Digital Technology as the key Factor in the Fourth Industrial Revolution - Industry 4.0

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***Abstract*— This document gives formatting guidelines for au In the past ten years digital technology has significantly contributed to changing the lives of people throughout the world, because its application enabled a rapid transformation of all aspects of human life, especially fast transformations in the design, manufacturing, operation and maintenance of production systems, thus causing a sudden jump in productivity. We can easily say that fourth industrial revolution happened, which can be labeled in a variety of ways such as "Intelligent factory", "Smart industry" or "Advance manufacturing". In the near future (as expected by 2025), machinery, appliances, robots and people must be mutually linked, so that they can work together and communicate with each other via internet platforms (IOT). Information systems will create a virtual copy of the physical world, which will allow the action from one place to change a realistic process of industrial production. It will cause decentralization of decision-making, so that the production processes can make decisions independently, and only in the event of a fault or conflicting objectives decisions will be delegated to a higher level. The application of information and communication technology (ICT) enabled us to have information on the basis of which we can perform the integration of all systems at all stages of the creation of new products, both within the production process and outside the system (referring to the logistics and supply). Application of digital technologies in the production processes in the industry creates flexible automation, maximum adjustment of production to rapid change in the direction of customer demands, increased rate of production, better quality and increased productivity. All these advantages are realized with the implementation of the following technologies: Big Data, Cloud Computing, Internet, Simulations, Artificial Intelligence, and System Integration, representing support technologies such as Additive manufacturing, Autonomous Machines and Human-Machine Integration. The paper gives an overview of the technological revolutions that have so far occurred worldwide, and factors of changes in society meaning demographic, socio-economic and technological, with the emphasis on digital technologies that bring changes in all segments of society and production processes. The implementation of digital technology, robot technology and all the advanced technologies enable us to produce intelligent automation and intelligent factories, thus creating a society in which wealth is created through strengthening the global competitiveness, to serve the regulation of social issues in society.**

***Index Terms*— digital technology, factors of change, intelligent automation, M2M, industry 4.0, intelligent factory.**

I. INTRODUCTION

Many believe that today we are at the beginning of a new industrial revolution, and it is considered that it would be fourth similar step for mankind that can be called the fourth industrial revolution or "Industry 4.0". The term appeared for the first time at the Trade Fair 2011 in Hannover, Germany. It is the concept of development which largely coincides with the development in other European countries, but can in many ways be labeled as the "Intelligent factory", "Smart industry" or "Advance manufacturing". The fourth industrial revolution presents a group of fast transformations in the design, manufacture, operation and maintenance of production systems, thus causing a sudden jump in productivity and changes the lives of people worldwide[1,2,3,4,5,6,8,9,11,17-21]. The fourth industrial revolution is the successor to three previous industrial revolutions, Figure 1. As is already known, the first industrial revolution occurred in 1784, or mid-18th century, when steam engines were introduced in production processes. The second industrial revolution occurred in 1870, or late 19th century, when electricity was discovered, and mass production began on assembly lines with electrical drive. The third industrial revolution began in 1970, in the 20th century, with the use of electronics and information and communication systems and the introduction of industrial robots that further automated production processes. Currently we are at the beginning of the fourth industrial revolution which is characterized by the so-called "cyber-physical systems" (CPS) [7]. These systems are the result of deep-rooted causes of integration of production, maintenance, and cooperation of producers and customer to mutual satisfaction based on intelligent network systems and processes . Digital technology allowed us to develop many digital devices (microprocessors that are the brains of digital devices and systems),and substantial acceleration in the industry using the Internet: video cameras, RFID readers, mobile phones, tablets, computers, etc. All this is happening in order to improve the quality, safer production, plant maintenance, and increase of efficiency and effectiveness in all areas. Use of digital technology, sensor technology, robot technology and other advanced technology enables the application of the latest sensors, expansion of network communications, and arrangement and networking of intelligent robots and machines, and increased computing power (capacity) at a lower price, which in the coming period presents the potential to transform production processes both in Europe and throughout the world.

