producao-de-silicio-grau-solar-uma-oportunidade-para-a-industria-brasileira (accessed 18/11/2018).
3. Quiminet [Interesantes dados sobre El silício metálico] URL: www.quiminet.com/articulos/interesantes-datos-sobre-el-silicio-metalico-2683717.htm (accessed 17/11/2018).
4. Minas Ligas [Silicio Metálico] URL: www.minasligas.com.br/produtos (accessed 17/11/2018).
5. UNILESTE-MG [The history of Metallurgy]. URL: www.ebah.com.br/ABAAAeoGsAC/historia-metalurgia (accessed 16/11/2018).
6. INFO ESCOLA [Metalurgia]. URL: www.infoescola.com/engenharia/metalurgia/ (accessed 16/11/2018).
7. Portal da Educação [Indústria Metalúrgica] URL: www.portaldaeducacao.com.br/conteudo/artigos/esporte/industria-metalurgica/50338 (accessed 16/11/2018).

## CLASSFICATION OF ROBOTS IN MANUFACTURING

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According to the recent data, the application of robots has drastically increased around the world. About 5,4 million were sold in 2015, and that number doubled in 2016 to more than 10 million units. The top applications are in manufacturing, construction, rescue operations, and personal security.

The use of industrial robots deployed in factories has also expanded. Figure 1-1 shows the number of these devices in operation globally; as is evident from the figure there has been a substantial increase in the past few years. In 2013, for instance, an estimated 1,2 million industrial robots were in use. This figure rose to around 1,5 million in 2014 and to 1,9 million in 2017. Japan has the most, at 306700, followed by North America (237,400), China (182,300), South Korea

(175,600), and Germany (175,200). Overall, robotics is expected to grow from a $15 billion to a $ 67 billion sector by 2025. According to an RBC Global Asset Management study, the cause of this expanded usage is the substantial price drop for the industrial robots. [1]

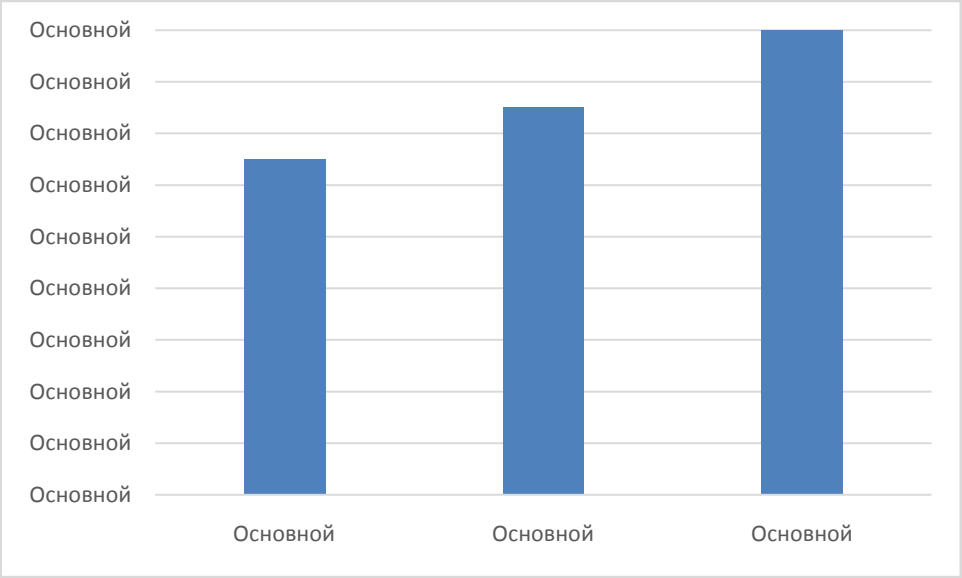


*Figure 1-1 Number of Industrial Robots around the World*

The robot has passed through a development period and is now entering an era in which robots are being utilized by industry in production. In Japan, about 1500 robots are used on production lines and more than 50 robot makers are supplying their products to the market. Many users have completed trials with industrial robots and have reached the situation in which repeat orders are being sent to robot manufacturers as a potential way of improving productivity. [2]

Different sources use different classifications of robots in production. One of the most common classifications is a classification by type of production:

1. Special perform a specific technological operation or an auxiliary model of equipment
2. Specialized perform operations of the same type, such as welding, assembly, and serve a specific group of equipment models;
3. Universal is the most advanced representatives of industrial robots, serve to perform various operations and operate with equipment for various purposes (disparate operations).

