ORIGINAL RESEARCH PAPER

Management

THE CREATION AND TESTING THE LOGISTIC MODEL IN THE ENVIRONMENT OF THE TX PLANT SIMULATION TOOL

KEY WORDS: Logistic, Creation, Simulation, Plant Simulation.

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ABSTRACT

Case study was devoted to the creation of a simulation model and the analysis of a line for the production of conveyors. All parts of the simulation were processed in TX Plant Simulation version 14.1 from Siemens. Thanks to this program, a simulation of the production line of the conveyor production, were created and subsequently, it was analysed. Using the analysis, ways to improve and optimize production were proposed.

INTRODUCTION

Simulation programs make it possible to create an accurate simulation of the production process and logistics flows with all the details before it is introduced into real production. This makes it possible to experiment and try new ideas that could help improve production. Simulations are monitored, modified, and can be stopped and restarted at any time. They are used to detect any errors and bottlenecks that may occur in actual production. The simulation aims to create an accurate plan of the production process before introduction into production and to ensure that no errors, downtimes and inaccuracies occur during production.

Simulation technology is an important tool for planning, implementation and operation of complex technical systems. Some trends in the economy lead to shorter planning cycles.

These contain:

- increasing the complexity and variety of products,
- increasing quality requirements in connection with high-cost pressure,
- growing demands for flexibility,
- shorter product life,
- decreasing batch sizes,
- increasing competitive pressure.

Simulation is used where simpler methods no longer provide useful results. Possible questions include:

- **Planning phase**

Identification of bottlenecks in deriving potential improvements, detection of hidden, untapped potentials, minimum and maximum utilization, comparison of different planning alternatives, testing of arguments related to capacity, control efficiency, performance, limits, bottlenecks, throughput and inventory volume, visualization of planning alternatives for decision making.

- **Implementation phase**

Performance tests, problem analysis, performance test of future requirements, simulation of exceptional system conditions and accidents, training of new employees (e.g. management), simulation of start-up and cooling behaviour.

- **Operational phase**

Testing control alternatives, reviewing emergency strategies and accident programs, proof of quality assurance and fault management, sending orders, and determining likely delivery dates.

The contribution of modern technologies to increase the efficiency of the production process, including simulation, provides several benefits. However, the simulation itself is still only a theoretical assumption, it is necessary to take into account inaccuracies. This means that it has its advantages and disadvantages.

Advantages:

- New policies, operational procedures, decision rules, information flows, organizational procedures, among others, can be examined without disrupting ongoing operations of the real system.
- Hypotheses about how or why certain phenomena occur can be tested for feasibility.
- A bottleneck analysis can be performed to find out where work, information, materials, etc. excessive delays.
- "What if" questions can be answered.

Disadvantages:

- Building a model requires special training.
- The simulation results may be difficult to interpret. Because most simulation outputs are essentially random variables, it can be difficult to determine whether the observation is the result of a system relationship or randomness.
- Simulation modelling and analysis can be time consuming and expensive.
- Simulation is used in some cases where an analytical solution is possible or even more advantageous.
- Although these disadvantages are latent, there are ways to deal with them:
- Simulation software vendors are actively developing packages that include models that only need input for their operation.
- Many simulation software vendors have developed output analysis capabilities within their packages to perform very thorough analysis.
- Thanks to advances in software and hardware, simulations can be designed and run faster.
- Closed-form models are not able to analyse most of the complex systems we encounter in practice.

Strengths:

- Fast simulation verification without the need for real-time. Detection of the restrictions. Enough reports to verify the simulation target. The simplicity of simulation, no need for programming.

Weaknesses:

- The need to know the researched object and the relationships between entities. Simplification of the model. Failure to anticipate employee behaviour. It is based on historical data. Higher initial costs. Methodological complexity.

THE PROCESS OF CREATING A SIMULATION IN THE TX PLANT SIMULATION ENVIRONMENT

The following case study deals with the simulation of the conveyor production process, Table 1. It focuses on the description of technological processes performed during production. Based on which the simulation model is processed and the simulation run is realized. Based on the above, it is possible to determine the optimal number of workers operating the machines and set the production line times. The output of the simulation runs is statistics, graphs and analyses of logistics flows and the use of production and handling equipment.

Table 1

Operation	Duration in seconds
Laser1	30s
Laser2	25s
Deburring	20s
Deburring2	20s
Thread cutting	20s
Edge chamfering	30s
Bending	10s
Bending2	25s
Welding	20s
Welding2	15s
Turning	25s
Milling	20s
Drilling	15s
Blasting	5s
Galvanizing	25s
Checkout	25s
Packing	25s

Workers working between welding2, turning, milling and drilling stations must transfer the material manually. This task is entered at each station where it is performed, at each workplace where the worker works and in the work pool where the assigned task is assigned to specific workers. Every machine can fail, create a faulty unit, or an error can occur caused by a worker, and therefore this probability must be ensured in the simulation as well. The failure time is set in each work station. We assume 95%.