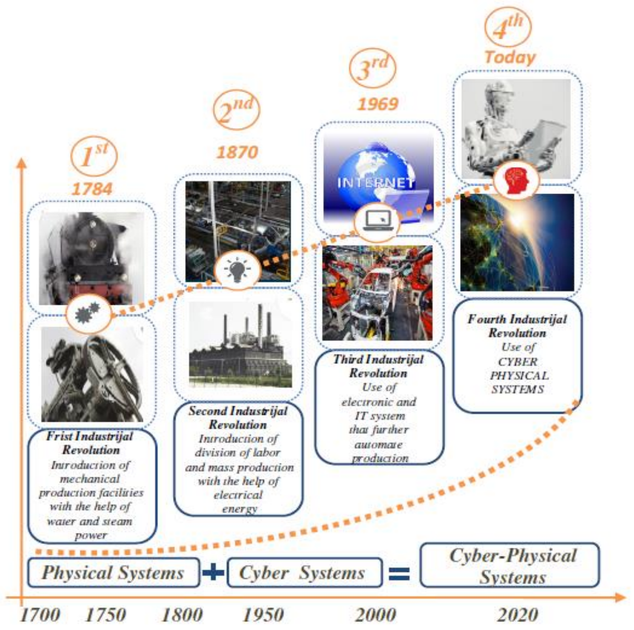

Fig. 1 Technological industrial revolutions in time periods

The fourth industrial revolution promises greater flexibility in the production processes, maximum adjustment of production to rapid change in the direction of customer demands, increase of the production rate, better quality and increased productivity. Companies that wish to remain on the market and be competitive need to use these advantages, invest in new equipment, information and communication technology (ICT) and conduct data analysis that will be within reach throughout the global value chain.

II. THE ROLE OF TECHNOLOGICAL AND SOCIO-DEMOGRAPHIC FACTORS IN THE FOURTH INDUSTRIAL REVOLUTION

The role of digital technology and its implementation in production processes brings the risks that will appear with technological changes. The introduction of "intelligent automation" in production processes will have impact on employment and inequality in earnings as a risk consequence of the system fragility because production processes are becoming more complex, and operation is conducted with information and communication technologies. Advanced innovation can create new risks that need to be confronted. There will be a dynamic change when it comes to demographics and employment. A completely new vocations and areas of expertise will emerge, and some that exist today will become completely obsolete in the years to come, as estimated by 2020. The World Economic Forum 2016 (World Economic Forum, Future of Jobs Survey 2016) published the demographic and socio-economic factors of change, as shown in Figure 2[3,12] . Based on Figure 2, we see that it is 44% chance that change in the business environment and flexible working engagement will occur, which can already be observed.

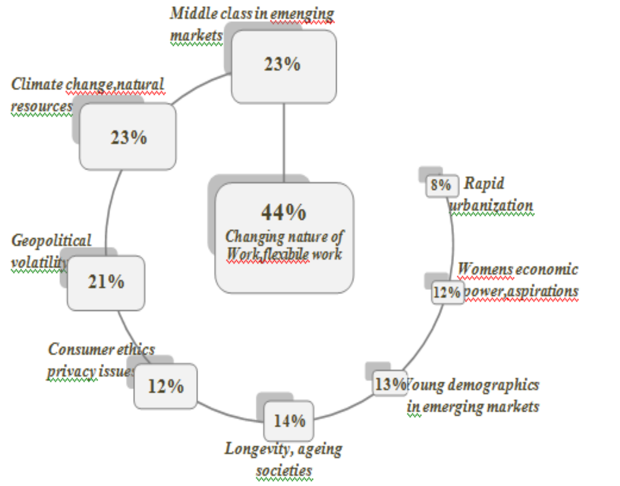

Fig. 2 Demographic and socio-economic factors of change in the fourth industrial revolution

The adoption of these technologies enable the work at distance (skype and internet allow continuous communication so that it is not necessary that a worker has a job within the company where he works). The companies will have fewer full-time workers, and will, through ICT technologies, employ external consultants from other countries and to carry out specific operations. It is expected that the market will experience an approximate 23% increase towards the middle class, and it is estimated that the world economic market will move, so that by 2030 Asia will have 66% of middle class market. About 23% is related to climate change, limitation of natural resources and the transition to a green economy, because climate change is the main driver of innovation. Examples include renewable energy sources, and over-exploitation of natural resources that lead to degradation of eco-system. About 21% is related to geopolitical instability because geopolitical landscape is constantly changing, which has implications for global trade and mobility of talents that industry require (e.g. oil, gas, tourism, etc.). Other demographic and socio-economic factors with certain percentages are shown in Figure 2, to name a few: new customer concerns, longevity and aging of population, demographics of youth, pursuitfor economic power of female population, etc. The importance of initiating changesin regard to technological factors are presented in Figure 3 [3,12].

