



ESSENTIAL

FREUDENBERG SEALING TECHNOLOGIES
THE MAGAZINE – ISSUE #2 2016



THE PULL OF THE CITIES

Megacities are changing the face of the world and our lives.

NETWORKING OUT OF A TRAFFIC JAM

How connectivity is expected to prevent global gridlock.

AUTONOMOUS TRUCKS

Pacesetter for an idea – commercial vehicles could soon be driving themselves.

LESS IS MORE

The products in the LESS portfolio – for greater efficiency and lower emissions.

ESSENTIAL the magazine – #2 2016

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A QUESTION OF PERSPECTIVE

The world is coming together. What is true for many metropolitan areas with barely discernible city limits, also applies to continental borders – through digital networking, about 104,000 airline flights a day or the global transportation of goods across oceans. Our cover illustration also tells this story, merging New York, Rio, Shanghai and London into a single city.

Illustrations can show things from a different perspective, opening the door to another world for the observer. In isometric illustrations like the one on the cover of this edition of ESSENTIAL, the edges of an object that are actually at a 90-degree angle to one another are drawn at a 30-degree angle to the horizontal. At the same time, none of the edges in the drawing is foreshortened and all three directions have a common scale.

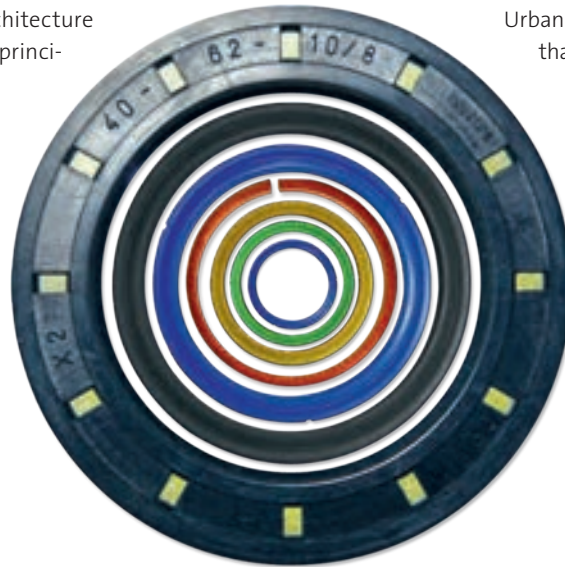
Isometric depictions come from architecture and are based on the mathematical princi-

ples of axonometry. They are widely used in computer games, in particular, when designers need to produce the impression of three dimensions.

The impact of games such as economic simulation Simutrans and the indie open-world of Minecraft in particular have made isometric representations increasingly popular for the illustration of ever more complex interrelationships.

Since its release in 2009, sales of Minecraft have surpassed the 100 million mark, and it is especially popular among young people. One of the key elements in the game is building a 3D world out of mostly cubic blocks – i.e. playful urbanization on the screen – and defending it in its “create” and “survive” modes.

Urbanization is a 21st century phenomenon that is engaging us in all spheres of our lives.





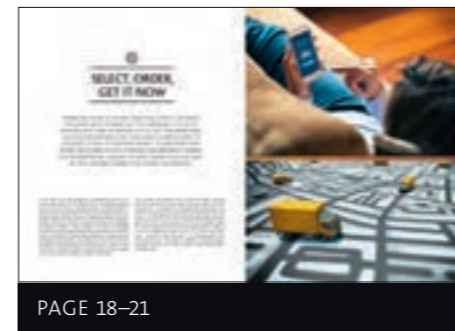
CONTENTS

- 1 INTRODUCTION
- 2-3 CONTENTS
- 4-9 MEGATRENDS
- 10-15 THE PULL OF THE CITIES
- 16-17 FIVE QUESTIONS FOR RAINER JOEST
- 18-21 SELECT, ORDER, GET IT NOW
- 22-27 NETWORKING OUT OF A TRAFFIC JAM
- 28-31 ALTERNATIVE TRANSPORT
- 32-37 BIG DATA ON THE FARM
- 38-41 UN HABITAT
- 42-45 FACTS & FIGURES
- 46-51 AUTONOMOUS DRIVING: TRUCKS AS PACESETTERS
- 52-55 LESS IS MORE
- 56-57 WITTENSTEIN PROFILE
- 58-63 TIRELESS WORKERS
- 64-69 FROM HYDROPOWER TO DATA STREAMS
- 70-73 A BAD ATMOSPHERE OVER THE WORLD'S OCEANS
- 74-75 NEWS
- 76 COMPANY INFORMATION



THE PULL OF THE CITIES

Urbanization is not a new phenomenon – but the new megacities of the 21st century are giving it a dynamic that is changing the face of the world.



SELECT, ORDER, GET IT NOW

The Internet has greatly changed our shopping habits. Many people prefer to have their purchases delivered to their homes. In the future, they will want them immediately.



NETWORKING OUT OF A TRAFFIC JAM

Ever-larger cities create ever-greater traffic. Cities must offer solutions so they won't be strangled by gridlock.



ALTERNATIVE TRANSPORT

To manage the transportation needs of megacities, companies are working on unconventional concepts. Tubes and stilts are playing a key role.



AUTONOMOUS DRIVING: TRUCKS AS PACESETTERS

Everyone is talking about cars that drive autonomously. Meanwhile, everything suggests that the technology will achieve success in commercial vehicles more quickly.



LESS IS MORE

Efficiency is the top priority in internal combustion engines and electric motors. Products in the LESS portfolio are helping automakers achieve their fuel consumption and emissions goals.



TIRELESS WORKERS

Robots and humanoids have been familiar elements in literature for more than 100 years. They have been used in industry for more than 50 years. What is their role now – and what will it be in the future?



FROM HYDROPOWER TO DATA STREAMS

Based in Heidenheim an der Brenz in Germany, Voith is a global player with a 150-year history. It is also at the forefront of the digital transformation.



A BAD ATMOSPHERE OVER THE WORLD'S OCEANS

Global trade would be inconceivable without huge container ships. The flipside is a huge emissions problem.



THE LIGHTS OF THE BIG CITY

#1

Megacities are increasingly defining life in the 21st century. In 2030, two-thirds of the world's population will live in cities. Hong Kong, strictly speaking, is not one of them because "only" a little more than seven million people live on the peninsula. Still, that works out at nearly 17,500 Hong Kong Chinese per square mile, which is roughly the population density of megacities Beijing and Shanghai. Fast growth on the city's periphery allows hardly any latitude for creativity. Megacities see themselves more and more alike in this respect.

#2

Their urban development is indeed proceeding in the same way – but the differences lie in the details. Hong Kong and New York City have roughly the same population, but the eight million people in the Big Apple are younger on average (35.5 vs. 41.7), can enjoy more museums (89 vs. 51) and have greater ethnic diversity (18 instead of 11 ethnic groups). Nonetheless, the well-known Mercer study assigns a higher quality of life to the southeast Asian metropolis. Hong Kong scores points, above all, for its low murder rate (0.8 vs. 6.4 per 100,000 residents), less corruption, lower income differential, a higher employment rate and universal state health insurance.



FROM THE BUNKER TO THE TABLE

#3

It looks like a red-light district for plants. In reality, it is a greenhouse in a London air raid shelter. As urban growth continues, supplying people in megacities is becoming a central issue. New solutions are required, whether they involve innovative logistics concepts or even cultivating lettuce locally. This is not just due to the constantly expanding amount of food, but also the difficulty of transporting it through an ever-expanding periphery.

#4

The global supply problem could be solved far more simply if there were less waste. According to UN estimates, about 190 kg of food are lost per person per year – a total of about 1.3 billion metric tons. In Western countries, consumers are the cause of about 40 percent of food waste. In many developing countries, the goods don't even make it that far. Nearly half is spoiled en route from farm to table – due to poor warehousing, inadequate transportation and the lack of marketing opportunities.



SOMEONE HAS TO DO THE WORK

#5

They can paint, fit, join, glue, mount, weld or measure tirelessly. Industrial robots are almost infinitely diverse.

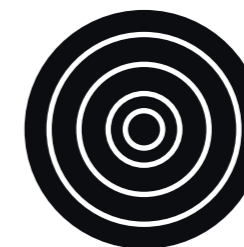
Now 60 years old, their triumphant march can not be stopped any longer – and who would want to? Contrary to all fears, robots haven't eliminated jobs. Instead, they have made a crucial contribution to the improvement of industrial working conditions. And advances in productivity through automation generate opportunities in the market and thus create jobs in other industries.

#6

Robots are increasingly catching on in other areas of life and work. Medical robots are assisting in surgery, diagnostics and care. They mow the lawn and do the vacuuming. Autonomous robots may soon deliver packages and pizzas. Exploratory robots investigate the surface of Mars and the narrow shafts of pyramids. They defuse bombs – but can also be used without scruple or misgivings. It depends on what we do with them.



THE PULL OF THE CITIES



IN ALL LIKELIHOOD, ROME HAD ABOUT 1.5 MILLION INHABITANTS AROUND THE YEAR 300 A.D., ALTHOUGH THIS IS AN ASSUMPTION AS HISTORIANS' ESTIMATES FLUCTUATE BETWEEN A LITTLE LESS THAN 500,000 AND THREE MILLION. AT ITS HEIGHT NEARLY 2,000 YEARS AGO, THE NEXUS OF THE ROMAN EMPIRE WAS THE FIRST MEGACITY. THE PHENOMENON OF URBANIZATION IS NOTHING NEW – BUT ITS IMPACT TODAY IS UNPARALLELED IN HUMAN HISTORY. AND THIS IS JUST THE BEGINNING.

Ancient Rome was the blueprint for later megacities, which the United Nations (UN) currently defines as metropolitan areas with a population of 10 million or more inhabitants. The number of megacities, or super cities, as they are also known, increases nearly every year. On its way there, London had already surpassed the five million mark at the end of the 19th century. New York, including its satellite cities, greeted its 10 millionth inhabitant in the 1950s and became the first true megacity.

Today, the American metropolis stands at about 19 million inhabitants. But other cities have long pulled ahead of New York. In the 1950s, greater Tokyo started out at about the same level as the Big Apple, but its population has almost quadrupled to about 38 million since then. Today, Delhi, Shanghai, Sao Paulo, Mumbai, Mexico City, Beijing and Osaka all exceed the 20-million mark.



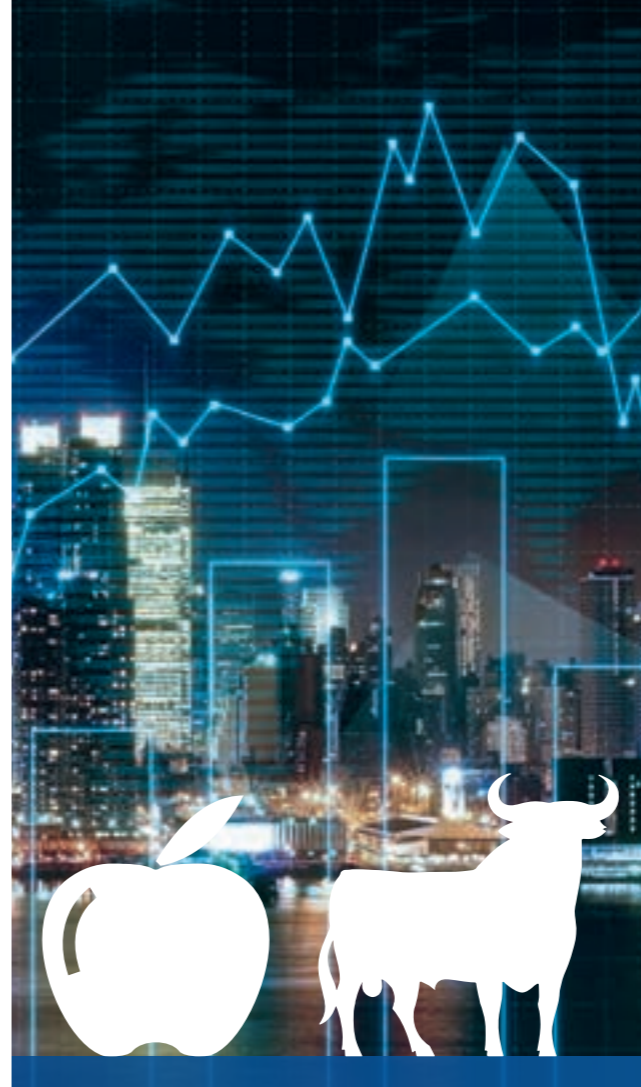
TWO-THIRDS OF ALL HUMAN BEINGS WILL SOON LIVE IN CITIES

The urbanization trend has been uninterrupted. A UN-Habitat study forecasts that nearly two-thirds of all people worldwide will live in a city by the year 2030. Urban growth is proceeding at a rapid pace. In 2000, just 47 percent of the global population lived in cities, and the number of urban dwellers only surpassed rural residents eight years ago. The importance of megacities has likewise been growing, with about 12 percent of all people today living in the world's 29 largest metropolitan areas. The UN expects 12 additional megacities to emerge by 2030. This is where the imbalance of population growth becomes evident. Asia and Africa are home to ten of these 12 new megacities. Researchers expect population increases of more than ten percent in Delhi (India) and Lagos (Nigeria) – and that's annually. The growth rates are on a comparable level for the Chinese cities of Shanghai and Beijing as well as for Dhaka (Bangladesh), Karachi (Pakistan) and Kinshasa (Congo). The prospects between now and 2050 are for even more dramatic growth. Four billion people worldwide now live in cities. By mid-century, that figure is expected to rise to 6.5 billion, with Africa and Asia accounting for about 90 percent of urban growth.

Developments in the megacities of the industrialized countries are shaping up completely differently. Not least of all, demographic changes and aging populations are leading to a situation where Tokyo and Osaka will actually shrink slightly by 2030, and New York, Los Angeles, Moscow and Paris will grow only marginally.

CHONGQING AS BIG AS AUSTRIA

While highly developed megacities are reaching the end of their burgeoning growth, other regions are just getting rolling. Not least of all due to this trend, the UN is introducing a new category, the "gigacity," as a designation for metropolitan areas with more than 50 million inhabitants. It is only a matter of time before the first economic regions in China exceed this threshold since urbanization is packing cities that were previously separate ever more tightly together. More than 170 million inhabitants could be living in greater Shanghai four years from now. One example of the huge demand for space is the Chinese city of Chongqing, which has 13.5 million inhabitants. They occupy a territory of about 83,000-square-kilometers (32,046,479-square-miles), roughly the size of Austria, while the Alpine republic has a population of barely 8.5 million.



NEW YORK AND SPAIN – ON AN EQUAL ECONOMIC FOOTING

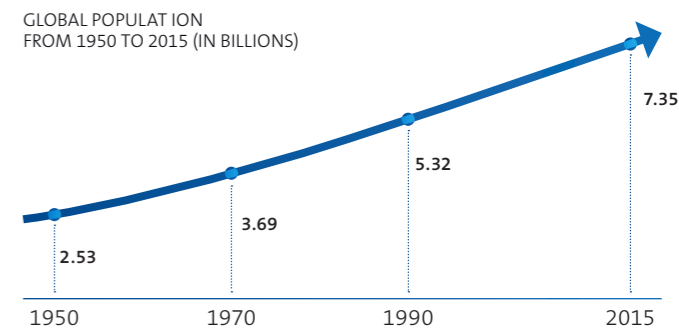
Geographic area and population size are two key indicators of the growing importance of megacities. Their true weighting in the overall global scheme first becomes clear from economic figures. According to a study of the economic output of megacities by business consulting firm PwC, New York City generates overall economic output of U.S. \$1.4 trillion a year. With results like these, the frontrunner on the list can compete with most national economies. Canada, Spain and Turkey are each only slightly higher. London generates more than U.S. \$800 billion annually, which puts the economic importance of the British capital on a par with Argentina and the Netherlands. The OECD expects this trend to continue since opportunities, talents and investments are increasingly concentrated in metropolitan areas.

