

CREATION OF SIMULATION MODELS USING THE FLEXSIM SOFTWARE MODULE

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Abstract: All companies and production processes, in the current trend of applying digitization, innovate at all levels of their operation. This trend is an essential factor in maintaining competitiveness in global markets. Companies that have applied digitization and electronic data collection are intensifying these processes and extending them to the next levels of business processes. Those companies that have not used this trend so far are gradually introducing it. Data collection, archiving and transformation is an essential parts of accelerating innovative elements in every company. An important factor when working with data is to be able to process it correctly. Elements of digitization are no longer common not only at the level of product modeling, equipment, and production lines but also in the mapping of current older productions, which are still used but are not transformed into a virtual form.

Keywords: *Digitization, Simulation, Production process*

1. INTRODUCTION

The paper is focused and describes the course of digitization on the production line in the real production process. FlexSim simulation software is used for its transformation. The paper describes the process of creating such simulation models using this software module. The current trend in production management and planning is the use of computer simulations. Under the term computer simulation, we can also imagine a digital enterprise as a tool of Industry 4.0. The paper points out the possibility of using computer simulation. The digital enterprise is one of the modern tools, thanks to which it is possible to obtain a digital model of various elements of the enterprise, such as technology, people, production, production lines and the like. Subsequently, it is possible to implement various changes in the digital model and see their impact before they are implemented. Which can ultimately save high costs, which is the goal of any business [1, 2].

2. LITERATURE REVIEW

The beginnings of computer simulation date back to the 1950s. In the next decade, the first programming languages appeared, the main task of which was to facilitate the implementation of all modeling activities. Gradually, ready-made simulation programs began to be created, which mapped processes in the 3D dimension [3, 4].

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Many modeling and simulation programs are currently appearing on the market. Due to the growing efforts of companies to reduce optimization and process costs, manufacturers are ahead in creating ever more sophisticated software that helps build virtual models of various processes and thus facilitates the adoption of appropriate decisions [5]. This speeds up and makes it easier for companies to improve work efficiency, increase employee safety and reduce costs, work hours, and find bottlenecks and weaknesses in their processes and other important factors [6, 7]. Examples of modern simulation programs include FlexSim, Witness Simulation Software, Plant Simulation, SIMUL8, Enterprise Dynamics Simulation Software, and more.

Basic simple statistical simulations can also be performed using the Excel spreadsheet program. Collaboration with databases plays an important role, especially in Industry 4.0, because a number of calculations can be done outside the spreadsheet by the database engine itself [8, 9]. In addition to the basic functions available, the spreadsheets also provide the ability to create macros and work with the VBA application, but despite the relatively simple operation of creating models, they do not match modern professional computer simulation programs [10, 11]. Computer simulation can be successfully used in both underground and opencast mining [12]. May include a wide range of problems of investment finance by planning to simulation [13, 14].

FlexSim allows you to perform simulations in virtually any area, from manufacturing to logistics, material handling, warehouse planning to mine, healthcare, customer service, and more, with access to a library containing a large number of objects. The program allows simulation and visualization of processes in 3D, which greatly facilitates the understanding and interpretation of the assembled model [15]. FlexSim is also user-friendly, specific objects selected from the library can be easily and quickly dragged into the dimension area with a single mouse click. In addition, the available library can be extended with new proprietary objects to best represent the modeled system [16]. To interpret the conclusions and the results obtained, the program allows you to generate appropriate reports, allowing you to more accurately estimate the places requiring optimization and the need to implement changes. FlexSim also allows you to create models that are freely extensible, which means that space is unlimited [17, 18].

3. CREATION OF A PRODUCTION SIMULATION MODEL USING THE FLEXSIM SIMULATION MODULE

Based on the analysis of the production line, it was subsequently possible to create a digital model using the FlexSim simulation tool. The following chapter describes how to create a digital model.

The model was created in FlexSim software in version 2020. The first step is to set the simulation time, or its length. The production line is currently operating in two shifts. Each change takes 12 hours. In the simulation, it was necessary to count down the break time, which represents a total of 55 minutes. The simulation lasts 11 hours 5 and minutes. FlexSim simulation software allows you to use the Warmup time function. Warmup time in translation means warm-up time, which in the simulation represents the filling time of the production line since even in practice; production lines do not start production empty. By using the Warmup time function, the simulation takes an hour longer, just to fill the production line. After this time, all counters are reset and the simulation continues under normal conditions. In the Run-Time section, it is necessary to click on the right arrow and

then check Stop Time and Warmup time (Fig. 1). Warmup time is set to 3600 seconds, which represents 1 hour, the duration of the simulation is from 5:00 to 17:05.

