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Strong in the U.S.: Bosch increases capital expenditure – 400 million euros for the current year Innovation driver U.S. offers a promising market

November 14, 2016
9476 Bö/KB

- ▶ Headcount also growing: 18,800 Bosch associates in the U.S. by 2017
- ▶ Plans to expand production capacity for automotive components in Charleston, SC
- ▶ Major potential for connectivity business, whether smart cities or Industry 4.0

Palo Alto, U.S. / Stuttgart, Germany – The Bosch Group is expanding in the U.S.: the supplier of technology and services plans to invest nearly 400 million euros (around 450 million dollars) in the U.S. over the course of the current year, about one-fifth more than in 2015. Bosch's headcount is also expected to rise, from 17,800 associates at present to more than 18,800 by early 2017. Speaking at a press conference in Palo Alto, the Bosch board of management member whose responsibilities include the Americas, Dr. Werner Struth, said: "This underscores our confidence in the United States as an established market and a strong driver of innovation."

The company also announced its plans to continuously expand its oldest plant in the U.S.: the manufacturing facility in Charleston, SC, and the occupational training and professional development activities there. The more than 1,700 associates currently employed at the plant manufacture original equipment for vehicles, including components for the ABS and ESP® automotive safety systems.

Bosch also recently intensified its development activities in the U.S. For instance, it expanded its engineering center in Pittsburgh, PA, and consolidated its local activities at a new, central location. The associates there will develop internet and security technologies for the internet of things (IoT). Bosch also expanded its technical center in Plymouth, MI, where developers are working on key technologies for the mobility of the future, such as automotive electronics and driver assistance and safety systems. Over the past five years (2011 to 2015),

the company has invested a total of 1.5 billion dollars (just under 1.2 billion euros) in the United States.

Bosch is pursuing its expansion strategy in the U.S. with acquisitions as well: “The U.S. market is a highly promising one. Moreover, U.S. companies are among the most innovative in the world. For this reason, we will continue our high level of acquisition activity in the United States.” Just recently, Bosch purchased Skyline Automation, a leading specialist in building automation located in Clifton, NJ, in a move that increased the company’s market presence. Skyline Automation specializes in building automation and systems integration, which includes the installation and networking of various technical systems in buildings. This follows Bosch’s 2015 acquisition of Climatec, a leading U.S. provider of energy-efficiency, building-automation, and security solutions.

Major potential for business in connectivity

With a population of more than 320 million, the world’s biggest economy by gross domestic product offers enormous potential for Bosch, especially in the IoT sector. The company expects this market to be worth some 250 billion dollars (or about 280 billion euros) by 2020, and 35 percent of this to be generated in America. According to an OECD study, the U.S. is one of the top five countries as ranked by the number of connected devices – making it a key market for IoT business. “There are so many different opportunities for Bosch to generate genuine value with connected solutions that make everyday life easier and enhance quality of life,” Struth said. The goal, he continued, is to offer solutions in many areas – such as smart cities, homes, energy, industry, and mobility – that offer more safety, convenience, and efficiency.

On the road to the smart city

The trend towards smart cities opens up new possibilities for connected solutions. The energy efficiency potential in cities is enormous: cities consume 75 percent of the energy produced globally, with buildings alone accounting for 40 percent. Market experts estimate that by 2019, cities could cut approximately 11 billion dollars or about 12 billion euros) in energy costs.

One such project can be found in San Francisco, where new, attractive, waterfront communities are being built on the site of a Navy shipyard and the Candlestick Park stadium: [The San Francisco Shipyard](#) and Candlestick. With plans for 12,100 homes, over 350 acres of parks and open space, an urban outlet shopping mall, up to five million square feet of commercial space comprised of research/development, makers space and office space, along with nearly 300 artists’ studios. This is the biggest urban redevelopment project in San Francisco since the 1906 earthquake. FivePoint and Bosch technologies are

working together to bring connectivity to The SF Shipyard, offering a taste of life in a “smart city” with solutions for smarter homes and communities and widespread mobility and connectivity. Bosch is working as a technology partner to FivePoint, on smart solutions for these modern districts, including a Smart Community app, which will provide residents with localized, real-time information on public transport as well as access to intelligent surveillance solutions. There are also plans for future-oriented solutions for efficient traffic management and smart buildings, which will promote a high quality of life.

Connected manufacturing improves efficiency

Bosch is driving connectivity forward in manufacturing as well, and is also implementing Industry 4.0 solutions in its own plants in the United States. In its 23 facilities across the country, Bosch makes products for its four business sectors. Seven of these plants manufacture components for industrial production. The associates in the Anderson, SC, plant were the first at Bosch to employ smartwatches for data communication and the description of conditions in manufacturing operations. Connected solutions are also applied in the Charleston plant in the same state. With respect to Industry 4.0, the company favors open standards, since they make it easier to connect machines and software made by various manufacturers between companies and across national borders. This is why Bosch welcomes the recently adopted collaborative agreement between Germany’s Industrie 4.0 platform and the U.S.-based international Industrial Internet Consortium. The company is represented in both bodies and is thus playing a role in promoting the cross-border implementation of standards.

U.S. as a driver of innovation for Bosch

Bosch employs more than 2,300 researchers and developers in the United States. In 1999, Bosch’s corporate research and advance engineering opened its first branch outside Germany, the Research and Technology Center (RTC) in Palo Alto. Today, some 100 highly qualified associates research future trends there. These include web technologies, automated driving systems, and robotics. In its research and development activities, Bosch relies on the expertise of its associates and its long-term partnerships with renowned U.S. universities, such as Carnegie Mellon or Stanford.

Start-up culture in California

The Bosch Research and Technology Center in Palo Alto also benefits from its proximity to many high-tech companies. Through its internal start-up platform and its subsidiary Robert Bosch Venture Capital (RBVC), the Bosch Group manages to keep its finger on the pulse of Silicon Valley's vibrant start-up culture. Some 55 percent of the world's venture capital is invested in the United States. "Silicon Valley is a mecca of the American start-up scene, so it's no wonder that start-ups spring up like mushrooms there," Struth says. "Bosch believes it is important to regularly share information and make well-judged investments, since this allows it to respond early on to new trends and in this way acquire access to disruptive industry developments." One example is the start-up Aimotive, which receives funding from RBVC. Like Bosch, it is working on further developing automated driving. Overall, RBVC holds a stake in 30 start-ups around the world. Eight of them are located in the U.S., and four of those in Silicon Valley.

Bosch has also achieved success with its own start-ups, such as Bosch eBike Systems, whose portfolio includes drive systems and on-board computers for pedelecs. Founded in 2009 as a start-up within the Bosch Group, it is now a global market leader. In March 2014, the company penetrated the U.S. and Canadian markets by establishing Bosch eBike Systems Americas in Irvine, California. Key technologies for e-bikes include the lithium-ion battery, which Bosch is working to refine in Palo Alto and elsewhere, as well as motors and their control units.

Bosch's success story in the U.S.

Bosch has a long history of success in the United States. As a young man, Robert Bosch voyaged to the New World back in the 1880s, and found a job at Edison Machine Works in New York City. One decisive milestone in his company's journey from start-up to global corporation was its entry into the U.S. market in 1906. After all, at the start of the 20th century, the American automotive market was 40 times larger than Germany's. Today Bosch is ideally positioned in the U.S. to tap the potential of this highly promising market. Its business saw excellent growth there over the past year (2015), with sales rising to 12.2 billion dollars (or 11 billion euros). And despite some economic challenges, the Bosch Group expects its business to have developed steadily in the region in the current year.

Experience Bosch's connected solutions in Las Vegas, Nevada, U.S.

