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SIMULATION AS A MEANS OF ACTIVITY STREAMLINING OF CONTINUOUSLY AND DISCRETE PRODUCTION IN SPECIFIC ENTERPRISE

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Abstract: The advantage of simulation is that it works with a model of real system, so it do not influence the system straight. The provision of quality simulation is also quality model, which has almost the same parameters as the real system. The goal of the project is to create a model and to try its different states, real or hypothetic. A system analysis is used for analysing and to reach of modelled system specifications. The base of synthesis is to create the simulation model. Described simulation model is the result of these steps. Description consists of the functional principle, importance and item setup. The section of variation calculations consists of several measured states of the system. At the output of every calculation, there lies summary of defined differences, their influence of gravure printing process in the technological and the economic aspects.

1 Introduction

Computer simulation in present time is the instrument, which is used in industry and science activities. It represents another possibility for optimization and upgrade of various processes, units, machines and activities. Today's time is characterized by a high degree of automation, robotics and informatization almost all parts of the manufacturing companies. Increasingly, highlight the need for streamlined operations of individual sections to ensure smooth company operations, at the condition of the lowest possible, respectively cost-effective. Increasing the efficiency of the production process is one of the ways to achieve higher earnings, respectively reduce costs [1]. One of the tools how to detect bottlenecks in the technological process, and which need to be "fine-tune" is just a simulation [2]. In contrast to interfering the operation of the production line is the intervention to the simulation model which represents this production line, without costs or negative impacts. In the event that solution is found by simulation and the simulation model, nothing precludes that solution was implemented into itself real process. Creation of the correct simulation model of course precedes acquiring sufficient theoretical knowledge (simulation technique, a specific simulation system, etc.), as well as the current state of the modelled system (system description, its elements and their mutual links) [3]. The results of the simulation model are monitored at every stage. It is possible to derive the impact on the overall system function of the changes that occur at the output of simulation [4].

Necessary value of simulation model depends on the characteristics of the real system - changing and experimenting with the system without interfering in the real system. The problem is in need to try many variations in terms of designing new solutions in the absence of technical equipment [5], [6]. The specific need for simulation model arises from the fact that in times of financial crisis are changes that have a major impact and impact also on customers of specific company, which was subsequently, reflected in itself production process of the company [7]. The simulation model and a simulation application contribute to eliminating these problems and reduce the impact to their customers and the market in general [8].

2 Simulation and its theoretical aspects

For creation of true of simulation model it is necessary to know in detail the actual workplace of firm, simulation techniques and have knowledge from other areas of logistics, such as production logistics and logistics of service processes. One of the main problems is a thorough analysis of material flows in the process of printing, which has a significant impact on the exactness of the simulation model in comparation with reality [9]. The basic principle of the simulation lies in a simplified representation of the real system, its simulation model describing only the properties of the real system which interest us [10]. After verifying and the validating of the simulation model, it followed realization of experiments using a simulation model. These simulation experiments suggest various "enhancements" of simulated system (variants of solving) and verify their impact on the modelled system. Results of these experiments are applied back to the real system, in order to improve its properties [11].

Simulation is not a utility that allows to obtain directly the optimal solution. Rather, it is support instrument that allows the designer to test the effects of their decisions on the simulation model [12]. Great advantage of this approach is that it is possible to visualize the future behaviour of the system and on this base of knowledge to implement its necessary interventions, in a real system [13]. When evaluating the simulation results, we must aware of that the results obtained by simulation are probable values of simulation model and it is necessary to understand it while using them in further work [14]. As already mentioned, the simulation does not have any systematic procedure, the application of which would mean automatically finding the optimum. For design of systems the simulation is therefore suitable for searching answers for the questions "What happens if ...?". In the event that it is a real system that does not work according our ideas, simulation helps to find an answer to the question "What now?" [9].

The model in the case of computer simulation becomes in final form a computer program, that should capture the structure of the modelled system, its dynamics and the its a probability character [15]. There are several reasons to give the simulation priority over the learning experience by experimenting with the real system - it is cheaper, faster (simulation time can run much faster than real), we can test many more possible scenarios, it is safe (It can be tested also for catastrophic variants), we can analysed also planned systems that do not exist yet [16].

