



2021 56th International Scientific Conference on Information, Communication and Energy System and Technologies (ICEST)

June 16-18, 2021, Sozopol, Bulgaria

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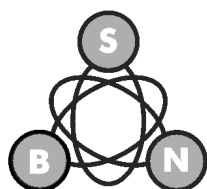
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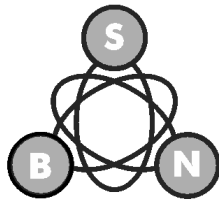
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The Impact of Industry 4.0 on Education and Future Jobs

Filip Anackovski¹, Mitko Kostov¹, Roberto Pasic¹, Ivo Kuzmanov¹

Abstract – The subject of this paper is the analysis of the **Impact of Industry 4.0 on Education and Future Jobs**. The purpose of this paper is to explore the impacts of recent trends and characteristics related to digital transformation in the field of Education and Future Jobs, namely, to further understand how such a digital transformation will transform the modern living and working. Some jobs will not exist, other jobs going to be developed, and new jobs that do not exist these days will become usual. What is known is that in the future will be required new skills to master.

Keywords – Industry 4.0, 4th Industrial Revolution, Education, Future, Jobs

I. INTRODUCTION

In the past few years, Industry 4.0 has become one of the most discussed concepts and has aroused great welcome in the academic and industrial sectors [1]. Industry 4.0 will have huge influence on the Education and Future Jobs.

The Industrial Revolution brought about a comprehensive transformation of economic and social organization [2].

Increasing innovation led to higher levels of motivation and education, which led to several groundbreaking inventions that are still in use today [3].

Engineers have always tried to solve problems related to the operation of machines and machines maintenance. Their main target is to increase production quality and efficiency, and in same time to reduce the production cost. In general, to improve processes in the organization of production and other related entities.

Intelligence is the most important factor for future development and progress. Intelligent manufacturing has participated in industrial practice to some extent, but it is expected to play an important role in the near future. It is also expected to affect global manufacturing operations to any degree, thereby making the company flexible enough to react quickly to production changes. A very important modern concept related to advanced and intelligent production is the concept of Industry 4.0 [4].

Industry 4.0 – should increase manufacturing flexibility, together with mass customization, improved productivity and better quality. On that way, will enables companies to meet the challenges of producing more individualized products with higher quality and faster production times. Intelligent manufacturing has an important role in Industry 4.0. With

converting of typical resources into intelligent objects, they can feel and act within intelligent environment [5].

In this paper, the history of the Industrial Revolutions is described, with a focus on the features and components of the Fourth Industrial Revolution and its impact on Education and Future Jobs.

II. INDUSTRIAL REVOLUTIONS

The Industrial Revolution began in Great Britain and quickly spread cross whole world. The Industrial Revolution was a period of major industrialization and innovation which happened during the late 1700s and early 1800s [6].

Over the years, the company has achieved higher productivity through the use of steam engines, electricity, and the transition from analog technology to digital technology. However, the impact of the Fourth Industrial Revolution is broader, not only affecting production, but also indirect sectors, especially engineering processes. This means that the potential for productivity growth lies especially in improving brain function and decision-making processes. Cooperation at all levels can help expedite this process.

The first industrial revolution was after the original industrialization period. It started from the end of the 18th century to the beginning of the 19th century. The biggest change comes from the mechanized form of the industry. Mechanization is the reason why agriculture began to be replaced by industry as the pillar of social economy [7]. The steam engine, like the locomotive, enabled an enormous increase in transportation efficiency. In 1784 the first mechanical weaving loom was put into operation.

Second revolution marked the use of electricity for new mass production and new types of production organization (Fordism, Taylorism). This is followed by the development of the chemical industry. In 1870, the first conveyor belt was installed in the Cincinnati slaughterhouse [8].

The development and application of electronics and the IT sector have opened up new possibilities for production management and automation. The third revolution initiated the rise of electronics, telecommunications and of course computers. With these new technologies, the third industrial revolution enable to have space expeditions, research, and biotechnology. In 1969, the first control program with the help of programmable logic circuits (PLC), Modicon 084 was realized.

In this revolution, smart factory machines and Plants are largely self-organizing, supply chains are self-synchronizing, and raw materials (working parts) for machines, which they make themselves in the real world, provide information about production. Experts call such an industry a stock exchange where machines offer their services. These are the new, so-

¹Filip Anackovski, Mitko Kostov, Roberto Pasic and Ivo Kuzmanov are with the St. Kliment Ohridski University, Faculty of Technical Sciences – Bitola, Makedonska Falanga 33, Bitola 7000, Republic of Macedonia, E-mail: filip.anackovski@gmail.com

called Smart Factories. This revolution has already begun, and proof of this are the existing technologies as its prerequisite: Internet, IIoT (data connection for industrial systems), simulation software, TIA (Totally Integrated Automation) portal for fast engineering. Fig. 1 shows visual history of the industrial revolutions.