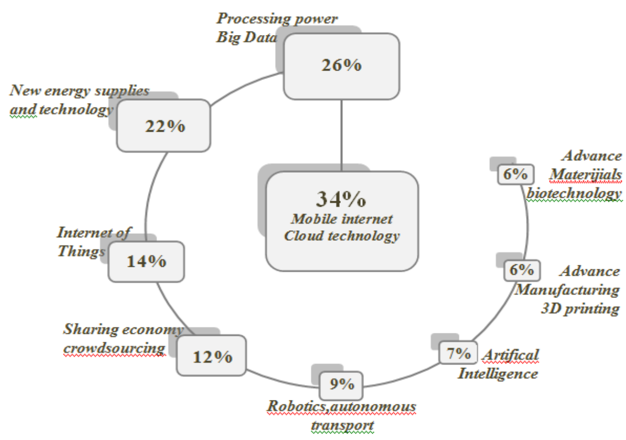

Fig. 3 Technological factorsof change in the fourth industrial revolution

When technological factors of change are in question, the first place is held by the mobile Internet and "Cloud technology" with 34%, and it is assumed that the change will last for the period 2015-2017. We are witnessing these changes nowadays because mobile internet and applications for business allow more efficient provision of services and the increase in the labor force. "Cloud Technology" enables companies to rapidly spread Internet business and services in a short period of time. The second place of technological factor of changes with around 26% is held by the advancement in computing power and the technology that enables the collection and processing of large amounts of structured and unstructured data in real time "Big Data".It is necessary to develop systems that are able to offer the optimum and necessary data out of large amounts of data. It is estimated that changes will occur in the period 2015-2017. According to [12], in the third place of technological factors of change are renewable energy, supplies and technology with around 22%, that will have complicated geopolitical and environmental consequences, as well as crisis caused by the price of oil. The expectations are that changes will occur in the period 2015-2017, although this period will last longer. The other factors of change in terms of technology is use of remote sensors, communication and data processing when the production process is concerned, the use of the platform "peer-to-peer" (watching and watching), while companies and individuals can performs tasks that used to require major companies. In addition, advanced robotics and intelligent transport represent a factor of change, because the new generation robots with improved senses and intelligence will be more convenient than human labor. We are currently at the stage of creating cars, trucks, aircraft and ships that will be either completely or partially autonomous, as expected period 2020-2025. The factor of technological change is advancement in artificial intelligence and machine learning that enables automation and tasks that were so far only performed by workers, and it was thought impractical to be performed by devices. As already mentioned, there is a continuous change in business models in all industries that will have far-reaching consequences and implications for different skillsof workplaces and the nature of work. The effect of the application of these technologies is expected on the level of employment, skills profiles in various segments of tasks, different industries and different geographical areas.

III. DIGITAL TECHNOLOGY IS THE LEADER OF IMPLEMENTATION OF THE FOURTH INDUSTRIAL REVOLUTION

As it is well known, in the past 20 years the development of digital technologies, and the development of new methods and new technologies in the world, as well as their implementation in production, gave the companies throughout the world a task to constantly monitor the development and conduct modernization and automation of their production process in order to remain on the market and be competitive. One of the reasons that named technologies are already partially available is low cost, which has been steadily declining, and in the near future will be fully represented in the production processes. Another reason why companies need to monitor the development and implementation of these technologies is that the buyers through the ICT technologies arevery quickly reaching information and expanding their demands, and the products that customers demand are becoming more complex and complicated for the production process [1-9]. Around us and wherever we are, whether at work or at home, the quiet revolution is emerging and thanks to the Internet and sensors embedded system scompletely new possibilities for the combination of mental, physical and mechanical work are opening for us. Currently, the latest phase is being developed as a basis for the deep-rooted causes of the integration of information technology (IT) and operational technology (OT), Figure 2. Digital technologies conduct integration in several ways so that we have the potential to reduce costs in production processes, preventive maintenance, and ability to increase the speed of production, due to communication of machine to machine and improvement of product quality. Digital technology enables new tendency of automation of office and business processes which correspond to the automation of production processes and factory automation [7]. The above integration is already in progress, and the basic structure, as shown in Figure 4, is provided by internet for integration of information and operational technologies.