3 Current enterprise short analysis

The company has been on Slovak and the European market for many years. At present, the company mainly focuses on the production and the printing of flexible films for the leading producers of food industry and the hygienic production. In the company there are four basic material flows, which are characterized by parts with final production. The first stream - film production: charging plastic granules in storage - film production - packaging - foil expedition. The second flow - packaging printed film: plastic granulate charging into storage - film production, or the input purchased foil - foil printing - lamination, or the metallization - cutting - packaging - expedition of printed foils. The third flow - production pockets and the bags: plastic granulate charging into storage - production of foils, or the input purchased foils - foil printing - cutting - making bags - packaging - expedition of bags. The fourth flow - making sachets: purchase foils - cutting - printing - laminating - making bags - packaging - bags expedition [17].

Department of printing as a system consists of elements (HSW and the HSR printing machines, auxiliaries parts) and their mutual links (flows of transport, information, materials) within the Department of printing can define several types of material flows (Figure 1). The main material flow represents the printed foils. Subsidiary flows are e.g. colour flow, residual foils, rollers. Side flows are part of service processes within the department gravure printing [17].

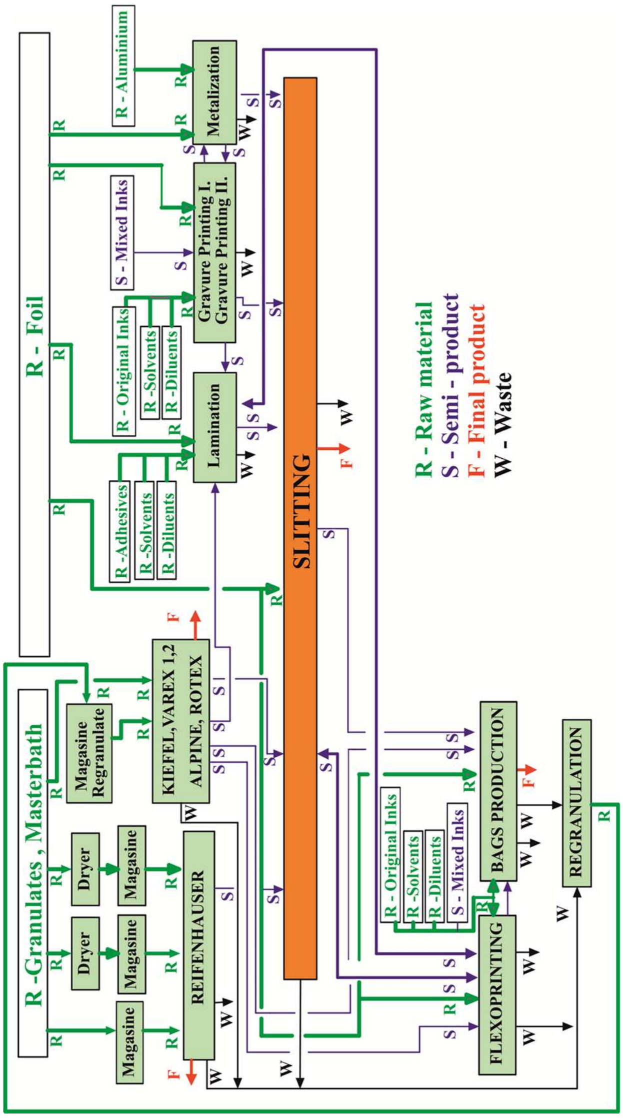

Figure 1 The scheme of production with the material flows

Printing department operates in cycles, where one cycle represents fitted of a single order. Each of this cycle consists of four phases, where are made the following operations:

1 Preparation phase (approx. 35 min)

a. preparation of foils,

b. preparation of scraper blades,

c. preparation of colours,

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d. preparation of press rollers and their transfer to the printing machine.