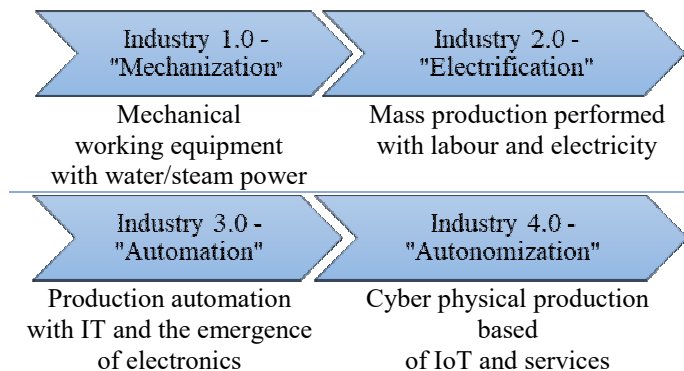


Fig. 1. Industrial Revolutions History

III. INDUSTRY 4.0

Industry 4.0 is defined as "the name of the current trends in automation and data exchange in manufacturing technology, including cyber-physical systems, the Internet of Things, cloud computing and cognitive computing, and the creation of smart factories" [9].

Industry 4.0 can be understood as a combination of production technology, process technology, and information technology (IT). The concept of Industry 4.0 is a term introduced, which actually refers to the "Fourth Industrial Revolution" that first appeared in the German-speaking region in 2011, named "Industry 4.0". Today, the subject of Industry 4.0 has aroused great interest in the field of industrial engineering. One of the basic characteristics of Industry 4.0 is the transition from the concept of automated manufacturing to the concept of intelligent manufacturing, which includes the integration of organization, equipment, personnel, and products, as well as the collaboration between them and the ability to communicate in real time.

Industrial Internet of Things (IIoT) and Cyber-Physical Systems (CPS) are the two key technologies that will provide Industry 4.0 to deliver: high level of automation and digitalization, artificial intelligence, to enhance the possibility to manipulate and evaluate large amounts of information and exchange data within a networked system [4].

The benefits that Industry 4.0 can bring to industry – and therefore to customers – include: better resource efficiency, faster production, better quality control and greater product and component traceability and most important lower costs [10].

IIoT allows multiple devices (simple as a single sensor or complex as a machine tool) to exchange data using Internet and Ethernet-Based Technologies. Manufacturers should consider the current levels of factory automation and network

architecture that exist in the factory today. Adopting the principles of Industry 4.0 and smart manufacturing may require high levels of investment, due to requires of high levels of automation and network infrastructure, so the road to digitalization will not be cheap.

Table I compares the advantages and disadvantages of Industry 4.0.

TABLE I
INDUSTRY 4.0 ADVANTAGES AND DISADVANTAGES

Advantages	Disadvantages
Automation of repetitive tasks	"Fear" of new technology/too much transparency
Utilization of e-workflows	Many of the current machinery and stations in stores are not compatible with digitalization
Production detail data (e.g., current manufactured pieces.)	Accurate definition/design of data structure
Available in real time → Ability to make quick decisions	Incompatibility issues between different databases/systems

Industry 4.0 target is to implement a smart factory based on a Computer Physical System (CPS – Cyber Physical System). CPS collects and analyzes information about equipment and people in the real world and help to control it based on the results of the analysis. This concept provide possibility to improve the efficiency and system optimization. In manufacturing plants, the practice of using sensors to collect information and use it to monitor and control production facilities has been implemented. In the future, the improvement of sensor networks and analyzes will result in factories becoming intelligent and autonomous, i.e., smart factories.

In a smart factory, all the equipment is networked. Analyze the data they collect and use the results as a basis for the coordination and control of equipment and personnel to achieve the following purposes:

1. Maximizes production quality
2. Minimize the costs

While all existing Supply Chain Management (SCM) systems are advanced to enable the above, it is expected that industrial operations (operations management) will use AI (artificial intelligence) technology to provide particularly important innovations [11].

Intelligent manufacturing or also called smart manufacturing is a broad manufacturing concept that can optimize production and product transactions by making full use of advanced information technology and manufacturing. It is considered as a new production model based on intelligent science and technology, which greatly upgrades the design, production, management and integration of the entire life cycle of typical products. Through the use of various smart sensors, adaptive decision models, advanced materials, smart devices and data analysis, the entire product life cycle can be

simplified. Production efficiency, product quality and service levels will be improved. A manufacturing company's ability to cope with global market dynamics and fluctuations can enhance its competitiveness.

In the era of Industry 4.0, Intelligent Manufacturing System – IMS uses Service-Oriented Architecture (SOA) over the Internet to provide collaborative, customizable, flexible, and configurable service to end users, enabling a highly integrated human-machine manufacturing system.

