INFLUENCE OF SELECTED ATTRIBUTES IN ASSEMBL SYSTEMS PLANNING ITH USE OF SIMULATION SOFTWARE

Doc. Ing. Václav Š. PhD.[1], Doc. Ing. Košťál P. PhD.[1], Ing. Lecký Š. [1], Ing. Dávid M.[1]
Faculty of Materials Science and Technology – Slovak University of Technology, the Slovak Republic [1]

simon.lecky@stuba.sk

Abstract: *At present, there is an increasing emphasis on planning production and assembly systems. In the planning phase, it is important to eliminate as much as possible, ideally all deficiencies and errors of the intended system. Simulation software helps to find shortcomings in production or assembly systems. Using simulation, we can analyze individual parts of production systems in a virtual environment before they are implemented. This all leads to cost savings in the implementation of production systems. The article deals with simulation of production systems and their planning. The case study will illustrate the simulation process in choosing the right manufacturing system.*

Keywords: ASSEMBLY PLANNING, SIMULATION, ASSEMBLY SIMULATION

1. Introduction

Based on the competition of the international manufacturing network, it is felt to increase pressure to improve the efficiency of production systems. International logistics networks need a linked logistical concept. These requirements can be managed only by using the right digital business tools in the context of the product lifecycle management environment (PLM). This allows the resulting data to be used as the basic support for cooperation between different departments and offers everyday relevant data for every user who needs them. Simulating a complete material flow, including all major manufacturing, storage and transport activities, is a key component of a digital enterprise in the industry. A 20-60% reduction in inventory and production throughput and a 15-20% increase in the productivity of an existing production process can be achieved in real projects. Reasons for using simulations can be strategic or tactical operational goals.

Fig. 1 Product lifecycle management

From a strategic point of view, users answer questions about which plants in which countries are best suited to producing a new product, with regard to factors such as logistics, workforce, time lags, flexibility, warehouse costs, this is all about production from the years to come. In this context, users also assess the flexibility of the production system and, therefore, the significant change in production figures (statistical data - a topic that is becoming more and more important today).

Simulation models make evaluation of different variant of production and effectiveness measurement possible [1]. "In addition, the simulation allows to use new strategies and procedures, verification of the production in the revised system, locate bottlenecks in the flow of materials, increase productivity while reducing inventory and reduce the cost of the implemented changes [1]."

"A bottleneck is defined as a workstation limiting the production efficiency of the entire process (Betterton, 2012; Hsiao et al., 2010). It is the enterprise's workstation or a production cell that is characterized by the lowest level of a specific production parameter
among all co-participating parameters in the manufacturing process. This can lead to a situation, in which a workstation before the bottleneck completes processing, but it cannot forward materials, as the workstation that follows it, being the bottleneck of the process, is still engaged in processing earlier orders. Bottlenecks can also extend the time of the standstill in the processes occurring at subsequent stages (Li, 2009), prolonging the waiting time for further orders. Bottlenecks mark the pace of the entire process. All definitions are consistent in one sense – bottlenecks have an adverse effect on the efficiency of production systems, the flow of materials in the process as well as even burdening of workstations. [2]"

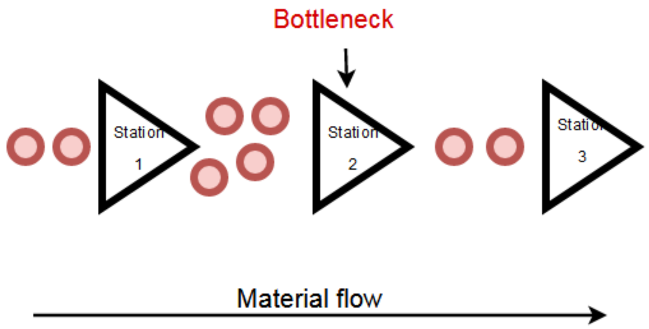

Fig. 2 Bottleneck characteristics

Application/ benefit

Plant Simulation (formerly eM-Plant, Simple++) is a standard software for the simulation of highly complex production systems and control strategies. The tool features object-oriented, graphic and integrated modelling, simulation and animation of systems and business processes [3].