2 Installation phase (approx. 70 min)

a. rollers removal and their washing, the outpouring of colours, removing the rest of the unused foils from the previous order,

b. installation of press rollers, new coils of foils and the pouring new colours,

3. Running in (approx. 30 min)

a. set the machine for correct print, eventual fine tuning of tone colours,

4. Print (variable time depending on the size of order)

a. press monitoring,

b. installation of a new foils,

c. topping up of colours,

d. wash and the conservation of rollers from the previous order.

Phase no. 1 usually works with the phase no. 4 order so that the preparation of the next order expired at the latest time, when the previous order expires printing.

4 Creation of simulation model

ExtendSim simulation system was chosen for creating of a simulation model which can design continuous and discrete models (Figure 2). Model represents not only the actual printing (implementing blocks Activity), but simulates also coming of orders from the customer (block Generate) with the set attributes of the order [3].

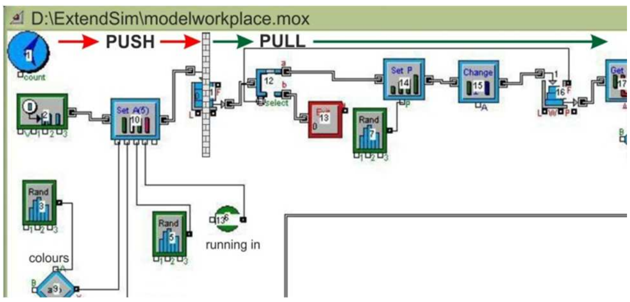

Figure 2 the breaking point between the PUSH and the PULL system in the simulation model of the printing workplace

Figure 3 was made two types of alternative calculations on the model:

1. based on the real state of the system - the role of these alternative calculations is to determine if and how the selected distribution of input interval of random number into the simulation model influence the use of individual devices, the finding what interval is effective for a given setting of the modelled system and the determine which machine represents bottleneck of the process.

2. based on hypothetical states - their task is to examine behaviour of system at a magnification and to reduce the number of machines.

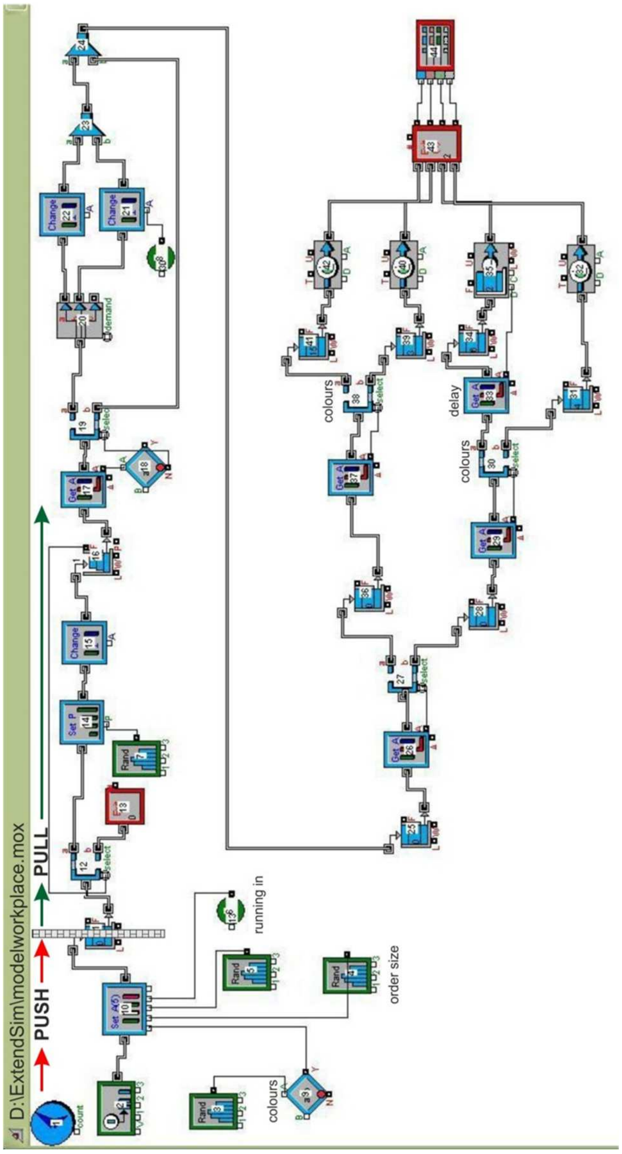

Figure 3 Simulation model of printing workplace in simulation system ExtendSim

In the alternative calculations there has been studied the impact of three types of distribution of arrival order into the company and the behaviour of the system, and this:

1. Triangular - setting the distribution is based on three values (minimum, maximum and the most likely value). To calculate the average value of the input is necessary to calculate average values.

