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APPLICATION OF FLEXSIM FOR MODELLING AND SIMULATION OF THE PRODUCTION PROCESS

Abstract: This paper presents a methodology of simulation the production processes and, in particular the utilization of the FlexSim program to design production processes. It is explained the basic issues related to modeling and simulation, and introduced the use of certain tools of the program to model a simple manufacturing process.

1. Introduction

Computer programs are important tools for adding management of production processes. There are many spheres of business activity. One special area among them is information technology which help to solve problems considered with production organization. One issue in this area is the simulation of production processes. There are many programs designated to simulate production processes. One of them, presented in this paper, is FlexSim.

FlexSim simulation program is used primarily for modeling, simulation and visualization of business processes. Importantly, it can help to solve inventory and work in progress(WIP) problems, to optimize the production line, to determine business performance, to manage bottlenecks, to test new planning practices, to justify productivity and capital expenditure. FlexSim allows to realize and animate 3D models and to create models directly using C++. It is supported by simulation and graphic libraries [1].

2. Modelling a specific approach to experimental tests

The word "model" (from the Latin: *modulus*, which means the image, measure) is used in many different science areas and sometimes even in a contradictory mode. In technical sciences, apart from the obvious meaning of the model as a copy of a real existing object (e.g. the model of tools, machines etc.), there are also two other meanings of this term. The first one means the characterization of new, foreign and less understandable phenomena through the use of the already known one. The second one is used for the created theoretical structure which reflects elements of the analysed reality [2].

Modelling means the creation of a system whose main purpose is to imitate the characteristics of a part of another system embodying the original. It means that a model is a

specific decomposition of a real system to different levels of detail. In this case, the model is a representation that describes the system at each of the specified levels [3].

The modelling methods are used when reaching a solution by analytical methods is not feasible or it is too complicated, and a direct experiment on the physical (real) model is too expensive, dangerous, complex or time-consuming. Modelling is also used when other methods do not provide the expected level of assurance. In this case manufacturing process is realized in accordance with the assumptions for the theoretical model. There are several phases of model development, and namely: defining the problem, identifying and collecting relevant information and data, formulating hypotheses, defining the basic logic of the model and defining parameters and variables. In this paper are described three modelling methods used to realize the representation of real processes: deterministic one, stochastic one, as well as the one basing on expected values. All these methods are used for modelling and realized computer simulation. They can use the same model if it is verified. A large majority of process simulations is a combination of these three methods. Selecting one of them to model a particular function must be justified. The deterministic procedure is used when random factors have no impact on desirable results and when the random factors are not present in the analysed problem. The stochastic procedure is used in modelling when it is highly desirable to know the individual results rather than the aggregate results or it is important to find the cumulative distribution of results and determining, in addition the average value of the variance. On the modelling result the following factors have an impact: the characteristics of randomness associated with efficiency, reliability, the occurrence of the event, a measurement error in the system or the function operating time. The expected value method is used when changes in individual data do not influence the results obtained from the model. To solve the problem the average values are sufficient and it is not necessary to know the individual results in the problem. It is not important for modelling results to appoint the variance and cumulative distribution functions[2].

3. Simulation of production systems

During the simulation of the modelled processes are calculated values of parameters describing the course of the characteristic quantities of the tested process. The simulation relies on the replication of the elements occurring successive with the passage of time [4].

In the computer simulation the queuing theory is used, which allows to analyse the queue of elements pending at the service station; for example, customers waiting in the checkout line or production orders waiting to be performed in a given workstation. The essential parameters of this method are: service time on the workstation and the time before the publication of the next report [5].

Computer simulation can be used to aid the effective and innovative manufacturing concepts such as Material Requirements Planning, Just In Time, Lean Production, Total Quality Management, Virtual Factory, Optimized Production Technology [4].The basic condition for the success of the project simulation is realizing it at the right time period. Very often companies use this method when the possibilities in relation to the impact on the final solution and the level of investment are already very limited. Structure of the simulation algorithm is shown in Fig. 1.

