SELECTED ENGINEERING PROBLEMS
NUMBER 8
DEPARTMENT OF ENGINEERING PROCESSES AUTOMATION AND INTEGRATED MANUFACTURING SYSTEMS

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COMPUTER SIMULATION OF MANUAL OPERATED AND ROBOTIZED TECHNOLOGICAL LINES IN FLEXSIM SOFTWARE

Abstract: The article present current research realized during works on production planning and manufacturing system quality improving with use a methods of computer modelling and simulation techniques. Except that, the functional analysis of simulation software FlexSim are shown in context of manual operated and robotized technological lines. At realized tests, the possibility of the selected application were examined in the optimization of material flow through internal system, especially in the context of automated and robotized medium-series and high volume production. During research two models were created and compared, at the end some conclusions were presented. The article was created on the base of master thesis [1].

1. Introduction

The beginning and development of the 4.0 industry philosophy, obliged the producers to look for the better manufacturing solutions, even more than before today [2,3]. Contemporary production processes and internal logistics requires use of modern solutions in a different aspects of material flow, especially in context of inter-operational breaks and Lean Manufacturing [4,5], which involves the need to analyze a lot of industrial data. In this situation, only the use of a computer simulation, with the use of software available on the market, seems to be appropriate. In our research, FlexSim software was used, because it is designed, among others, for modeling and analysis of flexible manufacturing systems with discrete flow of materials [6]. During ours works, related to the preparation of the master's thesis [1] and other parallel realized research [7], the comparison of the production line efficiency with the assumption of two types of the inter-operational transport was focused. In the first stage a manual handling and transport, with the use of an operator, was modelled and analyzed, in the second stage an industrial robots were used.

2. Modelling and virtual simulation of technological lines in Flexsim

The first step of the activities started with the review of the existing and available 3D VIMS simulation software (Visual Interactive Modelling System). By verifying the available components, parameters and analytical capabilities of the production logistics software, already at the outset, FlexSim and Enterprise Dynamics were selected, as suitable for carrying out research in the aforementioned scope [8,9]. Both software have a similar modelling philosophy and simulation capabilities, but FlexSim was finally decided, especially due to the availability of the full version, at the Institute of Engineering Processes Automation and Integrated Manufacturing Systems. Next step was creating two models of production line: with human operated transport and its modification by using industrial robots. Partial models are presented on Fig. 1.

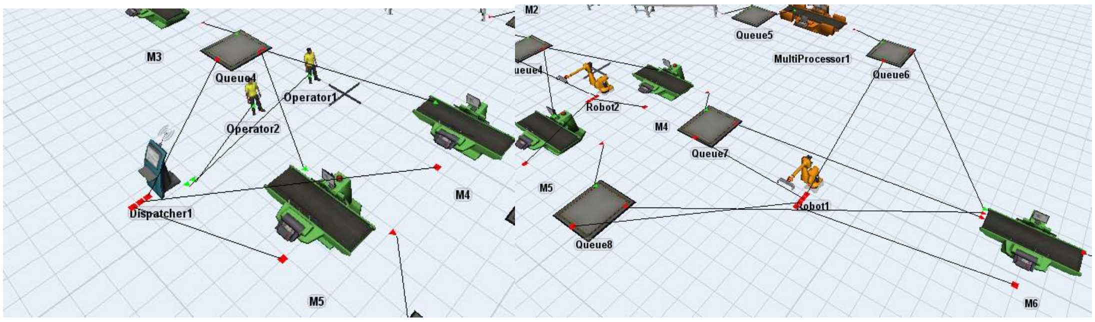

Fig. 1. Two partial models: human–operated and robotized cells

The following FlexSim elements [8,9] were used when we built the models: *Sources* of raw materials, *Queues* - inter-operational buffers, *Processors* and *Multiprocessors* - technological machines, *Conveyors*, *Transporters* - e.g. forklifts, *Rack* - final product warehouse and of course *Operators* and industrial *Robots* - which were most important during research on material manipulation and handling tasks and so called "short transport" processes inside the system. The final layout (here only for robotized part) is presented below on Fig. 2.

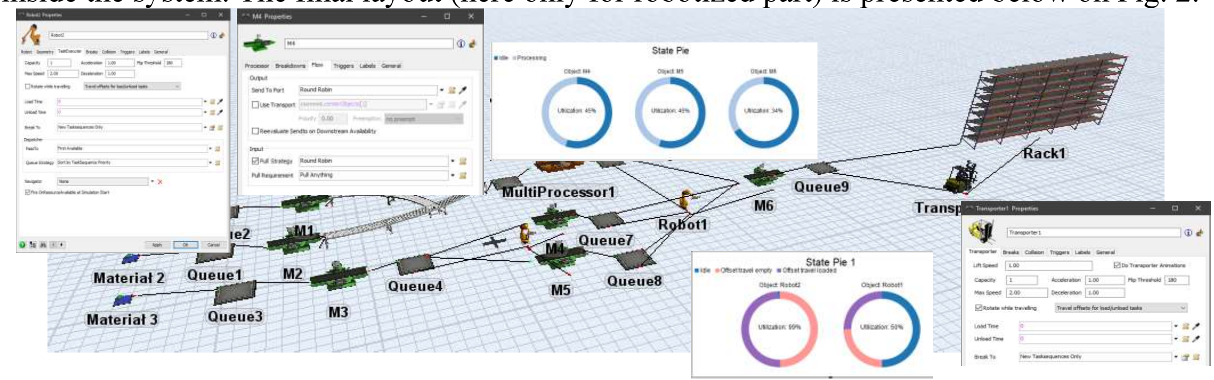

Fig. 2. The FlexSim model of automated and robotized manufacturing system

After optimization of the layout (correct locations of all production devices) connections between elements were created. The connections give information about materials flow through the production system.

