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LOGISTICS OF WORKING ROLLERS AND POSSIBILITIES OF PRODUCTION STREAMLINING

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Abstract: Within the preparation of the production – rolling of flat surfaces, it is necessary to ensure the required amount of rollers with different diameters and lengths. This article deals with the logistics of the working rollers of the service of the specific working place. It aims to provide solution possibilities and to determine the optimal state using the simulation approach. The experiments in real companies are very rare, expensive and tedious. Simulation models allow us to explore more options, they avoid the system failures, machines damaging and human exposure to danger. Although the simulation requires some time to create the model and some professional knowledge, it takes less time, saves costs and does not involve in the production process and has a limitless number of experiments.

1 Introduction

Since nowadays the production output of rolled products for the automotive industry, constructions, etc. rises, so does the number of rollers replacements and therefore the number of the timely deliveries of the working rollers.

The problem that occurs is the determination of the working rollers number for the individual stools. Gradual grinding lowers the working rollers diameter. Afterwards, the number of working rollers with low diameter rises and the number of larger ones is decreasing. The required number of working rollers for the individual stools change and there occurs an excess of the lower diameter working rollers for the first stools and vice versa with the last ones. [1].

One of the solutions consists of the production process modelling, using the simulation language EXTEND. The simulation of the rolling tracks aims to determine the optimal number of working rollers for the individual stools.

Simulation models allow us to explore more options, it avoids the system failures, machines damaging and human exposure to danger.

The simulation requires a certain model. Simulation model imitates the system we want to simulate, which is limited to artificial, substantial object, created for the purposes of the simulation. Later on, the simulation represents the experiment with the object, which aims to predict the system's behaviour, lower the costs and understand the system and to improve it.

Simulation model contains static objects (production machines, storages) and dynamic objects (moving items, e.g. raw materials). After the creation of the simulator, there is the modelling, where the dynamic process is replaced by simulation model [2].

Computer simulation allows us to do infinite number of experiments on the created model, to evaluate the results and to optimize and apply them to the real process. The aim of the simulation also is to verify, whether the system would work better after applying the obtained parameters and it helps us to verify our ideas and decisions in the simulation model [2].

2 Production working rollers flow

When working, the rollers are exposed to high forces, therefore it is necessary to grind them and prepare them for the rebuilding into the rolling tracks [3]. The working rollers have a lower diameter then the supporting rollers (outer rollers). It limits the bending of the rollers and rises the stiffness of the rolling stool. The axes of all the rollers lay in the same plain (Figure 1).

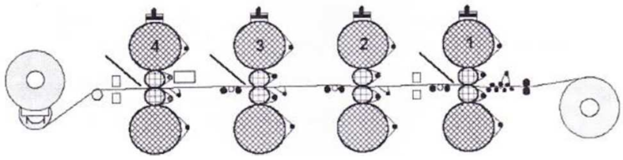

Figure 1 Working rollers deposition scheme of a 4-stools tandem [4]

In order to make the working roller usable again, it has to undergo several procedures. The working rollers are transported in sets by the overhead cranes to the "Rollers Preparation – Mounting and demounting of the working rollers" working place. There, the mounting and demounting of the bearing bodies take place. The mechanic performs their inner and outer control and eliminates the defects. When the defects are more serious, he removes the bodies and sends them for revision, where the bearing bodies are inspected more precisely and the defects are removed. Then, the rollers themselves are transported using the transporting trolleys to the "Working rollers – grindery" working place. Here, the rollers are grinded, electro-sparked and chromed to the required shape. The remade rollers are paper-packed and equipped with a label, which contains this roller information:

- number
- diameter
- facet
- roughness
- stiffness
- oval information
- conic information
- grinders name
- roughness after the electro-sparking
- final surface finish (EIS- sparking, T- jet, CR- chroming, EL- polishing)

Such rollers are returned by the transporting trolley to the "Rollers Preparation – Mounting and demounting of the working" working place.

After the mounting of one set of the working rollers, the mechanic uploads the mounting to the system. Then, he prints the protocol about the release of the set, which contains the following information:

- numbers of the upper and lower roller
- diameter of the rollers
- facet of the rollers
- roughness of the rollers
- stiffness of the rollers
- finish
- oval and conic information.
- numbers of the bearing bodies
- name and signature of the grinder and other mechanics

After the preparation of the working rollers sets, they can be rebuilt into the roller tracks.

3 Simulation of the production process of the roller tracks

The simulation model is created by the blocks of the simulation program EXTEND. In order to achieve the most correct results, it is necessary to have the information from all the production machines. With the help of this information, it is possible to create the simulation model of the roller tracks. According to the analysis, the best values for the 4-stool tandem are the values from the first month and for the 5-stool tandem the values from the second month. The noted months have the highest number of the working rollers replacements.