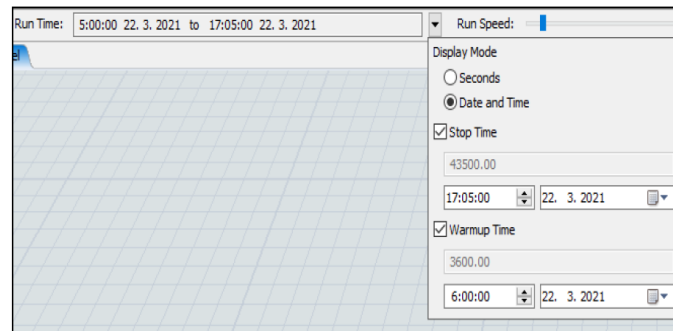


Figure 1. Simulation time setting

4. ADDING A LAYOUT TO THE SIMULATION AREA

It was essential to insert the layout of the production line in the area reserved for modeling (Fig. 2). The area for modeling is also important for inserting individual objects that correspond to a real production line. The layout was chosen to maintain the distances between the individual devices, as well as the lengths of the individual conveyors and the distances traveled by the workers. The layout also ensures the correct arrangement of production equipment and their storage. The Backgrounds function has been selected in the top bar, which means background in translation. Next, in the File name column, it was necessary to select the required file with the content of the selected layout. Subsequently, the position, rotation and size of the layout were set in the dialog box. The layout was provided in .dwg format, created in a CAD program.

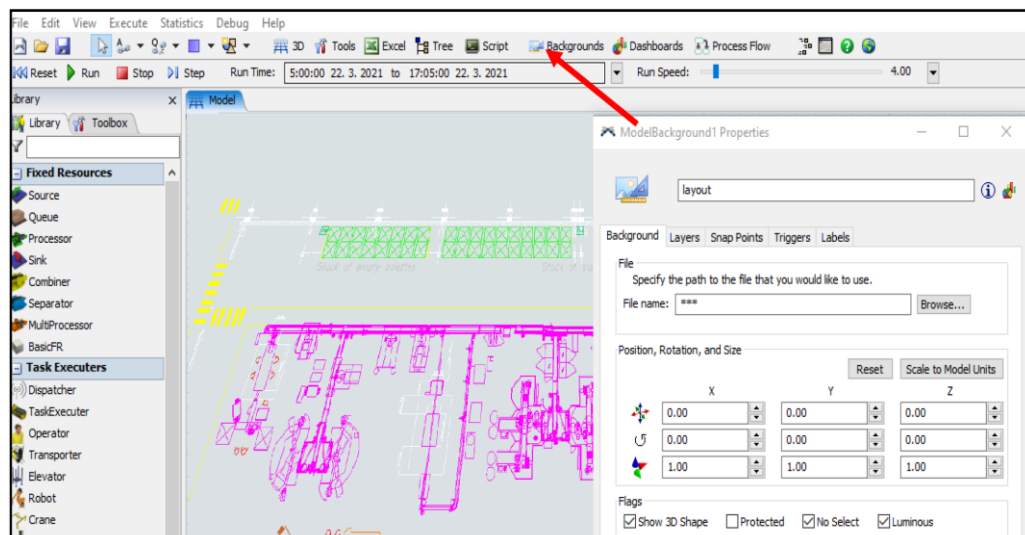


Figure 2. Layout settings

After setting the simulation length and inserting the layout, it was then possible to insert production line objects. The objects are connected to each other by connectors that ensure their interconnection, the connector is created by holding down the A key. In the simulation, a simple shape of production line objects was chosen due to better handling and size. Also because of the performance capabilities of the computer. Blocks named Source, Queue, Processor, Sink, Combiner, Separator, Operator, Conveyor, Decision Point, Straight Conveyor, Curved Conveyor, visual elements and others were inserted on the modeling surface. Operator logic control was implemented by creating algorithms from the ProcessFlow library. The shape, color, size, rotation of objects can be changed by clicking on the object itself and then clicking on the General tab. You can then select the appropriate object shape from the software menu or insert your own file in the 3D Shapes section. It is important to name each object according to the real names of the production facilities in terms of the exact configuration of the model and the prevention of errors and shortcomings of the model. The basic shape of the conveyors was changed in the same way.

