IMPROVEMENT OF THE PRODUCTION PROCESS IN FLAMEART, LTD. VIA SIMULATION IN WITNESS

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ABSTRACT

This work demonstrates the possibilities of simulation in production process improvement and presents concrete results in production capacity increasing and cost reduction in a small company. The simulation tool WITNESS 2002 has been used for modelling of dynamic behaviour of the production system and for evaluation of its performance and costs.

1 INTRODUCTION

Company FlameArt, Ltd., resident in Western Slovakia, is a producer of various kinds of candles. As the demand on candles exceeds the plant capacity, and financial resources of the company are limited, the analysis focused on capital non-intensive measures – better worker, machine and area utilization. Another analysis has been made for an intended reconstruction of the plant. All the variants had to be cost-evaluated.

2 ANALYSIS OF THE ACTUAL STATE OF PRODUCTION SYSTEM

The first step to production system improvement was an analysis of its actual state and building its model in WITNESS. Necessary technical and economical data and other information about the production system were acquired from the company's owner and by measuring in production hall. Measured data were processed by program Statgraphics to find appropriate probability distributions for each random variable (cycle times and failure rate for each machine, service time for each worker and machine, transportation times, etc.).

Production of candles in the FlameArt, Ltd. is partially automated with high share of manual labour in material handling and transportation. Candles are manufactured from paraffin boards. Production process consists of the operations of paraffin pulverization, pressing the paraffin to make a paraffin roller, sawing the roller and milling the roller to final candle. There are seven buffers located between the workplaces and ten workers operating

machines and handling material in the process. Relationship of machines, buffers and labours is shown on Fig. 1 - WITNESS model of candle production process.

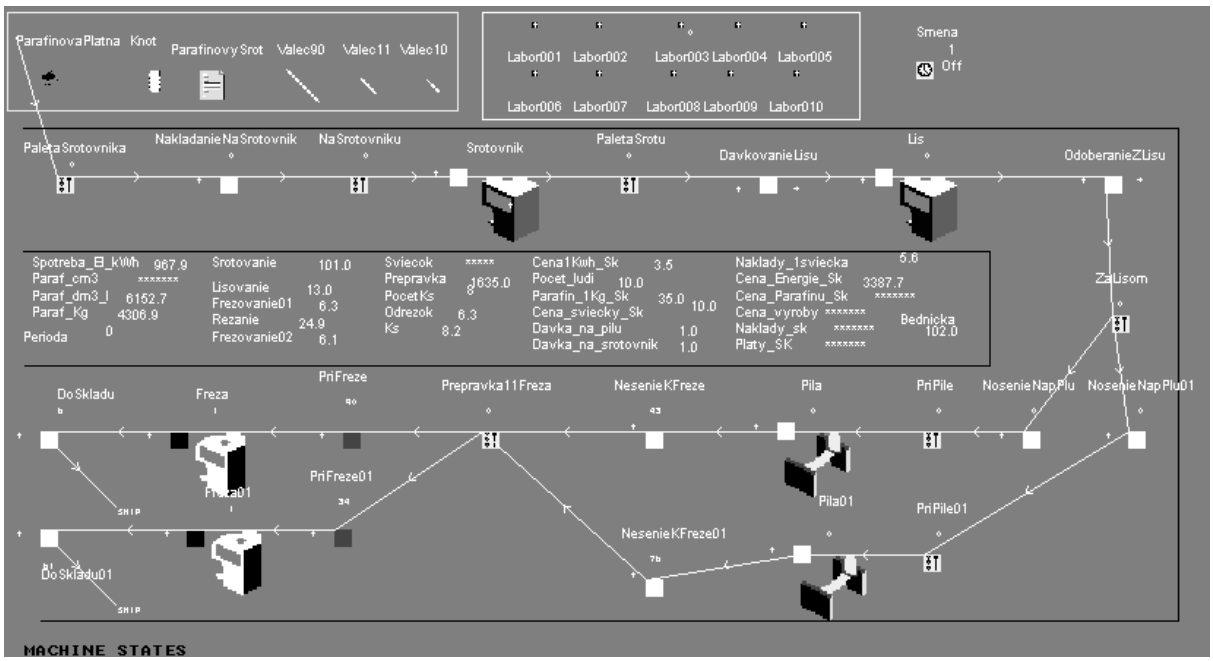

Fig. 1: *WITNESS model of candle production process*

The ground of the simulation model was built from WITNESS standa1rd elements. The control logic was programmed in WITNESS programming language as input-output and decision rules. Additional variables and formulas for cost and performance evaluation were added: average direct labour cost, electricity cost (for production equipment only), direct material cost, total direct cost, direct unit cost per candle, quantity of recyclable paraffin sawdust produced as a scrap, number of produced candles etc. After large number of simulation experiments and model changes a required behaviour of the model, true to the real production system, has been achieved.

The results of the original production system simulation can be characterized by the number of produced candles (8097 pc), direct unit cost (4,45 Sk per candle) and annual direct production cost by annual sales at 2 000 000 pc 8 900 000 Sk. As a candle lead-time can be taken time from the output of the press to the beginning of the milling (130 min.).[1]

To increase the production system performance and to reduce the costs it was necessary to analyse WITNESS statistical indicators of process element utilization (Tab. 1 - Values of WITNESS statistical indicators for the original system).

