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SIGNIFICANCE OF SIMULATION AS A FUTURE TREND: WORKPLACE STUDY USING SIMULATION SOFTWARE WITNESS

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Abstract: Globalization in manufacturing industry, aiming to reach the highest level of productivity and competitiveness oblige companies to innovate their products, technologies, processes. Using simulation and modelling to solve production problems is one of the research topics and priorities for future actions in manufacturing industry. After the simulation model is built, validated and verified, many scenarios can be tested before applying changes in a real performance, avoiding unnecessary costs if the change would have a failing effect. This article is focused on a simulation method and its application on a case study applied in manufactory.

1 Introduction

1.1 Trends in manufacturing industry

In an environment characterized by rapid social, economic and technological changes, new demands are still being placed on manufacturing research. The most common aspects of change in manufacturing research are considered following [1]: *globalization, competitiveness, high productivity, innovation, market factors, social factors, environmental factors*.

Globalization represents new ways and ways of how the individual national economies work together. National economies have become integrated through the free movement of goods and capital across borders. Standard theoretical models are to reduce trade barriers and transport costs, which will increase trade between producers in one country and consumers in another country. Such newly created international relations underline the importance of the development of manufacturing research [2].

The goal of *competitiveness* is to maintain sustainable development based on the business strategy. The strategy should be chosen in such a way that quality, productivity and innovation have a steadily increasing tendency [2]. Consequences of the implementation of the new competitiveness strategy lead to:

- the flexibility of the production process,
- reducing resource consumption,
- lower production costs,
- efficient use of transport and other components,
- applications of automated and sophisticated technologies.

High productivity - the flow of production activities is reflected in the efficiency of production systems. Growth of productivity is one of the main ways to increase competitiveness. At present, the main source of economic growth is the continual increase in labour productivity. The main types of developmental changes according to [2] can be stated:

- placing new products and services on the market compared to competitors,
- use of new materials, sources and raw materials,
- new organization of production,
- placing products and services in new market segments.

The effort of enterprises to make changes is also influenced by [3] following factors:

- *Market factors* - high competition, globalization, unstable environment, product lifecycles and production systems are diminishing; emphasis is placed on high quality at the lowest prices, customer demands are constantly evolving.
- *Social factors* - changes in the organization of working time, wage increases, emphasis on humanizing work, seeking new ways to motivate people, actively engaging employees in business changes, changing views on the job position in human life, changing the rankings of values influenced by raising the standard of living.

2 Materials and Methods

2.1 Description of latter possible solutions that are used in production industry

Production systems with breakthrough innovations are at the stage of research and development. In the literature and in the projects, they are referred to by various terms, Factory of Future (FOF), Intelligent Manufacturing (IM), Agile Manufacturing, Sustainable Manufacturing, Breathing Factory, Excellent Production, Teaching the Learning Organization and many others [4].

General trends in system manufacturing innovation characterize productivity, flexibility, high precision and quality, environmental friendliness and investment cost acceptability (Figure 1) [5]. Other features include flexible adaptability, ergonomic standardization, cost-saving without redundancy, elimination of waste, instant availability, the ability to install and place anywhere in the world, the absence of long recovery and commissioning times, the exclusion of extra costs, optimal energy performance, the ability to rearrange and reorganize activities on a case-by-case basis to suit current products and production volumes. The general feature is the application of advanced technologies, particularly ICT (Information-communication technologies) [6].

Recently, there has been a debate about the future of production in the United States, Japan and Europe. Production is in relative decline compared to services, but the financial crisis has brought back the benefits of a stable production base into a focus. In order to assess this issue, society needs to know why production is falling and whether it really is a problem for the current economy [6].

Recently, the pace of production decline has stopped or at least slowed down. Outsourcing jobs to Asia has also slowed down. Further trends point to a better future for global production. These include new sources of demand for industrial products, with a large number of consumers in emerging economies entering the global consumer goods industry. The supply side of the supply chain is a stream of new technologies that are waiting for further use to bring new types of products to the market, to re-discover existing products and also to improve the efficiency of production processes. An example is additive production using 3D printers, robotics, nanotechnologies, and intelligent communication systems [7,8].

The future direction of European Industrial Manufacturing Research has been incorporated into the Factory of the Future project. Research activity has four core priorities:

- Sustainable production,
- Intelligent production,
- High-performance production,
- Use of new materials in production.

On the basis of analyses, information and knowledge about production research can be summarized research topics and priorities for future actions and funding [7,9]:

- Sustainable development based on the efficient use of production sources,
- Production technologies exploiting the potential of new technologies (bio and nanotechnologies),
- Using simulation and modelling to solve production problems,
- Agile, responsive production systems for customer-oriented production.

