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## **Technology and innovation at Bosch**

### **Outline of product history**

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Robert Bosch never saw himself primarily as an inventor. History backs up his self-image – he was more an entrepreneur than an inventor. Ever since his company was founded in 1886, it has been known for taking good ideas and turning them into marketable and innovative products.

From the very beginning, the company has been characterized by the remarkable talent shown by Robert Bosch, his colleagues, and successors for recognizing interesting inventions and ideas that have the potential to make successful products.

This “nose” and the ability to turn ideas or basic designs into large-scale series products is also central to the company’s rise from a small workshop to a major technology group.

#### **1. Technology from the workshop – the birth of a company**

On November 15, 1886, Robert Bosch opened a small craft business in Stuttgart which he called “Workshop for Precision Mechanics and Electrical Engineering.”

Bosch and his two associates were involved with constructing and installing electrical equipment of all kinds, including telephone systems and remote electrical water-level indicators. Initially, Bosch did not produce any in-house developments, instead opting to focus on existing products that were usually manufactured and installed in line with customer requirements.

Even the magneto ignition device that Bosch produced in 1887 for a stationary internal-combustion engine at the request of a customer was initially just one of many products. Bosch scrutinized such objects in great detail, made up his own drawings of them, and improved them wherever possible. In the years that followed, up to 1897, the magneto ignition device accounted for 50 percent of sales at the small company. The device alone did not bring massive growth for the company, but its use in an automobile did.



## **2. From innovation to large-scale series production: magneto ignition**

The installation of a magneto ignition device in a three-wheeled vehicle in autumn 1897 was the start of the company's development as a successful automotive supplier. Robert Bosch's factory manager succeeded in improving the design so that the magneto ignition device could also be used in high-speed automotive engines. It was the only automotive ignition device that could be relied on in everyday driving conditions – and Bosch was the sole supplier.

But Bosch could not have known just how important magneto ignition was to be for his company, as the true potential of the automobile was yet to be revealed. Nonetheless, the company scored its initial success when the device was unveiled at the "First Motor Vehicle Exhibition" in Berlin in 1898 and the first customer, Gottlieb Daimler, was secured. Bosch achieved its commercial breakthrough in 1902 when it designed an improved version of the device: the high-voltage magneto ignition system with spark plug. The system design had been optimized to allow it to be used in almost every popular type of vehicle at relatively little extra expense.

## **3. Everyday technology for the car**

Magneto ignition rapidly established itself as the standard automotive ignition system. This achievement was also reflected in the company's development. Bosch opened its first factory in 1901, employing 45 associates. One year later, the factory produced its 50,000<sup>th</sup> magneto and, by 1912, one million units had rolled off the production lines.

By around 1900, Robert Bosch was marketing a range of twelve different product variants for motor vehicles – all of them magnetos. This dependency on a single product was risky.

In order to counter this business risk, Bosch expanded its product portfolio in 1913 to include the "Bosch automotive lighting system", a complete electrical lighting system for motor vehicles comprising generator, headlights, regulator, and battery. It formed the basis for an on-board electrical power supply that allowed a number of further components to be added – such as starters, electric horns, windshield wipers, direction indicators, and car heating systems. Bosch concentrated on components such as these, since they were needed to make the car suitable for everyday driving.

One important example of such an addition to the company's product portfolio was the electric starter. This device represented an enormous improvement for drivers, as it spared them the strenuous procedure of cranking up the car, meaning there was also no need to worry about the crank handle kicking back and causing injuries.



#### **4. Motorization fuels demand**

The starter was typical of many products launched on the market by Bosch in the period between the end of the first world war and the first crisis in the automobile industry in 1926. The company's aim was to eliminate the shortcomings in operation and safety that were coming to light as motorization really took hold. Robert Bosch primarily looked for new product ideas that lent themselves to further development, or that were conceived in-house and then developed until ready for series production. The hand-operated rubber wiper developed by Prince Heinrich of Prussia became the electric windshield wiper, the electric horn replaced the manual bulb horn, and car heating systems consigned hand warmers and long johns to the history books. The direction indicator – as from around 1950 electric turn signals – carried out the function previously performed by the driver's outstretched arm.

#### **5. Diesel and gasoline**

##### **Diesel injection**

An engine needs fuel and fuel needs to be injected into the engine's combustion chamber in the right dosage. Around 1920, the growing trend of using diesel engines in trucks was a cause for concern at Bosch, as diesel engines did not need an ignition system – the main sales driver at Bosch. To ensure that any technological changeover to diesel-powered vehicles did not put the company at risk, Bosch began to focus on this technology and started developing diesel injection pumps in 1922.

