ORIGINAL RESEARCH PAPER

Engineering

OPTIMIZATION OF PRODUCTION LINE WITH USING THE PLANT SIMULATION MODULE

KEY WORDS: Production line, Simulation, Digital Factory, Modeling, Plant Simulation

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ABSTRACT

This work is focused on the analysis of the production line for the so - soft shafts using the Plant Simulation module. Outputs from the software provide the information us, which it needed for suggestions for improvements in production. Subsequently, the benefits of each proposal will be appreciated and the best alternative will be selected.

INTRODUCTION

Nowadays, the fourth industrial revolution, almost all engineering companies are trying to implement the LEAN and Digital Factory model, reduce process times for production lines or increase production capacity. One of the best ways to achieve quality results is simulation and modeling. These terms represent the possibility to advance the possibilities of improvement, to discover bottlenecks in existing processes, or to create a new model so as to include as few narrow spots as possible.

This work is also focused on modeling and simulation. Specifically, a production line simulation for the so-soft shafts and outputs from this simulation. Output information is used to compile improvement suggestions, and then the most appropriate alternative is selected. The most suitable alternative is the improvement with the largest capacity increase in production.

ANALYSIS OF THE PRODUCTION PROCESS

Analysis of the current state is the first important step towards achieving concrete results.

An gearbox production includes a number of tasks. These include machining of soft and hardened shafts, machining of soft and hardened gears, heat treatment of shafts and gears and assembly of gearboxes. Each production line produces multiple types of work pieces, all of which are mounted in the final version on the transmission line on the assembly line. We will more closely analyze the line for machining soft soles. On this line, the shafts are processed before the heat treatment. The raw forgings and the process of processing come through the turning, milling and other operations. The output shaft is suitable for heat treatment (hardening). The raw forgings come to the initial operation in the container. Subsequently, after processing on individual operations, the work pieces are loaded on the trolleys. On these trolleys, the work pieces move from operation to operation, but not directly, but through the interlayer. An important factor of this line is the process time (tab 1). This time varies between operations. This also varies the process time for shaft types [1].

TABLE 1

Operation/ Shaft	H1	H2	H3	H4	H5
Truncating (A)	-	26.8657	31.0345	34.9515	30.0000
Turning (B)	-	2:04.1379	1:22.8947	1:13.0435	51.4286
Milling (C)	50.9915	1:02.5000	1:01.0169	1:18.6885	46.1538
Burring (D)	23.6842	22.9299	21.3018	23.2258	24.1611
Rolling (E)	15.1261	31.5789	25.8993	28.3464	-
Drilling (F)	24.0000	29.7521	38.2979	37.5000	-
Finish	-	1:00.6061	-	-	-

PROCESS TIMES

Analyzing the production process by simulating the Plant Simulation module helps to identify procedural deficiencies, bottlenecks, and all the details that can be later worked on when designing improvements. Using the information obtained in the analysis of the production process on a given line, it is now necessary to model its virtual copy using the Plant Simulation software. The outputs of the analysis show the values that can be used to suggest improvements to the modeled situation.

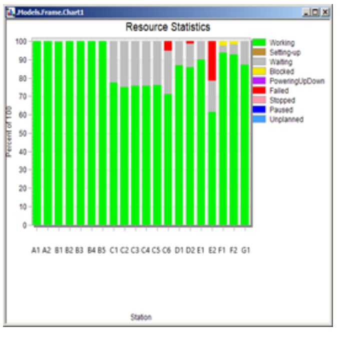

Figure 1: Load graph after 24 hours operation

Since the company GETRAG works in continuous operation, it is necessary to monitor breaks or exchange changes. Therefore, the first reference values we set twenty-four-hour operation. It can be seen from the graph that some workstations are blocked or waiting. Our task will be to eliminate these downtimes and increase the production capacity of the work-line. For some situations, twenty-four-hour simulation is inadequate. We are talking mainly about outages and refilling of bills.

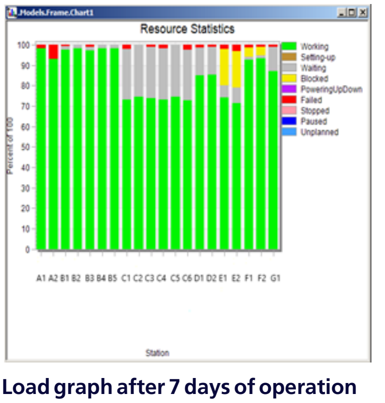

Figure 2: Load graph after 7 days of operation

Therefore, it is necessary to extend the simulation time to several days [2]. In our case, we set the time to seven days. In the graph in Fig. 2 is a few items that are different from twenty-four-hours of simulation. Multiple outages can be read, and operations E and F are blocked.

