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Keywords: FlexSim, simulation, creation of simulation models.
Abstract: This paper points out the possibilities of streamlining production processes based on simulation, created by the simulation software FlexSim. The intention is to point out the importance of simulation in the change design phase. The main task is to create a quality model that should reflect the real conditions on the line, and to design control logic to ensure that the line model works as a real line.

1 Introduction

The paper points out the need and importance of creating digital models, on which we can experiment with optimizations and then we can implement these verified and simulation-based optimizations into real operation and thus save costs thanks to the established measures. Saving costs is the main purpose of why we create digital models based on which we optimize the process. The digital line model can also serve as a subject for early diagnosis of problems or, if necessary, line analysis [1,2]. The aim of the paper is to present the possibilities for creating simulation models in the FlexSim software application and to present the possibilities of how to work with it and create digital models.

2 FlexSim sotware

FlexSim is a simulation software whose software package includes FlexSim Healthcare, OptQuest and ExpertFit in addition to the simulation software itself. Used to model, simulate, visualize and optimize systems in various industries [3,4]. In addition to its proven benefits, this program delivers high-level graphics. Compared to older simulation software, thanks to this reality, even a layman can easily understand what is going on in the process. Thanks to ExpertFit, we can determine one of the 40 statistical distributions for the data obtained, thus taking into account the variability that occurs in real processes. This program allows you to analyze the system, while modeling we get a realistic form of the process. Perhaps the biggest advantage of the program is the simplicity of modeling thanks to the drug and drop principle.

Thanks to the fact that the program allows the import of 3D models or CAD drawings, the simulation becomes reliable, as it is created according to real dimensions. This brings not only the visual but also the factual form into the simulation [5,6].

The Process Flow tool is a great benefit when modeling more complex processes. To create simple models, it is enough to define the properties of objects, for more complex models we use Process Flow. This Process Flow is used to create logic, which we create using blocks in the form of flowcharts.

The company has developed a scripting language called FlexScript and is also a program compatible with the C ++ programming language, which allows almost unlimited possibilities.

After modeling and simulations, the program allows you to analyze events and results, which we obtain in the form of graphs or diagrams with the possibility of exporting to a table. Based on the results of the simulation, we can then evaluate and propose changes to any part of the system without financial loss, as we work in a virtual environment [7-9]. FlexSim is used in areas such as warehouses, logistics, airports, healthcare, service, transport, mining.

After loading the program, the user will see the welcome menu of the program with the menu.

Part of this menu is the menu, which allows the user to do the following:

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1. Explore Tutorials - after clicking on Explore Tutorials, a new window will appear, which is a kind of manual for creation. It is chronologically arranged and progresses from basic to more complex functions. It contains instructions for creating models, instructions for entering tasks, a description of the Process Flow function and many other tips, instructions and procedures needed for creation.
2. What's new in FlexSim - by clicking on this we are redirected to the FlexSim website. The goal is for the user to be constantly aware of the developers' news.
3. FlexSim in Education - After clicking on this icon, we are redirected back to the FlexSim website. This section provides basic information about learning opportunities in this program. It writes about student versions of this software, but also about training opportunities for companies.
4. New model - By clicking on New model, we will first see the option of the most basic settings, namely units of time, distance, flow. After choosing these quantities, we get to the basic working environment, which allows us to model and simulate.
5. Open model - Clicking on this will bring up a new window that will allow us to search the computer and open models created by FlexSim.
6. Getting Started - Similar to position 1 and contains instructions for creating models.
7. Preferences - The Preferences icon allows us to set preferred settings such as fonts, different part colors, different templates, allowing object rotations and resizing, library selection, panel tool customizations, chart settings, and various other software settings in the form of preferences.
8. Licensing - in this menu we will see a window that allows you to enter the activation code and provide information about licenses and license conditions.
9. User Manual - again provides us with a manual that is very similar to points 1 and 6.

After clicking on New Model, we get to the setting of basic quantities (Figure 1).

