ORIGINAL RESEARCH PAPER

Engineering

TESTING THE PRODUCTIVITY INCREASING OF PRODUCTION LINE IN SOFTWARE TECNOMATIX PLANT SIMULATION

KEY WORDS: Simulation, Modeling, Plant Simulation, Productivity

Ing. Miriam Pekarcikova Technical University of Košice, Faculty of Mechanical Engineering, Park Komenského 9, 042 00 Košice, Slovakia

prof. Ing. Peter Trebuna* Technical University of Košice, Faculty of Mechanical Engineering, Park Komenského 9, 042 00 Košice, Slovakia *Corresponding Author

Ing. Marek Kliment Technical University of Košice, Faculty of Mechanical Engineering, Park Komenského 9, 042 00 Košice, Slovakia

ABSTRACT

Computer simulation is a modern tool for analysing complex manufacturing, communication, supplying and other business processes. It is one of the methods of assisting managers to predict system behaviour when changing internal and external conditions, to optimize business processes according to specified criteria (profit, cost, reliability) and to compare the proposed alternatives of the organization of the studied process. The advantage of simulation is the fact that everything is simulated only in computer models, without interfering with business management.

INTRODUCTION

Simulation reduces the risk of mistaken decisions to a minimum, or allows exploring various alternatives to system changes, to verify their impacts and consequences, and to choose the solution that is best for the situation. Errors found in experiments are always cheaper than the error found when implementing a particular unexamined proposal.

Simulation programs are being used more and more often, and their programming is largely replaced by operations with predefined objects in a user-friendly graphical environment with today's obvious animations of the simulated system and graphical outputs. In the article is used software product TX Plant Simulation for testing the increasing the production line productivity.

Simulation programs are being used more and more often, and their programming is largely replaced by operations with predefined objects in a user-friendly graphical environment with today's obvious animations of the simulated system and graphical outputs.

SHORT DESCRIPTION THE PRODUCTION PROCESS USING TX PLANT SIMULATION

The TX Plant Simulation software is a tool for discrete events simulation. It is focused on creating digital models of logistics processes and simulating the behaviour of logistics systems. It allows examining selected system characteristics (e.g. productivity, value added, transport, workers) and optimizing performance. These digital models further enable to carry out experiments and scenarios, without compromising production systems, if used in the planning process, long before the actual production systems are installed. Integrated analytical tools such as bottleneck analysis, statistics, and graphs make it possible to evaluate potential production scenarios. The TX Plant Simulation module is part of the PLM, which enables company to process, evaluate, use and access any information obtained in real time and in any place where access is possible. The software environment is characterized by open architecture, object-based models with hierarchical structure, optimization using genetic algorithms as well as automatic analysis of simulation results.

Analysed production line produces 5 kinds of shafts, 4 of which have several variations. The variety of components in this line and the lack of machinery cause supply problems for the assembly line itself. The hard shaft production line is the last part of the production line.

Production section begins with the acceptance of individual shaft types from the furnace workstation, followed by machining to delivery to the assembly line. The goal of the analysis is to define bottlenecks in the production process and to design the optimal solution using simulation.

Figure 1: Production process of hard shafts

Production process of hard shafts, Fig. 2, Table 1:

- OP 160 - the shafts proceed from the heat treatment to the first honing operation - the grinding of the largest diameter of the shafts on the CNC machines. A worker from one pallet (on which n pieces are) the shafts inserts into the machine and then, after honing operation, inserts the shafts into empty pallets. Depending on the type of shaft involved, the number of shafts per pallet and the time required to process them vary. There are 4 types of machines in this operation.
- OP 170 - after turning the diameters, the shafts move to the second operation, which is the honing of recesses and small shafts. CNC machines are used for the process. A worker from one pallet (on which n pieces are) the shafts inserts into the machine and then, after honing operation, inserts the shafts into empty pallets. Depending on the type of shaft involved, the number of shafts per pallet and the time required to process them vary. There are 4 types of machines in this operation. The amount produced in this operation is reduced due to the difficulty of this operation.