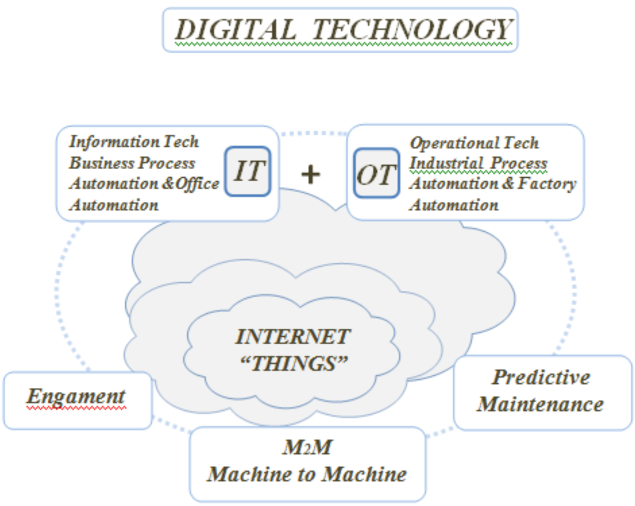

Fig. 4 The influence of digital technology in the implementation of ''Industry 4.0"

Operative technology through hardware and software detects or causes changes through the control of the process or the device itself, due to the Internet. The future of the industry is based on digital technologies that will offer innovative solutions to capacity in the industry and other economic sectors. The application of information and communication technology (ICT), enables us to have information on the basis of which we can perform the integration of all systems at all stages of the creation of new product, both within the production process and outside of it (referring to the logistics and supply). Figure 5 shows the key digital technologies (ICT), which enable the digital transformation of the industrial processes [1,3,12-17].The transformation of manufacturing processes in industry for the purpose of flexible automation, maximum adjustment of production to rapid change in the direction of customer demands, increased speed of production, better quality and increased productivity can be achieved through the implementation of the following technologies: Big Data, Cloud Computing, Internet, Simulations, Artificial Intelligence, System Integration, thus representing support to the technologies at the top of Figure 5, such as: Additive Manufacturing, Autonomous Machines and Human-Machine integration.

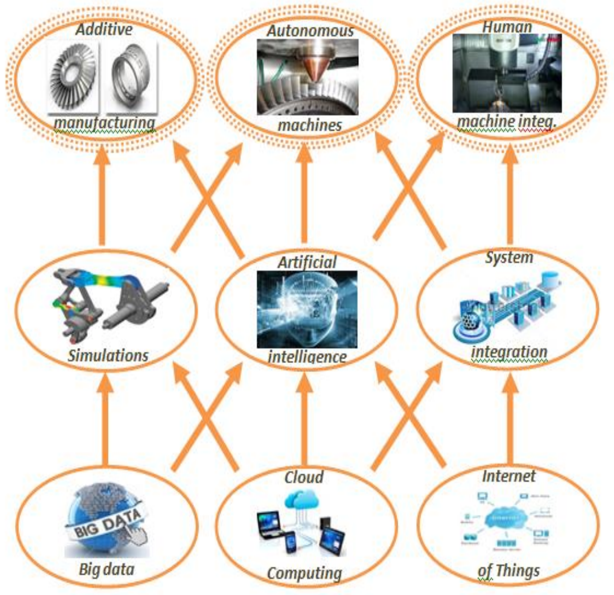

Fig. 5 The transformation of production processes through digital technologies[17]

There are two reasons why digital technology will transform the production processes in the industry: the first is that their representation in the manufacturing process increases every day, and the second is that by combining various ICT technologies converge with other technologies. The main effect which has an impact on productivity in the production process is given by the technologies shown at the bottom of Figure 5 that enable the technologies at the top of Figure 5. In order to achieve and use the above that was not possible until now (e.g. to control each piece during production, follow its distribution, change the parameter during the preparation, etc.), we need to implement all digital technologies shown in Figure 5.