ONE TREND – DIFFERENT MOTIVES

The future prospects of these major population centers have made them magnets for migration – albeit at totally different levels. Quality of life plays a key role in "mature" megacities marked by Western-style development. Besides the opportunity for professional development, this includes soft factors such as cultural diversity and the sense of being part of a pulsating metropolis. But inhabitants of London, Berlin or New York pay a high price for their wide range of options – excessively overpriced living space and highly limited individual mobility. From the standpoint of many megacity residents in Mumbai or Manila, these problems seem downright laughable. Here, it is more existential concerns that drive rural residents into cities.

There is a second trend that is intensifying challenges and that goes hand-in-hand with urbanization in poorer countries: population growth. In Africa today, each woman gives birth to an average of 4.7 children. In Niger, the figure is 7.6, which is three times the global average. The consequences are dramatic as one in three city dwellers in developing and newly industrialized countries lacks suitable living space. According to the UN, about 850 million people worldwide live in slums – in fact, their numbers could more than double by the end of the century.

Over the years and decades ahead, it will be a herculean task to satisfy their needs for secure supplies of clean drinking water and food, suitable living space, access to energy and mobility and, in the medium term, the Internet. Simple numbers games illustrate how explosive the trend is: If the global population grows as expected, new homes will have to be built for about 2.5 billion people by the year 2050. And urban infrastructure will have to keep up. Over the next three decades, the world will have to develop as much new infrastructure as it has since the beginning of industrialization. And this does not even take into account the need for the modernization of existing roads, waterways and buildings.



RESOURCES ARE NOT AVAILABLE

Even if the technical and financial resources were available, current climate goals could scarcely be achieved. Cement and steel production are among the biggest CO₂ emitters worldwide. The construction of an infrastructure on the level of Western megacities would consume the world's entire emissions budget intended to keep maximum global warming at 1,5°C (34,7°F). In China alone, more cement was used in construction between 2008 and 2010 than in the U.S. during the entire 20th century. "If humanity continues to live as it has until now, we will need two planets by the year 2030 to cover our need for food and renewable raw materials," the WWF wrote in its "Living Planet" study.



IDEA: SMALL CABLE CAR, GREAT EFFECT

Slums, huge infrastructure problems, logistical difficulties, endless traffic jams – is our future preordained? Certainly not, as global and low-profile local projects have already sustainably improved people's lives. The supply of clean drinking water is one transnational success story. Thanks to the construction of purification plants, the development of wells and the

creation of pipeline systems, at least 91 percent of the entire world's population had access to clean drinking water in 2015. According to Welthungerhilfe, the percentage was just 76 percent 25 years ago. Examples such as the construction of cable cars in Rio de Janeiro (Brazil) and Medellin (Colombia) show how even small projects can greatly improve residents' opportunities to participate in society. These aerial railways connect favelas with city centers and quickly open up job opportunities and prospects for residents in parts of the city that were previously hard to reach. Other prominent, groundbreaking projects demonstrate how technical progress creates approaches to solutions. For example, 3D printers have proven in pilot projects that they can be used to build entire houses from construction scrap.

There is no magic bullet – only individual solutions that will turn out differently in Kinshasa, London, Sao Paulo or Jakarta. "If people create quality of life in their immediate living space, the urbanization push between now and 2050 will be a great opportunity to develop cities humanely," wrote the German federal government's scientific advisory council in a study entitled "The Relocation of Humanity". The message can even be put more simply: Local solutions offer the best answers to global questions. ©

A QUESTION OF AGE

Megacities in Europe and North America differ substantially from metropolitan areas in Asia and Africa not only in their infrastructure, economic output and distribution systems but also in a dramatic difference in their age profiles. In the megacities of Asia and Africa, one inhabitant in four is generally younger than 15 years old. Here, the primary issue is access to medical care and education to increase opportunities to participate in society. In China's major cities, the primary objective is the creation of jobs and living space, since 80 percent of their population is of working age. The situation in Delhi (India) is similar. In 2025, only nine percent of all residents in the Indian metropolis will be over 65 years of age. Cities such as Tokyo and Osaka are facing an entirely different age pyramid. People over the age of 65 already represent more than 20 percent of the population. There, age-based adjustments to transportation are already high on the agenda. In addition, more and more residents of working age have to care for growing numbers of senior citizens – with a corresponding impact on the welfare system.



5

QUESTIONS for

RAINER JOEST

President Automotive Sales
Freudenberg Sealing Technologies

RAINER JOEST IS RESPONSIBLE FOR FREUDENBERG SEALING TECHNOLOGIES' GLOBAL AUTOMOTIVE BUSINESS. JOEST, A MECHANICAL ENGINEER, BEGAN HIS CAREER IN THE FREUDENBERG RESEARCH DEPARTMENT IN 1978. POSITIONS AS A DEVELOPMENT ENGINEER AND IN CUSTOMER CONSULTING FOLLOWED UNTIL 2001 WHEN HE TOOK OVER THE MANAGEMENT OF AUTOMOTIVE SALES IN EUROPE. FROM 2006 TO 2011, HE WAS IN CHARGE OF THE SPECIAL SEALING PRODUCTS DIVISION. HE THEN ASSUMED RESPONSIBILITY FOR THE GASKETS DIVISION, WITH SITES IN EUROPE, ASIA AND THE AMERICAS.

1 MR. JOEST, MORE AND MORE PEOPLE LIVE IN CITIES – A TREND THAT CAN BE OBSERVED EVERYWHERE. IN YOUR VIEW, WHAT DOES THIS MEAN FOR PRIVATE TRANSPORTATION? For us, growing urbanization primarily means a trend toward electric mobility, that is, vehicles with electric motors. After all, we are seeing a tremendous increase in environmental problems due to growth in private transportation, especially in megacities. It's impossible to take control of these problems without a paradigm change. Perhaps the first indications of this change will be limited geographic access for diesel engines. In fact, countries such as Norway and the Netherlands have announced that they will no longer allow vehicles with internal combustion engines into their city centers as of 2025. We're seeing a strong expansion of the charging infrastructure for electric vehicles there.

Our LESS initiative is helping automakers meet tighter emissions regulations. It bundles our product innovations that reduce frictional losses, emissions, installation space and weight for conventional engines as well as for electric powertrains.

4 COST-SHARING MODELS ARE ALSO SUPPOSED TO HELP ADDRESS FUTURE TRANSPORTATION CHALLENGES IN METROPOLITAN AREAS. IS THIS TREND RELEVANT TO YOU AS A SEAL MANUFACTURER? In our view, this will also help fuel the move to electric mobility, as it definitely makes sense for the handover or pickup location for shared vehicles to have a charging station. The notion also seems to be increasingly catching on in Asia, where vehicle ownership continues to be far more driven by status. But it seems that the very real problems ranging from emissions to parking spaces are changing this attitude more and more.

5 SUPPOSE THERE IS TREMENDOUS GROWTH IN THE IMPORTANCE OF ELECTRIC VEHICLES. WHAT DOES THIS MEAN TO YOU AS A SEAL MANUFACTURER? Quite possibly, the greatest change in our history. Many of our current products for internal combustion engines will no longer be needed in electric motors – crankshaft or valve stem seals, for example. That's why we're working intensively on seal innovations for electric

“THE GREATEST CHANGE IN OUR HISTORY”

2 WHAT DOES THIS TREND MEAN FOR DIESEL ENGINES AND WHAT CONSEQUENCES ARE YOU DRAWING FROM YOUR ASSESSMENT? Diesels will disappear from inner-city transportation. But they still have physical advantages that work in their favor. Diesel engines are very efficient and over the coming decades, it will be impossible to imagine long-distance transportation without them. Exhaust gas treatment is certainly costly, but large vehicles – such as classic long-distance trucks or buses – continue to benefit from good mileage. Diesels will always have a role wherever efficiency and costs are an issue, although primarily where there are great distances to cover.

3 IN YOUR VIEW, WHERE WILL WE SEE NEW TRANSPORT AND TRAFFIC CONCEPTS? We assume that the Internet will play a crucial role. Online ordering and delivery to your home will continue to take hold. This can happen with electric and possibly even autonomous delivery vehicles, and will surely bring major changes to inner-city distribution transport. In this particular field, we anticipate smaller vehicles with new powertrain concepts.

vehicles – an area where we also see great technological promise. Our goal is to deliver made-to-order products for nearly all the components of electric vehicles. Batteries with a high power density and a corresponding need for cooling require two-component parts, flat gaskets or Plug&Seals. Slide ring seals are needed for electric motors, and Simmerrings remain indispensable in the transmissions of electric-drive vehicles. Housings for sophisticated control electronics must ultimately be sealed. But we know that all this is not enough to offset the elimination of conventional sealing systems. That's why we're doing extensive research on even more innovations and, in sales too, we're focusing on new developments and new customers. We're talking about decades rather than years for this process of change and we expect the pace and paths of the global markets to be quite diverse. ©



SELECT, ORDER, GET IT NOW

A WARM DAY, A PICNIC IN THE PARK. EVERYTHING IS PERFECT... OR ALMOST. THE GLASSES ARE IN THE BASKET, BUT THE CHAMPAGNE IS STILL IN THE REFRIGERATOR AT HOME. NO PROBLEM, YOU PULL OUT YOUR SMARTPHONE, CLICK ON A FINE WINE AND A HALF HOUR LATER A COURIER DELIVERS THE CHILLED BOTTLE RIGHT TO YOUR PICNIC BLANKET. TO SOME EXTENT, WHAT SOUNDS LIKE A SCIENCE-FICTION UTOPIA HAS LONG BEEN REALITY. ADVANCES IN NETWORKING ARE CHANGING THE WORLD DRAMATICALLY AND CREATING NEW CONSUMER SCENARIOS AND DIFFERENT REQUIREMENTS.

In the smart home, the refrigerator automatically puts in an order for butter when it is out of the product. The washing machine does the same for fabric softener and the car books its next inspection appointment itself. The forerunners of this trend are now market-ready, and other products are following. What represents greater convenience for the consumer is posing new challenges for industry, however. "Basic changes in our lives are emerging from the accompanying individualization of products, the flexibilization of production and working conditions and stronger networking of all participants," according to the Fraunhofer Institute for Material Flow and Logistics in Dortmund. But it added, "It will take time to transform business models, value chains and equipment and move them toward complete networking."

Uber, Airbnb and Dropbox have proven that digital services have the potential to shake entire economic sectors to their foundations – all enabled by comprehensive networking. This doesn't merely apply to services like those offered by Uber and Airbnb. It is also true for manufacturing. Meanwhile, because goods still have to be transported from A to B, logistics capacity is becoming a key factor. Warehousing capacity is being reduced or transferred to road and rail. The "just-in-time" principle – standard in car production – is conquering other manufacturing sectors. Only what is needed for manufacturing is delivered. Products are picked up when they have just been manufactured.



WAITING FOR THE FIRST "WWW"

But who has access to this brave new world of logistics and the blessings of networking? From a global perspective, it is by no means everyone. According to UNESCO, a total of 3.2 billion people worldwide had access to the Internet in 2015 – representing a share of just 43 percent. In developing countries, the share drops to 35 percent, and the figure is less than 2 percent in Eritrea and Burundi.

So is the digital revolution failing due to the development bottleneck blocking the Internet's expansion? No, forecasts clearly assume that the digital transformation is succeeding and that consumer behavior is going through huge changes. The "ITF Transport Outlook 2015" report from the OECD (Organization for Economic Cooperation and Development) predicts that global trade will more than quadruple by 2050. A steadily rising share can be attributed to online purchases.



OPEN ALL HOURS

The 24/7 availability of online shops is generating a new level of desire. And delivery needs to be as fast as possible, too.

GROWTH BEYOND THE 10 PERCENT MARK

Worldwide, revenue of about 780 billion euros was generated through online purchases in 2015. This is expected to increase by 890 billion this year, with experts predicting a revenue jump to 1.33 trillion by 2020. That corresponds to an annual growth rate in excess of 10 percent. Between 2015 and 2020, the number of people buying goods online will have risen from 1.5 billion to a projected 2 billion.

FROM SHELF WARMERS TO BIG SELLERS

But it is not just the number of online buyers that is spurring growth. Product segments that have hardly played a role until now are coming into focus. Food and furnishings were once considered unsellable on the net but are now attracting more and more potential buyers. Fresh foods in particular are placing major demands on transportation and delivery. New business models such as Essen's "Foodora" and "Deliveroo" delivery services rely on their own logistics with bicycle couriers. Food retailers increasingly offer delivery services as well. Following successful projects with "Amazon Fresh" in major U.S. cities and London, Amazon is now considering the launch of its own food delivery service in other metropolitan areas.

DIGITAL IMPATIENCE DUBBED "NOWNESS"

Consumers are demanding shorter and shorter time periods between "want to have" and "have". Once again, Amazon is the pacesetter. Prime customers receive popular products in less than an hour in major cities such as Berlin and New York. The newly minted word "nowness" is a paraphrase for this digital impatience. To withstand the pressure, the logistics sector is on the brink of redefining previously successful sequences and processes. If it succeeds, leaving a bottle of champagne behind in the refrigerator will soon be just a minor irritation.

TRENDS IN THE LOGISTICS BRANCH

ANTICIPATORY LOGISTICS

Big Data analysis shows with high probability what online shoppers will be ordering. Goods are transported in advance to the delivery region of projected need. This cuts delivery time and cost.

LOGISTICS MARKETPLACES

What provider offers the most affordable and high-quality service? In the B2B area, logistics-marketplace comparisons such as "Intra" are standard practice. In its trend report, DHL says it expects consumers to apply these comparisons too, within the next five years.

UBER FOR THE LAST MILE

App-controlled services such as "UberRush" could revolutionize the transport of goods for the last mile. Depending on need,

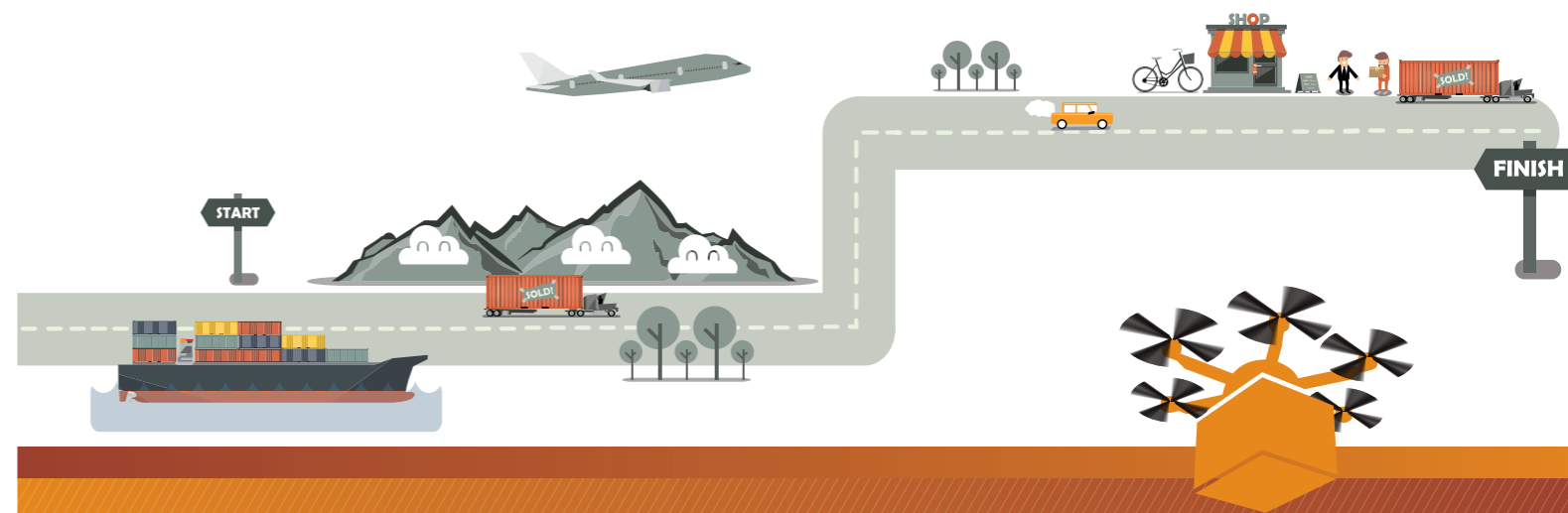
Uber uses an entire fleet of freelance couriers or private individuals who want to earn extra money for delivery.