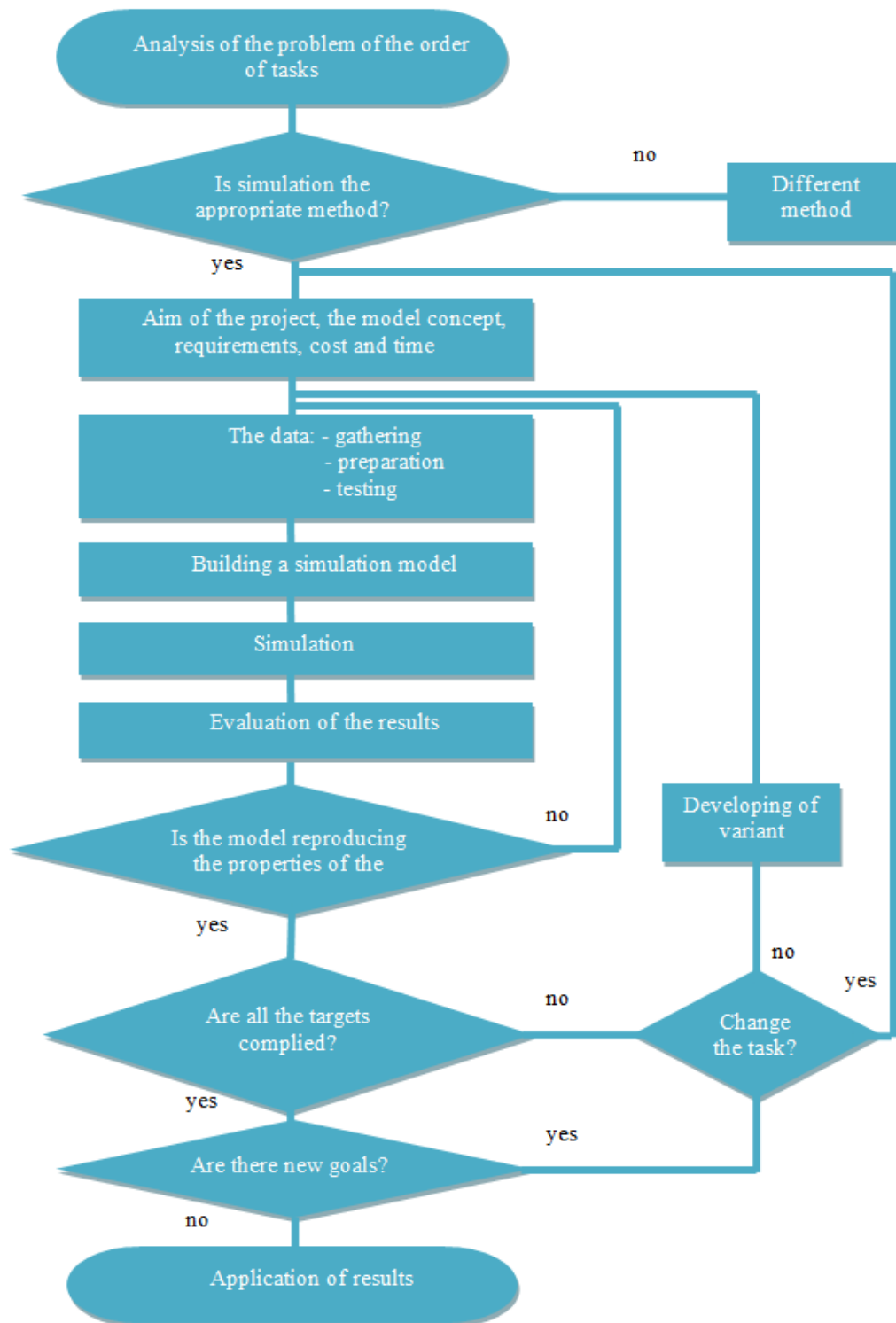


Fig.1. The main activities of the project simulation

4. Modelling in the FlexSim software

The presented model was elaborated taking into account its limitation considered with the quantity of elements that could be used. The created model (presented in Fig.2) consists of elements such as: *Source*, 4 *Queues*, 3 *Multiprocessors*, *Dispatcher*, *Rack*, *ASRS Vehicle*, *Transporter* and 4 *Operators*. The number of elements do not exceed 20.

From *Source* items are sent to *Queue1*, then *Operator1* moves them to *MultiProcessor1*, where they are processed. During operation, the machine changes its colour, which indicates the stage of the operation. When *MultiProcessor1* is occupied, it turns red. When the product is done then the machine turns colour into green which indicates that the object is ready for the next stage of the production process (Fig.3). *Operator2* receives the product and passes it to *MultiProcessor2* and *MultiProcessor3*. There the objects are painted, in *MultiProcessor2* in green colour, and in *MultiProcessor3* in pink colour. From *MultiProcessor2* painted items are transferred by *Operator3*, and from *MultiProcessor3* by *Operator4* and they are all transferred to *Queue2*. From there *ASRS vehicle* takes objects and places them on *Rack*. From the other side of the *Rack*, items are received by the *Transporter* and placed on *Queue3* and *Queue4* according to their colours (green and pink respectively) (Fig.4).

