

# **SIGNIFICANCE OF INDUSTRIAL ROBOTS IN DEVELOPMENT OF AUTOMOBILE INDUSTRY IN EUROPE AND THE WORLD**

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## **INTRODUCTION**

For vehicle production enlargement of all kinds is responsible the technology development of all kinds. One of the technologies is the new production technologies. The new production technologies, with the process integration as a main goal, production and quality enlargement, are based on a new techniques and short development time. The new technologies are made of the sophisticated knowledge, experiences and information techniques with a goal to approach a customer at a right time. Constant outbuilding of the production technologies is enabled with fast development of the information technologies. The new conceptual approaches have incurred in the last fifteen years in an area of the mechanical production engineering, with the main goal to shorten production cycle of a product. Researches indicate that about 80% of production quality is achieved in a development stage and that 70% of product costs are determined in this stage. The other responsible technology for development of automobile industry is the robotic technology, i.e. an application of industrial robots in production processes of automobile industry. At the beginning, the industrial robot applications in production processes are used for performing jobs that were dangerous for an employee health and for performing jobs in difficult conditions of work. The development of information technology, sensor technology and robotic technology is extending the industrial robot application in production processes of automobile industry, so that any process in automobile industry today is unconceivable without the industrial robot [1, 2, 3]. The industrial robots are used in welding process of the car shell, painting, montage and inspection. The industrial robots are also used in many other applications in automobile industry, like: different forms of mechanical processing in making parts for vehicles, plastic moulding, seal application on an automobile windshield, and taking parts from a transporters and their packing on the palettes for a forklift truck. The application of robot's vision on the industrial robots leads to extending of industrial robot application in vehicle production processes, and also a number of produced motor vehicles of all kinds are increasing year after year.

## **1. INDUSTRIAL ROBOT APPLICATION IN AUTOMOBILE INDUSTRY OF EUROPE AND THE WORLD**

An application of industrial robots in Europe and the World is shown in a table 1, and a figure 1. The statistical data that are shown in table 1 and figure 1 are used from the IFR (International Federation of Robotics) [6, 7, 8].

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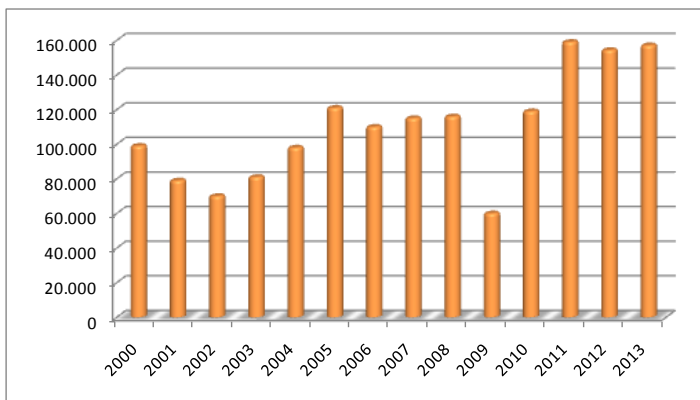
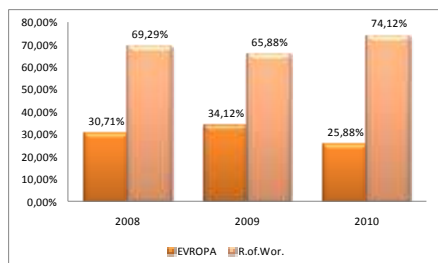


Figure 1 Trend of annual application of industrial robots in the World,

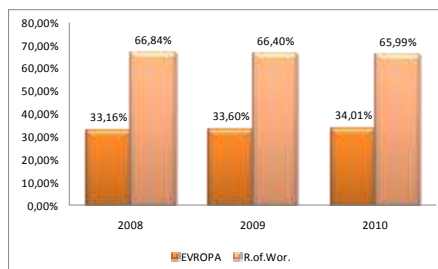
An annual application trend of industrial robots in the World for a period of 2000 - 2013 is shown at figure 1. The annual industrial robot application in this period moved from 60.000 to 120.000 of robot units. According to shown trend it can be concluded: in a period of 2000-2002 the industrial robot application trend is decreasing at annual level, then the increasing trend from 2002-2005. From 2005 - 2013 can be concluded that the robot application at annual level is almost constant and moves about 157.000 units, but in 2009 the application decline has been recorded to 60.000 units. In the last three years 2011 – 2013 industrial robot application is increasing to 155.000. In this period, the minimal industrial robot application has been recorded in 2002 and 2009 due to industrial world crisis, as shows figure 1.

