



# CONNECTED

Annual Report 2016

**KNORR-BREMSE**



# THE YEAR 2016 FOR KNORR-BREMSE



**JANUARY.** After just over two years in the making, construction of the new Development Center in Munich is completed. Knorr-Bremse invested some EUR 90 million in this new building, which offers engineers and technicians from both divisions a top-class working environment and hosts 100 state-of-the-art test rigs and facilities. This is where pioneering new system solutions for the rail and commercial vehicles of the future are developed and tested.



**FEBRUARY.** Knorr-Bremse acquires the rail transportation activities of brake pad specialist TMD Friction. Through this move, Knorr-Bremse not only reinforces its systems competence but also adds to its friction materials expertise.



**MARCH.** Major order from Brazil: Knorr-Bremse is to supply braking systems for 8,500 freight cars run by South America's largest railroad logistics operator RUMO/ALL. In addition, Knorr-Bremse is responsible for maintaining the brakes over the next 15 years.



**APRIL.** Heinz Hermann Thiele, Honorary Chairman of the Supervisory Board and proprietor of Knorr-Bremse AG, celebrates his 75<sup>th</sup> birthday on April 2 in the company of 300 VIP guests from more than 20 countries.



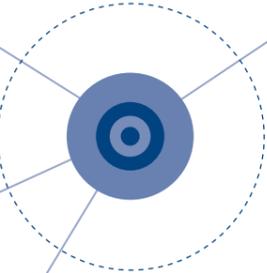
**DECEMBER.** The Company's bid for Haldex harvests an acceptance rate of 86.1% of the shares. Knorr-Bremse acquires the Electrical Systems business unit of Vossloh AG (Vossloh-Kiepe), thereby adding advanced drive technologies to its portfolio for metros, light rail vehicles, and regional rail networks, as well as for electrically powered buses in the commercial vehicle sector.



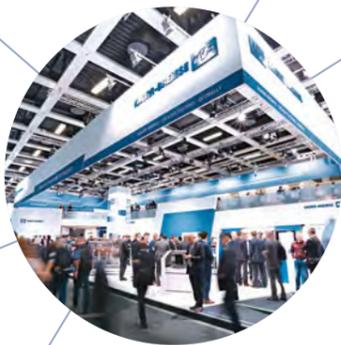
**NOVEMBER.** Knorr-Bremse's French subsidiary opens a new building in Tinquex near Reims. The new facility represents the state of the art in terms of sustainability, with features including charging stations for electric cars, energy-efficient LED lighting, and special thermal insulation.



**MAY.** To mark its tenth anniversary, Knorr-Bremse Global Care invites entries for an Innovation Award. The award goes to Engineering students from Deggendorf Technical University for the prototype press they designed for brick production in developing and emerging countries.

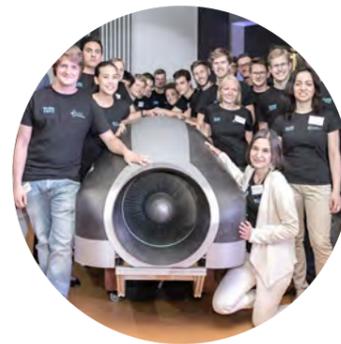


**OCTOBER.** Knorr-Bremse acquires the outstanding shares in the ICER Rail joint venture. This further strengthens the Company's position in friction materials, an important and technically demanding component of braking systems.



**SEPTEMBER.** At the world's premier industry trade fairs Knorr-Bremse showcases innovative system solutions and customer-oriented services. At the Automechanika, the new aftermarket brand Knorr-Bremse TruckServices makes its worldwide debut. Visitors to the IAA Commercial Vehicle show witness the first fully-automated semitrailer rig from Knorr-Bremse in action. At the InnoTrans fair, under the heading of "Connected Systems" Knorr-Bremse demonstrates how smart connected subsystems not only further increase the safety and reliability of rail vehicles but can also help manufacturers and operators cut life cycle costs. Knorr-Bremse submits a bid for Haldex.

**AUGUST.** The WARR Hyperloop group of students at the Technical University of Munich tests a Hyperloop prototype in the context of a worldwide student competition. The transportation pods travel through a vacuum tube at speeds of up to 1,200 km/h. The team is supported by Knorr-Bremse and in the final round they win the prize for the fastest pod.



**JULY.** Standard & Poor's raises Knorr-Bremse's creditworthiness rating from "A-/Outlook positive" to "A-/Outlook stable" in recognition of the continuity of the Group's performance, its stronger competitive position, and its substantial growth.



**JUNE.** Knorr-Bremse acquires tedrive Steering Systems and accesses the commercial vehicle steering business. Knorr-Bremse also takes over the UK-based GT Group, a leading manufacturer of exhaust gas recirculation valves and exhaust brakes. In addition, the Company initiates the acquisition of Bosch Japan's TRS transmission components business.



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## Heinz Hermann Thiele Honorary Chairman of the Supervisory Board

**To honor Heinz Hermann Thiele for his tireless efforts on the Company's behalf over many decades, the Supervisory Board of Knorr-Bremse AG invited the entrepreneur and proprietor of Knorr-Bremse to become its Honorary Chairman.**

The name Heinz Hermann Thiele will always be associated with the rise of Knorr-Bremse to become the world's leading manufacturer of braking systems for rail and commercial vehicles. Thiele acquired the Company in 1985 in a precarious position and through his hard work, determination, and entrepreneurial vision developed it into a jewel in the crown of German industry. The Supervisory Board thanked Mr. Thiele for his life's work, not least on behalf of all the Company's 25,000 employees, and invited him to become its Honorary Chairman.

In the context of the Annual Shareholders' Meeting on March 11, 2016, at the instigation of the Supervisory Board Heinz Hermann Thiele, until then Chairman of the Supervisory Board, was appointed Honorary Chairman of the Supervisory Board after deciding not to stand for a further term of office as its Chairman. The term of office of the members of the Supervisory Board ended with the

resolution of the Annual Shareholder's Meeting on March 11, 2016 releasing the members of the Supervisory Board from liability for the 2015 financial year.

Since Heinz Hermann Thiele took charge of Knorr-Bremse in 1985, the Company has grown into a profitable and globally successful Group which, through its pioneering technologies, contributes to greater safety by road and rail. In 1985, Knorr-Bremse posted sales of approximately EUR 180 million. Since then, sales revenues at the Company have multiplied more than thirty times over. On behalf of Knorr-Bremse AG, the Executive Board, and the workforce of the Knorr-Bremse Group, the Supervisory Board thanks Mr. Thiele for his life's work and his successful and tireless efforts on the Company's behalf as a member of the Executive Board since 1979 and as Chairman of the Supervisory Board since 2007.

## The Executive Board of Knorr-Bremse AG



## Mission Statement

# Connected.

**Generating positive impetus in a difficult market environment is something Knorr-Bremse has been doing for 112 years. In fiscal 2016, this once again proved a recipe for success.**

Against a backdrop of volatile markets across the globe, ever fiercer competition, and a simultaneous rise in customer expectations, Knorr-Bremse reaffirmed its status as the leading manufacturer of braking systems and other sub-systems for rail and commercial vehicles. As innovation and technology leader we were able to bring new solutions to market in both divisions, consolidate our market shares, and even build on them in some market segments. This enabled us to offset the weak market performance – on an unforeseeable scale – particularly in China and North America. But we did not stop there: With a total of seven acquisitions initiated and in part completed, we have strengthened our strategic position substantially. The resultant additional volume of sales will reach approximately EUR 1 billion when closure is obtained on all the acquisitions. As a result, we can look back on a successful and active year in 2016.

The basis for this success is a strategy of systematically expanding our systems competence. Knorr-Bremse connects up products to form integrated system solutions that deliver clear efficiency benefits for our customers in

terms of procurement, operation, and maintenance. We bring together the competence of more than 25,000 people at some 100 sites around the world to develop tailor-made solutions that meet the widest variety of customer requirements. We leverage the benefits of digitalized industrial value creation to generate more and more efficient production processes. And we bring together many different facets of ecological and social engagement to shape a meaningful roadmap for our corporate responsibility.

To meet the increasingly diverse requirements of an ever more digitalized and mobile world we also employ new business models. By doing so we are laying the foundations for long-term success and safeguarding the future of our Company. We sum up this mindset, this approach, in one word: "Connected" – which is why we also made this the golden thread running through this annual report.

The Executive Board of Knorr-Bremse AG hopes you find it informative.

**Dr. Lorenz Zwingmann**

Member of the Executive Board since 2008, responsible for Finance, Controlling, and IT.

**Klaus Deller**

Member of the Executive Board since 2009, Chairman of the Executive Board since January 1, 2015, and since July 1, 2016 also responsible for the Rail Vehicle Systems division.

**Dr. Peter Laier**

Member of the Executive Board since January 1, 2016, responsible for the Commercial Vehicle Systems division.

# Vossloh Kiepe

Vossloh Kiepe has over a century of experience in electrical systems for rail vehicles. Through this acquisition, completed in January 2017, Knorr-Bremse is adding state-of-the-art drive technology to its portfolio, in particular for metro, light rail vehicle, and regional rail networks, as well as for electric buses in the commercial vehicle sector.



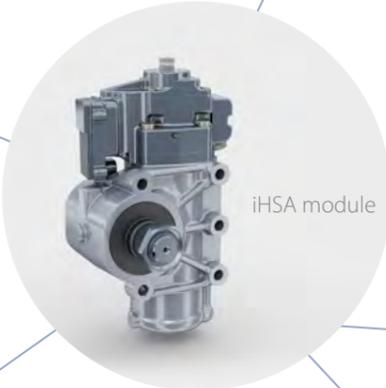
Traction converter for light rail vehicles



Gearbox actuator for dual clutch transmission

# TRS

TRS is a Japanese specialist for systems that assist the driver with gear shift and clutch operations, for instance in automated manual transmissions (AMT) and dual clutch transmissions for commercial vehicles. For Knorr-Bremse this acquisition is an important step in further expanding its presence in the high-growth Asian market for these products.



iHSA module

# tedrive Steering Systems

tedrive Steering Systems develops hydraulic steering systems and electronic control modules for commercial vehicles. With this acquisition Knorr-Bremse is accessing the steering business. One strategic goal here is the meaningful connection of steering and braking systems in order to provide customers with integrated overall solutions, not least for longitudinal and lateral guidance for automated driving.

# TMD Friction

Providing braking systems complete with matching brake pads is a strategy that offers multiple advantages for Knorr-Bremse customers in the rail sector. So the acquisition of the rail activities of friction material manufacturer TMD Friction made sound strategic sense. Now Knorr-Bremse is also in a position to offer "whispering" brake pads for freight cars.



Cosid pad for rail vehicles



Brake pad pioneer

# Icer Rail

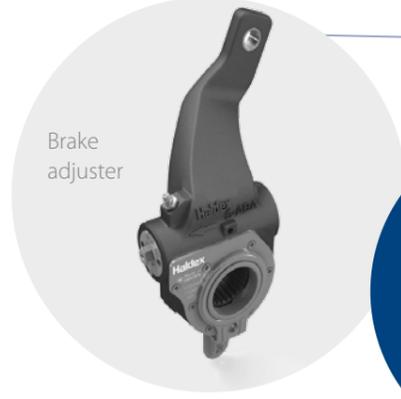
Since 2010, Knorr-Bremse has held a stake in the Icer Rail joint venture in Pamplona, Spain. Here, organic brake pads and brake shoes, as well as sintered pads for the high-speed rail market have all been successfully developed. In 2016, Knorr-Bremse increased its holding to 100%.

## Connected Growth. Acquisitions initiated in the year under review.

In the year under review, Knorr-Bremse initiated seven acquisitions and completed the majority of them. All of these moves were undertaken in pursuit of the strategic goal to offer customers connected system solutions from a single source that will enable them to master present and future challenges successfully. Consequently, these acquisitions help safeguard the future of Knorr-Bremse.



Exhaust brake



Brake adjuster

# Haldex

Together with the listed Swedish supplier Haldex, Knorr-Bremse is expanding the product portfolio in the segment of suspension systems for trailers, and actively drive forward the development of system solutions for automated driving for truck-trailer combinations. Knorr-Bremse duly submitted an offer for Haldex at the end of September 2016.

automotive aiming to expand of braking and air

# GT Group

With some 250 employees, the GT Group of Peterlee, UK is one of two European market leaders in exhaust gas recirculation valves and exhaust brakes. This acquisition opens up new worldwide growth opportunities for Knorr-Bremse in the truck engine segment.

## The Supervisory Board of Knorr-Bremse AG



Werner Ratzisberger*	Erich Starkl*	Wolfgang Tölsner	Günter Wiese*	Michael Jell*	Georg Weiberg	Julia Thiele-Schürhoff	Hans-Georg Härter	Franz-Josef Birkeneder*	Dr. Wolfram Mörsdorf	Sebastian Roloff*
Project engineer Knorr-Bremse Systeme für Nutzfahrzeuge GmbH, Munich	Second Authorized Representative of the IG Metall Trade Union, Passau Office, Passau	Management consultant, Uetersen	Chairman of the Works Council of Knorr-Bremse Systeme für Schienen- fahrzeuge GmbH, Berlin	Deputy Chairman of the Works Council of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, Knorr-Bremse AG, KB Media GmbH, Knorr-Bremse IT Services GmbH, Munich	Retired Head of Development, Daimler Trucks, Stuttgart	Member of the Supervisory Board since March 11, 2016, Chair of the Executive Board of Knorr-Bremse Global Care e.V., Munich	Chairman of the Supervisory Board since July 5, 2016, former Chairman of the Executive Board of ZF Friedrichshafen AG, Salzweg	1st Deputy Chairman of the Supervisory Board since March 11, 2016, Knorr-Bremse Plant Manager, Aldersbach	Retired Member of the Executive Board of Thyssen-Krupp AG, Essen	Attorney-at-law with IG Metall Trade Union, Munich Office, Munich

\* Employee representative.

# Report of the Supervisory Board

In the course of fiscal 2016, the Supervisory Board concerned itself in detail with the state and development of Knorr-Bremse AG and all Group companies.



Along with important individual transactions and human resources decisions, the Supervisory Board also considered fundamental aspects of strategic direction and corporate planning. In addition, the Supervisory Board received regular reports from the Executive Board, either in the course of its meetings or in written or oral form, regarding the commercial and financial development of the Company, as well as its risk situation and risk management. The Supervisory Board examined important individual transactions as well as deciding on items of business that required its approval either by law or in line with Company statutes. The information and analyses upon which the decisions of the Supervisory Board were based were discussed and assessed in depth together with the Executive Board. In addition, two meetings of the Financial Statements Committee were held in mid-year. At its meetings, the Financial Statements Committee dealt in particular with the supervision of the accounting process, the efficacy of the internal controlling system, the risk management system, and the internal audit system, as well as the work of the auditors.

In fiscal 2016, the Knorr-Bremse Group posted worldwide sales of EUR 5.49 billion (including EUR 39.7 million from the initial application of the Accounting Directive Implementation Act). This represents a 5.8% downturn over the previous year's record level of sales. The decline was due to the difficult market environment. The Rail Vehicle Systems division returned sales of EUR 2.99 billion in 2016 (2015: EUR 3.34 billion). The Commercial Vehicle Systems division, by contrast, reported an increase in sales from EUR 2.49 billion in the previous year to EUR 2.52 billion in 2016.

In 2016, Knorr-Bremse triggered seven acquisitions. In the commercial vehicle sector, the acquisition of tedrive enabled Knorr-Bremse to access the steering business. The acquisition of UK-based GT Group and of Bosch Japan's TRS transmission components business for on-highway vehicles opened up additional growth opportunities. In September 2016, Knorr-Bremse submitted an offer for the listed automotive supplier Haldex of Sweden. The acquisition is subject to approval by the anti-trust authorities in the USA and in the EU.

In the rail vehicle sector, Knorr-Bremse expanded its product range through the acquisition of friction material manufacturer TMD Friction and of all the outstanding shares in the ICER Rail joint venture. In December 2016, Knorr-Bremse signed the contracts governing acquisition of the Electrical Systems business unit (Vossloh Kiepe) from Vossloh AG; the transaction was completed in January 2017.

In September 2016, at the key trade fairs – Automechanika, InnoTrans, and IAA Commercial Vehicles – Knorr-Bremse presented new, pioneering system solutions to its customers. The Development Center at the Munich site became operational.

Knorr-Bremse was again certified "Top Employer for Engineers in Germany." In addition, the Commercial Vehicle Systems division won the accolade of "Best Brand" in the "Brakes" category for the eleventh time in succession. Bendix Commercial Vehicle Systems, a subsidiary of the Knorr-Bremse Group, was named a Diamond Supplier by Navistar. The leading U.S. commercial vehicle manufacturer presents this award to its top suppliers in recognition of their advanced technology, high quality, and on-time delivery.

The 2016 Financial Statements and the Management Report on Knorr-Bremse AG, the 2016 Consolidated Financial Statements and the Management Report on the Knorr-Bremse Group drawn up by the Executive Board and the Company's accounts were examined by the auditors elected by the Annual Shareholders' Meeting, KPMG AG Wirtschaftsprüfungsgesellschaft, Munich, and endorsed with their unqualified opinion dated March 1, 2017.

The Financial Statements of Knorr-Bremse AG and the Consolidated Financial Statements were prepared in line with the principles of adequate and orderly accounting and with the accounting provisions of the German Commercial Code (HGB), as well as with supplementary legal and statutory regulations.

The Financial Statements Committee also examined the Financial Statements for fiscal 2016, the Management Report, the proposed allocation of unappropriated retained earnings, and the Consolidated Financial Statements and Management Report on the Knorr-Bremse Group. As there were no objections to be raised, the Financial Statements Committee recommended that the Supervisory Board approve the Financial Statements. At its meeting on March 17, 2017, the Supervisory Board approved the 2016 Financial Statements of Knorr-Bremse AG and the Consolidated Financial Statements, which thereby became legally binding. The Supervisory Board concurs with the Executive Board's proposal for the allocation of unappropriated retained earnings. The auditors attended the meeting of the Financial Statements Committee on February 24, 2017 as well as the financial statements meeting of the Supervisory Board on March 17, 2017, reported on their key findings, and answered outstanding questions.

KPMG AG Wirtschaftsprüfungsgesellschaft, Munich, also examined the Executive Board's Report on Relations with Affiliated Companies, drawn up in line with Section 312 German Corporation Law (AktG). The auditors endorsed this report with the following opinion: "In the legal transaction shown in the Report on Relations with Affiliated Companies, in accordance with the circumstances known to us at the time at which the said transaction took place, our Company paid appropriate consideration." The Supervisory Board also examined the Executive Board's Report on Relations with Affiliated Companies and has no objections to the concluding statement by the Executive Board or to the auditors' findings.

The term of office of the members of the Supervisory Board ended with the resolution of the Annual Shareholders' Meeting on March 11, 2016 releasing the members of the Supervisory Board from liability for the 2015 financial year. In the context of the Annual Shareholders' Meeting on March 11, 2016, at the instigation of the Supervisory Board, Heinz Hermann Thiele, previously Chairman of the Supervisory Board, was appointed Honorary Chairman of the Supervisory Board. The existing employer's representatives, Hans-Georg Härter (2nd Deputy Chairman), Wolfram Mörsdorf, Wolfgang Tölsner,

and Georg Weiberg, were re-elected to the Supervisory Board. In addition, Julia Thiele-Schürhoff and Dr. Bernd Bohr were appointed to the Supervisory Board.

Manfred Wennemer, 2nd Deputy Chairman until the end of the term of office of the Supervisory Board, is no longer a member of the Supervisory Board. On the employee side, the elections to the Supervisory Board of January 27, 2016 saw Franz-Josef Birkeneder, Michael Jell, Werner Ratzisberger, Sebastian Roloff, Erich Starkl, and Günter Wiese elected. Dr. Eduard Gerum, 1st Deputy Chairman until the end of the term of office of the Supervisory Board on March 11, 2016, is no longer a member of the Supervisory Board. On behalf of Knorr-Bremse AG, the Supervisory Board wishes to thank Dr. Gerum and Mr. Wennemer for their contributions to its work.

At its constituent meeting on March 11, 2016, the Supervisory Board elected Dr. Bernd Bohr as Chairman, Franz-Josef Birkeneder as 1st Deputy Chairman, and Hans-Georg Härter as 2nd Deputy Chairman of the Supervisory Board. Effective July 4, 2016, Dr. Bohr relinquished his seat on the Supervisory Board and the position of Chairman. He was succeeded as Chairman of the Supervisory Board by Hans-Georg Härter, until then 2nd Deputy Chairman.

With effect from January 1, 2016, Dr. Peter Laier was appointed to the Executive Board with responsibility for the Commercial Vehicle Systems division. Effective June 30, 2016, Dr. Dieter Wilhelm, Member of the Executive Board responsible for the Rail Vehicle Systems division since July 1, 2003, resigned from his position on the best of terms with the Company. Along with his role on the Executive Board, Dr. Wilhelm was also Chairman of the Supervisory Board of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, a position from which he had already stepped down with effect from March 11, 2016. On behalf of Knorr-Bremse AG, the Supervisory Board wishes to thank Dr. Wilhelm for his many years of successful work for the Company. Dr. Wilhelm's responsibilities have been assumed by Klaus Deller in addition to his existing duties as Chairman of the Executive Board of Knorr-Bremse AG.

Munich, March 17, 2017

The Supervisory Board

Hans-Georg Härter,  
Chairman



Knorr-Bremse technology was chosen for a new mass transit concept in Rio de Janeiro.

### Connected Transportation



How Knorr-Bremse uses the potential offered by Industry 4.0 for its production processes.

### Connected Production



### Connected Value-Added

Why local production networks underpin Knorr-Bremse's success.



### Connected Responsibility

How a product's total cost of ownership can be controlled.



### Connected Truck Systems

Networked products prepare the ground for autonomous vehicles.



### Connected Knowledge

The Management Evolution Program teaches young recruits to think outside the box.

# Connected Competence.

Using the diversity of markets, requirements, and trends as an opportunity to develop innovative solutions for tomorrow: In 2016 Knorr-Bremse continued to work on smart networks of people, knowledge, sites, systems, and sub-systems. The articles that follow provide some examples.



### Connected Care

Global Care and Local Care take on responsibility by funding aid projects all over the world.



### Connected Rail Systems

Smart networking of vehicle sub-systems benefits manufacturers and operators alike.



Connected Transportation

## A mass transit concept for Rio

The huge challenge facing Rio de Janeiro was to develop a mass transit concept that would efficiently channel the crowds of spectators at the 2106 Olympics and then deliver a sustainable improvement in everyday mobility for the local people. How was it done? Light rail transit in the shape of the “VLT Carioca” and Bus Rapid Transit lines had a key role to play – as did Knorr-Bremse as a dependable systems partner.

First there came the sound of a bell, then a motorcycle shot out of the tunnel, with a light rail vehicle right behind. The outrider was there to clear the route for the VLT Carioca, as Rio’s new trams are known. Line 1 is the first of three planned light rail lines and was inaugurated just in time for the Olympic opening ceremony. And since some Cariocas – the people of Rio – need time to adjust to these new, quiet trams, running through the busy traffic, initially they were preceded by motorcycle outriders.

### VLT Carioca: modern and environmentally friendly

The new line was opened in June 2016. It runs for around 14 kilometers from Santos Dumont airport, between long rows of downtown blocks, to the new Novo Rio bus station. En

route the LRV glides smoothly past the extraordinary Museu do Amanhã (Museum of Tomorrow), and also stops outside Rio’s famous carnival center, Cidade do Samba (Samba City).

The 44-meter LRV units are powerful performers: With seven cars each they can transport 420 passengers and effectively carry as many as 200,000 people a day. Of the 32 new units, 27 were built in Taubaté at Brazil’s first light rail vehicle factory. Knorr-Bremse supplied numerous components including hydraulic brake calipers, magnetic track brakes, electronic brake control systems, and control units. “Along with the trusting relationship that has evolved over the years, our modern production operations and competent employees on the ground were instrumental in Knorr-Bremse being

Feats of art and engineering at the Praça Mauá, a rendezvous for visitors to the 2016 Olympics.

chosen as a project partner," says Oliver Erxleben, Managing Director of Knorr-Bremse Brazil. By delivering its reliable components just in time, Knorr-Bremse played its part in ensuring that the new line opened for business on schedule in time for the Olympics.

#### Bus Rapid Transit: an efficient network

Another mode of transportation at the heart of Rio's mass transit concept takes the shape of the buses that run on the city's Bus Rapid Transit (BRT) routes. During the Olympics and Paralympics, the BRT buses were lined up like pearls on a necklace, ready to transport spectators to and from the various stops around the Olympic Park. Then they would move off along their new lanes in all directions, heading for the different venues.