After setting the basic values, click OK and the basic workspace for creation is loaded.
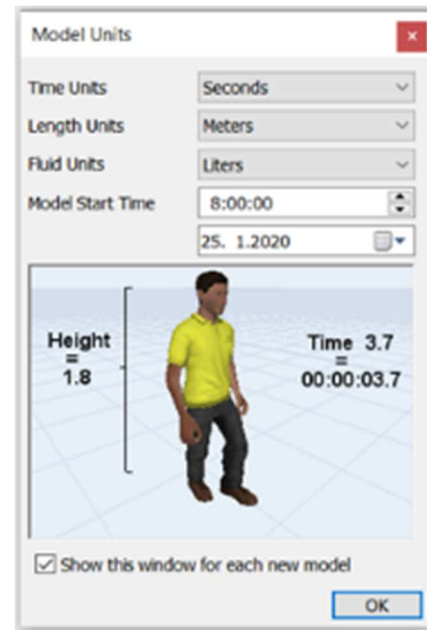

Figure 1 Initial settings

For explanation, we divide this space into several parts (Figure 2).

1. This area is reserved for modeling space. We create a model in this space and the model simulation also runs in it. We can edit the area in various ways, either by changing the color or by adding a grid. In engineering practice, the background of this area is often the layout or floor plan of the line.
2. From the point of view of creating a simulation, this part is the most important as it contains objects from which we create a process model. It is a kind of library of all available tools needed for modeling. In this section you will find inputs, outputs, buffers, processors of various characters, conveyors, operators, trucks, robots, elements used for control and much more. We place these objects in the space for modeling with the principle of drug and drop.
3. Main bar. This bar is used for control itself. This bar contains icons for opening and saving, tools for creating objects, linking to Excel, an icon for previewing the tree structure of model creation, help, dashboards or reports, Process Flow for creating logic of more complex processes, and. i.
4. This part is used to control the created simulation. Use the icons in this section to start, stop and reset the simulation. Here we set the speed of the simulation and especially the duration of the simulation, which we can set either in the manner of the specified time or in the form from - to.
5. This window makes our work easier as we have fast properties in this window, such as switching between modes or setting the basic environment and many other useful tools after clicking on objects that will speed up the work.

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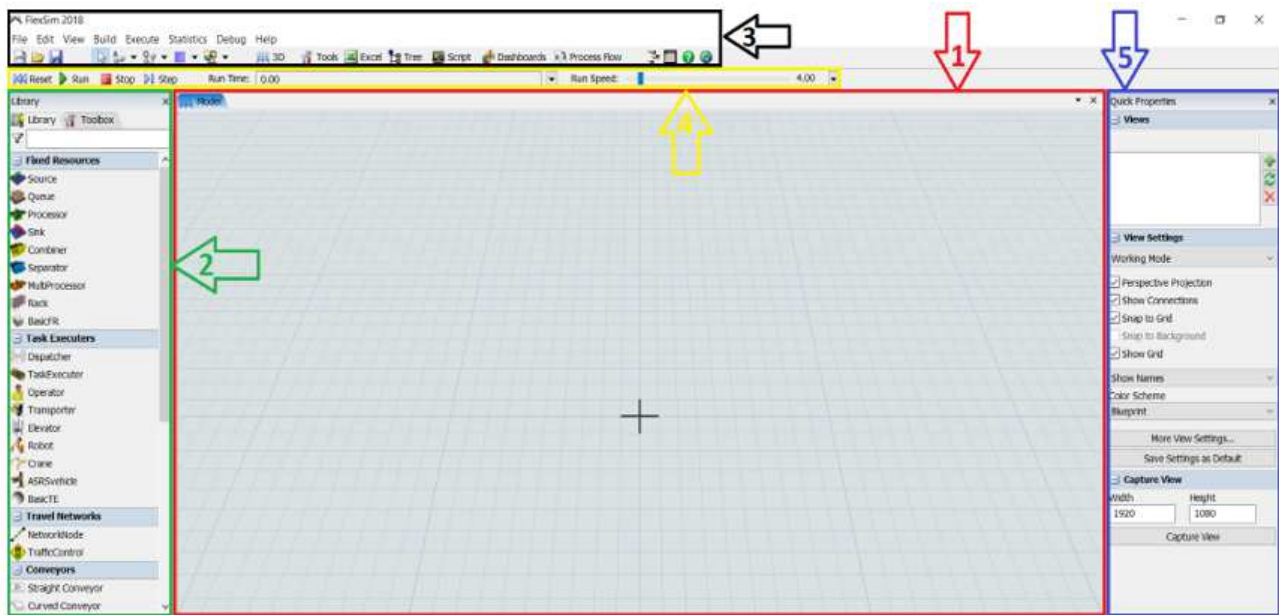Marek Kliment, Miriam Pekarcikova, Jozef Trojan, Jana Kronova