Table 1. Application of industrial robots at annual and total level in Europe and World [6, 7, 8]

Instalation Cont./Yar	Annual application of robots units			Total application of robots units		
	2008	2009	2010	2008	2009	2010
EUROPA	34.695	20.480	30.630	343.329	343.661	352.031
Rest of the World	78.277	39.538	87.707	691.972	677.070	682.985
Total World	112.972	60.018	118.337	1.035.301	1.020.731	1.035.016



Annual application of robots units



Total application of robots units

Figure 2. Percentage of industrial robot application in Europe and World At annual and total level in production processes

Table 1 and figure 2 are showing the annual and total industrial robot application in Europe and the World at annul and total level in period of 2008 - 2010. If we overlook the

application trend of industrial robot in Europe, it is seen that at annual level in this period moves from 20.480 - 34.695 units, i.e. 22, 88%-34, 12%, in relation to total annual application in the World. When considering the total industrial robot application, in Europe is applied 343.329 - 352.031 units, i.e. 33, 16%-34, 01%, in relation to 1.030.000 units of industrial robots in the World. We come to a conclusion that 34% of industrial robots are installed in production processes in Europe, and the rest of 66% is installed on other continents in the World. Let us analyse the industrial robot application in the drives of automobile industry in the World. The trend of robot application in production processes of motors and motor vehicles at annual and total level is shown in figure 3.

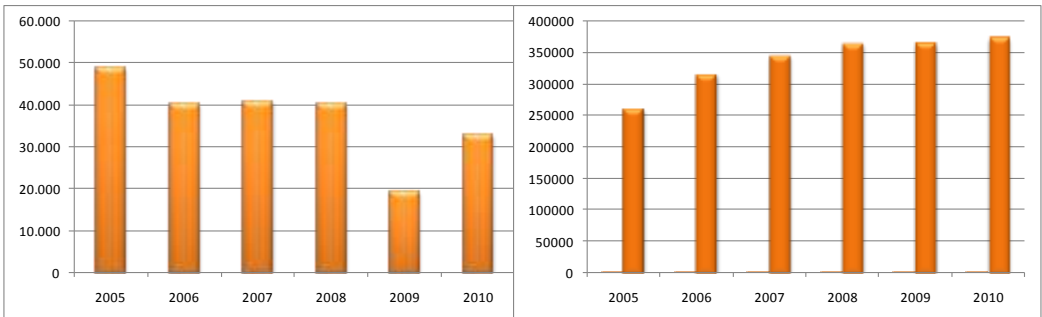


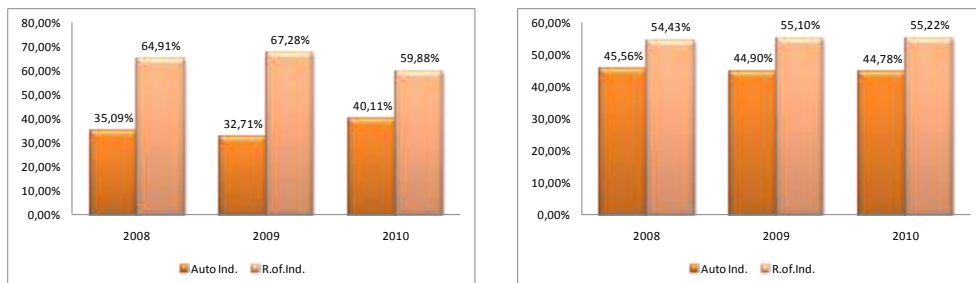
Figure 3. Application of industrial robots in production processes of motors and motor vehicles at annual and total level in the World

According to figure 3, the robot application trend at annual level in automobile industry has the decline trend with 50.000 units to 40.000 units from 2006 to 2008, and then the decline to 20.000 units in 2009, while in 2010, the robot application increase to 33.000 units. The smallest application has been recorded in 2009 due to a huge industrial crisis in the World. The trend of robot application in automobile industry at total level is in increase year after year, and has increased from 260.000 units in 2006 to 373.000 in 2010. It happened due to automation and modernization of fabrics that produce vehicles and opening of the new fabrics for vehicle production.

