers per hour. Knorr-Bremse is equipping them with state-of-the-art electropneumatic braking systems – further proof that the company, with its strong local presence in R&D, production and customer service, is capable of meeting China’s most exacting localization requirements.

From its research, development and manufacturing hub in Suzhou near Shanghai, Knorr-Bremse is ensuring that the braking systems intended for Chengdu’s metro trains (among others) reach the customer as fast as possible. All the systems for the new trains – 288 metro cars in total – are scheduled for delivery by mid-2024 at the latest.



ORDER to supply braking systems for 36 metro trains destined for the megacity of Chengdu | © CRRC

Driving rail innovation

Under Europe's Rail Joint Undertaking (ERJU), the European Union (EU) and Europe's rail industry are developing the technologies required to make the shift from road to rail and preparing them for market. A total of 25 partners – many of them also competitors – have joined forces to support a common European climate and mobility policy.

The European Green Deal is the framework for achieving an ambitious objective: to reduce the European Union's net greenhouse-gas (GHG) emissions to zero by 2050. To make this possible, the European Commission plans to invest EUR 95.5 billion – by 2027 alone – in the current Horizon Europe research framework program. The program supports innovation in many different areas – and through ERJU, the successor to Shift2Rail, also provides huge support for the transportation of people and freight by rail.

The EU is making some EUR 600 million available for developing digital and green rail products. The partners involved are contributing roughly the same amount again. This represents a total investment of over EUR 1.2 billion over a seven-year period. The funding is being used to develop a raft of new technologies that will give rail transportation of people and freight an even more important role to play in tomorrow's environmentally compatible mobility ecosphere. Once the various projects have been completed, the partners will use demonstrator applications to prove that the resulting developments are also practicable.

Great start

FP5TRAN54M-R
Transforming
Europe's Rail Freight

FP1 MOTIONAL
European Rail Network and Mobility Management

Rail
FP4
EARTH

KNORR-BREMSE

FP2 R2DATO

FP3
iam4Rail

With nine development projects, Knorr-Bremse is involved in five of ERJU's six Flagship Areas. Here we present a brief progress report on ERJU's first year, from Knorr-Bremse's perspective.



FP1 MOTIONAL
European Rail Network and Mobility Management

Flagship Area 1: Digital enablers and mobility management in a multimodal environment

Federated data spaces: Only by sharing data securely while maintaining data sovereignty will it be possible to build new, innovative, value-added services. Based on this premise, the project partners involved in this work package have spent the year developing a preliminary concept for a common data space ecosystem to be shared by Europe's rail operators. The aim is to create a data space with an open, secure, trustworthy architecture, along the lines of the concept proposed in the EU Data Act, in which the various players involved can share their data and network their business processes. A preliminary test environment that complies with the guidelines of the International Data Space Association (IDSA) is already available.

Preparations are under way to run the first examples of data-sharing applications from other Flagship Areas in the new Rail Federated Data Space in the near future. More than 18 ERJU partners are involved in these trials.





Flagship Area 2: Digital and automated up to autonomous train operations

Knorr-Bremse's activities in FA2 are focused on supporting the future of automated train operation (ATO) under ETCS by providing systems for managing braking and adhesion. At the heart of these activities are the various subfunctions covered by the company's **Reproducible Braking Distance (RBD)** program, which aim to deliver higher transportation capacity, greater operational stability and (as a direct outcome) improved punctuality, even in poor environmental conditions. The various solutions under development – including, for example, a train-wide, situationally adaptive adhesion management system – are making a key contribution to these goals.

Detailed scheduling of field trials slated to take place on Deutsche Bahn's advanced TrainLab (aTL) in 2024 have already started, in collaboration with Deutsche Bahn. Plans are also being drawn up for subsequent trials of the various solutions on a demonstrator train, in a joint venture with ERJU partners Nederlandse Spoorwegen, ProRail and CAF. Knorr-Bremse has been running tests on the company's ATLAS test rig in preparation for the field trials.



Flagship Area 3: Intelligent and integrated asset management for Europe's rail system

One of the main tasks on the way to standardizing rail systems throughout the EU is to develop common concepts and methods for reducing life-cycle costs while simultaneously improving rail vehicle reliability and availability. The **Integrated Asset Management** work package is focused on developing a condition-based monitoring algorithm for optimizing wear and behavior models. The end- result should be a new, systemic approach to the condition-based maintenance of all rail systems. The process of installing the various sensor systems required on the test vehicle is due to start by the end of 2023, by which time the first cloud-to-cloud data transfers between the various partners involved should also have taken place.



