THE ISSUE OF MANAGEMENT OF PRODUCTION PROCESSES IN MODERN ENTERPRISES IN ACCORDANCE WITH THE STANDARD OF INDUSTRY 4.0

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Abstract: *The present is an age of technical progress, the rapid development of new technologies and digital transformation in the industry. In the professional experience is often mentioned as the fourth industrial revolution and there is generally used the term "Industry 4.0". The article describes the current state of the problem in area of management and trends and perspectives of management of complex structures using Business Intelligence (BI). At the end of the article is given a summary of requirements that must be implemented for the possibility of establishing a compatible management system that link all elements of the marketing chain.*

Keywords: INDUSTRY 4.0, PROCESS, MANUFACTURE, STANDARDS, CONTROL, ROBOTS, BUSINESS INTELLIGENCE

1. Introduction

New, advanced computer systems and their application into our life alters the social life and change our life style in all levels of society. New trends in customer behavior in the world together with the improvement of technology and increasing availability of computers represent new approaches to the implementation of production.

Modern industries are undergoing a transformation in accordance with the standards of Industry 4.0. This is a modern standard used mainly in the Germany and it is an approach to implementing new technology into production [15]. In otherwise, in other countries, the process is known as Smart Factory (SF) [12]. Individual enterprises made in accordance with the standard of 4.0 Industry can be integrated into larger units, thus creating virtual enterprises known as Cyber Physical Systems (CPS) [14]. Due to the complexity of such systems, it is clear that the part of the production management needs to be appropriate Enterprise Resource Planning system (ERP) associated with the appropriate Customer Relationship Management (CRM) system. In addition it is necessary to create a direct connection with CRM systems on side of suppliers and customers.

The combination of these advanced software tools along with other production technologies together with BI and new methods of design and analysis is a really big challenge. The potential of such a solution is enormous but also presents a number of problems when applied in practice and in a dynamic environment of modern automated robotic manufacturing systems.

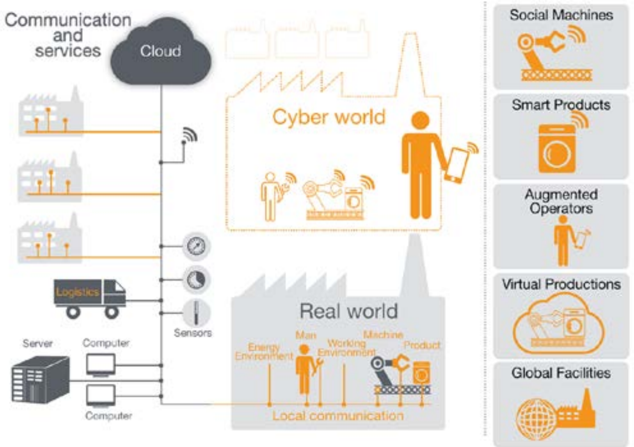

Fig. 1 *Communication in real world and CPS [8].*

The public is familiar with term Internet of Things (IoT) [17], which represents the next generation of products and communication between them. The implementation of this technology in practice (IoT) is directly linked with the standard Industry 4.0. The existence of smart products [2] and communication between products is one of the main prerequisites for the realization of intelligent manufacturing. Due to the complexity of the whole process it is necessary to include Customer Relationship Management (CRM) systems and supply systems into communication process.

The implementation of new standards in the realization of manufacturing enterprises will place increased demand on industrial communication. Communication occurs at various stages of the production process. In CPS regards communication between departments of production, on lower levels is a communication between products and machines, machine and man, alternatively product (smart product). Communication paths yet represent most vulnerable points especially in the use of wireless technology and connecting to a network.

2. The current state of implementation Industry 4.0 in practice

Scientific and Technical Development can be divided into several revolutions. The first three were the result of the technical revolution and revolution in electronics and mechanics. The current stage of development of the industry can be described as a revolution of informatics and communications. This results in a high degree of globalization and the creation of enterprises, whose existence is based on communication. Solutions realized in accordance with the standards of Industry 4.0. respectively Smart Factory, are slowly beginning to appear in all industry sectors. The overwhelming majority of solutions, however, exist only in the form of models or theories, exceptionally in test operation in a specialized case. According to the authors [18], the problem is the cause of the lack of implementation of the following functions in the production process:

- horizontal integration through value networks
- end-to-end digital integration of engineering across the
- entire value chain
- vertical integration and networked manufacturing systems

Moreover, the authors in their work set 8 different targets to be met in the future for the successful implementation of Smart Factory in practice. Similar conclusions are contained in the work of the author Defang Li [5]. He clearly defines the estimated plan of implementation of necessary functions in practice in specialized production. However, it is everything in the stage of preconditions without any real deployment.