IV. COMMUNICATION MACHINE TO MACHINE M2M IS THE HEART OF THE FOURTH INDUSTRIAL REVOLUTION

It is a well-known fact that leading paradigm in every automation of the production process is the limit of human intervention, and the tasks need to be entrusted to the machine, robot, devices and systems. Digital technology with information and communication technologies, currently with microelectronics, sensors, actuators and fixed and wireless networks, provides us with the possibility to achieve communication of machine to machine. This digital interaction between and within the machines and the system is the heart of the fourth industrial revolution. The strategies of industrial development of any country in the world are going in the direction of industrial automation of production processes using digital and advanced technologies, and define M2M communication in the context of man and machine, taking account that companies engaged in robotic technology developed the second generation robots which have the ability to work together with people, unlike the first generation industrial robots that needed to be separated with compartments for the safety of workers and other plants. Human-Machine Interface (HMI) and machine-to-machine communication is expected to be the key element in the expansion of automation of production systems, and these applications lead to the "intelligent automation". The goal of the fourth industrial revolution is to improve the business in terms of increasing the overall efficiency of the installed capacity (equipment). Here we must note that communication of machine to machine in production process in the industry is not the only goal, but also to enable communication of all possible devices and systems with the application of digital and other advanced technologies. In other words, M2M applications can be directed to the individuals, companies, communities, and organizations in the public and private sectors. As shown in Figure 6, M2M is focused on ten common areas in different sectors, for example monitoring whether a student is attending lectures, unloading of raw materials in warehouse, or monitoring traffic in one street [7,8,9].

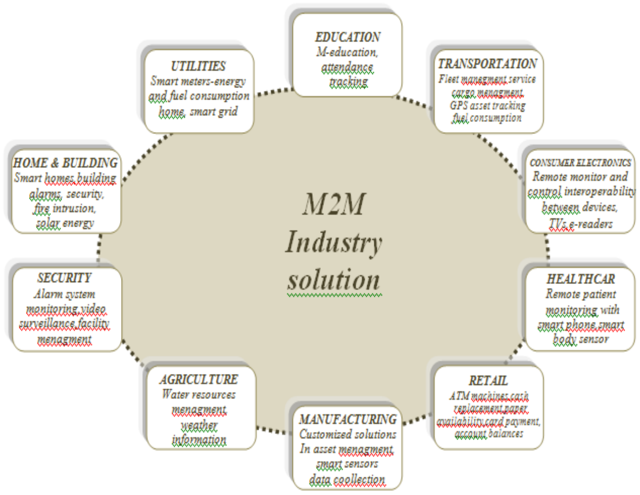

Fig. 6 M2M application is directed towards ten different areas in different divisions

This is a pioneering industrial internet which will include all production machines, appliances, devices and systems which perform specific tasks. Nowadays they can communicate to each other just by implementing the above named digital technology, and in this communication they may, for example, exchange the following information:

- I have produced 20 units and I have to stop because my inbox is empty.
- I have the ability to work 12% faster if my inbox is always full.
- Of the 30 product pieces, two products were discarded.
- I waited in production for 20 minutes because the inbox was empty.
- I am able to reduce my energy consumption for production if my equipment is idle while waiting.
- Please check? I worked five minutes longer to achieve the right temperature, etc.

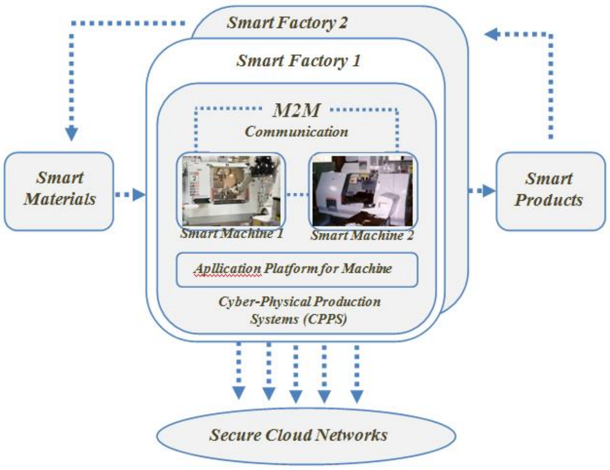

Fig. 7 Actual example of application of M2M system in the production process in the industry