[1] To keep secret an information about the company economy not to endanger its competitive position on the market, some input data used for cost calculation in this document differ from the real values.

Machines	*Used [%]*	*Used [min]*
Pulverizer		
Pulverization	20,5	98,4
Bag changing on pulverizer	3,28	16
Loading of paraffin boards	8	38,5
Saw		
Sawing	44	211,2
Preparing of paraffin bars	12,5	60
Changing of crates	9	43
Miller		
Milling operation	88	422,4
Emptying of sawdust	2	10
Changing of crates	4,06	20
Workers *– Avg. utilization [%]*	56,5	271,2

Tab. 1: *Values of WITNESS statistical indicators for the original system*

3 DESIGN OF PRODUCTION PROCESS IMPROVEMENT

Having analysed WITNESS statistical indicators, it was revealed the under-loading of the saws and miller and of the worker at the press. The press was detected as a bottleneck.

Analysis related to the building the simulation model and the simulation results stimulated creation of various innovation ideas. One of them was the reduction of the time from output of the press to the beginning of the milling (from 130 min to 10 min). It caused that decrease of the paraffin temperature wasn't so significant as sooner, what allowed increasing the miller speed.

From the analysis of simulation results, machine technical parameters, production layout and worker utilization possibilities was drawn a design of production system changes:

- to remove the buffer behind the press
- to relocate the saws to enable the worker to put paraffin rollers to one or to another saw
- to make the worker at the press to move and change full crates at the saw as well (and thus to increase the worker utilization and the miller productivity)
- to relocate millers over the existing floor pit so that sawdust produced by the miller can drop right to the pit and it is no need of constantly changing the sawdust container
- to double the miller speed

The proposed changes were built into the model and the dynamic behaviour of the designed system was simulated with this results: the daily production of candles has grown from 8097 to 17 443 pieces (by 115,5%), the unit cost (without indirect cost) decreased from 4,45 Sk to 4,02 (by 9,67%), annual direct production cost by annual sales at 2 000 000 pc decreased from 8 900 000 Sk to 8 060 000 Sk and candle lead-time shortened from 130 min. to 10 min.

The designed changes were accepted by the owner of the company and executed. Real

effect of the production process reorganization meets the results of the simulation experiment. The designed changes had an organizational character and they were realised without any investment.

4 SIMULATION OF THE PRODUCTION LINE RECONSTRUCTION

The goal of another analysis was to design and verify production system reconstruction using higher level of automation. According to the results of simulation experiment with the origin system, a bottleneck is the press, while the saws, the miller and the worker at the press were under-loaded. To increase total production system capacity, it is necessary to automate material handling and transportation. Choosing of appropriate equipment was based on the WITNESS results analysis and technical possibilities of the offered equipment. The choice was aimed to maximize the synchronization and fluency of the production process.

The improving measures were based on replacing the manual transport and handling by conveyors, automation of the sawing process and adding one miller. These measures led to reduction of the number of workers from 10 to 2.

The proposed changes were built into the model and the dynamic behaviour of the designed system was simulated with this results: the daily production of candles has grown from 8097 to 32 181 pieces (by 297%), the direct unit cost decreased from 4,45 Sk to 3,87 (by 13 %), annual direct production cost by annual sales at 2 000 000 pc decreased from 8 900 000 Sk to 7 740 000 Sk and candle lead-time shortened from 130 min. to 1,26 min. Cost savings were ensured mainly by reducing the number of workers from 10 to 2.

5 COMPARISON OF THE ACHIEVED RESULTS

Table 3 shows the results of all three variants of production process. [2]

	Original process	Alternative I	Alternative II
***Machines** – Avg. Utilization [%]*			
Pulverizer	20,43	43,1	80,3
Press	8,21	17,43	97,85
Saw	44,12	93,24	97,8
Miller	88,45	96,7	98,26
***Workers** – Avg. Utilization [%]*	56,4	69,3	80,3
Capacity and costs			
daily production of candles	**8097 pc**	**17 443 pc**	**32 181 pc**
avg. Lead time	**130 min.**	**10 min.**	**1,26 min.**
direct unit cost per candle	**4,45 Sk**	**4,03 Sk**	**3,87 Sk**
Annual direct cost (by 2 0000 000 pc)	**8 900 000 Sk**	**8 060 000 Sk**	**7 740 000 Sk**
Annual direct cost saving (by 2 000 000 pc)	**x**	**840 000 Sk**	**1 160 000 Sk**
time to produce 2 000 000 pc	**247 days**	**114,7 days**	**62,2 days**

Tab. 2: *Values of Witness statistical indicators and capacity and cost variables*

[2] To keep secret an information about the company economy not to endanger its competitive position on the market, some input data used for cost calculation in this document differ from the real values.

6 CONCLUSION

This work demonstrates the possibilities of the modelling and simulation in the production system improvement in practice. There were designed two alternatives of the candle production in the FlameArt, Ltd. The first alternative was based on the organizational changes only and it was realised without any investment and it represents annual direct cost saving about 840 000 Sk. The second alternative consists in achieving the higher level of automation. It requires the investment about 1 300 000 Sk and it represents annual direct cost saving about 1 160 000 Sk.

This way I would like to thank management of the company FlameArt, Ltd. for their cooperation and comprehension with this project.

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