At the CES 2017, Bosch will show how the Internet of Things is getting personal – turning things into partners. Connected technology enables personal assistance across all domains of people's lives: improving mobility, shaping the life in the cities of the future, making homes smarter, healthcare more efficient

and working holistic. Exhibiting at CES for the fifth year, Bosch will introduce an extended portfolio of solutions that are “simply.connected.”

BOSCH PRESS CONFERENCE: Wednesday, January 4, 2017, 9:00 – 9:45

AM (local time) with **Werner Struth**, member of the Bosch board of management at Mandalay Bay Hotel, South Convention Center, Ball Rooms B, C & D

FOLLOW Bosch’s CES 2017 highlights on Twitter: [#BoschCES](#)

BOSCH BOOTH: Thursday until Sunday, January 5-8, 2017: Central Hall, #14128

BOSCH EXPERTS AT PANELS:

- Thursday, January 5, 2017; 11:30 AM – 12:30 PM (local time): [Conference track “MEMS & Sensors: Personalizing Consumer Technology”, Session “Where are Consumer Electronics Taking the Sensors Industry?” with Dr. Stefan Finkbeiner, CEO and General Manager, Bosch Sensortec; Venetian, Level 4, Marcelllo 4501](#)
- Friday, January 6, 3:30 – 4:30 PM (local time): [Conference track “Vehicle Technology”; Session “Redefining the Automotive Infotainment Experience” with Mr. Torsten Mlasko, Las Vegas Convention Center N258](#)

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The Bosch Group (www.bosch.com) is a leading global supplier of technology and services. The company employs roughly 375,000 associates worldwide (as per December 31, 2015). The company generated sales of 70.6 billion euros in 2015. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiaries and regional companies in some 60 countries. Including sales and service partners, Bosch’s global manufacturing and sales network covers some 150 countries. The basis for the company’s future growth is its innovative strength. At 118 locations across the globe, Bosch employs 55,800 associates in research and development. The Bosch Group’s strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is “Invented for life.”

The company was set up in Stuttgart in 1886 by Robert Bosch (1861-1942) as “Workshop for Precision Mechanics and Electrical Engineering.” The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant up-front investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

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Smart City Expo World Congress 2016, Barcelona Bosch presents intelligently connected solutions for enhanced convenience, security, and energy efficiency in cities

November 14, 2016
PI 9474 RB Ho

- ▶ San Francisco: smart technology for a new community development
- ▶ Stuttgart: smartphone app as a guide to free parking spaces
- ▶ Smart-city solutions for mobility, energy, buildings, security, and e-governance

Stuttgart, Germany – By 2050, more than six billion people worldwide will live in cities, which need to provide increasing levels of convenience, energy efficiency, and security. That requires completely new concepts for urban mobility and the sustainable use of resources. The evolution of a city into a smart city can help to meet these needs. At the [Smart City Expo World Congress 2016](#) in Barcelona (November 15-17), Bosch will present solutions and projects for intelligently connected cities that provide their citizens with a higher quality of life and, at the same time, save energy and operating costs. The energy efficiency potential in cities is enormous: cities consume 75 percent of the energy produced globally, with buildings alone accounting for 40 percent. Market experts estimate that by 2019, cities could cut approximately 11 billion dollars in energy costs.

San Francisco: smart technology for a new community development

The former sites of a Navy shipyard and the Candlestick Park stadium, are being developed into new, attractive, waterfront communities: [The San Francisco Shipyard](#) and Candlestick. With plans for 12,100 homes, over 350 acres of parks and open space, an urban outlet shopping mall, up to 5 million square feet of commercial space comprised of research/development, makers space and office space, along with nearly 300 artists' studios. This is the biggest urban redevelopment project in San Francisco since the 1906 earthquake. FivePoint and Bosch technologies are working together to bring connectivity to The SF Shipyard, offering a taste of life in a smart city with solutions for smarter homes and communities and widespread mobility and connectivity. Bosch is working as a technology partner to FivePoint, on smart solutions for these modern districts, including a Smart Community app, which will provide residents with localized,

real-time information on public transport as well as access to intelligent surveillance solutions. There are also plans for future-oriented solutions for efficient traffic management and smart buildings, which will promote a high quality of life.

Stuttgart: Smartphone app as a guide to free parking spaces

Mobility is the pulse of every city. But more and more metropolitan areas are at risk of gridlock. Thirty percent of urban traffic is caused solely by drivers who are unable to find a free parking space. As part of a pilot project with the Verband Region Stuttgart, the Stuttgart regional authority for mobility, Bosch is testing out smart parking space management. Bosch has fitted around 2,500 sensors over the past few months to a total of 15 park-and-ride spaces along both of Stuttgart's commuter train lines. And the principle of using these sensors to display parking space utilization in real time works. This was proven by a demonstration at a park-and-ride parking garage in mid-October. For representatives of participating municipalities and the Verband Region Stuttgart as the pilot project partner, the Bosch team responsible for the project demonstrated how it worked. Just park a car, and seconds later, the online display changes to red: the space is occupied. Move the car out of the space, and seconds later, the display changes to green: the space is available. The project is due to go live at the beginning of 2017.

Bosch smart-city solutions for mobility, energy, buildings, security, and e-governance

For smart cities, Bosch offers solutions in the areas of mobility, energy, buildings, security, and e-governance – in other words, digital city administration. With regard to mobility, these solutions include environmental monitoring, connected parking, fleet management, e-mobility, and intermodal transport, which is the linking of different modes of transport. When it comes to energy, the range includes virtual power plants, energy-efficient heating, hot water, and cooling systems, as well as energy storage units. The security solutions encompass systems for fire protection, access control, and video surveillance. For residential buildings, Bosch provides smart home technology and connected household appliances. As for e-governance, the range includes the Community app and the City Data Platform.

At CES 2017 (January 5-8) in Las Vegas, Bosch will present its smart city solutions as well:

EXPERIENCE BOSCH at the CES 2017 in Las Vegas, Nevada, U.S.: At the CES 2017, Bosch will show how the Internet of Things is getting personal – turning things into partners. Connected technology enables personal assistance across all domains of people's lives: improving mobility, shaping the life in the

cities of the future, making homes smarter, healthcare more efficient and working holistic. Exhibiting at CES for the fifth year, Bosch will introduce an extended portfolio of solutions that are “simply.connected.”

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Bosch acquires U.S. building automation specialist Expansion of international activities with connected energy and building technology

November 3, 2016
PI 9448 RB Ho/Na

- ▶ Acquisition of Skyline Automation broadens technical expertise and market presence
- ▶ Stefan Hartung: “strategic step on path to single-source provider of connected systems and services for buildings”
- ▶ Growth with new business models and services for greater convenience, security, and energy efficiency

Stuttgart, Germany – Bosch is bolstering its international business with integrated services for commercial buildings – a strategic growth area for the Energy and Building Technology business sector. The Bosch subsidiary Climatec, based in Phoenix (AZ) in the United States, has acquired Skyline Automation. The company, which specializes in building automation and systems integration, provides installation and connectivity services for a variety of technical systems in buildings. Building automation can reduce energy consumption by up to 40 percent. Based in Clifton, New Jersey, Skyline Automation has a workforce of 40, and generated sales of 12 million dollars in 2015. The building service provider Climatec was acquired by Bosch in 2015, and has so far been active in the western United States.

“In acquiring Skyline, we are bolstering our activities in energy and building technology at a technical level and expanding our presence in the North American market, which is showing solid growth,” said [Dr. Stefan Hartung](#) at a press conference in Stuttgart. Hartung is the member of the board of management at Robert Bosch GmbH responsible for the Energy and Building Technology business sector. “Following the takeover of Climatec, this is the next strategic step on our path to becoming a single-source provider of connected systems and services for buildings.”

