INFLUENCE NEW TECHNOLOGY ON THE PROCESS OF MAKING WOODEN PREFABRICATED BUILDINGS

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ABSRACT

New advanced production techniques combined with the Internet of things enable the concept of a digital manufacturing company that is not only interconnected but communicates, analyzes and uses information to encourage further intelligent action back into the physical world.
The process of making wooden prefabricated buildings changes with the application of new technologies, digitization and automation in design phases, component manufacturing and / or entire buildings, prefabricated buildings, and the whole process of marketing.
The paper will be presented some aspects of the impact of advanced technology on the process of making wooden prefabricated buildings.

Keywords: advanced technology, wooden prefabricated buildings, process of making buildings

1. INTRODUCTION

Global megatrends such as climate change, lack of resources, demographic migrations, automation and digitization greatly affect the economies, governments and society. In order to assist the construction sector to adapt and prepare for emerging changes, the World Economic Forum, in co-operation with representatives of leading companies, universities, industry associations and governments, has developed three scenarios for possible construction development and strategic implications based on them. Each scenario represents an extreme but plausible versions of the future. In Building in a virtual world, virtual reality touches all aspects of life, and intelligent systems and robots run the construction industry.
In Factories run the world, a corporate-dominated society uses prefabrication and modularization to create cost-efficient structures. In A green reboot, a world addressing scarce natural resources and climate change rebuilds using eco-friendly construction methods and sustainable materials.
It is important to keep in mind that these scenarios are not predictions of the future, but the construction industry in the real future will include the elements of all three versions. According to present knowledge, the production of prefabricated wooden buildings will the best respond to these requirements and versions of the future.
The prefabricated building system (i.e. i.e. pre-cut, panelised, modular, and mobile home building system) has been recognized as one of the alternative solutions to fast-changing speeds of conventional construction methods. Volumetric prefabricated building construction systems comprise modular of volumetric units that are typically manufactured complete with architectural finishes and services at an off-site, quality-controlled factory. These modules are then transported and installed on-site as one of the many load-bearing structural blocks of the building.
Reductions in cost and time are the major advantages offered by the prefabricated building systems when compared to conventional construction methods. Other benefits include improved quality and

accuracy in production, on-site installation speed, and can also be dismantled and reused. This form of prefabricated buildings also provides environmental benefits, such as reduction of construction waste and CO2 emissions, and less disturbance to the building site's neighbours by minimizing on-site noise and dust. These advantages are the driving force within the European building industry for the growth of prefabricated building systems. Because of the growth of the population and other countries (eg USA, Canada, Japan, etc.) also use modular building technology for building houses, flats, offices, etc.
Using modular steel elements, composite materials, lightweight structurally insulated panels SIP), concrete-filled steel hollow sections, elements of wood-concrete composites, as well as elements made of wood and wood-based materials, such as cross laminated (CLT) elements.