Flagship Area 4: A sustainable and green rail system

Knorr-Bremse is also prioritizing **green refrigerants** (by developing new technologies that use halogen-free and low-GWP refrigerants in rail vehicles), as well as **air quality for a healthy environment**, including field trials of technologies capable of effectively suppressing particulates, viruses, bacteria and volatile organic compounds (VOCs). The relevant case studies were launched in the course of the year. The project partners will kick off the final test phase as soon as the results become available next year.

An electropneumatic brake caliper suitable for official homologation is currently under development for the **electromechanical brake system (EM brake)**, which operates without compressed air or hydraulic fluid. The next major step involves several months of operational tests, during which the benefits of the control system, braking dynamics and diagnostics will be analyzed by comparison with existing systems.



Flagship Area 5: Transformation of European rail freight services

Under the **Digital Automated Coupling Type 5** work package, the development of a coupling system that can be remotely operated from the locomotive has already begun. This functionality is considered essential for meeting FA5's main objective: to increase the proportion of European freight transported by rail to 30 percent. The **Digital Interoperable Freight Train** work package is focused on developing a range of automation system products for digital freight trains, covering various functions such as train integrity, automatic brake testing and remote-controlled parking brakes. The key finding after the first year of this project: These work packages are capable of defining future processes for interoperable rail freight transportation in Europe.

An interview with Julia Thiele-Schürhoff

One of the special features of non-profit association Knorr-Bremse Global Care is its close relationship with the Knorr-Bremse Group. Established in 2005, the aid organization has paid out over EUR 30 million in support of more than 500 projects, reaching over one million people in the process.



» We've made social entrepreneurship an integral part of our projects. «

JULIA THIELE-SCHÜRHOFF is a founder member of Global Care, and has chaired the association's Executive Board since 2005. A fully qualified lawyer, she has worked in the Corporate Law, Sales & Marketing and HR departments of Knorr-Bremse AG; as Head of the Sustainability Department, she was responsible for championing corporate citizenship at an early stage. She is a member of the Supervisory Board of Knorr-Bremse AG.

TWO WOMEN TAKE PART IN THE HARVEST
© arche noVa – Initiative für Menschen in Not e.V.

Ms. Thiele-Schürhoff – for almost 20 years, Knorr-Bremse Global Care e.V. has been managing projects that give new hope and life prospects to those who find themselves in need through no fault of their own. How did it start?

On Boxing Day 2004, a catastrophic tsunami in South-east Asia shook the world. My father was determined that the victims should receive fast, efficient help and support. After successfully completing our first projects, we wanted to strengthen, enhance and professionalize this spirit of compassion. The non-profit association we founded, with its close ties to the Knorr-Bremse Group, turned out to be the best way to do this.

Today, the main focus is no longer on providing emergency aid after natural disasters.

Our focus has shifted, in that our work currently prioritizes educational and WASH projects – the acronym stands for “Water, Sanitation, Hygiene”. Education, because it gives individuals opportunities to improve their chances of success; at the same time, it provides marginalized groups with greater access to equal opportunities. And WASH, because clean drinking water is one of the fundamental prerequisites for a life with dignity and meaning. Combined with training in hygiene principles and proper sanitation, it helps protect communities from disease, increases life expectancy and provides people with a foundation for improving their lives, obtaining an education and developing their skills.

The association has put down strong roots in the Group. Where is this most clearly visible?

We work as a decentralized team, with units in Europe, North America and Asia, and nowadays we’re most active in countries where Knorr-Bremse also has a presence. For us one thing is clear: If you know a country’s culture, speak its language or languages, and are familiar with the local needs and issues, your work there will be more effective in the long term, and you’ll be able to reach local people more effectively. The Knorr-Bremse Group supports the association with an annual donation of EUR 3 million. And our aid projects also rely on the commitment and expertise of Knorr-Bremse employees. It’s an effective way to embed genuine, credible social responsibility, social engagement and sustainable thinking in our corporate strategy. And another thing that’s very important to me personally: Thanks to our entrepreneurial background, we’ve made social entrepreneurship an integral part of our projects, with the aim of making them as effective and efficient as possible.



APPRENTICE MOTORCYCLE MECHANIC IN OHIO, USA
© Motogo & Boys Hope Girls Hope USA

You regularly visit aid projects in person.

What is it about them that touches your heart?

Well, that’s obvious: direct, personal contact with the people we’re supporting! Just seeing how many of them must fight for their very existence, for the health, safety and education of their children, moves and inspires me very much. And also, whenever I visit our projects, I realize just how well-off we are and how grateful we should be for that.

One of the major issues for aid organizations is ensuring that funding is used effectively. How does Global Care do this?