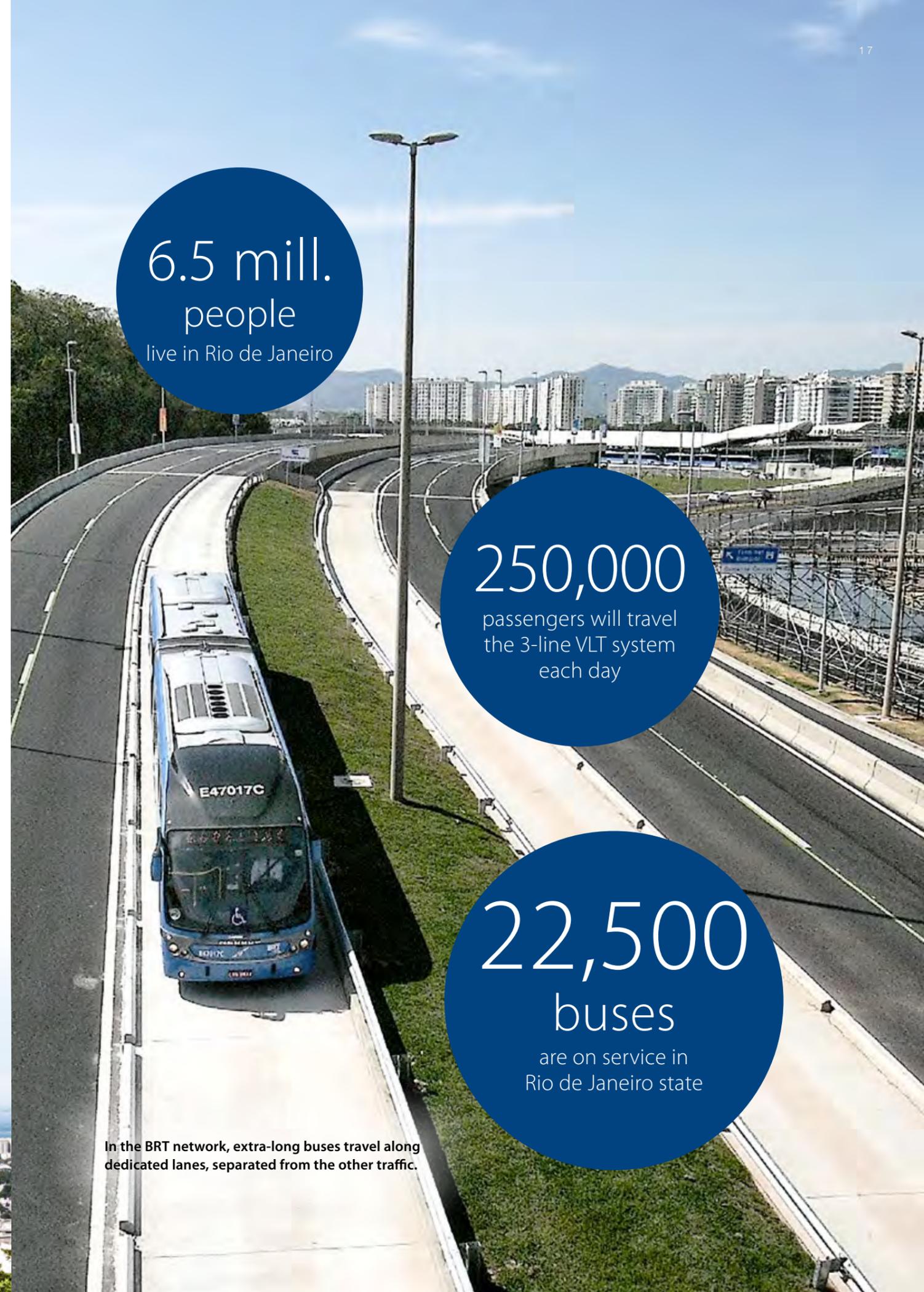
The BRT buses have their own dedicated lanes, separated from the remaining traffic and in many cases running along the center of the road, between the lanes for the cars. Fitted with many doors, they halt at what are often big station-like stops. This way, regardless of the traffic density, running at short intervals the buses can transport large numbers of passengers efficiently to their destination. BRT networks have already proved their worth in Brazil – in Brasilia, Curitiba, and Belo Horizonte, for example. Since the first line was opened in Rio in 2012 the network has been gradually expanded – not least in time for the 2014 World Cup – with the latest addition, the Transolímpica BRT line being inaugurated in 2016. Covering 26 kilometers including four tunnels, it links the western suburb of Barra da Tijuca with Deodoro in the north. A total of 158 buses serve 18 stops and carry up to 70,000 passengers a day. Together with the existing Transoeste and Transcarioca lines, that brings the total BRT network in Rio de Janeiro to around 120 kilometers.

The mass transit system is highly connected: In time for the Olympics, the existing Transcarioca line was extended to link up with a newly opened metro line. An additional BRT line – Transbrasil – is in the pipeline. Knorr-Bremse in Brazil forms part of this huge mass transit project and believes its success is the result of a systematic development process. As Oliver Erxleben puts it: "The various models of BRT bus are built by different OEMs in Brazil. These are absolutely

high-tech vehicles, some of them 4-axle models more than 23 meters long that can accommodate up to 200 passengers. Knorr-Bremse supplies components for all BRT buses built by the various manufacturers, reflecting the strength of our market position in Brazil." The impressive outcome is that many BRT buses in Rio are equipped with Knorr-Bremse ABS, Electronic Leveling Control (ELC), and Electronic Air Control with integrated Electronic Parking Brake. Other models of bus are fitted with visco-dampers, pneumatic disc brakes, and conventional valves. Clearly, Knorr-Bremse's product portfolio meets all of the OEMs' requirements – making a substantial contribution to ensuring safe, efficient, and eco-friendly mobility.

#### Metropolis scale

On the two older BRT lines, Transcarioca and Transoeste, more than 300 buses transport some 450,000 passengers per day along routes spanning 97 kilometers. One day, when all four BRT lines have been completed, the network will cover 150 kilometers with a probable total of 164 stops. Added to these there are countless other local bus routes linking the various suburbs of this metropolis. All of this adds up to an attractive market for Knorr-Bremse, which has maintained a local presence in Brazil for the past 35 years or so. The Company's new production plant in Itupeva, 85 km northwest of São Paulo, opened in 2013. At the main joint production plant of the Company's Commercial Vehicle Systems and Rail Vehicle Systems divisions (Knorr-Bremse Sistemas para Veículos Comerciais Brasil Ltda./ Knorr-Bremse Sistemas para Veículos Ferroviários Brasil Ltda.) 500 employees implement the very highest production standards, keeping throughput times extremely short. The product range includes the complete portfolio for the South American commercial vehicle market, as well as braking, entrance, power supply, and HVAC systems for rail vehicles.



6.5 mill.  
people  
live in Rio de Janeiro

250,000  
passengers will travel  
the 3-line VLT system  
each day

22,500  
buses  
are on service in  
Rio de Janeiro state

In the BRT network, extra-long buses travel along dedicated lanes, separated from the other traffic.

## Connected Rail Systems

# Smart networking of sub-systems

**Modern rail vehicles are highly complex and make more use of electronics than ever before. Knorr-Bremse's 'Connected Systems' approach helps vehicle builders to shorten time-to-market, and fleet operators to run their vehicles more reliably and cost-effectively.**

Nowadays, passengers take it for granted that sophisticated HVAC systems will maintain a comfortable temperature inside a modern rail vehicle, whatever the external temperature, and however many people are on board. But one side effect is a massive increase in the use of electronics. The bad news for vehicle builders is that this complicates the development engineers' task of integrating such sub-systems and increases the amount of documentation required for the homologation process. Adhering to customers' time-to-market schedule becomes more difficult.

### New level of sub-system integration

But the good news, according to Frank Uder, Senior Director X-System Business Development, is this: "As networking technology matures, the complexity can be reduced again." Knorr-Bremse created his department during the course of 2016 with a view to marketing this approach more effectively. "At the center of it all is a new level of sub-system integration," says Uder. A crucial role is played by a control unit serving several sub-systems and making multiple use of sensor data. But equally important are standardized interfaces and carefully matched, pre-tested hardware and software solutions. If vehicle

builders are offered well-designed, networked solutions from a single source, they benefit from much lower levels of complexity and improved project planning. And if the system architecture is adapted to operational requirements, this also simplifies the vehicle homologation process. "Both factors mean lower costs," comments Uder.

### Maximum benefits for vehicle builders and operators

Effective networking of vehicle sub-systems also opens up new, as yet unexploited scope for increasing the efficiency of systems diagnostics. For example, if an operator currently wishes to examine the data from a train's entrance system electronics, a technician has to embark on a long, time-consuming process. He works his way along the train with a laptop under his arm, plugging it in at each door and using the appropriate software to download the data from the system's memory. He also has to bring along a separate interface in the form of plug adapters and diagnostics programs for virtually every sub-system. The 'Connected Systems' approach enables diagnostics to be performed on the various sub-systems using a single service tool. This considerably shortens commissioning and servicing times, saves costs, and means higher levels of vehicle availability.

**The iCOM system connects and utilizes existing data and signals from the vehicle's sub-systems.**



**The iCOM system connects and utilizes existing data and signals from the vehicle's sub-systems.**

### Open standard broadens range

The central element of 'Connected Systems' is the train control management system (TCMS) supplied by Selec-tron, the Swiss company that Knorr-Bremse acquired two years ago. "This means we now have in-house specialists in advanced solutions for automation, networking, and control of rail vehicles," explains Uder. Knorr-Bremse adheres to a philosophy of open standards, which means that other manufacturers' systems can also be integrated into the network. The precise nature of the Connected Systems architecture is as varied as the individual vehicle projects themselves, but always involves a scalable range of performance based on the principle that more extensive networking results in greater benefits. The first applications for various manufacturers' vehicle platforms are already up and running.

### iCOM – a platform for the digital railroad world

The advantages offered by networking and utilization of existing signals and data is demonstrated by Knorr-Bremse's iCOM system. This innovative platform for the digital railroad world bundles a number of functions offering efficient, low-wear driving, real-time energy consumption measurement, and preventive diagnostics. In the case of the latter, iCOM Monitor sets new standards for maintenance processes: Whatever the vehicle platform involved, it offers operators immediate information about the state of any sub-system. And thanks to its open architecture it can be used equally well for Knorr-Bremse systems or those of another supplier.

At the moment, much maintenance is carried out on a cyclical basis or at predetermined service intervals. "Technicians replace components whether or not they still might have life in them," explains Kathrin Moder, Head of Marketing and Sales at Knorr-Bremse RailServices. "But depending on the sub-system involved, components have different maintenance cycles, each with a certain safety margin, and this means there is always an element of waste involved."

The result is that fleet operators have to achieve a difficult balance between keeping their vehicles running and not taking them out of service for maintenance more than is absolutely necessary. This is where iCOM Monitor comes in: Whatever the vehicle platform, it can monitor the condition of any of the sub-systems. The application's algorithms are designed to provide operators with an overview of all the relevant condition-related data. Status messages contain specific maintenance recommendations that can be tailored to customers' individual requirements. This transition from reactive to pro-active maintenance can save up to 20% of operating costs.

### Implementing specific customer concepts

iCOM Monitor is already being piloted under regular operating conditions, supplying data on the hydraulic braking system of a light rail vehicle in service with Berlin mass transit operator Berliner Verkehrsbetriebe (BVG). And since mid-2016, DB Regio has also been testing the application on a number of IFE entrance systems in its regional trains, with onboard sensors detecting opening and closing duration, temperature, and tilt. As well as various HVAC projects involving UK operator ScotRail, iCOM was also due to be installed for condition-monitoring of oil-free compressors in regional trains operated by Dutch company NedTrain at the end of 2016.

iCOM Monitor is only one of three applications available on the platform. iCOM Meter, which measures and records energy consumption in real time, and the driver information system iCOM Assist provide further functions that use the same hardware and back-office environment and offer operators significant potential synergies and savings.



iCOM Assist  
reduces consumption  
and wear for

300

DB Cargo  
locomotives

Up to

20%

operating cost savings  
with predictive  
maintenance

R&D expenditure by  
Knorr-Bremse accounts

for 6%

of annual  
sales revenue

Condition-based, preventive maintenance increases  
the reliability and punctuality of rail services.



### Connected Truck Systems

# The road to fully automated driving

The most important safety system in any road vehicle is still the driver – but smart, networked assistance systems are increasingly helping to take some of the load off his shoulders. Knorr-Bremse is driving forward this development at various levels.

"Digitalization has introduced another driver of innovation in our sector," says Dr. Peter Laier, Member of the Executive Board responsible for the Commercial Vehicle Systems division. "Closer networking of individual components combined with inter-truck communications – and even links to the transport infrastructure or other service providers via the Internet – offer considerable scope for making truck logistics more efficient. In 2016 we showed that our systems expertise is helping shape a development that goes well beyond automatic control of individual vehicles." The Wingman® Fusion™ adaptive cruise control system developed by Knorr-Bremse's U.S. subsidiary Bendix, the LDWS lane departure warning system, and the AEB automatic emergency braking system represent the first steps towards fully automated, accident-free driving. All three already rely on a combination of video cameras and radar sensors linked to the braking and drive systems in order to maintain a safe distance from the vehicle in front, warn the driver if he drifts out of lane, and automatically apply the brakes to prevent rear-end collisions.

At the moment, systems like these do not yet automatically intervene in the vehicle's steering system. But con-

trolling the steer angle independently of the driver – in close coordination with the braking system – is going to be crucial for the next generation of assistance systems. In this context, Knorr-Bremse's strategic acquisition of tedrive Steering Systems GmbH in 2016 was another logical step: By adding steering to its portfolio, the company is paving the way for integrated automatic control of vehicles' lateral and longitudinal dynamics.

#### Networked solutions for greater safety and efficiency

Knorr-Bremse presented its Blind Spot Assistant at the 2016 IAA Commercial Vehicles. This enables the driver to check the area to the side and rear of his vehicle using a monitor mounted on the A-pillar of his cab that provides a view of the street rather like a conventional rear-view mirror. When the truck stops at an intersection, the radar sensor and camera keep a watchful eye on the driver's blind spot. If anything is blocking it, the monitor switches to a bird's-eye view and marks the image in yellow. And if the vehicle's indicator has been activated or the system senses that the steering wheel is being turned to the side, the image is framed in red and an acoustic warning sounds. This considerably improves the driver's ability to assess the situation.

Knorr-Bremse assistance systems are paving the way for fully automated driving.

Like the Blind Spot Assistant, the current lane departure warning system merely alerts the driver – in this case if his vehicle starts to drift out of lane. But a new, extended function – Lane Departure Prevent – combines the existing monitor with an automatic braking function: If the driver fails to react to warning signals, the system first applies the brakes to individual wheels to prevent the vehicle from leaving its lane and brings it safely to a halt.

**Many routes to the same destination**

An important step towards fully automated driving is going to be the Highway Pilot, which will enable a truck to follow a pre-set route without the help of the driver. One of the next stages in this development is 'platooning', which promises to deliver fuel savings and reductions in CO<sub>2</sub> emissions of up to 10%. It involves a convoy of vehicles traveling at 80 km/h and safely maintaining a gap between each other of 10 to 15 meters. The prescribed gap at that speed is currently about 50 meters, so to make this possible there has to be communication between the vehicles to ensure that the entire convoy can brake virtually instantly if necessary. During 2016, Knorr-Bremse carried out the groundwork in the USA for testing such a system on public roads. In order to share out the economic benefits fairly amongst all the vehicles in the convoy, smart telematics systems will be needed to carry out calculations that ensure that even the lead truck benefits from the fuel savings achieved by the other vehicles.

**A taste of autonomy**

The Autonomous Yard Maneuvering System developed by Knorr-Bremse and showcased at the IAA Commercial Vehicles is a pilot system that enables a truck to operate completely independently of its driver. Video cameras, radar, and other chassis sensors around the vehicle continuously survey the vehicle's surroundings for possible obstacles, stopping it if the designated route is blocked, and only allowing it to continue when the coast is clear. The driver uses his cellphone to check the vehicle in and hand it over to the depot management. When the yard manager receives the information that the vehicle is ready to go, he transfers the order details and clears it to start maneuvering. The system then selects the route and drives the vehicle to the appropriate loading bay.

The Intelligent Hydraulic Steering Assistant (iHSA) produced by tedrive is a key component in enabling the truck to be automatically steered. In a conventional steering system, the driver is in control of the steering torque and a valve passes this on to the hydraulic steering assistance. The iHSA system uses the same hydraulic valve but controls it with a compact electric motor, steering the truck without the help of the driver. Any number of maneuvers can be carried out with unrivaled precision and avoiding collisions and minor damage. Combined with automated processing of load data and the reductions in the driver's working hours, automated yard maneuvering offers clear scope for lowering costs. The products showcased by Knorr-Bremse in 2016 demonstrate the sheer range of performance offered by networked assistance systems. In combination they offer a foretaste of the future development of assistance systems.

**All that is needed for a long service life: Knorr-Bremse TruckServices**

At the prestigious Automechanika trade fair, Knorr-Bremse celebrated the launch of TruckServices – a new brand that has put the Company's aftermarket offer under one roof and enabled it to further develop its products and services for this segment at all levels. Business partners now benefit from an expert network run by one of the leading companies in the commercial vehicle supply sector. TruckServices also cooperates with the Alltrucks full-service workshop system operated jointly by leading suppliers Knorr-Bremse, ZF, and Bosch. By the end of 2016, almost 280 multi-brand commercial vehicle servicing businesses had joined Alltrucks. During the course of the year, the company also made further progress in the field of logistics: In partnership with Microlise, Knorr-Bremse announced TruckServices ProFleet Connect – a modular telematics solution for 2017 that will closely link vehicles to operators' management systems.



40%  
less congestion  
with fully automated  
vehicles

7.7 mill.  
platooning  
systems by 2025

80%  
emissions  
reduction through  
automation

At the IAA Commercial Vehicles, Knorr-Bremse presented an autonomously maneuvering truck.



Connected Value-Added

## Global player, local presence

**Any company looking to achieve worldwide sales in the rail and commercial vehicle business needs to establish global development and production operations. Knorr-Bremse's integrated global production and engineering network is a central element of its international market leadership.**

The expectations of vehicle builders and operators alike are crystal clear: "Competent staff need to be on hand to deal immediately with customers' concerns," says Christian Witzleben, Head of Strategic Projects in the Rail Vehicle Systems division. "When an issue arises, possibly one as vital as keeping vehicles running smoothly, it's too late to think about sending for someone from Germany." Instead you need people on the ground with expert knowledge, backed up by the necessary infrastructure.

The picture on the systems development front is similar, as Dr. Gert Fregien, Head of Support Operators and Technology in the Rail Vehicle Systems division explains: "Vehicle manufacturers want short-term implementation of project-specific outcomes, despite development cycles getting shorter and end products becoming more complex than ever. Thanks to our local engineering teams we are able to deal with these regional requirements and specifics right there on site."

When the two managers talk about "speaking the same language" in this international context, these are no empty words but in fact touch upon an aspect that is key to the efficient implementation of their projects. If staff are to handle projects efficiently, they need to understand the market and be familiar with the mentality of the local vehicle manufacturers and operators and the way they work. Consequently, making global expertise available at local level is one of the core guiding principles.

### **Integrated global production and engineering network**

Knorr-Bremse was among the early adopters of this trend. Be it in St. Petersburg in Russia, Palwal and Pune in India, Granville in Australia, Kecskemét in Hungary or Shiyang

and Suzhou in China, the list of Knorr-Bremse sites either newly founded, expanded or added through joint ventures in recent years is long. Today, the Group maintains a presence in all of the major rail and commercial vehicle markets. This is not about expansion for its own sake or establishing an integrated production and engineering network because it looks good when there are lots of colored dots on the map of the world. In St. Petersburg, Kecskemét or Suzhou this approach has led to Knorr-Bremse actually being perceived as a Russian, Hungarian, and Chinese company respectively, which is essential, given the importance of localization in commercial terms.

### **Localization essential for project awards**

One of the driving forces behind localization is government policy designed to ensure that as much industrial value as possible is added in the domestic market. Vast volumes of imports would be counterproductive here. Cash would exit the country and the balance of trade would suffer. Consequently, the authorities lay down localization or 'domestic content' quotas – stating the proportion of value-added that a vehicle manufacturer must generate within the respective country. In the rail vehicle sector, for example, 60 or 80% are typical values. Or in place of fixed quotas, gentle pressure can be applied, for example by granting tax breaks for the sale of commercial vehicles that achieve a certain minimum domestic content.

Whatever the approach, "the manufacturers pass on the localization requirements to their suppliers," explains Oliver Erxleben. As Managing Director of Knorr-Bremse Brazil, Erxleben is responsible for the Group's rail and commercial vehicle business in South America. When it comes to choosing a supplier, he says, these quotas are a

In many markets, a company that can offer local development and production capacities can rapidly become an indispensable partner.

key criterion. "If you can't meet them, because you don't have local production operations, you're soon out of the race." Deliver the required domestic content, however, and you are just as quickly a highly valued partner to the local industry. But there is more to it than that, because local production also makes sound business sense. "Above all in long-term projects, this way you become more immune to volatile currency markets," says Erxleben. After all, local production also means a high level of local outsourcing, paid for in local currency.

#### Localized products and assembly

Localization is a fact of life in the rail and commercial vehicle industries across the globe. In China, for example, since the fall of 2016 Knorr-Bremse has successfully localized the first smart air supply system for the Chinese commercial vehicle market. Start of production is scheduled for April 2018. State-owned manufacturer FAW has already ordered this system for its new T099 platform. When production ramp-up is complete, output is slated to reach over 50,000 units a year – making a tangible contribution to Knorr-Bremse's high market share in the Chinese air supply market. In Turkey, Knorr-Bremse is busily ramping up production of Merak HVAC systems for the new Anatolian Diesel Multiple Unit. After being trained on the Merak assembly lines in Getafe in Spain, Turkish Knorr-Bremse employees are now playing a key part in achieving the required level of domestic content.

#### Creating global communities

However, localization does not imply that the individual production sites operate in isolation. "There's never any doubt about the fact that Munich is the hub where all the separate threads run together," is how Fregien describes the way things work. "And while that does mean implementing harmonized and in most cases more complex project planning processes, it has the advantage that the individual developments are available to the entire Group." The expansion of the brake control portfolio for locomotives is a case in point: In the past, this product line took its lead from the world's major railroad standards, so there was one control system for the North American AAR standard, one for the UIC market in Europe, one for the Russian GOST market, and another to

meet the Chinese standard. "In a globalized world, that would be failing to keep up with the times," says Fregien. "Today a U.S. manufacturer wants to be able to sell its locos in Europe as well, while a Chinese OEM will be looking at the South American market, too." And once a locomotive platform has been developed, adapting it to different railroad standards after the event involves a great deal of cost and effort.

With the new CCB-3 brake control unit there is no need for that extra expenditure. "This system can be configured to meet the various standards and can therefore be adapted with relatively little effort," says Fregien, describing the concept. The cross-standard principle is a USP for Knorr-Bremse, the only company to offer it. "No one else can bring to the table the expert knowledge of local markets required for such a development." The CCB-3 is the result of joint efforts by development engineers in Watertown (USA), Munich (Germany), Melksham (United Kingdom) and Pune (India) – and thus itself a product of advancing globalization and connectivity.

#### Always a must: outstanding quality

No less global here is the emphasis on outstanding quality. "To make sure this is achieved we have implemented the worldwide Knorr-Bremse Production System (KPS) and our quality management system QFMA," explains Xia Fei, Managing Director of the Knorr-Bremse DETC Commercial Vehicle Braking Technology Co., Ltd. joint venture in Shiyan, China. "In this way, we too deploy Group-wide standardized processes along the entire supply chain – from raw material processing to assembly to quality testing."

Make no mistake, localization is still on the up and up. In line with Buy America regulations, only last fall, the U.S. Federal Transit Administration (FTA), which among other things governs passenger rail transportation in the USA, raised the required level of domestic content to 60%. A series of incremental increases are planned that will lift this to 70% by 2020. The car sets slated to serve the planned high-speed route from Sacramento to San Diego, with links to San Francisco and Los Angeles, could already be among those affected.

**Knorr Brake Company: Westminster, Maryland plant in the USA.**

60-80%  
domestic content in rail  
vehicle projects

Over  
100  
plants in  
30 countries

Over  
80  
companies acquired  
in the past  
30 years

In demand and making sense: local production based on uniform global standards.

Connected Knowledge

# Management Evolution Program

**Knorr-Bremse managers think in terms of networks that transcend the rail and truck divisions, internal departments and individual specialist areas, and focus consistently on the customer's value chain. Management trainees receive their training on the Management Evolution Program (MEP). Here, four members of the workforce – a trainee, a newcomer to the management team, and two experienced managers with impressive track records – report on their experiences.**

In a digital age it would be easy enough to use robot recruiters to select young participants for the Management Evolution Program (MEP) on the basis of algorithms. The criteria are clear: In demand are Master's graduates in technical subjects with at least one year's practical experience – six months of it spent abroad. In addition, candidates should have an open personality with an intelligent and socially competent approach to entrepreneurial challenges. This is where the computer begins to falter and passes the baton back to the Knorr-Bremse human resources team. After all, selecting the best graduates calls for an individualized approach that balances the interests of the company with those of the trainee and the requirements of Knorr-Bremse's customers and suppliers.

#### **Networking: the key to success**

Markets, business models, customer relations, work processes: Digitalization is transforming the parameters of the working world. Today's project managers increasingly require extensive interdisciplinary knowledge, as there is a growing overlap between disciplines such as IT, electronics, technical design, and business management, and the boundaries between them are becoming more and more fluid. Knorr-Bremse's MEP program is designed to prepare the young graduates for this type of career: Over a period of 18 months they carry out project work that enables them to get to know both the rail and truck divisions, various specialist departments, and other company sites around the world. By the end of the program, they are capable of taking on posts as project managers, project engineers or global purchasing specialists. It is not just Knorr-

The MEP program gives young managers an insight into the rail and truck divisions and various international fields of work.

Bremse that benefits from such rigorous training but also the company's business partners, as they find themselves working from the outset with people who have taken on board the need for customer orientation, product and process expertise, and just-in-time solutions.

**Cross-disciplinary thinking**

This idea of networking has always been the underlying ethos of the MEP program, both in terms of selection of participants and program content. As **Wolfgang Krinner** (44), member of the Commercial Vehicle Systems Management Board and himself a participant in the MEP program back in 2001, puts it: "MEP smoothed the way for me and laid the foundation for my career. Nowadays, it is taken for granted that everything is networked to a very high degree. Back then, four trainee projects in very different business functions gave me an insight into how companies can work on an interdisciplinary basis. The experience enabled me to incorporate the idea of networking into my professional life from the very outset." At present, trainees spend a total of 18 months at three different Knorr-Bremse locations, the second of which has to be abroad. A mentoring system offers the young people advice and help in making decisions.

On the MEP program, networking is all about supporting individuals' personalities and further developing their specialist skills. It was through the MEP program that



Wolfgang Krinner gained his first knowledge of economics. "At university, I received a purely technical training, and that was also my main area of interest," he remembers. "The MEP program included some basic business modules, and in the projects I had to deal with business management issues and complete a project on controlling." It was an excellent start for a managing director who now sees teamwork, enthusiasm, willingness to assume responsibility, and openness as further key factors for professional success.

**MEP – the early stages**

"I was born and grew up in China. I think one has to be open to new things – new cultures, new people, and new ways of thinking. It's a decision that anyone can make; it involves courage and respect – but it's fun." The cultural competence acquired by **Lizhu Qu** (27), who entered the MEP program in 2016, is clearly an asset. During a placement in the company and her Master's degree course in engineering and management she had worked hard on developing her specialist knowledge and getting to know Knorr-Bremse as an employer. Her personal impressions and professional experience were such that joining the MEP program was the next logical step. Qu is keen to gain even more intercultural experience, but in different places from her European peers: "During my studies and travels I've seen a lot of Asia and Europe, but the USA and



Australia are completely new to me. I'm very interested in landscapes and cultures, and the way people in these countries think and work."

**After the MEP: a professional career**

"This combination of technology, business management, and teamwork – and facing your first management challenges – is something you can build on when you assume future management responsibilities." That is how Wolfgang Krinner describes the modular approach taken by the MEP. The program provides training in hard and soft skills for new recruits. Former MEP participant **Christina Zimmermann** (29) found the social skills she acquired (negotiation, leadership etc.) particularly useful at the start of her career. In her role as project manager and system engineer in Niederhasli, Switzerland she is responsible for various OE projects and their commercial and technical planning. With her technical background, she sees herself as the link between customers and the in-house specialists in the Centers of Competence. It is a role that requires tact and an ability to put across facts and articulate individual points of view in a comprehensible way. Christina Zimmermann actually wrote her Master's thesis while she was with Knorr-Bremse Commercial Vehicle Systems, and it was only during her training that she developed her enthusiasm for the rail sector and for project planning (system design).