2. VISION INDUSTRY 4.0 IN CONSTRUCTION INDUSTRY

In the last decades, all branches of industry have experienced and are experiencing major and significant improvements, including the construction sector. Today, more and more talk about smart products and smart factories. The Vision Building 4.0 includes a smart construction, smart building component, smart layout and design, smart quality control, smart communication, and smart energy management. The concept is based on IT-in that includes a decentralized management system, autonomy, global communication and monitoring.
Industry 4.0 refers to the convergence and application of nine digital industry technologies: Advanced Robotics (autonomous industrial robots that collaborate, as well as numerous integrated sensors and standardized interfaces), Additive Manufacturing (3D printing, especially for spare parts and prototypes, decentralized 3D facilities to reduce transport distances and inventory), Augmented Reality (augmented reality for maintenance, logistics and all kinds of SOP, ability to display of supporting information, e.g., through glasses), Simulation (simulation of value networks, optimization based on real-time data from intelligent data), Horizontal / Vertical Integration (cross-company data integration based on data transfer standards, which is a precondition for a fully automated value chain from supplier to customer, from management to shop), Industrial Internet (network of machines and products, multidirectional communication between networked objects), Cloud Computing (management of huge data volumes in open systems, real-time communication for production systems), Cybersecurity (operation in networks and open systems, high level of networking between intelligent machines, products, and systems), Big Data and Analytics (full evaluation of available data (e.g., from ERP, SCM, MES, CRM, and machine data, it provides real-time support and optimization for decision making).
The concept of Industry 4.0 incorporates and expands digital connectivity in the context of the physical world in digital enterprises and digital supply networks.
This connects the physical act of manufacturing, distribution, and performance in an ongoing cycle known as the physical-digital-physical (PDP) loop.
This cycle - loop is executed in three steps: establishment of a digital records (recording records of the physical operation and supply network), analysis and visualization (of machines working of sharing information with the application of advanced analytics and data visualization in real-time from multiple sources) and generate movement (using algorithms and automation to translate decisions and actions from the digital world into a movement in the physical world).
Through this cycle, real-time access to data and intelligence is driven by a continuous and cyclical flow of information and action between the physical and digital world. Many manufacturing and supply chain organizations already have some parts of the PDP loop in physical-to-digital and digital-digital processes.
Today, most manufacturers implement Industry 4.0 technology to improve a particular process or resolve a certain painful point, but thanks to the fact that these technologies are
becoming more and more advanced, many companies are beginning to apply a more complete solution. This transition can be divided into three horizons of Industry 4.0.
These three horizons of Industry 4.0 are also found in newer solutions for the production of prefabricated buildings. In the phase of Initial Connection, the implementation of the basic levels

of data collection, analysis and communication is implemented. In the first horizon - Process optimization - increases networking and digitization, improving current processes and optimizing the use of existing technology at all. In order to reduce the cost of production, the automation of production, the application of upgraded and improved standards of building, the maximization of data collection and exploitation using advanced algorithms, is increasing. In the second horizon, Process flow and quality, generate digital connections throughout the process, from raw material suppliers, processes production to transport to the ultimate customer, implementing new cyber security measures to address the risk of increased connectivity. In the last horizon - New business models - new revenue streams and values are created for customers through the use of collected data and insights and new products are also built on the basis of digitally collected data from clients.

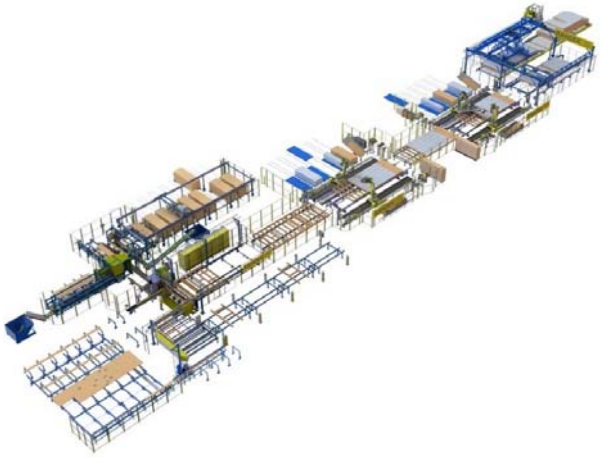
3. ADVANCED TECHNOLOGIES IN THE SECTOR OF CONSTRUCTION OF PREFABRICATED BUILDINGS

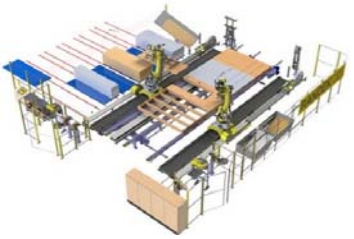
For many years, manufacturers of prefabricated buildings are focused on increasing productivity and reducing operating costs by improving processes. Many advanced and innovative solutions are applied.

3D-CAD systems are applied effectively in the design and construction phases of each element of the building, designing of different variants, structural analysis and simulation, production planning, production process monitoring, and control of all relevant process parameters in real-time, quality control of each individual construction element. Production and processing of elements is performed on CNC machines, automatic lines or used robots (Figure 1). By applying such production equipment, man's work is minimized and safety at work has increased. Changing and maintaining the equipment is easy and fast.