It is an important component and entry tool for the Digital Factory in the software portfolio of Siemens PLM.

Typical questions that Plant Simulation can help to answer

- How can investment costs be minimized?
- Is the required output reached?

- What happens in case of quantity changes?
- How can stocks be reduced?
- What is the best control strategy?
- What effect do rush orders have?
- What is the best planning alternative [3]?

Statistical Evaluation

Plant Simulation offers different statistics for model parameters: Interval statistics, overall statistics and momentary statistics. Comprehensive analysis tools such as automatic bottleneck analysis, Sankey diagram and Gantt chart (planning chart) [3]

Structure / Modules

All Plant Simulation basic and user modules are visible and accessible in the modular library, which can be configured freely. Arbitrary user modules are graphically and interactively created from basic modules by the user himself. These include:

- Integrated neuronal networks
- Factor analysis
- Experiment administration
- Automated optimization of system parameters
- Batch size and sequence planning (sequencing)

The complex production lines and manufacturing processes of today's manufacturers are best understood through a rigorous, analytical framework. It is no surprise that digital modeling and simulations are becoming essential pieces of the manufacturing IT toolbox. Industrial simulation software provides insight into potential problems and presents opportunities for improvement in plant and production line layout, process flow, and other aspects of a manufacturer's operations [3].

2. Simulation with Tecnomatix Plant Simulate

Tecnomatix Plant Simulation software makes the simulation and optimization of production systems and processes easy and effective. By use of Plant Simulation, material flow can be optimized, utilization of resources and logistics for all levels of plant planning from global production facilities, through local plants, to specific lines is effective and time efficient [4].

Benefits

– Enhance productivity of existing production facilities by as much as 20 percent

– Reduce investment in planning new production facilities as much as 20 percent

– Cut inventory and throughput time by as much as 60 percent

– Optimize system dimensions, including buffer sizes

– Reduce investment risks through early proof of concept

– Maximize use of manufacturing Resources

– Improve line design and schedule Features

– Simulation of complex production systems and control strategies

– Object-oriented, hierarchical models of plants, encompassing business, logistic and production processes

– Dedicated application object libraries for fast and efficient modeling of typical scenarios

– Graphs and charts for analysis of throughput, resources and bottlenecks [4]

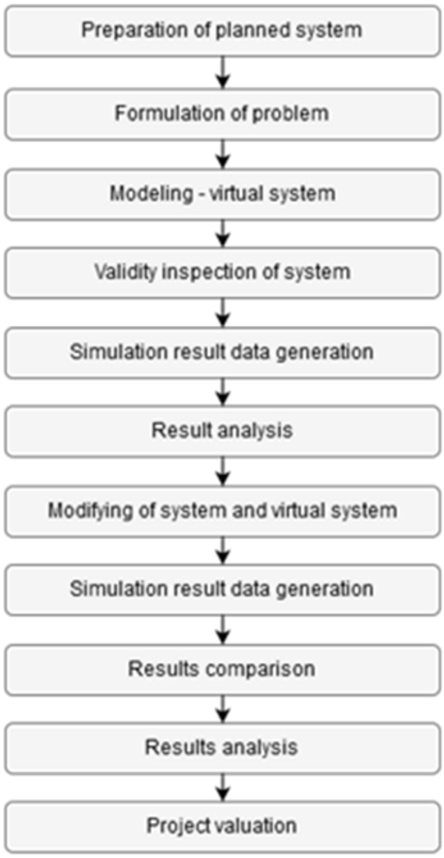

Fig. 3 Simulation workflow steps

3. Simulation case study

In this section will be discussed and shown case study. This case study is aimed on simulation solutions for production lines and systems with use of simulation software Tecnomatix Plant Simulate from company SIEMENS. Tecnomatix Plant Simulate is based on discrete simulation.