Our projects all follow a carefully thought-out impact logic that tackles problems at the root. We don’t want “quick wins”; we want sustainable solutions. We use systematic impact measurement to record our projects’ practical consequences for the recipients, as well as their longer-term effects, such as reduced youth unemployment. What’s more, we regularly evaluate selected projects and apply the results of our evaluations to other projects. Because we’re very serious about ensuring that what we’re doing is effective, scalability plays an important role.



JESSICA AND EUNICE fetch water from a well provided by KBGC in Ghana; | © World Vision Deutschland e.V.

Helping people to help themselves

Two current aid projects run by Knorr-Bremse Global Care e.V. in Ghana and Brazil are representative of the association's worldwide commitment.

In the Western world, simply turning a tap to get a glass of clean drinking water is something we take very much for granted. But in many other parts of the world, the situation is very different: No access to clean water is a serious risk to health, especially in warmer regions. This is why non-profit organization Knorr-Bremse Global Care e.V. and NGO World Vision Deutschland e.V. have been running a WASH project in Ghana's rural Nkwanta South District since mid-2022 – WASH stands for water, sanitation and hygiene. Although the district has no mains water supply, some 13,000 people now have access to clean drinking water. This has been achieved by installing two mechanized well systems. Both wells provide water for the general population, and each of them also provides water for two health facilities and two schools. By running hygiene courses for health workers and teaching local communities about water management and hygiene practices, the project is significantly reducing waterborne diseases such as dysentery and cholera.



EKPE WASHES HER HANDS USING HAND-WASHING FACILITIES PROVIDED BY THE PROJECT | © World Vision Deutschland e.V.



SCHOOLCHILDREN ARE ABLE TO ACCESS CLEAN DRINKING WATER IN GHANA | © World Vision Deutschland e.V.

One of them is the "Women Entrepreneurs Project", a collaborative venture between NGO Instituto Anchieta Grajaú and Knorr-Bremse Global Care Brazil that offers training in entrepreneurship to socio-economically disadvantaged women. Many of them have experienced domestic violence, and as single parents, must provide for what are often large families. The program develops their business skills so they can build their own small businesses as self-employed individuals. The project has trained 79 women to date.



APPRENTICES ON THE CURRENT TECH+ TRAINING PROGRAM IN BRAZIL | © Knorr-Bremse Brazil



ONE OF THE PARTICIPANTS IN THE WOMEN ENTREPRENEURS PROJECT IN BRAZIL | © Instituto Anchieta Grajaú

Promoting social justice through training courses and apprenticeships

According to the World Bank Atlas, half of all young people in Latin America – to take just one example – do not yet have access to high-quality education. Structural social inequality in Brazil is especially evident among women and young people in socially disadvantaged neighborhoods, who do not have the financial resources for vocational training. Two projects in particular are tackling this problem in Brazil, enabling participants to achieve financial independence in the long term and giving them opportunities to become more socially engaged and influential in their own country.

The Tech+ apprenticeship program is a cooperative venture between Knorr-Bremse Global Care and SENAI, Latin America's largest training institution. Here, young people from socially disadvantaged backgrounds are given seven-month paid apprenticeships, during which they learn about electronic control systems, technical drawing, the assembly and disassembly of machinery and ball bearings, and practical machining and repairs. The program takes on 16 apprentices at a time, and is currently running for the seventh time since it was first launched in 2015. Nearly 80 percent of the program participants have gone on to become full-time employees of Knorr-Bremse Brazil.

» Cybersecurity can be designed in «

In the rail sector, the digital security of systems, products and applications is one of today's major challenges – and will continue to be challenging for decades to come. Dr. Maximilian Eichhorn, Vice President Digital Products & Services, talks about cybersecurity in future rail applications and Knorr-Bremse's "Security by Design" approach.



» Cybersecurity can be designed in. And if we look at automatic train operation (ATO) or developments like the digital freight train, it's clear that our 'Security by Design' approach is absolutely vital. «

Dr. Maximilian Eichhorn,
Vice President Digital Products & Services

Dr. Eichhorn – until quite recently, when people were asked to create a password, all they needed was a simple, four-digit PIN... ... and nowadays they're usually asked for passwords of 12 characters or more, that must include capital letters, numerals and special characters. Very soon, we can expect even more complex authentication mechanisms to become standard – such as multifactor or biometric authentication methods that don't use any passwords at all.

What does this trend tell us about future rail applications – and what's Knorr-Bremse's approach to all this?

Rail-vehicle life cycles are often decades-long. Systems, products and applications currently emerging from factories and IT departments must be capable of protecting themselves in threat scenarios that may not appear for years to come. The good news is, cybersecurity can be designed in. And if we look at digital projects in particular, such as automated train operation (ATO) or developments like the digital freight train, it's clear that our "Security by Design" approach is vital. Our version of this approach includes governance, risk management and security controls tailored to the specific requirements of every single product platform. Our organization operates on a matrix structure that binds us tightly together with the Knorr-Bremse Product Cybersecurity Center of Excellence based at Selectron AG in Switzerland.