Figure 2 Basic workspace

In order to have a good understanding of model creation and consequently more complex line models, we will start by modeling the simple processes that make up the more complex production line processes. We will explain the basic functions that we set on elementary objects. After introducing the issue of modeling in this program, we move on to a comprehensive line model used in practice, which will then be functionally described.

We will create a simple process using objects from the Fixed Resources library. We get objects into space by dragging from the library to the modeling area. We connect the individual objects in the direction of the required material flow with the A key (Figure 3).
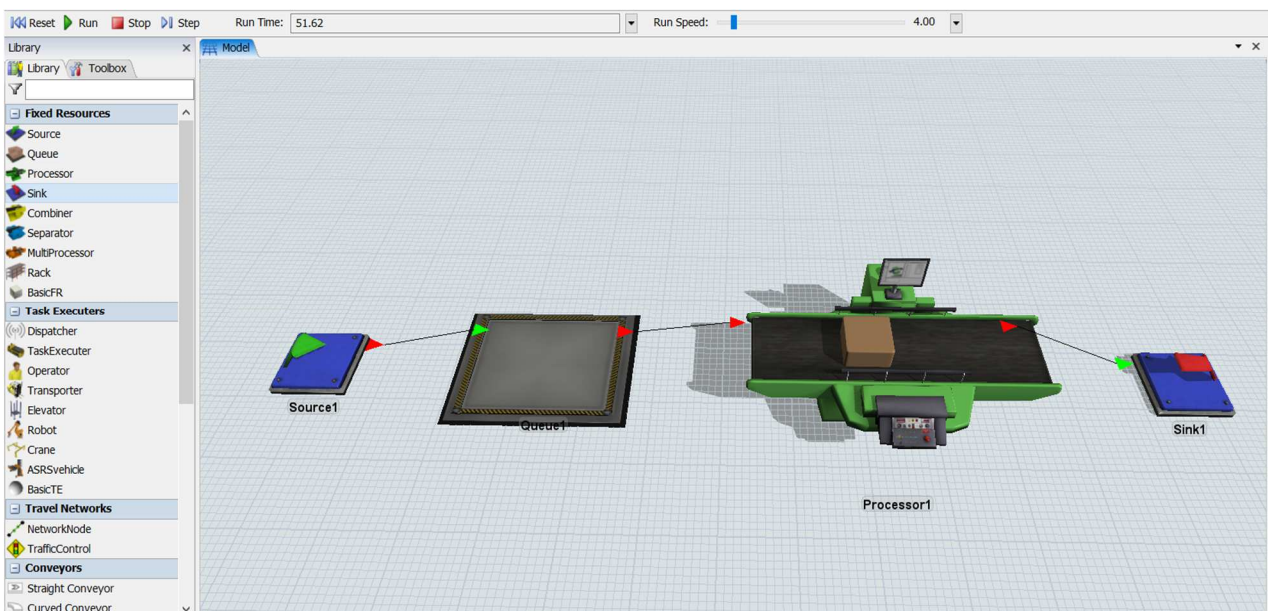

Figure 3 Simple process

Source1 - is an input that generates simple geometric objects. It is possible to generate other CAD models after importing the model into the library. After double-clicking on Source 1, a menu will appear where we can change the appearance and size of the source itself, port priorities, quantity and time of object generation - it can be entered as a fixed number but also in the form of a mathematical function, and other properties. The material flow will follow the orientation of the arrow.

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Queue 1 - serves as an intermediate buffer. Here, the generated objects from Source1 are collected. After clicking, we change similar functions as with Source1, ie the visual appearance, port priorities, and especially the capacity of Queue1 itself. The object jumps to the Processor1 imaginary as it is directly connected, but this translation is often performed by the operator, robot, truck or. conveyor. We will ensure that the object does not jump into the process by selecting the Use transport function in the Queue1 properties, thus the object that is connected to the central port will be used for transport. We drag the required form of transport into the model and connect it with the buffer.