EXPANDED REALITY

Product scanners will soon be a thing of the past in logistics centers. Employees will use data glasses as they navigate through the halls, minimizing the error rate. Initial applications are already being tested.

SELF-DRIVING CARS

Break times or bad weather? Not a problem for self-piloted delivery vehicles. They can be used 24 hours a day. But the legal framework for them is still mostly up in the air, and their practical use is uncertain.



DELIVERY BY DRONE

Drones as delivery vehicles: Hype notwithstanding, no online or logistics company can afford to ignore this issue. Google, Amazon, DHL and Rakuten are experimenting with the use of mini-copters for package delivery. They are designed to evade traffic jams in metropolitan areas and supply rural areas quickly. But initial euphoria has evaporated as legal prob-

lems remain unsolved. Aviation authorities are at the center of the issue, requiring constant observation of drones in use. Currently, only humans are allowed to do this, leading to extremely high staffing costs. It is also questionable in the longer term whether consumers will accept flocks of drones swarming through urban areas. ©



NETWORKING OUT OF A TRAFFIC JAM

MORE AND MORE CARS, LESS AND LESS SPACE: MEGACITIES ARE GROANING UNDER THE BURDEN OF POPULATION GROWTH COMBINED WITH AN EVER-INCREASING DESIRE FOR MOBILITY. AS MUCH PUBLIC TRANSPORT AS POSSIBLE, AS MUCH PRIVATE TRANSPORTATION AS NECESSARY – THAT IS THE FOUNDATION OF FUTURE MOBILITY CONCEPTS. THE SHARED ECONOMY AND BIG DATA ASSESSMENTS COULD ASSUME A KEY ROLE.

The strict spatial separation of living, working and recreation – that has long been the central requirement of city planners and architects. The “Athens Charter” emerged at the International Congress of Modern Architecture in 1933 with the best of intentions. More than eight decades ago, participants could not have been foreseen that they were creating the foundation for the problems of the modern mobility society. Transportation was supposed to play a key role as the connection between urban districts. Instead, it is the basis for a global society of cars and traffic jams, where quality of life and efficiency have declined in equal measure.

The megacities of the 21st century offer little hint about the ideas of the founding fathers of city planning. But their residents are paying the price for an approach that can no

longer fulfill their own mobility requirements. Beijing is one example: Even with eight lanes, traffic moves at walking pace as solid lines of cars struggle through the Chinese capital. The expansion of the transportation infrastructure cannot keep up with the growing desire for mobility and the automobile as a status symbol. No fewer than 3.6 million private cars are now registered in Beijing – 21 times more than in 2000.

Gridlock is only one result. Extreme pollution from emissions is another. Smog is an ongoing problem. The metropolis of 20 million borders on a chain of mountains, and the winds from the south often fail to push the dirty air over them. Other megacities have similar complaints. Urban São Paulo has traffic jams as long as 200 km (124 mi) on rainy days, and driving around greater Tokyo is a similar ordeal.

TRAFFIC IN MEGACITIES WILL GROW 60 PERCENT BY 2030

There are three main reasons why these problems are no more likely to disappear into thin air than smog is. The number of megacities continues to rise and demand for mobility is growing unchecked, while transportation's share of global emissions is massive. Direct action has to be the watchword. It is estimated that more than 50 cities will have more than 10 million inhabitants by the year 2030. The figure currently stands at 30. In parallel, traffic will increase in metropolitan areas by more than 60 percent. If nothing changes, the impact on the environment will be devastating. Cities emit more than 80 percent of the

greenhouse gases generated globally. Mobility scores worst in a comparison of emissions sources. Since 1990, industry has reduced its CO₂ volume by nearly one-third and private households are 24 percent below their starting levels. The problem is the transportation sector: Despite all efforts to improve the efficiency of conventional internal combustion engines, emissions have risen more than one quarter. Greater individual mobility and more demand for the transportation of goods are devouring all the improvements resulting from more efficient engines, alternative fuels and electric mobility.

RENAISSANCE OF A CLASSIC

Climate neutral by 2025 – that's the goal set by Copenhagen. Meanwhile, its mayor is turning to a 19th century invention as the transportation of the future. The Danish capital has spent more than 13.5 million euros per year since 2006 on the construction of a bicycle infrastructure. The bike path network covers 1,000 km (621.4 mi), with 200 (124.3) of them being express routes through green areas. Most of the bike paths are wide enough for two or three cyclists to ride side-by-side, and the traffic light settings are geared to a steady speed of 20 km/h (12.4 mph). Almost half the residents who work or study within Copenhagen use bicycles for at least one leg of their trip. This share rises to 60 percent for inner-city residents. Incidentally, the large volume of bike traffic has had no negative impact on safety. A true cycling culture leads to greater consideration and fewer accidents. In 1995, the city recorded about 300 accidents. Two years ago, the figure was just 90 despite a substantially greater proportion of bicycles.



LIMITATIONS ON NEW REGISTRATIONS ALLEVIATE THE SYMPTOMS

Nearly all megacities face the same problems to varying degrees: limited space, growing populations, increasing vehicle density and rising environmental stress. To handle the latter, at least, Beijing is turning to limitations in its vehicle inventory: 400,000 trucks and minibuses that merely fulfill the Euro 4 standard are supposed to disappear from its roads by 2020. In addition, on specified days only cars with either even or odd license plates are allowed to drive in the Chinese capital. Paris, London and Madrid ban transit traffic from their city centers.

Admittedly, urban transportation concepts for the future require solutions that do more than merely address the symptoms:

- **The expansion and networking of various forms of transportation play a key role. Vehicle ownership becomes secondary.**
- **Adapting a city to the mobility needs of its people is not a one-off project but an ongoing challenge.**
- **Networking and Big Data are cited as the key technologies for optimized individual transportation.**

PRIORITY FOR SUBWAYS, BUSES AND BICYCLES

The focus on the individual automobile is a dead-end – there is no serious doubt about this. The scarcity of space alone in megacities is forcing people to turn to local public transportation. Subways in particular have the greatest impact but require high investment and enormously long time frames. One alternative is rapid transit bus systems in which buses benefit from the use of their own lanes. The car has to re-

linquish priority status. Planners dream of a demand-driven transportation zone, where the current traffic situation and demand determine whether the zone is a road, cycle lane, pedestrian route or streetcar system. Pedestrians and cyclists in particular are back in the spotlight. The growing electrification of individual and public transportation also reduces noise levels.



CHANGE IS THE ONLY CONSTANT

Megacities are under enormous pressure to adapt. Migration is pushing their growth upward and outward. This is resulting in brand new city districts and satellite cities. Planning of the transportation infrastructure has to adapt continually to these changes. Viable concepts for the future must be found, existing solutions must be modified, and ideas that are no longer feasible must be jettisoned. The philosophy is as much local public transportation as possible, as little individual transportation as necessary. This approach, combined with the desire for more comfortable, more affordable and faster mobility, will take center stage. The operating life of cars and public transportation systems will tend to grow rather than decrease.

APP NAVIGATES THROUGH TRAFFIC AND SERVICES

It's a burden in some industrialized nations but highly desirable in emerging and developing countries. The era when the automobile was the number one status symbol in Europe and North America is coming to an end. Vehicle ownership holds the greatest appeal for many people in other regions of the world. Nonetheless, the potential for a "shared economy" grows every day and "use, not own" is becoming more appealing to increasing numbers of city dwellers. Estimates predict that car sharing will account for more than \$6.2 billion in revenue worldwide by the year 2020.

Frequency and availability are not the sole factors impacting how successful car sharing, buses and railways will be in solving the transportation problems of the future. Links to other means of transportation are even more important. Mobility apps for smartphones are pioneering this trend. These urban mobility guides serve as an interface between the various options. They enable you not only to call up timetables in real time and book tickets for local public transportation, they can

also schedule further travel by taxi, long-distance bus or car-sharing. This virtually eliminates the strict separation of different forms of transportation. The cooperation between Uber and Did-iChuxing in China shows that car-sharing agencies will play a role that the Chinese hope will relieve their highway system.

The evaluation of transportation data in real time promises to boost the efficiency of individual transportation. Based on current traffic situations, information systems not only compute the fastest connection between two points, but also consider different means of transportation.

This dynamic system creates the greatest possible flexibility and continually adjusts the traveler's options. For example, an original combination of subway and rental bike might turn into a pedestrian route with a subsequent trip in a rental car. But it will take a few years before this is ready for widespread use. Until then, the solid line of cars will continue to struggle through megacities on the lanes wrought by the "Athens Charter". ©

KEEP OUT!

London, Paris and Madrid – all use deterrents to keep individual transportation out of their city centers and ask drivers to pay a hefty bill. The "congestion charge" was introduced in London in 2003. Anyone venturing into the environmental zone with a private car must shell out the equivalent of nearly 14 euros. There are plans to expand the environmental zone tenfold and to levy an additional fee for diesel vehicles built before 2015. In Paris, bus lanes have been prioritized for several years, and pedestrian zones and bike traffic systems are being created, making car ownership less attractive. One-third of Parisians gave up their vehicles between 2001 and 2014. Madrid is even more resolute, banning car traffic entirely from the city center. The only exception is for residents' vehicles.





ALTERNATIVE TRANSPORT



THE WORLD POPULATION IS GROWING, AND MORE AND MORE PEOPLE MUST BE TRANSPORTED AND GOODS DISTRIBUTED. UNCONVENTIONAL SOLUTIONS ARE IN DEMAND TO HANDLE THE CHALLENGES OF FUTURE MOBILITY. WHETHER THEY CAN PREVAIL IS LESS A QUESTION OF TECHNOLOGY THAN OF ECONOMIC VIABILITY. ESSENTIAL PRESENTS TWO SPECTACULAR PROJECTS.

New, utopian solutions were in demand in the mid 19th century. In large cities such as New York, Berlin, Vienna and London, long-distance railways – which were subject to increasingly heavy use – each ended at different train stations on the edge of the city. The stations were poorly interconnected, and changing trains was only possible with a time-consuming hackney cab ride through throngs of people in these major cities. Rail connections through the cities would have cut swathes through existing buildings. Solutions such as putting transportation on stilts or moving it below the ground sounded foolhardy and placed entirely new demands on engineers and architects. The very first plans for a subway emerged in Vienna in 1844. Nineteen years passed before

ground was broken. In 1863, the construction of the Metropolitan Railway began in London. Four years later, the first columns for the New York elevated railway were standing.

A century and a half later, attention is turning once more to stilts and tunnels to help relieve future traffic congestion. The Hyperloop in the U.S., begun by Tesla and SpaceX owner Elon Musk, and the “Cargo Sous Terrain” (CST), which is supposed to revolutionize goods transport in Switzerland starting in 2030, are two examples. Although these two projects adopt entirely different technological approaches, they have interesting parallels since neither is based on conventional transportation.



© Hyperloop One

THROUGH THE TUBE AT THE SPEED OF SOUND

That is the vision Elon Musk is pursuing with the Hyperloop. First presented in August 2013, the basic idea is to transfer the principle behind pneumatic mail delivery to personal transportation. Passengers in capsules are supposed to be transported within a steel tube at up to 1,200 km/h (745.6 mph). The trip would cover the 650 km (404 mi) route between Los Angeles and San Francisco in a little more than half an hour.

The Hyperloop's slogan is "Faster than the train – cheaper than a plane". The capsules, which have seating for 28 passengers, float friction-free on an air cushion produced by a compressor using air sucked away from the front of the vehicle. Because this eliminates drag, driving resistance is reduced to an absolute minimum. The energy required for such propulsion would be extremely low. The vision behind the approach is more than 200 years old, but no one has managed to pull it off so far.

The Hyperloop concept envisages placing tubes with a diameter of 2.23 or 3.3 meters above the ground on stilts – ideally along existing freeways. The aluminum capsules are propelled and braked by long stator linear motors – a technology similar to the propulsion concept of the Transrapid, which has been in regular operation shuttling between Shanghai International Airport and the newly built quarter of Pudong since 2003. A prototype of the Hyperloop is expected to be unveiled in 2017 to demonstrate the concept's technological feasibility. There are also plans to build a 1:2 scale model for component testing. It's not just the technology that's in-

novative – its development model is breaking new ground as well. Thanks to an open-source approach, numerous engineers are being given the chance to participate in the project's development.

AUTOMATIC GOODS TRANSPORTATION BELOW GROUND

The Hyperloop is pursuing the goal of linking major American cities that are too far apart for a trip by car but too close for flying to be a worthwhile alternative. The goal of "Cargo Sous Terrain", however, is quite different. Freight traffic in Switzerland is due to be relocated underground, revolutionizing the logistics world with greater automation and 24-hour operation. The goods would travel at the sedate speed of 30 km/h (18.6 mph).

A mountainous transit country, Switzerland expects a 50 percent growth rate in overall transportation by 2050. The situation requires fundamentally new approaches since current transportation cannot handle the growth. The CST plan envisages linking Swiss cities with a network of tunnels consisting of tubes 6 meters in diameter, lying 50 meters below ground. The tubes contain three driving lanes – one for each direction and a service lane in the middle. Unmanned, fully automated vehicles like those used in high-rack storage facilities, propelled by electromagnetic induction, travel along these lanes. Each carries two euro pallets as well as suitably standardized containers. A suspension track in the middle of the tunnel sends packages or unit loads at double the normal speed. Loads can be picked up or delivered at ramps or elevators. Like the Hyperloop, the idea was born in 2013; con-

cept and feasibility studies have been available since 2016. Hubs in major cities and even the central storage facilities of major companies are integrated components of the transit system. It also includes a final distribution system on the surface employing a fleet of electrically powered vans. In this way, carbon dioxide emissions per transportation unit are expected to be reduced by up to 80 percent compared to conventional methods. Experts also expect a roughly 40 percent reduction in freeway traffic after the overall plan is implemented. It is hard to compute the time savings expected once transportation delays due to traffic jams are practically eliminated. In any event, whole new prospects are opening up for consumers based on the philosophy "ordered in the evening, delivered in the morning".

The advantages of unmanned and automated transportation in tunnels are obvious. Refuge areas and signal systems are superfluous – as are prohibitions on nighttime travel. Moreover, transportation of a single pallet is economically viable. Having to wait for a truck to be fully loaded is a thing of the past. But how realistic is this scenario? The successful completion of the Gotthard Century Tunnel has certainly sent an optimistic message. In a survey in early 2016, more than 53 percent of all Swiss indicated that they expected the project to be implemented despite the first stage alone requiring an investment of 3.5 billion francs. It is expected to enter operation by 2030, with ten hubs over a total length of 67 km (41.6 mi). Ultimately, this "freight metro system" is supposed to cross Switzerland from west to east – from Lake Geneva to Lake Constance.