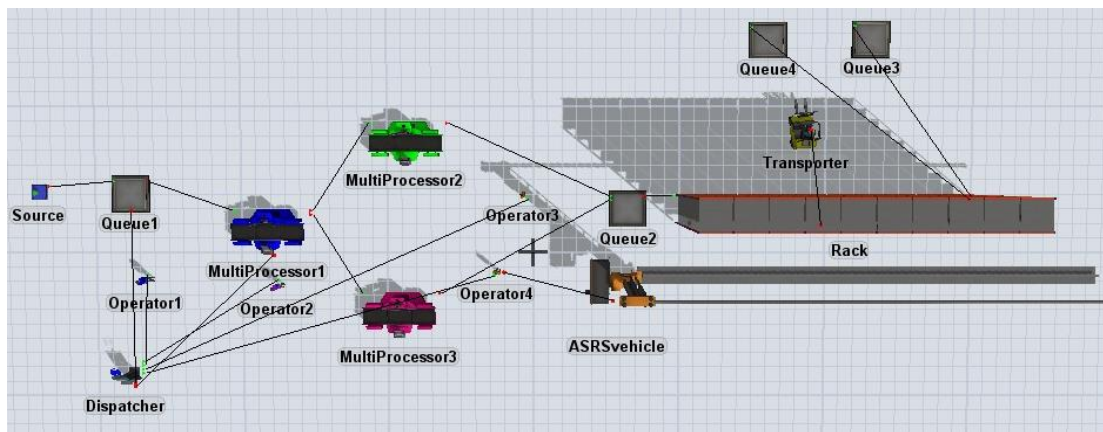


Fig.2. The basic elements and connections of the model

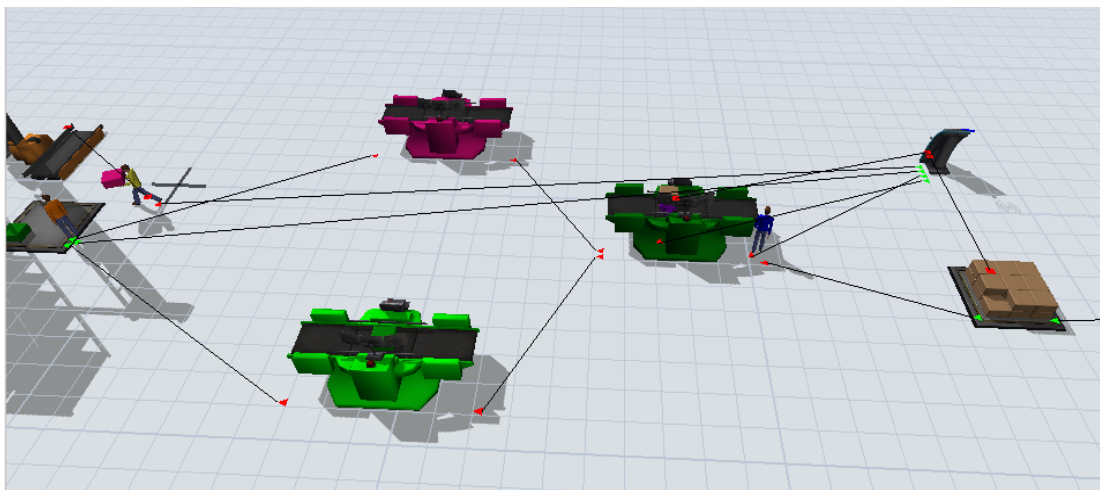


Fig.3. The view of simulation - colour change by the Multiprocessor1

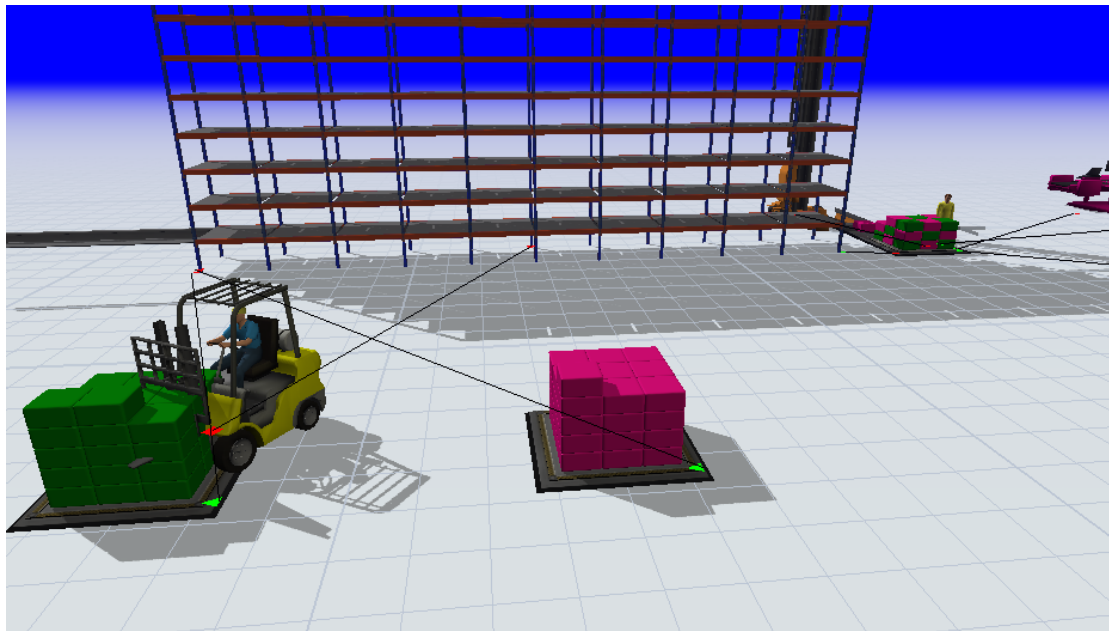


Fig.4. The view of simulation - separation of the products by colour

The program gives the user the ability to create charts showing the relevant data related to the simulation of the production process (Fig.5).

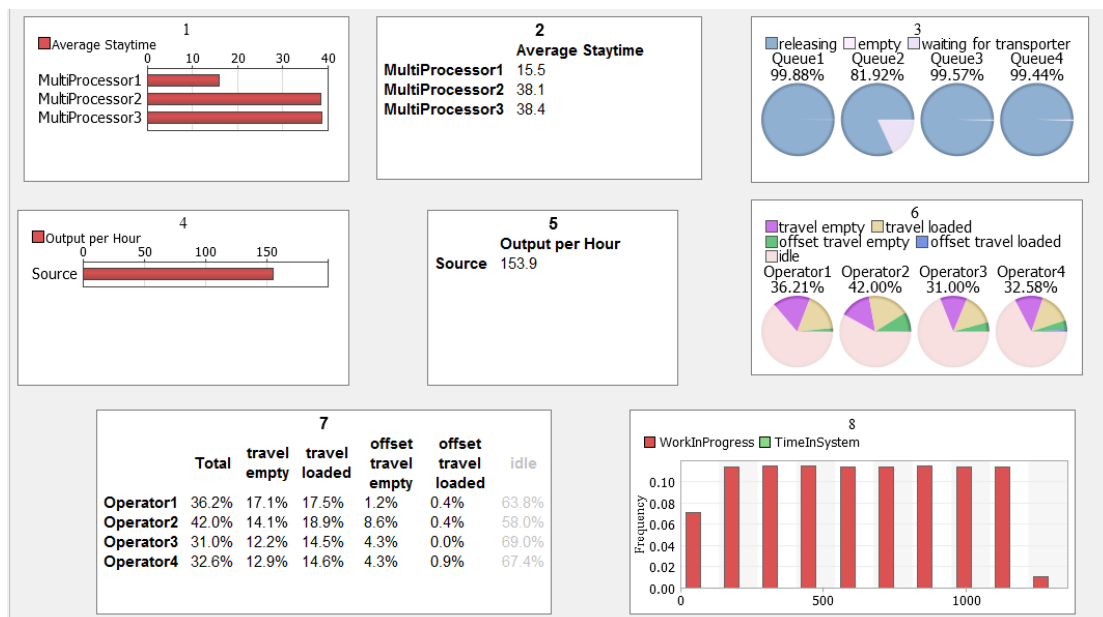


Fig.5. The view of dashboard

These charts show the information after 8 hours work (28,800 seconds). The first chart shows the average stay time of the product in *MultiProcessor1*, *MultiProcessor2* and *MultiProcessor3*. The second chart shows the same data in the numeric format (for *MultiProcessor1* is 15,5, for *MultiProcessor2* - 38,1 and for *MultiProcessor3* - 38,4). The third chart shows the status of the queues. During 28,800 second of work for *Queue1* the releasing value is 99,88%, for *Queue2* it is 81,92%, for *Queue3* - 99,57% and for *Queue4* it is

equal to 99,44%. The fourth and fifth charts inform that output per hour for *Source* is 153,9. The sixth and seventh charts show the status of the operators and the last one presents work in progress, specifying the frequency value.

5. Conclusions

The aim of this paper was to present the problems of modelling and simulation as well as to describe the basic tools used in this process. The analysed process was modelled in the FlexSim program. Due to the limited number of items used in the modelling processes in the program it was not possible to present all advantages and the full range of capabilities of this software. This program has the tools which, together with the appropriate user knowledge and experience, can lead to optimize production processes.

The FlexSim program is a powerful analysis tool that helps engineers and planners to make more sophisticated decisions on the design and operation of the system. It provides the ability to build a 3-dimensional model of the real system, and then to analyse the system in shorter time and at a lower cost than it would before the analysis of a real system. The FlexSim program characterizes by a realistic graphic interface and the ability to generate comprehensive performance reports. It also provides the ability to identify problems and evaluate alternative solutions in a very short period of time [6].

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