Basics of every simulation is to solve some problem or answer some of the questions mentioned before. In this case assembly/production system is tested if there is some room for update or improvement of throughput.

That means for this example that adjusted version of system will be tested and compared with base model of system. The point is to find improvement that would increase throughput or decrease resources.

This case study deals with assembly/production system which consist of input station, pick and place mechanism, three work stations, three assembly stations, four buffers and two conveyors.

First in Tecnomatix Plant Simulate every station, assembly station, conveyor or pick and place mechanism must have time management setting done before running the simulation.

Table 1: *Time management of stations*

Station	Time (seconds)
Pick and place	50
Preparation	300
Assembly	300
Assembly 2	240
Assembly 3	240
Packing	120
Preparation and handling	120

Time management for stations mentioned in Table 1 is between 50 seconds and 300 seconds. Buffers capacities are 1000 pieces except buffer 3 where capacity is 500 pieces.

Table 2: *Capacity management of buffers*

Buffer	Capacity (pieces)
Buffer	1000
Buffer 1	1000
Buffer 2	1000
Buffer 3	500
Failed parts buffer	1000

Table 3: *Speed settings of conveyors*

Conveyor	Speed (m/s)
Line	1
Line 1	1
Line 2	0,5

All the information in tables are parameters that can be changed with respect to technological limits of production/assembly system. By changing parameters, we can adjust model and analyze different output characteristics or behavior of system. Based on that can be chosen the right set up for system.

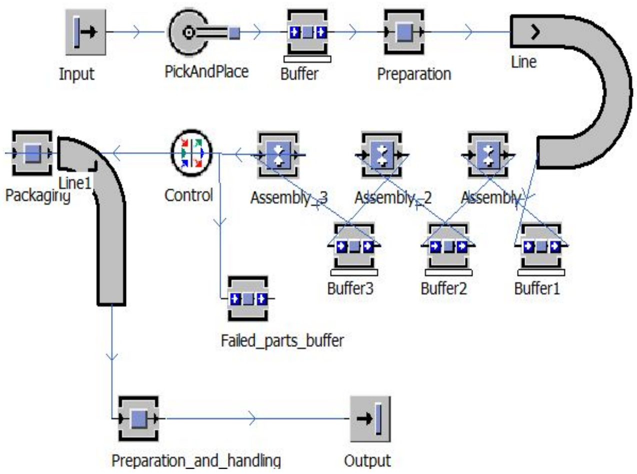

Fig. 4 Base model of system (Tecnomatix Plant Simulate)

In figure number 4 is show production/assembly model which starts at input station where pick and place mechanism moves units to buffer. Pick and place mechanism sets the speed of whole input. Next in preparation station, units are prepared for assembly line. To assembly line are units transported by conveyor with speed 1 m/s.

Assembly part of system consists of three assembly workstations with three buffers. At control point are units sorted and failed parts are moved to failed parts buffer, other parts are transported to preparation and handling station to get ready for output.

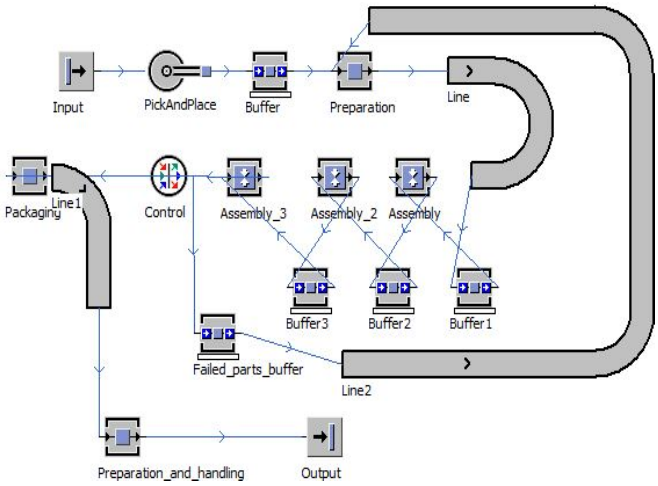

Fig. 5 Adjusted model of the system (Tecnomatix Plant Simulate)

Difference between base model and adjusted model in figure number five is that failed parts buffer is connected to conveyor. Through conveyor failed parts transport to preparation station again, so they are disassembled and ready for next assembly process.