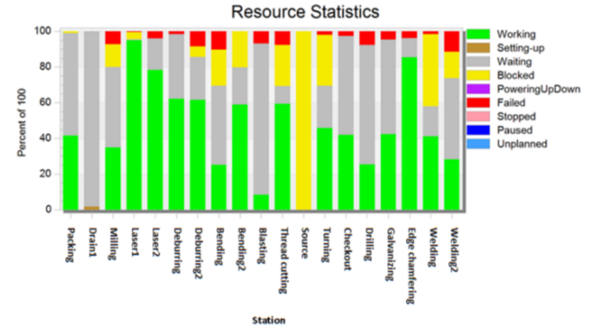

Figure 1: The utilization after 12 hours of operation

Receipt of material from the source is set to 1 minute. This is the estimated time it takes for production to operate. A low time would disrupt the entire production and the machines would be blocked, the production would not work.

After starting the simulation, the entire production hall is marked and after pressing F6 the output is displayed in the form of tables and graphs.

The first output is a graph of utilization of operatin (Fig. 1). Green values represent work, grey waiting, yellow when the material is blocked, and red downtime. It is possible to see that the big problem is just the waiting time for new material. This is due to the layout of the production hall and the number of workers.

The following analysis (Table 2) provides information on the workers transferring the material. The number of these workers is 5 and they work about 25% of the time, transfer about 15% and wait for the material of about 38%.

Table 2 Time Periods Of Workers

	Working	Setting-up	Repairing	Transporting	En-route to job	Waiting for Importers	Waiting for MUs	Failed
Worker	26.57%	0.00%	0.00%	13.78%	15.25%	36.31%	8.10%	0.00%
Worker	24.19%	0.00%	0.00%	16.59%	17.72%	30.36%	11.14%	0.00%
Worker	29.00%	0.00%	0.00%	9.89%	8.64%	45.58%	6.89%	0.00%
Worker	24.14%	0.00%	0.00%	19.02%	18.81%	27.78%	10.25%	0.00%
Worker	27.94%	0.00%	0.00%	9.21%	4.33%	52.32%	6.21%	0.00%

The utilization analysis provides information on the use of machines, waiting, outages and blocking. The waiting time between machines is around 50 to 60% of the total production time. The use of conveyor belts is 100%. The use of machines is relatively low, precisely due to the waiting time for material.

Workers who transfer material between machines will travel a relatively long distance in 12 hours. In total it is 85,391m. The number of these workers is 5. Their task is to take material from one station, transfer it to another, process it and finally take it to the next station. This process is constantly repeated during operation. Other workers spend most of their time operating one machine and do not have as much movement. The analysis indicates outages - machine downtime. For each production, it is necessary to take into account the losses, and this simulation created at least a rough overview of what it might look like in reality.

The aim of the analysis of the current state model is to propose measures that will increase the monitored parameters of logistics and production. The main problem that emerged from the analysis is the solution of downtime due to waiting for material. Up to 80% of the time, the workers tasked with transporting and processing the material wait, creating a bottleneck that needs to be removed.

SUGGESTIONS RESULTING FROM THE SIMULATION RUN

There are several options for increasing production efficiency. One of them may be the optimal number of workers who operate and at the same time transfer the material; another may be, for example, the relocation of a turning station. These stations are fenced for safety in the workplace and therefore it is necessary to change the layout of these stations and fences. Another option could be to reduce processing times and add more stations, but this option is financially demanding.

A combination of the first two options will be used for optimization. At the same time, the time of material receipt at the beginning of production will be adjusted. Thanks to simulations, it is possible to determine the most advantageous one.

Implementation of proposals to improve the logistics flow

The first change is the adjustment of the number of employees. After implementing and testing the various options for the number and distribution of workers, a clear conclusion was reached. The case where the number of workers transferring the material is 6 and the remaining 13 is optimal and achieves the best results, Table 3. More or fewer workers either performed worse or had to wait unnecessarily because there were more than necessary.

Table 3 Creation Table After Editing

.Models.Frame.WorkerPool.CreationTable

*.Resources.Worker

	Worker	Amount	Shift	Speed	Efficiency	Additional Services	
1	*.Resources.Worker	13					
2	*.Resources.Worker	6				process	carry

OK Cancel Apply

The next change in the production hall will be the relocation of the turning station. The aim is to be as close to the welding station2 as possible, but it must be far enough away due to safety conditions. The railing was also relocated and modified. This change will reduce the number of meters travelled by workers in 12 hours of operation. However, the result will not be fewer meters, as the optimal number of workers will change. The adjustment looks as follows, Fig. 2.