Connectivity enabling new business models and services

Connected solutions enable Bosch to tap into many new possibilities in its activities with energy and building technology, particularly where services are concerned. Market experts estimate that the global market for intelligent building technology will grow from its current level of around 6 billion dollars to around 25 billion dollars by 2021 – the equivalent of an average annual growth rate of 34 percent. “Services are becoming an integral part of our business. Every sale of hardware will be followed by the sale of complementary services in the future,” Hartung said. When it comes to developing and launching services for the connected world, Bosch’s broad business portfolio is a huge advantage, as is its expertise in software and sensors. “We are connecting cars with houses, and connecting entire cities. For tasks like this, Bosch contributes technical expertise from a wide range of different types of devices in a way that no other company can.”

Bosch Energy and Building Technology includes the Thermotechnology, Security Systems, and Service Solutions divisions, as well as the subsidiaries Smart Home and Energy Storage Solutions. In 2015, the Energy and Building Technology business sector generated sales of 5.1 billion euros.

Service Solutions: 15 percent annual sales growth

The new Service Solutions division, which was created at the start of 2016, is showing solid growth. The division’s roughly 7,600 associates provide communication services, remotely monitor buildings and industrial facilities, and ensure greater safety for cargo and vehicles along the entire logistics chain. Secure Truck Parking, for example, allows to book secure parking spaces for trucks at rest areas online before the journey. On behalf of automakers, Service Solutions provides the eCall automatic emergency call service and a concierge service. In 2015, Bosch Service Solutions handled more than 120 million customer contacts in 14 countries on behalf of more than 1,000 companies – 30 million more contacts than in 2013. Bosch expects the Service Solutions division’s sales to grow by about 15 percent each year.

Smart homes: global market potential of 10 billion euros

In smart homes as well, increasing connectivity will make life easier and relieve residents of tedious routine tasks. Market experts expect the global market potential of smart homes to reach 10 billion euros as early as 2017. By 2020, some 230 million households – 15 percent of all households worldwide – will be equipped with smart-home solutions. Since the beginning of the year, Bosch has pooled its activities in this area in the company Robert Bosch Smart Home GmbH. With its Bosch Smart Home system, the company offers a simple and secure solution for connected homes. At the IFA 2016, Bosch presented new

products, including a small interior camera with a 360° view and a smart smoke alarm which also sounds in the event of a burglary and measures air quality.

Leading provider of smart heating solutions

Having sold more than 210,000 network-enabled products, Bosch is the leading supplier of smart heating solutions that greatly increase convenience, energy efficiency, operating safety, and service quality. The “HomeCom” portal provides installation companies with detailed information about their customers’ connected heating systems, including faults and predictions of what might have caused them. End users receive clear information about their heating system, along with consumption data and personalized energy-saving tips. Together with British Gas, Bosch has developed the “Boiler iQ” connected service. This allows British Gas to remotely monitor the heating systems of its U.K. customers around the clock. If the system detects a problem, it automatically sends an immediate appointment request to the customer’s smartphone. The service technician has all relevant information available for maintenance issues. Bosch is focusing on three business fields in this market: heating systems for residential buildings, domestic water heaters, and systems for commercial and industrial heating and air-conditioning systems. In all three segments, Bosch is making good progress and intends to grow faster than the market.

Smart video technology growth market: more than just recording images

Modern cameras do more than just record images – they also track speeds, directions, colors, and much more. A security guard who has to spend hours watching several surveillance monitors can easily overlook something important now and again. In this situation, it helps if the cameras can do some of the thinking and independently notify the guard if someone is climbing over a fence or stealing an artwork. Intelligent video analysis makes this possible. Bosch cameras are now equipped with this technology as standard. They recognize burglars and unattended luggage, count crowds of people, and sound the alarm in the event of fire. The intelligent algorithms behind this technology had previously only been available in top-of-the-range cameras, which are installed in critical areas such as airports and government buildings. This year, Bosch is making a complete package of analysis functions, known as “Essential Video Analytics,” available for the mid-price segment as well, thus making the solution attractive for new target groups such as hotels and retailers. The system allows large quantities of video data to be sifted quickly and easily for vital information. Because only relevant images are transferred, the memory requirements and the load placed on the network are considerably lower – as are the operating costs.

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March 10, 2016
PI 9167 RB Res/af

Bosch is using Industry 4.0 to increase its competitiveness

More than 100 projects worldwide

- ▶ Data mining and RFID increase productivity in ABS/ESP braking-system manufacturing by one-quarter
- ▶ Data mining cuts hydraulic-valve testing time by 18 percent
- ▶ Inventory 97 percent shorter thanks to RFID

Berlin and Stuttgart – Bosch is making its manufacturing connected, with more than 100 projects already successfully running worldwide. Among other benefits, this increases the availability of its machinery – and hence also its productivity and competitiveness. Here are a few selected examples:

One production line, 200 different hydraulic modules

On its multi-product assembly line in Homburg, Germany, Bosch can manufacture 200 different hydraulic modules from more than 2,000 different components. Thanks to connectivity, these components are automatically ordered in time. The modules control the work and driving hydraulics in trucks or tractors, which help do things such as incline loading surfaces or lift a plow. The production line's nine stations are connected by a smart network. Thanks to an RFID chip attached to the workpiece, the stations know how the finished product has to be assembled and what steps are necessary. This facilitates efficient production, even for small batch sizes. That flexibility is important, since some modules are requested more often than others. What is more, Bosch can produce different types of module simultaneously on the multi-product line. This cuts tooling times on machinery, which increases productivity. The work plans required for assembling the hydraulics components are automatically called up and shown on the monitors as a photo or video. The display is customized to each associate's level of training, and shown in their native language. The aim is to offer associates the best possible support in their work. This is an example of how Bosch is successfully putting multiple core elements of Industry 4.0 into practice: distributed intelligence, rapid connectivity, contextualization in real time, and autonomous behavior. Details: <http://bit.ly/1TOCbsh>

Industry 4.0 boosts productivity in ABS/ESP braking-system manufacturing

Award-winning success: in less than one year, Bosch improved its productivity in the manufacture of ABS/ESP braking systems by nearly one-quarter by deploying Industry 4.0 solutions throughout its international manufacturing network. In recognition of this achievement, the Blaichach plant – which spearheaded the initiative – received the prestigious Industry 4.0 Award in 2015. One reason for this productivity increase is that Bosch collects data from the thousands of sensors that are installed along the plant's production lines. Sensors record the movement of cylinders, the cycle times of grippers, and the temperature and pressure levels in the manufacturing process. This wealth of information is entered into massive databases, with a clear structure. And thanks to RFID (radio frequency identification) technology, Blaichach can also digitally map its internal flows of goods. The result is a computer-generated virtual representation, or "digital twin," of the actual factory. This digital representation facilitates transparency across the entire value stream. And in turn, this transparency makes many more I4.0 solutions possible.

One of these solutions is applied in machinery maintenance: software analyzes machinery performance to spot deviations from the target state and indicate in good time when maintenance is necessary. The system helps associates detect and deal with errors by offering them instructions on how to carry out these repairs. On their tablets, for instance, associates can call up videos showing them how to replace parts. If they encounter a problem they cannot solve immediately, they can use a wireless video link to speak with experts who then assist in solving the problem remotely. All this reduces unplanned downtimes as well as increasing productivity and hence also competitiveness.