Simulation models work usually with failure settings of 95% working time to 5% failure. In pick and place mechanism was calculated fail time 1% based on real model information.

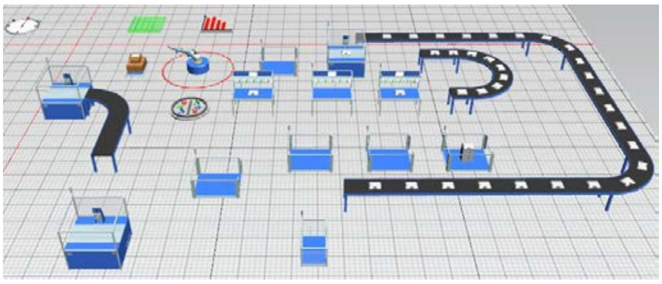

Fig. 6 3D model of adjusted system (Tecnomatix Plant Simulate)

In figure six we can see adjusted model in 3D view of Tecnomatix process simulate window. 3D models in simulation will be important in future as concept of industry 4.0 is becoming more popular nowadays.

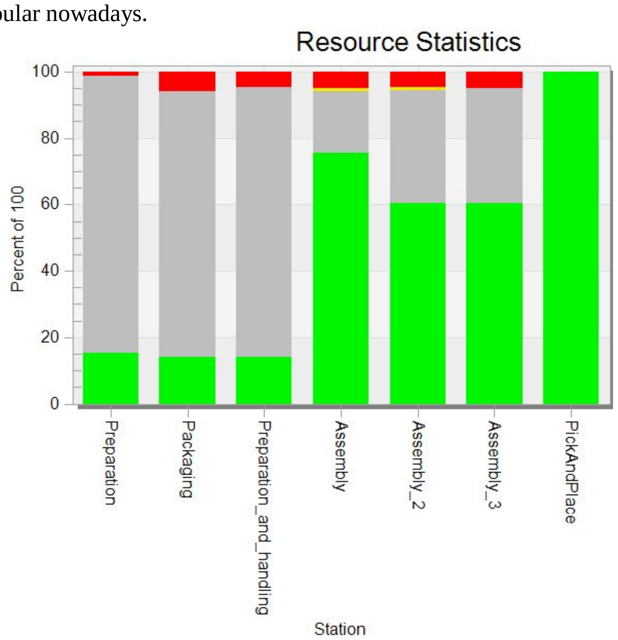

Fig. 7 Resource statistics of base model

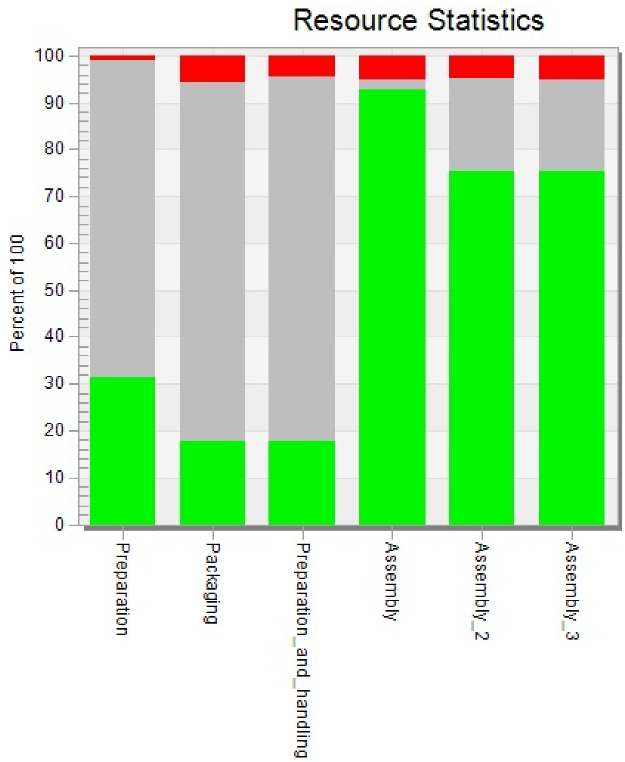

Fig. 8 Resource statistics of adjusted model

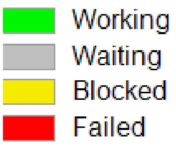

Fig. 9 Legend for resource statistics

Based on figure seven and eight we can see how working time of assembly stations increased only by managing the material flow and better timing on pick and place and conveyors.

Cycle time of five working days was tested for throughput evaluation. As is shown in table four, throughput in adjusted model is higher by 136 pieces of products.

Table 4: *Throughput of models in five working days*

	Base model	Adjusted model
Throughput	1064	1200

4. Conclusion

Computer simulation with IT tools is currently an essential activity to support the design of new production and logistics systems or even existing systems [5]. Simulation methods are used to evaluate different aspects of manufacturing systems or subsystems. Repeatability is an important and fundamental feature of computer simulation. Because of the exact values and parameters that have inherent values, the same process can be executed many times. In real life it is not possible [6].

The application of innovative design methods is one of the factors that has positively influenced the process of introducing fast, modern assembly systems [7].

This article describes the application of Tecnomatix Plant Simulation from SIEMENS in computer design and manufacturing process planning. Simulated production systems, created as examples, have shown that if the production system has some shortcomings, it can be improved by simulation. The simulation experiment can be tested with different characteristics and different modification types. It is a user choice when it is necessary to change the base model or just some features of the production model.