The first source of the model is the input, which ensures the arrival of parts into production. Creating an entity consists of activities where in the Toolbox section it is necessary to right-click the FlowItem Bin and then click on the green cross to insert a new object that will represent the parts in question. In the right part, we adjust the dimensions on the X, Y and Z axes. In this case, the name for the input was chosen. It is also possible to change the color of created objects or choose your own object.

During the creation of the simulation model, the cycle times of individual production line operations were entered into the Global Table. The first step was to open the Global Table from the Toolbox, then the second step was to rename and fill in the table according to the length of each operation of the production process. Cycle times are defined for each part model and vary in some manufacturing operations. Subsequently, in the third step, it was possible to assign cycle times to the individual Processors (Fig. 3).

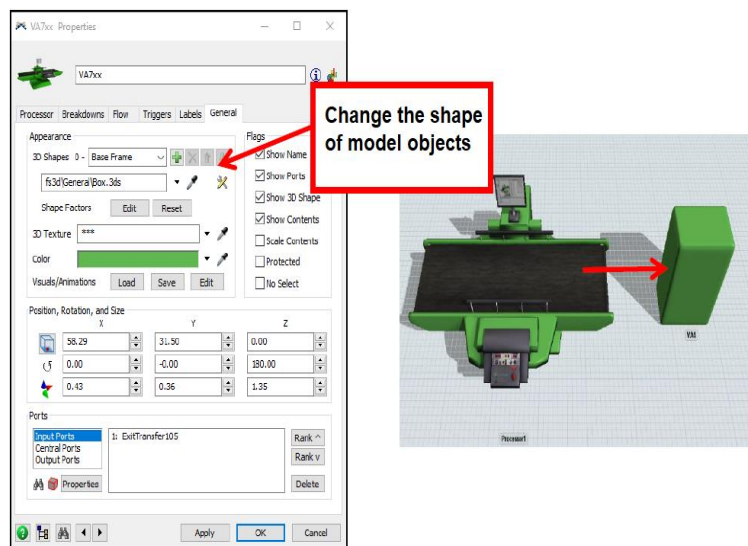


Figure 3. Edit object visuals

5. ENTITY CREATION IN SIMULATION AND DEFINITION OF CYCLE TIMES

After creating input entities in the FlowItem Bin, it was subsequently possible to set their input (Fig. 4). The first step is to insert the Source object on the modeling surface. Clicking on the object will open a dialog box where it was then possible to configure the input to the requirements of the model. In the Arrival Style section, the Arrival Schedule was selected, which means that the given entities will enter the model according to the production plan. The created entity was selected in the FlowItem Class section.

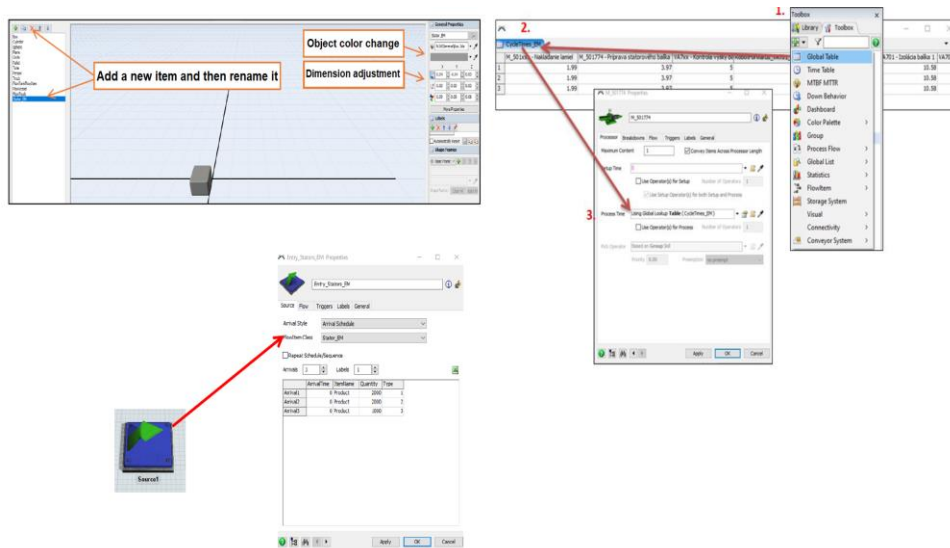


Figure 4. Creation of entities for entry into production, Defining cycle times in the table and assignment to the device, Setting the entry of entities