What does "Security by Design" mean in practice?

We combine certified-secure rail hardware with powerful cybersecurity functions and customized services to build a full-spectrum, end-to-

end cybersecurity architecture. Access is controlled by conventional security products like our Secure Gateway (SGW).

A Public Key Infrastructure (PKI) assigns digital security certificates to devices and software, protecting them from unauthorized changes and modifications. Like an early warning system, our Threat Detection Solution (TDS) identifies anomalous data traffic within the rail network – both to and from the vehicle – and in addition, only allows authorized communications and devices into the network. That's how we proactively pre-

vent hackers from infiltrating rail networks with their own malicious software or devices. We call this multi-layered approach "defense in depth". Even if hackers manage to break through one layer, they'll immediately be confronted by another layer with a different structure.

All of that sounds like a fairly major investment...

... but shutting down an entire rail line after a cyberattack – even for just a few hours – is much costlier than implementing cybersecurity measures in good time. What's more, it's not just train operators or vehicle manufacturers who are making demands of cybersecurity – legislators too are imposing increasingly stringent requirements.

Can cybersecurity solutions be retrofitted to vehicles that have already been operating for a number of years?

A retrofit in the traditional sense is very challenging. Most security measures require what can only be called substantial changes to the vehicle. This means there's always a new, mandatory process to satisfy – not just for homologation, but even for certification. And these processes cover the entire rail vehicle, not just the new components or applications. So the amount of work involved would be enormous and definitely not cost-effective. But if new subsystems are being installed as part of a modernization project, there are sensible retrofitting options which we would recommend.



Close acquaintances

For years, Alstom has relied on Knorr-Bremse's modular CubeControl brake control system in a wide variety of rail projects around the world. Now the French manufacturer is installing the latest generation of the platform on a high-speed train fleet soon to be running in Sweden.



ALSTOM RELIES ON THE LATEST GENERATION OF THE BRAKE CONTROL SYSTEM CubeControl, as well as other Knorr-Bremse technologies. | © Knorr-Bremse

A brief recap: CubeControl had not long been on the market when Alstom had to make an important decision. Shanghai Metro had just ordered 12 Metropolis eight-unit LRVs from the French manufacturer for the West-Extension (as it was then) known of Shanghai's Line 2, and the metro trains required a state-of-the-art control system capable of optimizing brake performance in any situation, based on multiple variables such as – to pick one example – passenger weight distribution. Alstom decided in favor of CubeControl, at that time still marketed under the product name EP 2002. Knorr-Bremse was ready to deliver immediately, so Alstom was able to install the first “Cubes” – each one a single mechatronic unit integrating all mechanical and electronic components – in the Metropolis rail vehicles back in 2007.

The manufacturer's UK arm (then still known as Bombardier) had already installed CubeControl in vehicles destined for London's sub-surface lines and underground Victoria Line (2005), and aboard the Aventra

platform for the Crossrail project. To date, more than 130,000 CubeControl units have been delivered to over 350 projects worldwide. One of the main reasons for CubeControl's popularity? Knorr-Bremse's regular, ongoing upgrades of the brake control system.

Latest CubeControl upgrade delivers even better braking performance and dynamics

New Ethernet specifications have opened up connectivity to other systems and enabled condition-based maintenance (CBM). The system now includes functions such as Brake Disc Temperature Monitoring, which simulates the temperatures of the individual brake discs in real time and helps to avoid unnecessary speed restrictions. Optional integrations such as WheelGrip Adapt – the latest wheel slide protection (WSP) algorithm – can further reduce braking distances, even in extremely low-adhesion conditions. And increasingly, Deceleration Control (DCC) is decoupling deceleration from the highly variable conditions and tolerances typical of vehicles in operation. In future, the benefits of CubeControl will extend to other vehicle

platforms such as regional and urban express trains, as well as high-speed intercity trains.