**MEP: valuable throughout your career**

Have the courage to show curiosity, gain a wide range of experience, and network in a variety of different areas – and reap the benefits throughout your entire career: That could well be the motto of **Fabian Stambrau** (39), Director of Driver Assistance and Autonomous Driving in the Commercial Vehicle division at Knorr-Bremse Munich and responsible for business development and operations. He always recommends young management recruits to "choose operational projects that are as varied as possible – even in areas where you have little or no experience." Wolfgang Krinner agrees: "It is important to be able to cope with a variety of projects in different areas. Having to work your way into a different area calls for analytical thinking and trains you in structuring complex topics, putting together teams, and working with them as efficiently as possible." Networking in projects is all about understanding other people's point of view and challenging them. That is why the MEP alumni meeting is an established part of the program: "Young inspires Old." A mere 39 years old himself, Fabian Stambrau appreciates conversations with young management trainees, and admires their ambition and determination. "I can always learn something from young people – both the young specialists who join Knorr-Bremse direct, and the participants in the MEP program."

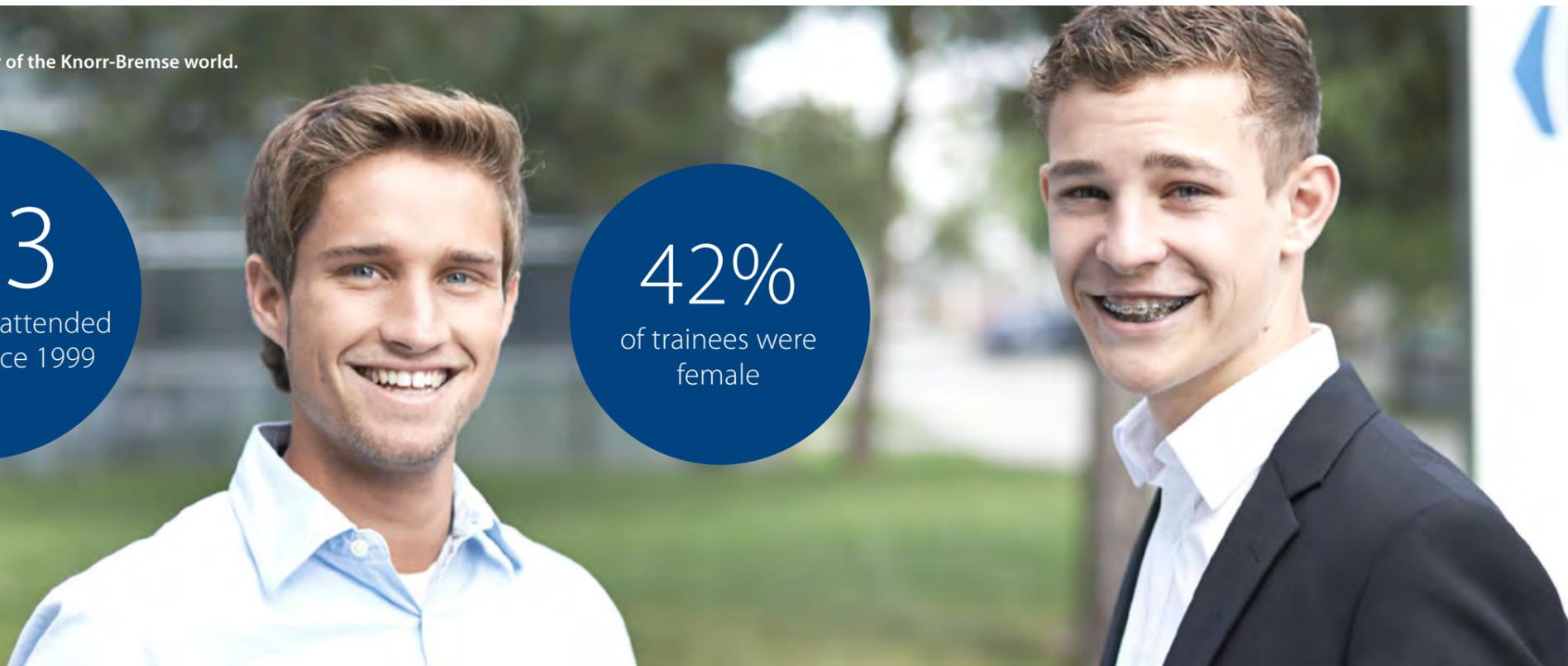


An 18-month tour of the Knorr-Bremse world.

153 people have attended the MEP since 1999

42% of trainees were female

8 trainees per year  
400 applicants



Connected Production

## Industry 4.0: total networking

**Driverless trucks thundering along the highway, fully automated metro trains, robots working alongside skilled technicians. One thing is clear: Industry 4.0 is set to revolutionize transport and radically change the entire sector. Knorr-Bremse is focused on preparing for a digitalized future.**

"Now scan in the production order" – the command appears on the mechanic's augmented reality goggles. He follows the instructions and selects the assembly box indicated for the components that make up a rail vehicle control unit. Carrier plate, valves or pressure sensors – the AR goggles tell the mechanic by text or voice command what quantities of which parts should go where in the box. Everything runs more smoothly and rapidly without the need for written lists – and at the end of the process his colleagues on the assembly line receive a perfectly prepared box.

### Smart operations

Augmented Reality is a particularly striking example of what Industry 4.0 is all about: It is a vision of 'smart operations' that involve man, machine, materials, and products interoperating smoothly, communicating with each other as part of the Internet of Things. Like the AR goggles, every machine, product, or application supplies information on its utilization and environment and contributes to a two-way flow of data that ensures reliable production control, with products finding their own way through the manufacturing process. The idea is to produce goods flexibly, with an eye to minimizing costs and reducing consumption of resources, and then to integrate them into the customer's digitalized value chain. Knorr-Bremse is thoroughly

familiar with customers' logistical and technological requirements – and is well placed to fulfill them.

Successful production relies on 'big data' generated by smart operations. When this is analyzed and integrated into the value chain, the result is ongoing improvement of production processes. Such value chain transparency is provided by RFID sensors embedded in machines and products, which feed data to a manufacturing site's central control software. Are all the elements of the assembly line working together optimally? Is a particular machine consuming an unusually high volume of electricity? The manufacturing execution system (MES) knows the answers to these questions. It evaluates the data and is capable of controlling, monitoring, and strategically optimizing production in real time. To ensure efficient data analysis, it helps if departments, global sites, and customers all operate with uniform standards. In this context, for example, Knorr-Bremse is currently working on Think Works – a software package developed by the truck division that operates as a sort of translation machine, transferring the datasets it receives into a standardized IT language. This simplifies data communication between departments such as Finance, Purchasing, and Production as well as between them and customers or suppliers.

**Augmented reality instructions help colleagues achieve efficient workflows.**

**Using additive processes**

Digitalization is set to transform manufacturing technologies in Industry 4.0. Knorr-Bremse is currently testing additive manufacturing (3D printing) using its own printers, for example for making valves. Three-dimensional printing could be of interest to the company for supplying spares and parts subject to wear through RailServices. But is 3D printing economical compared with casting processes? Knorr-Bremse is looking into this, examining and analyzing the entire product life cycle of a 3D-printed object. Aspects such as new geometrical forms, weight reductions, logistical advantages (on-site printing) or flexible service are all factors to be taken into consideration. But there are also technical challenges: For example, Knorr-Bremse does not work with plastic as a material; and the materials it does use, such as aluminum alloys with silicon, are subject to very high safety requirements.

**Automated driving with truck and rail**

Knorr-Bremse has been quick to take up the idea of networked industry, creating a number of pioneering products in the truck and rail divisions that are paving the way for current megatrends such as automated driving or innovative preventive maintenance models. Knorr-Bremse's new autonomous yard maneuvering system for trucks demonstrates the scope for improving freight depot efficiency. Complex driving functions are controlled by the interoperability of drive, steering, and braking systems, combined with the use of sensors to monitor the vehicle's immediate surroundings. An app informs the driver about the status of the loading and unloading process. Another app, iTAP (Intelligent Trailer Access Point), processes trailer EBS data and enables the driver to remotely control the trailer using a smartphone or tablet. In addition, networking with vehicle manufacturers' and fleet operators' technology enables creative aftermarket business models to be developed. Under the TruckServices brand, Knorr-Bremse offers ProFleet Connect, a telematics solution developed jointly with Microlise that in future will offer a range of safety functions, better vehicle planning, and live coaching sessions for drivers that add value for fleet operators and their employees.

"Uncompromising safety, top reliability, and low life cycle costs are the main advantages of our smart networking solutions," says Klaus Deller, CEO of Knorr-Bremse AG. iCOM, the onboard networking platform for trains, provides information about the rail vehicle fleet and optimizes train control systems by monitoring and analyzing data from vehicle sub-systems.

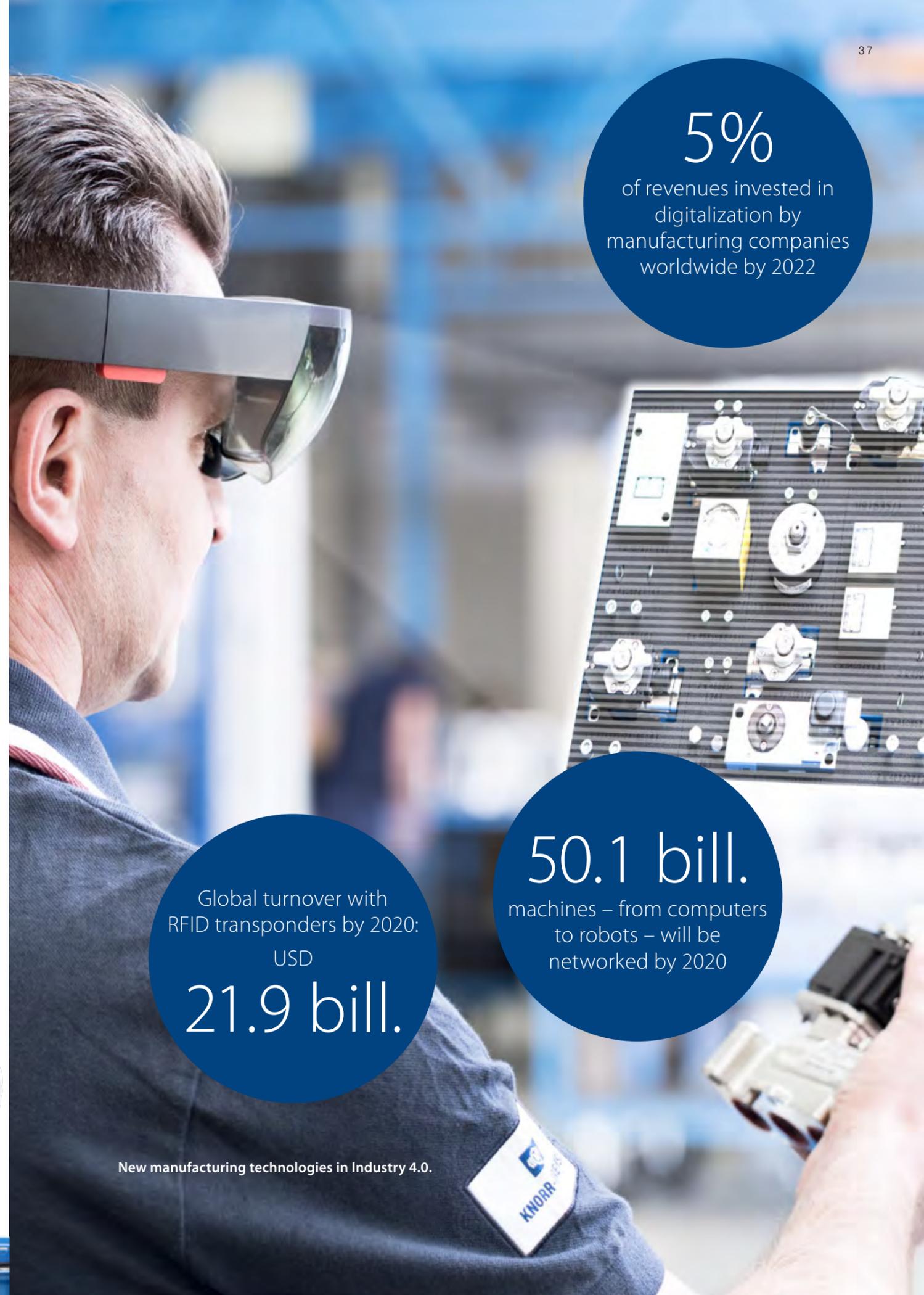
**Systematic training on the job for employees.**

**Changing employee profile**

For Industry 4.0 to develop innovative products, new employee skills are required: connected thinking for engineers, and expertise in new assistance systems for production workers. That is why systematic on-the-job training is essential for the workforce. But in addition to formal training measures, Knorr-Bremse's 'Digital Days' also promote an exchange of expertise across sites and sectors. These international events offer a chance to examine the opportunities offered by digitalization in terms of new business fields and the development of system-relevant products. At the same time, the global challenges brought by Industry 4.0 such as data security, the need for process standards, and the lack of a legislative basis can be discussed. Swift decisions are called for – the fourth industrial revolution is going to bring rapid change to industry and transport. Knorr-Bremse is systematically preparing itself in terms of production, infrastructure and its product portfolio.

**Industry 4.0 or the Internet of Things?**

Networked, digitalized industrial value creation has many names, depending on the particular perspective taken. In the USA it is referred to from the point of view of sales as the Internet of Things, but another term increasingly used is the Industrial Internet. Germany calls it Industry 4.0, and in Japan they see it as a natural extension of the industrial value chain. China has embedded digitalized production into its Made in China program. But common to all the world's industrial nations is a determination to benefit from the same advantages: future-proof, competitive, high-quality products, flexible production, efficient logistics – and successful, satisfied customers.



**5%**  
of revenues invested in digitalization by manufacturing companies worldwide by 2022

Global turnover with RFID transponders by 2020:  
USD  
**21.9 bill.**

**50.1 bill.**  
machines – from computers to robots – will be networked by 2020

New manufacturing technologies in Industry 4.0.





Connected Responsibility

# Making total cost of ownership sustainable

**How do you design a product that offers both economic and environmental advantages to customers in a wide range of different sectors, each with different requirements? And not just in the short term but across the product's entire life cycle? A brief introduction to the issue.**

Everything comes at a price. But the full price is usually not what is on the price tag. In addition to the initial cost of purchase, there are a number of indirect costs: electricity for a refrigerator, transport for new furniture, or insurance for a car. In everyday life we often have to make purchasing decisions that involve us considering the use we are going to make of the object we are buying, weighing up various factors, and – at least roughly – calculating the overall cost. Only then can we answer the question: Is it worth it?

Industry has had a name for this for many years: Total Cost of Ownership (TCO). Calculating TCO involves analyzing the indirect costs of an investment – ranging from initial purchase and homologation via installation and maintenance, right down to end-of-life disposal. "It clearly makes sense to carry out this analysis, but for many investment decisions it tends to be the purchasing price only, rather

than the total cost across the entire life cycle that is taken into account," says Stefan Bräuherr, Head of Corporate Responsibility at Knorr-Bremse. He suspects the reason lies in the particular nature of the sectors and applications involved, which can make accurate calculation of TCO difficult. Thus a solution that makes sense for a vehicle manufacturer from the point of view of TCO may be relatively unimportant for a fleet operator. For a freight company, for example, which only keeps a truck for a relatively short period of time, the investment has to pay off within the first two years. On the other hand, for the operator of a local authority bus that has to have a long operating life, the amortization period can be longer. That is why Knorr-Bremse develops products to meet a wide range of requirements – immediately improving efficiency for manufacturers and operators, but also offering long-term advantages across the entire life cycle.

**Only by looking at the total cost of ownership across the entire life cycle can valid investment decisions be made.**

#### Immediate efficiency, long-term future-proofness

One example is the active caliper release mechanism on the Synact® truck disc brake. This retracts the pad and centers the caliper against the disc in order to minimize residual braking friction. The result is reduced pad wear and up to 1% less fuel consumption. Immediately. In the long term, too, the new Synact® generation is future-proof, as it is capable of having additional sensors added. This means that manufacturers are already prepared for any future steps towards greater automation, for example in the form of so-called 'platooning'. "At the same time it means that Synact® can also be integrated into an overall system of condition-based maintenance – which will reduce life cycle costs," explains Winfried Schmelkus, Head of Vehicle Technology and Innovation at Knorr-Bremse Commercial Vehicle Systems.

#### Modular and fully networked

To optimize TCO, it makes sense to have modular, networked solutions that offer users products that are tailored to their precise needs and can be extended as required. In this context, Knorr-Bremse has developed iCOM for the railroad industry. iCOM provides operators with real-time information on the condition of systems throughout the entire train, monitoring, diagnosing, and prioritizing all the most important systems on board and displaying maintenance requirements in the central iCOM Monitor database. Other applications can be added: iCOM Meter calculates actual energy consumption in real time, raising staff awareness of efficient energy use and opening up scope for making savings. And iCOM Assist helps the locomotive engineer to operate his train in a way that is both energy-efficient and minimizes wear, reducing energy consumption by an average of 10%.

It is important that modular systems can be easily integrated into the customer's infrastructure: "As the system is based on an open standard, it is suited to both vehicle builders and operators," explains Johannes Gräber, Head of Innovation Management and Homologation Support at Knorr-Bremse Rail Vehicle Systems. This modular approach is also used for the TruckServices ProFleet Connect telematics solution developed by Knorr-Bremse for commercial vehicles. With an optional seven additional applications, the system links up individual vehicles to the fleet management system, delivering intelligent services that generate added value for fleet owners and drivers on the basis of automatically collected data.

#### Reduced maintenance, increased efficiency

The TCO advantages are particularly clear in the case of innovations whose smart design minimizes maintenance requirements. One example is the new 4th generation of IFE entrance systems for rail vehicles. The door leaves have a backlash-free rack-and-pinion drive that requires no adjustment during installation and is also completely maintenance free. The drive system's compact design uses up to 40% fewer components and weighs 20% less than comparable systems.

Products with lower noise and pollutant emissions can also reduce life cycle costs. They offer cost advantages for initial purchase and disposal but also during their operating lives. Electric-powered screw compressors for commercial vehicles, for example, operate particularly quietly and without generating irritating noise in electric vehicles. "For urban distribution operations that is important, particularly where there may be night-time or regional operating restrictions. Quiet-running vehicles will in future be able to operate more flexibly, whatever the time of day, for example supplying supermarkets in residential areas," explains Winfried Schmelkus. The reductions in noise emissions are similar to those achieved by modern freight trains equipped with Knorr-Bremse 'whispering brakes'.

#### Fine-tuning sustainability

But the best way to save money is not to spend it in the first place. That is why industrial re-manufacturing of products can play an important role in reducing life cycle costs. Remanufactured products offer comparable quality but at lower prices than new ones. There are also environmental advantages, which Knorr-Bremse has calculated using life-cycle analyses: Compared with a new product, the process of remanufacturing a truck compressor produces 79% fewer CO<sub>2</sub> emissions, uses 72% less energy and requires 75% less new material. These are advantages that are appreciated by customers: "In future we expect 8% of our turnover to come from remanufactured products," says Stefan Bräuherr.

So in terms of total cost of ownership, products and solutions from Knorr-Bremse have both economic and environmental advantages. "For me, TCO analyses are the most effective way of achieving greater sustainability," concludes Bräuherr. That is why he advocates using key TCO indicators as the basis of all purchasing decisions – not just when buying a car or refrigerator.

The UN Global Compact Progress Report for 2016 provides information about Knorr-Bremse's sustainability policy

79%  
fewer CO<sub>2</sub> emissions  
when products are  
remanufactured

10%  
lower energy consumption  
with iCOM Assist

Cost advantages of  
remanufacturing.



Connected Care

## Helping communities globally and locally

**Global social responsibility requires a global perspective and detailed knowledge of aid projects on the ground. In 2016, Knorr-Bremse developed a more connected approach that brought together its skills in these two areas. One important focus was on sport as a key to education and for teaching social skills.**

Knorr-Bremse takes its responsibilities seriously – for products, staff, the environment, and society. The Company's social commitment consists of two pillars: Local Care and Global Care. Knorr-Bremse Global Care e.V. is an independent charitable organization that supports people all over the world who find themselves in difficulty through no fault of their own. Local Care covers all the local community activities carried out at Knorr-Bremse sites – from charitable donations to staff participation in corporate volunteering events. Local Care also includes the 'Get involved' initiative, through which Knorr-Bremse sites support projects where staff do voluntary work in their free time. At the start of 2016, Knorr-Bremse tight-

ened the organizational profiles of Local Care and Knorr-Bremse Global Care. At the same time, the aim is for greater collaboration between the two areas in countries with Knorr-Bremse sites, in order to create more synergies. Together, more can be achieved.

In future, Knorr-Bremse Global Care therefore plans to invest most of its funding in projects based in countries with Knorr-Bremse sites. Julia Thiele-Schürhoff, Chair of Knorr-Bremse Global Care, explains why: "Our staff who are involved in Local Care projects have detailed knowledge of the needs of their local communities. They know how people can be helped effectively. This means we can

Sport often opens doors to education.

target Global Care resources very specifically." Another advantage is that in countries with Knorr-Bremse sites, Global Care can make use of existing corporate structures and communicate in the local language. All of this makes aid work more efficient.

#### Sports equipment for elementary schools in China

A Knorr-Bremse project that benefits two Chinese elementary schools provides a good example of how this works. The schools are both located in impoverished rural areas and had been suffering for years from dilapidated infrastructure and rising numbers of pupils. Since they received very little state funding and no private support, the schools were at risk of being completely neglected. Staff at the Knorr-Bremse sites in Shiyuan and Chongqing assessed the situation at the schools, spoke to the principals, drew up a detailed project plan, and recommended it to Global Care as worthy of support. Knorr-Bremse Global Care contacted two local aid organizations that helped with the administrative side of things, and eventually, thanks to the financial assistance, the two schools were equipped with new tables, chairs, beds, books, and solar-powered boilers, as well as plenty of new sports equipment.

So why sports equipment? Julia Thiele-Schürhoff explains: "Sport is not only good for you physically; it also has a social effect. Playing sports together teaches children important lessons about how to behave, for instance respecting rules, team spirit, fair play, and the merit principle. Sport can also kick-start and reinforce individual educational and learning processes."

Knorr-Bremse Global Care provided the financial resources for this project, while Knorr-Bremse staff in the Local Care teams took on the task of project management as well as sourcing the equipment and handling the logistics. And some staff at the Shiyuan site even developed a special road safety course for children.

#### Sport as a means of preventing violence

The concept of sport as a door to education is also behind another project that Knorr-Bremse Global Care has been involved with since 2015. For this project, the organization is working with Knorr-Bremse South Africa and AMANDLA EduFootball. Together with the Oliver Kahn Foundation, AMANDLA has so far set up three education centers that it runs in inner city areas – two of them in townships in Cape Town. These 'Safe-Hubs' combine holistic education with sporting activities, particularly soccer. "The Safe-Hubs are above all a central place for young people to go, offering safety and a positive learning environment," says Jakob Schlichtig, one of the man-

aging directors of AMANDLA. "By playing team games like soccer and through group activities, the young people slowly develop trust and learn alternatives to the violence and negative influences that dominate their everyday lives. This builds the foundations for a holistic education, giving girls and boys a chance of a better future. At the Safe-Hub they can start to realize their full potential!"

The training sessions bring structure to the lives of children who are otherwise often left to their own devices. Children aged between nine and eleven see themselves as valuable members of society and develop social skills. In the long term this enables them to develop their own life plans, which AMANDLA helps them achieve through specific courses, workshops, and valuable contacts. Every year, as part of its PlayMaker educational program, AMANDLA also trains 15 young people in youth work or sports management at each of its Safe-Hubs. These young people not only act as soccer coaches and teachers, organizing sports programs for between 1,500 and 2,000 children each week, but also take on the role of advisors and life coaches. "The PlayMakers' function as role models should not be underestimated," says Schlichtig. "The children realize they, too, can get out of the township, take advantage of educational and work opportunities, and break the cycle of poverty, unemployment, and inequality." The figures confirm the project's effectiveness: At the Safe-Hub in Khayelitsha, school performance in math and English improved by 38% on average within the space of a year, while the crime rate in the Safe-Hub's catchment area fell by up to 44% in some categories between 2009 and 2014. Fair play, tolerance, and responsibility make people winners – on and off the pitch.

Two of these Safe-Hubs have received considerable assistance from Knorr-Bremse Global Care. At the Oliver Kahn Safe-Hub in the south of Cape Town, Global Care helped fund the construction of an education center. And in Diepsloot near Johannesburg, it financed a one-year PlayMaker training course for 15 young people between the ages of 18 and 25. The aim is to consolidate the positive effects of the Safe-Hubs and contribute to sustainable change in the community. Since 2013, 77% of PlayMaker trainees have immediately gone on to find a job or a place on a further education course.