By utilizing these IT systems, significant progress has been made in the field of integrated management of process, organization and product. Based on the above it is evident that the first horizon of Industry 4.0 has been significantly fulfilled in the production of wooden prefabricated buildings.

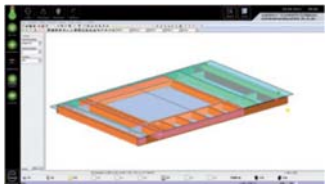
The introduction of computer tools in architecture, engineering and construction has made it possible to successfully change the traditional way of design/production in computer design/production. This industry (construction) is slowly switching to sophisticated Building Information Modeling (BIM), which requires the integration of specific knowledge in the BIM's domain of tools for manufacturing.



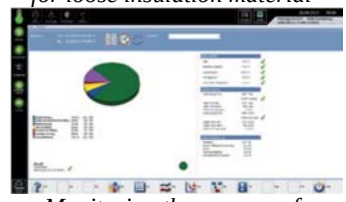


Production of building elements

Fully automatic blow-in process for loose insulation material

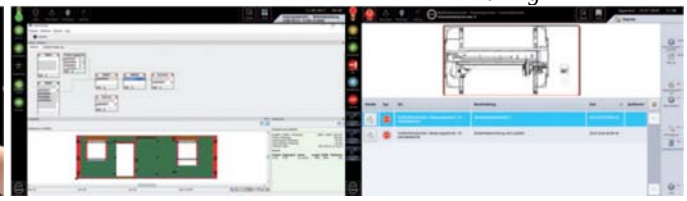


Designing elements of the building or whole buildings



Monitoring the process of making

Converting edited drawings to macros on the production line



Control of production process

Diagnosing possible errors

Figure 1. Examples of the technologies applied in the production of wooden prefabricated buildings

Several different BIM use in construction of prefabricated buildings. These models are divided into four main functions: an integrated planning system of building construction, system automation of the factory, system of site automation and multi-activity management system (multi-project system) from one central place of management and single central database. They are based on rules that enable designers to create models of construction according to modular coordination rules. Modular

coordination and BIM enabled the development of smart building components based on rules and standards.
Control of certain parameters is carried out in the production hall, but also during the process of transporting the element of the wooden prefabricated building to the place of installation (e.g. control of the temperature, humidity and relative humidity of the components of the wooden walls during transport to the site using mobile data collection), and also after the construction of the building, i.e. during the life of the building.
The components of the building and in the built-in products are installed sensors which monitor certain parameters.
These parameters measure the environmental characteristics of the environment outside and inside the building (relative humidity, temperature, condensation, solar radiation, wind power, etc.), performance of built-in products in the building (e.g. window lighting characteristics, window or wall thermal characteristics etc.) but also certain structural changes in the components of the building (the stress value in the construction structure due to the action of the earthquake or typhoon, the appearance of cracks, vibration, differential pressure, etc.). Information is transferred to designers, contractors, but also to building owners. Data can be collected in a wireless, wired or cellular way.