This type of M2M communication between machines, appliances, devices and systems forms the basis for "intelligent automation" Figure 7, or "intelligent factory", and applications may be in heavy industry, food industry, production of consumer goods, and in all segments of society and different sectors. Modern M2M applications use micro-electronics and wireless digital technology, with which embedded devices collect and distribute information in real time. In this way, tens of billions of connections can be accessed whenever and at any time. M2M application uses sensors and timers for different events ranging from temperature, via the communication network (fixed, wireless or hybrid) to application software that converts raw data into meaningful information. Telecommunications companies in particular recognize the opportunity to expand their services to gain access to the operational aspects of their clients. They are in research stage of different architectures for M2M systems and technologies that enable the development and deployment of these systems. M2M communication systems are in development phase, including the integration and adaptation to the existing technologies and communication systems that are currently in various processes. It is necessary to enable the algorithms that will provide functionality, efficiency, reliability and safety of the M2M system. Predictions are that by 2020 around billions devices worldwide will be able to communicate with the M2M system. When using M2M system, it is necessary to expect modernization, and this is one of the sub-categories of "interference" (disruption), the term used for the enormous changes that the new company will cause through technological innovation in every industry branch. The convergence of digital technologies with other technology created the second generation of industrial robots. I strongly believe that the third generation of industrial robots is arriving, which will be smaller than the previous generation of robots, cheaper, more autonomous, flexible and fully cooperative, simplifying programming so that they can be programmed by the workers. The third generation of industrial robots are intelligent and autonomous robots so that their improvement will be in the direction of: identifying specific objects, manipulation, knowledge, increase in computing performance, numerically controlled remotely, work with miniature and complex products that require adjustment in the installation, reliability and accuracy which exceeds human ability [10,11,15,16,18,20,21] Due to these reasons the industrial and service robots are at the center of automation of production processes today and in the future, and it is impossible to create "intelligent automation" and "intelligent factory" without the participation of a new generation of robots, as shown in Figure 8.

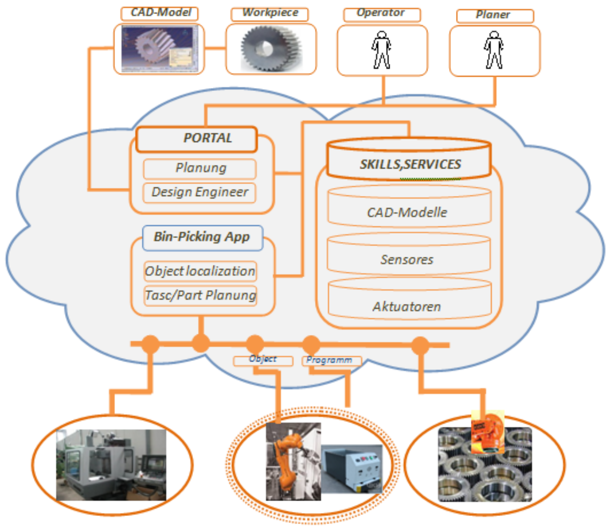

Fig. 8 Intelligent production process of gear realized with digital and robotic technology

Digital technology with other technologies, including robotic technologies, are the foundation of every intelligent production as evidenced by the example of making gear in Figure 5. With advanced information technologies we conduct construction, simulation of actual plant at all stages of production (virtual reality), e.g. gear, assembly, quality control, planning, management, diagnosis and optimization of production all from one place. This method leads to the production process of high productivity, low cost and high quality.

V. CONCLUSION

Digital transformation is the key to fourth industrial revolution, so that the development of humanity accelerates exponentially. This is the third phase of acceptance of digital technology, preceded by digital competence and digital use. Digital transformation enables innovation and creativity in the individual domain not only traditional but also adopted technology. Internet of Things (IoT Internet of things) present the new way we communicate with machines, in the same manner in which the devices that we use at home, at work, and transport will be connected. Communication M2M is expected to be the key element in the expansion of automation in the production process, which will, with the participation of sensor and robotic technology, lead to "intelligent automation". In addition, new way to communicate with devices that are used in the home or transport to work presents the key to the implementation of the fourth industrial revolution, so that it is estimated that by 2020 about 50 billion devices will be interconnected, of which about 10 billion will be traditional computer devices. In the next five years, the largest application of digital technology will be achievedby global companies, hence will reduce costs, increase productivity, and allow an extension to the implementation in new areas. Digital design and virtual modeling of the production process will reduce the time between the design of a product and its delivery to the market. In this way we come to great improvements in product quality and a significant reduction in manufacturing defects. The fourth industrial revolution that included digital and other technologies will bring us to the "intelligent production" in the next 10 years. The fourth industrial revolution provides technology available to everyone. It is assumed that in the future the technology will not provide a competitive advantage, but rather the way we use it will be competitive advantage.

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