The most difficult task, during modelling is correct description of main and auxiliary parameters of production system elements with use of FlexSim existing internal functions or macros created by user in FlexSim programming language. It was necessary to reproduce the real model. When research was conducted on comparison of human operated and robotized transport we focused on parameter of the two elements, because the properties of another devices are the same in first and second model. On the Fig. 3 some properties of *Operator* and *Robot* are presented, and described below the picture.

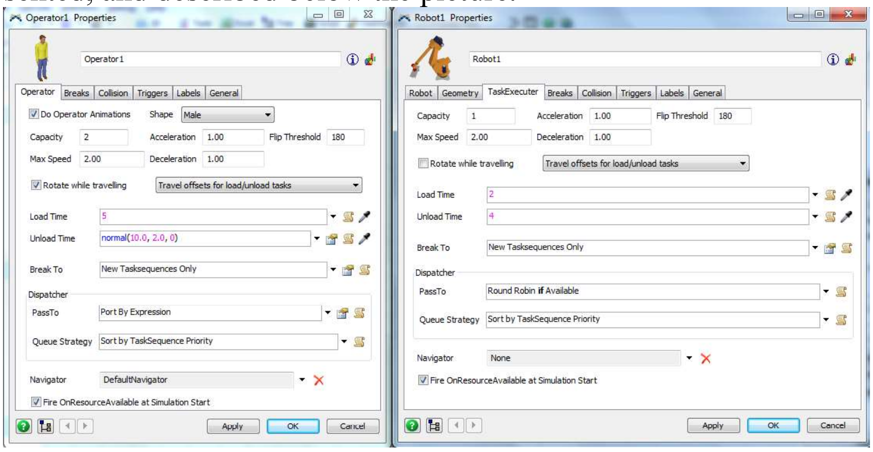

Fig. 3. Main and auxiliary properties for Operator and Robot

In that case chosen parameters (grouped in specific menu: *Operator/Robot*, *Geometry*, *Task Executer*, *Breaks*, *Collision*, *Triggers*, *Labels*, *General*) are similar but some are different. Identical parameters are connected with *Load/Unload Time*, *Queue Strategy*, *Flow*, *Speed* and *Acceleration*, *Capacity*, *Dispatching* rules, *Collisions*; of course these real values for operator and robot can be different. Other parameters, like Geometry and Trajectory are specific only for industrial robot or other automated device, but another properties e.g. for human are difficult or not possible modelling in FlexSim software - e.g. skills, experience, psychophysical capabilities.

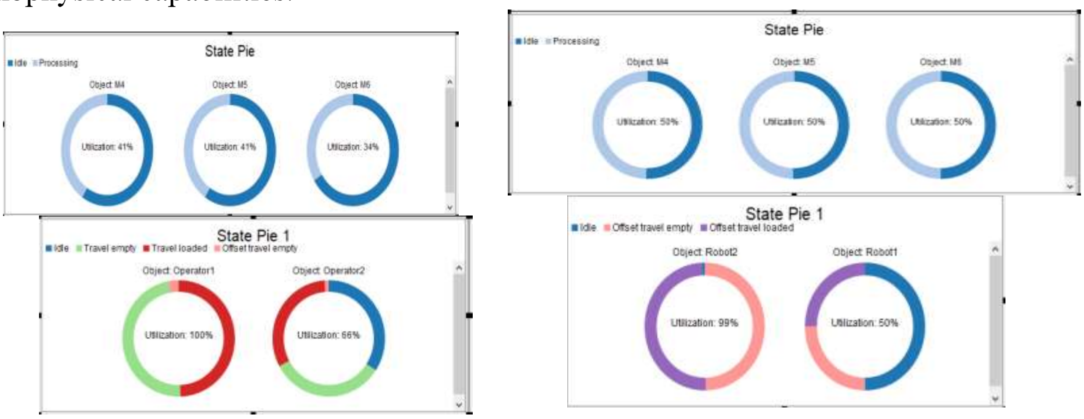

Fig. 4. Comparison of improved models: machines efficiency and humans/robots utilization

After simple modelling process it is possible to start simulation research. In this case, we focused on the analysis of the work efficiency of the production cell (technological machines) supported by operators (1^{st} model) and by robots (2^{nd} model), as well as checking the utilization of the transport and manipulation subsystem (human operated and robotized).

On the Fig. 4. the results described above are presented, of course, we show only final results after multistage improvement process of the model.

3. Conclusions

The application of different computer simulation software (e.g. FlexSim) and making any tests of designed and existing production systems e.g. in the aspects described here in context of improving the efficiency of the system working is currently one of the most important activities aimed at optimizing the flow of materials, reducing inter-operational breaks, and thus reducing the costs related to selected functions of internal logistics. In further research, the analysis area should be extended to the entire integrated production and logistics environment paying particular attention to the optimization of material flow, especially in relation to the ergonomics of operators work and off-line planning the trajectories of robots (but these may involve the use of other specialized software - e.g. Process Simulate).

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