After each of these operations, a regular measurement test is carried out to check the tolerance.

- OP - 180 honing operation with the marking 180 is specific in that only the type 5 of shafts are produced here, this CNC machine is produced continuously without various dwellings and set-up of the machine.
- OP 190/200 - after processing the diameter shafts are moved to the OP 190, where the last part of the shaft is honed - toothing. There are 4CNC machines in this operation that have similar functionality, handling and software. Each of these machines can process different types of shafts. For the continuity of production, one type of machine is used for one type of shaft in order to prevent often set- up of machine and with it associated downtime.

As the company precedes to higher production batches the frequent set-up and downtimes occurred on OP 190/200. It was necessary to test the production line's potential in implementing a new machine that would compensate the time and capacity losses.

The possibilities that arise from the installation of a new machine OP210 was tested by software Tx Plant Simulation. OP 210 is relatively new operation in the production of hard shafts. The CNC machine has the largest production capacity in this production line. Model of the current state and the state after the implementation of the new machine is shown in Fig.2. The results of testing are processed in Table 2.

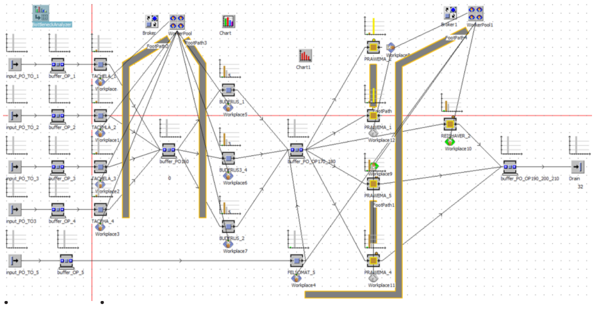

Figure2: Model of current state

TABLE 1
CUMULATED STATISTICS REPORT OF OUTPUTS CURRENT STATE

Simulation time: 12:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Drain	shaft_1	3:54:41.6667	3	0	94.89%	0.00%	5.11%	1.15%	
Drain	shaft_2	3:33:05.0000	1	0	99.80%	0.00%	0.20%	1.25%	
Drain	shaft_3	3:45:42.0000	5	0	78.36%	0.00%	21.64%	1.26%	
Drain	shaft_4	3:04:00.0000	3	0	93.84%	0.00%	6.16%	1.45%	
Drain	shaft_5	32:52.2500	20	2	88.48%	0.00%	11.52%	6.34%	

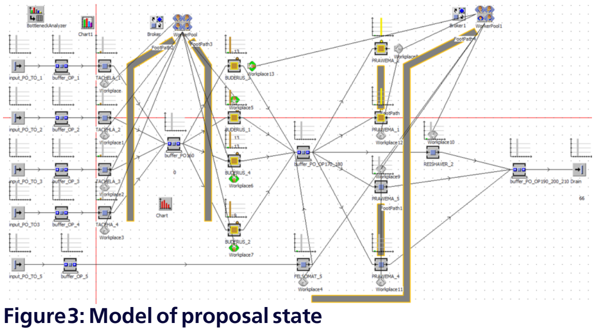

Figure3: Model of proposal state

TABLE 2
CUMULATED STATISTICS REPORT OF OUTPUTS PROPOSAL STATE

Simulation time: 12:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Drain	shaft_1	1:35:01.8182	11	1	65.87%	0.00%	34.13%	2.73%	
Drain	shaft_2	1:23:18.1818	11	1	75.14%	0.00%	24.86%	3.11%	
Drain	shaft_3	1:46:08.5000	10	1	59.18%	0.00%	40.82%	2.65%	
Drain	shaft_4	1:02:55.8333	12	1	83.62%	0.00%	16.38%	4.17%	
Drain	shaft_5	2:05.0000	22	2	100.00%	0.00%	0.00%	100.00%	

As a result of the analysis and testing of the simulation model in the software Tx Plant Simulation environment, a bottleneck place is in the production of hard shafts. This is negatively affected by the flow of production parts at this workplace.