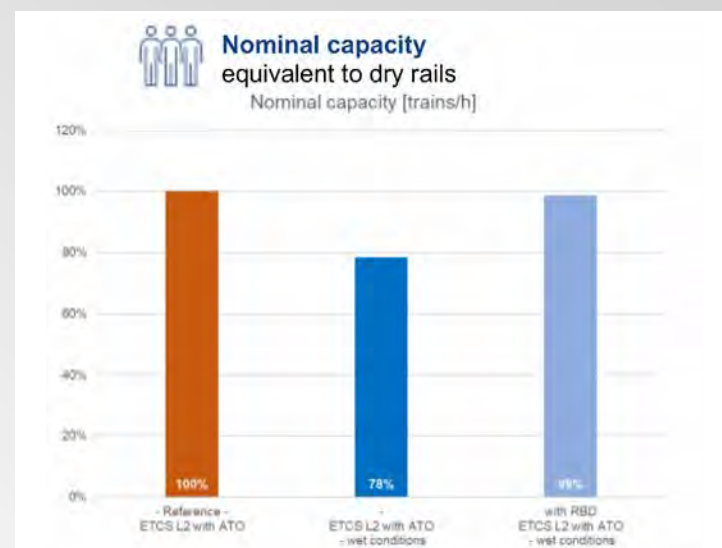
As the first manufacturer to order the latest generation of the system, Alstom is once again leading the way in the adoption of CubeControl – which Knorr-Bremse will now install on an Alstom-built fleet of Swedish high-speed trains over the next few years.

The new CubeControl upgrade integrates the various braking system components even more intelligently. Among other things, it enables more sophisticated synergy between electropneumatics, mechatronics, smart software and data. This further enhances braking performance and dynamics, making it possible to proactively avoid delays. And by combining several of the innovations described above, CubeControl's latest upgrade will also enable Reproducible Braking Distance (RBD), a trailblazing feature slated to appear when the upgrade is launched early next year. Deliveries to Alstom will start in 2024 and are scheduled to continue into 2028.



COMPREHENSIVE TESTS ARE ALL PART OF DEVELOPING new technologies for train braking systems. CubeControl's many functions help to maximize safety, as well as improving rail service availability, efficiency and punctuality. | © Knorr-Bremse

RBD is on track!



BY USING RBD FUNCTIONS, it is possible to achieve almost the same capacity on wet rails as in dry rail conditions (operating simulation conducted by Nextrail ViaCon).



KNORR-BREMSE HAS FITTED A DECELERATION CONTROL SYSTEM to a NEWAG passenger train for field trials on the Polregio network (Poland).



DB ADVANCED TRAINLAB (aTL) during RBD test runs on the RegioInfra test track between Krakow am See and Karow (Germany)

Step by step, Knorr-Bremse is validating the multiple functions required for Reproducible Braking Distance (RBD). Now new findings are available, ranging from a sensitivity analysis of rail fleets equipped with various levels of RBD, a one-year field trial, driver surveys, and test runs on the “aTL”.

According to the IFB Institute, RBD is theoretically capable of reducing metro train headway times by between nine and 19 percent. A value-for-money study by rail consulting firms NEXTRAIL and VIA-Con has shown that RBD reduces uncompensated delays on wet suburban track by 57 percent – a result suggesting that a level of punctuality similar to dry track could eventually be feasible (ZEV Rail, July 6, 2023). Now new findings have emerged from the RBD research program.

First, a sensitivity analysis – also conducted by NEXTRAIL and VIA-Con – quantified the RBD effect on fleets equipped with different levels of RBD functionality. The operating simulations, based on Hamburg’s suburban rail network for illustrative purposes, suggested that a train equipped with just 25 percent of full RBD functionality reduces secondary delays by four percent. With an RBD equipment level of 50 percent, the figure rises to ten percent, and when equipped with the full range of RBD functions, secondary delays are reduced by as much as 20 percent. It is also worth noting the impact on the total delay (i.e. the sum total of uncompensated delays). Taking existing margins in train timetables into account, the operating quality of trains equipped with around 50 percent of RBD functions is already comparable with that of fully equipped trains.

First DCC field trial: 100 percent availability and positive feedback from drivers

The first RBD function, Deceleration Control (DCC), recently completed a 12-month field trial. The system’s availability in a NEWAG EN63A multiple unit operating on a number of Polish passenger lines was uniformly excellent, remaining at 100 percent over the entire period. This applied to both the controlled service brake and the controlled emergency brake (CEB).

Subsequently, a standardized questionnaire completed by 36 multiple-unit drivers provided insights from a driver’s-cab perspective. Of the 17 drivers who, according to their own statements, drove the test vehicle occasionally or often, 53 percent rated its braking behavior as “better”, another 41 percent as “identical”. Stopping precision at the platform was rated as “better” by 47 percent of the drivers, and as “identical” by the remaining 53 percent.