Data mining cuts the time needed to test hydraulic valves

By evaluating manufacturing data from its own facilities, the Bosch plant in Homburg, Germany, has managed to cut the time taken to inspect hydraulic valves by 18 percent. Given the frequently high level of optimization in modern manufacturing, such huge savings represent a major advance. Assuming an annual rate of production of 40,000 valves, the savings add up to 14 days per year. An analysis of the production data relating to 30,000 manufactured hydraulic valves showed that certain subsequent testing steps in the inspection process are unnecessary, provided the results of several earlier steps are positive. The outcome of those subsequent steps can be reliably predicted by analyzing the earlier steps. Pinpointing such correlations – which are generally much more complex than the example given here – saves time and money. When the number of parts runs into the millions, even savings of just a few seconds can soon add up to days, turning a few cents into millions of euros. The

search for new correlations (a process called data mining) requires that, over a long period of time, companies collect and appropriately evaluate the data they generate. Bosch has been doing this for many years.

Details: <http://bit.ly/21G5ZsG>

Predictive maintenance of machine tools

One of the items Bosch manufactures at its plants in Stuttgart-Feuerbach (Germany) and Jihlava (Czech Republic) is high-pressure pumps for injection systems. Part of the manufacturing process for the aluminum housing involves precise drilling of holes and milling of other parts. Large machine tools are deployed in the process, whose motorized drive units are referred to as “spindles.” Each spindle weighs some 50-70 kilograms and spins at a rate of 30,000 to 40,000 rpm. Sensors record vibrations in the operation of these spindles, and software stores and evaluates the data. Whenever the system registers that the intensity of vibrations exceeds a set limit, it sends a signal to the service associate in charge. The technician can then decide if and when to replace the spindle. Maintenance becomes easier to plan, machine availability improves, and productivity rises. Continuous monitoring of machine parts such as these spindles is also referred to as “condition monitoring.” Planned servicing is called “predictive maintenance.”

Ultrasound gloves for quality assurance

The Reutlingen plant is involved in electromobility, among other business areas. Manufacture of the necessary power electronics involves many manual activities. To support its associates in this work, Bosch introduced a system that records their hand movements. The system is based on special gloves worn by the associates. Ultrasound technology helps determine the position of these gloves. In turn, this indicates if associates have carried out a hand motion correctly, and which work step is being performed at any given moment. The entire work process is displayed step by step on a screen until it has been completed. This helps improve quality assurance.

Radio signals create transparency in the flow of goods

In many of Bosch’s more than 250 plants worldwide, the company has equipped plastic crates for the internal transport of parts and finished products with RFID (radio frequency identification) tags. RFID readers are positioned at all the doors to the manufacturing shops. When a transport cart goes from one shop to another, the reader registers its tag automatically and without any need for physical contact. The result is a digital map of the flows of goods in that particular plant. At any time, the company can determine when parts will most likely arrive on the production line, when and how many finished products have to be packaged, where a specific part is located, and what the inventory levels are.

The system also knows how many packaging boxes are required and can reorder these as needed. RFID technology ensures transparency in the flow of goods, as well as reducing manual effort and keeping inventory levels low. It simultaneously increases reaction speed and productivity. This is how Bosch achieves leaner logistics processes. Thanks to its use of RFID, Bosch was able to boost productivity in its Homburg plant's intralogistics by ten percent, and reduce storage in production by nearly one-third.

China: RFID cuts inventory time by 97 percent

In the Bosch plant located in the Chinese city of Suzhou, the yearly task of taking machine inventory used to be a major undertaking. Plant 1 has four manufacturing areas, each with up to 2,500 machines, test benches, and items of measuring equipment. For ABS manufacturing alone, the inventory process used to take up to a month in some cases. Sometimes associates printed out lists to help them manually record machine inventory. Now, thanks to smart connectivity, inventory takes just four hours. All the machines and equipment items have been fitted with RFID (radio frequency identification) transponders. This allows objects to be identified without physical contact. Now, associates push RFID trolleys fitted with a laptop and antennas through the manufacturing shop. As they move along, the trolleys use RFID technology to automatically identify machines and devices. It cuts the time needed for inventory by 97 percent, or 440 man-hours.

Transporters with swarm intelligence

Engineers in Bosch's Nuremberg plant have developed and successfully tested an AutoBod – a driverless, self-navigating transport system equipped with swarm intelligence. The two-wheeler AutoBod, which is equipped with four additional stabilizer wheels, knows when to pick up production materials that have previously been automatically ordered. It then takes these materials to the production line. Using a laser sensor, the system navigates by following a map drawn up during its first drive. It recognizes and evades obstacles, then wirelessly transmits information about them to the other AutoBods. This collective behavior relies on data about the location, electric drive charge level, and maintenance status of the various transporters. This means requests are routed to the AutoBod that is closest to the pick-up point, that is not already busy with another request, and that has enough battery charge. This kind of intelligence sets the AutoBod apart from other driverless transport systems, which are incapable of deviating from their programmed route. In contrast to conventional driverless transport systems, AutoBods do not require the installation of expensive in-plant infrastructure. The deployment of AutoBods reduces the time and effort spent on transport, frees up space, and considerably decreases inventory.

Press photos: 1-RB-21936, 1-RB-21910, 1-RB-21911, 1-RB-21913,
1-RB-21915, 1-RB-21916, 1-RB-20864-d, 1-RB-20863-d, 1-RB-20994,
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The Bosch Group is a leading global supplier of technology and services. It employs roughly 375,000 associates worldwide (as of December 31, 2015). According to preliminary figures, the company generated sales of more than 70 billion euros in 2015. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiaries and regional companies in some 60 countries. If its sales and service partners are included, then Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. In 2015, Bosch applied for some 5,400 patents worldwide. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life."

The company was set up in Stuttgart in 1886 by Robert Bosch (1861-1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant up-front investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

Additional information is available online at www.bosch.com, www.bosch-press.com, twitter.com/BoschPresse



Old machine + rapid connectivity = new benefit Sensors and software take Robert Bosch's lathe from 1887 into the age of Industry 4.0

October 6, 2016
PI 9418 RB Res/KB

- ▶ Werner Struth: "Bosch is opening up the benefits of connected industry to operators of older machines as well."
- ▶ Customer benefits include predictive maintenance
- ▶ Industry 4.0 retrofit solutions is a global market worth billions
- ▶ Solution includes new PPMP machine language

Stuttgart, Germany – It is 129 years old, treadle-operated, and an Industry 1.0 gem. The company founder Robert Bosch himself worked with this 300-kilogram cast-iron lathe beginning in the years after 1887. Among other things, it was used to manufacture parts for the magneto ignition device – the very product that helped the company to achieve its breakthrough at the end of the 19th century. Now, at one fell swoop, Bosch has catapulted this historic lathe right out of the museum and into the age of Industry 4.0. The new Bosch IoT (internet of things) gateway provides the necessary technical support. The connected system combines sensors, software, and IoT-compatible industrial controls, making it possible to monitor the condition of the lathe. Speaking in Stuttgart, Dr. Werner Struth, who is the Bosch management board member responsible for industrial technology and manufacturing coordination, said: "This is the only construction of its kind in the world. It shows that even ancient machines can be connected quickly and easily with the IoT gateway." As a result, he explained, Bosch is "opening up the benefits of connected industry to operators of older machines as well."

Many machines still not part of Industry 4.0

"Many of the machines used in skilled trades or manufacturing are still not connected to Industry 4.0. Among other things, they lack sensors, software, and connections to companies' IT systems – which means that they do not fulfill the essential prerequisites for connected industry. In Germany alone, the number of

such machines runs into tens of millions. And globally, the market for retrofit solutions like the Bosch IoT gateway is worth billions,” Struth said. He noted that industry needs connected machines if it is to be successful over the long term. That is exactly what the IoT gateway ensures – quickly and flexibly. With this gateway, Bosch shows how operators of older manufacturing systems can connect their machines, and thus monitor them in real time and optimize them. This enables things such as predictive maintenance, reducing downtime while increasing productivity.