Let us analyse the industrial robot application in automobile industry in Europe, and through an analysis let us cover those countries with the most developed automobile industry. The robot application trend in automobile industry has been given in table 2.

Table 2. Trend of industrial robot application in automobile industry at annual and total level in Europe [6, 7, 8]

Instalation Cont./Yar	Annual application of robots units			Total application of robots units		
	2008	2009	2010	2008	2009	2010
Aut. Ind.Europa	12.177	6.700	12.288	156.447	154.308	157.646
Re. of Indus.	22.518	13.780	18.342	186.882	189.353	195.385
Total EVRO.	34.695	20.480	30.630	343.329	343.661	352.031



Annual application of robots units

Total application of robots units

Figure 4. Percentage of industrial robot application in automobile industry in Europe at annual and total level in production processes [14, 15, 16]

If we analyze the industrial robot application in automobile industry in Europe, table 2 and figure 4, it is obvious that at annual level is applying about 12.000 units, which is about 38% of total robot application at annual level, while 62% of robot units is applying in other production processes. The total industrial robot application trend in automobile industry is somewhat different, and is applied about 190.000 units of total application of 350.000 units. In other words, in automobile industry robots are mostly applied, about 45%, while in other industries are applied about 55% of total industrial robot quantity. We can conclude that in Europe, the production processes are modernizing and are more automated in automobile industry as a result of constant development of the new technologies, information technologies and robotic technology.

## 2. PRODUCTION OF AUTOMOBILE AND LOAD VEHICLES IN THE WORLD

The production trend of automobile and load vehicles in automobile industry is given in a figure 5, according to data from the OECD (*Organization for Economical Co-operation and Development*).

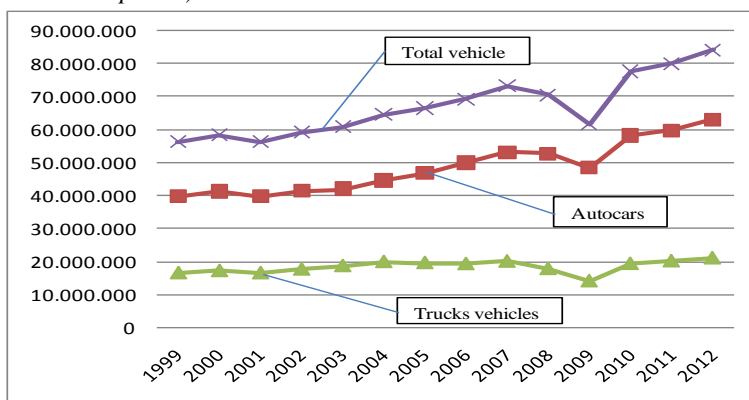


Figure 5. Annual automobile and load vehicles production in period 1999-2012 [4, 5]

According to figure 5, it is seen that the production trend of automobile and load vehicles is increasing year after year. In 1999 have been produced about 40 million of automobiles and about 16 million of load vehicles which gives the number of 56 million vehicles. In 2012 has been produced about 63 million of automobiles and 21 million of load

vehicles, and the total production in 2012 amounts to 84 million of vehicles. It is obvious that in 13 years the production of vehicles increased for 28 million units.