2. Constant - generating of entry on the basis of a constant (constant time step).

3. Lognormal - distribution based on the natural logarithm of normal distribution. Entered are: mean (average) value and the standard deviation, for example 100 ± 25.

For each type of the distribution there were made 4 set of values, each of 10 reps. During each calculation there were observed following values:

1. number of generated orders,
2. number of completed contracts,
3. number of pending orders,
4. machine utilization individually,
5. the use of machines globally.

For each group, after 10 repetitions it was calculated average values, which are worked further when creating addictions and the conclusions. Multiplication of calculations has been chosen because of averaging the results and to obviate possible deviations caused by extreme course of simulation in one repetition. Selected number of repetitions has proven to be sufficient; because the average value changed was from 8 repetitions are very small, around of 4%. The defined values have been derived from the following indicators:

1. The dependence of the number of completed orders from the average utilization of machines.

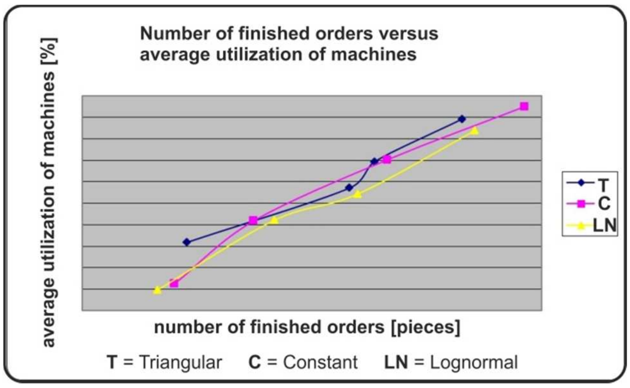

Figure 4 Curves of the average utilization of machines

The graph shows (Figure 4) that the average utilization of machines grows linearly with the number of completed orders for any type of the distribution of arrival requirements to the system. The optimal value of the average use of the machine (approx. 80-85%) is achieved for the volume of 15 completed orders the whole system for 24 hours, representing 1 order / machine / change (8 hrs.).

2. The ratio of equipped and the backlog of orders.

Graph shows (Figure 5) the ratio of equipped and backlog of orders in contemporary displaying of the average utilization of machines (size of the circle). In the chart there are visible two trends in depending:

a. The increase of the number of processed orders is more progressive than the increase of the backlog of orders. This trend can be observed in the range of values ⟨0;15⟩ equipped orders.

b. In the interval ⟨15;140⟩ is increase number of processed orders less than the increase in the backlog of orders.

Point of trend changes (15 equipped orders) can be regarded as effective ratio to number of processed and the backlog of orders. After that point is the increase of number of unserved orders more progressive then the increase of number of served orders.