Long innovation cycles make retrofit solutions necessary

The IoT gateway makes sense technically and economically: innovation cycles in mechanical engineering differ from those in many other industries. Once purchased, machines often remain in use for decades. They can only be changed to meet new demands at great effort and expense. A large part of the installed machinery worldwide is therefore still not networked with connected industry. The need for retrofit connected-industry solutions is correspondingly huge. The same holds true for Bosch: “We are already using the IoT gateway ourselves and saving money. And our subsidiary Bosch Rexroth will be offering our customers this solution from this fall,” Struth said. The IoT gateway will be presented to a specialist audience at the [sps ipc drives](#) trade fair.

Investment pays off in just 18 months

At the Bosch plant in Homburg, for example, engineers have connected a 2007 test facility for hydraulic valves with the IoT gateway. Thanks to new sensors that monitor the quality of the oil used, it is now possible to determine the point at which oil needs to be changed much more precisely than before. This saves time and money, and is good for the environment. In this specific case, retrofitting with the IoT gateway paid for itself within just 18 months. In a next step, Bosch will retrofit 22 of its other test facilities and then a number of other machines. Aside from the gateway, Bosch also provides the software necessary to analyze, prepare, and present the data on the Bosch IoT Cloud, for example.

The IoT gateway: no need for programming

Depending on the application, the IoT gateway is augmented by sensors that are mounted on the machine to be retrofitted. The sensors record factors such as temperature, pressure, vibration, power consumption, oil quality, angle of inclination, rotational speed, and other parameters. The software translates this data in real time into a format that can be integrated into existing production environments – “like a tireless simultaneous interpreter for Industry 4.0,” Struth said. The IoT gateway does not have to be programmed for this purpose; it only needs to be configured using a browser, which means it can be taken into operation much faster. Configuration uses the new, open [machine language](#)

(PPMP, production performance management protocol) that was presented recently.

Better quality, timely maintenance

After having been “tuned” for Industry 4.0, the museum lathe is ready for essential new features of connected manufacturing. One of these is process monitoring for constant quality assurance, another is condition monitoring in order to prevent unplanned downtimes. For process monitoring, sensors measure a range of values, including the speed at which the workpiece turns. Cutting speeds that are too high or too low decrease the quality of turned metal parts and can damage the tool. For example, a look at a monitor reveals the data recorded and transmitted by the IoT gateway data, showing the workers operating the treadle that they have to pedal faster or slower in order to reach the ideal speed.

In addition, the newly connected lathe recognizes gradual changes to the drive belt. As it grows older, the leather belt can slip between the drive wheel and the spindle carrying the workpiece. For the human eye, this process is initially imperceptible, but sensors can already recognize deviations in the low percentage range. Once a predefined threshold value – 2 percent slip, say – has been reached, the connected system automatically notifies the maintenance worker responsible, who replaces the belt within a preset period. In this way, the sensors, gateway, and software prevent unplanned downtime of what is now an Industry 4.0-enabled lathe. This increases productivity.

507 German marks for the lathe

Robert Bosch bought the lathe in February 1887, and also worked on it himself. It seems to have been in use until 1901. Converted to today’s currency, what was a purchase price of 507 German marks is the equivalent of around 30,000 to 40,000 euros – for the small company that Bosch had only founded in 1886, it was a considerable investment that was calculated for the long term. “It’s still the same today: Machines are expensive. We have to use them as efficiently as possible. Connectivity can play a decisive role here,” Struth said.

Internet

The new PPMP machine language:

<http://bit.ly/2d7ZYIA>

sps ipc drives trade fair:

<http://bit.ly/1Qwjet1>

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More information at <http://www.bosch.com>, <http://www.bosch-presse.de>,
<http://twitter.com/BoschPress>.



September 26, 2016

PI 9411

Industrial IoT leaders work towards interoperability and open source collaboration

GE Digital and Bosch Software Innovations announce cooperation aimed at connecting the industrial world

- ▶ Software divisions of GE and Bosch work together on common standards to help machines and devices understand each other
- ▶ Organizations to cooperate closely on open source IoT platform development
- ▶ GE Digital and Bosch Software Innovations executives present together at Bosch ConnectedWorld event in Chicago

CHICAGO – GE (NYSE: GE) and Bosch are working together to shape the connected world through a collaboration between the software divisions of both organizations, GE Digital and Bosch Software Innovations. The organizations have signed a memorandum of understanding where GE Digital and Bosch Software Innovations will further facilitate openness and growth of the Industrial Internet of Things (IIoT). The agreement focuses on technology interoperability and platform integration through GE's Predix operating system and the Bosch IoT Suite. GE Digital and Bosch Software Innovations intend to make complementary software services available on the other company's cloud platforms to enhance the overall value of each cloud offering and provide solutions to a wider customer base.

Device connectivity at the heart of IoT applications

Both companies intend to establish an open source-based technical IoT core and jointly grow a larger ecosystem around this technology stack, which IoT platforms can be built upon. Key engagement is within the Eclipse Foundation, one of the major global open source software communities, where both companies are members.

The focus projects Eclipse [hono](#), Eclipse [Vorto](#), Eclipse [Leshan](#), GE-enhanced [UAA](#) (User Account and Authentication) and [Eclipse ACS](#) (Access Control Service) are specifically tailored around device connectivity. In any IoT application, things need to be connected to a backend where data and functionality of the devices are leveraged to provide higher-level business value.

Within the Eclipse Community, through the contribution of many IoT developers, tools and standards are openly created, which many companies can benefit from for their IoT applications.

Openness is key driver of IoT growth

In order to tap the full potential of the Industrial Internet, global organizations need more than ever to cooperate closer and within open standards. Customer benefit in IoT emerges when organizations focus on their core strengths and jointly foster market penetration of IoT technology and applications.

“Our organizations both have a rich history of manufacturing products, big and small, so we share a common understanding and vision regarding the opportunities in connectivity,” said Rainer Kallenbach, CEO of Bosch Software Innovations. “No company can realize the IoT on its own. It is very important for Bosch to engage in business ecosystems and open source communities. The collaboration with GE Digital is another important milestone for Bosch’s connectivity strategy.”

"It's industrial companies working together that will make a difference in the Industrial Internet of Things," said Bill Ruh, CEO of GE Digital. "We're incredibly excited to be partnering with Bosch Software Innovations to advance our IoT platform development."

GE Digital and Bosch Software Innovations executives present at Bosch ConnectedWorld in Chicago

Ruh and Kallenbach will present together at the Bosch ConnectedWorld event in Chicago to discuss the partnership between GE Digital and Bosch Software Innovations as well as key industry trends like global standards and IoT ecosystems.

[Bosch ConnectedWorld](#) in Chicago brings together leaders in business and technology to present digital strategies, case studies and best practices around connected products, services and solutions in an ongoing, collaborative effort to advance the Internet of Things (IoT).

More information:

- [William Ruh and Rainer Kallenbach at Bosch ConnectedWorld event in Chicago](#) (Sept. 27)

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About GE Digital

GE Digital connects streams of machine data to powerful analytics, providing Industrial companies with valuable insights to manage assets and operations more efficiently. World-class talent and software capabilities driving big gains in productivity, availability and longevity. For more information, visit the website at www.ge.com/digital.

About Bosch Software Innovations

Bosch Software Innovations, the Bosch Group's software and systems house, designs, develops, and operates innovative software and system solutions that help our customers around the world both in the Internet of Things (IoT) and in the traditional enterprise environment. We place particular focus on the topics of mobility, energy, manufacturing, and building. The Bosch IoT Suite is Bosch Software Innovations' comprehensive toolbox in the Cloud. The software package, which is provided as Platform as a Service (PaaS), allows the interaction of devices, users, companies and partners on a centralized platform. This enables the development of innovative and future-oriented solutions for new business models.

