Background Information United States of America:

The U.S.: High Potential Zone for Industry 4.0 Applications

Current Economic Situation

Broad economy – moderate growth: Assuming a relatively stable economic situation until the end of 2016, the outlook for the United States’ industry output is generally positive but developing under reduced dynamics.

The persistence of a strong dollar in relation to the euro is considered to have a dampening effect on previous strong optimism. Depending on the how strong the dollar remains, this could limit further development potential, especially the export of competitive products and technologies “made in the USA”. As a result, the U.S. market will keep on being a predominantly domestic market for the time being, working through the well-known problems in the raw material-based industries and and dealing with in the more dynamic automation and construction industry/real estate business segments that are still highly dependent on economic trends.

Industry 4.0 and Internet of Things are topics that, at the moment, are of significant interest and active developments by companies in the automotive, aviation and aerospace industries. While the automotive industry in the U.S. is once again getting ready to break records, some market segments are currently shrinking and show only a limited tendency to recover in the short to medium term. The reasons for this are the falling prices for raw materials such as crude oil, agricultural products, and metals.

Experts also expect slower growth, and even contraction, in the construction equipment business where manufacturers already suffer from excess capacity.

American Industry Portrait

Despite the enormous growth in China in the past two decades, the U.S. remains by far the world’s biggest economy with a nominal gross domestic product (GDP) of $17.4 trillion in 2014. It is responsible for almost a quarter of the global value added. Although U.S.
growth rates are lower than those in emerging countries, the country’s extremely large and broadly-based economy means that even small percentage changes result in high nominal deflections.

While manufacturing industries only have a 12% share of the total economy (Germany: 22.3%), the tremendous size of the U.S. economy provided jobs in these sectors for 12.3 million people in 2015 (Germany 5.4 million).

Apart from internationally operating major corporations, the U.S. industry is characterized especially by a multitude of small and medium sized businesses. According to the trade National Association of Manufacturers (NAM,) there are 256,363 firms in the U.S. manufacturing sector, with about 250,000 of them having fewer than 500 employees. About three quarters of non-public spending, i.e. $229.9 billion, was used by the U.S. companies for research and development in 2014.

The tendency toward higher automation received increased momentum due to a noticeable shortage of skilled workers and engineers. Additionally, wages for industrial workers in the U.S. are above average. In 2014, the average manufacturing worker in the United States earned almost $80,000 annually, including pay and benefits, according to information provided by NAM. (http://www.nam.org/Newsroom/Facts-About-Manufacturing/).

A Changing U.S. Economy

The U.S. economy is extremely versatile and has been a deciding factor in the global economy for almost 100 years. After becoming the world's biggest economy in the 1920s, the U.S. industry's potency has always been a symbol for modernity. From the late 1970s, the significance of the industrial sector within the economy decreased and at the same time, information technology and software became increasingly important. Silicon Valley remains the hotbed for information technology, even though the hardware products that are developed here are often no longer produced in the United States.

During the dot-com boom around the turn of the millennium, many experts were expecting the manufacturing industry in the United States to disappear completely but this prediction changed during the 2008 financial crisis. President Barack Obama’s administration specifically supports the re-industrialization of the U.S. Until recently, the extremely low energy costs resulting from the fracking boom were playing a major role in this agenda. This provided a huge competitive
advantage for U.S. companies, although this effect is currently muted by the sharp fall of crude oil prices worldwide.

**Mechanical Engineering in the U.S.**

Mechanical Engineering is an important economic sector, since the U.S. is the second largest manufacturer of machinery and equipment in the world. Domestic suppliers hold a market share of almost 60%. The sector provides jobs for approximately 1.3 million people and in 2014 created €324 billion in sales (German Engineering Federation (VDMA)). In 2014, U.S. companies exported machinery and equipment worth €105 billion according to calculations by the United States International Trade Commission (https://www.usitc.gov/research_and_analysis/trade_shifts_2014/machinery.htm) – an increase of 4% compared to 2013. At the same time, the United States imported machinery and equipment worth €119 billion and is therefore, depending on the perspective one utilizes, the largest market for machinery worldwide. In 2015, the United States was, for the first time since the financial crisis, the most important export market for German companies in machinery and plant construction, according to information provided by the German Engineering Federation (VDMA). In the first three months of 2015, German machine exports to the U.S. increased by 14.2% to €12.5 billion.

**Trends in Factory Automation**

In the areas of factory automation and process industry, the Association for Manufacturing Technology, AMT, (http://www.amtonline.org/amt_items/TrendsInBrief.pdf) identifies three substantial trends in the manufacturing technology industry relevant for all sectors:

- Automation and Robotics
- Digital Factories
- Additive Manufacturing

They characterize the main areas of research and development relating to industrial manufacturing and define the criteria for purchasing new investment goods.
Automation and Robotics

High labor costs and an increasingly noticeable shortage of engineers and skilled workers force American companies to push automation in order to remain competitive. Progress made in peripheral industries such as fast, high-resolution cameras, new sensors, and RFID offer new opportunities. In combination with intelligent software that issues work instructions geared toward individual language skills and experience, they increase productivity in the complex area of assembly.

In the long run, robots will assume tasks which have so far only been performed by human workers as robots become able to recognize and handle pliable materials. Another focus is a closer collaboration between humans and robots. Thanks to newly developed safety functions, they detect humans and cooperate with them safely.