3. The average utilization of machines.

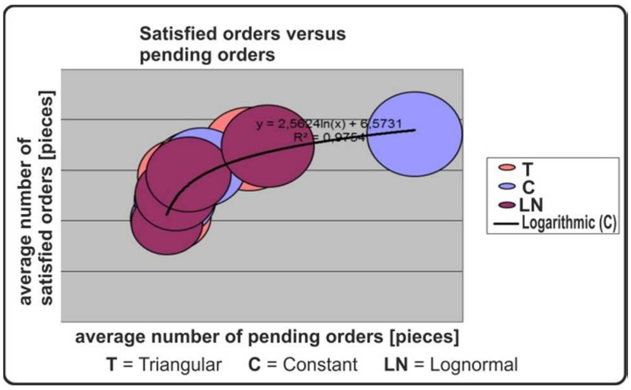

Figure 5 Graph ratio of equipped and the backlog of orders

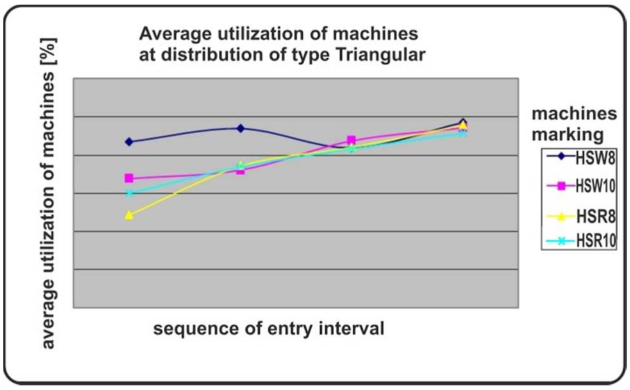

Figure 6 Curves of average machines utilization by distribution function type of Triangular

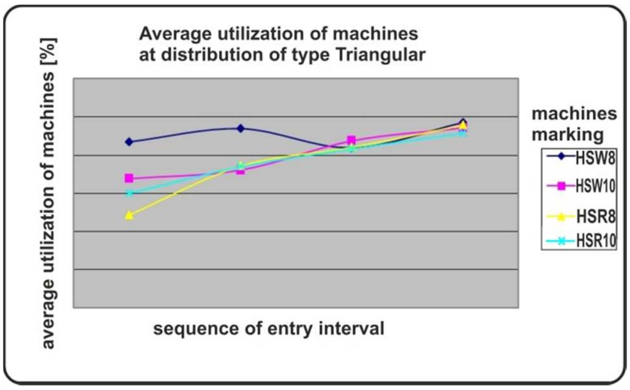

Figure 7 Curves of average machines utilization by distribution function type of Constant

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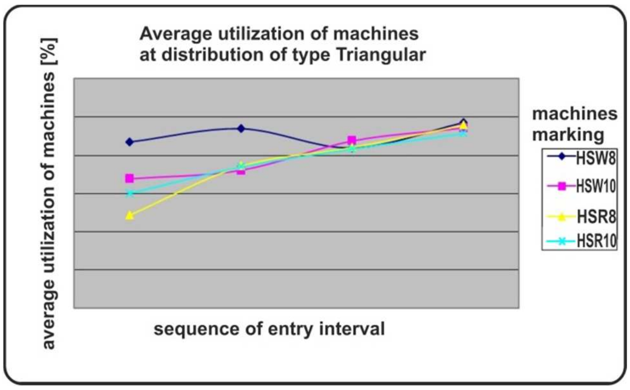

Figure 8 Curves of average machines utilization by distribution function type of Lognormal

From the graphs of the average utilization of machines it results (Figure 6, Figure 7, Figure 8), that the largest deviations in utilization of machines are in distribution function of type Lognormal and the smallest are in distribution function of type Triangular. For each type of the distribution the machine HSW8 is the busiest. Also machines with the 8 inking are busier than machines with the 10 inking too (Table 1).

Table 1 Total average utilization of machines

Machine	Average utilization total [%]
HSW8	90,76
HSW10	70,25
HSR8	78,18
HSR10	70,34
Average sum	77,3825

Conclusion

By simulation it has been found that none of the three types of distribution of random entry of order into the system change radically the behaviour of the simulation model, as well as the output parameters of the system. It follows, that the selected type of the distribution has not a significant impact on the behaviour of the system over other types of the distribution. It was also detected bottleneck of production process in the form of most utilization of the machine, which is HSW8 device, which can be seen also from graphs of the average utilization of machines. Its average utilization is 90.76 %. The least utilized machine can be considered HSW10 machine, which average utilization is 70.25 %. For effective of entry interval, i.e. one in which is the average utilization of machines in the values of 80-85% can be considered for different types of the distribution of following parameters:

1. Triangular – value T 10, 80, 40 (η=0,847),
2. Constant – value C 40 (η=0,851),
3. Lognormal – value LN 50, 20 (η=0,772).

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