Processor1 - represents an operation that can have a different character. This Processor1 can represent the process of drilling, welding, grinding, assembly, etc. We set the classic settings again, and in addition we set the maximum contents of the processor, the processing time, the length of the fault on the machine, the set up time. We can enter these times fixedly, but the vast majority are based on the statistical processing of the values obtained from the real process and thus determine the distribution that best characterizes the values obtained. Processor 1

operates so that the object that enters the processor stays in it according to the processing time and then proceeds. Transport is again imaginary, but again we can provide it similarly to Queue1.

Sink1 - This object can be understood as the place where the process ends. It is a kind of output resp. the end of the process, where when the objects cross the line and reach the Sink, they are counted in the produced pieces and then lost in the Sink.

Combiner 1 - The function is similar to the classic Processor, but the difference is that Combiner has 2 inputs and 1 output (Figure 4). This means that the given process and processing time in Combinery will not start until the Combiner has received an object from both input ports. The number of inputs to start can be set. In simplicity, this means that for a given process we need e.g. one flange and 4 screws to it, the process will not start until there is one flange and exactly 4 screws in Combinery1.

Separator1 - is an inversion of the combiner, it has one input and two outputs (Figure 4). The input is to one port and contains min. 2 combined components which remain in the separator for a process time and subsequently exit already separated from the two or more output ports.
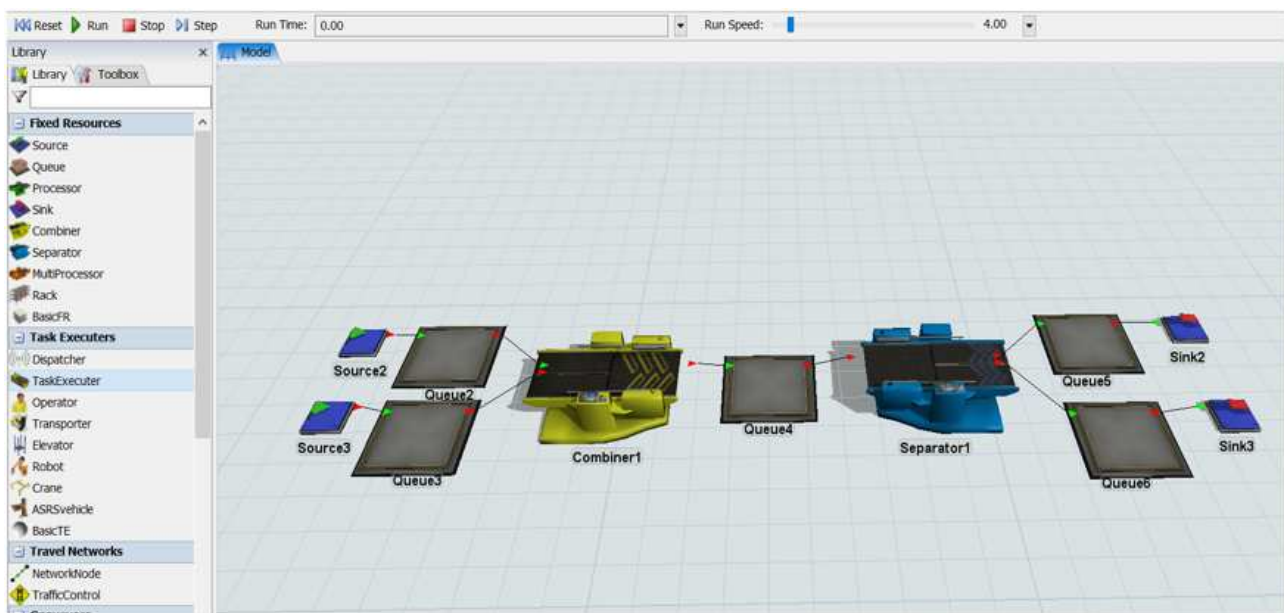

Figure 4 Principle of operation Combiner and Separator

Multiprocessor1 - It is a processor that is able to perform multiple operations (Figure 5). We define several processes for the multiprocessor and the individual processing times are determined for these processes. The

given object leaves the multiprocessor only after all processes have run, ie after all processing times have elapsed.