Industry experts expect a massive increase in productivity due to the comprehensive introduction of modern, compatible automation technologies. That is why users in the U.S. expect machinery manufacturers to use open interfaces and programming standards more than ever. It is the only way users can connect the manufacturing systems of different manufacturers with each other.

Digital Factory

Concepts relating to the Internet of Things (IoT) or the Industrial Internet are currently highly debated in the U.S. industry. The high affinity toward information technology and Internet technologies can also be backed up with figures. According to studies performed by Tata Consultancy Services (http://sites.tcs.com/internet-of-things/regions/north-america/), North American companies, when compared to their European and Asian competitors, invest the most in activities surrounding the Internet of Things. Apparently, around $100 million has already been invested in IoT projects in 2015. Approximately half of U.S. companies are in contact with their customers using apps on their mobile devices. The second most frequent application is supply chain monitoring.

The introduction of IoT applications is exploratory in the U.S. and, contrary to Europe, mainly IT- and Internet-based. This is further illustrated by how the Industrial Internet Consortium (IIC) was formed in the U.S. This organization was founded in 2014 by major IT companies and has more than 200 members today. Bosch was the first German company to join this initiative in 2014.
In Germany, the Industry 4.0 platform focuses on the definition of standards and architectures, while the IIC in the U.S. initiates and coordinates so-called test beds. In these pilot projects, companies try new ideas relating to the merging of the physical manufacturing with the virtual world of information technology and the Internet. One of the first test beds was introduced in the aviation industry. Here, thousands of screws with different, precisely defined torques have to be tightened with electric screwdrivers. To avoid errors, all screwdrivers are equipped with a transmitter precisely reporting the position of the tool down to 30cm within the facilities. This way, the software can send the exact torque required at this place to the tool and document every tightening operation online. The intelligent screwdrivers used in this test bed have been contributed by Bosch Rexroth.

U.S. industrial companies generally expect that components, machines, and equipment can be integrated in IT-driven approaches. In order to do so, they must have their own intelligence, and support open communication and programming standards that are not specific to any manufacturer. The IT world uses programming languages completely different from those used in machine automation. Here, Bosch Rexroth was able to bridge between the two worlds with its software solution Open Core Engineering and thus supports open standards for automation.

**Additive Manufacturing**

Additive manufacturing, also known as 3D printing, was identified by the AMT as the third substantial trend. The association sees great potential here through joint research and development projects by machinery and material manufacturers and the IT industry. Main research areas are printed electronic circuits and multi-material printing. With additive manufacturing, users are already producing prototypes and small series economically, building highly complex aircraft components, for example.

**Bosch Rexroth in the U.S.**

Since 1967, Bosch Rexroth has been an established supplier and solution partner for U.S. industry, employing 1,865 people in the country. In two production facilities in Bethlehem, PA, and in Fountain Inn, SC, the company manufactures hydraulic components and system solutions. In customizing centers, local specialists customize electric
drives and controls and linear motion and assembly technologies. U.S. industry and technology specialists at Bosch Rexroth also develop products, solutions, and services adapted to local requirements.

Rexroth solutions are used throughout the entire value chain: in mobile machines for agriculture, construction and raw materials extraction, as well as in steel production and wood processing. In the field of factory automation, Bosch Rexroth is traditionally a supplier of the automotive industry. Furthermore, as a drive and control specialist, we work closely with machinery manufacturers from the food and packaging industry. Newspapers, catalogs or solar cells: Rexroth technology is used in all kinds of printing devices, as well as in 3D printers. In addition, the company offers automation solutions for the semiconductor production and general automation segments.

As a Drive & Control Company, Bosch Rexroth is committed to the re-industrialization of the U.S. economy. Industry 4.0 and the Internet of Things play a vital role here. In a dual strategy, Rexroth gains experience implementing pilot projects in its own plants and sharing these findings with users and machinery manufacturers. Thus, Rexroth is currently switching production in Bethlehem to meet Industry 4.0 standards and show users in the U.S. how much productivity they can gain this way. As a result, the requirements for integrated production play a role in the development of products, solutions, and services relating to Industry 4.0.

The Bosch Group has been involved in the Industrial Internet Consortium since 2014, and its components and software solutions are included in test beds. What is particularly attractive for U.S. companies is that Rexroth has been using open standards and interfaces for decades whenever possible. Since U.S. production systems are increasingly integrated, this requirement is becoming more and more important. One breakthrough in this regard was the software solution Open Core Engineering, which received several international awards. It bridges the gap between traditional SPS automation and the IT world, so functions written in IT and Internet languages can directly access controls and drives for the first time without having to write so much as a line of SPS code. This creates a comprehensive integration of company software, machinery, and any number of end devices such as smart phones, something U.S. industrial companies are aiming for.

U.S. IT companies such as National Instruments or Oracle are already using Open Core Engineering for their IT-based solutions. In
this way, they seamlessly incorporate Rexroth drive and control solutions into their integrated concepts.

In addition, Rexroth has established itself as a system partner for the energy-efficient automation of machinery and equipment. Here, we are collaborating with machinery manufacturers and support industrial end users in optimizing the energy consumption of installed equipment.