Major benefit of simulation like the one made in case study is that adjustments or improvements of production/assembly systems are made without shutting down the production. Real system work without changes and adjustments are made just after simulation shows that these adjustments will increase production or decrease spending etc.

The information obtained from the simulation results is influenced by the accuracy of the input data and model. The use of simulation methods of different processes in production, logistics or planning of new production systems is an element of Industry 4.0. It simplifies the planning of production systems and the optimization of existing systems.

Acknowledgement

The article was written as part of the Young Researcher project 1383“Influence of selected attributes in manufacturing systems and sub-systems planning in digital enviroment” supported by the scientific program - Motivation and support in quality and effectivity elevation of young researchers and scientists. Slovak University of Technology.

References

[1] Hromada, J., & Plinta, D. (2000). Modelowanie i Symulacja systemów produkcyjnych [Modelling and simulation of production systems]. Bielsko-Biała, Poland: Wydawnictwo ATH.

[2] Kikolski M., (2016). Identification of production bottlenecks with the use of Plant Simulation software. Economics and Management Volume 8 Issue 6.

[3] Plant Simulation: Product overview. SIEMENS, ©2017 [quotation 2017-11-11]. Internet source: www.plm.automation.siemens.com/

[4] Soble, B., Tecnomatix Manufacturing and Plant Simulation: Case study. SIEMENS, ©2014 [quotation 2017-11-11]. Internet source: https://www.hylasoft.com/en/posts/tecnomatix-plant-simulation

[5] SIDERSKA, J., 2016. Application of Tecnomatix Plant Simulation for modeling production and logistics processes. VGTU, ©2016 [quotation 2016-11-10]. Internet source: http://www.bme.vgtu.lt/index.php/bme/article/view/316

[6] KLOSOWSKI, G., 2011. Zastosowanie symulacji komputerowej w sterowaniu przepływem produkcji mebli, Zarządzanie Przedsiebiorst-wem / Polskie Towarzystwo Zarządzania Produkcją 2: 29–37.

[7] MADARÁSZ, L., KOVÁČ, J., SENDERSKÁ, K., 2008. Selection of assembly system type. SAMI 2008 6th International Symposium on Applied Machine Intelligence and Informatics - Proceedings, art. no. 4469196, pp. 44-47. ISBN 978-1-4244-2105-3