And the Hyperloop? After initial skepticism, the Deutsche Bahn has expressed an interest in participating as a business partner in Hyperloop One. And French railway company, SNCF, is one of the project's financiers. In turn, Hyperloop One is interested in "Cargo Sous Terrain", with a partnership deal struck at the end of May. "We are convinced that CST will fundamentally change logistics," said Rob Lloyd, Hyperloop's CEO.

But the time is long gone when large, technological transport projects could be realized based solely on technical feasibility and the impact of their image. Ultimately, the Franco-British Concorde didn't fail because of its devastating accident in 2000 or unmanaged technical problems. It was the fact that its operators failed to make any money with the supersonic plane between 1976 and 2003. In another case, the Transrapid maglev train has thus far not made it through the demonstration phase – which is how the operators see the 30-km (18.6 mi) route in Shanghai. It has been in operation since 2003. An expansion of the Transrapid has been put aside because the current route, operating at less than 20 percent capacity, is deeply in the red, losing at least 100 million euros in its first six years of operation.

Thus, the feasibility of financial forecasts and assumptions will determine whether Hyperloop and "Cargo Sous Terrain" will go forward, carrying passengers through tubes mounted on stilts and freight underground come the mid-21st century. ©



© www.cargosousterrain.ch



BIG DATA ON THE FARM

A SMALL TRACTOR PULLS A DOUBLE-DISC PLOW ACROSS A FIELD. TWO HORSES STAND IN AN ENCLOSURE NEARBY AND FIVE DAIRY COWS ARE MILKED BY HAND. IT IS A SCENE STILL OFTEN SEEN IN ADVERTISING. BUT IT HAS AS LITTLE TO DO WITH MODERN AGRICULTURE AS A TYPEWRITER HAS WITH A TABLET PC. AGRICULTURE 4.0 – OR SMART FARMING – STANDS FOR EFFICIENT FOOD PRODUCTION ON AN INDUSTRIAL SCALE FAR FROM THE WORLD'S MEGACITIES. ONE ALTERNATIVE IS URBAN FARMING THAT PRODUCES LETTUCE IN FORMER AIR RAID SHELTERS AND CULTIVATES APPLE TREES IN CITY PARKS.

A new middle class is emerging, and average income is growing. Undernourishment will sharply decline as a mass phenomenon. That's the good news from a study by the Potsdam Institute for Climate Impact Research in Germany. The flipside is that researchers expect demand for food to double by the year 2050. This is posing completely new challenges for agriculture. Besides the demand for greater quantities in emerg-

ing and developing countries, there is an increased desire for high-quality foods among the growing middle and upper classes. Productivity increases and the development of new, sustainable land for cultivation are expected to help satisfy the world's hunger. The approaches based on "smart farming" and "urban farming" trends could hardly be more different – yet they have an identical goal.

HYGIENIC DESIGN FOR THE NEXT PROCESSING STAGE

The rising demands placed on food production continue past the harvest and affect processing as well. Modern food processing involves both careful food handling and the longest possible maintenance intervals for the industrial equipment. As a result, equipment manufacturers are facing new challenges: Even as early as the design phase, they must consider the fact that the machinery must be easy to clean and exclude the risk of any contamination. "Hygienic Design" also means the equipment must not need dismantling before cleaning, which means no opportunity to perform visual checks. Equipment cleaning reliably delivers good results only when dead spaces – where residue initially accumulates and microorganisms can later establish themselves – are ruled out at the design phase. Nowadays, closed systems and the use of stainless steel tanks provide a

level of purity that could only be achieved in the production of medicines even just a few years ago. The seals in use today play a dual role: They have to offer the maximum period of maintenance-free use, while standing up to aggressive cleaning agents. Seals designed especially by Freudenberg, including radial seals with a forward-mounted sealing lip in accordance with Hygienic Design, close up dead spaces and prevent the penetration of contaminants into the food processing system.

Beverage-filling systems face the additional challenge of minimizing flavor transfer. "Beer-based drinks followed by mineral water with a delicate lemon flavor are mixed in one and the same facility," said Dr. Ulrich Liedtke, Technology Director at Freudenberg Process Seals.



TRANSFORMATION INTO EFFICIENT AGRICULTURAL ENTERPRISES

“Smart farming” refers to the transformation of the traditional farm, with its cultivation of land and raising of livestock, into highly efficient food-producing enterprises. On its way to fully networked Agriculture 4.0, the sector has long left the idyll of the small farm behind and is in the forefront of technological development in many sub-disciplines. Autonomous driving – which is still a distant proposition on the roads – has become a standard feature of farming. Technology-savvy farmers are no longer satisfied with just GPS since geolocation is simply too imprecise. Modern sensors control their huge machines and limit deviations to no more than two centimeters as they move across their fields. Overlap during sowing or harvest is being reduced to a minimum. At the same time, sensors are capturing the soil’s characteristics in real time and directly adjusting fertilization or sowing. This conserves resources such as working hours, equipment operating times, fuel and seed supplies.

TRANSPARENT FIELDS AND TRANSPARENT COWS

The Association of German Engineers estimates that about 30 percent of value creation in agriculture is being generated with modern electronics. The rewards coming from this trend are considerable. For example, the wheat harvest per hectare has quadrupled since the 1950s and the potato harvest has at least doubled. And progress has not stopped at the door to the cow shed. Milking robots recognize teat position by laser, record the quantity of milk per cow and allocate concentrated feed to each cow on an individualized basis. Patterns of movement are also evaluated and lead to conclusions as to whether the cow is in rut or ailing. In the event of anomalies, the farmer receives a report via smartphone app and can respond immediately.



RELIABLE DATA CAPTURE UNDER EXTREME CONDITIONS

Big Data will determine the success or failure of an agricultural enterprise in the future. At the same time, the generation and transfer of data is as reliant on electronics as their subsequent interpretation with the complex software systems employed in the management of agricultural operations. Seals also play a role here. For example, Freudenberg Sealing Technologies can support this trend with Simmerrings containing embedded elastomer RFID sensors, which reliably generate data out in the fields under extreme conditions.

Encoders, in the form of transducers, can precisely capture every position of the shaft – whatever its speed. And finally, tire inflation systems ensure that the air pressure of agri-



cultural vehicles is always perfectly adjusted to the soil conditions and the particular operation. Seals and sensors play an important role here as well. “To survive in global competition, farmers will not be able to get around the increases in productivity and efficiency provided by smart farming,” said Angelika Mulac, Segment Director, Agriculture & Material Handling at Freudenberg Sealing Technologies. “The pervasive networking across all areas of a farming operation plays a key role. Internal communication from the individual stations in the work process – between machines and equipment – as well as the communication with business partners takes place electronically. Assessments are automated and Internet-based portals ease the handling of large quantities of data.”



COOKING AND EATING – FROM NECESSITY TO HOBBY

“Smart farming” is specifically geared to boosting productivity with more technology and steadily declining numbers of farmers on increasingly large acreages per farm. “Urban farming”, on the other hand, targets the use and development of new acreage in urban environments – especially in industrial countries. The forerunners of this trend were the rediscovery of allotment gardening and the construction of roof gardens. One example is the crops already growing on a surface totaling 1,500 square meters on roofs in the New York borough of Brooklyn. In communities, urban and landscape planners are already discovering the trend in their own right. More and more cities are replacing their once-customary ornamental trees and shrubs with fruit trees when it is time to replant. More than 25,000 users keep each other informed via apps such as “Mundraub” (a reference to the petty theft of food) covering the 16,000 locations in Germany where fruit can be picked free of charge. Another factor behind the trend is the desire for a new lifestyle and the desire of many consumers to plant and harvest crops themselves. Urban farming is the natural progression of bringing organic products into the distribution system and demonstrates that demand for good nutrition is growing in developed countries. Eating and cooking are enjoying a renaissance and have gone from necessity to conscious recreational activity.

CULTIVATING FRUIT AND VEGETABLES DOWNTOWN

Still, it will take more than replacing decorative shrubs with fruit trees to meet the food needs of people in megacities. Nonetheless, with its “inFarming” project, the Fraunhofer Institute for the Environment, Safety and Energy Technology (UMSICHT) sees great prospects for the cultivation of foods in urban environments. Peter Ladner, former city councilman in Vancouver, spelled out the concept: By 2025, 25 percent of the city’s requirements for fruit and vegetables will be produced in its urban heart. And Michigan State University estimates that 70 percent of the fruit that Detroit needs will be grown locally – thanks to the re-naturation of developed lots that are no longer in use. Another spectacular project is thriving underground in London. Lettuce is being grown under artificial light in a former air raid shelter, and is harvested and sold daily. The project benefits from a 70-percent reduction in the need for water, no climatic fluctuations and a pest-free environment. The plants do extremely well in the conditions 33 meters below the British metropolis. “Pig City”, on the other hand, is setting its sights higher. Pigs from about 40 farms are expected to make their home in a skyscraper there. The slaughterhouse is on the ground floor.

440 ACRES PER FARMER IN THE U.S., BUT JUST 4,5 IN SOUTHEAST ASIA

“Smart farming” and “urban farming” are trends that are sustainably changing food production. But the global outlook offers a different perspective, with two-thirds of all people still supplied by small farmers. The World Bank has calculated that an average farm in the U.S. cultivates about 440 acres. The figure is still nearly 277 acres in Latin America. The smallest

farms tend to be in Africa or Asia: South of the Sahara, the average size is barely 5.9 hectares and just 4.5 acres in Southeast Asia. But these extremely small operations are helping to shape the global trend as well. Their productivity can, incidentally, be increased by exactly 100 percent relatively easily – by buying a second ox. ©





SAVING THE WORLD IN FOUR DAYS

THE RECOGNITION THAT SUSTAINABLE, CONTROLLED URBANIZATION IS CRUCIAL FOR THE FUTURE OF HUMANITY HAS BEEN DEMONSTRATED MORE AND MORE CLEARLY IN RECENT DECADES. TO FIND SOLUTIONS, 36,000 EXPERTS GATHERED AT “HABITAT III” IN QUITO, THE CAPITAL OF ECUADOR, IN MID-OCTOBER. IT TOOK THE UNITED NATIONS CONFERENCE ON HOUSING AND URBAN DEVELOPMENT FOUR DAYS TO SET A NEW DIRECTION FOR DEVELOPMENT OF CITIES WITH A GLOBAL PERSPECTIVE AND, AT THE SAME TIME, TO ADOPT ITS “NEW URBAN AGENDA”.

Government representatives only meet every 20 years at the United Nations Conference on Housing and Sustainable Urban Development to discuss the next steps in development, the next two decades and make key decisions on future direction. In 1976, the first gathering established the basis for UN HABITAT. The second summit 20 years ago in Istanbul dealt more fully with concepts for sustainable buildings and settlements since urbanization and the growth of slums were central challenges even back then.

CLIMATE AND SUSTAINABILITY GOALS SET THE FRAMEWORK

Two decades later, the problems of major cities have further intensified because the influx into the cities has been uninterrupted, especially in emerging and developing countries. Living spaces are becoming increasingly tight. Habitat III can be dis-

tinguished from the two previous conferences in one key respect: Sustainability is no longer merely a sincerely held desire. It is a goal that the United Nations has laid down in its “Agenda 2030”, which in September 2015 defined the objective as a basis for economic development in the international community.

Both set the framework for Habitat III and the “New Urban Agenda” that was ultimately approved. The 23-page paper is seen as a guideline for governments and cities as they manage sustainable development. The future of urban metropolitan areas is supposed to be more environmentally friendly and, at the same time, more socially just. It also addresses the issue of adequate living space, including sufficient mobility services, regulated waste disposal and access to education. In the event of natural catastrophes, emergency aid is also supposed to mesh more closely with urban planning. This is more easily said than done. For example, many areas of the Philippines are considered unsafe. But the people who live in these regions have no options for resettlement.

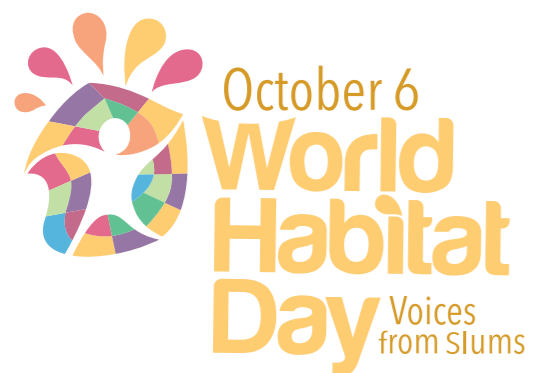


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UN HABITAT
FOR A BETTER URBAN FUTURE

Even as early as the 1970s, the United Nations (UN) recognized the growing importance of urban settlement policies for global development. The first global housing summit, dubbed “Habitat”, took place in 1976. One result of this conference was the formation of “UN Habitat” (The United Nations Centre for Human Settlements) as the main organization for urban development, human settlements and housing in both developing countries and those moving from a centralized to a market economy. The organization’s headquarters is in Nairobi, Kenya. Additional regional offices are located in Fukuoka for the Asia/Pacific region, Rio de Janeiro for Latin America/the Caribbean, and in Cairo, Egypt, for the Arab states. There are other offices in New York, Brussels, Geneva and Beijing.

UN Habitat’s highest priority is the promotion of sustainable urban development. It is currently supporting projects in more than 70 countries and covering a wide range of fields. It is involved in everything from planning the city of the future, to disaster control and mobility, all the way to climate protection, water distribution and the improvement of living conditions in slums. Its 400 administrative employees are supported by 2,000 staff assigned to projects. The work of UN Habitat is financed by payments from the regular UN budget. Thus, highly developed industrial nations are financing the organization – which almost exclusively operates in developing countries and those converting to market economies – through their contributions to the UN budget. In addition, there are donations from governments and companies involved in individual projects.



Yves Daccord, General Secretary of the International Committee of the Red Cross, sees dealing with migrants fleeing from war or natural catastrophes as a central problem for the international community. He is calling on cities to face up to the challenge and recognize that the ability to keep the consequences of migration under control “at an extremely remote location” is steadily diminishing.

The “New Urban Agenda” does not cite specific measures – which are mainly associated with differing initial conditions of the individual cities. One urgent recommendation emerging from the housing summit was to grant cities and their administrations greater leeway and for national governments to make the necessary resources available to them. The Scientific Advisory Council on Global Change (WBGU) also recommends granting cities the right to address and participate in UN negotiations.

70 PERCENT OF ALL GREENHOUSE GASES ARE PRODUCED IN CITIES

“The cities hold the key to a sustainable world that embodies climate justice. With the new urban development agenda, the community of nations is committed to strengthening the world’s metropolitan areas. Strong cities are in a better position to fight poverty and promote climate protection,” said Barbara Hendricks, the German Federal Minister in charge of construction. Cities already generate about 70 percent of all greenhouse gases, and this proportion is expected to grow with the further influx of inhabitants. Germany’s Development Minister Gerd Müller sees another reason as well: “The issue of whether sustainable development and climate protection will succeed is being decided in the cities. We want livable cities, worldwide. That is the only way we can prevent climate collapse, misery, violence and flight.”