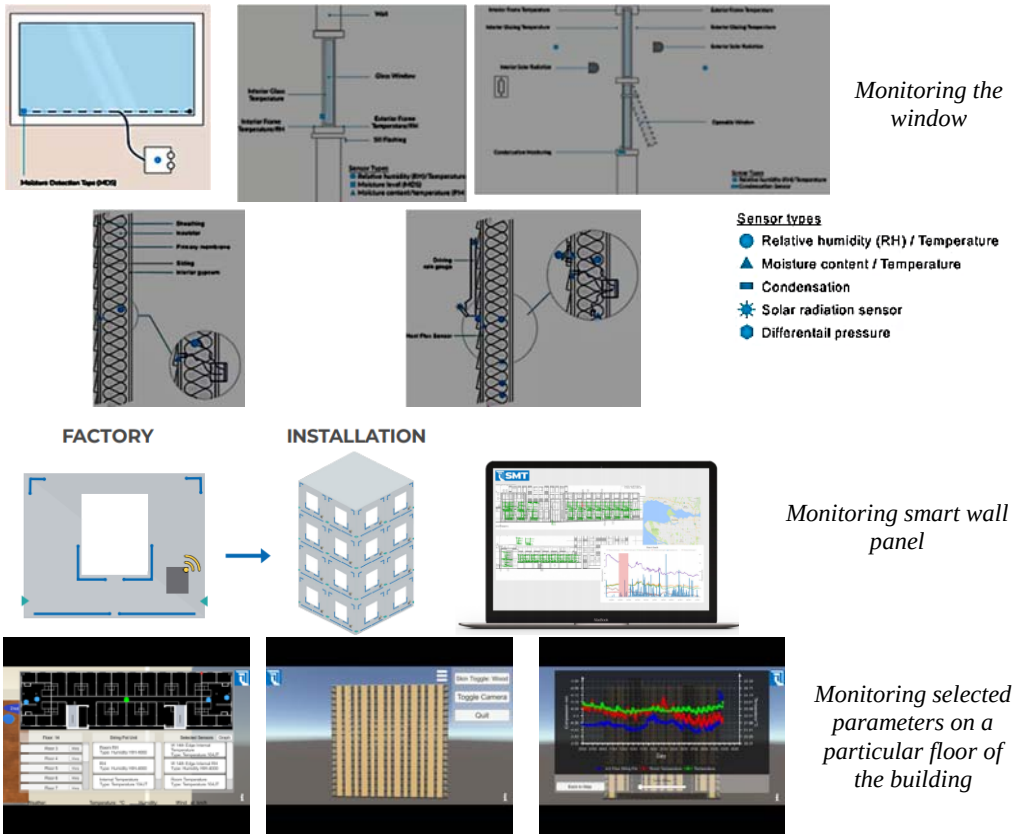


Figure 2. Smart monitoring components of buildings (prefabricated buildings)

The decision-making problems in the construction project are often caused by a precise division of project processes and functions due to the complexity and diversity of current construction projects. In order for the system to achieve its purpose it is necessary to achieve a high level of coordination between man and computer, and to ensure a well-organized data transfer environment in order to

avoid instantaneous errors in the coordinated transmission of information and data between different organizations. In this way, the process of deciding on a problem in the construction process is facilitated and flexible.
The current IT applications for the exchange of information and knowledge among individuals, groups and organizations in construction projects are divided into four main functions:

- Internet real-time monitoring systems for structured performance data exchange and information on the transport of construction material between site engineers and auxiliary engineers at headquarters, branch offices and technology institutes;
- Web information management systems for the exchange of information on the progress of construction, unresolved issues and visual site information between clients, designers, engineers, constructors, manufacturers and suppliers;
- Total system of project management between different project blocks on site and
- a knowledge management system between the same types of construction projects, such as multi-storey buildings, hospitals, semiconductor plants, etc. which require specific engineering knowledge and technical information.

It is expected that the Internet of Things (IoT) will be installed throughout the life cycle of the construction project. Existing IoT solutions add new types of sensors to enrich the types and amounts of data collected, and organizations are expected to expand their use of real-time monitoring and control data.

4. CONCLUSION

The production of wooden prefabricated buildings has significantly developed over the past decade, and further growth in the manufacture of wooden prefabricated buildings is expected.
Industry 4.0 can be described as increasing digitization and automation of the production environment, and creating a digital value chain that allows communication between products and their environment and business partners.
Using the technologies that lead to realization of the vision Industry 4.0 in the process of making wooden prefabricated buildings, a number of advantages are achieved, such as: construction of a prefabricated building according to the requirements of each individual customer, improvement of the quality of the building, reduction of the construction time, reduction of the construction costs, easier coordination and better cooperation between all stakeholders connected with the value chain, control and monitoring of the entire process, the possibility of quick application of knowledge for the following projects, the possibility of developing new improved products or buildings, etc.
At present, a large number of manufacturers of wooden prefabricated buildings still use the traditional way of production enhanced by the use of automatic lines and robots, however, the rapid development and application of IT technology also contributes to the faster application of Industry Industries 4.0 in this branch of production.

5. REFERENCES

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