After testing the production line with the new plant in Plant Simulation, it was possible to note the reduction of the bottlenecks and the increase of the production line, Fig. 4.

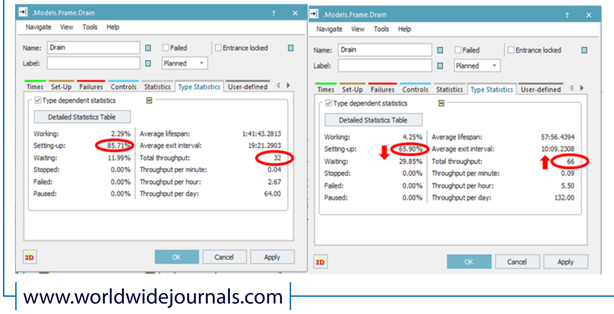

Figure4: Drain statistics after the simulation a) current state b) proposal state

However, with a constant increase in the production site, it is possible that these bottlenecks in production will emerge again.

By implementing a CNC machine OP210, the material flow was improved not only at this workplace but also throughout the production process.

CONCLUSIONS

Outputs from the simulation of the current state model have been the basis for designing measures to increase the productivity of the production system. Based on this information, a simulation model was created in the Tx Plant Simulation software program, and after verification of the model, an experiment was performed to verify system stability and production stability. Collection of the necessary information and subsequent simulation of the process revealed a bottlenecks place in the production line, which reduced the production throughput at the production line of hard shafts. This bottleneck was revealed in OP170 manufacturing operations. The main reason for not meeting the production quantity was the frequent set- upping of the machine and the associated downtime. The proposal was related to the implementation of the new machine for the manufacturing operation, which would increase the throughput and increase productivity of production line.

Acknowledgement

This article was created by implementation of the grant project APVV-17-0258 Digital engineering elements application in innovation and optimization of production flows and VEGA 1/0708/16 "Development of a new research methods for simulation, assessment, evaluation and quantification of advanced methods of production".

REFERENCES:

[1] Bangsow, S. (2015), "Tecnomatix Plant Simulation. Modeling and Programming by means of examples." Springer. 2015, ISBN 978-3-319-19502-5.
[2] Poór, P., Kuchtová, N., Šimon, M. (2014). "Machinery Maintenance as Part of Facility Management." Procedia Engineering, 69, 1276-1280. doi: 10.1016/j.proeng.2014.03.119
[3] Straka, M., Malindzak, D. (2009), "Algorithms of capacity balancing of printing machineries for Alfa Foils, a.s. planning system." Acta Montanistica Slovaca, Volume 14 (1), 98-102.
[4] Bárdy, M., Kudrna, J., Šrámková, B.B., Edl, M. (2014), "Interactive game supporting SMED method." Applied Mechanics and Materials, 474, 141-146.
[5] Saniuk, S., Samolejova, A., Saniuk, A., Lenort, R. (2015), "Benefits and barriers of participation in production networks in a metallurgical cluster - research results.", Metalurgija, 54(3), 567-570.
[6] Rosova, A., Malindzakova, M. (2014), " Material flow - starting point for recovery of inputs in the production company." International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM 3(5), 14th International Multidisciplinary Scientific Geoconference and EXPO, SGEM Albena; Bulgaria.
[7] Wicher, P., Staš, D., Karkula, M., Lenort, R., Besta, P. (2015), "A computer simulation-based analysis of supply chains resilience in industrial environment.", Metalurgija, 54(4).
[8] Tecnomatix Plant Simulation Basics, Methods and Strategies Student Guide, 2012, Siemens PLM.
[9] Vilamová, Š., Besta, P., Kozel, R., Piecha, M., Vaněk, M., Samolejová, A., Janovská, K., Čech, M.. (2015), "Increasing the efficiency of production of iron by means of reduction of harmful elements", Metalurgija, 54(4).