Extended braking distances in xnH conditions reduced by up to 25 percent

As part of the Shift2Rail technology initiative (PIVOT2 project) – the program that preceded Europe’s Rail Joint Undertaking – Knorr-Bremse and DB Systemtechnik GmbH conducted joint test runs using the latter’s “advanced TrainLab” (aTL). The results confirmed the benefits of the new “WheelGrip adapt” wheel slide protection algorithm, which will eventually form part of the RBD system: In trains with identical performance ratings, the new algorithm reduced the prolongation of braking distances in low-adhesion (nH) conditions and extremely-low-adhesion conditions (xnH) by between ten (nH) and 25 percent (xnH) compared with existing systems. Furthermore, when a train-wide adhesion management system using distributed sanding systems was activated, braking distances were further reduced by tangible margins.

CubeControl is equipped with initial RBD functions

RBD development is also progressing on the hardware side: Knorr-Bremse has already installed the first RBD functions in the RBD-capable CubeControl brake control system and subjected it to extensive testing. Specifically, a local deceleration measurement function was embedded in the CubeControl, capable of automatic self-calibration in operation, and of calculating train-wide deceleration values based on information supplied by networked local control units.

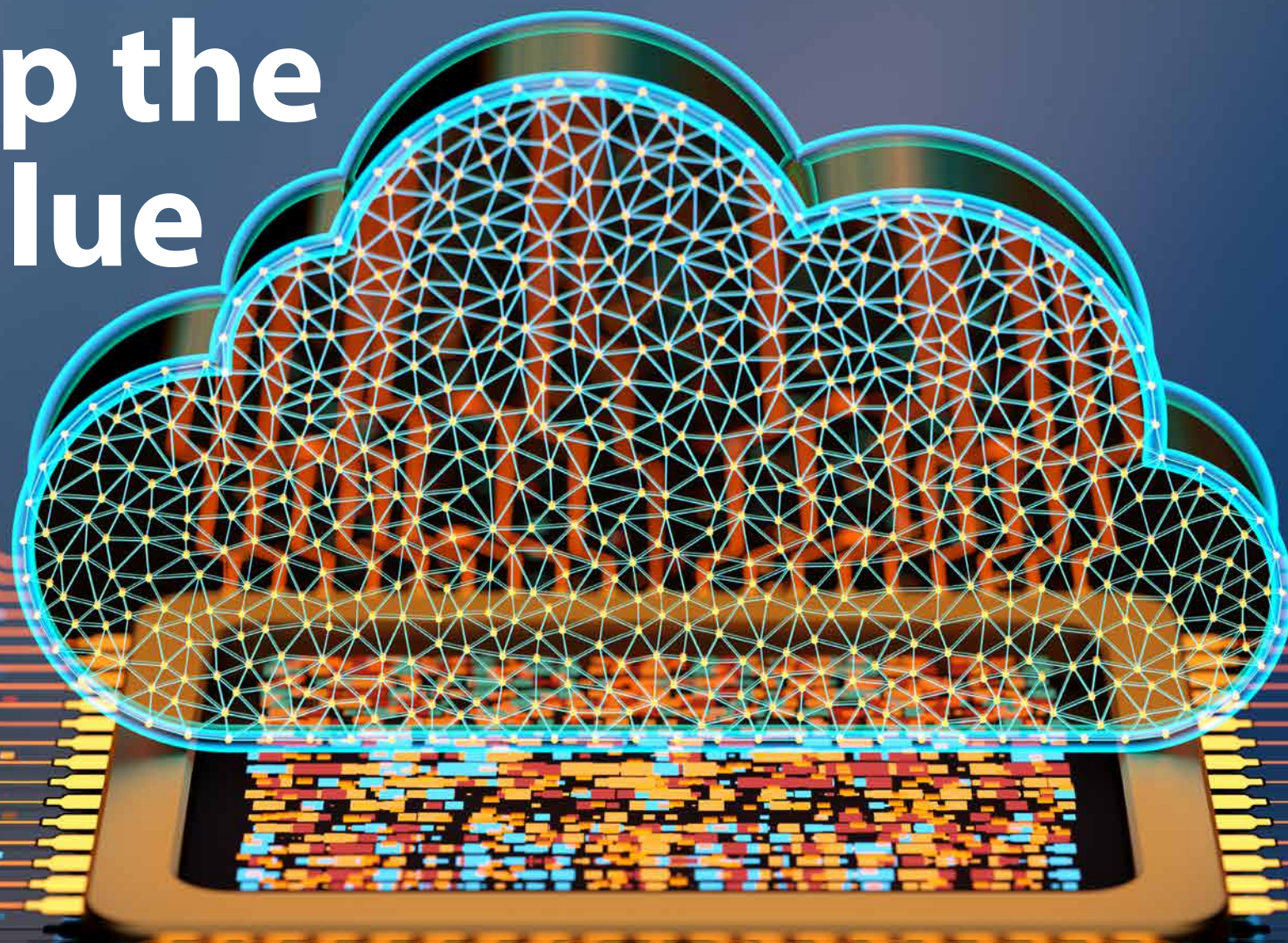
How RBD works

Under the Reproducible Braking Distance program, Knorr-Bremse is combining a new type of deceleration control system (DCC) with an optimized wheel slide protection algorithm (WheelGrip adapt) and an enhanced, train-wide adhesion management system with situational adaptivity (ADM). Used together, these three functions can significantly reduce the spread (variance) of braking distances, while at the same time improving deceleration values. If the characteristic braking curves for ATO and ETCS are adjusted to take this into account, it should be possible to reduce train headway times without compromising safety and thus increase the frequency of train services – a major step toward optimizing the utilization of existing rail infrastructure.



