INDUSTRY 4.0 – THE NEXT REVOLUTION

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ABSTRACT
Every kind of industrial revolutions caused fundamental changes on the whole society. Nowadays we are in the middle of a fourth epoch of technological progress – the new revolution: appeared the new digital industrial technology identified as Industry 4.0. Our article describes the nine technology components that are the building elements of Industry 4.0 and their influence for the company management. We attempt to show potential technical and economic benefits of Industry 4.0 for manufacturers and production equipment suppliers and the challenges for management.

KEY WORDS: *Industry 4.0, nine technologies*

INTRODUCTION

Technological progress caused dramatic growth in industrial productivity since the beginning of the Industrial Revolution. The steam engines in the nineteenth century, the electrification in the early part of the twentieth century, introduction of mass production and automatization of industry guided to very fast increasing of productivity. When we compare development of IT, e-commerce or mobile communication technologies, the industrial technological increases were less dynamical. But every kind of industrial revolutions caused fundamental changes on the whole society.
Nowadays we are in the middle of a fourth epoch of technological progress – the new revolution: appeared the new digital industrial technology identified as Industry 4.0. The transformation process is powered by improvements of nine basic technologies. During this conversion the processes, sensors, machines, workpieces, and IT systems are going to be connected for cooperating together. These connected systems (also mentioned as cyberphysical systems) can work together each other using standard Internet-based protocols. They can analyse data for failure predicting, for autoconfiguring themselves, and for adapting to changes. Industry 4.0 allows to gather and analyse data from machines, enabling faster, more flexible, and more efficient processes to produce products with reduced costs and higher-quality. The above-mentioned facts will increase manufacturing productivity, accelerate economics, support industrial growth. This process requires creative, flexible and swiftly operate leaders, quickly assimilating new knowledge.
Our article describes the nine technology components that are the building elements of Industry 4.0 and their influence for the company management. We attempt to show potential technical and economic benefits of Industry 4.0 for manufacturers and production equipment suppliers and the challenges for management.
Some of the advances in technology that create the basic of Industry 4.0 are already used in manufacturing. New technologies in manufacturing, producing and services are calling for new approaching in the company managing processes. Coupling them with Industry 4.0, they will convert production to totally integrated, automated, and optimized production flow, leading to greater performance and changing traditional production relationships between providers, manufacturers and customers, as well as between human and machines.

1.1 BIG DATA AND ANALYTICS

Analysis based on big data sets has appeared only at a last few years in the industrial world. His function is to optimize the quality of production, to decrease energy consumption, and enhance equipment services. In the Industry 4.0 context, collection and wide-ranging evaluation of big data from many different sources will change into standard to support real-time decision processes. The participants of the mentioned processes are production equipments and systems as well as enterprise - and customer-management systems.

1.2 AUTONOMOUS ROBOTS

Manufacturers in many field of industry are using long time ago robots to provide complex functions, but robots are able for even greater usefulness. They are becoming more autonomous, flexible, and cooperative. They are co-operating with each other and work safely together with humans – cobots (collaborative robots) and the robots will learn working procedures from people. Robots are now cheaper and have a greater range of facilities. Some modern solutions offer to us maximum flexibility by natural automation, optimally support us as an assistant in the case of workload peaks and resource bottlenecks in our production operations.
Human-robot collaboration is revolutionizing industrial production and manufacturing in the factory based on I4.0 and offers for us the following benefits:

- Continually increasing flexibility in production.
- Release employees from unfavourable work by performing ergonomically steps that could not be automated earlier.
- Reducing risk of injuries and infections, overloading.
- High-quality performance of reproducible processes – without requiring type-specific or component-relevant investment.
- Increased productivity and improved system complexity based on the integrated sensors, and continually high level of quality.

1.3 SIMULATION

3D simulations of products, materials, and production processes are already used in the designing phase. Simulations are used more extensively in production operations in the Industry 4.0. These simulations utilize real-time data to transform the physical world into a virtual mathematical model, which includes machines, products, humans and processes also. This allows engineers to test and optimize the machine settings and the processes online for the next product in the virtual reality before the physical realization, to decrease machine setup times and increase the product quality by excluding possible mistakes.