MORE CONCRETE MEASURES IN MID-2017

That is why the housing summit in Quito also served as a venue for proposals on implementation. In mid-2017, the UN General Assembly is scheduled to learn how the “New Urban Agenda” can be implemented. It will be presented with measures and clear definitions setting the criteria for successful implementation. What happens next? Every two years since 2002, HABITAT has organized the World Urban Forum (WUF), where progress and additional developments are discussed. In the cities’ view, one thing in particular has to change between now and the potential HABITAT 2036: The cities’ representatives must not merely have an advisory role. They have to be integrated into the global decision-making process. In Quito, the mayors of Paris, Barcelona and Madrid, for example, could only participate in the discussions – national representatives made all the decisions. ©

HOW MEGACITIES STACK UP

When cities expand, old borders disappear. In urban metropolitan areas, city limits are no longer important. For example, New York City's economic region extends far beyond its actual boundaries, just as Yokohama is a component of Greater Tokyo – and cities such as Offenbach, Mainz and Wiesbaden

round out the Frankfurt/Main economic region. Here DEMOGRAPHIA's experts compare urban metropolitan areas worldwide based on the same criteria, and ESSENTIAL compares the world's megacities in terms of their surface area, number of inhabitants and population density.



LONDON VS NEW YORK VS RIO DE JANEIRO VS HONG KONG

Some people are faced with the question of whether they would rather be based in London, Rio, New York or Hong Kong. Website versus.com provides exactly this comparison and delivers some surprising insights into the differences between megacities.

LONDON

RIO DE JANEIRO

UNIVERSITIES



21

New York	18
Hong Kong	16
Rio de Janeiro	11

Universities as centers of higher education and research, are important contributors to a city's development. Source: Wikipedia, 2016.

BILLIONAIRES

FROM ANNUAL FORBES REPORT RESIDING WITHIN THE CITY



72

New York	39
Hong Kong	38
Rio de Janeiro	6

The number of billionaires can indicate if the city has significant agglomerations of personal wealth. Source: Forbes, 2016.

BIG SPORT FACILITIES (STADIUMS, ARENAS, ETC.)



13

Rio de Janeiro	5
Hong Kong	4
New York	3

With more large sport facilities (20,000 seats +), a city is able to organize more important sporting events. Source: worldstadiums.com, 2016.



PROPORTION OF WOMEN



53.2%

New York	52.51%
London	51.1%
Hong Kong	51.1%



There's an oversupply of female population which can be good for single men. Source: Wikipedia, 2016; city's official stats, 2016.

AVERAGE TEMPERATURE



24.1 °C

Hong Kong	23.24 °C
New York	12.7 °C
London	11 °C

Pleasant average temperatures raise the quality of life. Source: Wikipedia 2016.



NEW YORK

HONG KONG

GLOBALLY CONNECTED (INDEX)



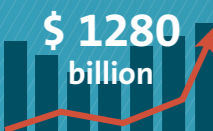
6.35

London	5.79
Hong Kong	4.56
Rio de Janeiro	1.31

The Global Cities Index is unique in that it measures global engagement of cities across five dimensions: business activity, human capital, information exchange, cultural experience and political engagement. Source: ATKearney, 2016.



GROSS DOMESTIC PRODUCT (GDP)



\$ 1280 billion

London	\$ 565 billion
Hong Kong	\$ 351 billion
Rio de Janeiro	\$ 169 billion

The level of GDP shows how rich and productive the city is. Source: Wikipedia, 2016.

MURDER RATE



0.8

London	2.1
New York	6.4
Rio de Janeiro	39

Murder rate expresses number of murders per 100,000 inhabitants. Lower murder rate indicates safer city and better quality of life. Source: Wikipedia, 2016.

UNEMPLOYMENT RATE



3.2%

Rio de Janeiro	5.7%
New York	7.8%
London	8.1%

Low unemployment rate indicates better career opportunities and economic growth. Source: Wikipedia, 2016; city's official stats, 2016.

BIG MACS PRICE (BIG MAC INDEX)



\$ 1.94

New York	\$ 4.07
London	\$ 4.93
Rio de Janeiro	\$ 6.16

The Big Mac Index is published by The Economist as an informal way of measuring the purchasing power parity (PPP) between two currencies. The Big Mac PPP exchange rate between two countries is obtained by dividing the price of a Big Mac in one country (in its currency) by the price of a Big Mac in another country (in its currency). Source: Economist, 2016.



AUTONOMOUS DRIVING – TRUCKS SET THE PACE



EFFICIENCY AND SAFETY ARE AT THE HEART OF AN AUTOMOTIVE MEGATREND THAT WILL CHANGE OUR MOBILITY LIKE ALMOST NO OTHER: AUTONOMOUS DRIVING. IT IS NO LONGER A VISION OF THE FUTURE BUT ALREADY A REALITY IN CERTAIN SECTORS. MANY EXPERTS ASSUME THAT IT WON'T BE LUXURY SEDANS THAT TAKE ON A PIONEERING TECHNOLOGICAL ROLE IN THIS DISCIPLINE – IT WILL BE COMMERCIAL VEHICLES. ESSENTIAL TRACKS DOWN THE REASONS.



identify too little distance between the vehicle and an approaching traffic jam without an appropriate response from the truck driver, the assistance system takes control using the vehicle's electrohydraulic power steering. In fractions of a second, it calculates whether immediate emergency braking would still be sufficient to bring the vehicle to a stop before running into another vehicle whether a parallel evasive maneuver – for example, driving onto the side of the road or a hard shoulder – should be undertaken. EMA draws on both the speed and load condition of the articulated truck to do its calculation and make a decision that the truck driver would scarcely be capable of reaching so quickly.

ZF and WABCO have installed the new technology in their “innovation truck”, which reliably avoids a second hazard. **Highway Driving Assist** not only warns the driver acoustically and optically in the event of unintended lane departures as a result of distraction or fatigue, it also keeps the articulated truck independently and actively on course if the driver makes no manual correction. Furthermore, it also maintains a safe following distance even when coming to a stop.

Commercial vehicle experts at business consulting firm Roland Berger see great potential in the automation of truck transportation and subdivide the trend toward autonomous driving into five phases. Phase 1 represents the current state of technology. Lane-keeping and emergency-braking assistants are already stipulated as standard equipment – at least in the EU. Full automation, which experts predict will take about 15 years to develop, will ultimately be achieved by phase 5. Complexity and costs rise with every phase. Nonetheless, enormously important factors are driving its development and are indicators of an unstoppable trend.

In addition to the push for increased safety, a shortage of staff and rising operating costs are also challenging the transportation sector. In the U.S. alone, there are currently 4.3 million trucks on the road. About 70 percent of all goods are conveyed to their destination by truck. But there is a shortage of at least 50,000 truck drivers nationwide. Autonomous trucks could solve a large number of the current problems. Driverless vehicles on the highway would at least alleviate staffing problems and drastically reduce costs. Networking could help avoid the

It is a horror that haunts many freeway motorists: A truck driver overlooks the back end of a traffic jam forming in front of him and rams the full weight of his 38 ton rig into an already stopped vehicle. Given the increasing amount of traffic on the world's roads, such unfortunate accidents are becoming a routine occurrence. In the United States alone, statistics show that eight people die every day in accidents involving heavy trucks.

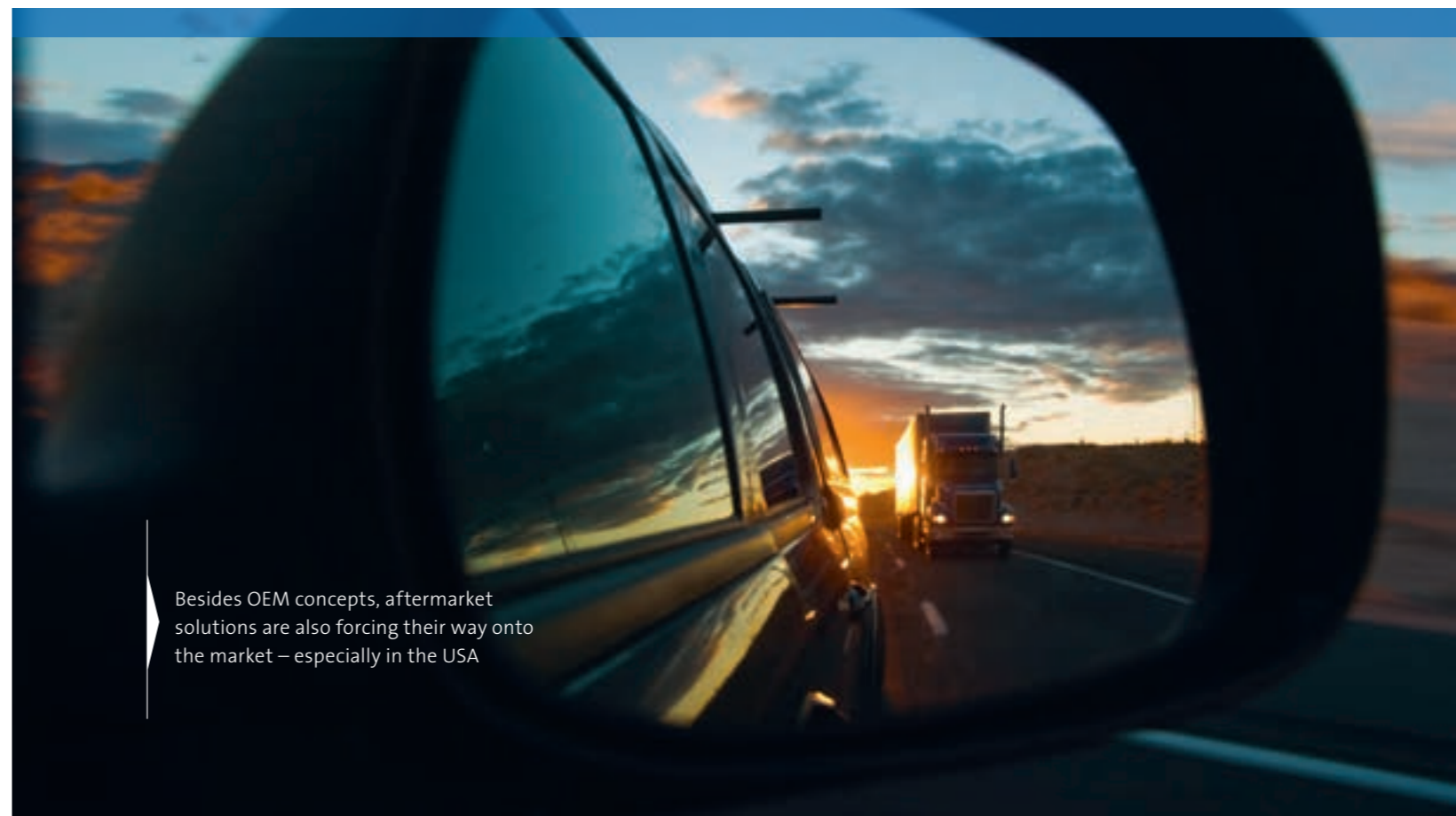


END OF AN ERA? Autonomous trucks will turn truckers into mobile logistics agents

One of the main drivers of intense research into autonomously driven trucks is the avoidance of such accidents. One thing is clear: Reliable sensor systems with corresponding actuator systems will soundly beat even the most rested professional trucker when it comes to reaction times. While he will need about 1.4 seconds to respond to unforeseen circumstances, automated systems handle the task in a fraction of a second – with reactions implemented within 0.1 seconds. And autonomous systems are not distracted by phones, fatigue or use of a navigation system.

In addition to significantly greater safety, the vision of autonomously driven trucks offers even more advantages. The spotlight is on less fuel consumption, better utilization of available traffic lanes, a higher degree of truck utilization and shorter transportation times – especially if the driver uses autonomous operation to make himself more comfortable in his bunk during the trip.

On the way there, partially autonomous systems will relieve the driver and make roads safer one step at a time. For example, in spring 2016, auto suppliers ZF and WABCO introduced their **Evasive Maneuver Assist** (EMA). If the system's sensors



Besides OEM concepts, aftermarket solutions are also forcing their way onto the market – especially in the USA

current issue that one truck in seven drives to the depot empty, consuming energy and generating emissions unnecessarily. Intelligent “platooning” of several networked trucks in a convoy could conserve up to 7 percent of their fuel use due to the aerodynamic benefits of tailgating. This would also better utilize the available traffic lanes, with three trucks driving in a convoy using only 80 meters of asphalt instead of 150 – an important argument on routes prone to traffic jams.

Developing the gigantic U.S. market as quickly as possible is the goal of the “Otto” start-up. High-caliber Google managers are working on autonomous driving solutions that can be retrofitted onto conventional trucks. America and Australia, with their endless miles of highway, are ideally suited to this technology because the environmental conditions are less complex than those on European motorways. A test fleet with three Volvo trucks is now in use and traveling fully automatically on highways in the state of Nevada. They are retrofitted with cameras, sensors and actuators. The founders of “Otto” see great potential for a retrofit solution because the lifecycle for trucks in North America – an average of 10 years – is particularly long. The conversion of older vehicles and their more

efficient use should be the foundation for an especially promising business model.

“Otto” is also benefiting from the fact that Nevada is already granting licenses. The highways in this large yet sparsely-populated desert state (9 inhabitants per square kilometer / 23 inhabitants per square miles) are an ideal proving ground. In other regions, the technology is currently only permitted on closed roads or with individual approval.

The regulatory boundaries are also tightly set for the intermediate steps on the way to autonomous driving. For example, Mercedes-Benz presented its “Highway Pilot Connect” system in March 2016. It facilitates the formation of a “platoon” of three articulated trucks via vehicle networking (Vehicle-to-Vehicle – V2V). The system represents an early expansion stage on the way to autonomous trucks. Daimler test vehicles may only use Highway Pilot Connect on Autobahn A81 in the federal state of Baden-Württemberg. Stuttgart’s metropolitan area is excluded. But there is approval for the A52 in the Düsseldorf metropolitan area. Other demonstration and test drives are only possible as exceptions with individually granted approvals.



Consequently, the German commercial vehicle manufacturer also uses the expanses of Nevada for extensive testing. In May 2015, the state certified two vehicles from American Mercedes-Benz subsidiary Freightliner for regular operation on public roads. Since then, its two “Inspiration Trucks” have covered countless miles and are contributing to making autonomously driven stretches of U.S. highways commonplace in the next few years.

Truckers, for decades the symbol of freedom, adventure and independence in the tradition of the American cowboy, could also soon be the first profession to see its image change due to autonomous systems. Although this would certainly detract from the romanticism, it would ultimately be a low price to pay for greater safety, climate protection and the more efficient use of our roads.



THE LONG-TERM VIEW WITH DIESEL



Autonomous trucks can exploit their advantages best in long-haul transport. When combined with highly efficient diesel engines, they form an unbeatable team. After all, tank capacities of up to 1,300 liters deliver tremendously long ranges – without critically shrinking the payload – and substantially reduce transportation times with autonomous opera-

tion. This advantage could hardly be realized with electric-drive trucks due to their frequent and lengthy charging cycles. Friction-optimized sealing technology for engines, transmissions and axles can, however, significantly improve the efficiency of conventional trucks. The LESS initiative from Freudenberg Sealing Technologies offers the right solutions for this. ©



LESS IS MORE

FREUDENBERG SEALING TECHNOLOGIES IS BUNDLING PRODUCTS THAT REDUCE FRICTIONAL LOSSES, EMISSIONS, INSTALLATION SPACE AND WEIGHT. SEALING SOLUTIONS FOR ENGINES, TRANSMISSIONS AND ALTERNATIVE POWERTRAINS BENEFIT FROM THE COMPANY'S UNIQUE MATERIAL EXPERTISE. ITS COMPREHENSIVE SOLUTIONS FOR ALL VEHICLE COMPONENTS THAT AFFECT ENERGY CONSUMPTION AND EMISSIONS ARE ACTIVELY HELPING MANUFACTURERS REACH THEIR DEVELOPMENT AND CLIMATE GOALS. A NEW MICROSITE AND A BROCHURE SHOWCASE THE LESS PRODUCTS.