TEST BRAKE CONTROL SYSTEM INSTALLED ON THE aTL, with the new wheel slide protection software (WheelGrip adapt) and adhesion management

Joining up the digital value chain



In the summer of 2022, Knorr-Bremse took a stake in Internet of Things (IoT) specialist Nexxiot. Since then, the next-generation “Internet of Trains” has been making swift progress!

The goal is nothing less than a new generation of data-driven services. Because once Knorr-Bremse’s system technologies have been connected to the new, jointly developed Knorr-Bremse digital ecosystem, it will be possible to generate “insights” above and beyond current analytical capabilities. Insights that will help rail operators to improve the availability of their trains, optimize life-cycle costs and eco-footprints, and enhance their operational efficiency.

“To do this, we’re essentially building a complete digital value chain,” explains Dr. Sebastian Kassner, Product

Manager Digital Products & Services. This involves retrieving key data from each asset (which might be a braking, entrance, HVAC or sanitary system), preparing it for data transfer, and then transferring it to the cloud.

Subsystem data uploaded to cloud via adapters and gateways

But to join up the entire digital value chain, two pieces of hardware are essential. And thanks to the partnership, both of them are at an advanced stage of development. “The first is an adapter, the Knorr-Bremse Node, which takes the form of a circuit board that connects directly to each train component’s controller,” explains Kassner. This interface enables the controller to send data from the connected

sensors to the second new piece of hardware via Bluetooth. This device “collects” the data and uses the mobile network to upload it to the cloud. “In network techspeak, the device is acting as a gateway,” adds Kassner.

A prototype of the Knorr-Bremse Node already exists, and the gateway – the Knorr-Bremse Hub – should be available by the beginning of next year. In collaboration with logistics and railcar-leasing company VTG, a trial project is currently running in England, testing a user interface (UI) connected to Nexxiot’s back-office system.

Next year, the developers intend to equip 50 freight cars with the hardware required to provide an end-to-end digital service. In collaboration with Knorr-Bremse’s U.S. rail freight subsidiary New York Air Brake (NYAB) and other partners in the U.S. rail freight sector, freight-train brake control systems will be fitted with the Knorr-Bremse Node so they can communicate with previously installed Nexxiot technology.

Where braking begins



OPERATING A MASTER CONTROLLER on a test bench



MULTIPLE CONTROL LEVERS ARRANGED on a driver's console

Motion controllers “translate” a train driver’s desire to brake or accelerate into braking or traction commands for the vehicle. Thanks to a modular design that uses tried-and-tested technologies, Knorr-Bremse can customize the human-machine interface to meet even very specific customer requirements.

“What is essential is invisible to the eye,” says the Little Prince in the eponymous story by Antoine de Saint-Exupéry – and you could easily say the same thing about the human-machine interfaces installed in hundreds of thousands of rail vehicle cabs around the world. “The lever you see is just the proverbial tip of the iceberg,” explains Michael Holz, Development Team Leader in Munich. “There’s much more going on under the surface.”

Below the driver’s console, a large number of mechanical, electrical and pneumatic components transfer signals according to the lever’s position. They include a variety of electromechanical switches and an angle sensor. In an emergency, an emergency brake valve – usually built into the system – can directly vent the main air pipe. If required, accessories such as locks, interlocks, additional buttons or lighting can be installed; in some cases, this might include a “dead man” function.

Often, the specific implementation must also comply with country- or vehicle-specific rules and regulations; the same applies to different types of handles such as ball knobs, conical handles or T-bar handles. Certain levers – in metro trains, for example – are in constant use, so they must move smoothly and easily. In other applications, such as shunting locomotives, the levers should be designed so as to be extremely precise and sensitive to the slightest movement.

A single source for the entire chain of braking system functions

“The basis for all this is Knorr-Bremse’s MotionLead Kit, as it’s been for over 15 years now. The kit is essentially a comprehensive, modular tool-kit of tried-and-tested technologies and components, which customers can put together in highly flexible combinations to configure their own human-machine interface in the driver’s cab,” explains Holz, a qualified

mechanical engineer. He goes on to explain that every project is different, every installation has its own challenges. The systems are manufactured at Knorr-Bremse’s production facility in Mödling, Austria.