2016 achievements:

63

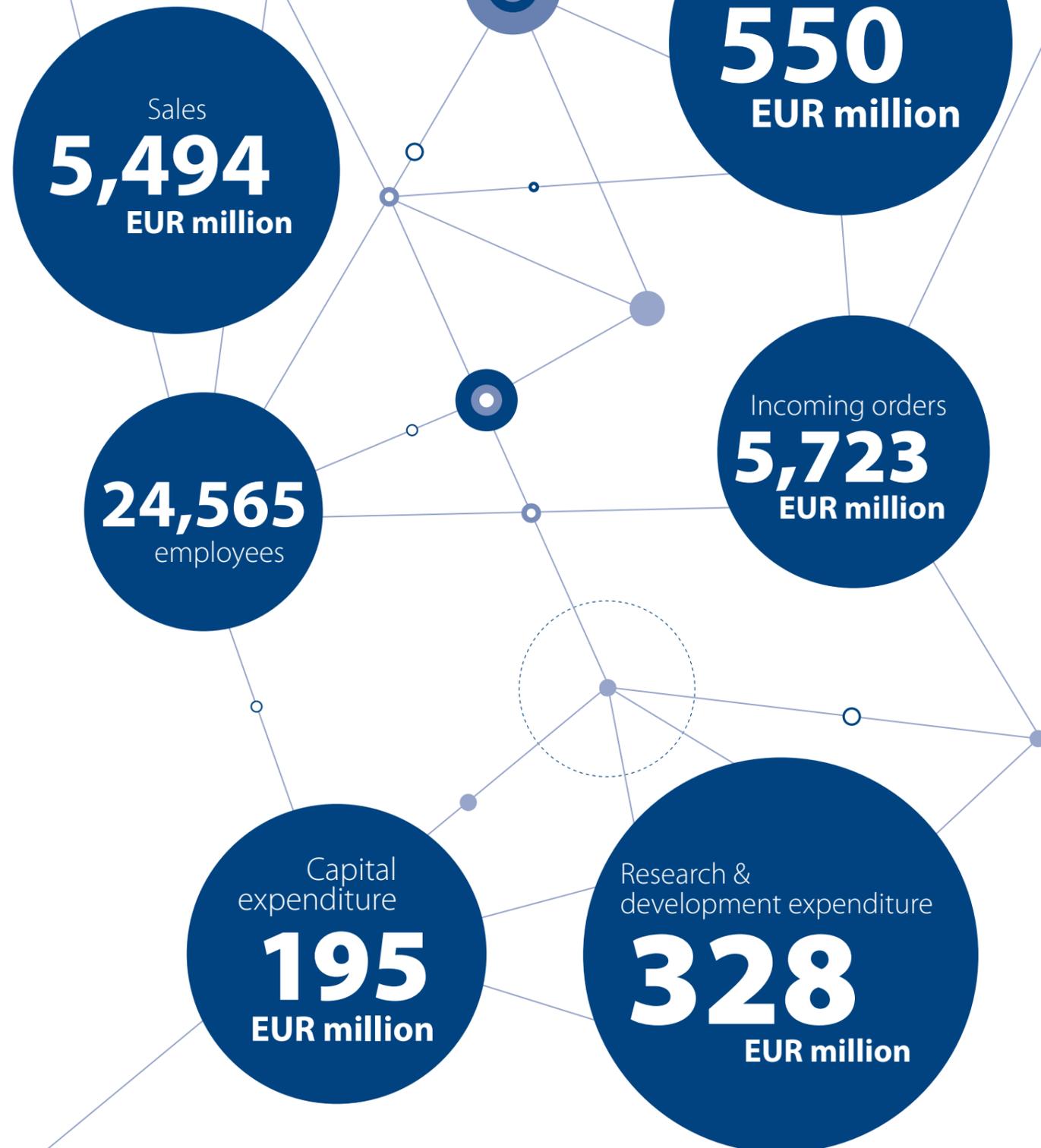
aid projects  
in 28 countries

52,000  
people in need  
helped in 2016

The  
Annual Report 2016  
contains information  
about the work of  
Knorr-Bremse  
Global Care.

Knorr-Bremse promotes sports at schools in China.

## The Year in Figures.



## Combined Management Report Knorr-Bremse AG and Group

### Status and Development

In fiscal 2016, Knorr-Bremse posted sales of EUR 5.49 billion (2015: EUR 5.83 billion). In line with expectations, in a difficult market environment sales showed a moderate 5.8% decline compared to the record year 2015. This meant that they were slightly down on our budget targets. In particular, the rail vehicle market in China and the freight transportation sector in North America returned weaker performances than in the previous year. Incoming orders eased ahead from EUR 5.67 billion to EUR 5.72 billion.

### About the Group

#### An Overview of the Knorr-Bremse Group

Knorr-Bremse is the leading manufacturer of braking systems and supplier of additional sub-systems for rail and commercial vehicles. Ever since 1905 the Company has been pioneering the development, production, marketing, and servicing of state-of-the-art braking systems and related sub-systems. In the rail vehicle systems sector, other lines of business include platform screen doors, entrance systems, energy supply systems, driver assistance systems, HVAC systems, control technology, friction material, windscreen wiper systems, simulators, and control components. The product range in the commercial vehicle systems sector includes complete braking systems with driver assistance systems, steering systems, torsional vibration dampers, power-train-related solutions, and transmission control systems for enhanced energy efficiency and fuel economy. The structure of the Knorr-Bremse Group is based on the regions Europe/Africa, North America/South America, and Asia/Australia, and the Group's efforts are geared to meeting the specific requirements of these markets and customers. The Group's regional structure is designed to offer globally active customers uniform technical platforms which at the same time take specific local needs into account. It also ensures that customers who operate on a regional basis are supplied with globally proven components and systems.

### Business Report

#### General Economic and Industry-related Backdrop

The dominant factors in the year under review were the volatile development of the global economy coupled with slow market growth, particularly in China and North America. China appears to be moving toward a domestic market driven economy. Europe witnessed a moderate economic downturn in the course of 2016. The developing and emerging economies were able to pick up a little speed again. Global economic growth remained roughly on a par with the previous year.

The worldwide market for rail vehicles was in decline. This was reflected in the marked drop in demand for high-speed trains and locomotives in China, and a cyclic slowdown in the freight car and locomotive business in North America. Through further expansion of its commuter rail and/or RailServices business in these markets, Knorr-Bremse was able to partly offset the resultant decline in sales.

The global commercial vehicle market showed a modest upswing in the year under review. Vehicle output in both North and South America fell by approximately 20%. The truck and trailer business in Europe and Asia showed progress and offset the cyclic market volatility in North America.

#### Europe/Africa

The rail vehicle market in Europe remained at its prior-year level. While the market volume was largely unchanged year-on-year in Germany, France, and the Scandinavian countries, the UK posted marked growth as large-scale projects were ramped up. Following a further decline, Russia/CIS stabilized in the course of the year at a significantly lower level.

The European commercial vehicle market was able to compensate for the moderate decline in output in Eastern Europe through higher production figures for Western Europe. European truck production rose 1% in 2016 after growing 5.5% in 2015.

### North America

The North American mass transit market continued its growth, leading to positive development in the passenger sector. In contrast, the rail freight sector showed a marked downturn – due in part to the large investments in rolling stock over the last few years creating a surplus of vehicles as demand declines.

The commercial vehicle market in North America showed a negative development. Freight forwarders canceled orders, truck manufacturers laid off employees, freight prices and volumes fell. Unit sales of trucks of 15 tonnes and over were down by approximately one-third against the previous year. Trailer sales also declined, although not as steeply as those of tractor units. In general, market demand shifted away from standard tractor units and toward special-purpose vehicles – for the construction industry, for example.

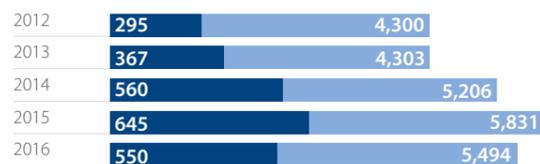
### South America

In the South American rail vehicle sector, against the backdrop of the continuing political and economic crisis in Brazil, which also impacted on neighboring countries, no positive impetus was forthcoming. As a result, South American truck production remained at a low level. In 2016, truck output in Brazil was roughly 70% down compared to its pre-crisis level in 2013.

### Asia/Australia

The rail vehicle market in Asia/Australia showed a 13.5% downturn against the previous year. This was primarily due to weaker demand for high-speed trains and locomotives in China. This negative development was partly offset by growth in the metro segment in China, as well as in the Indian market, where demand for locomotives also increased.

The commercial vehicle business made particularly good progress in China.



Sales and net income for the Knorr-Bremse Group in EUR millions

■ Sales  
■ Net income

## Development of the Knorr-Bremse Group in 2016

### Developments by Region and Division

#### Europe/Africa

##### Rail Vehicle Systems

Knorr-Bremse maintained its strong market position in Europe by securing numerous important orders. UK operator First Great Western continues to expand and in the year under review ordered seven mainline trains from Hitachi's AT300 series. As with the first tranche ordered in 2015, Knorr-Bremse is to supply the braking systems for the new nine-car sets.

Knorr-Bremse took a share of a major order from Belgian rail operator SNCB through the Company's Austrian subsidiary IFE, who are supplying the entrance systems. The 445 M7 Bombardier double-deck cars travel at speeds of up to 200 km/h and are destined to run on all main routes in Belgium, as well as in cross-border operations in The Netherlands and Luxembourg.

The CFCB – Compact Freight Car Brake – from Knorr-Bremse has only been on the market for eight years but already the Company has supplied the 10,000th unit in Europe including Turkey. The CFCB is low-wearing and substantially lighter than conventional brake equipment. Direct transmission of the brake force makes for high efficiency and with just four brackets for attaching to the bogie, installation is straightforward.

As part of an extensive modernization project, Budapest Metro has commissioned Russian manufacturer Metro-wagonmash to upgrade 37 trains comprising 222 cars. In 2015 Knorr-Bremse had already been commissioned to install new entrance systems and the order to upgrade the braking systems then followed. The new wheel-slide protection control unit was supplied by Knorr-Bremse subsidiary Selectron.

Ever since the X2000 high-speed trains were launched by Swedish state rail operator SJ AB in 1990, they have ranked among the most comfortable mainline trains in the world. Now these trains are up for extensive modernization. Swedtrac RailServices AB, a service subsidiary of Knorr-Bremse, is equipping 227 cars with new seats, floors, wall and ceiling panels, internal doors, and kitchens and toilets.

RailServices is also implementing three modernization projects in Africa, where 15 locomotives belonging to Namibian operator TransNamib are being fitted with new braking systems, while the BB1100 locos operated by Camrail from Cameroon are getting new compressors. For mining company VALE, which operates a stretch of railroad between Mozambique and Malawi, Knorr-Bremse is replacing the old vacuum brakes on 100 freight cars with modern pneumatic braking systems.

##### Commercial Vehicle Systems

In 2016 the disc brake and electronic braking systems product segments were the key sales drivers for the Commercial Vehicle Systems division in Europe. Among other things, Knorr-Bremse was able to build on its leading market position in the brake control segment. A major European commercial vehicle manufacturer signed an agreement running until 2027 governing the supply of Global Scalable Brake Control (GSBC) systems. This new systems architecture lays the foundations for the next steps along the road to autonomous driving. Further long-term agreements were signed with several European customers for the supply of disc brakes, compressors, valves, and air treatment systems, thereby safeguarding the long-term future of the business.

The Company also made progress with the introduction of environmentally compatible technology. From 2017 onward, Knorr-Bremse is to supply one of the major European commercial vehicle builders with the new generation of the electrically powered screw-type compressor. Numerous other agreements concluded around the world ensure further growth in terms of brake control systems, wheelend systems, and driver assistance systems.

In the trailer segment too, Knorr-Bremse scored further successes. Trailer EBS (TEBS) systems were placed with Spanish market leader Lecitrailer, while Krone, one of the major trailer manufacturers based in Germany, also introduced TEBS from Knorr-Bremse. The system integrates all braking functions, the ABS system, the load sensing, and the stability program, and regulates all processes electronically. Vlastuin from The Netherlands opted for the iLvl electro-pneumatic suspension system.

In 2016, TIP Trailer Services began using iTAP Push. This system records vehicle operating data and makes them available online for subsequent evaluation. Knorr-Bremse scored another iTAP success with Schmitz Cargobull, where development work on the innovative S.KI Control tipper trailer was concluded. This model, featuring various iTAP functionalities, is slated to enter series production in 2017.

In the shape of Wielton and Schwarzmüller, two other major European trailer builders introduced the ST7, the lightest twin-piston brake on the market. By year-end 2016, this brought the number of these disc brakes out on the road to 400,000 units.

In the aftermarket sector, Knorr-Bremse celebrated the global debut of its new TruckServices brand at the 2016 Automechanika fair. The new brand brings together the Company's services for this segment under one roof. TruckServices aims to offer reliable and economical diagnostics, maintenance, and repair solutions for any commercial vehicle, irrespective of model and age.

The Company also expanded its existing service portfolio. The wide range of industrially remanufactured products was complemented in the year under review by actuator units for air disc brakes for tractor units and trailers. A cost-effective and environmentally friendly alternative, above all for repairs to older commercial vehicles, this product group is now marketed under the uniform brand name EconX.

During the year under review, Alltrucks, a joint venture between the leading automotive and commercial vehicle suppliers Bosch, Knorr-Bremse, and ZF, was launched in Italy, the Benelux countries, and Spain. By the end of 2016 almost 280 cross-brand commercial vehicle service workshops had joined the Alltrucks network. In addition, the service portfolio was also expanded, not least through a cooperation agreement with low-loader specialist Goldhofer and collaboration with ADAC truck service subsidiary EuropeNet.

#### North America

##### Rail Vehicle Systems

The Los Angeles County Metropolitan Transit Authority authorized option orders for a further 60 light rail vehicles, bringing the total volume to 235 car sets. Knorr Brake Company equipped the cars with braking, entrance, and HVAC systems, as well as auxiliary power supply systems. In addition, Knorr-Bremse was awarded the order for the braking and – in some cases – entrance systems for more than 100 light rail vehicles in Calgary, Denver, Oklahoma City, Milwaukee, Minneapolis, and Guadalajara.

A locomotive consortium consisting of the U.S. federal states of Illinois, Michigan, Missouri, California, Pennsylvania, and Florida ordered braking systems for 92 locomotives. The California Department of Transportation

and Maryland Transit Administration ordered another 22 units. In the freight sector, Knorr-Bremse's U.S. subsidiary New York Air Brake (NYAB) reached the 10,000 milestone in sales of DB-60 Gen II units with Brake Cylinder Maintaining.

#### Commercial Vehicle Systems

Despite a challenging market environment, 2016 was a year of substantial achievement for Knorr-Bremse's North American subsidiary Bendix Commercial Vehicle Systems LLC in Elyria, Ohio. By way of example, Bendix launched the ADB22X-LT – the first Bendix air disc brake engineered specifically for trailers. At the manufacturing campus in Acuña, Mexico, a new state-of-the-art driver control module production line came on stream. A large proportion of these modules are destined for the nearby production facility of commercial vehicle builder Navistar.

As well as initiating an extensive retrofit program for FedEx, Bendix also concluded critical long-term agreements with multiple manufacturers. Most major North American OEMs have issued releases for the high-performance Wingman® Fusion™ driver assistance system from Bendix. Also, Bendix® Wingman® Advanced™ was named standard by International Truck, the first manufacturer to do so.

Further milestones in 2016 included air disc brake production reaching 1.5 million units, while 500,000 Bendix ESP systems are now on the road; the company's proprietary online training platform exceeded 45,000 enrollments, and remanufactured brake shoe production surpassed the four-million mark in mid-year.

#### South America

##### Rail Vehicle Systems

In the year under review, Knorr-Bremse focused on the ramp-up of the replacement and upgrading of the braking systems on a total of 8,500 sugar cane cars at South America's largest logistics operator, RUMO/ALL. The shop-in-shop principle allows Knorr-Bremse to install the systems directly in the customer workshops on site.

##### Commercial Vehicle Systems

Despite commercial vehicle manufacturers having cut their output and shelved development projects, Knorr-Bremse Brazil succeeded in placing the new Global Scalable Brake Control (GSBC) in numerous models from VW Trucks and further increased its trailer ABS market share.

#### Asia/Australia

##### Rail Vehicle Systems

With new orders placed for over 5,400 Chinese metro cars in 2016, Knorr-Bremse secured a substantial 65% market share. The Company equipped 93 new eight-car metro units for MTRC Hong Kong with braking and HVAC systems. Together with Japanese rail vehicle builder Kinki Sharyo, Knorr-Bremse won the contract for Phase 1 of the Metro Doha project in Qatar. This is the Company's first order for entrance and HVAC systems for metro cars from Kinki Sharyo.

In the Chinese high-speed rail sector, Knorr-Bremse was awarded contracts governing 738 cars. The Company is supplying complete braking systems for 226 of these cars, and bogie equipment for the 512 others. 264 cars are also to be equipped with IFE entrance systems, while Merak HVAC systems will be installed in 189 cars.

Knorr-Bremse also won a major order from India. The Company is to supply the braking systems for 800 double locomotives to be built by Alstom for state rail operator Indian Railways. The package also includes responsibility for servicing the brakes in 250 of the WAG12 double locomotives for a minimum of 13 years and in a further 250 locos for at least four years. Knorr-Bremse was also able to secure an order for braking systems for 112 metro cars for New Delhi RS 13, and is to supply both braking and entrance systems for new metro cars in Kolkata.

Knorr-Bremse expanded its market position in Australia with orders for 104 light rail vehicles. Along with vehicles for the Gold Coast route, the Company is to supply braking, entrance, and HVAC systems for new light rail vehicles destined for Melbourne, Sydney, Canberra, and Newcastle.

RailServices too recorded successes in Asia/Australia, as the Taiwan Rail Authority (TRA) awarded Knorr-Bremse a modernization order to retrofit more than 4,700 entrance systems in multiple units and passenger coaches.

##### Commercial Vehicle Systems

While the Chinese commercial vehicle market posted year-on-year growth of 25%, Knorr-Bremse's business moved ahead almost twice as fast, growing by more than 49%. Major contributory factors here included orders from key account customers such as the Weichai Group, FAW, and BYD Bus, who particularly appreciate the system solutions and the broad product portfolio that Knorr-Bremse offers.

Vehicle manufacturer Weichai ordered substantial numbers of compressors and dampers, while FAW ordered air treatment systems and compressors for its wide range of commercial vehicles and buses that are marketed in more than 70 countries. The BYD conglomerate opted to equip its electric buses for the local mass transit sector with air disc brakes and ABS systems from Knorr-Bremse. Further positive impetus in the Chinese market was generated by the electronic components business.

##### Acquisitions, additions, and joint ventures

On January 1, 2016, through its subsidiary Microelettrica Power Pty. Ltd., Knorr-Bremse acquired a 60% stake in Semikron (Pty.) Ltd. of Johannesburg, South Africa (since renamed Semiconductor Solutions (Pty.) Ltd., Johannesburg, South Africa). On February 1, 2016, Knorr-Bremse acquired the rail transportation activities of brake pad specialist TMD Friction Group. On November 21, 2016, the outstanding 50% stake in Icer Rail S.L., Pamplona, Spain, was acquired from long-standing joint venture partner Berkshire, S.L.U. Icer Rail manufactures brake pads for rail vehicles.

Effective July 5, 2016, Knorr-Bremse acquired 100% of the shares in GT Group Ltd., Peterlee, UK, which mainly manufactures exhaust gas recirculation valves and exhaust brakes for commercial vehicles. On June 22, 2016, Knorr-Bremse Commercial Vehicle Systems Japan Ltd. signed a purchase agreement with Bosch Corporation Japan, governing acquisition of all of the assets of the Bosch Transmission Systems division (TRS) in Japan. In view of the need for a prior carve-out and integration into the systems architecture at Knorr-Bremse, completion of the agreement is set for March 31, 2017. TRS develops, manufactures, and markets systems and components for manual and automatic transmissions for on-highway commercial vehicles in Asia. On September 8, 2016, tedrive Steering Systems GmbH of Wülfrath near Wuppertal, Germany, was acquired. tedrive develops, manufactures, and markets vehicle steering systems for the global market.

##### Quality and processes

In the Knorr Excellence management system that has been rolled out worldwide, Knorr-Bremse has brought together its initiatives targeting continuous improvement of its business processes. The focus here is increasingly on IT-assisted process organization and execution. This digitalization enables more effective and efficient development collaboration between the various locations around the world. It also contributes to the continuous improvement of production processes. Knorr-

Bremse uses pilot projects to study the efficiency potential that can result from data connectivity and analytics, for example when using augmented reality technologies to ensure the more efficient supplying and equipment of production lines.

Knorr-Bremse examines and enhances the implementation of its quality management system through internal quality audits and assessments conducted worldwide. This is confirmed by external IRIS and/or ISO/TS 16949 certification audits. In 2016, various sites in countries including Germany, Turkey, Russia, United Kingdom, and Sweden were additionally certified in line with different standards (ISO 9001, IRIS, ISO 14001, OHSAS 18001, and ISO 50001).

In the year under review, one focus of activities at Knorr-Bremse was on reducing the cost of quality. In the Rail Vehicle Systems division, the relative cost of quality was cut by 8% compared to 2015 in what was a further significant reduction. Contributory factors here included a raft of improvement measures along the entire value chain, as well as even stricter cost control and quality management. In the Commercial Vehicle Systems division too, as in 2015 the cost of quality remained at a low level. The division has introduced a database-based tool for the improvement of the product creation process. The Liberec plant in the Czech Republic has implemented and expanded processes for industrial-scale product remanufacturing.

In the context of ongoing process improvement, in 2016 the Company made its purchasing and HR processes more transparent and more efficient. Knorr-Bremse works to raise awareness of quality among its partners and suppliers. To this end, Supplier Days and training courses for suppliers were staged in the year under review.

Product safety is one of Knorr-Bremse's core competencies and is assured through regular audits, as well as coaching and training sessions. The systematic improvement of warranty processes and the application of a field evaluation tool made for greater transparency. Along with Six Sigma training courses and projects, in 2016 Design for Six Sigma (DfSS) methodology was applied to support development projects. Through involvement in working groups of the Association of the German Automobile Industry (VDA) or of UNIFE and VDB in the rail vehicle sector, Knorr-Bremse drove forward the creation of new standards and/or the improvement of existing ones.

##### Research and development

Knorr-Bremse continued to pursue its research and

development efforts in the year under review in close collaboration with its customers. Total expenditure on research and development and customer-specific development modifications amounted to EUR 328.4 million in 2016 (2015: EUR 347.3 million), which as in the previous year equated to 6% of consolidated sales.

The opening of the new Development Center at the Munich site represents the next step in the Company's extensive worldwide program of investment in the modernization of its production equipment and facilities, as well as in the expansion of its research and development capacities. With more than 100 different test rigs and dynamometers, the new Development Center offers state-of-the-art conditions for the development and testing of innovative braking systems for the rail and commercial vehicle markets. The new facility hosts 350 engineers and technicians from both divisions, pursuing interdisciplinary development work on future technologies that will bring a further increase in customer benefits and strengthen the Company's competitiveness. A highly sophisticated dynamometer permits wheel/rail adhesion characteristics to be studied using original components, opening up new brake control options. Knorr-Bremse is aiming to use this test rig to greatly simplify the type approval process for braking systems.

By delivering smart sub-system connectivity, Knorr-Bremse offers manufacturers and operators safe and efficient solutions for high-performance rail transportation. In the service arena the digitalization of the rail industry is leading to special solutions designed to save energy and permit condition-based maintenance. With iCOM, Knorr-Bremse is offering a universally applicable platform for the digital world of railroads. The system permits the automated diagnosis and display of the status and maintenance requirements of all key systems on the train. The onboard equipment is supplemented by applications such as iCOM Meter (energy metering) and the driver assistance system iCOM Assist (LEADER®). With LEADER®, drivers can reduce the energy requirements of their trains by between 10% and 15%. The system has been in operation in 300 DB Cargo AG locomotives since 2016.

At InnoTrans, the world's leading rail industry trade fair, Knorr-Bremse chose to spotlight its connected systems for rail vehicles. The advantage for the customer is that groups of functionalities that can be homologated in advance can be integrated into the vehicles, enabling the elimination of many steps in the type approval process. This saves time and cuts costs.

The EU-funded Shift2Rail program, approved in 2015 and providing a framework for rail transportation projects to the value of almost EUR 1 billion, entered the implementation phase. Within this program, Knorr-Bremse will be executing development projects on a significant scale.

In the Commercial Vehicle Systems division, the focus of development activities in the powertrain sector was on the use of rapid and precise mechatronic valves in the intake and exhaust manifolds to boost the efficiency of diesel engines. Another development focus was on compressors with optimized thermal management. With their enhanced thermodynamics, compressors with water-jacket cooling permit longer periods of operation and, through a further reduction in oil carry-over, achieve maximum purity in the compressed air. In turn, clean compressed air improves the reliability of the braking system as a whole. For alternative drive systems, the screw-type compressor is being further developed with the aim of achieving additional reductions in installation space, weight, and cost. In the air treatment segment the focus was on additional applications for the integrated parking brake within the Electronic Air Control (EAC) system, as the trend toward replacing pneumatic parking brakes in heavy vehicles continues.

Initial development outcomes for automated driving were presented at customers' premises as well as at the IAA Commercial Vehicles show. Driver assistance functionalities enable the tractor unit to be steered by applying the brakes on individual wheels. Highway Assist eases the load on the driver during normal freeway driving; Knorr-Bremse coordinates the longitudinal and lateral guidance to keep the vehicle stable even in critical driving situations. The Highway Pilot marks a milestone on the development roadmap: Here the vehicle and its intelligent Hydraulic Steering Assist (iHSA®) system drives in automated mode without driver intervention. In the event of a system failure a smart back-up structure ensures the vehicle is brought safely to a standstill. iHSA® technology is a hydraulic steering system with electronic activation, specially developed to meet the demands of automated driving in commercial vehicles.



Consolidated research and development expenditure in EUR millions

At the IAA Commercial Vehicle show, the predevelopment projects Autonomous Yard Maneuvering and Turning Assist illustrated the potential for greater efficiency and road safety that can be leveraged by consistently connecting the sub-systems in a truck, as well as through additional sensors.

In the wheelend segment, development activities for trucks focused on the in-vehicle and product release tests for the new Synact disc brake. The Active Caliper Release function, which minimizes pad wear and residual braking torque, was endorsed in an in-vehicle test. In a preliminary study, Brake Condition Monitoring is defined for the next upgrade of Synact, offering greater depth of diagnostics and maintenance.

For trailers in Europe the focus was on the development of an application-specific brake which, in North America, can also be used for the tractor unit. A study was drawn up presenting draft designs for an integrated compact wheelend for long-haul applications, which promise to deliver significant weight savings. The next generation of Trailer EBS (TEBS G3) has been prepared with the aim of integrating additional individual components. The functionalities of iTAP are being constantly added to and expanded. In the year under review, trailer remote control and fleet management systems were joined by the possibility of integrating video cameras.

Along with the megatrend of automated driving, connectivity too is becoming more and more important. Substantial cost savings can be achieved through the smart connection of all areas involved in transportation and logistics. In this context, at the Automechanika trade fair Knorr-Bremse announced its entry into the field of telematics.

#### Sustainability and social responsibility

Sustainability represents an important component of Knorr-Bremse's business model. The Company combines the creation of long-term economic value with ecological and social responsibility. That is why it has been committed to the principles of the United Nations Global Compact since 2010. Knorr-Bremse's own Corporate Responsibility Guideline (CR policy) is based on these principles. In addition, a CR Roadmap establishes annual areas of focus, which in 2016 included energy efficiency and safety. Knorr-Bremse integrates the basic principle of sustainability into all its processes – from the initial vision and strategic planning, via product development and manufacturing, right down to sales and logistics. Even in the early stages of development, the results of life cycle analyses are taken into account, so

that negative environmental impacts can be avoided as far as possible from the very outset.

The range of industrially remanufactured products bundled under the new EconX brand name ensures significantly improved sustainability for the commercial vehicle aftermarket: Life cycle analyses of a compressor, for example, have shown that, compared with the production of a new unit, remanufacturing requires 75% less material, emits 79% less CO<sub>2</sub> and consumes 72% less energy. In 2016, Knorr-Bremse set itself the goal of achieving climate-neutral organic growth by the year 2020.