TABLE 2 TABLE OF ENTITIES AFTER 7 DAYS OF OPERATION [3]

Name	Mean Life Time	Throughput	Throughput per Hour	Production	Transport	Storage	Value added
H1	5:13:39.3198	8686	51.70	1.00%	0.00%	99.00%	0.60%
H2	5:17:31.8314	8682	51.68	2.28%	0.00%	97.72%	1.88%
H3	5:16:32.4208	8683	51.68	1.75%	0.00%	98.25%	1.37%
H4	5:16:48.2651	8683	51.68	1.89%	0.00%	98.11%	1.45%
H5	3:26:39.1826	8937	53.20	1.74%	0.00%	98.26%	1.22%

DESIGN OF AN IMPROVED MODEL LINE

There are several ways to improve the modeling line. One option is to increase or decrease the capacity of the bins, the next is to add a workstation to one of the operations or to add multiple workstations. One option is to move the CNC machine to another operation where it is more necessary.

Based on Fig. 1 we can say that operations A and B are taken up to one hundred percent. However, this can not be said about the following operations. The workstations for operation ,,C" and any subsequent operations already have a gray indicator on the chart indicating the wait. If a workstation or entire operation has to wait, it means that the previous operation should process multiple work pieces. It is therefore appropriate to add another workstation, or a new CNC machine, to the second operation [4].

Further improvement is the increase in the capacity of the intermediate bins due to the different output of work pieces from the production line. since shaft H5 leaves the production line after operation "D" and shafts H1, H3 and H4 leave after operation "F". In this case, output shafts may be blocked earlier. For example, if at both the "F" workstations the shaft H2 can not move to the next work position because it is occupied, the other shafts must wait in the intermediate position before the "F" operation. However, if an intermediate load is added to this operation, the H2 shaft can continue to release the work station for other types of shafts. In our case, we have suggested adding an intermediate record for operation "F".

The movement of the machine has its limits. Not all machines can be used for all operations and the shift makes sense, the operation from which we take the machine is a waiting operation (the gray field in the graphs). In our production line, such an operation is found and in Fig. 1 shows that this operation is "C". Workstations in this operation are used only seventy percent. And since this CNC machine is a milling machine, it can be used in the first operation "A".

EVALUATION OF IMPROVEMENT

In order for this work to bring results to society, every improvement should represent a certain increase in production. These data will be done by the counter with the end output of the simulation. As the counter is set in the middle, the output counter is also set. Not all improvements are bringing about an increase in production. Therefore, it is important to evaluate them. The evaluation should produce the final data on which a decision needs to be taken, which improvement will also be made in a real environment [5].

Simple improvements often do not produce sufficient results. For best results, it is good to combine several improvements. The combination of improvements does not only bring together the sum of the improved values but also makes a much better use of the potential of this production line. For combinations to make sense, we need to pick them right. The graph (Figure 3) shows the workstation load after all the improvements in a seven day simulation. Workstations on the first and second operations appear to be blocked on the graph. However, since the "F3" workstation is loaded to almost a hundred percent, a narrow location is shifted to operation "C".

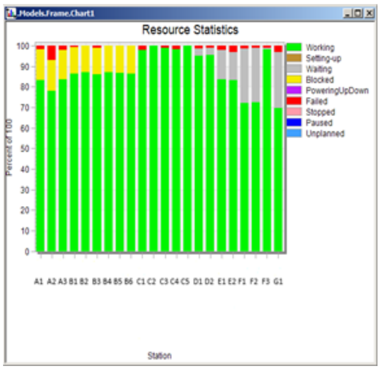

Figure 3: Graph of loading after adding workstation to second and sixth operation, CNC replacement and addition of intermediate storage

The final value after combining all the appropriate improvement proposals is 49836 and this represents a 6165 increase in production in seven days. Percentage increase in production thus reaches a value of 14,12.

TABLE 3 TABLE OF ENTITIES AFTER ADD WORKSTATION TO SECOND AND SIXTH OPERATION, CNC REPLACEMENT, AND ADD INTERMEDIATE

Name	Throughput	Throughput per Hour
H1	10004	59.55
H2	9828	58.50
H3	10001	59.53
H4	10000	59.52
H5	10003	59.54

Concluding, we can say that each of the improvements brings about an increase in production. When monitoring production value increases, it depends on the effort and finance needed to implement the proposed improvements to make effective choices.

CONCLUSIONS

In this work we have been devoted to modeling, simulation and analysis of the production line. All of these parts were processed by Siemens Plant Simulation software package Tecnomatix. Thanks to this module, we have accurately modeled an existing production line to match reality as much as possible. The model was then analyzed by the simulation and, according to the results of the analysis, we designed possible solutions for narrow spots and improving the overall running of the line.

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