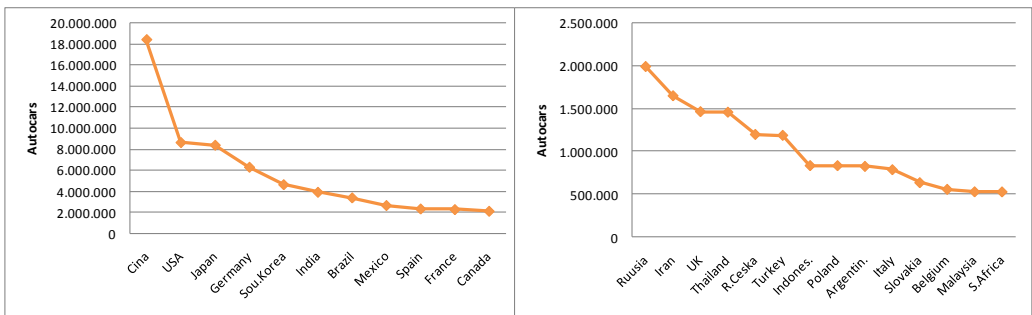
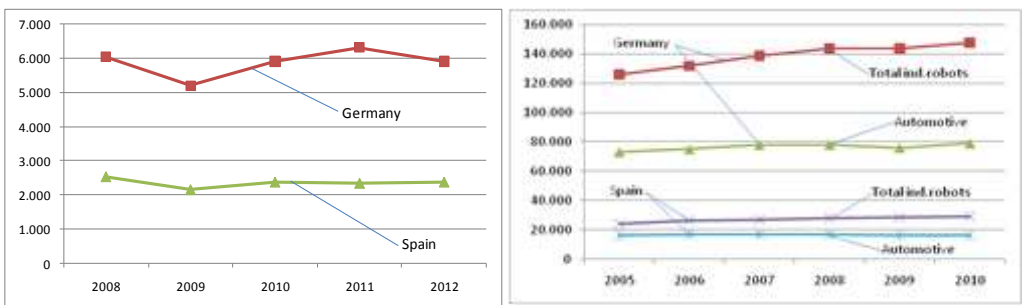


Figure 6. Annual production in automobile industry in 2011 by countries [4, 5]

According to figure 6, the first place in production in automobile industry in the World in 2011 takes China with over 18 million vehicles, the second place takes the USA with over 8 million vehicles and the third place takes Japan with over 8 million vehicles. The production trend is logical in automobile industry because the trend is influenced by the installing trend of industrial robots. China is the best example as it is seen in figure 6, because the number of industrial robot applications in China is increasing year after year.

When it comes to the trend of automobile production in Europe, we analysed those countries where the automobile production at annual level is over 500.000 units, and those countries are: Germany, Spain, France, Italy and the Czech Republic. Other countries in Europe are not taken into consideration due to vehicle production under 500.000 units at annual level. The annual trend of vehicle production and total trend of industrial robot application in all industrial branches and in automobile industry in Germany and Spain is shown in figure 7.



Production of the vehicles  
 The total use of the robot and the auto industry  
 Figure 7. Production of vehicles in Germany, Spain and total application of industrial robots in all industrial branches and automobile industry [4, 5, 6, 7, 8] naziv y ose

According to figure 7, the first place in vehicle production in Europe takes Germany, and the trend of vehicle production moves from 5, 2 million of vehicles to 6, 3 million of vehicles. When analysing the industrial robot application in Germany (right figure), in a period from 2005-2010 has been applied totally 125.000-145.000 of industrial robot units, a part of that number is applied in automobile industry, about 80.000 units at annual level which represents more then 50% of industrial robots which are installed in fabrics that produce vehicles. Considering an average, on one robot comes 75 vehicles (1/75

robot/vehicles). At a same graph has been shown the vehicle production in Spain, and the trend moves from 2 million of vehicles to 2, 5 million of vehicles, while total industrial robot application in Spain at annual level moves from 24.000-29.000 units, and in automobile industry has been installed 16.000-17.000 units which represents about 60% of all installed robots in all industrial branches. In Spain, on one robot comes 117 vehicles (1/117 robot/vehicles).