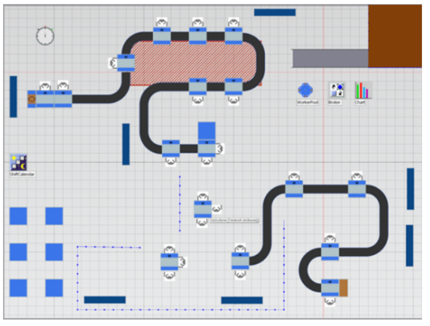

Figure 2: Workplace layout after adjustment

The last change is to change the material receipt interval. The original state was set to 1 minute. After testing many simulations, it turned out that the workplace can handle the reception of material every 47 seconds. This time is optimal for production. Once the time was set to 46 seconds, production failed, the machines were blocked and the results were insufficient. After all changes were introduced, new analyses were created.

EVALUATION OF SUGGESTIONS FOR IMPROVEMENT

Compared to the periods of the exporters before adjustment, an improvement can be seen. Workers work with machines for longer and transfer material shorter, Table 4, Table 5.

Table 4 Time Periods Of Workers After Editing

	Working	Setting-up	Repairing	Transporting	En-route to job	Waiting for Importers	Waiting for MUs	Failed
Worker	27.36%	0.00%	0.00%	10.58%	13.84%	35.68%	12.55%	0.00%
Worker	24.15%	0.00%	0.00%	12.18%	17.32%	31.22%	15.12%	0.00%
Worker	27.07%	0.00%	0.00%	12.65%	10.12%	40.34%	9.82%	0.00%
Worker	24.20%	0.00%	0.00%	14.33%	15.57%	28.74%	17.16%	0.00%
Worker	30.56%	0.00%	0.00%	10.58%	7.32%	43.42%	8.13%	0.00%
Worker	34.37%	0.00%	0.00%	8.25%	3.27%	47.53%	6.58%	0.00%

The distance travelled by workers has even increased. In total it is 87,640 m. This distance is greater mainly because the workers carrying the material are not 5 than before, but 6. However, the individual distance of the workers has decreased, which means an improvement for the workers

Table 5 The Distance Traveled By Workers After Adjustment

	Traveled Distance
Worker	18046 m
Worker	22802 m
Worker	13295 m
Worker	20855 m
Worker	8974 m
Worker	3668 m

Graphical display the utilization of workplaces after the implementation of suggestions, Fig. 3.

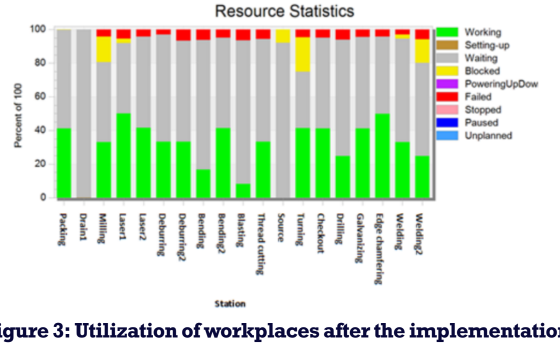

Figure 3: Utilization of workplaces after the implementation of suggestions

Although the waiting time is still quite high, the use of machines has definitely improved and this can be seen in the units produced during operation. Initially, 704 products were produced in 12 hours of operation, after the introduction of the changes, 894 will be produced. This means that after the implementation of all proposals, production has improved by as much as 190 products, Fig. 4.

Object	Working	Set-up	Waiting	Stopped	Failed	Paused	Mean Life Time	Mean Exit Tim
Drain1	66.64%	0.01%	30.60%	0.00%	2.75%	0.00%	10:56.2545	47.497

Figure 4: Conveyor production output after modification

CONCLUSIONS

In conclusion, it can be said that each of the proposals brought an improvement in production and improved work for workers. Better results have been achieved in the form of more units produced per operation. The use of machines has increased and the optimal time of receiving material from the source has been found.

The simulation allows:

Solving analytically unsolvable problems. Investigate the dynamics of the system. Temporal and spatial comparison. Disclosure of new facts. Decision support at different levels of decision making. System improvements. Cost savings in various areas of the company.

The simulation does not allow:

Replacing a person in the decision-making process. Complete production management. Data accuracy with incorrect parameters. Automatic system optimization. Result if the goal is not defined.

Acknowledgement

This article was created by the implementation of the grant project APVV-17-0258 "Digital engineering elements application in innovation and optimization of production flows", APVV-19-0418 "Intelligent solutions to enhance business innovation capability in the process of transforming them into smart businesses", VEGA 1/0438/20 "Interaction of digital technologies to support software and hardware communication of the advanced production system platform" and KEGA 001TUKE-4/2020 "Modernizing Industrial Engineering education to Develop Existing Training Program Skills in a Specialized Laboratory."

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