This means that by 2020, despite an increase in production capacity, CO<sub>2</sub> emissions from operations at current sites will not exceed the figure for 2015. In a Group-wide analysis in 2016, Knorr-Bremse identified the biggest generators of CO<sub>2</sub> emissions within the Company. A list of short-, medium-, and long-term measures aimed at reducing CO<sub>2</sub> emissions has been drawn up, and implementation has started.

Knorr-Bremse works continuously on improving its health and safety and environmental policy and where possible is submitting it for certification by external bodies according to the international environmental management standard ISO 14001. By the end of 2016, 47 production sites had achieved such certification. Knorr-Bremse deliberately selects suppliers who can be relied on to assume responsibility for safety and environmental protection. In 2016, more than 75% of the Company's purchasing volume came from suppliers who had committed themselves to the principles of the UN Global Compact – a year-on-year increase of 10%. In addition, Knorr-Bremse works on optimizing logistics processes with a view to making the best possible use of the scope offered by rail, road, and waterways to minimize the environmental impact of product transportation. Strict environmental guidelines have also been formulated for new production facilities, and are defined in the Knorr-Bremse Construction Manual.

As a company, Knorr-Bremse assumes responsibility for solving social tasks. Its social commitment is based on two pillars: Knorr-Bremse Global Care e.V. and Knorr-Bremse Local Care. As an independent charitable organization, Knorr-Bremse Global Care supports people all over the world who are in need through no fault of their own. As in previous years, Knorr-Bremse supported Knorr-Bremse Global Care and promoted its activities in 2016. The organization's projects open up new prospects for people in need and are based on the principle of

helping them to help themselves. Knorr-Bremse Global Care was founded at the beginning of 2005 in response to the tsunami disaster in Southeast Asia to provide unbureaucratic and effective help to the victims. In the year under review, 63 aid projects were realized in a total of 28 countries on four continents. In most cases the projects are implemented in countries where there are Knorr-Bremse sites, and are supervised with great dedication by Knorr-Bremse employees.

Funding of EUR 1.92 million provided by Knorr-Bremse Global Care in 2016 reached almost 52,000 people. The organization's key project areas are education and WASH (water, sanitation and hygiene), but it also continues to provide global emergency disaster relief.

Local Care covers all the local community activities of employees at Knorr-Bremse sites around the world. In 2016 the Company revised its social commitment strategy. In particular, Global Care and Local Care jointly drew up a clearer definition of the focus of Knorr-Bremse Local Care's activities. Two new guidelines now provide a more distinct organizational demarcation of the two pillars, but at the same time strengthen the synergies resulting from closer coordination of joint projects in countries with Knorr-Bremse sites.

## Assets, Financial Status, and Profitability

### Profitability

At EUR 5,494.3 million, in the year under review consolidated sales were 5.8% down on the prior-year level (2015: EUR 5,830.6 million), falling slightly behind the forecasts for 2016. Adjusted for foreign exchange effects at actual 2015 rates, the decline in sales amounted to just 1.9%. The sales figures include EUR 39.7 million from the initial application of the Accounting Directive Implementation Act (BilRUG), whereby certain items previously carried under other operating income are to be shown as sales. In Europe/Africa, sales climbed 4.2% to EUR 2,728.2 million (2015: EUR 2,617.8 million), which corresponds to 49.7% of the consolidated total (2015: 44.9%). In the Americas, sales fell 14.9% to EUR 1,219.2 million (2015: EUR 1,432.7 million), contributing 22.2% (2015: 24.6%) to the consolidated total. In the Asia/Australia region, sales were down 13.1% to EUR 1,546.8 million (2015: EUR 1,780.1 million), which equates to 28.1% (2015: 30.5%) of the consolidated total.

The Rail Vehicle Systems division was unable to reach the previous year's level, returning sales of EUR 2,990.3

million (2015: EUR 3,341.1 million). The Commercial Vehicle Systems division posted an upturn in sales in the year under review, with revenues totaling EUR 2,523.2 million (2015: EUR 2,491.8 million). Further details are reported under Development of the Knorr-Bremse Group.

Incoming orders were valued at EUR 5,723.4 million (2015: EUR 5,668.3 million), 1.0% up on the previous year. Orders on the books at the Knorr-Bremse Group rose 8.6% in the year under review to EUR 4,154.2 million (2015: EUR 3,823.7 million).

In the year under review the cost of materials ratio developed in proportion to sales revenues, while the personnel cost ratio remained almost unchanged against the prior year. This is explained by the addition of new employees as a result of the new acquisitions.

Net income for the Knorr-Bremse Group was down in 2016 to EUR 549.7 million (2015: EUR 644.8 million). As a result of weak developments in China and in freight transportation in North America, the forecast net income for 2016 was not reached by a clear single-digit percentage margin. Net return on sales reached 10.0% (2015: 11.1%). The European/African region contributed EUR 241.7

million to net income, corresponding to a net return on sales of 8.9%. Net income from the Americas totaled EUR 100.0 million, with a net return on sales of 8.2%. The Asia/Australia region posted net income of EUR 208.0 million, which equates to a net return on sales of 13.4%.

### Assets

The consolidated balance sheet total rose 15.1% in 2016 to EUR 4,604.2 million (2015: EUR 4,001.9 million). At year-end 2016, total assets represented 83.8% of sales. As a proportion of the balance sheet total, intangibles, fixed assets, and investments were up from 26.0% in the prior year to 27.0%. Working capital, defined as the sum of inventories and accounts receivable, minus accounts payable trade, stood at EUR 666.8 million at year-end (2015: EUR 669.4 million) or 44 days' sales (2015: 41 days), which was roughly in line with forecasts for 2016. The equity ratio fell by 3.9 percentage points from 43.4% to 39.5%. Of the Group's total assets, 58.6% are tied up in the European/African region (2015: 49.6%), 14.9% in the Americas (2015: 17.8%), and 26.5% in the Asia/Australia region (2015: 32.6%).

### Financial status

The increase in cash and cash equivalents to EUR 1,716.2 million (2015: EUR 1,341.8 million) is primarily made up of the positive balance of inflow of funds from operating activities (EUR 709.4 million), outflow of funds to investments (-EUR 423.2 million), disbursements to company owners and minority shareholders (-EUR 428.3 million), and inflow of funds from a bond issue (EUR 498.3 million).

However, as a key performance indicator, Knorr-Bremse does not use reported cash and cash equivalents but net liquidity, defined as the balance of liquid funds, other securities, and receivables from unconsolidated affiliates, as well as bonds and liabilities to financial institutions. Net liquidity fell from EUR 1,199.5 million in the previous year to EUR 1,071.4 million in the year under review. This represents a clear shortfall compared to our forecast for 2016.

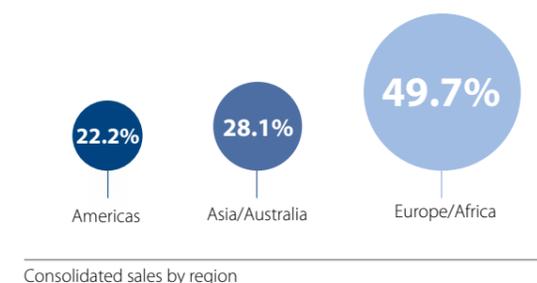
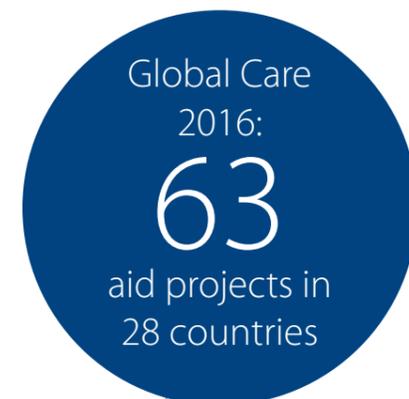
The Knorr-Bremse Group's investments in fixed and intangible assets totaled EUR 194.6 million, which is 7.4% down on the previous year and well below our forecasts for 2016. At EUR 135.6 million, 69.7% of the Company's capital expenditure was invested in Europe/Africa. EUR 32.0 million (16.4%) was invested in the Americas and EUR 27.0 million (13.9%) in Asia/Australia. In 2016, investment activity focused primarily on expenditures for the expansion of the Budapest plant; for machines and equipment related to the introduction of new prod-

uct generations; for the new facility of the Company's French subsidiary in Tinquex near Reims; and for the new Development Center in Munich. Replacement investments were also undertaken. Broken down by division, the allocation of capital expenditure was such that the Rail Vehicle Systems division benefited in the amount of EUR 103.5 million (2015: EUR 117.6 million) and the Commercial Vehicle Systems division in the amount of EUR 82.4 million (2015: EUR 81.1 million).

Depreciation on intangible and fixed assets declined across the Group, falling from EUR 198.9 million in 2015 to EUR 179.4 million in the year under review. With EUR 118.3 million, Europe/Africa accounted for the largest share of depreciation, followed by the Americas with EUR 37.6 million, and Asia/Australia with EUR 23.5 million. A breakdown of depreciation by division shows that the larger proportion of EUR 96.9 million was accounted for by the Rail Vehicle Systems division, while depreciation at the Commercial Vehicle Systems division amounted to EUR 71.4 million. The ratio of net liquidity to shareholders' equity stood at 58.9%, compared to 69.1% in 2015.

The Group has committed credit facilities in place in the amount of EUR 1.3 billion, of which EUR 0.9 billion remained untapped at the end of the financial year. Due dates and interest rates for the liabilities are in line with the market.

Two external agencies have been rating the Knorr-Bremse Group's creditworthiness since 2000. The ratings have been of investment grade status from the outset and they have improved continuously over time. Based on the results of fiscal 2015, Standard & Poor's and Moody's currently rate the Knorr-Bremse Group "A" and "A2" respectively, both with "Outlook stable." This represents an upgrade of one increment in each case over the previous "A-" and "A3" ratings. Through their ratings, the agencies recognized the continuity of the Group's management performance and its stronger



competitive position, particularly as a result of high investments in research and development. They also commended the Knorr-Bremse Group's substantial growth through acquisitions and the establishment of joint ventures. The current ratings put Knorr-Bremse among the top-placed automotive, commercial vehicle, and rail vehicle suppliers worldwide.

Knorr-Bremse AG issued a corporate bond with a volume of EUR 500 million. The bond bears interest at a fixed rate of 0.50% p.a. and has a five-year term. The revenue from the bond will serve to finance the growth of the Knorr-Bremse Group while at the same time optimizing the ratio of equity to outside capital in its financing structure.

## Overall Assessment of the Financial Position of the Group

Within the general economic environment described above, the Knorr-Bremse Group was not quite able to attain the previous year's position with regard to its assets and financial status, but was able to further optimize its liquidity position. The Group's profitability was ensured through rigorous cost management and continuous improvements to internal processes and structures.

With an equity ratio of 39.5% and net liquidity of EUR 1,071.4 million, the structure of the Group's assets is extremely stable. In sum, the Executive Board confirms that the representation of the Group's assets, financial status, and profitability presents an accurate overall picture of the Group on December 31, 2016.

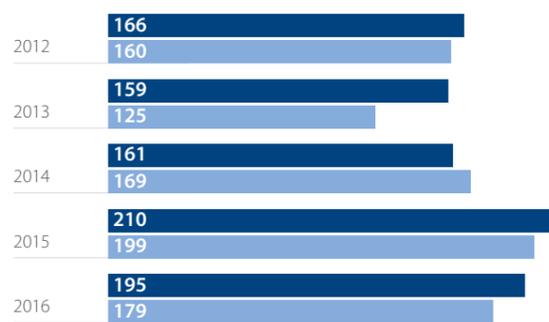
### Development of Knorr-Bremse AG in fiscal 2016

As the parent company, Knorr-Bremse AG performs the role of service provider and holding company, as well as a strategic management function on the operational side. Resulting from continuing strong performance in the regions Europe/Africa, the Americas, and Asia/Australia, income from investments in associated and related companies was approximately at the prior-year level, leading to a slight decline in income before taxation, which totaled EUR 469.1 million in the year under review (2015: EUR 485.7 million). Owing to the development of Group earnings, at EUR 442.4 million (2015: EUR 447.6 million), income from investments in associated and related companies was slightly below our forecasts for 2016.

Along with interests in affiliated companies, the balance sheet of Knorr-Bremse AG largely reflects receivables from and payables to Group companies. These are centrally administered, partly within the framework of a cash-pooling process managed by Knorr-Bremse AG.

Knorr-Bremse AG acts as an in-house bank for its subsidiaries around the world. This includes handling the central hedging of market price risks. The subsidiaries contract their hedging transactions with Knorr-Bremse AG, which in turn hedges part or all of the net residual risk for the Group with external banks.

With the aid of global process standardization and transparency, achieved through Knorr Excellence, Knorr-Bremse AG is able to efficiently control its own business and that of the associated and related companies.



Consolidated capital expenditure and depreciation in EUR millions

■ Capital expenditure  
■ Depreciation

## Non-financial Performance Indicators

### Human resources

At year-end 2016, the Knorr-Bremse Group employed a total of 24,565 persons (22,221 excluding HR leasing). This equates to a year-on-year increase of 1.2% (2.0% excl. HR leasing) and was in line with our expectations for fiscal 2016.

In the European/African region, there were 14,055 employees on the Knorr-Bremse payroll at year-end 2016 (12,975 excl. HR leasing), compared to 12,858 at the end of 2015 (11,950 excl. HR leasing). This meant that, at 57.2%, the proportion of the Group workforce employed in Europe was higher than in the previous year (53.0%). The workforce in Germany totaled 5,044 employees (4,661 excl. HR leasing), up from 4,742 in 2015 (4,416 excl. HR leasing).

The number of employees in the Americas fell in 2016, reaching 4,428 at year-end (4,134 excl. HR leasing), compared to 4,797 in 2015 (4,644 excl. HR leasing). The proportion of the Group workforce in the Americas stood at 18.0% (2015: 19.7%).

In Asia/Australia, the size of the workforce declined from 6,620 in the previous year (5,189 excl. HR leasing) to 6,082 at year-end 2016 (5,112 excl. HR leasing). The proportion of the total headcount employed in the region fell from 27.3% in the previous year to 24.8%.

### Appropriation of retained earnings

Knorr-Bremse AG posted unappropriated retained earnings of EUR 676.1 million in fiscal 2016 (2015: EUR 618.3 million). The Annual Shareholders' Meeting will be asked to approve the proposal that an amount of EUR 364.0 million from these unappropriated retained earnings be used to pay a dividend of EUR 140 (2015: EUR 140) per dividend-bearing share with a par value of EUR 26, with the balance to be carried forward to new account.

### Relations with affiliated companies

KB Holding GmbH, Grünwald, Germany, directly holds more than half the share capital of Knorr-Bremse AG. Pursuant to Section 312 German Corporation Law (AktG), a Report on Relations with Affiliated Companies has been drawn up which includes the following statement: "In the legal transaction shown in the Report on Relations with Affiliated Companies, in accordance with the circumstances known to us at the time at which the said transaction took place, our Company paid appropriate consideration." The report was verified by the Auditors and received their unqualified opinion.

Assets	Balance sheet total in EUR millions	2015	4,001.9	2016	4,604.2
Fixed assets/Intangibles		24%		25%	
Investments		2%		2%	
Current assets/Prepaid expenses		40%		36%	
Liquid assets		34%		37%	
Liabilities	Balance sheet total in EUR millions	2015	4,001.9	2016	4,604.2
Shareholders' equity		43%		40%	
Pension accruals		6%		5%	
Short-term debt		47%		41%	
Borrowings		4%		14%	

Structure of assets, liabilities, and finances of the Knorr-Bremse Group

In the Rail Vehicle Systems division, the number of employees fell from 14,502 in the previous year (12,600 excl. HR leasing) to 14,440 at year-end 2016 (12,843 excl. HR leasing). In the Commercial Vehicle Systems division, by contrast, the headcount rose from 9,320 employees in 2015 (8,734 excl. HR leasing) to 9,674 at year-end 2016 (8,930 excl. HR leasing). The holding companies employed an additional 451 staff (448 excl. HR leasing), compared to 453 employees (449 excl. HR leasing) in the previous year.

In view of demographic trends and a foreseeable shortage of specialists in technical professions, it is important for Knorr-Bremse to recruit increasing numbers of well-trained and highly qualified women. However, raising the proportion of women in management roles will take time. Knorr-Bremse makes targeted use of programs that aim to increase the proportion of women in management roles. These include the Knorr-Bremse management trainee program MEP. On this program the proportion of female trainees in 2016 was 42% (2015: 42%). While the proportion of women in management roles across all fields of activity stands at 11.6% (2015: 11.0%), in non-technical fields women fill 32.8% of management positions (2015: 32.5%).

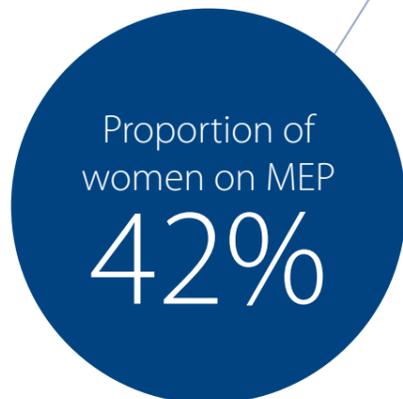
In its efforts to meet the target quotas set in fiscal 2015, in the year under review Knorr-Bremse achieved the following quotas – changes are accounted for by shifts in management personnel, all the way to the Supervisory Board:

Knorr-Bremse AG:  
 Supervisory Board target quota 0%, actual quota 9.1%  
 Executive Board target quota 0%, actual quota 0%  
 Management Level II target quota 15.4%, actual quota 0%  
 Management Level III target quota 0%, actual quota 6%.

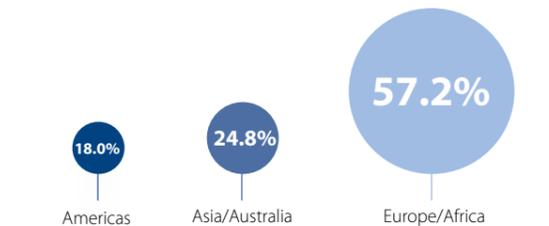
Knorr-Bremse Systeme für Schienenfahrzeuge GmbH:  
 Supervisory Board target quota 0%, actual quota 0%  
 Management Board target quota 0%, actual quota 0%  
 Management Level II target quota 0%, actual quota 0%  
 Management Level III target quota 5.9%, actual quota 4.3%.

Knorr-Bremse Systeme für Nutzfahrzeuge GmbH:  
 Supervisory Board target quota 12.5%, actual quota 16.7%  
 Management Board target quota 0%, actual quota 0%  
 Management Level II target quota 0%, actual quota 1.3%  
 Management Level III target quota 5.1%, actual quota 10.8%.

Knorr-Bremse would like to thank all of its employees for their commitment and hard work in 2016. Thanks also go to the employee representatives for their constructive collaboration.



Group workforce on Dec. 31, 2016



Group workforce by region on Dec. 31, 2016

## Report on Risks and Opportunities

### Risk management system

The Knorr-Bremse Group employs an established, multi-stage, worldwide planning, reporting, and controlling system in order to identify risks early on and be able to generate an appropriate response. Standard reporting periods and report contents have been defined across the Group. These formal reports are supplemented in greater depth by presentations on routine and special subjects at monthly review meetings.

In addition, there is a standardized risk management reporting system at top management level, including a risk report covering identified risks that is regularly submitted to the Executive Board. Based on this report the Executive Board decides on concrete measures.

This interplay of a risk management system anchored within the organization and strategic reporting has proven its worth over time. Knorr-Bremse thus has a reliable network in place for the early identification and remediation of potentially undesirable developments.

The findings of this risk assessment and their management were also flowed into the description, documenting, and continuous improvement of operating processes within the Knorr Excellence model.

### Business risks

Every entrepreneurial activity involves an element of risk. This is particularly the case for a globally active corporate group, as regional markets are subject to different and very irregular cycles. This can lead to market volatility or fluctuating growth affecting individual suppliers, market segments, or regions. The global rail and commercial vehicle markets are subject to this volatility, which means that Knorr-Bremse is operating in a fundamentally high-risk environment within the global economy.

The year under review was marked by a lack of stability in the development of the global economy, weak market growth – particularly in China and North America – and changing market structures. China appears to be moving toward a domestic-market driven economy. Europe also witnessed a moderate economic downturn in the course of 2016. Other destabilizing factors for the global economy included the failed coup in Turkey, trouble spots such as Syria, and an increase in populist trends, reinforced not least by the United Kingdom’s vote to leave the European Union. Terrorist attacks around the world, including in the vicinity of Knorr-Bremse plants, made for added instability in terms of economic development.

In order to minimize and/or anticipate risks affecting its sales, the Group carefully monitored the economic development of the individual countries and regions, as well as the worldwide trade flows. At the same time, Knorr-Bremse’s international presence rendered the Group largely immune to crises that are restricted to individual regions.

Knorr-Bremse operates in increasingly competitive markets, putting price stability at risk. A macroeconomic environment marked by uncertainty involves the risk that customer creditworthiness could fall, receivables outstanding could be lost and/or payments delayed. In the year under review, Knorr-Bremse was able to counter this risk successfully through effective receivables management.

A further risk for Knorr-Bremse results from its dynamic growth in recent years. In the course of this process, a number of companies or shareholdings had to be integrated into the Group. Knorr-Bremse effectively minimized the financial and cultural risks associated with such integration processes through the systematic analysis and assessment of the target companies. The Company’s experience in successfully overcoming cultural barriers has been mapped in the form of structured processes, so that it can be utilized in future acquisitions and joint ventures in which Knorr-Bremse holds a majority stake.

Knorr-Bremse and its products and solutions are at the leading edge of technological development. This also engenders risks which, because of the safety-critical nature of the applications concerned, require particularly careful monitoring. To this end, Knorr-Bremse routinely employs comprehensive quality planning, quality assurance, and testing procedures. To ensure continuous improvement of its business processes, Knorr-Bremse takes its lead from international standards. The individual plants regularly undergo internal and external audits in this context. Both divisions work intensively and continuously to further improve the exceptionally high quality and safety level of their products.

### Operational risks

For Knorr-Bremse, an operational risk is defined as the risk of incurring a financial loss due to procedural, technical, or human error. As there is clearly no means of entirely eliminating these risks, in the year under review the Group duly found itself confronted with operational risks.

Owing to the risk of delayed deliveries from suppliers, quality defects in the parts supplied, or supplier insolvency, Knorr-Bremse is exposed to the latent risk of lost production time and loss of earnings. In the year under review the Company was able to minimize this risk effectively through comprehensive supply chain management. This is founded upon careful supplier selection procedures and continuous technical and commercial supplier audits.

Another risk results from the possibility of unforeseen shifts in capacity. Flexible working hour models means that Knorr-Bremse is well prepared to counter this risk. If necessary these models could have been deployed in an efficient response to shifts in capacity.

Given the dynamic development of the markets and regions of the world, Knorr-Bremse is constantly confronted with the challenge of relocating development and production capacities from one Group site to another, in order to respond flexibly to changing market and customer requirements.

Warranty risks for products already supplied are another ongoing consideration. If Knorr-Bremse is under contractual obligation to compensate the customer for damage or loss, this can have substantial financial consequences. In the year under review, Knorr-Bremse successfully kept these risks under control through systematic contract management.

Exchange rate risk is not of crucial importance for the Knorr-Bremse Group because geographic diversification over recent years has enabled the Group to establish a high proportion of local manufacturing and local suppliers within the respective currency zones. In order to limit the residual exchange rate risk related to transactions across different currency zones, Knorr-Bremse is increasingly identifying opportunities to exploit compensatory supply volumes within the Group. In selected cases, risks extending above and beyond this are hedged by means of derivatives. Such measures, however, serve exclusively to hedge basic transactions within the scope of normal business operations.

The basis for managing foreign exchange risks is provided by the Guideline on Managing Currency Exposure in the Knorr-Bremse Group, which sets out the procedures to be followed and the necessary scope of hedging transactions in binding form for all Group companies. The monitoring of compliance with this guideline is part of the relevant process. The risk of fluctuations in the price of commodities is also hedged to an appropriate extent by means of derivatives, insofar as these fluctuations could have a substantial impact on the Group's profitability and they are not otherwise secured against.

A powerful IT landscape is a decisive factor for the global connectivity of the partners in process chains. Operational interruptions and inefficient business processes can lead to the risk of losses. To prevent this, in 2016 Knorr-Bremse forged ahead with the harmonization of its hardware and software architecture. At the newly acquired companies it is crucial to drive forward the integrity, security, and organizational integration of the existing data. Along with appropriate back-up solutions and careful access control management, ensuring the quality of master data is essential. Compliance with IT Security Guidelines is comprehensively monitored with the aid of internal and external audits. In this way, the necessary global transparency and the integration of all new sites were further enhanced.

Another risk concerns possible failure to comply with increasingly stringent environmental requirements. To prevent this happening, Knorr-Bremse has aligned its worldwide activities with the international standard ISO 14001. The majority of the Company's sites around the world have already been certified or recertified accordingly.

The risk of exposure to financial losses as a result of imitation and counterfeit products persisted in 2016. In Asia in particular this remains a threat to business in the rail vehicle and commercial vehicle sectors. Knorr-Bremse counters this threat with its technical excellence and quality, which are recognized and duly appreciated by customers around the world.

In the high-tech environment in which Knorr-Bremse's solutions are used, there is a risk that products will reach their physical limits. By focusing on high quality in the research, development, and production sectors, as well as on its comprehensive materials expertise and inspection technology, in the year under review Knorr-Bremse ensured that customers across the globe could rely on Knorr-Bremse products.

As a globally active enterprise, Knorr-Bremse operates in countries with complex fiscal and judicial regulations that are open to multiple interpretations. Future interpretations and/or changes in taxation or legal systems could influence the Company's business, assets, financial status, and profitability. Knorr-Bremse is regularly inspected by the tax authorities in various jurisdictions and the Company identifies and assesses the relevant risks on an ongoing basis. The monitoring and control of risks related to competition and anti-trust law form part of the Company's compliance management activities. In sum, Knorr-Bremse was able to minimize the various operational risks in the year under review by means of comprehensive controlling and reporting systems. These will be duly continued and, where necessary, expanded.

### Opportunities

The multi-stage, worldwide planning, reporting, and controlling system established at Knorr-Bremse identifies not only risks but also opportunities for the various business areas. Thus the Group was quick to recognize an incipient upward trend in investments in infrastructure measures and positioned itself accordingly.

In general terms, Knorr-Bremse identified additional sales opportunities as a result of the continuing rise in worldwide transportation volumes in 2016. This led to investments in rail vehicles and commercial vehicles, which generated new business for Knorr-Bremse.