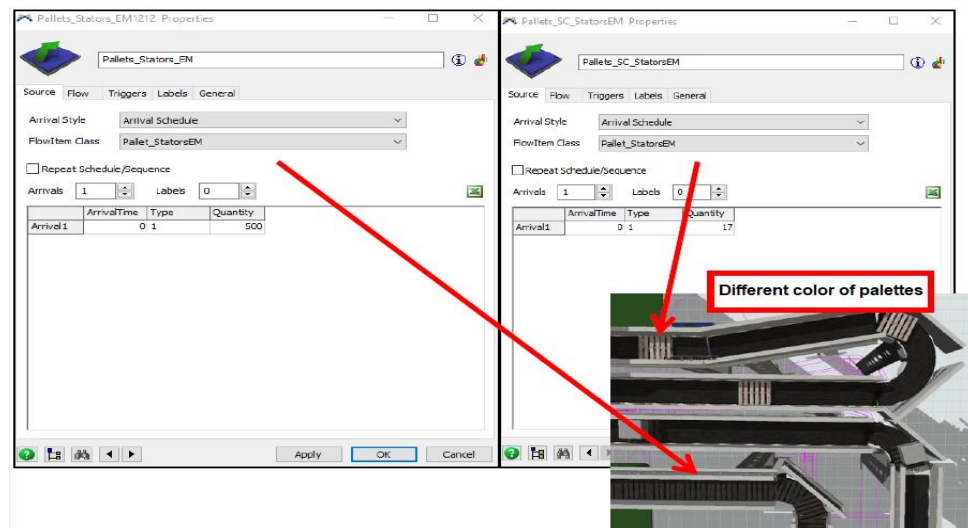


Figure 5. Defining pallet entrances

Other inputs are pallet sources, on which the individual parts are transported along the conveyor belt. There are 2 types of pallets on the production line. When loading the products, there are metal pallets on the conveyor belt, which allow the operator to accurately store the products. There are 17 metal pallets in circulation and 500 plastic pallets. As with the previous input setup, Arrival Style - Arrival Schedule was selected and another entity for the pallets was created in the same way as the parts, but in this case the shape of the pallet object was chosen. From a visual point of view, the created entity was duplicated and subsequently a different color was chosen for the metal and plastic pallets (Fig. 5). In the Quality section, the real number of pallets in circulation was subsequently selected.

6. PROCESS CREATION IN SIMULATION

The first object of the production line is a turntable, where the operator loads the products. The Queue block, which represents the rotary table, was selected in the simulation. Its maximum capacity is 80 pieces. All other settings of this block remain preset. A part of the turntable is the Processor, where the cycle time of loading products on the turntable from the created table was defined. An important part of the model is the creation of assembly units from the turntable and loading them on pallets. This process is secured via the Combiner block. A combiner is a combination of two or more entities. In this case, it is necessary that the assemblies are placed on the pallets. The block that enters the Combiner using the connector first will perform the main activity and will send pallets one at a time to the Combiner. It will send one piece of assemblies from port 2. In the Combine Mode section, the Pack option has been selected, which will ensure the connection of the palette with the products, but a new entity will not be created, but it will then be possible to separate these entities from each other.

From the gray-green cylinder (Fig. 6), the entities advance to the Queue, then go to the orange block. The orange block represents the preparation of the assembly unit, the Processor block was used with the reference of the cycle time to the table. The yellow block represents the Combiner, i. e. the connection of the pallet with the assembly unit (Fig. 7).

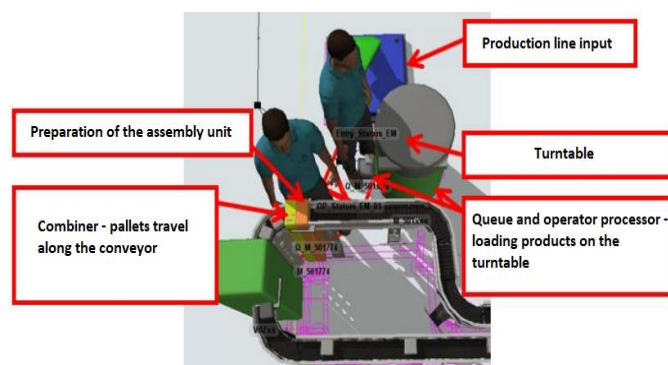


Figure 6. Loading assemblies on pallets using a combiner

The combiner has a cycle time of 0, due to the function of joining two entities. The pallets come along the conveyor belt, which is connected to the Combiner first, i. e.

it performs the main function. Subsequently, an orange block is connected to the combiner via a connector. It is also necessary to connect the yellow block output and the conveyor input with the connector so that the assembly units can continue along the conveyor belt.