1.4 HORIZONTAL AND VERTICAL SYSTEM INTEGRATION

Most of current IT systems are not totally integrated. Companies, suppliers, and customers are seldom closely linked, in contrast of the departments such as engineering, production, and service. Functions from the company management to the shop floor level are not fully integrated. The complete integration is missing from the design process of products up to workshop automation. Based on principles of Industry 4.0, companies, departments, functions, and capabilities will become much more complex, because of cross-company,

universal data-integration networks are developing and enable automated communication and control connections.
Vertical integration is meant to connect the business from sensor and actuators on the shop floor up to the ERP systems in real-time. In the other direction, control actions such as plan changes are affecting the system down to the shop floor. Autonomous parts of the total system can automatically adapt to changes. Manufacturing Execution Systems (MES) are central in bridging the communication gap between shop floor and management level. Management Information Systems (MIS) are powerful tools for support decision making processes also.
Horizontal integration refers to the digitally supported connection of supply chain processes from supplier to customer. The horizontal integration will expanse outside company boundaries, connecting suppliers and customers through digitized value creation networks. Industry 4.0 is likely to generate new business models, in which production capabilities are not rigidly distributed in the value chain. The supply chain will consist of collaboration networks that utilize manufacturing capabilities flexibly between partners. Tasks will be distributed according to factors such as capability, capacity and proximity to the customer. All information from shipping, manufacturing, and usage will be stored in the cloud, enabling full traceability. Realtime control will make it possible to navigate customer-specific adaptations through the value chain in minimal time. Sales and Operations Planning (S&OP) processes will play a key role in realizing the horizontal integration. The improved loads on flexibility and mass customization require reliable and accurate forecasts. The most powerful tool for ensuring accurate forecasts of customer requirements is big data analytics.

1.5 THE INDUSTRIAL INTERNET OF THINGS

Today, only some of a manufacturer's sensors and machines are networked and make use of embedded computing. They are typically organized in a vertical automation tree in which sensors and field devices with limited intelligence and automation controllers feed into a central manufacturing-process control system. With the Industrial Internet of Things, more devices—including even unfinished products—will be improved with embedded computing and connected using standard network (WiFi, 5G) technologies. This allows devices on workshop level interact to each other and to communicate with more centralized controllers if it is required. It also decentralizes analytics and decision making, enabling real-time responses.

1.6 THE CYBERSECURITY PROBLEM

Many companies are using management and production systems that are separated or closed today. To protect critical industrial systems and manufacturing lines from cybersecurity attacks is very important and is caused by increasing connectivity and using of standard communications protocols integrated in the Industry 4.0. The secure, reliable communication, sophisticated identity and access management of machines and users are extremely important requirements, which have to be fulfilled.

1.7 THE CLOUD COMPUTING

Companies are already using cloud-based software for some applications, but with Industry 4.0, more production-related enterprises will require increased data sharing. The performance of cloud computing technologies is improving; the reaction times achieves of

just few milliseconds. As a result of extremely short reaction times data and machine functionality will be progressively relocated to the cloud, which enables using of more data-driven services for production systems. Monitoring and control processes of manufacturing systems will be cloud based also.

1.8 ADDITIVE MANUFACTURING

3-D printing systems are used by companies to produce prototypes or individual components. With Industry 4.0, these additive-manufacturing methods will be extensively used to produce small sets of customized products that offer construction benefits, such as complex, lightweight designs. High-performance, decentralized additive manufacturing systems will reduce transport distances and stock on hand. This technology allows performing 3-D printing of metals with machining process for finalizing of a product.

1.9 AUGMENTED REALITY

Augmented-reality (AR) based systems support a variety of services. AR supports selection of a component in a warehouse or allows sending repair instructions over mobile devices for the serviceman. These systems are in the beginning period, but in the future, companies will offer much extensive use of augmented reality to support workers with real-time information to improve decision making and work procedures.
Workers may receive repair instructions on how to replace a part as they are looking at the actual system needing maintenance. This information may be displayed directly in workers' field of sight using augmented-reality glasses.
Another useful application is virtual training. In this virtual world, operators can learn to operate with machines by clicking on their computerized representation. They also can change parameters and retrieve operational data and maintenance instructions.

1.10 MANAGEMENT APPROACH FOR I4.0

We can say regarding human resources that in I4.0 HR manager needs to be innovative, creative and learning skilled. Companies should offer to the employees to enable them for multitasking, to increase variety of skills. Training should concentrate on team building, team work skills. Very important is to enhance the problem solving skills of the employees. Organization should make the innovation process a part of routine, by developing the long term capabilities in employees, i.e. by developing the innovative work behaviour, and enhancing the knowledge management practices in the organization, which has the potential to positively influence innovativeness. By adopting the right management practices organizations can develop the dynamic capabilities for innovation. In simple words organizations and employees should be capable enough to change their direction according to the changing situations.

CONCLUSION

Industry 4.0 presents tremendous opportunities for innovative producers, system suppliers, and entire regions. Manufacturing processes will increase in flexibility and allow for the economic production of small lot sizes. Along the value chain, production processes will be optimized through integrated IT systems. Automated logistics, using autonomous vehicles and robots, will adjust automatically to production needs. The development and deployment

of these solutions will be incremental and part of a long-term trend, but the opportunity is already here today.

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