Targeted acquisitions and the establishment of joint ventures result in opportunities to access new fields of business and add to Knorr-Bremse's portfolio of systems, not least for vehicles capable of automated and/or autonomous driving. This approach plays a key part in the rigorous implementation of Knorr-Bremse's growth strategy. With this in mind, Knorr-Bremse continuously monitors current and future markets to identify suitable partners.

Early in September 2016, Knorr-Bremse submitted an offer for the listed automotive supplier Haldex of Sweden.

The acceptance period for the offer began on September 27, 2016. The aim here is to join forces with Haldex to expand the product portfolio particularly in the segment of braking and air suspension systems for trailers, and actively drive forward the development of system solutions for automated and/or autonomous driving for truck-trailer combinations. At the end of the original acceptance period on December 5, 2016, the sharehold-

ers had tendered 31,477,821 Haldex shares. This corresponds to 71.19% of the share capital and voting rights in Haldex. Together with the shares already held by Knorr-Bremse, this brought the aggregate total to 38,072,860 Haldex shares, corresponding to 86.11% of the share capital and voting rights in Haldex. The strong support from investors confirms the attractiveness of our offer and also the strategic rationale of the proposed combination of the two companies.

The transaction is subject to approval by the anti-trust authorities in the USA and in the EU, and Knorr-Bremse has already attained initial important milestones in this process. The Company is committed to sparing no effort to drive progress in the clearance process and is engaged in constructive discussions with the relevant authorities and with Haldex.

Effective February 1, 2017, Knorr-Bremse acquired the Electrical Systems business unit (Vossloh Kiepe) from Vossloh AG. The acquisition will generate goodwill in double-digit millions. In financial 2015 Vossloh Kiepe reported sales of almost EUR 250 million in line with IFRS and employed some 800 people. Through this acquisition, Knorr-Bremse is adding advanced rail vehicle and commercial vehicle drive technologies to its portfolio.

Knorr-Bremse invests in new technologies across a broad front in order to build on its technologies and market leadership and thereby safeguard existing sales markets and access new ones. This includes expanding the Company's development competence: Growing demand for high-quality technology in emerging countries leads to additional sales opportunities for Knorr-Bremse. Further growth potential results from revised regulatory requirements in the Company's markets.

Within the framework of Knorr Excellence, Knorr-Bremse works constantly to optimize its cost management and boost its process efficiency, in order to further enhance the competitiveness of the Company's products and services.

### General statement on the risk and opportunity situation

Careful analysis of the Group-wide risk profile has revealed that no identifiable risks exist that would threaten the survival of the Company or have a substantial impact on its assets, financial status, or profitability. Nor are any such risks currently expected to arise in the future.

## Outlook

For fiscal 2017, Knorr-Bremse is anticipating a highly volatile market environment, with the regional markets being impacted by great uncertainties. These include geopolitical uncertainties in various regions, as well as declining investment activity in certain parts of the world. In addition, relations between China, the USA, and Russia are expected to prove particularly challenging. Other factors include shifts in commodity prices and in particular the anticipated continuing low price of crude oil, as well as the performance of the euro and the U.S. Dollar.

Populist trends are expected to gather strength in Europe as a result of Brexit and in the USA following the outcome of the election. Growing anti-EU sentiment within the Union can lead to increasingly protectionist behavior. In general, an anti-globalization mindset can be expected to rise worldwide, potentially leading to national trade barriers and subsidies for local products. Thanks to an established approach of ensuring a high level of local value added, Knorr-Bremse views these developments with equanimity.

Overall, Knorr-Bremse expects to see moderate global economic growth. Russia will return to positive economic growth, while forecasts in the USA and Canada predict stronger growth than in 2016. In Japan, Knorr-Bremse anticipates a modest market upturn, driven by moderate growth in rail-borne mass transit and mainline traffic, as well as a slight increase in local truck production.

For the Rail Vehicle Systems division, Knorr-Bremse is forecasting largely stable development of the OE market in all regions, accompanied by growth in RailServices. The market looks set to be dominated by consolidation, as vehicle builders increasingly target growth through acquisitions. For 2017 Knorr-Bremse expects to see a recovery in the Chinese high-speed market. While the North American passenger market looks set for renewed growth, positive impetus from the freight transportation sector will probably not be forthcoming.

For the Commercial Vehicle Systems division, Knorr-Bremse anticipates moderate growth in the global commercial vehicle market in 2017. In the long term, the Company expects to see worldwide truck production approaching its 2014 level again by 2019.

Knorr-Bremse anticipates that the overall level of the European market will remain essentially unchanged in

2017. The Commercial Vehicle Systems division expects to see 1% year-on-year growth in the European market.

2017 will see further extensive investments in the North American passenger transportation sector. The freight sector appears to have bottomed out and market volatility is, in any case, in line with the customary cyclic developments. In the commercial vehicle sector, Knorr-Bremse anticipates a slight increase in truck production. The big unknown in 2017 is the change in the U.S. administration and the associated impact on the business sector. This was one reason why the industry exercised restraint, particularly toward the end of 2016.

In South America, Knorr-Bremse is not expecting to see a tangible market recovery in 2017. The need to keep public spending on a tight rein will mean no significant investments in the rail passenger transportation sector in 2017. No significant signs of recovery are anticipated for the commercial vehicle business either.

For Asia/Australia the Rail Vehicle Systems division is anticipating a moderate recovery, with India playing a key part. The Company expects to see clear signs of recovery in the Chinese high-speed and locomotive markets in 2017. In Australia the principal signs of growth are in the regional rail sector. The Commercial Vehicle Systems division is also expecting to see moderate growth in the Asia/Australia region.

2017 and the years ahead can be expected to bring a further increase in the volumes handled by parcel and courier services, driven mainly by online retailing. This will be accompanied by a rise in freight traffic by road and rail. Vehicle manufacturers can be expected to step up their investments in connected services and digitalization, with a concomitant shift in sales to software-driven components. This will lead to a transformation of the competitive landscape and to the market entry of other industrial players such as IT corporations.

The topics of highly automated driving, active safety, eco-efficiency, and connectivity will continue to dominate the business for the next decade and beyond. In the future, vehicle and infrastructure operating data will be connected to enable optimal control of vehicles in networks shared by vehicles traveling at different speeds. Thus, for example, freight trains will be able to reach their destinations without stopping and without obstructing express trains.

Based on the assumptions set out above, Knorr-Bremse is planning for sales to show a slight rise in 2017, accompanied by a moderate downturn in earnings due to increased pressure of competition. The forecasts do not take account of future acquisitions that had not reached closure by the balance sheet date.

The number of employees is expected to increase slightly. Tied-up working capital, measured in days' sales, is expected show a slight improvement. Despite the prevailing uncertain market environment and the challenges posed by the global market, Knorr-Bremse is planning a further marked increase in capital expenditure. In line with expectations in terms of profits, working capital, and investments, Knorr-Bremse is reckoning with a further slight improvement in net liquidity.

Given the anticipated development of the Group, Knorr-Bremse AG is expecting a marked downturn in income from investments in 2017. This will not, however, affect its future ability to pay dividends.

Based on the assumptions made for the Group, the assets, financial status, and profitability of Knorr-Bremse AG can be expected to show a slight decline.

**Trends**  
Automated Driving  
Active Safety  
Eco-Efficiency  
Connectivity

Since 1905, Knorr-Bremse has been driving the development, production, marketing, and servicing of state-of-the-art braking systems.



# Consolidated Financial Statements

## 1 Principles and methods

The consolidated financial statements have been drawn up in accordance with generally accepted accounting principles, complying with the accounting requirements of the German Commercial Code (HGB) and additional statutory provisions. Figures in the consolidated financial statements are shown in thousands of euros (TEUR). Certain items on the balance sheet and in the statement of income are combined for the sake of greater clarity. These items are explained separately in the Notes to the Consolidated Financial Statements.

### Implementing the provisions of the Accounting Directive Implementation Act

As from the beginning of fiscal year 2016, the Knorr-Bremse Group has started to apply the provisions of the German Accounting Directive Implementation Act ("BilRUG"). Due to the new definition of net sales set down in Article 277 (1) HGB (new version), other operating income totaling EUR 39.7 million is reported under net sales for the first time. The figures for the previous year have not been adjusted. If these provisions had been applied to the previous year's accounts in the same way, the Group would have been required to report a total of EUR 44.7 million in other operating income under net sales.

### Accounting and valuation

The financial statements of the companies included in the consolidated financial statements are prepared according to uniform principles of accounting and valuation applied to the Group as a whole. For the purposes of consolidation according to the equity method, any valuations in the financial statements of associated companies that deviate from the uniform principles applied to the Group are retained. Purchased intangible assets are valued at acquisition cost less scheduled depreciation; additional depreciation is taken where necessary.

Fixed assets are recorded at acquisition or production cost, less scheduled depreciation in the case of items subject to wear and tear; additional depreciation is taken where necessary. Depreciation on fixed assets is generally applied using the linear method, based on useful life. In the case of German companies included in consolidation, additions prior to January 2008 and after January 2009 are for the most part depreciated using the declining balance method, switching over to the linear method as soon as the latter results in higher depreciation. Minor fixed assets are depreciated to the maximum extent permissible under the respective countries' tax provisions.

Interests in affiliated companies and miscellaneous investments are stated at cost or, in the event of a probable sustained diminution in value, at fair value (where the latter is lower). Pursuant to Article 312 (1) HGB, associated companies are stated at book value. Materials and supplies are carried in inventories at the lower of average acquisition cost or replacement cost. Provision against realization risks is made where necessary.

Work in process and finished products are stated at production cost, but in no case higher than the projected sales revenues less any costs accruing prior to sale. Production cost includes direct cost of materials and labor, as well as material and production overhead. A reasonable allowance is made where there is a risk of a decline in inventory values. Receivables are stated at their nominal value, less any necessary provisions against specific debts. Receivables bearing no or low interest are stated at their net present value. General charges have been made to cover the general credit risk. Other assets are stated at the lower of acquisition cost, net present value or fair value. Cash at banks and in hand is stated at par value. Bank balances in foreign currencies are stated at the mean spot exchange rate at the balance sheet date. Earnings or disbursements prior to the balance sheet date are shown as prepaid income or prepaid expenses where they represent revenues or expenses for a certain period after the balance sheet date.

Foreign currency items are valued at the rate existing at the transaction date or – if less favorable – at the rate at the balance sheet date. Where foreign currency items have been hedged, they are valued at the corresponding hedging rate. Where the remaining term is one year or less, foreign currency items are valued at the mean spot rate at the final balance sheet date.

Rate-hedging and option transactions are performed selectively and exclusively for hedging purposes. Wherever possible, financial derivatives covering assets, borrowings, open contracts or transactions with a high probability of closure are bundled together as single items for valuation purposes ("hedging relationships").

Accrued liabilities include reasonable and sufficient allowance for all perceivable risks and any contingent liabilities. Accruals are valued in accordance with Article 253 (1) and (2) of the German Commercial Code (HGB), whereby use has been made of the options for retention of control within the meaning of Article 67 (1) clause 2 and (3) clause 1 of the Act Introducing the German Commercial Code (EGHGB). Transfers to accrued liabilities are made using the net method. The company has made use of the option not to discount the interest on accruals with a term of one year or less.

In Germany, pension plan accruals and similar commitments are set up according to actuarial principles based on realistic assumptions. Assumptions included in the calculations include future salary increases and future pension adjustments (within the meaning of Article 16 of the German Law on Occupational Pensions [BetrAVG]), as well as assumptions relating to staff turnover. The calculations are based on the biometric reference values devised by Klaus Heubeck (mortality tables RT 2005 G).

The company has taken advantage of the option provided under Article 253 (2) clause 2 of the German Commercial Code (HGB) whereby the discounting rate may be applied with an assumed remaining term of 15 years.

The following parameters were used to calculate pension plan accruals in Germany:

Interest rate:	4.01% p.a. (2015: 3.89%)
Salary increases:	3.00% p.a. (2015: 3.00%)
Annuity trend:	1.50% p.a. (2015: 1.50%)
Fluctuation:	1.80% p.a. on average (2015: 1.80%)

Pension plan accruals are determined using the modified discount value method. Our foreign subsidiaries cover pension plans and similar commitments by making accruals. Applying the statutory 10-year average interest rate when calculating German pension plan accruals results in accruals that are TEUR 18,300 less than they would be if the 7-year average interest rate for the Group were applied.

Liabilities are stated at their settlement value.

### Consolidated companies

The parent company of the Knorr-Bremse Group is Knorr-Bremse AG, Moosacher Strasse 80, 80809 Munich, Germany. The individual and consolidated financial statements are filed with the local first-instance court in Munich under Commercial Register number HRB 42031. In addition to Knorr-Bremse AG, 24 German and 115 foreign subsidiaries over which Knorr-Bremse AG can exert a direct or indirect controlling influence are included in the consolidated financial statements. Investments in 2 German and 2 foreign companies are shown in the consolidated financial statements as investments in associated companies. Eight foreign subsidiaries and one German subsidiary have not been included in consolidation because of their minor significance in relation to the net worth, financial position, and results of the Group. Two German companies are not shown as associated companies, but instead are stated at acquisition cost.

During fiscal year 2016, the following companies were acquired, founded or included in consolidation for the first time:

Aldona Seals Ltd., Peterlee/United Kingdom  
 Alpha Process Controls (International) Ltd., Peterlee/United Kingdom  
 Black River Air Logistics Company LLC, Watertown, New York/USA (previously not included in consolidation)  
 G.T. Group Ltd., Peterlee/United Kingdom  
 GT Emission Systems Ltd., Peterlee/United Kingdom  
 GT Project Engineering Ltd., Consett/United Kingdom  
 Guangdong Knorr-Bremse Guo Tong Railway Vehicle Systems Equipment Co., Ltd., Jiangmen, Guangdong/China  
 Icer Rail S.L., Pamplona/Spain (previously valued at equity)  
 Semiconductor Solutions (Pty.) Ltd., Pretoria/South Africa  
 tedrive Steering Systems GmbH, Wülfrath/Germany  
 tedrive Yönlendirme Sistemleri Sanayi ve Ticaret Limited Şirketi, Istanbul/Turkey  
 Zelisko Elektrik Sanayi ve Ticaret Limited Şirketi, Istanbul/Turkey

During fiscal year 2016, the following companies were acquired or founded but not included in consolidation, pursuant to Article 296 (2) HGB:

Knorr-Bremse Services Europe s.r.o., Stráž nad Nisou/Czech Republic  
 RBL-Technologie Ltd., Naberezhnye Chelny/Russia  
 tedrive Steering Systems Inc., Wixom, Michigan/USA

The following companies were wound up:

Webasto Kiekert Bustüren GmbH (in liquidation), Karlsfeld/Germany  
 Sigma Coachair Systems (US) Inc., Chicago, Illinois/USA

The following companies were renamed:

Knorr-Bremse Commercial Vehicle Systems (Shanghai) Co., Ltd., Shanghai/China  
 (formerly Knorr-Bremse Brake Equipment (Shanghai) Co., Ltd., Shanghai/China)

Knorr-Bremse Ibérica S.L., San Fernando de Henares/Spain  
 (formerly Bost Ibérica S.L., San Fernando de Henares/Spain)

Knorr-Bremse PowerTech Corporation USA, Atlanta, Georgia/USA  
 (formerly Transtechnik Corporation, Atlanta, Georgia/USA)

Knorr-Bremse PowerTech GmbH, Berlin/Germany  
 (formerly PCS Power Converter Solutions GmbH, Berlin/Germany)

Knorr-Bremse PowerTech GmbH & Co. KG, Holzkirchen/Germany  
 (formerly Transtechnik GmbH & Co. KG, Holzkirchen/Germany)

Knorr-Bremse PowerTech Verwaltungs GmbH, Berlin/Germany  
 (formerly Transtechnik Verwaltungs GmbH, Holzkirchen/Germany)

Knorr-Bremse Systemy Kolejowe Polska Sp. z o.o., Cracow/Poland  
 (formerly Knorr-Bremse Systemy dla Kolejowych Środków Lokomocji Pl. Sp. z o.o., Cracow/Poland)

This means that compared to the previous year, the number of fully consolidated companies has increased by 11. On the following pages, a detailed list of affiliated and associated companies appears in a separate breakdown of the Group's shareholdings.

The above-mentioned changes in the scope of consolidation had no significant impact on the Group's net worth, financial position or operating results. The newly consolidated companies caused the balance sheet total to increase by TEUR 28,800.

#### Principles of consolidation

Until December 31, 2009, the book value method was used to consolidate investments in subsidiaries. This entailed offsetting book values against the value of our interests in the shareholders'

equity of the subsidiaries at the time of initial consolidation. Companies were included in consolidation at the date of acquisition or at the balance sheet date. Since fiscal year 2010, investments in subsidiaries have been consolidated using the revaluation method. This entails reporting shareholders' equity at the value corresponding to the market value of the assets and borrowings to be included in the consolidated financial statements. Companies are included in consolidation at the date of acquisition. Since 2002, any resulting goodwill has been capitalized in compliance with GAS standards. Scheduled depreciation is applied using the linear method on the basis of operational considerations relating to useful life; within the Group, this may not exceed 20 years. The useful life of goodwill is determined using the subsidiaries' longer-term, strategic business models.

The acquisition of indirect non-controlling shares is based on the group share method. In this procedure, the interests of non-controlling shareholders are offset against the proportionate consolidated net assets. Any goodwill attributable to indirect minority shareholders is netted out against the adjustment item for non-controlling interests.

Wherever possible, a negative goodwill resulting from the consolidation of investments is released for the year in which it arises, as permitted by German commercial law and accounting standards.

Associated companies are consolidated using the equity method, with goodwill generally included as part of the cost of acquiring interests in associated and related companies. Associated companies acquired prior to January 2010 were consolidated at the date of acquisition or the balance sheet date. As from fiscal year 2010, companies are included in consolidation at the date of acquisition. The Knorr-Bremse Group's share in the annual results of companies consolidated in accordance with this method, including amortization on goodwill, is shown in the statement of income under Financial results. The overall valuation of associated and related companies has not been adjusted by applying the valuation methods used in the consolidated financial statements.

Receivables and payables between consolidated companies are netted. Unrealized intercompany profits resulting from intercompany trade in goods and services are eliminated in the consolidated statements. In the consolidated statement of income, revenues from intercompany sales and other intercompany income are offset against the corresponding expenses.

#### Foreign currency translation

The individual financial statements of the foreign companies included in consolidation are translated into euros at the mean spot rate at the balance sheet date, with the exception of shareholders' equity, which is translated into euros at the historic rate. Income statement items are translated into euros at the mean rate. Any resulting translation difference is reported under Group equity and noted in the statement of changes in Group equity.

#### Deferred taxes

Deferred taxes as defined under Articles 274 and 306 of the German Commercial Code (HGB), resulting from temporary differences between the amount stated in the tax accounts of individual group companies and the amount stated in the consolidated balance sheet (including differences arising as a result of accounting and valuation adjustments or during the consolidation process), are netted wherever possible, as permitted by law. In the individual balance sheets prepared according to the uniform principles of accounting and valuation applied to the Group (Financial statements II), the option to capitalize assets to the amount of probable tax relief in subsequent years is used in individual cases. The calculation of deferred taxes is based on the tax rates that, according to current legislation, are expected to be valid at the time of their realization.

Deferred taxes on losses carried forward are capitalized in individual cases, where there is sufficient probability that the tax benefits can be realized. At each balance sheet date, the book value of deferred tax assets is reviewed and, if necessary, adjusted as appropriate.

## 2 Changes in intangibles, fixed assets, and investments

### Acquisition or production cost

Additions to purchased fixed and intangible assets amounted to TEUR 410,519 in fiscal year 2016 (2015: TEUR 328,130). This figure includes investments (but excludes changes in the scope of consolidation and goodwill) in the amount of TEUR 194,576 (2015: TEUR 210,155).

In EUR thousands (TEUR)	Acquisition or production cost						Depreciation/amortization							Net value Dec. 31, 2016	Net value Dec. 31, 2015	Depreciation/amortization during the fiscal year
	Carried forward Jan. 1, 2016	Additions	Reclassifications	Disposals	Currency differences	Balance Dec. 31, 2016	Depreciation/amortization carried forward Jan. 1, 2016	Currency difference	Additions	Disposals	Reclassifications	Accrued depreciation/amortization Dec. 31, 2016				
Industrial property rights/trademarks	348,484	15,341	579	(2,245)	5,048	367,207	(290,093)	(3,930)	(16,679)	2,210	(58)	(308,550)	58,657	58,391	15,564	
Goodwill	457,443	103,007	0	0	4,436	564,886	(339,159)	(4,453)	(34,918)	304	24	(378,202)	186,684	118,284	38,033	
<b>Purchased intangibles</b>	<b>805,927</b>	<b>118,348</b>	<b>579</b>	<b>(2,245)</b>	<b>9,484</b>	<b>932,093</b>	<b>(629,252)</b>	<b>(8,383)</b>	<b>(51,597)</b>	<b>2,514</b>	<b>(34)</b>	<b>(686,752)</b>	<b>245,341</b>	<b>176,675</b>	<b>53,597</b>	
Land, equivalent rights to real property, and buildings, including buildings on land not owned	404,729	31,157	45,895	(7,173)	9,074	483,682	(149,423)	(1,602)	(11,841)	1,952	(67)	(160,981)	322,701	255,306	11,109	
Technical equipment and machinery	656,757	83,722	34,503	(26,143)	12,051	760,890	(424,905)	(7,433)	(72,248)	22,446	(39)	(482,179)	278,711	231,852	53,181	
Other equipment, plant, and office equipment	609,750	109,143	21,425	(14,373)	9,626	735,571	(470,440)	(7,497)	(94,001)	12,959	(65)	(559,044)	176,527	139,310	61,249	
Advances to suppliers and construction in progress	160,289	68,149	(102,402)	(1,368)	3,154	127,822	(4,664)	(21)	(313)	34	205	(4,759)	123,063	155,625	314	
<b>Fixed assets</b>	<b>1,831,525</b>	<b>292,171</b>	<b>(579)</b>	<b>(49,057)</b>	<b>33,905</b>	<b>2,107,965</b>	<b>(1,049,432)</b>	<b>(16,553)</b>	<b>(178,403)</b>	<b>37,391</b>	<b>34</b>	<b>(1,206,963)</b>	<b>901,002</b>	<b>782,093</b>	<b>125,853</b>	
Investments in affiliated companies	56,447	136	7,695	(63,598)	2	682	(99)	(6)	0	0	0	(105)	577	56,348	0	
Investments in associated companies	7,416	2,947	(7,695)	(685)	26	2,009	0	0	0	0	0	0	2,009	7,416	0	
Miscellaneous investments	20,538	79,356	0	(2,438)	1,733	99,189	(4,207)	0	(163)	0	0	(4,370)	94,819	16,331	1	
<b>Investments</b>	<b>84,401</b>	<b>82,439</b>	<b>0</b>	<b>(66,721)</b>	<b>1,761</b>	<b>101,880</b>	<b>(4,306)</b>	<b>(6)</b>	<b>(163)</b>	<b>0</b>	<b>0</b>	<b>(4,475)</b>	<b>97,405</b>	<b>80,095</b>	<b>1</b>	
<b>Intangibles, fixed assets, and investments</b>	<b>2,721,853</b>	<b>492,958</b>	<b>0</b>	<b>(118,023)</b>	<b>45,150</b>	<b>3,141,938</b>	<b>(1,682,990)</b>	<b>(24,942)</b>	<b>(230,163)</b>	<b>39,905</b>	<b>0</b>	<b>(1,898,190)</b>	<b>1,243,748</b>	<b>1,038,863</b>	<b>179,451</b>	

## 3 Intangibles

This heading includes the acquisition of goodwill, patents, rights to the use of names and trademarks, and IT software. IT software and goodwill account for the majority of additions. Additions to goodwill relate primarily to the acquisition of tedrive Steering Systems GmbH, Wülfrath/Germany. This resulted in goodwill of TEUR 12,993, which is being amortized over 5 years. The residual book value at December 31, 2016 was TEUR 12,127. The acquisition of G.T. Group Ltd., Peterlee/United Kingdom generated goodwill of TEUR 71,137, which is being amortized over 10 years. The residual book value at December 31, 2016 amounted to TEUR 67,580. The step acquisition of Icer Rail S.L., Pamplona/Spain, produced goodwill of TEUR 14,406, which is being amortized over 5 years. As at December 31, 2016, the residual book value was TEUR 14,166.

In determining the useful life of goodwill additions during the fiscal year, the impact on the acquired firms of underlying economic conditions and changes in sales and procurement markets was taken into account. Amortization on goodwill for the fiscal year includes additional (unscheduled) amortization of TEUR 0 (2015: TEUR 13,739).

Any goodwill resulting from the consolidation of investments is subject to linear amortization over a period not exceeding 20 years. Other intangibles are subject to scheduled amortization over periods of between 3 and 10 years. All intangible assets have a limited useful life.

#### 4 Fixed assets

Movements of fixed assets are presented in the compilation on the preceding pages. To take technical and economic factors into account, scheduled depreciation was applied to acquisition costs. Depreciation on fixed assets includes no additional depreciation (2015: TEUR 8,619).

#### 5 Investments

Investment movements are set out in the compilation above.

Miscellaneous investments consist of TEUR 173 in loans to affiliated companies (2015: TEUR 0), TEUR 13,409 in miscellaneous loans (2015: TEUR 14,102), TEUR 81,088 in long-term investments (2015: TEUR 2,080), and TEUR 149 in investments in other companies (2015: TEUR 149).