In many countries, the emphasis on production research is on high value-added industries and on their development. Experts agree that there are prerequisites that drive production research to a successful end. The assumptions are based on a multidisciplinary nature, i.e. on the interconnection of science and technology [10].

The solution suggestions of new complex tasks according to innovation of production systems can be identified as:

- network structures,
- systematic prospective studies,
- transnational forums,
- creating innovative scenarios, etc.

These recommended forms have the potential to raise awareness and relations between organizations (academia, industry, government and other innovation organizations).

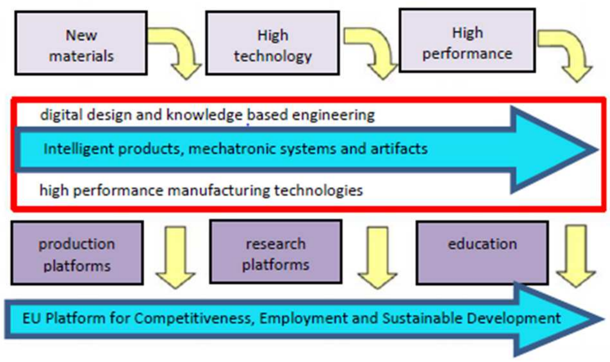

Figure 1 Industrial technology direction in the EU according to [4]

2.2 Case study description for simulation modelling

The simulation model was built in order to evaluate the value flow in the production factory of plastic and aluminium products from a window manufacturer.

First, technological process would be introduced for better understanding of a product flow in the production area. The production process starts by adding material to the cutting centre, where the material is cut to the required length. Shredded material profiles travel to the machining centres where a metal reinforcement is inserted into the profiles. At the same centre, holes are drilled into the profile for handles, posts, hinges, and drainage holes are milled. From the machining centres, the material loaded in the racks travels to the four-headed welding machines. There, it is split into wings and frames. Through the belt conveyor, the welded products are moved to the CNC cleaners, where the welding of the corners of the windows and the door is completely assisted by a variety of tools. After machine cleaning, it is also advisable to clean with the help of the staff for perfect cleaning around the welding site. Subsequently, the wings and frames are placed in the container. According to the plan, the worker selects from the storage container which window or door will follow. With the screws, he fixes the fittings manually on the wing, which is screwed by the screwing centre, which ensures the accurate drilling and screwing, allowing the wings to be mounted securely in the frame.

The last operation in the production process is glazing, for which an insulating double glazing or triple glazing is used. It is glazed using spacers and glazing bars that are cut to exact size [11].

2.2.1 Simulation model in Witness software

Based on input data from the production plant - cycle time; production lead time; time for machine operation and setting; logistics times: time for supply of material and quantity of production batch; simulation model was created (Figure 2, Figure 3) [11]. The operation day was set for one 8-hour working shift, according to real conditions. As working conditions, one operator performs work next to one machine, but there are operations requiring cooperation of two workers due to a weight of the piece, for example moving window frame from one position to another.