Another classification is given by Klas Nilsson, who works in depurate of computer science at university in London. [3]

1. Articulated. This particular robot design showcases rotary joints, ranging from the simple 2 joint structures (to 10) or more joints. The arm, the most important part of any industrial robot, is attached to the base, and paired with a twisted joint.

2. Cartesian. Also known as gantry or rectilinear robots, this type features three linear joints that operate with the help of the Cartesian coordinate system. This type of industrial robot can also feature an attached wrist meant for rotational movement of the arm.

3. Cylindrical. Attached at the base with one rotary joint and at least one prismatic, cylindrical robots operate within a cylindrical shaped space. This is because the rotary joints uses the rotational motion while prismatic operates in a linear motion.

4. Polar. This type of robot is also known as spherical robots. The configuration of polar industrial robots is; the arm is linked to the base with the help of a twisting joint and combination of rotary and linear joints. The name of the industrial robot is derived from the range of motion, i.e. polar coordinate system.

This article proposes a different classification of robots in production. Classification of automation of technological processes in production.

1. **Robots to reduce man-hour costs.**

Most production robots are implemented to reduce the cost per person hour. This process is necessary to reduce the cost of products, especially if the demand for a product falls. These robots have their drawbacks and merits. First of all, it saves the financial costs of staff salaries. But the robots in our time reduce the demand for certain types of labor. To understand the impact, one gas to have both understand whether these technological advancements are evolutionary improvements or extinction events for certain jobs and how large the employment is in those jobs.

2. **Robots to improve quality.**

The inherent accuracy and repeatability of robots means you can achieve a consistently high-quality finish for every product produced. Robots eliminate the problems associated with tiredness, distraction and the effects of repetitive and repetitive tasks.

3. **Robots to reduce production time.**

For example, employing robots alongside with humans in factories can reduce production time. Similarly, using self-driving trucks to deliver products can improve delivery times and reduce the chances of damage. Robotics will help drive automation in the manufacturing industry, an unavoidable and ultimately productive trend that will help manufacturing output and the jobs of factory managers in a variety of ways

4. **Robots to increase danger in using raw materials.**

A variety of chemical and hazardous materials have the potential for use in manufacturing, putting workers at risk. That is, unless a robot can do the job. The ability of robots to take tasks in dangerous working environments is impressive, handling everything from dangerous chemicals to radioactive substances. Robots can undergo programming to handle these materials with precise care, with the worst-case scenario involving a technological repair rather than a human casualty.

5. **Robots to reduce rejects.**

No risk of errors caused by human factors such as tiredness, distraction or the effects of repetitive and tedious tasks.

Incorporation of all types of robotics improves output, resulting in revenue and greater efficiency. The development of technology is rapid, and robotic augmentation to aid human efforts on the assembly line is nothing new. Its origins can be traced as far back as the rope-and-pulley system on Henry Ford’s first assembly line. Although paling in comparison to today's hyper-focused robots that aid with everything from welding and die casting to painting and boxing, the rope-and-pulley system in Ford’s assembly line shows an early willingness attempt to

optimize the process, which today reaches its natural arrival at AI and automation. Ford has over 20,000 robots in operation today on their assembly lines. [4]

***References:***


1. The future of work [Electronic resource]. - URL: https://about.jstor.org/terms/ (accessed 17/11/2018).
2. CüneytDirican. Article: «The Impacts of Robotics, Artificial Intelligence On Business and Economics» [Electronic resource]. - URL: https://www.researchgate.net/publication/282556879_The_Impacts_of_Robotics_Artificial_Intelligence_On_Business_and_Economics (accessed 17/11/2018).
3. Martin Hägele, Klas Nilsson, J. Norberto Pires. Industrial robots [Electronic resource]. - URL: https://www.researchgate.net/publication/226964084_Industrial_Robotics (accessed 17/11/2018).
4. Samuel Bouchard. Industrial robots: What are the different types? [Electronic resource]. - URL: https://blog.robotiq.com/bid/63528/what-are-the-different-types-of-industrial-robots (accessed 17/11/2018).
5. The Editors of Encyclopaedia Britannica: «Robotics» [Electronic resource]. - URL:http://www.roboticsobserver.com/article.abstract/1583091.html (accessed 17/11/2018).