With some 650 associates worldwide, Bosch Software Innovations has locations in Germany (Berlin, Immenstaad, and Stuttgart), Singapore, China (Shanghai), Japan (Tokyo), and the United States (Chicago).

More information can be found at www.bosch-si.com, www.twitter.com/BoschSI, www.blog.bosch-si.com.

The Bosch Group is a leading global supplier of technology and services. It employs roughly 375,000 associates worldwide (as of December 31, 2015). The company generated sales of \$78.3 billion (70.6 billion euros) in 2015. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiaries and regional companies in some 60 countries. Including sales and service partners, Bosch's global manufacturing and sales network covers some 150 countries. The basis for the company's future growth is its innovative strength. Bosch employs 55,800 associates in research and development at roughly 118 locations across the globe. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life."

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Exchange rate: 1 EUR = \$1.1095

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Robert Bosch Venture Capital sets up third fund with 150 million euros Focus on disruptive start-ups

April 8, 2016

PI 9234 RB MK/HN

- ▶ Now 420 million euros under management
- ▶ Investments from seed to growth stage
- ▶ Bosch CEO Denner: “Robert Bosch Venture Capital successfully shapes the innovation leadership of Bosch through valuable connections to the start-up ecosystem.”

Stuttgart, Germany – Robert Bosch Venture Capital GmbH, the corporate venture capital company of the Bosch Group, has set up its third fund with 150 million euros. “Robert Bosch Venture Capital successfully shapes the innovation leadership of Bosch through valuable connections to the start-up ecosystem”, says Dr. Volkmar Denner, Chairman of the Board of Management of Robert Bosch GmbH. Its investments give Bosch an early access to disruptive innovations generated by the start-up ecosystem. Furthermore, the activities of Robert Bosch Venture Capital support Bosch’s technology leadership with open innovation powered by start-ups.

Extension of start-up portfolio

With its third fund, Robert Bosch Venture Capital now has 420 million euros under management. It will continue investing in innovative start-ups and in selected industry-specific venture capital funds in Europe, the US, Israel, and China. “The new fund will continue focusing on disruptive start-ups in the areas of automation and electrification, energy efficiency, enabling technologies, and healthcare systems. Investments will also be done in services and business models as well as new materials that are relevant to the above-mentioned areas of business”, says Dr. Ingo Ramesohl, Managing Director and co-head of Robert Bosch Venture Capital. Well-known companies belong to the existing portfolio of Robert Bosch Venture Capital, such as Movidius, market leader in embedded machine vision, and Greenpeak, market leader for smart home communication devices. In one of its latest exits, the Israeli company Pebbles, which Robert

Bosch Venture Capital identified early as a leader in the field of gesture recognition, was sold to Facebook.

Investments from seed to growth stage

Robert Bosch Venture Capital invests in seed, early and late stage venture capital rounds and participates in the follow-on investments in privately held companies. Depending on the stage of the company the initial amount of investment ranges from below 500 thousand euros for a seed funding to more than five million euros in an early to late stage funding round. The typical aggregate investment allocation per portfolio company, including follow-on investments, ranges typically between six and 15 million euros for usually a ten to 25 percent equity position in each company.

Start-ups interested in getting in contact with Robert Bosch Venture Capital can find more information at www.rbvc.com.

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About Robert Bosch Venture Capital GmbH

Robert Bosch Venture Capital GmbH (RBVC) is the corporate venture capital company of the Bosch Group, a leading global supplier of technology and services. RBVC invests worldwide in innovative start-up companies at all stages of their development. Its investment activities focus on technology companies working in areas of business of current and future relevance for Bosch, above all, automation and electrification, energy efficiency, enabling technologies, and healthcare systems. RBVC also invests in services and business models as well as new materials that are relevant to the above-mentioned areas of business.

Additional information is available at: www.rbvc.com

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Career opportunities in the connected world **Bosch: Industry 4.0 calls for Occupational Training 4.0** 1,550 apprenticeships offered for 2017

July 27, 2016

PI9321 RB MK/BT

- ▶ Bosch integrates Industry 4.0 content into existing training programs
- ▶ Chief personnel officer Kübel: “For connected manufacturing, we need highly qualified technicians in addition to university graduates.”
- ▶ For openings see bosch.de/ausbildung

Stuttgart – Getting ready for the connected world: Bosch is seeking roughly 1,550 apprentices and dual-education students across Germany for 2017.¹ Applications are already being accepted. At 1,550, the number of openings for occupational training programs matches the high levels seen in previous years. Applicants have a choice of over 30 different professions they can apply for online. Bosch is primarily seeking apprentices in the areas of mechatronics engineering, industrial mechanics, and electrical engineering for automation technology. Connected manufacturing is placing new demands on associates. For instance, associates need broader knowledge of manufacturing workflows due to the interconnected nature of processes. Bosch is already taking that into consideration in its training programs. “For connected manufacturing, we need highly qualified technicians in addition to university graduates. Industry 4.0 calls for Occupational Training 4.0, and that’s exactly what we offer our apprentices,” says Christoph Kübel, member of the board of management and director of industrial relations at Robert Bosch GmbH.

Encouraging independent and interdisciplinary work

In Industry 4.0, machines and products are interconnected and continuously exchange data. That makes IT skills increasingly important. Technicians are also increasingly working on interdisciplinary projects that involve multiple areas of specialization. “Right from the start, we give our apprentices more autonomy and project responsibility. In multiple practical assignments, they familiarize

¹ including BSH Hausgeräte GmbH

themselves with manufacturing workflows and engage in cross-functional collaboration with other specialist units,” says Siegfried Czock, the head of occupational and continuing professional development in Germany. “At the end of their training, apprentices are able to shape digital connectivity. And they enhance their communication skills in the process. Both are key capabilities in a connected world.” In addition, roughly one in five apprentices in technical and industrial disciplines spends several weeks of their apprenticeship on a work assignment abroad. In the “junior company” training module, apprentices take command and are responsible for handling jobs at a plant.

“Occupational Training 4.0” in practice

Apprentices at Bosch in Homburg, Germany, for instance, already get insights into the manufacturing systems of the future in the first year of their apprenticeship. For example, they see smart workstations that adjust to associates’ individual skill levels and offer support accordingly. Second- and third-year apprentices get to apply their theoretical knowledge on the job so that they can deepen their experience with connected manufacturing. They might, for instance, modify a robot stand or upgrade a wireless communication channel to enable the exchange of information with a tablet computer. At the same time, they pass on their knowledge to associates in the plant. “The large amount of hands-on experience offered by the training program and the various different projects on which we get to work make Industry 4.0 a very tangible concept for us,” says Laura Kästner, a second-year apprentice specializing in electrical engineering for automation technology in Homburg. “We are being well prepared for the connected future.” Czock adds: “Our trainers on site, together with the specialist departments, continuously determine what skills are needed and adjust the training content and teaching methods as necessary.”

Connected industry also poses new challenges for trainers and teaching institutes when it comes to imparting the necessary skills. Bosch Rexroth’s [Drive & Control Academy](#) supports internal and external trainers as well as institutes of higher education with courses, training systems, and advanced media on the topic of Industry 4.0.

Degree opportunities and number of female apprentices on the rise

One in four apprenticeships offered at Bosch is part of a university degree program. Aside from programs that follow the traditional dual-education model, the company also offers cooperative programs that combine a university degree with an apprenticeship, such as an applied computer science degree combined with an apprenticeship as a certified IT system integration technician. Today, women make up just under one-sixth of all apprentices in technical and industrial disciplines. But Bosch hopes to get even more young women interested in

technical careers by partnering with schools and for initiatives such as Girls' Day or Technology Experience Days.