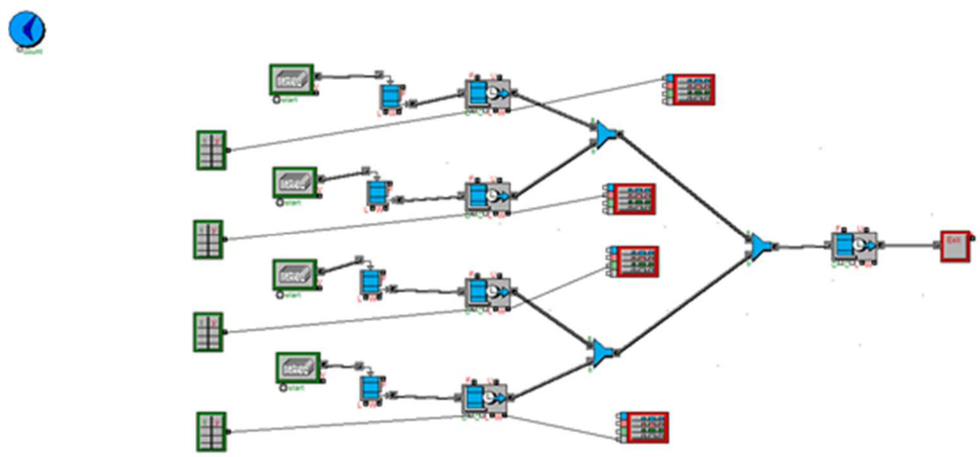

Figure 2 Simulation model of a 4-stool tandem [4]

Simulation model (Figure 2) is created from the individual blocks of the simulation system EXTENDSIM.

The block "Executive" sets the time of the simulation, the length of one month. The parameters of the block "Program" are set directly from the production. The block Queue "FIFO" is the queue of the waiting requirements (First in - First out), meaning that the requirement that entered the queue the first, leaves if the first. The block "Activity delay" processes the requirements from the queue. In this case, each block in the simulation represents one rolling stool. This block processes the requirement according to the data from the block "Input Data". This block contains the information about time of the roller stool replacements and also about their delay, which means the time length of the roller set usage. This block contains the real times, because of the high rate of dispersion of the usage length of the sets in the stools. The block "Activity Multiple" processes the requirements that leave the individual stools. In our case, it represents the storage of the built working rollers and their 480 minutes long cooling. The block "Combine" connects the output of requirements from the individual stools into one – input of all the requirements into the "storage of the built working rollers". The block "Plotter" displays the graph of the delay course and replacements according to the individual rolling stools. The block "Exit" is used to let the requirements out of the system.