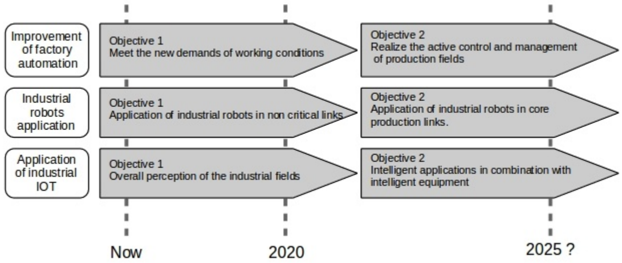

Fig2. *Prediction of application of Industry 4.0 standards in production [5]*

There are many articles as implement Smart Factory. The authors of the source [14] believe that it is mainly the implementation of universal cells and working model of production as a dynamic process. Authors of sources [29, 12] elaborated a design of implementation of the flexible production line in accordance with the standards elaborated Industry 4.0. Part of their work is simulation and they are also present diagrams and calculations with respect to optimizing the quality, availability of resources and energy consumption of factory. The real model of production unit is a work of team of authors [19] and similar solutions are implemented in the aerospace industry [25] and in the petrochemical industry [5]. The implementation of virtual enterprises is described in other sources.

The authors [3] describe CPS (Cyber Physical Systems) which represent the next stage of industry innovation.

A very interesting approach to the proposal of CPS production unit with optimization to localization of sources of raw materials and territorial conditions is outlined in [19] in the food industry. In [16], the team deals with predictive maintenance and data management using BigData and neural networks. Similarly, authors of work [26] describe the realization of factory for production of hybrid electric drive in accordance with the standard of Industry 4.0.

Authors of the article [4] and [7] define a framework for Industry 4.0 that meets the requirements for the implementation of the CPS. They define the system for connection of the real and the virtual world by creating virtual objects within the Smart Factory. Because the processes in these objects are considerably complicated, to deal with them is necessary to use methods such progressive methods as BMMN [1] and MDCN (Multicriteria Decision Making) [6].

The highest level of implementation of Industry 4.0 is in practice creation of virtual enterprises with almost universal possibilities of production. A detailed description of the implementation of these factories is the content of the work of authors [13] and [11]. They defines the term Ubiquitous Manufacturing (UM), which represents the Smart Factory implementation of such a high degree that is almost unimportant the type of manufactured products, production technology and factory location. The mentioned literary sources are largely only theoretical or experimental laboratory solutions. However, there are working models of Smart Factory implemented in real practice. For example Zhang et al. [6] established a real-time management system for a small flexible manufacturing system (FMS) by using smart objects such as RFIDs and auto IDs and Web services. The FMS was composed of three workstations, one trolley, and one shelf. RFID tags were used to identify operators, components, pallets, and locations on the shelf. RFID readers were integrated with a smart gateway and wrapped with Web services to be easily invoked. Thus, the material flows in the FMS could be automatically traced; the WIP level could be monitored, and, based on the monitoring results, proper shop floor control actions could be taken. Bose and Pal [30] installed auto-ID readers at point-of-sale, storage, and receiving locations to automate data collection. During their investigation, several concerns were raised regarding whether an auto-ID application could be successful, including the acceptable initial investment, item-level or pallet-level tagging, data storage, analysis, privacy, big-band or phased adoption, and integration with existing management information systems (MISs).

The application of Industry 4.0 standards is the aim of research of many world leaders in automation and they have testing facilities for testing of deployment and development of new technologies for Industry 4.0.

3. Problem identification

The common element of all the work is only partial implementation of standards, which is of course due to the lack of standardization of processes, devices and applications. The team of authors in [11] identify the causes of this condition. According to them, this is because of the great variety of materials, products and procedures. They offers solution through the creation of industrial clusters, where are created groups of facilities with similar orientation to the production units and taken together form a Virtual Enterprise (VE). A similar approach asserts authors of the work [15, 20]. Similarly standardization is needed for a communication tools and software interfaces. In addition the communication is often wireless and it is also necessary to originate a unified encryption and security system.