The high integration of human-machine collaboration aims to establish an ecosystem of various product elements contained in IMS, so that organization, management and technical levels can be seamlessly combined.

AI (Artificial Intelligence)-Artificial Intelligence plays a vital role in IMS by providing typical functions such as learning, reasoning, and action. By using AI technology, people's participation in IMS can be minimized. For example, materials and production components can be automatically organized, and production processes and production operations can be monitored and controlled in real time. As Industry 4.0 continues to be popular, it will eventually realize autonomous wake-up, intelligent interconnection, intelligent learning analysis and intelligent decision-making. For example, an intelligent scheduling system can allow tasks to be scheduled based on AI technology and troubleshooting procedures and can be used as an Internet-Enabled Services (Internet-Enabled Platform) to provide other users [5].

The systems for Augmented Reality providing different services, from sending maintenance instructions via mobile devices to selecting parts in a warehouse. Companies, in the future will use augmented reality systems much more mainly to improve the work procedures and will help employees with real-time information to improve decision-making.

For example, operators may receive maintenance instructions for changing of some particular spare part because they are looking at a real system that needs repair. These data can be displayed directly to the operator's vision using devices such as glasses for augmented reality.

Another possibility is virtual training. Siemens has developed Como's software that uses a realistic, 3D data-driven environment with augmented reality glasses to train emergency plant personnel. It is a virtual production operator training module. Operators can also change parameters and download operating data and maintenance instructions [12].

IV. THE IMPACT OF EDUCATION AND FUTURE JOBS

The world is entering the Fourth Industrial Revolution and smart technologies are leading to a series of changes in the economy, the labor market and our lives. Education is a way to prepare young people for the challenges of the new age. In addition to the classic technical knowledge in the field of information technology, 21st century jobs will require new knowledge and new skills. With digital literacy, the progress of individuals and societies will require creative, critical, and analytical thinking to solve challenges [13].

The development of the Fourth Industrial Revolution will transform the modern living and working. Some jobs will not exist, other jobs going to be developed, and new jobs that do

not exist these days will become usual. What is known is that in the future will be required new skills to master.

A report from "The Future of Jobs" [14] indicates what skills would be needed in the future:

1. Solving complex problems
2. Critical thinking
3. Creativity
4. Managing people
5. Coordination
6. Emotional intelligence
7. Reasoning and decision making
8. Service orientation
9. Negotiations
10. Cognitive flexibility

Creativity will be among the first necessary skills. Workers will have to be more creative to benefit from the large number of changes that will occur. Robots can help us to be faster, but they cannot be as creative as humans.

Negotiation and flexibility are high on the list at the moment, but in the next years they will start to fall because the machines will make decisions for us.

Active listening will be deleted completely.

Emotional intelligence, which is not in the top 10 list of current skills, will be among the first in the future.

The nature of change will depend most on the industry itself. Some areas are already far ahead of others, mobile technology, artificial intelligence, 3D printing already have an impact on the way we work.

Change will not wait for businessmen, educators and governments should be proactive and educate people so that everyone can easily adapt and be part of the Fourth Industrial Revolution.

V. CONCLUSION

Industry 4.0 will dramatically change current environment. With interconnection of work cells, workstations throw sensors and IT systems going to be linked with the supply chain outside of a one company. These connected cyber-physical systems will use standard IP protocols to share information with each other and analyze the data to predict failures, configure themselves and adapt to changes.

Industry 4.0 will enable the collection and analysis of data, faster and more flexible, highly efficient processes and producing better quality finish goods with reduced costs.

The Fourth Industrial Revolution will have a strong impact and bring benefits in many areas by increasing productivity, revenue growth, employment, education and future professions, investment, sales, operations management, production flexibility – allowing shifting from mass production to mass customization [15].

In addition, there will be lower costs, faster production, better resource efficiency, avoidance of delays, greater quality control and greater traceability of products and components, and greater safety for workers. Also, this will have huge influence to change the economy, change the structure of the workforce, boost industry growth, which will dramatically change the competitiveness of companies and industrial zones [10]. Smart factories are mobile and adaptable, and can

support different production scenarios. They are also flexible and can handle different quantities of production and production technologies. In terms of manufacturing, Industry 4.0 usually involves applying sensors to devices, controls, and other digitally aware devices, then networking them, sharing data to drive changes in automated manufacturing, and providing executives with insights analysis, solutions and decision-making [16]. By using artificial intelligence data and IoT devices, companies can easily perform more product analysis to provide high-quality information.

The development of the Fourth Industrial Revolution will transform the modern living and working. Some jobs will not exist, other jobs going to be developed, and new jobs that do not exist these days will become usual. What is known is that in the future will be required new skills to master. The nature of change will depend most on the industry itself.

Change will not wait for us: businessmen, educators and governments should be proactive and educate people so that everyone can easily adapt and be part of the Fourth Industrial Revolution.

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