The big advantage of using these standardized components? “We’re talking about higher quantities, meaning we can offer cost benefits. What’s more, the various functions are already prequalified, so we don’t need to obtain project-specific approvals.” This also applies to the motion controller subsystem, so the time to market is very short. Mödling can usually present a 90-percent solution after just two weeks. “Even at this early stage, we almost always provide the customer with a preliminary installation model so they can run initial installation tests,” adds Holz.

Another major advantage of working with Knorr-Bremse: If they wish, customers can buy MotionLead controllers and the pneumatic brake control system as a package. “This means we use a single lever to send electrical signals to the brake control system at the same time as sending pneumatic signals directly to the main air pipe controller.” In short, Knorr-Bremse can supply the entire chain of functions from lever to control system to the brake equipment on the wheel – that is, every function in the braking system – from a single source, all optimized to work together perfectly.

ASSEMBLY TEAM IN MÖDLING, Austria



Channeling the (data-driven) future

The new generation of KEf valves has attractive features that support modern freight car operations. It also lays the foundations for digitizing the freight train – the next industry milestone. In operation, the valves make an excellent impression thanks to very high levels of availability.

In the decades after the KE valve was first launched in 1953, around 500 variants appeared on the market. In each case, this involved designing and manufacturing a more or less unique relay valve to match each individual specification, complete with its own part number. One of the reasons for developing the new KEf generation from scratch was to clear up this proliferation of variants. Although the new range has been reduced to just 50 different configurations, the KEf family boasts an even broader range of adjustable settings for project-specific applications.

The jewel in the crown is the modular KEf/KRf system, with its focus on the 90 percent of characteristic curves with a gradient between 0.6 and 1.5 typically achievable in the field. Despite a few outliers, the developers made this decision for very good reasons: "It meant we could reduce the number of T springs to ten without having to ask operators to accept restrictions on standard freight car characteristic maps," explains Thomas Petter, who heads the KEf development team. "The characteristic curves are easy to adjust mechanically at the production stage."

In particular, whereas the only way to install the "old" KE valve in space-critical low-floor applications was

to build a unique, dedicated solution for each application, the new KEf valve obviates this problem – even in its standard configuration. "We've developed the platform in such a way that you can mount the distributor and relay valves separately on the carrier," adds Petter. When it comes to maintenance and spare parts management, the benefits of this design show up in another, not insignificant advantage: It is now easy to independently remove and replace the small, lightweight distributor and relay valves. The valve carrier itself has no serviceable parts, so it simply stays on the vehicle while the valves are being serviced.

Retrofittable actuators open the door to new functions in the future

But the KEf valve generation was also developed as a key element in the urgently needed digitization of the freight train. The valve's new data channel, which includes an interface for collecting pneumatic operating data, will act as the cornerstone of applications ranging from condition-based monitoring – including continuous brake status monitoring by train drivers – through to automated brake testing for speeding up train preparation.

Designed as a platform that will last for decades, the valve also supports all the automation enhancements currently under discussion by the Digital Freight Train developers currently involved in "Flagship Area 5" of the Europe's Rail Joint Undertaking technology program.

» The new modular approach replaces around 500 variants. «

Thomas Petter,
Manager Development Pneumatics/Electropneumatics

The ability to integrate actuators opens the door to a whole raft of new functions in the future, such as a networked electropneumatic brake.

High levels of availability, e.g. on state-of-the-art T3000 pocket wagons

Four years or so after they were first launched, the KEf and KRf valves are already very well established. Over 100,000 units are now in daily operation; the new valves are steadily replacing the previous generation. More and more vehicle manufacturers and operators are opting to equip their new vehicles with systems based on the new KEf platform rather than a conventional KE variant.

By the end of last year, for example, more than 3,000 KEf and KRf valves had been fitted to some 400 state-of-the-art T3000 pocket wagons built by Swiss rail car designer Ferriere Cattaneo. The company has been very impressed by the valves' high availability levels. And it was the KEf's compact design that made it possible to install the valves in the manufacturer's very exacting, ultra-low T3000 "pocket wagon" configuration.



CARRIER WITH KEf DISTRIBUTOR VALVE
plus KRf relay valve and additional sensor box

 **KNORR-BREMSE**

 **NEW YORK AIR BRAKE**

 **IFE**

 **MERAK**

 **MICROELETTRICA**

 **SELECTRON**

 **KIEPE ELECTRIC**

 **EVAC**

 **ZELSKO**

 **RAILSERVICES**