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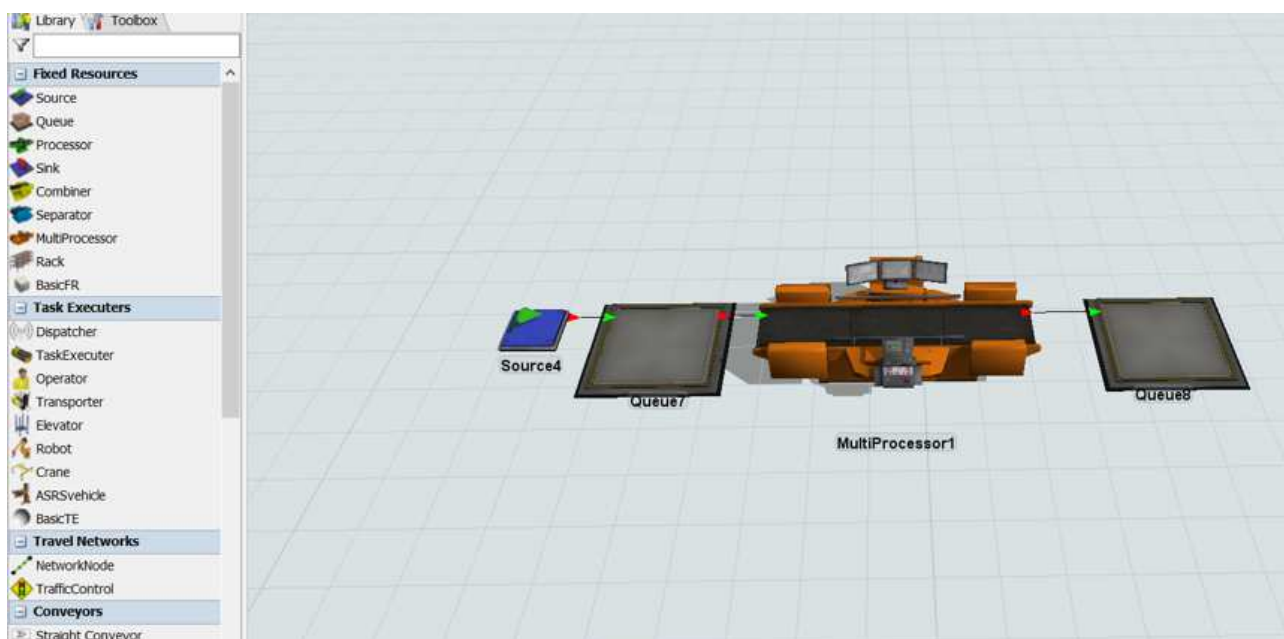Marek Kliment, Miriam Pekarcikova, Jozef Trojan, Jana Kronova

Figure 5 The principle of operation of MultiProcessor

Other software libraries offer an additional number of options for setting model parameters.

In the library, in the Task Executers section, we have objects performing tasks. This offer includes operators, trucks, robots, elevators, cranes, but also functionality for control in the case of multiple objects performing multiple operations, namely the Dispatcher function. An important setting in this section is speed, acceleration and deceleration.

The Travel Networks library has a tool for creating a sidewalk for moving objects. Such walkways are necessary if we have the limits and standards that the operator can walk during the change, and this walkway is also used if we want to avoid collision situations, ie the truck goes around the machine and does not pass through it. We perceive this as a lack of simulation software that it cannot detect an obstacle in the path of motion.

In the library we have the offer Conveyors, which relates to conveyors. It contains a tool for modeling a straight, curved conveyor, a tool for connecting conveyors, a photo gateway, decision points in case we avoid collisions if we connect several conveyors on which products go, station - which works by stopping the flow at this point.

The library also uses the Visual menu to simulate processes, which contains tools for comments, shapes, and backgrounds.

The Process Flow tool is used to create logic for more complex processes, where the options offered after clicking on objects are no longer enough, but it is necessary to define relationships, variables or conditions. In this section we will get acquainted with the environment of creating logic using Process Flow. After clicking on Process Flow on the top bar, the environment for creation

and a library with blocks needed for creating logic will open.