#### List of shareholdings

1 Consolidated affiliated companies	Share in capital in %
Albatros GmbH, Munich/Germany	100.0
Aldona Seals Ltd., Peterlee/United Kingdom	100.0
Alpha Process Controls (International) Ltd., Peterlee/United Kingdom	100.0
Anchor Brake Shoe Company LLC, West Chicago, Illinois/USA	100.0
BCVS Canadian Holdings LLC, Anjou, Quebec/Canada	100.0
BCVS Mexican Holdings LLC, Cd Acuña, Coah/Mexico	100.0
Bendix Commercial Vehicle Systems LLC, Elyria, Ohio/USA	100.0
Bendix CVS Canada Inc., Anjou, Quebec/Canada	100.0
Bendix CVS de Mexico SA de CV, Cd Acuña, Coah/Mexico	100.0
Bendix Spicer Foundation Brake Canada, Inc., Kingston, Ontario/Canada	100.0
Bendix Spicer Foundation Brake LLC, Elyria, Ohio/USA	80.0
Black River Air Logistics Company LLC, Watertown, New York/USA	100.0
BSFB Holdings, Inc., Elyria, Ohio/USA	100.0
Casram Rail S.p.A., Crimido/Italy	60.0
Comet Fans S.r.l., Solaro, Milan/Italy	100.0
Distribuidora Bendix CVS (de) Mexico SA de CV, Cd Acuña, Coah/Mexico	100.0
Dr. techn. Josef Zelisko Ges.m.b.H., Mödling/Austria	100.0
G.T. Group Ltd., Peterlee/United Kingdom	100.0
GT Emission Systems Ltd., Peterlee/United Kingdom	100.0
GT Project Engineering Ltd., Consett/United Kingdom	100.0
Guangdong Knorr-Bremse Guo Tong Railway Vehicle Systems Equipment Co., Ltd., Jiangmen, Guangdong/China	49.0
Hasse & Wrede CVS Dalian, China Ltd., Dalian/China	70.0
Hasse & Wrede GmbH, Berlin/Germany	100.0
Heine Resistors GmbH, Dresden/Germany	100.0
Icer Rail S.L., Pamplona/Spain	100.0

1 Consolidated affiliated companies (continued)	Share in capital in %
IFE-ČR a.s., Brno/Czech Republic	100.0
IFE North America LLC, Westminster, Maryland/USA	100.0
IFE-Tebel Technologies B.V., Leeuwarden/The Netherlands	100.0
IFE-VICTALL Railway Vehicle Door Systems (Qingdao) Co., Ltd., Qingdao/China	59.0
IGE-CZ s.r.o., Brno/Czech Republic	100.0
Kalmar Tågkompetens AB, Kalmar/Sweden	100.0
KB Gamma Beteiligungs GmbH, Munich/Germany	100.0
KB Lambda Beteiligungs GmbH, Munich/Germany	100.0
KB Media GmbH Marketing und Werbung, Munich/Germany	100.0
KB Omikron Beteiligungs GmbH, Munich/Germany	100.0
KB Sigma Beteiligungs GmbH, Munich/Germany	100.0
Knorr-Amabhiiki (Pty.) Ltd., Kempton Park/South Africa	100.0
Knorr Brake Company LLC, Westminster, Maryland/USA	100.0
Knorr Brake Corporation Canada Holdings Ltd., Montreal, Quebec/Canada	100.0
Knorr Brake Holding Corporation, Watertown, New York/USA	89.3
Knorr Brake Ltd., Kingston, Ontario/Canada	100.0
Knorr Brake Realty LLC, Westminster, Maryland/USA	100.0
Knorr Brake Truck Systems Company, Watertown, New York/USA	100.0
Knorr-Bremse 1520 OOO, Burashevskoe/Russia	100.0
Knorr-Bremse/Nankou Air Supply Unit (Beijing) Co., Ltd., Nankou/China	55.0
Knorr-Bremse Asia Pacific (Holding) Ltd., Hong Kong/China	100.0
Knorr-Bremse Australia Pty. Ltd., Granville/Australia	100.0
Knorr-Bremse Benelux B.V.B.A., Heist-op-den-Berg/Belgium	100.0
Knorr-Bremse Beteiligungsgesellschaft mbH, Munich/Germany	100.0
Knorr-Bremse Braking Systems for Commercial Vehicles (Dalian) Co., Ltd., Dalian/China	100.0
Knorr-Bremse Brasil (Holding) Administração e Participação Ltda., Itupeva/Brazil	100.0
Knorr-Bremse CAFF Systems for Commercial Vehicles Chongqing Ltd., Chongqing/China	66.0
Knorr-Bremse CARS LD Vehicle Brake Disc Manufacturing (Beijing) Co., Ltd., Daxing/China	50.0
Knorr-Bremse Commercial Vehicle Systems Japan Ltd., Tokyo/Japan	80.0
Knorr-Bremse Commercial Vehicle Systems (Shanghai) Co., Ltd., Shanghai/China	100.0
Knorr-Bremse DETC Commercial Vehicle Braking Technology Co., Ltd., Shiyao/China	51.0
Knorr-Bremse España, S.A., Getafe/Spain	100.0
Knorr-Bremse Fékrendszerek Kft., Kecskemét/Hungary	100.0
Knorr-Bremse Ges.m.b.H., Mödling/Austria	100.0
Knorr-Bremse Ibérica S.L., San Fernando de Henares/Spain	100.0
Knorr-Bremse India Pvt. Ltd., Faridabad/India	100.0
Knorr-Bremse Investment GmbH, Munich/Germany	100.0
Knorr-Bremse IT-Services GmbH, Munich/Germany	100.0
Knorr-Bremse KAMA Systems for Commercial Vehicles OOO, Naberezhnye Chelny/Russia	50.0
Knorr-Bremse Nordic RailServices AB, Lund/Sweden	100.0
Knorr-Bremse Pensionsgesellschaft mbH, Munich/Germany	100.0
Knorr-Bremse Polska SIn Sp. z o.o., Warsaw/Poland	100.0

1 Consolidated affiliated companies (continued)	Share in capital in %
Knorr-Bremse PowerTech Corporation USA, Atlanta, Georgia/USA	100.0
Knorr-Bremse PowerTech GmbH, Berlin/Germany	100.0
Knorr-Bremse PowerTech Verwaltungs GmbH, Berlin/Germany	100.0
Knorr-Bremse PowerTech GmbH & Co. KG, Holzkirchen/Germany (unlimited liability shareholder: Knorr-Bremse PowerTech Verwaltungs GmbH, Berlin/Germany)	100.0
Knorr-Bremse Rail Systems CIS Holding OOO, Moscow/Russia	100.0
Knorr-Bremse Rail Systems Italia S.r.l., Campi Bisenzio/Italy	100.0
Knorr-Bremse Rail Systems Japan Ltd., Tokyo/Japan	94.0
Knorr-Bremse Rail Systems Korea Ltd., Seoul/South Korea	100.0
Knorr-Bremse Rail Systems OOO, Moscow/Russia	100.0
Knorr-Bremse Rail Systems Schweiz AG, Niederhasli/Switzerland	100.0
Knorr-Bremse Rail Systems (UK) Ltd., Melksham, Wiltshire/United Kingdom	100.0
Knorr-Bremse RailServices (UK) Ltd., Melksham, Wiltshire/United Kingdom	100.0
Knorr-Bremse Railway Technologies (Shanghai) Co., Ltd., Shanghai/China	100.0
Knorr-Bremse Raylı Sistemler Turkey Sanayi ve Ticaret Limited Şirketi, Ankara/Turkey	100.0
Knorr-Bremse S.A. Holding Company (UK) Ltd., Melksham, Wiltshire/United Kingdom	100.0
Knorr-Bremse S.A. (Pty) Ltd., Kempton Park/South Africa	75.0
Knorr-Bremse S.R.L., Bucharest/Romania	100.0
Knorr-Bremse Sistemas para Veículos Comerciais Brasil Ltda., Itupeva/Brazil	100.0
Knorr-Bremse Sistemas para Veículos Ferroviários Ltda., Itupeva/Brazil	100.0
Knorr-Bremse Sistemi per Autoveicoli Commerciali S.p.A., Arcore/Italy	100.0
Knorr-Bremse System för Tunga Fordon AB, Malmö/Sweden	100.0
Knorr-Bremse Systeme für Nutzfahrzeuge GmbH, Munich/Germany	80.0
Knorr-Bremse Systeme für Nutzfahrzeuge Pensionsgesellschaft mbH, Munich/Germany	100.0
Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, Munich/Germany	100.0
Knorr-Bremse Systeme für Schienenfahrzeuge Ibero Holding GmbH, Munich/Germany	100.0
Knorr-Bremse Systèmes Ferroviaires France S.A., Tinqueux/France	100.0
Knorr-Bremse Systèmes pour Véhicules Utilitaires France S.A.S., Lisieux/France	100.0
Knorr-Bremse Systems for Commercial Vehicles India Pvt. Ltd., Pune/India	100.0
Knorr-Bremse Systems for Commercial Vehicles OOO, Moscow/Russia	100.0
Knorr-Bremse Systems for Commercial Vehicles Ltd., Bristol/United Kingdom	100.0
Knorr-Bremse Systems for Rail Vehicles Kazakhstan LLP, Astana/Kazakhstan	100.0
Knorr-Bremse Systems for Rail Vehicles (Suzhou) Co., Ltd., Suzhou/China	100.0
Knorr-Bremse Systemy Kolejowe Polska Sp. z o.o., Cracow/Poland	100.0
Knorr-Bremse Systémy pro užitkovú vozidla ČR s.r.o., Stráž nad Nisou/Czech Republic	100.0
Knorr-Bremse Technology Center India Pvt. Ltd., Pune/India	100.0
Knorr-Bremse Ticari Arac Fren Sistemleri Limited Şirketi, Istanbul/Turkey	100.0
Knorr-Bremse US Beteteiligungs GmbH, Munich/Germany	100.0
Knorr-Bremse US Investment GmbH, Munich/Germany	100.0
Knorr-Bremse Vasúti Jármű Rendszerek Hungária Kft., Budapest/Hungary	100.0
Knorr-Bremse Verwaltungsgesellschaft mbH, Munich/Germany	100.0
Merak Jinxin Air Conditioning Systems (Wuxi) Co., Ltd., Wuxi/China	51.0

1 Consolidated affiliated companies (continued)	Share in capital in %
Merak Knorr Climatización S.A., Buenos Aires/Argentina	100.0
Merak North America LLC, Westminster, Maryland/USA	100.0
Microelettrica do Brasil Comercialização e Importação de Produtos Eletromecânicos Ltda., Barueri, São Paulo/Brazil	100.0
Microelettrica Heine (Suzhou) Co., Ltd., Suzhou/China	100.0
Microelettrica Power Devices (Pty) Ltd., Johannesburg/South Africa	100.0
Microelettrica Power (Pty) Ltd., Johannesburg/South Africa	74.0
Mircoelettrica Scientifica (Pty) Ltd., Johannesburg/South Africa	100.0
Microelettrica Scientifica S.p.A., Buccinasco/Italy	100.0
Microelettrica USA LLC, Randolph, New Jersey/USA	100.0
MST Elektrotechnik Sanayi ve Ticaret Limited Şirketi, Şerifali, Istanbul/Turkey	100.0
M.S. Resistances S.A.S., Saint-Chamond/France	51.0
New York Air Brake LLC, Watertown, New York/USA	100.0
Selectron Systems AG, Lyss/Switzerland	100.0
Selectron Systems Pvt. Ltd., Gurgaon/India	100.0
Selectron Systems (Beijing) Co., Ltd., Beijing/China	100.0
Semiconductor Solutions (Pty) Ltd., Pretoria/South Africa	60.0
Sigma Air Conditioning Pty. Ltd., Granville/Australia	100.0
Sigma Transit Systems Pty. Ltd., Granville/Australia	100.0
Skach Ges.m.b.H., Mödling/Austria	100.0
STE Schwingungs-Technik GmbH, Klieken/Germany	100.0
Swedtrac RailServices AB, Solna/Sweden	100.0
Swedtrac Trafik AB, Solna/Sweden	100.0
SWT Swedtrac Svets & Smide AB, Solna/Sweden	100.0
Sydac Ltd., Manchester/United Kingdom	100.0
Sydac Pty. Ltd., Granville/Australia	100.0
Technologies Lanka Inc., La Pocatière, Quebec/Canada	100.0
tedrive Steering Systems GmbH, Wülfrath/Germany	100.0
tedrive Yönlendirme Sistemleri Sanayi ve Ticaret Limited Şirketi, Istanbul/Turkey	100.0
Transtechnik Asia Pacific Pty. Ltd., Sydney/Australia	100.0
Unicupler GmbH, Niederurnen/Switzerland	100.0
Zelisko Elektrik Sanayi ve Ticaret Limited Şirketi, Istanbul/Turkey	100.0

2 Associated companies valued using the equity method	Share in capital in %
Alltrucks GmbH & Co. KG, Munich/Germany (unlimited liability shareholder: Alltrucks Verwaltungs GmbH, Munich/Germany)	33.3
Alltrucks Verwaltungs GmbH, Munich/Germany	33.3
Knorr-Bremse DETC Commercial Vehicle Braking Systems (Shiyao) Co., Ltd., Shiyao/China	49.0
Westinghouse Platform Screen Doors (Guangzhou) Limited, Guangzhou/China	35.0

3 Affiliated companies not included in consolidation	Share in capital in %
Di-Pro LLC., Fresno, California/USA	100.0
EKA DOOEL, Skopje/Macedonia	100.0
Foro Verwaltungs GmbH & Co. KG, Munich/Germany (unlimited liability shareholder: Knorr-Bremse Systeme für Schienenfahrzeuge Ibero Holding GmbH, Munich/Germany)	100.0
KB Investment UK Ltd., Chippenham/United Kingdom	100.0
Knorr-Bremse Services Europe s.r.o., Stráž nad Nisou/Czech Republic	100.0
Metco Technical Consulting AG, Zug/Switzerland	100.0
SCI pour l'Industrie, Pau/France	100.0
tedrive Steering Systems Inc., Wixom, Michigan/USA	100.0
RBL-Technologie Ltd., Naberezhnye Chelny/Russia	100.0

4 Associated companies valued without using the equity method and other shareholdings	Share in capital in %
IFB Institut für Bahntechnik GmbH, Berlin/Germany	6.7
Megalith Grundstücksverwaltungsgesellschaft mbH & Co. Vermietungs KG, Mainz/Germany (Deutsche-Anlagen-Leasing GmbH holds majority voting rights)	100.0
MORCAR Grundstücksgesellschaft mbH & Co. oHG, Munich/Germany	5.0
Sanctor Grundstücks-Vermietungsgesellschaft mbH & Co. Objekt Marzahn KG, Düsseldorf/Germany (unlimited liability shareholder: Knorr-Bremse AG, Munich/Germany; SABIS Grundstücks-Vermietungsgesellschaft mbH, Düsseldorf/Germany, holds majority voting rights)	99.0

Shareholdings in associated companies correspond to voting rights.

The subsidiaries listed in section 3 of the above table (under "Affiliated companies not included in consolidation") have not been included in consolidation because of their minor significance in terms of providing a true and fair view of the Group's net worth, financial position, and operating results.

## 6 Inventories

	2016 TEUR	2015 TEUR
Materials and supplies	268,570	268,189
Work in process	103,291	92,049
Finished products, merchandise	234,612	246,699
less advances received on orders	(192,840)	(192,847)
plus prepayments on inventories	5,853	3,701
<b>Total</b>	<b>419,486</b>	<b>417,791</b>

In last year's financial statements, advance payments received on orders were offset against prepayments on inventories.

## 7 Receivables and other assets

	2016 TEUR	2016 TEUR	2015 TEUR
	Remaining term more than 1 year	in total	in total
Accounts receivable, trade	1,084	961,414	939,763
Receivables from affiliated companies not included in consolidation	140	140	0
Other assets	9,339	173,609	144,978
<b>Total</b>	<b>10,563</b>	<b>1,135,163</b>	<b>1,084,741</b>

## 8 Cash and cash equivalents

This item includes cash at bank, checks, and cash in hand.

## 9 Prepaid expenses

Group prepaid expenses amounted to TEUR 23,529 (2015: TEUR 23,731). Prepaid expenses include a discount of TEUR 1,723 on the issuance of a bond, accrued over the 5-year term of the bond.

## 10 Deferred taxes

At the balance sheet date, deferred tax assets amounted to TEUR 62,171 (2015: TEUR 76,695). No deferred tax liabilities were reported for the current or previous years.

In compliance with legal requirements, deferred tax assets and liabilities are stated at the netted amount. Of the deferred tax assets, TEUR 18,129 (2015: TEUR 21,678) relate to deferred taxes on individual balance sheets of Group companies and TEUR 44,042 (2015: TEUR 55,017) relate to consolidation entries affecting net income. Deferred tax assets on individual balance sheets result primarily from temporary differences in accrued liabilities, receivables, and other assets. Deferred tax assets relating to consolidation adjustments are primarily the result of eliminating unrealized intercompany profits. Deferred tax liabilities relate solely to deferred taxes on individual balance sheets of Group companies.

At individual company level and at Group level, deferred taxes are stated at the projected tax rate in the respective countries at the time of realization. Tax rates range from 0% to 40%, while the rate on consolidation activities is approx. 35%.

## 11 Capital stock

The capital stock of Knorr-Bremse AG is divided up into 2,600,000 bearer shares, each with a par value of EUR 26. Stella Vermögensverwaltungs-GmbH, TIB Vermögens- und Beteiligungsholding GmbH and KB Holding GmbH, all based in Grünwald/Germany, have informed Knorr-Bremse AG that directly or indirectly, they hold a majority interest in Knorr-Bremse AG.

## 12 Capital reserves

Capital reserves are unchanged from the previous year. Like the legal reserve, they are subject to the restrictions of Article 150 of the German Corporation Law (AktG).

## 13 Retained earnings

In addition to the legal reserve, retained earnings include the accumulated earnings of the companies included in consolidation, where these have not been distributed. Furthermore, this heading reflects all Group items that exert an influence on shareholders' equity.

The legal reserves amounted to TEUR 9,045 (2015: TEUR 8,726). The statutory reserves increased to TEUR 7,583 (2015: TEUR 7,453). Miscellaneous retained earnings amounted to TEUR 860,964 (2015: TEUR 818,878) at the balance sheet date.

## 14 Pension plan accruals

Pension plan accruals are valued in accordance with Article 249 (1) of the German Commercial Code (HGB) in conjunction with Article 67 (1) clause 1 of the Act Introducing the German Commercial Code (EGHGB).

	2016 TEUR	2015 TEUR
Pension plan accruals	242,851	240,587

## 15 Other accrued liabilities

	2016 TEUR	2015 TEUR
Provisions for taxes	131,169	146,314
Miscellaneous accruals	878,830	853,530
<b>Total</b>	<b>1,009,999</b>	<b>999,844</b>

The taxation provisions include projected income tax payments for the year under review or, where the fiscal year diverges from the financial year, an income tax charge allocated on an accrual basis. Tax charges are also shown for preceding assessment periods. Miscellaneous accruals relate primarily to warranty and product liability commitments at TEUR 430,722 (2015: TEUR 410,722), personnel costs and restructuring activities at TEUR 185,786 (2015: TEUR 173,547), anticipated losses on contracts and other risks in connection with current operations, as well as invoices outstanding at TEUR 14,103 (2015: TEUR 19,288).

## 16 Liabilities

	2016 TEUR	2016 TEUR	2016 TEUR	2016 TEUR	2015 TEUR
	Remaining term less than 1 year	Remaining term 1 to 5 years	Remaining term more than 5 years	in total	in total
<b>Bonds</b>	<b>0</b>	<b>500,000</b>	<b>0</b>	<b>500,000</b>	<b>0</b>
<b>Accounts payable, banks</b>	<b>8,462</b>	<b>126,925</b>	<b>13,436</b>	<b>148,823</b>	<b>160,585</b>
<b>Accounts payable, trade</b>	<b>713,673</b>	<b>391</b>	<b>0</b>	<b>714,064</b>	<b>688,147</b>
<b>Other liabilities:</b>					
Liabilities from accepted bills	4,751	0	0	4,751	4,798
Miscellaneous liabilities	156,052	327	75	156,454	163,946
(thereof for taxes)	(39,792)	0	0	(39,792)	(51,303)
(thereof for social security)	(16,181)	0	0	(16,181)	(14,545)
	<b>160,803</b>	<b>327</b>	<b>75</b>	<b>161,205</b>	<b>168,744</b>
<b>Total liabilities</b>	<b>882,938</b>	<b>627,643</b>	<b>13,511</b>	<b>1,524,092</b>	<b>1,017,476</b>

Knorr-Bremse AG has issued a bond on Luxembourg's EURO MTF stock exchange, with effect from December 8, 2016. Revenue from the bond will serve to finance the growth of the Knorr-Bremse Group. The volume of the bond is EUR 500 million at a fixed coupon rate of 0.5% p.a. over a 5-year term (to maturity).

## 17 Contingencies and miscellaneous financial commitments

	2016 TEUR	2015 TEUR
Warranties	19,074	19,662
Guarantees	21,082	25,996
Leasing commitments	277,105	235,013

The Knorr-Bremse Group has entered into leasing contracts primarily for office buildings and production facilities in which the leased asset is assignable to the lessor. These off-balance-sheet leasing transactions represent an alternative form of finance to borrowing. Commitments associated with these leasing agreements are carried under Miscellaneous financial commitments and amount to TEUR 277,105 (2015: TEUR 235,013); commitments with terms of 1 year or less total TEUR 65,262 (2015: TEUR 36,851); commitments with terms ranging from 1 to 5 years amount to TEUR 145,001 (2015: TEUR 119,325), and commitments with terms of over 5 years total TEUR 66,842 (2015: TEUR 78,837). The agreements do not include any unusual termination or renewal options.

Thanks to the risk management system in place, the risk of a claim arising on contingent liabilities is rated as minimal.

## 18 Other operating income

Other operating income consists primarily of gains on currency exchange, income from the reversal of reserves, and income from disposals of fixed assets. The heading also carries gains on currency differences amounting to TEUR 123,974 (2015: TEUR 111,181).

Income relating to other accounting periods in the amount of TEUR 48,593 (2015: 65,947), generated primarily from the reversal of reserves, is also shown under Other operating income.

## 19 Cost of materials

	2016 TEUR	2015 TEUR
Expenditure on materials, supplies, and merchandise	2,378,636	2,563,210
Expenditure on services purchased	182,229	167,413
<b>Total</b>	<b>2,560,865</b>	<b>2,730,623</b>

## 20 Personnel expenses/staff

	2016 TEUR	2015 TEUR
Wages and salaries	996,776	984,572
Statutory social welfare contributions and expenses relating to pensions and employee benefits	199,816	228,650
<b>Personnel costs</b>	<b>1,196,592</b>	<b>1,213,222</b>
(thereof for retirement benefits)	(25,655)	(54,931)
<b>Average number of employees during the fiscal year</b>	<b>Number</b>	<b>Number</b>
Wage earners	10,247	10,167
Salary earners	11,532	11,334
Apprentices and trainees	190	237
<b>Total</b>	<b>21,969</b>	<b>21,738</b>

## 21 Depreciation

	2016 TEUR	2015 TEUR
Depreciation and amortization on purchased intangibles and on fixed assets	179,450	198,871

In addition, rental and leasing expenses totaling TEUR 74,183 (2015: TEUR 70,050) were incurred during the reporting period. For more details of additional depreciation, please see Notes 3 and 4 of these Notes to the Consolidated Financial Statements.

## 22 Other operating expenses

Other operating expenses consist primarily of maintenance costs, direct sales costs, legal and consulting fees, commissions, travel expenses, and miscellaneous administrative expenses. Other operating expenses also include the costs associated with the bond issue. Other taxes for the Group amount to TEUR 22,755 (2015: TEUR 30,794). Expenses resulting from foreign exchange fluctuations during the fiscal year amounted to TEUR 136,164 (2015: TEUR 130,832). The fee paid to the independent auditors, KPMG AG Wirtschaftsprüfungsgesellschaft and their affiliates, amounted to TEUR 629 for fiscal year 2016 (2015: TEUR 547). Of this, TEUR 500 (2015: TEUR 514) was paid out for audit services and TEUR 129 (2015: TEUR 33) for other services.

## 23 Financial results

	2016 TEUR	2015 TEUR
Miscellaneous interest and similar income	10,031	17,359
Interest and similar expenses	(15,282)	(18,930)
(thereof for discounts on accruals)	(9,411)	(11,424)
Income from associated, affiliated, and other companies	2,666	815
<b>Total</b>	<b>(2,585)</b>	<b>(756)</b>

## 24 Taxes on income

Taxes on income and earnings amounted to TEUR 279,775 (2015: TEUR 331,791) and included a deferred tax charge of TEUR 10,697 (2015: TEUR 3,443).

## 25 Net income

	2016 TEUR	2015 TEUR
<b>Net income</b>	<b>549,685</b>	<b>644,762</b>
Non-controlling interests	(64,897)	(76,521)
Retained earnings brought forward from the previous year (after distribution of dividends)	254,256	178,777
Transfers to retained earnings	(62,907)	(128,762)
<b>Unappropriated consolidated net income (Knorr-Bremse AG unappropriated retained earnings)</b>	<b>676,137</b>	<b>618,256</b>

## 26 Financial derivatives

Financial instruments are not held for trading purposes.

Underlying transactions and their derivatives are bundled together as single items for valuation purposes ("hedging relationships"). These hedging relationships are netted out without affecting net income wherever the respective impact on income of the underlying transaction (hedged item) and the related hedge offset each other (net hedge presentation method).

Forward exchange and option transactions are performed purely and exclusively in order to hedge current and future foreign currency receivables and payables from the sale and purchase of goods and services and the elimination of exchange rate risk for selected assets. The aim of hedging operations at Knorr-Bremse is to reduce the risks posed by foreign exchange fluctuations to the ordinary course of business. Currency hedging is based on the volume of open commitments arising or expected to arise from core business activities. Maturities are based on the lifespans of the underlying business transactions, whereby high-probability transactions are hedged over a rolling 3-year planning period. Because the conditions and parameters of the hedges match those of the hedged items, payment flows and/or changes in value largely offset each other. The Knorr-Bremse Group uses forward exchange contracts, currency options, and interest rate swaps as hedging instruments.

Hedging relationships have not been set up for currency option derivatives with a nominal value of EUR 24.0 million or forward exchange derivatives with a nominal value of EUR 44.0 million. Hedging relationships have been set up for financial instruments amounting to EUR 676.7 million in total (representing the hedged risks). Of this amount, EUR 169.4 million is attributable to the hedging of assets (micro hedges), EUR 27.0 million to the hedging of open contracts (micro hedges), and EUR 480.3 million to the hedging of high-probability transactions (portfolio hedges).

Commodity-related contracts are used exclusively to hedge price risks arising on fluctuations in the purchase prices of raw materials used in Knorr-Bremse Group products (portfolio hedges). The volume of underlying transactions (hedged items) is calculated on the basis of high-probability requirements for raw materials over a rolling 2-year planning period. The derivatives are based on reference indices traded on commodity futures exchanges. The effectiveness of this hedging approach is retrospectively analyzed using statistical correlation techniques, showing a correlation in excess of 80%. Concluded contracts with a total nominal value of EUR 1.9 million are carried in full in hedging relationships.

The nominal and market values of financial instruments as at December 31, 2016 break down as follows:

Financial derivatives	Total as at Dec. 31, 2016		Total as at Dec. 31, 2015	
	Nominal value	Market value	Nominal value	Market value
in EUR millions				
<b>Foreign exchange contracts</b>				
Forward exchange transactions	633.2	-11.4	712.9	-17.6
Currency options	76.0	0.2	46.0	0.1
<b>Interest rate contracts</b>				
Interest rate swaps	35.5	-7.7	35.5	-7.7
<b>Commodity-related contracts</b>				
Commodity swaps	1.9	-0.1	2.3	-0.2

Negative market values correspond to the risks associated with financial derivatives. Positive market values are offset by risks associated with the underlying transactions (hedged items) in the respective hedging relationships.