It took five years to get this challenging technology ready for series production. Injection technology demanded precision metering at high pressures. Manufacturing of the product began at the end of 1927 and, soon after, Bosch began supplying its first customer, the truck manufacturer MAN. Bosch launched the first diesel injection pump for passenger cars onto the market in 1936 – it was the first time the world had seen the diesel engine as a series-manufactured product in a passenger car.

##### **Gasoline injection**

Gasoline injection – which, like diesel injection, is today one of the company's main business fields – owes its origin to diesel technology. The diesel pumps had to be adapted for gasoline as the new fuel, unlike diesel, did not lubricate the moving metal parts. Gasoline injection was initially only developed for use in aircraft and entered series production in 1937. Improved performance and operational reliability were major advantages, as injection was a much more reliable means of delivering fuel in aircraft operation than the carburetor technology established in road vehicles.

The road vehicle market itself did not come into play until the beginning of the 1950's, when the benefits of improved performance brought fuel injection to



the attention of the racing scene and the system's advantages in terms of consumption and exhaust emissions met with new market requirements.

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## **6. Automotive electronics**

It is no longer possible to imagine cars without electronics. Whether air conditioning, braking assistance, or airbags, a vast range of functions are now controlled electronically. When automotive electronics was still in its infancy, Bosch was looking for a way to make automotive equipment durable and low on maintenance. Semiconductors proved to be products with good potential. They were to replace breaker-triggered circuits that were prone to wear and tear, and offered the benefit of smaller dimensions, a complete absence of mechanical movement, and therefore an almost unlimited service life.

Bosch first used semiconductors in 1958 in generators and also began manufacturing the components in house. The benefits of electronics also came to the fore in other areas such as ignition, transmission control, and gasoline injection systems. In 1968, the company decided to set up a plant specifically for semiconductor manufacturing in Reutlingen, near Stuttgart, where production started in 1970. The reason behind this move was that the electronic components available on the market until then had not been suitable for the extreme conditions in the automobile (temperature fluctuations, vibrations, humidity). As in the case of industrial technology, Bosch decided to be its own supplier because of a lack of suitable products on the market.

The next generations of semiconductors that Bosch developed in the 1970's – integrated circuits, hybrid, and microhybrid circuits – made it possible to develop a whole series of new products. These products include exhaust gas regulation systems using the lambda sensor (1976) and the ABS antilock braking system (1978) – all of which are systems we take for granted today. These reliable, maintenance-free auxiliary components have evolved to become sophisticated control centers virtually indispensable for the driver.

## **7. “More strings to the bow...”**

Up until 1913, Bosch had really only manufactured one kind of product – the magneto ignition device, later the magneto ignition system. To minimize the risk that this dependency created, the company initiated a comprehensive expansion of its portfolio of electrical equipment for the automotive industry. However, this was still not a broad enough basis to ensure consistent growth. The crisis that hit the European automotive industry in 1926 highlighted how susceptible Bosch was to fluctuations in this industry. As a result, the company diversified into other business fields.

Bosch developed new products outside the automotive sector, such as household appliances (1933), TV cameras and broadcasting equipment (1929), and power tools (1928). It also extended its product portfolio by acquiring other companies. Examples include the takeover of the natural gas-



fired appliances business of Hugo Junkers (1932), the purchase of the radio company Ideal (1933: later to become Blaupunkt), and the acquisition of the cinema projector manufacturer Bauer (1934).

## **8. Drills, screwdrivers, grinders**

Another new business field was power tools. In 1928, the Bosch subsidiary Eisemann marketed a hair-cutting device called Forfex that had a small electric motor located in its handle. This device was the precursor of the compact electric screwdrivers and drills we know today. Bosch engineers came up with the idea of using the same basic design to create hand-held power tools that were urgently needed for the manufacture of diesel injection pumps. The first tools were ready for use in 1930, and proved to be so good that Bosch launched the design onto the market in 1932 as the “hand-held motor”, the forerunner of all modern lightweight Bosch power tools.

At the same time, Bosch engineers were working on heavy-duty power tools for use on construction sites. The result of their work, the Bosch hammer drill, was launched at almost the same time as the smaller power tools and was marketed as a replacement for the construction tools used for manual chiseling and drilling work. At first, Bosch only offered these tools for professional use, but in the 1950's the company developed tools for use in the home.

Today, Bosch is the leading manufacturer of power tools for do-it-yourselfers and professional users, as well as of electrically powered garden tools.