Our purpose of the simulation is to obtain data on the use of machines and operators, which we can further use to streamline and optimize processes. To obtain such data, click on the Dashboards menu in the top bar. It will open in a new window, in which a menu of dashboards will appear after double-clicking. From this menu we can choose the form in which we want to display the data from the simulation. The simulation data is in most cases displayed in the form of graphs and bar graphs. After double-clicking again, a window will appear in which we define for which objects we want to draw a graph or diagram. The dashboard will be previewed later for the line models.

The creation of the line model is still preceded by analysis and determination of the purpose of creation. The subject of the analysis is the acquisition of data such as process times, the occurrence of failures, line layout but also factors such as logistics supply but also other aspects that are not directly related to the process but have an impact on it. In order for the simulation to be credible, we need to know the nature of the individual processes and it is necessary to study the given process so that we can develop a quality model. Without a thorough analysis, the simulation results will be unrepresentative and the proposed changes will be unattainable.

An important basis for creating a line model is the current line layout. Layout is a graphical representation of the arrangement of either the assembly or production system or. lines. The workstations are arranged along the line and connected to each other by a conveyor belt. The layout is necessary for the creation of the model because it gives us the arrangement of processes, distances between

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stations and thus the lengths of conveyors between stations. It is also important for managing the movement of trucks or people, as it allows us to model the size of workplaces or other objects such as walls, which in the event of movement are an obstacle for moving objects. Thanks to this, we get a realistic form of simulations. These layouts are most often created to scale and therefore in actual size in a CAD program. We can import such a CAD layout into

FlexSim and thanks to that it creates a kind of background on the modeling floor, thanks to which we can create a model according to real conditions.

We see that the line is, so to speak, seated on the layout (Figure 6), and thus copies the actual dimensions of the line, while the model is made up of simple objects that have been described and that are interconnected.
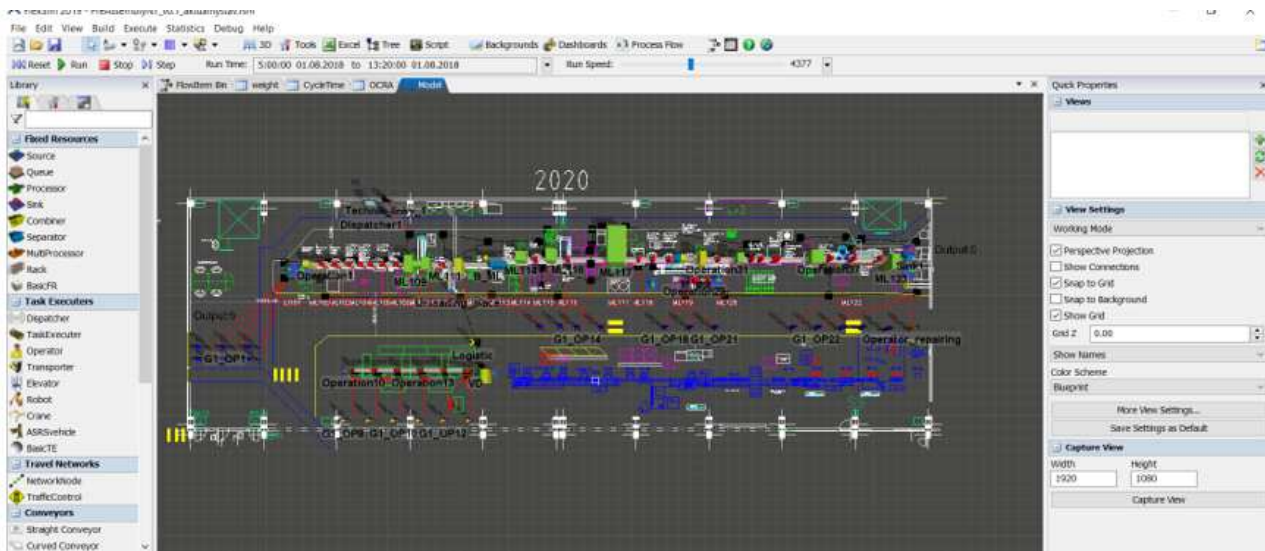

Figure 6 Simulation environment using production hall layout

3 Model control logic

Process control is given by the logic created by the Process Flow tool (Figure 7).