Due to climate change and the finite character of natural resources, the auto industry is obliged to further reduce emissions and fuel consumption. We are developing products that support this lead as it charts new courses globally. With innovative sealing solutions, LESS® is helping the industry to reduce frictional

losses and carry out downsizing measures. At the same time, it is increasing the potential efficiency of internal combustion engines so they can meet future exhaust gas limits. Built up over 165 years, Freudenberg's material expertise is also facilitating advances in electric drive and alternative fuel concepts.



LEVITEX®



POUCH CELL FRAME SEAL



THRUST WASHER

SEALS FOR ADVANCED INTERNAL COMBUSTION ENGINES

Even if new powertrain technologies are complementing it in cars and commercial vehicles, the internal combustion engine will continue to play a key role for a long time. "Downsizing" and smart engine management systems are raising the technology to a new level of efficiency – but are also creating new challenges as the industry tries to reduce friction and achieve material compatibility and resistance to heat and pressure. The possibility of significant new advances in technology is limited. When it comes to achieving emissions goals, the results are now measured in the small ranges beyond the decimal point. At the same time, reductions in friction are enormously important. The Levitex gas-lubricated, mechanical face seal can produce savings of between 0.5 and 1 gram of CO₂ per kilometer.

Weight offers enormous potential as well: While a compact car still weighed less than 800 kg 30 years ago, that figure has climbed to 1,200 kg due to growing demands for comfort and safety. That's why efficient, lightweight construction is high on the list of emis-

sions-reduction measures. Substituting plastic for metal reduces weight by as much as 50 percent. Plastic components also offer greater potential for the integration of seals and open up substantially more design freedom than metal parts. In addition, products made of thermoplastics facilitate more manufacturing flexibility during production and installation – which increases quality.

With the help of an O-ring configurator or a simulation tool to calculate the dimensions of the necessary lubricating film, designers can optimize material use without giving away a gram of weight or a millimeter of installation space.

Emissions are also an increasingly important issue for commercial vehicles. In a test over a distance of 1.6 million kilometers (approx. 1 million miles), the CASCO®cassette seal for the output end of the crankshaft has demonstrated that its reduced friction – cut by 60 percent – significantly reduces fuel consumption as well.



MORE GEARS – MAJOR CHALLENGES

But LESS doesn't just focus on engines. In today's vehicles, transmissions are a key factor in overall vehicle efficiency – if consistently in the correct gear ratio.

Transmissions with eight or more gears increase the efficiency of the drivetrain but create new challenges, with lightweight design and low internal friction being critical factors. The new polymer axial bearing thrust washer illustrates the benefit of close development collaboration. It combines outstanding friction and wear characteristics at increased pressures and sliding speeds. The plastic used scores extremely high in strength and rigidity up to a temperature of 275 °C (527 °F) – and offers outstanding wear values and excellent chemical resistance.

For sealing shafts, the LESS initiative also offers low-friction seals that perform reliably with significantly reduced frictional losses compared to conventional sealing systems. In these solutions, special materials resist chemical attacks from oils containing aggressive additives.

Levitas, a seal ring for rotary feed-throughs, is one highlight in the area of transmission solutions. It floats on a specially generated hydrodynamic oil film, reducing friction and wear to the absolute minimum. Even when there is no physical contact between the seal ring and shaft, the sealing function is totally ensured. In this way, Levitas offers full functionality with the least possible drag torque – which leads to a considerable reduction in CO₂ emissions.



AN ELECTRIC FUTURE

To clear the way for mobility in a sustainable future, LESS also includes solutions for new, regenerative powertrain concepts that produce less local noise and reduce exhaust emissions. Whether the ambitious forecasts for electric mobility are accurate or not, it is indisputable that drivetrain electrification is becoming increasingly important.

For example, in plug-in hybrid vehicles with an operating voltage of about 400 V, an electrostatic charge can build up between the transmission housing and shaft which, in extreme cases, can lead to the uncontrolled flow of the electrical current. A special Simmerring with an electrically conductive non-woven actually prevents the electrostatic charge from building up in the first place.

But new powertrain solutions also require new peripheral technologies. Whether it is sealing for battery systems or frame seals for lithium pouch cells, LESS provides impressive, innovative solutions to meet emerging challenges. ©





THE HARDNESS TEST



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WITTENSTEIN INDUSTRIAL GEARBOXES OPERATE WITH EXTREMELY HIGH RELIABILITY AND PRECISION, AND RADIAL SHAFT SEAL RINGS FROM FREUDENBERG SEALING TECHNOLOGIES HAVE PLAYED THEIR PART IN THIS. AN EVALUATION OF MORE THAN ONE MILLION SEALS IN USE HAS NOW FOUND THAT THEIR RELIABILITY HAS BEEN INCREASED BY A FACTOR OF TEN DUE TO THE USE OF A HIGH-PERFORMANCE ELASTOMER.

Anyone can recreate the difficulty with a simple do-it-yourself test. You take a milk carton filled to the brim from your refrigerator, open it and then walk briskly to the kitchen table before stopping abruptly. It takes a great deal of finesse to avoid spilling the milk. The food packaging industry faces similar demands. The sequence of motions during the folding and closing of a milk carton, for example, must be precisely harmonized with the filling process. The packaging must be precisely positioned and must not



oscillate at its individual stops, and fluids must not spill during subsequent transport. And all this has to happen under strict hygienic conditions and at very high speeds. To meet these requirements, packaging facilities have two key elements at their disposal, the first of which is low-backlash planetary gear boxes which ensure precision during the sequence of movements. The second is the wear-resistant, food-grade seals installed inside the gearboxes which provide the necessary reliability and hygiene.

Drive technology specialist WITTENSTEIN and Freudenberg Sealing Technologies are developing solutions of this kind in a close technology partnership. The goal of the collaboration was to keep improving the characteristics of Simmerrings and, if necessary, optimize them for special applications so that WITTENSTEIN gearboxes can always deliver the best possible performance across wide-ranging applications. “Users of our low-backlash, high-end angular gearboxes expect high reliability from their seals as well,” says Michael Schmidt, an expert on sealing technology at WITTENSTEIN. As a result, the family-owned company, which is based in Igersheim in the Tauber Valley but has operations worldwide, has turned to high-performance Simmerrings made of the wear-resistant elastomer 75 FKM 170055 for this line of gearboxes and other models, along with electromechanical drive systems. The seals are used on both the drive and output side of the gearboxes, ensuring no lubricant can escape and that no product residue or similar contamination can penetrate. Reliable sealing is especially important in the food industry. “There is also the consideration that only so-called H1-compliant lubricants, which have limited types and quantities of additives, are permitted,” says Schmidt. “In combination with standard FKM seals, this frequently leads to increased wear. On the other hand, premium Simmerrings made of 75 FKM 170055 guarantee significantly less friction and a much longer operating life.”

Another important aspect with an impact on the reliability of radial shaft seal rings is their running-in behavior on the shaft under high dynamic stresses and fast-changing rotational directions. “Under such high demands, standard seal rings can dig into hardened shafts quite quickly,” says Erich Prem, Product Developer for Industrial Applications at Freudenberg Sealing Technologies. This can disturb the lubricating film and produce a gap during disruptive axial movements, for example, which can lead to micro-leakage. The extent of wear increases as well. “The abrasion then leads to expanded track widths on the contact surface of the wedge-shaped seal lip,” Prem added. To counter the problem, Freudenberg Sealing Technologies developed high-performance Simmerrings made of elastomer 75 FKM 170055 especially for WITTENSTEIN gearboxes back in the early 2000s. Among other things, the robust characteristics of the material meant the seal lip’s contact pressure could be reduced and the design made narrower.



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WITTENSTEIN is using field data to evaluate the real-life failure behavior of its gearboxes. To this end, its engineers employ automated evaluation and forecasting software to determine the reliability of its servo gearboxes. The tool also makes it possible to describe and evaluate the failure behavior in terms of the individual components within the system and thus the seals made of elastomer 75 FKM 170055. Over a period of more than 10 years, more than one million seals made from the wear-resistant elastomer from Freudenberg Sealing Technologies were used in the field in the low-backlash planetary gearboxes of the SP+ model line alone. The field data paint a clear picture: “In comparison with the seals made from a standard material that were used previously, the number of seal-related failures of our gearboxes has dropped by a factor of 10 with the new elastomer,” says Volker Metzger, Director of Customer Service at WITTENSTEIN. “Since then, the number of failures due to leakage has been just 0.025 percent, and a large proportion could be traced back to premature failure and not to wear.”



The two partners are using the field experiences documented with evaluation and forecasting software to develop new special applications. “As applications become increasingly complex and technically demanding, the requirements for the productivity and reliability of individual components are rising,” Metzger says. WITTENSTEIN is now working with Freudenberg Sealing Technologies on the development of special, wear-resistant sealing solutions for other industries, giving gearboxes a substantially longer service life along with significantly fewer disruptions and less downtime. ©

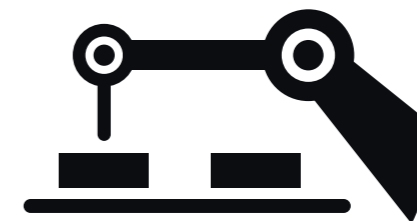


TIRELESS WORKERS



AS FILM LEGENDS, C-3PO AND R2-D2, THE ROBOT DUO IN STAR WARS, ENJOY A SPECIAL POPULARITY AND EVEN STEAL THE SHOW FROM SUCH CULT FIGURES AS SPACE SMUGGLER HAN SOLO AND PRINCESS LEIA. BUT MILLIONS OF ROBOTS IN MANUFACTURING PLANTS AROUND THE WORLD HAVE TO DO WITHOUT SIMILAR PERSONAL APPEAL. THEY ARE CONSIDERED JOB KILLERS AND “OVERACHIEVERS”.

THEY ARE WILLING TO WORK DAY AND NIGHT AND EVEN ON WEEKENDS WITHOUT COMPLAINT. THE FIRST ROBOTS WERE INSTALLED NEARLY 60 YEARS AGO, AND THEY ARE AN UNPRECEDENTED SUCCESS STORY.



George Devol and Joe Engelberger met each other at a cocktail party in 1956.

Engelberger, a physicist, developed monitoring systems for jet engines and nuclear power stations. Devol was a successful inventor and had just filed a patent for a programmable manipulator. Both raved about the novels of Russian author Isaac Asimov. The robots in his stories are not menacing entities that turn on their creators. They are helpful creatures. Devol and Engelberger were so fascinated with the idea that they formed a company called “Unimation” and from then on devoted themselves to the development and construction of robots.

In 1959, the company presented the first-ever industrial robot arm. The “Unimate” weighed two tons and was controlled precisely to 1/10,000th of an inch with a programming code deposited on a magnetic drum. The first industrial application took place in 1961 at a GM plant in Trenton, New Jersey. Unimate tirelessly took injection molded parts out of a still-hot tool. Unimation charged the automaker \$18,000 for the device, but spent \$65,000 on its construction and installation.

The calculation paid off from at least one standpoint: The news about the benefits of industrial robots spread

quickly. In 1967, the first industrial robot was at work on the European continent at Metallverken in Upplands Väsby, Sweden. Robots began to weld in 1969. At the GM assembly plant, Unimation robots took over a job that had been physically arduous, dirty and dangerous. Sizeable production tolerances and expensive rework immediately became a thing of the past. In 1969, Unimation teamed up with Kawasaki Heavy Industries to build the first robot in Japan. But Unimation’s founders, investors and shareholders would need plenty of staying power: It wasn’t until 1975, nearly 20 years after it was founded, that Unimation was able to turn an operating profit.

While the roughly 3,000 industrial robots in use worldwide in the 1970s were still moving somewhat stiffly, German company KUKA presented its “Famulus” (Latin for servant), the first robot with six axes of movement. The application options rose tremendously and were improved by using microprocessors, which began to facilitate compact dimensions and more precise control in 1974. For example, an industrial



higher than the figure for Germany. In the U.S., on the other hand, the number of industrial employees has declined – by about 30 percent, in fact. At the same time, the index for industrial robots has indeed tripled to 135, but it is significantly lower than that of South Korea, Japan or Germany. A look at

China is also interesting. China’s index stood at 21, and Brazil, with just 7, was the only country in the study ranking below it. The researchers took the view that robots increase productivity, improve competitiveness and create more jobs in peripheral areas, such as repair and maintenance, logistics and services.



Highly developed industrialized nations are out in front when it comes to robot density.

robot at Kawasaki featured the first system for sensing contact and forces. This gave the “Hi-T Hand” the ability to weld motorcycle frames and set bolts in the prescribed holes – accurately and at the rate of one per second.

At the end of the 1970s, purely electrically powered robots began to compete with earlier models with electrohydraulic drives. As of the mid-1980s, electric motors were even installed directly into the robot arm, making complicated gearboxes and directional movements superfluous. More than 70,000 industrial robots were in use during the mid-1980s.

The Z-Robot from KUKA offered a new degree of freedom in 1985. Its design brushed aside the traditional parallelogram and featured three translational and three rotary axes. Robots became widespread and made huge advances. In 1998, the FlexPicker from ABB had the ability to grasp and place up to 120 objects per minute – at a speed of 10 meters per second. Image-guided technologies and lasers were used increasingly frequently in control systems. In 2015, about 1.7 million indus-

trial robots were in use worldwide. Their population will rise to about 2.3 million by 2018¹.

HELPER OR JOB KILLER?

Over several decades, robots have again and again been blamed for pushing people out of factories and eliminating jobs. A scientific study in 2013² came to a different conclusion. It investigated the interdependency of industrial jobs and robots. The number of robots per 10,000 industrial workers is the widely used comparative index. In Germany, this figure rose from 146 to 261, an increase of more than 50 percent, between 2000 and 2011. The number of jobs in the manufacturing industry stayed almost exactly the same over that timeframe. This picture is even clearer in South Korea. Its robot index rose by 350 percent while the number of industrial workers stayed the same. At 347, Korea’s index is significantly

INDUSTRIAL ROBOTS UNLIMITED POSSIBILITIES

The range of robots is extremely diverse and extends from miniature robots that can assemble, package, pick or attach circuit boards in a workspace of 0.36 square meters, all the way to 4.7-ton heavyweights that can handle a load of 1.3 tons over a distance of 3.2 meters. And there are hardly any limits to the capabilities of robots. They can cut, weld, paint, measure, saw and much more. Varying application areas have led to four classifications of robots by the IFR (International Federation of Robotics). The distinguishing characteristics lie in the kinematics of the gripper.

- **Articulated robots**, which can move almost without restriction within a conceptual sphere around their position
- **SCARA robots** with one or several horizontal, articulated arms that can move within a half circle
- **Portal robots** with three linear axes on which the gripper moves in a classic coordinate system
- **Parallel robots** where the gripper is moved by several simultaneously articulated chains, achieving high speed and precision

¹ Source: Statista.

² Positive Impact of Industrial Robots on Employment, metra MARTECH, im Auftrag der IFR (International Federation of Robotics).

In some cases, more than 80 seals are at work in a single articulated robot arm – and are exposed to severe challenges. In contrast to nearly all other applications, the shafts do not turn continuously in one direction. The axes of robots make oscillating movements – often measured in just a few degrees and with constant directional changes. This not only hinders the formation of a lubricating film, but also affects the elastomer’s molecular composition, with micro-alignments forming inside it that can lead to leakage. To understand and analyze these phenomena, Freudenberg Sealing Technologies has simulated the real-life conditions of robot seals on test rigs. After the completion of testing, material mixtures emerge that are suited to the special stresses of robotic applications. In addition to Simmerrings, flat gaskets, valve stem seals, O-rings and spacer rings are also used in robots.