Occupational training offered for refugees

This year, the international supplier of technology and services is offering roughly 400 additional internships for refugees at about 30 occupational training departments. The aim is to prepare them for the labor market or an apprenticeship. The company prepares its trainers for this task by honing their intercultural skills. As Kübel explains, "From our experience [training Spanish apprentices in Germany](#), we have found that, apart from learning the local language quickly, intercultural support is also key to successful integration."

Check out openings online

[Openings for apprentices and university students at Bosch for 2017](#) are posted on an online platform, over which anybody interested can apply. For more information on occupational training and educational opportunities at Bosch visit [bosch.de/ausbildung](#). There, events are also listed at which anybody interested can visit Bosch's occupational training departments.

Background information for journalists:

[Connected learning at its best – training at Bosch in Germany](#)

Related links:

[Jobs and careers at Bosch in Germany](#)

[Bosch Software Challenge](#)

[Federal Institute for Vocational Education and Training – Annual report 2015](#)

Press photos: 1-PE-22424, 1-PE-22425, 1-PE-22426, 1-PE-22444, 1-PE-22445, 1-PE-19234, 1-PE-20237

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Car Symposium 2015

Bosch CEO Denner “Electric cars are good, but connected electric cars are better”

February 4, 2015

PI 8803 BBM FF/af

- ▶ Dr. Volkmar Denner: “Electrification will take combustion engines to new heights”
- ▶ Falling battery prices will halve costs by 2020
- ▶ E-bike as model: Europe’s most successful electric vehicle is about enjoyment

Powertrain electrification is picking up pace. The currently low oil price will not change that fact. This was the message underlined by Dr. Volkmar Denner, chairman of the board of management of Robert Bosch GmbH, at the Car Symposium in Bochum, Germany. Bosch expects roughly 15 percent of all new cars built worldwide to have at least a hybrid powertrain by 2025. For the Bosch CEO, advances in battery technology are the key to lower vehicle prices. Denner, whose responsibilities on the board of management include research and advance development, believes that by 2020 batteries will deliver twice as much energy density for half the present cost.

Electrification enhances the attractiveness of combustion engines

The EU has set strict fleet CO₂ targets for 2021. For this reason alone, Bosch expects hybrid powertrains to become the standard for SUVs. This will give diesel and gasoline engines an extra boost. “Electrification will take combustion engines to new heights,” Denner said. With electric support, the combustion engines of the future will consume significantly less fuel and be even cleaner. And the additional torque from the electric motor will add to driving enjoyment. Moreover, falling battery prices will make hybrids considerably more affordable.

Denner used the example of China to show how important it is in a mass market for electric cars to be suitable for everyday use. There are already more than 120 million electric scooters on China’s roads. And in China, Bosch sells the electric wheel hub drive for such e-scooters. With a top speed of 40 kph, this popular form of transport is fast enough for the traffic conditions in megacities.

And their range of roughly 50 kilometers is sufficient for everyday journeys. “The reason these two-wheelers are such a success is that they are a perfect match for Chinese commuters’ needs,” Denner said. And because they are designed to meet these needs, many models are less expensive than two-wheelers with combustion engines. According to Denner, the task now is to make such tailor-made solutions possible for cars as well.

One app to recharge the battery, nationwide

The main factor helping to make electromobility convenient will be connecting vehicles with the internet of things. “Electric cars are good but connected electric cars are better,” Denner said. At the moment, recharging vehicles is complicated. But this is expected to become much more convenient. Bosch Software Innovations, the Bosch Group’s software and systems unit, has developed an app that makes it significantly easier to reserve the charge spots of different providers and pay for the electricity. Up to now, doing this would have required a different customer card for each provider. Now all drivers need is a smartphone, the app, and a PayPal account to recharge anywhere in Germany. Bosch also complements this with a software platform that links 80 percent of all charge spots in Germany. As this example shows, Bosch no longer sees itself solely as a supplier of automotive components. The company is now combining its expertise in all three mobility domains – automation, electrification, and connectivity – and will in the future be offering its customers integrated mobility solutions.

Fun as a reason to buy: e-bikes show the way

However, rational arguments alone are not enough to win drivers over to electric powertrains. In Bosch’s view, emotion and fun play a decisive role. The example of e-bike drives illustrates this. Bosch’s “electric tailwind” makes riding a bike a joy – for serious athletes as well as recreational cyclists. Bosch is now the European market leader in this area, and its e-bike drives feature in more than 50 bike brands. “The e-bike is the most successful electric vehicle in the EU,” Denner said, adding that customers pay considerably more on average for e-bikes than they do for classic ones. “For more than 100 years, riding a bike was a mechanical process. No one saw any reason to change it. Then along came the e-bike, and completely redefined a market everyone thought would never change,” Denner said. The same could be true for the auto industry, he added. The Bosch CEO stressed that the supplier of technology and services will be using its comprehensive systems and connectivity know-how to take electromobility a decisive step forward.

Press photos: 1-EB-19739, 1-RB-20741, 1-UBK-20832, 1-RB-20590

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Mobility Solutions is the largest Bosch Group business sector. According to preliminary figures, its 2014 sales came to 33.3 billion euros, or 68 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. Mobility Solutions largely operates in the following areas: injection technology for internal-combustion engines, alternative powertrain concepts, efficient and networked powertrain peripherals, systems for active and passive driving safety, assistance and comfort functions, technology for user-friendly infotainment as well as car-to-car and Car2X communication, and concepts, technology, and service for the automotive aftermarket. Bosch has been responsible for important automotive innovations, such as electronic engine management, the ESP anti-skid system, and common-rail diesel technology.

The Bosch Group is a leading global supplier of technology and services. According to preliminary figures, its roughly 290,000 associates generated sales of 48.9 billion euros in 2014. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its more than 360 subsidiaries and regional companies in some 50 countries. If its sales and service partners are included, then Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. In 2014, Bosch applied for some 4,600 patents worldwide. The Bosch Group's strategic goal is to deliver innovations for connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life."

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Electromobility at Bosch
Facts about battery technology for hybrid and electric powertrains

February 2015
PI 8807 BBM FF/af

How range is increasing, why a battery has more than one lifetime, and how automated driving could change battery technology

Long service life, top quality, the highest degree of safety – we expect an enormous amount from high-voltage batteries in vehicles. That’s why today’s lithium-ion batteries, for example, have to be designed to run for at least 150,000 kilometers and to last up to 15 years. Even then, after spending all this time in the car, the battery still has to possess 80 percent of its original storage capacity and performance. “Developing a high-voltage vehicle battery that is cost-efficient, powerful, and reliable at the same time – this is the proverbial rocket science,” says Stefan Seibert, president of the Gasoline Systems division of Robert Bosch GmbH responsible for electromobility. Within the next five years, Bosch intends to offer high-voltage batteries that are twice as powerful. At the same time, the company is exploring new battery technologies.

Development: the path to the next generation of lithium-ion batteries

Lithium-ion technology: In the years to come, lithium-ion technology still has plenty of potential to offer. Today’s batteries have an energy density of approximately 115 W h/kg, but have the potential to go as high as 280 W h/kg. To research the next generation of lithium-ion batteries, Bosch has joined forces with GS Yuasa and Mitsubishi Corporation in a joint venture called Lithium Energy and Power. “The goal of this joint venture is to make lithium-ion batteries up to two times more powerful,” Seiberth says. In pursuit of this goal, the partners have pooled their strengths. GS Yuasa can apply its experience in cell optimization to creating a battery with a higher energy density and increased range. Bosch contributes its expertise in complex battery management and systems integration.

Post-lithium-ion batteries: Bosch’s corporate research department is working on post-lithium-ion batteries, such as those made using lithium-sulfur technology,

which promises greater energy density and capacity. Bosch estimates that the earliest the lithium-sulfur battery will be ready for series production is the middle of the next decade.