This logic controls all manually executed processes that are executed by the operator. Whereas in automatic processes modeling is a bit simpler because it is enough to enter only the processing time or faults and the recasting time, so manual processes are more complicated from the point of view of modeling. For this reason, the control logic is developed using logic blocks. One universal logic is created for these manual stations, which we can change and adapt to the circumstances.

4 Result of the simulation - obtaining a report

This part is the most important phase of computer simulation. Based on the model, logic of the model and

based on the simulation, we obtain results. We will use the Dashboard tool to interpret these results. The dashboard tool allows us various forms of graphical interpretation of the results, while we have included in the diagram the objects we want to analyze (Figure 8). By simulation, we found that the model is reliable because according to the simulation, the operation will create 1900 pieces, which is the same as the production standard of one change, and therefore the simulation can be considered representative. Thanks to a quality model, we can propose changes. Based on the simulation results, we can identify opportunities for improvement and suggest possible optimizations that we can consider achievable based on a well-developed line model and logic.

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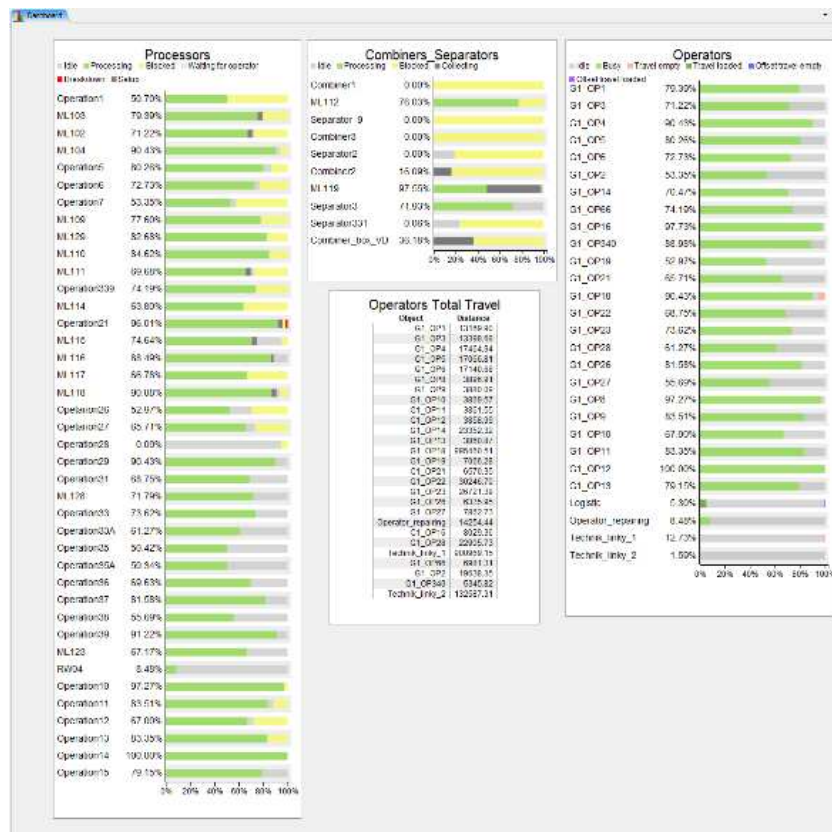

Figure 7 Logic demonstration in Process Flow

Figure 8 Bar chart of the use of machines, operators and distance traveled by operators

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5 Conclusions

Using any simulation software, the goal is to transfer the real form of production to the digital one and to map possible bottlenecks and opportunities for improvement in production processes [10-12].

The main purpose was to obtain data on production, on utilization, on the phenomena that occur during the process, on the state of the bottleneck - bottleneck and thus on obtaining reports. Based on a credible simulation and data obtained from it, we formulated conclusions. We discovered the potential of the line, we found the use of resources, processes but also operators. Based on the report, we concluded that there are opportunities for improvement. Based on the simulation, various variants of improvement can be evaluated quickly, efficiently and, most importantly, without the need for physical interventions in the ongoing production. These interventions are physically performed even after verification of the most advantageous variant in digital, ie simulation form.

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Review process
Single-blind peer review process.