“Our customers expect seals to outlast maintenance intervals of

at least 10,000 to 13,000 hours. We are currently working with our partners to develop products with twice the operating life,” says, Achim Ströhle, Segment Director, Machine Tools & Power Tools. The customers, mostly manufacturers of gearboxes and electric motors, have a worldwide footprint. “Our global operations allow us to be actively integrated into robotic developments,” says Ströhle.

One new development involves collaborative robots that are no longer located behind protective guards. Instead, they collaborate with people in the same spaces, which places special demands on sensor systems and safety procedures. This means that robots are increasingly becoming tolerated, tireless coworkers who handle work that is excessively strenuous, mindless or even harmful. Yet despite their diligence, they are not likely to be as popular as C-3PO or R2-D2 even decades on.



THREE LAWS OF ROBOTICS

The word “robot” appeared for the first time in 1920 in the play “Rossum’s Universal Robots” by the Czech author Karel Capek. In this piece, people use robots to make their work easier. It comes to a dramatic ending. The robots seize power and destroy humanity.

In a story entitled “Runaround”, which appeared in 1942, Isaac Asimov coined the term “Robotics” and postulated the “Three Laws of Robotics”:

- 1 A robot may not injure human beings nor allow harm to come to them due to inaction.
- 2 A robot must obey the commands of a human being unless such commands contradict the first law.
- 3 A robot must protect its own existence as long as this does not contradict the first or the second law.

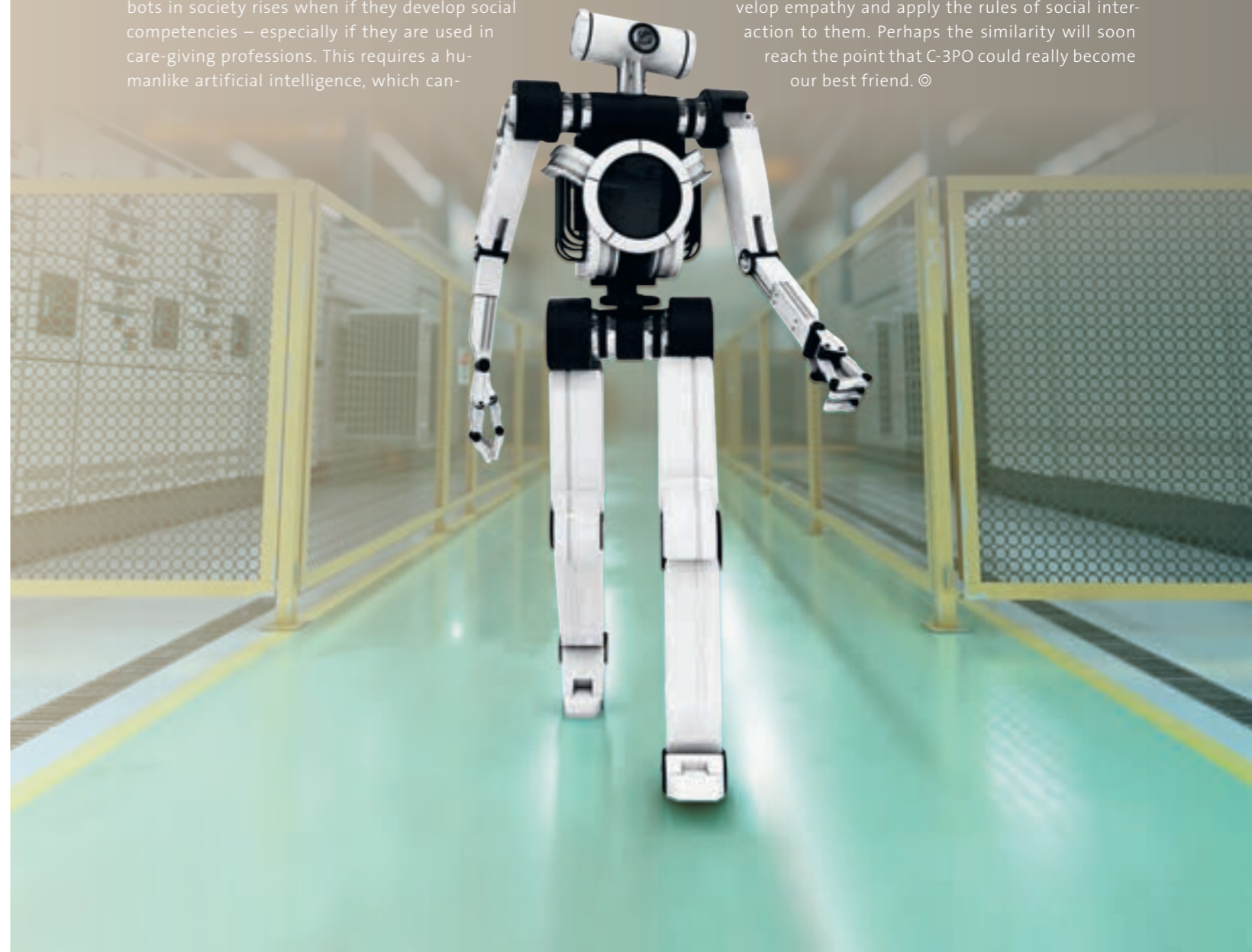
In 1950, Asimov published “I, Robot”, which contained nine short, interrelated stories, including “Runaround”. The book is considered a classic of science fiction literature.

HUMANOIDS: HELPER, COLLEAGUE – OR FRIEND?

Even if industrial robots have enabled the triumphant march of robotics around the world – humanoids are playing an ever-greater role as well. These robots, which are modeled after human beings, are expected to save labor and time or even be entertaining. Scientists especially hope that humanoids can help seniors in their everyday lives or take the burden off caregivers. There are two arguments in favor of constructing robots that looks as much like human beings as possible: First, our living spaces are oriented to human physiology, so a robot would be ideal if it adapted as fully as possible to these realities. Second, research at the Socially Intelligent Machines Lab at the Georgia Institute of Technology indicates that the acceptance of robots in society rises when if they develop social competencies – especially if they are used in care-giving professions. This requires a humanlike artificial intelligence, which can-

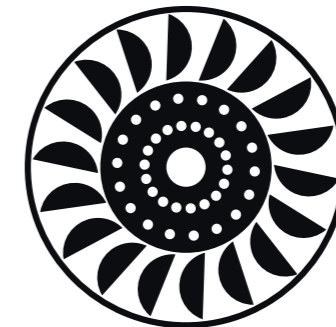
not be programmed but results from learning processes such as observation, interaction and communication.

In research projects, robots play an active part in the social lives of people so they can have these experiences and transfer them into algorithms that they can reproduce at any given time. It is important for the “adopted” R2-D2s to experience a relationship resembling that of a parent and child, at least at the start, and to be recognized as a being of equal value. But this recognition in turn requires a humanlike figure, mobility and a sensor system. Studies by researchers at Stanford University in California show that the more robots resemble human beings, the more ready we are to develop empathy and apply the rules of social interaction to them. Perhaps the similarity will soon reach the point that C-3PO could really become our best friend. ©





FROM HYDROPOWER TO DATA STREAMS



VOITH, BASED IN HEIDENHEIM AN DER BRENZ, CAN LOOK BACK ON A NEARLY 150-YEAR HISTORY. INNOVATION, GLOBAL OPERATIONS AND A CONSTANT VIEW OVER THE HORIZON ARE ALL PART OF ITS DNA. THEY ARE ALSO THE FOUNDATION FOR VOITH'S ABILITY TO HELP SHAPE DIGITAL CHANGE IN ITS INDUSTRIES. THE HISTORY SHARED BY FREUDENBERG SEALING TECHNOLOGIES AND VOITH DATES BACK MORE THAN 80 YEARS.

January 1, 1867 is the official date on which J. M. Voith was founded. It is in fact named for locksmith Johann Matthäus Voith, who had seen his small artisan business grow to 35 employees with the rise of industrial paper-making during the period after 1825. The company's factory was managed by his son, Friedrich Voith, who was drawn to hydropower and turbines as well as to paper-manufacturing equipment. Each of these fields has a direct relationship to Voith's current core areas today: hydropower plants, drive technology and paper production.

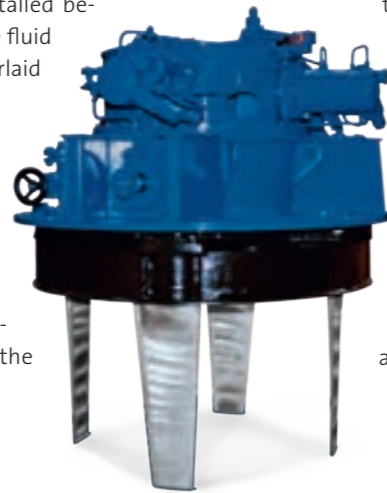
The company's growth and internationalization advanced rapidly. The Voith grinder was awarded the Progress Medal at the International Exhibition in Vienna in 1873. In 1903, the company received an order to construct the largest turbines in the world – the Francis turbines for the power stations at Niagara Falls.

Today, hydropower turbines are one of Voith's core businesses. Hydropower plants equipped with Voith Hydro components are found throughout the world, and the company, which is a full-system provider, is one of the sector's leading manufacturers. Its portfolio includes all components for large and small hydropower plants: generators, turbines, pumps, electrical and mechanical power station equipment, all the way to automation – i.e. measuring and control systems. Whether in hydropower or pump accumulator facilities in Brazil, China or India, Voith puts its trust in elastomer composite panels from Freudenberg Sealing Technologies – elements used for tolerance compensation for the turbine mounts. This involves extreme demands on the setting behavior of the elastomer to ensure that the turbine is always precisely positioned.

VOITH TURBO: DRIVES FOR ALL ELEMENTS

Expertise in fluid dynamics, such as hydro power, is also a prerequisite for Voith Turbo drives. As early as 1926, the company set a true milestone with the Voith Schneider Propeller (VSP), revolutionizing ship drive systems. Its advantages are impressive, even by today's standards. The VSP combines the functions of the ship's screw propeller and rudder. This makes it possible to vary the size and direction of the propeller as much or little as desired, without changing the rotational speed of the engine. The Voith-Schneider-Propeller drive can be installed beneath the hull in the position best suited to the fluid dynamics. Its blades follow a circular path, overlaid with an additional oscillating motion.

The VSP is particularly suited to ships that require extreme maneuverability – such as tug boats, ferries and off-shore support vessels. Equipped with one or more VSP, ships can move in any direction, even completely sideways. The technology has grown in popularity since the devastating accident involving the



“Exxon Valdez” tanker, which ran aground in 1989 off the coast of Alaska, triggering an environmental disaster. Since then, it has been mandatory for escort tug boats to accompany tankers near coasts, and nearly all of them are equipped with Voith Schneider Propellers.

There are VSPs in a wide range of sizes – from blade orbit diameters of 1.2 meters to a gigantic 3.6 meters. Whatever the size, all Voith Schneider Propellers have Simmerrings from Freudenberg Sealing Technologies. And in terms of seal engineering, the VSP is a true challenge because its rotor blades rotate on a central axis while oscillating by +/-57 degrees around its axis. This oscillation poses difficulties for the Simmerring because no hydrodynamic lubricating film can build up between the seal edge and the shaft surface. Highly wear-resistant elastomers are used in blade shaft seals for this reason.

The Voith Turbo Coupling operates in an entirely different element. In 1929, the company set a milestone with the component, which is now considered a fundamental technology. Since then, Voith has manufactured hydrodynamic couplings that can be traced back to engineer Hermann Föttinger. They are primarily used in conveyor systems, such as transport belts in mines, measuring several kilometers in length. They ensure that the conveyor belt does not accelerate to its operating speed abruptly when the electric motor is suddenly started up, causing valuable ore to slide off the conveyor. Instead, the coupling ensures a gentle torque build-up in the drivetrain, allowing a smooth start-up of the conveyor belt.

DIFFICULT WORKING CONDITIONS FOR SIMMERRINGS

The drive shafts of the Voith Turbo Coupling are sealed with Simmerrings from Freudenberg Sealing Technologies. The working conditions are harsh here, too. In 99 percent of their applications, Simmerrings sit firmly in a stationary housing, sealing a rotating shaft. But the Voith Turbo Coupling – and thus the Simmerring – rotates at a speed of up to 6,000 rpm. This puts the entire sealing system under the stresses of centrifugal force, placing enormous demands on materials and lubricants. The spring in the Simmerring must be designed in such a way that it does not pop out of its mounts despite centrifugal expansion. Today, a special simulation program helps sealing engineers perform weight and spring tension calculations. The high-tech springs for the rotating Simmerring (RWDR) are specific Freudenberg designs with a special closure that precludes all chance of opening – which would result in the immediate loss of the spring.

The principle of the Föttinger coupling has also taken hold in vehicle manufacturing. As the torque converter in the Buick Dynaflow, it paved the way in 1948 for the first General Motors vehicle with an automatic transmission. And in Heidenheim an der Brenz in 1950, the company began development of automatic differential converter transmissions for city buses – because Hanns Voith found the frequent gear shifting of local buses uncomfortable. In a newly built factory in Garching, near Munich, the company launched production of automatic transmissions for buses in 1963 – they have meanwhile become standard technology for public transit.



RETARDER: FROM INNOVATION TO STANDARD PRACTICE

Buses were the first field of application for what is now another Voith standard. Its fluid-engineering specialists developed the first retarder, an zero-wear hydrodynamic brake, in 1968. In addition to engine brakes and service brakes, the retarder represents a third braking system for heavy vehicles. In-line (integrated into the drivetrain) and off-line (attached to the side of the transmission), the retarder converts kinetic energy into heat. The system works by guiding oil into the working circuit where there are two opposing blade wheels – a rotor linked to the vehicle drivetrain and a stator. Centrifugal forces push



the oil outward, braking the rotor and thus the drivetrain. The resulting heat is fed into a separate oil cooler, which is particularly useful on longer uphill stretches. Today, Voith employs Simmerrings and O-rings from Freudenberg Sealing Technologies on a large scale to ensure the safe and reliable operation of its retarders.

Voith retarders convert kinetic energy into heat. They use spare braking systems as well as engines – they reduce fuel consumption and emissions, and today's commercial vehicles would be inconceivable without them.

INTELLIGENT SOLUTIONS FOR INDUSTRY 4.0

Paper manufacturing, the company's original focus, is still a mainstay. Today, the emphasis is on customer-oriented solutions that improve the paper production process. The company develops products that are particularly good at conserving resources, ensuring the most efficient use of energy, water and pulp. Voith's "Papermaking 4.0" innovation program is the pacesetter for Industry 4.0 in the paper industry. It focuses on smart, networked solutions and processes that provide the customer with clear added value. The company is also showing that it is state-of-the-art when it comes to data streams.

Growth in networking and digitalization is increasingly important in more than just the paper industry. These issues are making their mark on the entire business of building machines and facilities and revolutionizing the way manufacturers produce and sell their goods and services. With Voith Digital Solutions, the company is providing new concepts for automation and IT

for the manufacture of facilities and machinery. This new business division consolidates digital and automation activities companywide to enable development of new applications and business models. The goal is to achieve growth in new markets and with both existing and new customers.