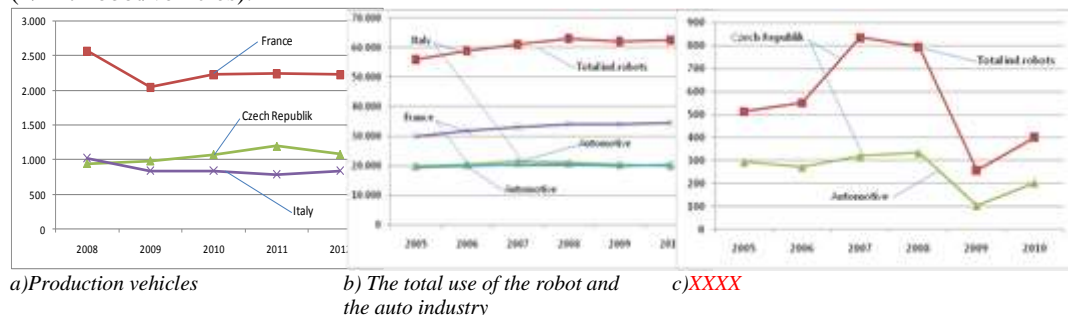


Figure 8. Production of vehicles in France, Italy, Czech Republic and total application of industrial robots in all industrial branches and automobile industry

When analyzing the diagrams from figure 8, we conclude according to a) that the motor vehicle production is maximal in France and moves from 2 million to 2.5 million annually, in a period of 2008-2012, the second place takes the Czech Republic where the production moves from 900 thousand to 1, 3 million of motor vehicles, and the third place takes Italy with the production of motor vehicles from 600 thousand to 1.1 million in a period of 2008-2012. In figure 8 b) total industrial robot application has been shown in Italy and France and also the total application in automobile industry. The total trend of industrial robots in all industrial branches in Italy moves from 58.000 to 63.000 of robot units, while the automobile industry uses only 20.000 robot units in a period of 2005-2010. The industrial robot application trend in France in the same period is from 30.000 to 36.000 of robot units, and automobile industry uses almost as Italy, about 20.000 of robot units. It is obvious that in France, in relation to Italy, is produced more then 2 to 2,5 million vehicles at annual level with almost the same number of installed industrial robots in production drivers in automobile industry. One of the conclusions can be that the industrial robots are not enough functional in drivers for vehicle production in Italy, or that the automation of the production processes hasn't been carried out properly; where in the same automation robots are included. The other conclusion can be that the companies that produce vehicles in France are performing total automation and modernization of the production processes and all lines for vehicle production are introducing innovations, are shortening the production time for production of one vehicle, and in this way are reaching this trend of vehicle production. The Czech Republic, ever since entering the EU, produces more vehicles than Italy and that trend moves from 900 thousand to 1.1 million vehicles in a period of 2008-2012, although the number of installed industrial robots in production drivers of automobile industry is small and moves from 100-300 of robot units. The reason for such production vehicle trend and robot application in production processes of automobile industry in the Czech Republic is because the German companies dislocated their production in the Czech Republic, and most of the vehicle parts that are produced in Germany come as a semi-finished product in companies for vehicle production in the Czech Republic, where only the montage is carried out. Besides Germany, in the Czech Republic are companies for vehicle production dislocated and the other companies from different countries. This way justifies

this trend of vehicle production in the Czech Republic with such small number of installed industrial robots in automobile industry.

### 3. CONCLUSION

According to all derived indicators in this paper it can be certainly predicted that the great robot application in vehicle production will continue to carry on in the future. The new generations of robots with more perfect sensory evaluation, and particularly with robot's vision will have greater application in this industry, and also in industry for production of vehicle parts. The production of vehicle parts of the renowned world's manufacturers is the chance for the industrial development of the countries in transition, like the Czech Republic. The robot application of the new generation in automobile industry will improve the quality and productivity of part production and of entire vehicle, and it will significantly influence on increasing the competitive competences of firms that produce vehicles for more demanding international market. The greater robot application in automobile industry will enable more continuous and more flexible production that will significantly contribute to satisfaction of market demand for higher variety of the same types of vehicles, by building certain supporting equipment and securing systems in vehicles. The future production drivers of the vehicle producers will look like „*The fabrics of the future*“ with more and more robots, and less and less production employee. These firms, from day to day, will increase a number of engineers which will have to have a proper knowledge from the modern technician discipline called mechatronics that represents an integration of mechanical engineering, management, electronics and computer science.

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