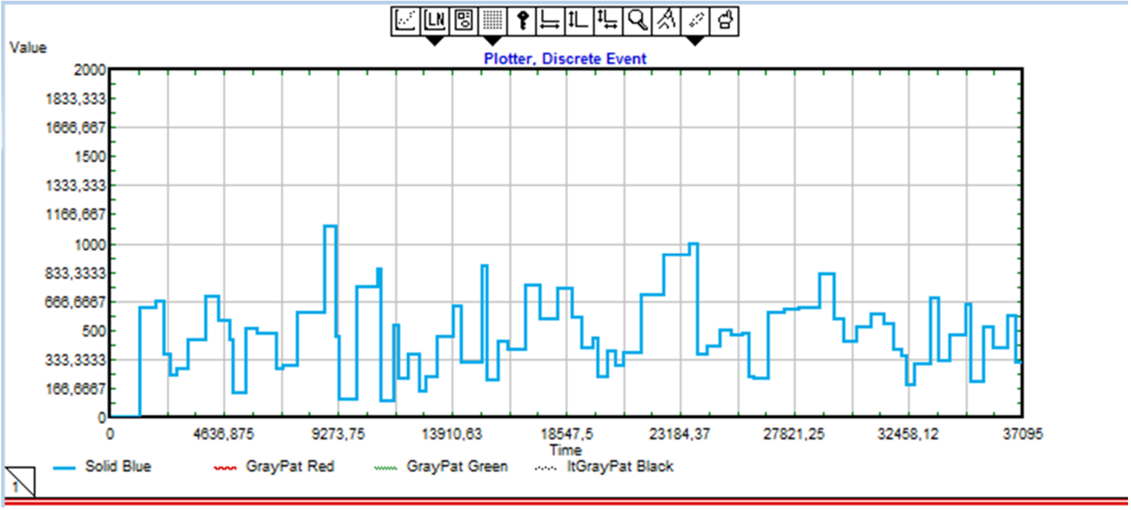

Figure 3 The course of the replacements on the first stool of the 4-stool tandem

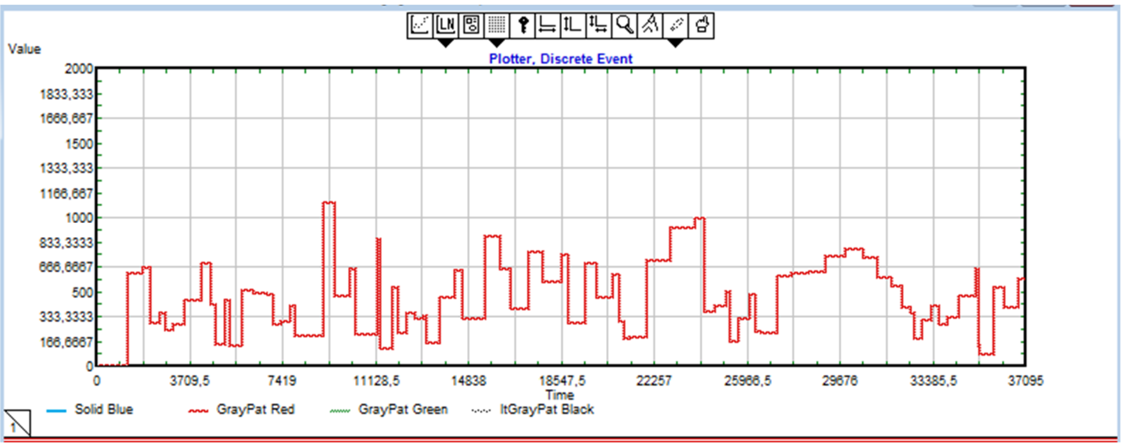

Figure 4 The course of the replacements on the second stool of the 4-stool tandem

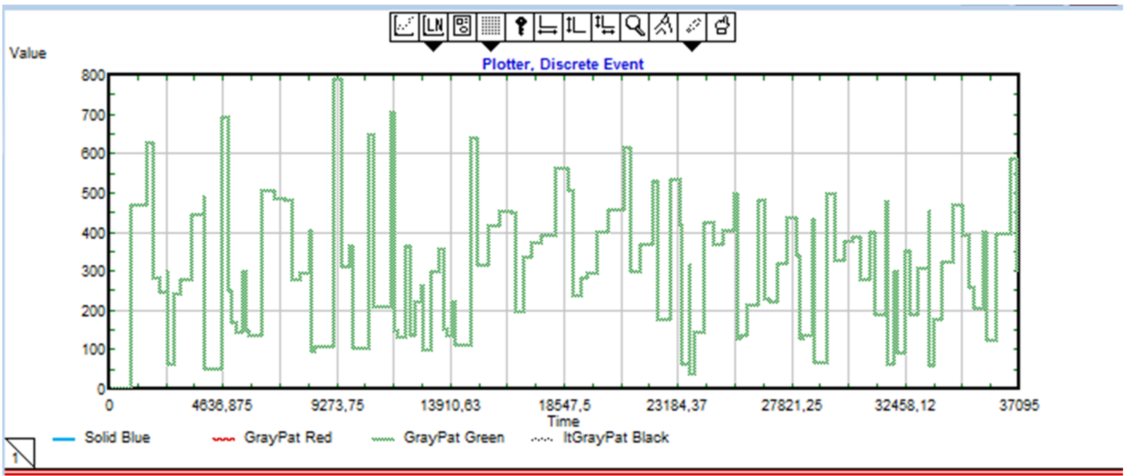

Figure 5 The course of the replacements on the third stool of the 4-stool tandem

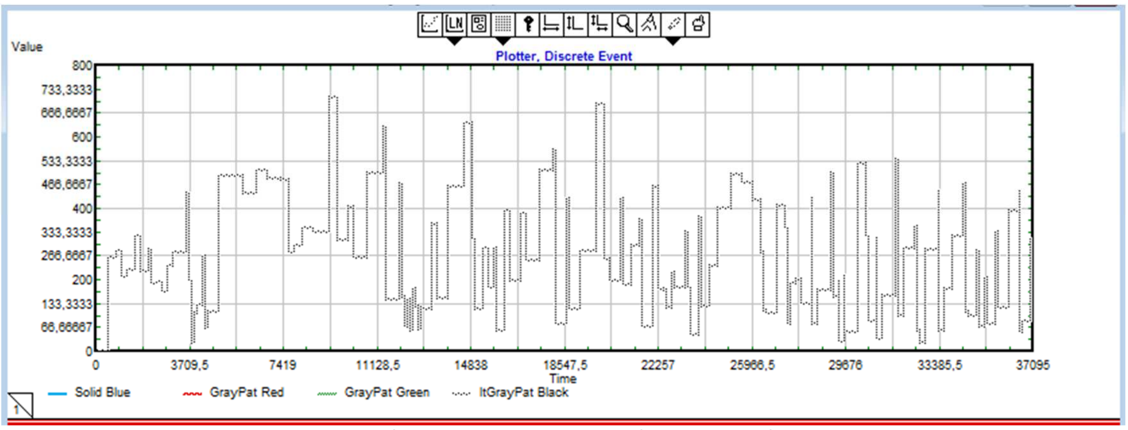

Figure 6 The course of the replacements on the fourth stool of the 4-stool tandem

The graphs show that the first and second stool contain a lower cadence of replacements, which means that the working barrels stay built in the tandem longer. The graphs of the third and fourth stool show that the barrels are replaced more often and their working time in the tandem is shorter.