## **9. Music in the car**

Bosch had been supplying radio parts to the Berlin-based radio equipment manufacturer Ideal since 1930. This business relationship culminated in the gradual takeover of Ideal in 1932. In the same year, Bosch and Ideal presented a jointly developed product: “Auto Super 5”, the first series-production car radio in Europe, which was marketed under the brand name “Blaupunkt”. The Ideal subsidiary was renamed “Blaupunkt-Werke” in 1938. Apart from car radios, Blaupunkt's main products at the time were radios for the household. The share of the business accounted for by the car radio sector with its numerous innovations including stereo sound, CD players, and the traffic news decoder continued to grow over the decades. From 1990, Bosch – still under the Blaupunkt brand up to 2008 – began focusing exclusively on in-car radio and the new navigation sector, which was unveiled in 1989 with the “TravelPilot IDS”. Today, the Bosch Car Multimedia division manufactures in-car infotainment systems such as navigation systems and car radios.

## **10. Helping out at home**



At the Leipzig Spring Fair in 1933, Bosch presented an electrically powered refrigerator for domestic use. This, too, was the result of efforts to establish business fields outside the automotive industry. In technical terms, the refrigerator was nothing new, as electricity was already in widespread use to keep foodstuffs cool in the food and catering industries. However, the truly innovative aspect of the product was Bosch's idea of producing a device that was affordable for private households and which would make electrical refrigeration part of everyday life in ordinary homes.

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This refrigerator formed the basis for the Household Appliances business unit, which was expanded in 1951 to include numerous products such as food processors, washing machines, and dishwashers. In 1967, Bosch transferred its household appliance activities to a joint subsidiary with Siemens AG, thereby creating what is today known as BSH Bosch und Siemens Hausgeräte GmbH.

## **11. Warm home, hot water**

Hugo Junkers patented his "Kalorimeter" in 1895, a device that was the technological basis for machines that use natural gas to heat water. When his company – which, as well as producing natural gas-fired devices, was also well known as a manufacturer of aircraft and aircraft engines – encountered financial difficulties in 1932, Junkers sold his natural gas-fired appliance manufacturing facilities to Bosch.

At the time, the product portfolio comprised a range of large devices for heating water in private homes and industry. Bosch expanded this range to include natural gas-fired boilers for room heating as well as devices that combined both functions.

Today, the Thermotechnology division at Bosch incorporates a range of brands including Junkers and Buderus. These brands offer natural gas-fired, oil-fired, and electrically powered heating systems and water heaters, as well as facilities that use renewable energy such as solar collectors and heat pumps.

## **12. Industrial technology**

The Industrial Technology business sector can trace its origins back to the construction of production machinery, which Bosch has been involved with since 1902. The grinders and lathes needed to produce magneto ignition systems were not available in the quality required. Ever the entrepreneur, Robert Bosch decided to manufacture them in-house.

These activities led to the establishment of an in-house business unit that was initially named *Sondermaschinenbau*, which specialized in building manufacturing equipment. It was renamed the Industrial Equipment business unit in 1968, and was then finally merged with other product lines to form the Automation Technology division in 1996. A major milestone in this area was the world's first swivel-arm robot, which Bosch began developing in 1976 and launched onto the market in 1984.



In 2001, the company's activities in the field of automation technology were brought together in the new subsidiary company Bosch Rexroth AG, which manufactures an entire range of hydraulic and pneumatic systems that stretch from stage technology in theaters, to coastal flood barriers, and finally to gearboxes and adjusting systems for wind turbines.

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To expand its competence in the generation of power from renewable sources, Bosch is now also active in the promising field of solar technology. In 2008, Bosch acquired the photovoltaics manufacturer Ersol.

Another segment in the area of industrial manufacturing technology is packaging technology. This originates from a series of takeovers of traditional packing technology manufacturers, including Hesser, Hamac-Hansella, and Höfliger & Karg that began in 1964. Today, the business field covered by the Bosch Packaging Technology division includes the proper packaging of foodstuffs, pharmaceuticals, and cosmetics in both liquid and solid forms.

### **13. Security and communication**

The company Hanseatische Notruf AG, founded in 1920, is the origin of what is today the Bosch Security Systems division. However, Notruf AG was not a Bosch subsidiary, but rather one of many precursor companies – the current Security Systems division was not established until 2002.

It goes back to a range of Bosch activities related to the topic of security systems where the company has developed technological know-how over a period of decades. These include the skills of several security systems manufacturers with which the company has cooperated in the past or whom Bosch has incorporated into its own Security Systems division. Knowledge and experience has also flowed in from Bosch divisions where the company is no longer active, such as television technology and telecommunications.

Today, this young Bosch division is mainly known for its intrusion systems, video surveillance systems, public address technology, access control systems, social-alarm systems, and biometric recognition methods.