The market value of financial derivatives is best defined as the price one party is prepared to pay in order to assume the rights and/or obligations of another party. Market values are calculated on the basis of market information available at the balance sheet date and by applying standard market valuation methods as follows:

- Currency hedging contracts are valued on the basis of reference rates, taking account of forward premiums and discounts.
- Commodity contracts are used to hedge risks associated with aluminum price fluctuations. The contracts are valued at market price. In the case of structured products, bank valuations at the balance sheet date are applied.
- Options are valued using recognized models for calculating option prices (e.g. Black-Scholes).

Paid and received option premiums are carried under Other assets. The book value of paid and received option premiums amounted to EUR 1.5 million at the balance sheet date.

## 27 Research and development expenditure

In fiscal year 2016, Group expenditure on research and development amounted to TEUR 328,449 (2015: TEUR 347,341).

## 28 Disclosure

The Group financial statements are published in the official Federal Gazette and in the Commercial Register at the local first-instance court in Munich, Germany. Under the terms of Article 264 (3) of the German Commercial Code (HGB), the subsidiary companies Knorr-Bremse Systeme für Nutzfahrzeuge GmbH, Munich/Germany, Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, Munich/Germany, Knorr-Bremse IT-Services GmbH, Munich/Germany, Heine Resistors GmbH, Dresden/Germany, and Hasse & Wrede GmbH, Berlin/Germany, are exempt from the obligation to publish their figures pursuant to Article 325 of the German Commercial Code.

## 29 Total remuneration of the Supervisory Board and Executive Board

The total remuneration of members of the Supervisory Board amounted to TEUR 720 (2015: TEUR 236) and the total remuneration of the Executive Board to TEUR 5,976 (2015: TEUR 6,157). Pension commitments to former members of the Executive Board and their surviving dependents are covered by an accrual of TEUR 34,921 (2015: TEUR 32,016); payments in the fiscal year amounted to TEUR 3,221 (2015: TEUR 3,252).

## 30 Executive Board of Knorr-Bremse AG

Klaus Deller, member of the Executive Board since 2009, Chairman of the Executive Board since January 1, 2015, responsible for the Rail Vehicle Systems division since July 1, 2016

Dr. Peter Laier, member of the Executive Board since January 1, 2016, responsible for the Commercial Vehicle Systems division

Dr. Lorenz Zwingmann, member of the Executive Board since 2008, responsible for Finance, Controlling, and IT

Dr. Dieter Wilhelm, member of the Executive Board until June 30, 2016, responsible for the Rail Vehicle Systems division since 2003

### 31 Supervisory Board of Knorr-Bremse AG

Heinz Hermann Thiele, Munich/Germany

Chairman of the Supervisory Board until March 11, 2016  
Entrepreneur

Dr. Bernd Bohr, Stuttgart/Germany

Chairman of the Supervisory Board since March 11, 2016, stepped down on July 4, 2016  
Former Chairman of the Automotive Technology business sector at Robert Bosch GmbH

Hans-Georg Härter, Salzweg/Germany

Chairman of the Supervisory Board since July 5, 2016  
Former Chief Executive Officer of ZF Friedrichshafen AG

Dr. Eduard Gerum\*, Rosenheim/Germany

1st Deputy Chairman of the Supervisory Board until March 11, 2016  
Consultant to the Executive Board of Knorr-Bremse Systeme für Nutzfahrzeuge GmbH

Franz-Josef Birkeneder\*, Aldersbach/Germany

1st Deputy Chairman of the Supervisory Board since March 11, 2016  
Knorr-Bremse Plant Manager, Aldersbach site

Manfred Wennemer, Bensheim/Germany

2nd Deputy Chairman of the Supervisory Board until March 11, 2016  
Former Chief Executive Officer of Continental AG

Michael Jell\*, Munich/Germany

Deputy Chairman of the Works Council of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, Knorr-Bremse AG, KB Media GmbH, Knorr-Bremse IT-Services GmbH

Dr. Wolfram Mörsdorf, Essen/Germany

Retired member of the Executive Board of ThyssenKrupp AG

Werner Ratzisberger\*, Munich/Germany

Project engineer mechanical surface treatment  
Knorr-Bremse Systeme für Nutzfahrzeuge GmbH

Sebastian Roloff\*, Munich/Germany

Attorney at law with IG Metall trade union, Munich office

Erich Starkl\*, Passau/Germany

Second Authorized Representative of IG Metall trade union, Passau office

Julia Thiele-Schürhoff, Munich/Germany

Member of the Supervisory Board since March 11, 2016  
Chair of the Executive Board of Knorr-Bremse Global Care e.V.

Wolfgang Tölsner, Uetersen/Germany

Management Consultant

Georg Weiberg, Stuttgart/Germany

Retired Head of Development, Daimler Trucks

Günter Wiese\*, Berlin/Germany

Chairman of the Works Council of Knorr-Bremse Systeme für Schienenfahrzeuge GmbH,  
Berlin plant

\* Employee representative.

### 32 Events of particular significance after the end of the fiscal year

Effective as from February 1, 2017, Knorr-Bremse acquired the Electrical Systems business unit (Vossloh Kiepe) of Vossloh AG. The acquisition resulted in a goodwill figure in the double-digit millions. Based on IFRS reporting standards, Vossloh Kiepe turned over nearly EUR 250 million with around 800 employees in fiscal year 2015. The acquisition will expand Knorr-Bremse's product range for rail and commercial vehicles by adding modern powertrain technologies.

On February 1, 2017, Knorr-Bremse announced a series of comprehensive initiatives to build up the Company's Berlin-based rail systems operations, reflecting Knorr-Bremse's solid commitment to the Company's home city of Berlin. The initiatives include:

- Moving the production of power supply systems for rail vehicles (Knorr-Bremse PowerTech) from Berlin-Tegel to Berlin-Marzahn
- Expanding Berlin rail systems operations by moving resources from Munich to Berlin
- Moving the production of torsional vibration dampers for commercial vehicles and stationary engines (Hasse & Wrede) from Berlin-Marzahn to the Commercial Systems Technology site in Liberec, Czech Republic
- Moving Knorr-Bremse PowerTech away from an employers' association bound by collective bargaining agreements to an employers' association that is not bound by collective bargaining agreements in order to standardize working conditions within the Knorr-Bremse Group

With the relocation of Knorr-Bremse PowerTech, which mainly produces power supply systems for rail vehicles, Knorr-Bremse is consolidating and strengthening the Company's rail systems operations in Berlin. Important elements of the manufacturing operations of Systeme für Schienenfahrzeuge GmbH – including the production of brake discs and brake control systems – are already located at the Marzahn plant. This means that Marzahn is evolving into a site that specializes in rail systems activities, where more than 900 employees will be working in the future. Relocation to Marzahn – where Knorr-Bremse PowerTech was located at an earlier stage in its development, between 1996 and 2003 – will affect around 275 employees. The relocation is scheduled for mid-2018, and should be complete by early 2019.

Knorr-Bremse PowerTech's move to Marzahn will be preceded by the relocation of torsional vibration damper production from Marzahn to Liberec in the Czech Republic and other sites in North America and Asia. Knorr-Bremse subsidiary Hasse & Wrede currently employs around 150 people at the Marzahn site, manufacturing torsional vibration dampers for commercial vehicles and stationary engines in particular.

The relocation of production operations to North America and Asia will satisfy the localization requirements of engine manufacturers in both regions and help to consolidate Hasse & Wrede's worldwide damper business. In view of these considerations and the growing cost pressures from customers, it is no longer economically viable to keep the company's remaining production opera-

tions at Marzahn. In Liberec, Knorr-Bremse already has a large facility for manufacturing commercial vehicle systems. The relocation to Liberec will affect 125 employees in production and production-related activities, for whom socially acceptable solutions must be found. The Center of Competence (CoC) Dampers will not be relocated, and will continue to manage its global business from Berlin. The relocation project is scheduled for completion in the first half of 2018.

Furthermore, at the end of January and effective as from December 31, 2017, Knorr-Bremse PowerTech stepped down from the Berlin-Brandenburg Metal and Electrical Industry Employers' Association, which is bound by collective bargaining agreements, and instead joined the General Business Association for Berlin and Brandenburg, which is not bound by such agreements. As part of the announced relocation to Marzahn, this step by Knorr-Bremse PowerTech following its acquisition by Knorr-Bremse completes the company's integration into the Group's structures and paves the way for harmonizing working conditions throughout the Group. In Germany, the 42-hour week has been the working standard within the Knorr-Bremse Group since 2006. Knorr-Bremse PowerTech is now planning to introduce a 42-hour week on April 1, 2017. In addition to the company's Berlin site, the new working week will also be introduced at Knorr-Bremse PowerTech's Holzkirchen site in Bavaria, where part of the workforce already works a 42-hour week.

Employee representative bodies and potentially affected employees at Hasse & Wrede and Knorr-Bremse PowerTech have already been informed about the new initiatives. Negotiations on reconciling the various interests involved, including redundancy programs, are due to start in the near future.

No other events of particular significance occurred after the end of the fiscal year.

Munich, March 1, 2017

Knorr-Bremse AG  
Executive Board



Klaus Deller



Dr. Peter Laier



Dr. Lorenz Zwingmann

## Consolidated Cash Flow Statement in Compliance with GAS 21 (German Accounting Standard)

	2016 TEUR	2015 TEUR
Result for the period (including minority interests in consolidated results)	549,685	644,762
Depreciation and amortization on/Additions to intangibles and fixed assets	179,450	198,861
Increase in accruals	15,433	39,498
Decrease (2015: increase) in inventories, trade receivables, and other assets not related to investing or financing activities	7,547	-53,009
Decrease (2015: increase) in trade payables and other liabilities not related to investing or financing activities	-21,447	52,720
Profits (2015: losses) on disposals of intangibles, fixed assets, and investments	-13,601	5,414
Interest expenses	5,251	1,571
Other income from shareholdings	-2,666	-815
Subsidies received	-9,735	-3,543
Income tax charge	279,775	331,792
Income tax paid	-280,290	-304,584
<b>Cash flows from operating activities</b>	<b>709,402</b>	<b>912,667</b>
Disbursements (2015: proceeds) from disposals of intangible assets	-298	34
Disbursements for investments in intangible assets	-21,039	-12,417
Proceeds from disposals of fixed assets	18,762	8,191
Disbursements for investments in fixed assets	-173,537	-197,738
Proceeds from disposals of financial assets	2,548	2,890
Disbursements for investments in financial assets	-78,759	-8,798
Disbursements for the acquisition of consolidated companies and other business units	-179,183	-102,305
Interest received	8,308	26,611
<b>Cash flows from investing activities</b>	<b>-423,198</b>	<b>-283,532</b>
Proceeds from equity contributions by minority shareholders	2,428	0
Proceeds from the issuance of bonds and (financial) borrowings	501,916	34,773
Disbursements for the redemption of bonds and (financial) loans	-8,700	-16,798
Proceeds from grants/subsidies received	9,735	3,543
Interest paid	-18,057	-21,848
Dividends paid to parent company shareholders	-364,000	-312,000
Dividends paid to minority shareholders	-64,298	-83,969
<b>Cash flows from financing activities</b>	<b>59,024</b>	<b>-396,299</b>
<b>Net change in cash funds</b>	<b>345,228</b>	<b>232,836</b>
Change in cash funds resulting from exchange rate and valuation-related movements	9,532	21,406
Change in cash funds resulting from changes in Group structure	19,339	778
<b>Changes in cash funds resulting from cash-relevant transactions</b>	<b>374,099</b>	<b>255,020</b>
Cash funds at the beginning of the period	1,341,761	1,086,741
Cash funds at the end of the period	1,716,241	1,341,761
<b>Cash funds are comprised as follows:</b>		
Cash and cash equivalents	1,720,060	1,360,063
Short-term marketable securities	51	11
Short-term bank debt (term less than 3 months)	-3,870	-18,313
	<b>1,716,241</b>	<b>1,341,761</b>

### Segment Report in Compliance with GAS 3 (German Accounting Standard)

In order to comply with GAS 3, Knorr-Bremse AG has compiled the following report on three segments that are subject to reporting requirements. The breakdown by segment is based on the Group's activities in the three major geographical regions that provide the geographical framework for the Group's internal organizational and reporting structures. The operating segments cover three regions: Europe/Africa, the Americas, and Asia/Australia, each of which is characterized by different market and customer demands. The Knorr-Bremse Group's main product lines – braking systems for rail and commercial vehicles – are represented in all three regions.

Fiscal year 2016	Europe/Africa	Americas	Asia/ Australia	Knorr-Bremse Group
<b>in EUR thousands</b>				
Sales by region	3,304,846	1,291,195	1,585,285	6,181,326
thereof net sales with third parties	2,728,247	1,219,219	1,546,826	5,494,292
thereof net sales with other segments	576,599	71,976	38,459	687,034
Net income	241,721	99,987	207,977	549,685
Income tax charge	123,031	50,890	105,854	279,775
Investments (excluding financial investments)	135,616	32,025	26,935	194,576
Depreciation (excluding financial investments)	118,288	37,588	23,574	179,450
Result for associated companies	2,620	0	20	2,640
Result for affiliated and other companies	26	0	0	26
Assets	2,700,103	683,525	1,220,580	4,604,208

Fiscal year 2015	Europe/Africa	Americas	Asia/ Australia	Knorr-Bremse Group
<b>in EUR thousands</b>				
Sales by region	3,142,665	1,544,679	1,829,462	6,516,806
thereof net sales with third parties	2,617,797	1,432,719	1,780,096	5,830,612
thereof net sales with other segments	524,868	111,960	49,366	686,194
Net income	228,870	143,793	272,099	644,762
Income tax charge	117,776	73,995	140,020	331,791
Investments (excluding financial investments)	128,136	42,794	39,225	210,155
Depreciation (excluding financial investments)	140,858	35,089	22,924	198,871
Result for associated companies	2,356	0	(1,554)	802
Result for affiliated and other companies	13	0	0	13
Assets	1,985,667	713,232	1,302,996	4,001,895

Fiscal year 2016	Net sales	Investments (excluding financial investments)	Depreciation (excluding financial investments)	Assets
<b>in EUR thousands (TEUR)</b>				
Rail vehicle systems	2,990,341	103,540	96,871	2,610,272
Commercial vehicle systems	2,523,183	82,403	71,402	1,687,570
Miscellaneous/consolidations	(19,232)	8,663	11,177	306,366
Knorr-Bremse Group	5,494,292	194,576	179,450	4,604,208

Fiscal year 2015	Net sales	Investments (excluding financial investments)	Depreciation (excluding financial investments)	Assets
<b>in EUR thousands (TEUR)</b>				
Rail vehicle systems	3,341,069	117,596	120,972	2,559,973
Commercial vehicle systems	2,491,839	81,137	68,430	1,528,136
Miscellaneous/consolidations	(2,296)	11,422	9,469	(86,214)
Knorr-Bremse Group	5,830,612	210,155	198,871	4,001,895

The analysis does not show borrowings or interest payable by region, because these items are controlled centrally across the Group by the parent company, thus are not dependent on regional decisions associated with day-to-day business operations.

The usual prices apply as agreed between counterparties.

## Statement of Changes in Group Equity in Compliance with GAS 7 (German Accounting Standard)

Changes in group equity 2016	Capital stock	Capital reserves	Retained earnings	Net income	Non-controlling interests	Knorr-Bremse Group
<b>in EUR thousands (TEUR)</b>						
As at Dec. 31, 2015	67,600	153	835,057	618,256	214,663	1,735,729
Dividend payments				(364,000)	(64,696)	(428,696)
Net income 2016				484,788	64,897	549,685
Transfers to retained earnings			62,907	(62,907)		0
Currency fluctuations			14,547		4,814	19,361
Other fluctuations			(34,919)		(22,348)	(57,267)
As at Dec. 31, 2016	67,600	153	877,592	676,137	197,330	1,818,812

Changes in group equity 2015	Capital stock	Capital reserves	Retained earnings	Net income	Non-controlling interests	Knorr-Bremse Group
<b>in EUR thousands (TEUR)</b>						
As at Dec. 31, 2014	67,600	153	679,651	490,777	205,027	1,443,208
Dividend payments				(312,000)	(83,969)	(395,969)
Net income 2015				568,241	76,521	644,762
Transfers to retained earnings			128,762	(128,762)		0
Currency fluctuations			28,558		5,792	34,350
Other fluctuations			(1,914)		11,292	9,378
As at Dec. 31, 2015	67,600	153	835,057	618,256	214,663	1,735,729

Group equity includes capital differences arising on foreign currency translation in the amount of TEUR 11,050 (2015: TEUR -8,311), of which TEUR 5,345 (2015: TEUR 531) relates to non-controlling interests.

Other changes result primarily from the acquisition of indirect minority shares, for which the proportional goodwill of TEUR 22,297 has been offset against the adjustment item for non-controlling interests, as well as the allocation of the TEUR 29,211 difference arising on the first-time consolidation of Black River Air Logistics LLC after the company was founded on a cash basis and initially not included in consolidation because of its minor significance pursuant to Article 296 (2) HGB.

## Independent Auditors' Report

We have audited the consolidated financial statements prepared by Knorr-Bremse Aktiengesellschaft, Munich – comprising the balance sheet, income statement, notes to the financial statements, cash flow statement, statement of changes in equity, and segment report – as well as the group management report for the business year from January 1 to December 31, 2016. The preparation of the consolidated financial statements and the group management report in accordance with German commercial law is the responsibility of the parent company's management. Our responsibility is to express an opinion on the consolidated financial statements and on the group management report based on our audit.

We conducted our audit of the consolidated financial statements in accordance with § 317 HGB (German Commercial Code) and German generally accepted standards for the audit of financial statements promulgated by the Institut der Wirtschaftsprüfer (IDW). Those standards require that we plan and perform the audit such that misstatements materially affecting the presentation of the net assets, financial position, and results of operations in the consolidated financial statements in accordance with German principles of proper accounting and in the group management report are detected with reasonable assurance. Knowledge of the business activities and the economic and legal environment of the Group and expectations as to possible misstatements are taken into account in the determination of audit procedures. The effectiveness of the accounting-related internal control system and the evidence supporting the disclosures in the consolidated financial statements and the group management report are examined primarily on a test basis within the framework of the audit.

The audit includes assessing the annual financial statements of those entities included in consolidation, the determination of entities to be included in consolidation, the accounting and consolidation principles used, and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements and group management report. We believe that our audit provides a reasonable basis for our opinion.

Our audit has not led to any reservations.

In our opinion, based on the findings of our audit, the consolidated financial statements comply with the legal requirements and give a true and fair view of the net assets, financial position, and results of operations of the Group in accordance with these requirements. The group management report is consistent with the consolidated financial statements and as a whole provides a suitable view of the Group's position and suitably presents the opportunities and risks of future development.

Munich, March 1, 2017

KPMG AG  
Wirtschaftsprüfungsgesellschaft

signed Rupprecht  
Independent auditor

signed Annast  
Independent auditor

## Consolidated Balance Sheet as at December 31, 2016

Assets	Notes	Dec. 31, 2016 TEUR	Dec. 31, 2015 TEUR
Purchased intangibles	(3)	245,341	176,675
Fixed assets	(4)	901,002	782,093
Investments	(5)	97,405	80,095
<b>Intangibles, fixed assets, and investments</b>		<b>1,243,748</b>	<b>1,038,863</b>
Inventories	(6)	419,486	417,791
Accounts receivable, trade	(7)	961,414	939,763
Receivables from affiliated companies not included in consolidation	(7)	140	0
Other assets	(7)	173,609	144,978
Other marketable securities		51	11
Cash and cash equivalents	(8)	1,720,060	1,360,063
<b>Current assets</b>		<b>3,274,760</b>	<b>2,862,606</b>
<b>Prepaid expenses</b>	<b>(9)</b>	<b>23,529</b>	<b>23,731</b>
<b>Deferred tax assets</b>	<b>(10)</b>	<b>62,171</b>	<b>76,695</b>
<b>Balance sheet total</b>		<b>4,604,208</b>	<b>4,001,895</b>

Equity and liabilities	Notes	Dec. 31, 2016 TEUR	Dec. 31, 2015 TEUR
Capital stock	(11)	67,600	67,600
Capital reserves	(12)	153	153
Retained earnings	(13)	877,592	835,057
Unappropriated consolidated net income	(25)	676,137	618,256
Non-controlling interests		197,330	214,663
<b>Group equity</b>		<b>1,818,812</b>	<b>1,735,729</b>
Pension plan accruals	(14)	242,851	240,587
Other accrued liabilities	(15)	1,009,999	999,844
<b>Accruals</b>		<b>1,252,850</b>	<b>1,240,431</b>
Bonds		500,000	0
Accounts payable, banks		148,823	160,585
Accounts payable, trade		714,064	688,147
Other liabilities		161,205	168,744
<b>Liabilities</b>	<b>(16)</b>	<b>1,524,092</b>	<b>1,017,476</b>
<b>Deferred income</b>		<b>8,454</b>	<b>8,259</b>
<b>Balance sheet total</b>		<b>4,604,208</b>	<b>4,001,895</b>

## Consolidated Statement of Income for the Fiscal Year from January 1 to December 31, 2016

	Notes	2016 TEUR	2015 TEUR
Net sales		5,494,292	5,830,612
Changes in inventories		(6,806)	(35,521)
Own work capitalized		390	630
<b>Total operating performance</b>		<b>5,487,876</b>	<b>5,795,721</b>
Other operating income	(18)	248,461	293,912
Cost of materials	(19)	(2,560,865)	(2,730,623)
Personnel expenses	(20)	(1,196,592)	(1,213,222)
Depreciation and amortization on purchased intangibles and fixed assets	(21)	(179,450)	(198,871)
Other operating expenses	(22)	(967,385)	(969,608)
Financial results	(23)	(2,585)	(756)
<b>Income before taxes</b>		<b>829,460</b>	<b>976,553</b>
Taxes on income	(24)	(279,775)	(331,791)
<b>Net income</b>	<b>(25)</b>	<b>549,685</b>	<b>644,762</b>
Non-controlling interests		(64,897)	76,521

# Main Majority-owned Subsidiaries of Knorr-Bremse AG

## The Americas

### Knorr Brake Holding Corporation, Watertown, New York (US)\*

Anchor Brake Shoe Company LLC (US)  
 Bendix Commercial Vehicle Systems LLC (US)  
 Bendix Spicer Foundation Brake LLC (US)\*  
 IFE North America LLC (US)  
 Knorr Brake Company LLC (US)  
 Knorr Brake Ltd. (CA)  
 Merak North America LLC (US)  
 New York Air Brake LLC (US)  
 Technologies Lanka Inc. (CA)

### Knorr-Bremse Brasil (Holding) Administração e Participação Ltda., Itupeva (BR)

Knorr-Bremse Sistemas para Veículos Comerciais Brasil Ltda. (BR)  
 Knorr-Bremse Sistemas para Veículos Ferroviários Ltda. (BR)

\* Minority holding in subsidiary by non-Group companies

\*\* 20% stake held by Robert Bosch GmbH, Stuttgart (DE)

\*\*\* Shareholders: 50% Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, Munich (DE); 50% Knorr-Bremse Systeme für Nutzfahrzeuge GmbH, Munich (DE)

As at December 31, 2016.

## Asia – Australia

### Knorr-Bremse Asia Pacific (Holding) Ltd., Hong Kong (HK)

Guangdong Knorr-Bremse Guo Tong Railway Vehicle Systems Equipment Co., Ltd. (CN)\*  
 Hasse & Wrede CVS Dalian, China Ltd. (CN)\*  
 IFE-VICTALL Railway Vehicle Door Systems (Qingdao) Co., Ltd. (CN)\*  
 Knorr-Bremse Australia Pty. Ltd. (AU)  
 Knorr-Bremse Brake Equipment (Shanghai) Co., Ltd. (CN)  
 Knorr-Bremse Braking Systems for Commercial Vehicles (Dalian) Co., Ltd. (CN)  
 Knorr-Bremse CAFF Systems for Commercial Vehicles Chongqing Ltd. (CN)\*  
 Knorr-Bremse CARS LD Vehicle Brake Disc Manufacturing (Beijing) Co., Ltd. (CN)\*  
 Knorr-Bremse Commercial Vehicle Systems Japan Ltd. (JP)\*\*  
 Knorr-Bremse DETC Commercial Vehicle Braking Technology Co., Ltd. (CN)\*  
 Knorr-Bremse India Pvt. Ltd. (IN)  
 Knorr-Bremse/Nankou Air Supply Unit (Beijing) Co., Ltd. (CN)\*  
 Knorr-Bremse Rail Systems Japan Ltd. (JP)\*  
 Knorr-Bremse Rail Systems Korea Ltd. (KR)  
 Knorr-Bremse Systems for Commercial Vehicles India Pvt. Ltd. (IN)  
 Knorr-Bremse Systems for Rail Vehicles (Suzhou) Co., Ltd. (CN)  
 Knorr-Bremse Technology Center India Pvt. Ltd. (IN)\*\*\*  
 Merak Jinxin Air Conditioning Systems (Wuxi) Co., Ltd. (CN)\*  
 Sigma Transit Systems Pty. Ltd. (AU)  
 Sydac Pty. Ltd. (AU)

## Europe – Middle East – Africa

### Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, Munich (DE)

Dr. techn. Josef Zelisko Ges.m.b.H. (AT)  
 Heine Resistors GmbH (DE)  
 Icer Rail S.L. (ES)  
 IGE-CZ s.r.o. (CZ)  
 Knorr-Bremse 1520 OOO (RU)\*  
 Knorr-Bremse Ges.m.b.H. (AT)  
 Knorr-Bremse España, S.A. (ES)  
 Knorr-Bremse Nordic RailServices AB (SE)  
 Knorr-Bremse PowerTech GmbH (DE)  
 Knorr-Bremse PowerTech GmbH & Co. KG (DE)  
 Knorr-Bremse Rail Systems Italia S.r.l. (IT)  
 Knorr-Bremse Rail Systems OOO (RU)  
 Knorr-Bremse Rail Systems (UK) Ltd. (GB)  
 Knorr-Bremse Rail Systems Schweiz AG (CH)  
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 Microelettrica Scientifica S.p.A. (IT)  
 Selectron Systems AG (CH)  
 Swedtrac RailServices AB (SE)

### Knorr-Bremse Systeme für Nutzfahrzeuge GmbH, Munich (DE)\*\*

GT Emission Systems Ltd. (GB)  
 GT Project Engineering Ltd. (GB)  
 Hasse & Wrede GmbH (DE)  
 Knorr-Bremse Benelux B.V.B.A. (BE)  
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