Progress: battery management results in 10 percent more range

Cell chemistry: There are several ways to improve battery performance. For example, the material used for the anode and cathode plays a major role in the cell chemistry. Most of today's cathodes consist of nickel-cobalt manganese (NCM) and nickel-carboxyanhydrides (NCA), whereas anodes are made of graphite, soft or hard carbon, or silicon carbon.

Cell voltage: High-voltage electrolytes can further boost battery performance, raising the voltage within the cell from 4.5 to 5 volts. The technical challenge lies in guaranteeing safety and longevity while improving performance.

Battery management: In terms of high-performance batteries, Bosch is focusing on driving forward the monitoring and management of the various cells as well as the overall system. The challenge is managing a high-voltage battery reliably, since up to ten microcontrollers regulate energy flow in the cells by means of a CAN bus system. Sophisticated battery management can further increase the range of a car by up to 10 percent – without altering the cell chemistry.

Infrastructure: automated vehicles have an effect on battery technology

Rapid-recharging charge spots: If there are lots of places where you can quickly charge your electric vehicle, then this will have a major impact on battery technology. The faster an electric vehicle's battery can recharge, the less important its range becomes.

Automated driving: Fully automated vehicles make charging much more straightforward, since they can search for charge spots without any assistance from the driver. How this works is demonstrated by V-Charge, a project spearheaded by Bosch, VW, and a number of European universities. The idea is that within a parking garage, for instance, the driver would be able to use a smartphone app to direct their electric vehicle to a charge spot. When the driver comes back, the car returns to the pick-up spot by itself. Other variations on this theme are also possible; for example, a driver could request a vehicle from a car-sharing fleet by cell phone and have it come right away to a designated spot. Fleets are in fact another area where demands on the battery – such as those regarding its service life – are changing, since fleet vehicles are often in service for fewer than the 15 years estimated for vehicle batteries.

Three lifetimes: for a high-voltage battery, the car is just the first step

Different stages in the life of a battery: A fleet vehicle, which drives many kilometers in a short space of time, requires a new battery with full performance and capacity. In contrast, a slightly used battery can work just as well in cars that are driven only occasionally for short routes. That would reduce the overall cost of an electric car. Even after twelve years – the average service life of a car – the battery still retains 80 percent of its original performance and capacity. This means its components can still be useful, for example as a power storage unit.

“Second Life” project with BMW and Vattenfall: In Hamburg, used batteries from electric vehicles are being joined together to form a large power storage system. It can provide energy within seconds and helps stabilize the grid. With this project, Bosch, the BMW Group, and Vattenfall are working together to drive electromobility and energy storage forward.

Press photo: 1-RB-20741, 1-UBK-20832, 1-UBE-20209-d

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Bosch initiates new machine language for Industry 4.0

Large and medium-sized companies will benefit

September 21, 2016

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- ▶ Bosch CEO Denner: “Open standards are one of the fundamental prerequisites for Industry 4.0”
- ▶ Barriers to entry for smaller companies removed
- ▶ Six SMEs already on board as partners

Stuttgart – Bosch wants to remove one of the biggest barriers for smaller companies seeking to enter connected industry. The company is seizing the initiative and presenting a new, open industry standard it has developed in-house for the exchange of data in connected industry. This will enable interplay between a wide variety of partners in the internet of things (IoT) and in Industry 4.0. Known as the Production Performance Management Protocol (PPMP), the new standard will for instance support the quick, easy, and secure transfer of data from sensors that SMEs supply to manufacturers to the production systems of large companies. The protocol is freely available and free of charge. This removes barriers to entry into connected industry. “Open standards are one of the fundamental prerequisites for making use of the opportunities Industry 4.0 presents. By letting everyone participate in data exchange, they increase interoperability, enable new business models, and enhance the competitiveness of all the companies involved,” said Bosch CEO Dr. Volkmar Denner. “This will help Industry 4.0 to become more widely established more quickly: companies large and small will be able to integrate their products more quickly. Both German industry and the global economy stand to benefit.”

Data improves production management

The new standard developed by Bosch experts supports Production Performance Management (PPM), a process that is central to Industry 4.0. It uses sensors to collect great quantities of data from manufacturing for analysis, with the aim of further improving production processes. Are all the components along a production line really working together as effectively as possible? Is one

component slowing the process down? Is one piece of equipment drawing an unusually large amount of power? Is a motor overheating and possibly about to fail? A PPM system can answer these and other similar questions – and correct faults. At the same time, PPM makes efficient, comprehensive production management possible.

Bosch creates easy-to-understand machine language

The best possible management of production processes calls for the many sensors and machines in a manufacturing facility to deliver their data to the central PPM software. This is a complicated undertaking, as until now all these machines and sensors have spoken many different languages. It is difficult to get them to communicate with each other, but Bosch has developed the PPMP to enable machines and sensors to communicate better. Like Bosch, many large companies put many components supplied by third parties – frequently specialized SMEs – to work in their manufacturing facilities. These components can be integrated into a production environment quickly, easily, and cheaply. Meanwhile, open standards help SMEs better integrate their products into the manufacturing systems of their large and small customers so both sides benefit. What's more, the PPMP underpins mechanical engineers' ability to connect their machinery directly with software. This means any machine faults can be reported to an app. The person in charge immediately sees the reason for the fault on their smartphone, along with an approach to take to resolve the problem.

Open source helps everyone make progress

The new standard is being further developed in the Eclipse open source community. Initial practical experience with it will also feed into this work, which means anyone can use the protocol free of charge. Several SMEs ([Balluff](#), [EGT](#), [Rampf](#), [Cadis](#), [KLW](#), [Schmalz](#)) already support this initiative, which was launched by Bosch. Other companies are expressly invited to get involved. In addition, the shared standard will be used in an innovation project, or testbed, overseen by the Industrial Internet Consortium (IIC) and the Germany-based Plattform Industrie 4.0. Located at Bosch's Homburg plant, the testbed is a [collaboration](#) of Tata Consulting, Dassault Systèmes, SAP, and Bosch. Thanks to this new data exchange standard, a production management system there is already receiving data from a variety of different objects, as well as machine data and energy consumption figures. "Many concepts and technologies for the Industry 4.0 era have yet to appear. In order to validate them and bring them to market, testbeds like the one in Homburg involving the IIC are very strategically important," Denner said. "At the same time, they offer smaller companies an opportunity to participate in IoT value chains."

Bosch joins the Labs Network Industrie 4.0

This is also why Bosch recently joined the Labs Network Industrie 4.0. Launched by industry representatives and Germany's Bitkom, VDMA, and ZVEI associations, the network aims to promote German SMEs' implementation of Industry 4.0 technologies. The Labs Network is the first port of call for questions relating to the development of Industry 4.0 solutions.

Related links:

Details about the PPMP at the Eclipse Foundation:

<http://bit.ly/2bPLS8d>

Details about the testbed in Homburg:

<http://bit.ly/2cabkJM>

Details about the Labs Network Industrie 4.0:

<http://bit.ly/2avZogY>

Press photographs: I4.0 sensor kit at the Bosch plant in Homburg, PPMP graph

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The Bosch Group is a leading global supplier of technology and services. It employs roughly 375,000 associates worldwide (as of December 31, 2015). The company generated sales of 70.6 billion euros in 2015. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiaries and regional companies in some 60 countries. Including sales and service partners, Bosch's global manufacturing and sales network covers some 150 countries. The basis for the company's future growth is its innovative strength. Bosch employs 55,800 associates in research and development at 118 locations across the globe. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life."

The company was set up in Stuttgart in 1886 by Robert Bosch (1861-1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant up-front investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

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