Today, Voith is a global player that is at home in more than 60 countries. It generates annual revenues of 4.3 billion euros and has about 20,000 employees. It is a technology company supplying equipment, products and industrial services to a number of markets: energy, oil and gas, paper, raw materials, and transport/automotive. One quarter of the energy gained from hydropower globally is produced with turbines or generators from Voith. Drive elements from Voith Turbo are used around the world in industrial facilities and for railways, roads and water transportation – almost always with seals from Freudenberg Sealing Technologies. ©





A BAD ATMOSPHERE OVER THE WORLD'S OCEANS

OUR WAY OF LIFE WOULD BE INCONCEIVABLE WITHOUT GLOBAL MARITIME TRANSPORTATION. IN TERMS OF INTERNATIONAL FREIGHT MOVEMENT, 95 PERCENT OF THE WORLD'S GOODS ARE TRANSPORTED BY SHIP – FROM MACHINERY TO CHRISTMAS ORNAMENTS. WITH SEA FREIGHT VOLUME DOUBLING OVER THE LAST 30 YEARS, MARITIME TRAFFIC IS AN EMISSIONS PROBLEM AS WELL. ALTERNATIVES ARE AVAILABLE, BUT SO FAR THEY HAVE NOT CAUGHT ON.

The “MSC Zoe” hardly inspires the romance of the sea when it calls at a container terminal. The keel of this 395-meter colossus, with a carrying capacity 19,224 standard containers was laid at the Daewoo shipyard in South Korea in 2014. It is now considered the world’s largest freighter. The mega carrier was launched in August 2015 at the Port of Hamburg. It is the third member of the “Olympic” series, which will ultimately encompass 30 ships. This giant with a beam of 59 meters, is propelled by a forced-induction, two-stroke diesel engine with a crankshaft acting directly on the fixed propeller without a transmission. Its 14-cylinder engine delivers about 136,000 horsepower and achieves a maximum rotational speed of 250 rpm.

This low-speed engine is extraordinarily frugal. With a specific fuel consumption of less than 160 g/kWh, it is more economical than a diesel truck (180g/kWh) or today’s turbocharged gasoline engines for cars, which offer 230g/kWh at best. Ef-

ficiency is not the problem with these giant ships, but rather the steadily rising quantity of combusted fuel in global shipping – and especially its composition.

Commercial maritime traffic relies on heavy fuel oil (HFO), which has very little relationship to standard diesel fuel. Heavy fuel oil is viscous and has to be heated to about 45°C (113°F) to reach a temperature at which it will flow. Before being injected into the cylinder, it is heated to 140°C (284°F). Non-combustible components make up 2.5 percent of HFO, and its sulfur content is 3,500 times higher than that of diesel. The emissions resulting from shipping have been considered alarming since the 1970s. Soot particles, CO₂ emissions, and nitrogen oxides are endangering oceans and people. The scale is alarming: In the Port of Hamburg alone, cruise ships emit 177 tons of nitrogen oxides (NO_x), 6.7 tons of sulfur dioxide (SO₂), 3.5 tons of particulates and soot, and 10,500 tons of CO₂.



MSC Zoe – next to the 395-meter ocean-going giant, even full-sized tractor-trailers look like toys.



There are no uniform global rules establishing limits on emissions – only regional restrictions, such as those for port areas or the 200-mile zone along the U.S. coast. They require the use of lower-sulfur fuel with “just” 1 percent instead of 3.5 percent sulfur content in those areas. Ferries, cruise ships and freighters are barely out of the ports when fuel feeds are switched back to cheap fuel.

The industry’s experience with tightened emissions regulations in the North and Baltic Seas, where only fuel with 0.1 percent sulfur content is permissible, has had positive effects. Since then, the emission of ship exhaust has declined by 50 percent. The rising costs that had worried ship owners have not proved problematic. For example, despite using marine diesel costing twice as much, shipping company DFDS had its best operating results ever – as shipping volume increased in parallel.

This is where the second component comes into play: the constantly growing flow of transportation. An estimated 100,000 freighters that burn fuel oil are on the world’s oceans. Due to the sulfur in the fuel, the 16 largest ships alone emit as much SO₂ as all the private vehicles on the world’s roads – up to 5,000 tons per ship. Based on estimates from the University of Delaware, it is assumed that nearly 90,000 people a year die as a result of these global ship emissions. Climate goals are also jeopardized: CO₂ emissions from ships putting out to sea from east Asian ports have doubled from 8 to 16 percent as a share of the industry’s total volume.



TRAFFIC JAM AT SEA
It can take some time for a freighter to get a slot for entry into the Port of Shanghai.

The UN’s International Maritime Organization (IMO) is at least planning to limit the amount of sulfur in fuel oil to 0.5 percent as of 2020. The right to delay the measure until 2025 is being reserved if the world’s refineries are unable to meet the demand for low-sulfur fuel. The more environmentally friendly fuel would be the precondition for other measures to reduce exhaust gases – such as exhaust gas treatment with SCR catalytic converters.

Low-sulfur fuel offers relief, but another technological measure can top it. Freighters running on liquefied natural gas (LNG) – either with a pure LNG power plant or with a hybrid system – could prove particularly effective at cutting greenhouse and sulfur emissions. But LNG requires a fueling infrastructure which does not yet exist. So far, LNG ships are being used in ferry operations on fixed routes – or for the power units driving LNG freighters carrying natural gas from the Middle East to unloading terminals in California.

LNG could prove interesting for cruise ships. Their enormous electricity consumption, even at anchor, is now covered by on-board diesel engines. A pioneering project at the Port of Hamburg is being developed for stationary LNG operation. At the Altona cruise ship terminal, port officials are proceeding with Europe’s first shore power connection for luxury liners. During layovers, the huge ships are expected to quench their thirst for energy from land-based green energy, an approach that reduces noise as well as pollution. The Papen-Burger Meyer shipyard is even planning LNG-fueled cruise ships, which are due to be completed between 2019 and 2021.

Low oil prices are now the main obstacle to clean seas and coastal regions – and they are bearing strange fruit along the way. For example, cheap fuel means that more freighters are choosing the 6,500-km (4,039-mi) South African passage to avoid high fees at the Suez Canal. Cheap fuel makes this possible. To partly offset the loss of time, mega-freighters are happy to depart from the “slow steaming” that they have practiced for ten years. Under full steam, CO₂ emissions climb by up to 6,800 tons. That’s a disaster for the environment – and an unfeasible option for any ship owner forced to use expensive marine diesel instead of cheap heavy fuel oil. ©

SULFUR LIMITS FOR LIQUID FUELS THAT ARE PROPOSED IN GERMANY OR ARE CURRENTLY VALID.

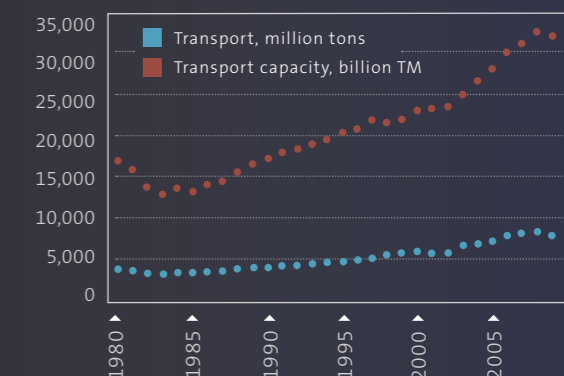
TYPE OF FUEL	SULFUR CONTENT TODAY			FUTURE SULFUR CONTENT
	Unit	ppm; mg/kg	%	
Gasoline		10	0.001	0.01
Superplus		10	0.001	0.01
Diesel oil		10	0.001	0.01
Light heating oil		2.000	0.200	2.00
Kerosene		300	0.030	0.30
Heavy oil land		10.000	1.000	10.00
Heavy oil sea		45.000	4.500	45.00

0.1 % as of 2008
based on ip 336

Baltic and North Sea 1.5%
(0.1% as of 2015)

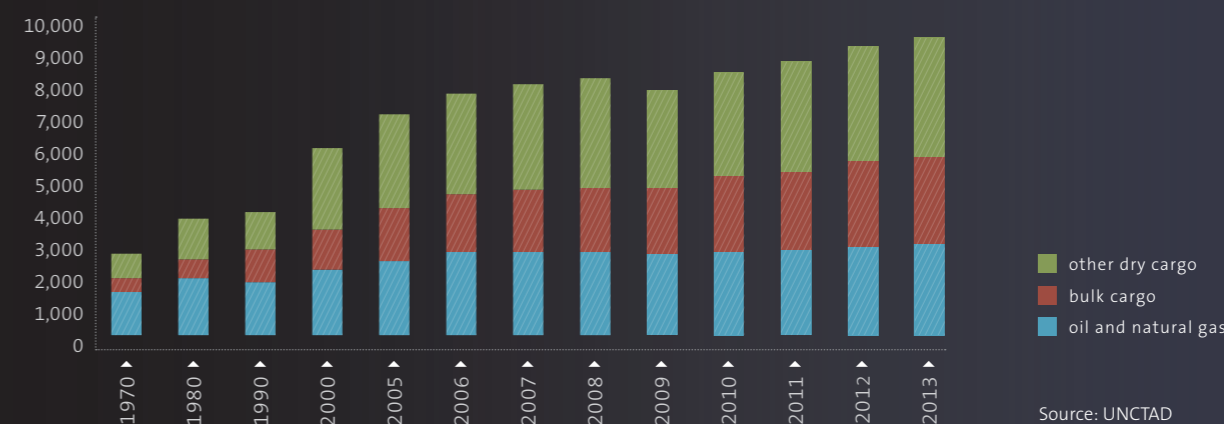
Source: Hochhaus-Schiffbetriebstechnik

MARINE TRANSPORT IN MILLIONS OF TONS AND MARINE TRANSPORT CAPACITY IN BILLIONS OF TM



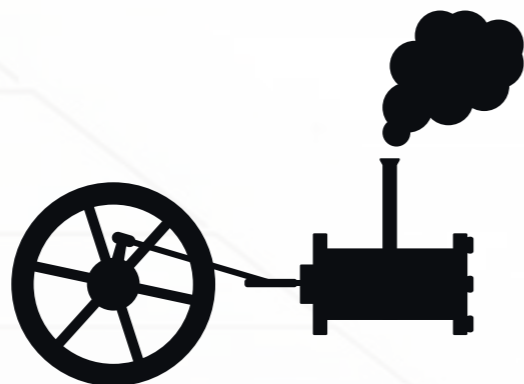
Source: ISL

WORLDWIDE MARITIME TRADE, MILLIONS OF LOADED TONS



Source: UNCTAD





ENERGY FROM EXHAUST GAS

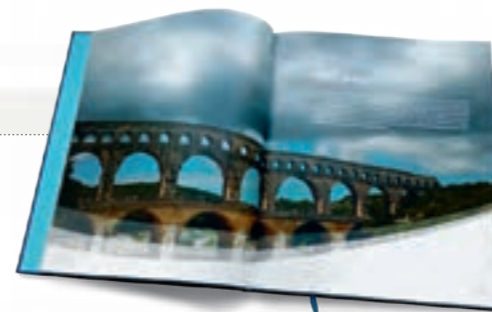
Reciprocating piston expanders based on the organic Rankine cycle use the heat from exhaust gases to recover energy. In commercial vehicles, they can improve efficiency and emissions performance. But they face a major challenge – the right sealing concept.

Even in efficient commercial vehicles, a large proportion of the chemical energy from the fuel is lost as largely useless heat energy. The organic Rankine cycle – which is already standard in many marine diesels – is set to change this. The idea is that the exhaust gas heats a working fluid until it vaporizes. At 250 °C (482 °F), the steam moves a piston or a turbine wheel with a pressure of up to 40 bar. The force either acts on the driveshaft or drives a generator. In a condenser, the working medium then cools to a point where it becomes liquid again. Unlike the classic steam engine, the ORC functions as a closed system. That means leaks must be precluded for the life of the truck, which is calculated at 1.6 million kilometers. (approx. 1 million miles)

Freudenberg Sealing Technologies supports ongoing research on ORC for trucks with innovative sealing solutions. The reason is that ethanol is the preferred medium for the tech-

nology due to its low boiling point – 78 °C (172,4 °F) – but it is extremely aggressive toward elastomers. Increased swelling and a reduction in mechanical characteristics, such as elongation at break and tensile strength, can lead to reduced leak tightness. Based on its experience with biogenic fuels, the company is using a special fluoro rubber material suited to heat recovery at high temperatures. The lines between the steam generator and condenser must be securely sealed as well – along with the inner workings of the pump, valves and expansion machine. There is a need for systems that simultaneously seal and enable a mechanical connection with the line. And Freudenberg Sealing Technologies has developed just such a sealing solution: “Plug & Seal”.

“Exhaust heat recovery systems based on the organic Rankine cycle are still in the pre-development stage,” said Oswaldo Anaya, Global Market Segment Manager, Freudenberg Sealing Technologies. “But production applications will become increasingly likely over the next decade due to more stringent CO2 standards and greater cost pressures in the transportation sector. There is the potential to reduce the fuel consumption of heavy trucks by at least 5 percent.”



CONCISE: THE SEAL COMPENDIUM

Consolidate practically everything worth knowing about seals into a single book – that was Freudenberg Sealing Technologies’ objective. More than 160 illustrated pages guide the reader on an entertaining and informative journey through the world of seals.

Bound in a rich blue cover, its six sections structure the journey. The “Introduction” sheds light on Freudenberg Sealing Technologies’ more than 165-year history – but also describes the first uses of leather seals in the drinking water system of ancient Rome. “Materials” presents the most popular sealing materials in brief highlights – from natural rubber to modern high-performance plastics and composite materials. The section on “Applications” recounts especially interesting problems and their solutions, and introduces the most important products for specific application areas – from dynamic to static seals, all the way to special seals.

These products, which are unremarkable at first glance, are often crucial to the functioning of complex systems. As a result, “Quality” has its own subject area. It delves into development partnerships, testing competency and exciting views inside components through the use of computer tomography. As a crucial core attribute of the global market and technology leader, the topic of “Innovation” has its own section. The company’s in-house Academy covers the systematic searches for new solutions at Freudenberg Sealing Technologies along with its innovation process, which has won multiple awards. In an “Outlook” section on markets, materials and applications, Dr. Ernst Osen and Eberhard Bock, Professor and Doctor of Engineering, discuss the next steps in sealing technology as well as foreseeable future trends.

English, is now available to order by sending an e-mail to stefan.mueller@fst.com. An online version can be downloaded in English and in German at (<http://compendium.fst.com/> or <http://kompendium.fst.de>).



COVETED AWARDS

FAW-Toyota, the Chinese joint venture between Toyota and First Automotive Works, has honored NOK-Freudenberg China (NFC) with its “Excellent Quality Award” for the third time in a row. And it wasn’t the only award from automakers in the Chinese market.

FAW-Toyota, the joint venture company between the world’s largest automaker and the largest vehicle and engine manufacturer in China, only bestows the company’s highest honor on a small group of especially outstanding suppliers. NOK-Freudenberg China can be pleased that it is the only member of the “rubber industry” to win the award.

The crucial criteria in granting the reward are the highest possible quality coupled with cost efficiency. The excellent cooperation is reflected in positive sales figures. FAW-Toyota sources a broad array of seals for engines, transmissions, steering, air-conditioning and vibration control systems from NOK-Freudenberg China.

Other Chinese companies have recently bestowed honors on NOK-Freudenberg China. GETRAG (Jiangxi) Transmission Co. Ltd. presented an award for “Outstanding Logistics Service” that has been given so far to only three suppliers. And the NOK-Freudenberg joint venture in China received the “Quality Contribution Award” from Anhui Jianghuai Automobile (JAC) for a second time, in recognition of its high product quality.



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