IMPROVING OF MANUFACTURING SYSTEMS IN INDUSTRIAL ENTERPRISES BY USING DYNAMIC SIMULATION

Ján HUDÁK, Natália HORŇÁKOVÁ, Helena VIDOVÁ

Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava,
jan_hudak@stuba.sk, natalia.hornakova@stuba.sk, helena.vidova@stuba.sk

Abstract
Simulation, as a tool for acquiring the optimal solution, is also representing a support tool that allows managers to test the effects of their decisions on the simulation model and not directly on a real system. This model also enables to implement various experiments, analyse them, evaluate them and consequently performs the optimisation. "Launching" simulation, after the implementation of the required changes, it is possible to detect the potential risks in advance and immediately apply the results to real system without investing any money and verifying or implementation it directly in practice.
The paper presents the idea of improving manufacturing systems in industrial enterprises by using dynamic simulation. The main goal of this paper is to present the practical example of spindle production process optimisation through software Tecnomatix Plant Simulation.

Keywords: Simulation, Optimisation, Production Process

INTRODUCTION
Small and medium production enterprises from the metallurgical sector must now compete with large enterprises, which have much larger capital, more advanced technologies and information systems. Due to this fact, enterprises are being forced to improve their processes to be better, faster, to produce the products in higher quality and do all of this for lower cost and higher level of customer satisfaction [1, 2]. One of the possibilities for the optimisation and development of the sector of SME’s is dynamic simulation by using various software as Witness Simple++, Cyberplan, Tecnomatix and its modules and etc. According to a survey which was conducted in Slovakia in 2010, the simulation was used as a tool for production and logistics processes optimisation in over 85 % of Slovak production enterprises. Enterprises are increasingly aware of the possibilities and benefits that simulation can bring them [3]. These benefits can include for example rapid design and deployment of equipment, assembly verification and also improving or planning of new or existing buildings layout. The average payback period accounts for 8 months.

1. METHODS
The basis for authoring this paper was to study literature and collect theoretical knowledge in the field of optimisation and simulation. Another necessary step was to obtain data from the real environment of production enterprise, namely from the production department focused on the spindle production. Based on these data, the simulation model of spindle production was constructed. Consequently the model was optimised by simulation.

Research methods used in the development of the contribution will be:
- Observation – used in mapping the order and the production process.
- Experiment – used to compile an optimised model of the production process.
2. OPTIMISATION BY SIMULATION

The Optimisation is one of the most important components of the planning system. The results of optimisation are an optimised production plan and also optimised configuration of the production system. This is particularly significant for flexible manufacturing systems, which are designed for adaptation to change production requirements [4].

Simulation is a method of replacing the designed system by its simulation model. Simulation models simulate the functions, activities, and processes of the real manufacturing or logistics system [11]. Simulation is a powerful tool for solving many problems, particularly in manufacturing [5, 6]. Its use in the modelling and analysis of manufacturing systems are one of its largest application areas, which have become increasingly important in the last couple of decades [7, 8]. Quantitative and qualitative benefits have been attributed to simulations, and experienced by organisations [6].

Computer simulation has become one of the most widely used techniques in manufacturing systems design, enabling decision makers and engineers to investigate the complexity of their systems and the way that changes in the system’s configuration or in the operational policies may affect the performance of the system or organisation. Material flow simulation enables the optimised movement of materials; to reduce inventories and support value added activities in the internal logistics chain [2, 9].

Plant Simulation (see Fig. 1) is a discrete-event simulation tool that helps you to create digital models of logistic systems (such as production), so that you can explore a system’s characteristics and optimise its performance. These digital models allow you to run experiments and what-if scenarios without disturbing existing production systems or – when used in the planning process – long before the real production systems are installed. Extensive analysis tools, such as bottleneck analysis, statistics and charts let you evaluate different manufacturing scenarios. The results provide you with the information needed to make fast, reliable, smarter decisions in the early stages of production planning. Using Plant Simulation, you can model and simulate production systems and their processes. In addition, you can optimise material flow, resource utilisation and logistics for all levels of plant planning from global production facilities, through local plants, to specific lines [10].

Fig.1 Tecnomatix Plant Simulation
3. PRACTICAL EXAMPLE OF SPINDLE PRODUCTION PROCESS OPTIMISATION BY USING SIMULATION

The following part of the paper is devoted to a practical example of production process optimisation by using simulation in medium industrial enterprises in Slovakia. The spindle production process was simulated through Tecnomatix Plant Simulation program (see Fig. 2). After completion of the simulation, Resource statistics chart was created (see Fig. 3), which display in % the usability of individual machines (marked with green colour in Resource statistics chart).

As it can be seen on Fig. 3, the minimum usability has welding machine 1 (lettered as WM1) and welding machine 2 (lettered as WM2). Another deficiency that was detected during the simulation is that the lathe is not able to take the material from his buffer lathe, which leads to the accumulation of material in this buffer (see Fig. 4).
The authors suggest that adding a second lathe (lettered as lathe 2) to this production department will lead to reduction of work in progress production and increase the usability of the following machines. New machines layout in the workplace can be seen in Fig. 5.

Resource statistics chart (see Fig. 6) proves that the WM1 and WM2 usability has increased by more than 15%. Adding a second lathe (lettered as lathe 2) the usability of lathe 1 decreased, however the usability of both lathes can still be considered as optimal.
Equally the problem with the accumulation of material on the buffer lathe was solved (see Fig 7)

CONCLUSION

By optimising the initial production process order, we have achieved improvement of WM1 and WM2 usability, which was the main objective. Other, equally significant, improvement was made at the other monitoring parameters as work in progress production and production time for one product. The obtained results before and after optimisation are summarised in Table 1.
Table 1 Obtained results before and after optimisation

<table>
<thead>
<tr>
<th></th>
<th>Input</th>
<th>Output – total</th>
<th>Output – per hour</th>
<th>WIP</th>
<th>Production time for 1 piece [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before OPT</td>
<td>322</td>
<td>214</td>
<td>5,706</td>
<td>108</td>
<td>10:20</td>
</tr>
<tr>
<td>After OPT</td>
<td>322</td>
<td>308</td>
<td>8,24</td>
<td>14</td>
<td>7:10</td>
</tr>
</tbody>
</table>

Besides the increased usability of welding machines, also the increased number of finished goods (work in progress production decreased) was achieved by adding one lathe to spindle production process. Production time for one piece was also reduced by more than three minutes (see Table 1).

In general, the simulation can be considered as particularly suitable for enterprises mainly because we can see and analyze the changes in the production process in advance and without need to implement them directly in to real production by method trial and error. Enterprises can save considerable funds that correction of erroneous decision would require.

LITERATURE