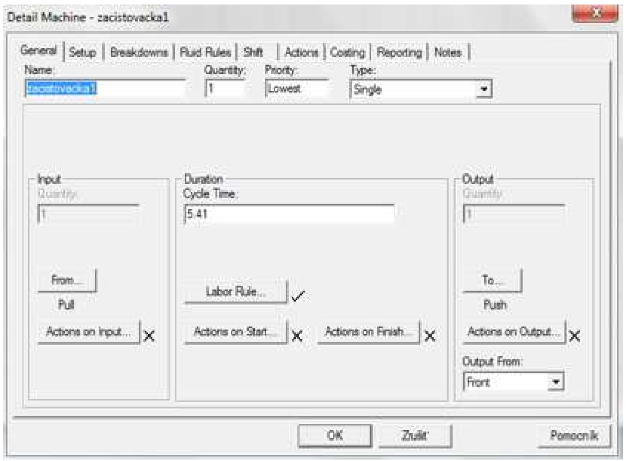

Figure 2 Detailing Workplace Weld Cleaning

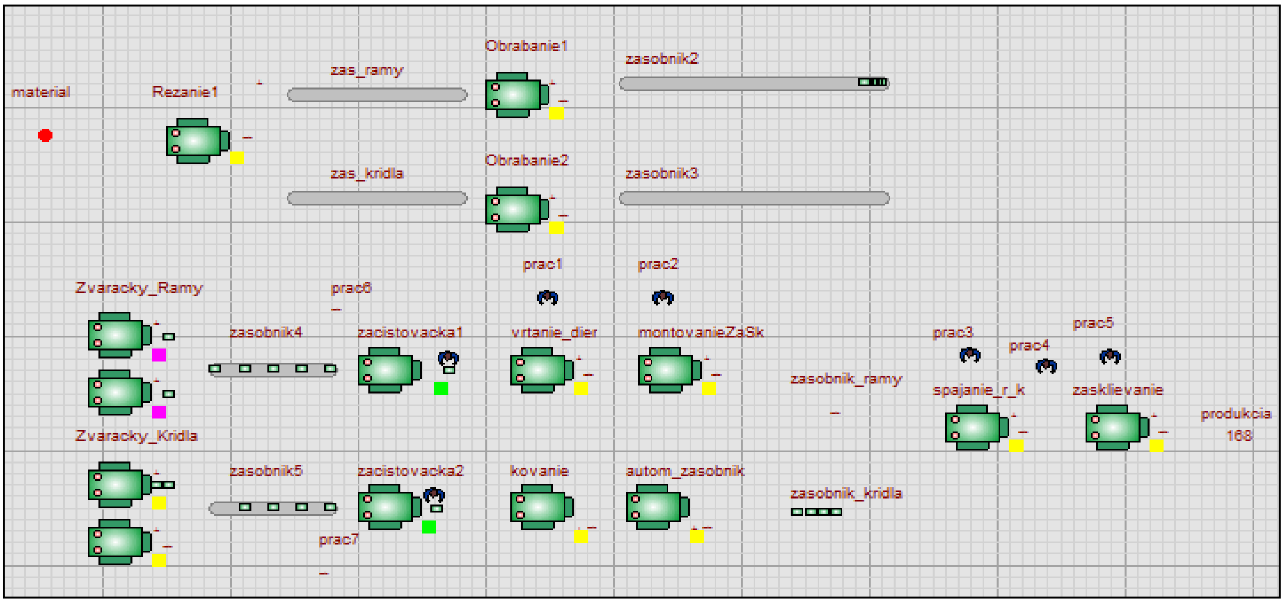

Figure 3 Simulation model of a manufacturing factory

The aim of the simulation model was to analyse the efficiency of the production plant and to propose measures due to increasing the throughput and productivity of the whole system.

After completing the simulation runs, it can be stated that the production hall is capable of producing 168 units of window units in an operation mode that can be seen in the statistics output from the model (Table 1) [11], with the actual number of machines and equipment. For a given type of production program, production output in real

operation is approximately 170 window units. Thus, can be stated, that built simulation model is validated and verified and available for experiments with a model.

The statistical outputs show that the most loaded machines are Machining and Cleaning stations, where the work is essentially continuous. On the contrary, the least loaded is the workplace for Glazing, joining frames, working station "Assembly_w" with wings, where there is a long waiting time for the semi-finished product arriving at the workplace.

The first results from simulation model indicate a possible improvement in the organisation of individual working places. Long idle times indicate speculations about efficiency and consistency of material flow on input, as well as interoperation transport.

Name	Idle [%]	Busy [%]	Blocked [%]	Setup [%]
Cutting1	53.88	19.63	25.49	1.00
Welding_	38.69	19.17	42.15	0.00
Welding_	22.53	3.11	74.35	0.00
Welding_	26.40	11.02	62.58	0.00
Welding_	26.63	11.02	62.35	0.00
Machining1	25.88	74.12	0.00	0.00
Machining2	25.88	74.12	0.00	0.00
Cleaning	3.36	95.76	0.00	0.88
Cleaning	3.36	96.19	0.00	0.46
Drilling	80.38	19.25	0.06	0.31
Forging	79.83	20.17	0.00	0.00
Assembly	80.00	17.50	0.00	2.50
AutoBuffer	96.33	3.67	0.00	0.00
Assembly_w	93.38	5.25	0.81	0.56
Glazing	97.31	1.75	0.00	0.94

Table 1 Statistics of machine productivity after simulation run

3 Conclusion

As most common scenario analysis of the results from simulation run is considered the what-if analysis. What-if analysis can be simply performed by operational manager as a part of a decision-making process. Professional operational manager can evaluate several scenarios to achieve the best operational result. Results from simulation model can be part of value stream mapping, in order to make a valuable product.

Using simulation and modelling to solve production problems is according to [7] one of research topics and priorities for future actions and funding.

The aim of the simulation model was to analyse the efficiency of the production plant and to propose measures due to increasing the throughput and productivity of the whole system. The first results from simulation model indicate a possible improvement in the organisation of individual working places. Long idle times indicate speculations about efficiency and consistency of material flow on input, as well as interoperation transport.

Such a way, experiments with valid and verified model would be further performed.

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