The first rolling stool (Figure 3) used 78 rollers in the particular month with the usage of 98,34% and with an average delay time of 471 minutes.

The second rolling stool (Figure 4) used 81 rollers with the usage of 98,34% and with an average delay time of 452 minutes.

The third rolling stool (Figure 5) used 118 rollers in the particular month with the usage of 98,74% and with an average delay time of 313 minutes.

The first rolling stool (Figure 6) used 145 rollers in the particular month with the usage of 99,31% and with an average delay time of 255 minutes.

The simulation data that matters to us is the average delay time in the individual stools. It allows us to calculate the usage of one rollers set in each stool. (Table 1).

Table 1 Usage time of one rollers set in individual stools [4]

4st / time	1st. stool	2nd. stool	3rd. stool	4th. stool
Time of rolling (delay time)	**471 min**	**452 min**	**313 min**	**255 min**
Cooling after the building	480 min	480 min	480 min	480 min
grinding	90 min	90 min	90 min	90 min
Chroming + manipulation	60 min	60 min	0 min	0 min
manipulation + transport to the grinded rollers storage	100 min	100 min	100 min	100 min
manipulation + mounting of the bearing bodies	30 min	30 min	30 min	30 min
Using	**1231 min**	**1212 min**	**1013 min**	**955 min**

4 Working rollers preparation streamlining

The optimal supply of working rollers consists of the sum of working rollers sets consumption per one usage, supplies before the tandem, supplies on the preparation cube and security supplies (Table 2, Table 3).

The ratio of one usage and average delay time tells us the number of consumed sets, after which the first stool will be ready to be rebuilt.

The supplies before the tandem and on the preparation cube are necessary because of the premature replacements, which may occur even after first 15 minutes and the replacement of the working rollers lasts longer.

The security supplies are stored for the cases of some necessary repairs or premature disengagement of the working rollers in case of some failure. This may be some cracks, excisions or the sheet sticked to the roller. In those cases the repairs last much longer.

Table 2 Optimal state of the 4-step rolling track [4]

4-stool tandem	Current state	Optimal state	Savings
Chromed rollers (CR)	**48 pieces**	**24 pieces**	**24 pieces**
Smooth rollers (H)	**38 pieces**	**36 pieces**	**2 pieces**
EIS rollers (EIS)	**36 pieces**	**22 pieces**	**14 pieces**
sum	**122 pieces**	**82 pieces**	**40 pieces**

Table 3 Optimal state of the 5-step rolling track [4]

5-stool tandem	Current state	Optimal state	Savings
Chromed rollers (CR)	**74 pieces**	**36 pieces**	**38 pieces**
Smooth rollers (H)	**54 pieces**	**30 pieces**	**24 pieces**
sum	**128 pieces**	**66 pieces**	**62 pieces**

Conclusions

The effective state of the working rollers for the 4-stool tandem is 82 pieces, which represents the saving of 33% and the effective state of the working rollers for the 4-stool tandem is 66 pieces, which represents the saving of 48%.

According to the statistics of the grinding, each working roller for the 5-stool tandem is repaired in average 208 times, with the loss of 0,17 mm. The rollers for the 4-stool tandem are repaired in average 180 times, with the loss of 0,17 mm. According to those data and the time of one usage it is possible to set the supply cycle of the working rollers ordering.

Then, it is necessary to change the system of rolling tracks supplying from the current LIFO (Last - in, First Out) to the FIFO (First In, first Out) system. This would lead to the achievement of continuous and managed reduction of the averages of individual working rollers to their discarding and replacing by new working rollers.

References

[1] MAJOROŠ, M.: *Analýza a posúdenie brúsenia valcov v USS Košice*, TU of Kosice, 2011. (Original in Slovak)
[2] STRAKA, M.: *Diskrétna a spojitá simulácia v simulačnom jazyku EXTEND*, Košice, AMS, Fakulta BERG, 2007. p. 98, 2007. (Original in Slovak)
[3] MALINDŽÁK, D.: Výrobná Logistika I., Košice, Vydavateľstvo Štroffek, 1997. (Original in Slovak)
[4] MAJOROŠ, M.: *Optimalizácia využitia a logistiky pracovných valcov na prevádzke valcovacej trate SVA, TU of* Kosice, 2013. (Original in Slovak)

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