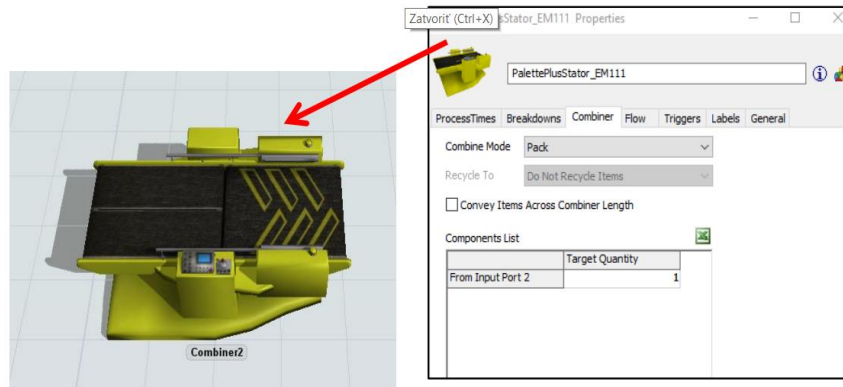


Figure 7. Setting the connection of the pallet with the assembly unit

Each manual position must include a Queue block that will represent the location for the operator. The Queue block will have a maximum content set to 1, which means that after processing the entities in the processes, the block will then release one entity into the process. This block has a cycle time of 0 and performs only the given function. The Queue block is also important in terms of the created logic, where the operator comes to the Queue block and then translates the piece from the Queue to the device - Processor. This operation simulates the operation of a given operator with the cycle time assigned to the Processor (Fig. 8).

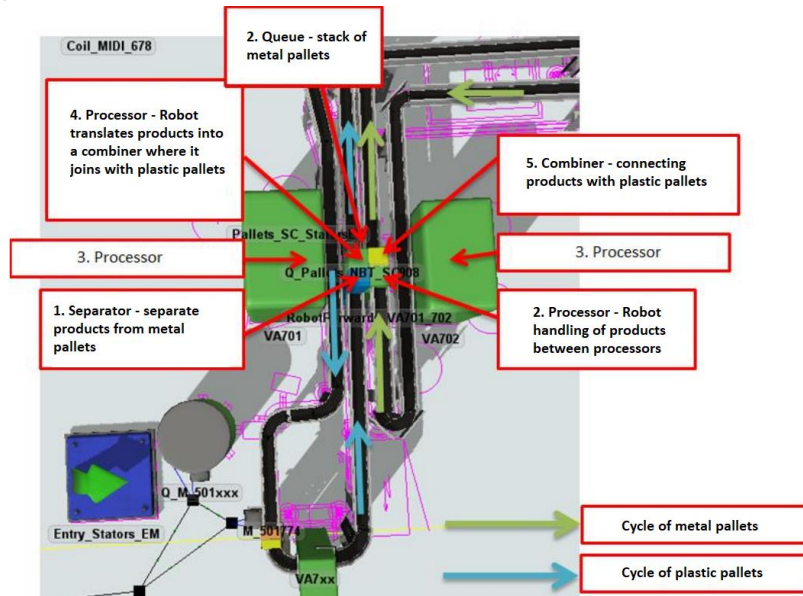


Figure 6. Important node of the production line

It is important to set the robots - Processor, where it is necessary to select in the tab Flow → Output → Send To Port → Round Robin if Available, which ensures the sending of entities alternately from the output to that port, or to the isolation device that is free. And also for the second robot, a pull strategy was chosen → Round Robin if Available, ie the pull principle is used, which will ensure that the robot will pull entities alternately from the port that is available. Subsequently, the robot will send entities to the port that is first available (Fig. 9). Output → Send To Port → First Available. For Separator, it is important in the Separator tab to select Unpack and Split / Unpack Quantity → Entire Contents, which will provide us with products from pallets.



Figure 7. Finished line ready to run the simulation

7. CONCLUSION

The simulation module provides a large number of options for creating models of various kinds. Within the simulation models, it is possible to perform various optimization scenarios and, based on the outputs from them, to select the most advantageous in terms of various factors. We can evaluate the time aspect of individual processes, productivity, energy efficiency, handling facilities, logistics flows, and the like. The application of simulation is a necessary parameter of success in meeting customer requirements in the current deployment of the Industry 4.0 trend. The use of data provided by the simulation offers companies a smooth response to the necessary changes in production processes when changing customer habits, or when entering new markets that companies plan to occupy. The application of simulation also has invaluable advantages in the construction of new production facilities, which can be built on it completely tuned sufficiently efficiently on the basis of the results. The data can also determine the payback time for production process innovation relatively accurately in advance.

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