Standardization issues in the implementation of Industry 4.0 process are clearly due to the insufficient level of flexibility of automation in general. Devices at the lowest level are highly specialized for a particular function and are focused on maximum efficiency. This results in a low variability and small level of compatibility.

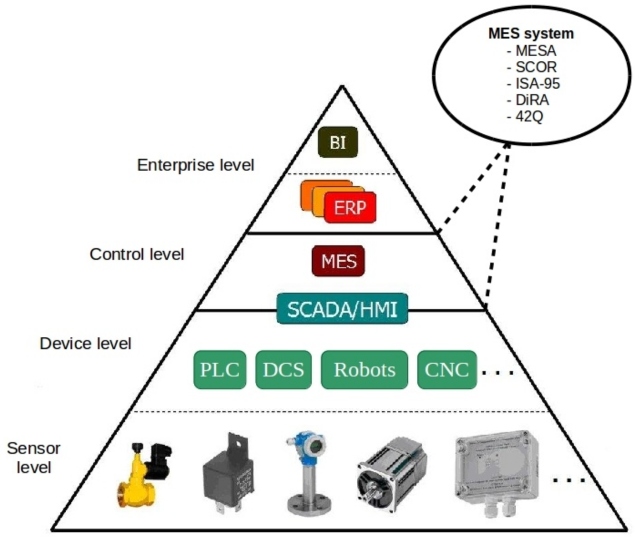

Fig. 3 *MES in standard automation model.*

For the realization of enterprises in accordance with the Industry 4.0 standard it is necessary to solve the above conditions. This involves hardware and software interference with the essential elements of the current automation. It requires a comprehensive approach and solution from the highest level to the lowest level of automation model. The current situation is opposite. For example, on control level, to existing standards for MES systems (MESA, SCOR, ISA-95) has been added new MES standard – DiRA. Behind the acronym is hiding activity of companies Hewlett Packard and Microsoft (Reference Architecture Framework for Discrete Manufacturers) and according to source [32] it represents their "enterprise approach" to MES and "fits nicely within the Microsoft framework to help companies meet today's manufacturing challenges more effectively." The expansion of family of MES systems however does not end. We have to add to them latest MES system 42Q [33].

3. Problem solution proposal

It is clear, that the key to solve a really large set of problems is probably deeper standardization for hardware and software basis. We consider that it is important to specify framework regions, in which it is necessary to make changes to the system.

For successful implementation of Industry 4.0 standards and creating SF is necessary to satisfy the following conditions in the production and planning process:

- need for standardization of communication protocols
- need for standardization of connectors and physical interfaces
- need for standardization of data exchange (standardization of applications)
- the necessity of the existence of a standardized management system (there is missing a unified ERP or MES system)

The process of real deployment of Industry 4.0 standards in practice itself implies significant progress in the development of key technologies, such as:

- artificial intelligence, neural networks (Intelligent Robotics)
- processing and analyzing "big data"
- automatic knowledge discovery, i.e. self-learning, self-adapting and subsequently self-optimization in a dynamic environment
- possibility of full automation of all processes
- possibility of virtualization and simulation of processes in all stages of the production cycle of a product (processing of raw materials - suppliers - production - sales - waste/recycling)
- improve interaction in the relationship man - machine (better perception of the environment by machine, better perception of human behavior and simplified communication of human and devices/computers)

The communication between all devices is an essential element on which it stands enterprise infrastructure in an Industry 4.0 standard. However, no existing standardized communication or network infrastructure has been used to widely accepted standard in automation. Most of protocols are based on TCP/IP communication; also the TCP/IP is part of many automation protocols. Difference between TCP/IP internet communication and automation networks is timing. Therefore one of top needs in Industry 4.0 is to create a possibility of communication and data transfer between networks of IoT, automation devices network, customers and suppliers systems.

4. Conclusion

The presented text makes it clear that the implementation of enterprises in accordance with Industry 4.0 standards in practice is a very complex process. The key to achieving a satisfactory state is mainly standardization. It means not only standardization of basic structural elements, but also standardization on higher levels, i.e. software, control systems and communication interfaces. Moreover, the current state of industrial automation in principle does not allow such flexibility as needed. We believe that it is possible with the gradual application of Industry 4.0 principles into practice over time to achieve high degree of flexibility in production companies but really universal production and virtual smart factories are currently dreams of the future. Success deployment of Industry 4.0 standards depends on the development of appropriate new standards as an application, as well as communication.

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