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MODELLING, SIMULATING AND ANALYSING A PROCESS FLOW FOR A MACHINING PART USING FLEXSIM SOFTWARE

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Abstract: *Nowadays, more and more emphasis is placed on production flexibility in the sense of achieving a wide range of product families, production costs as low as possible, delivery of products in the quality and quantity requested by the beneficiary. FlexSim is a 3D simulation software that models, simulates, predicts and visualizes systems in a wide range of industries: manufacturing, warehousing, health, material handling, logistics etc. Thus, based on FlexSim analysis, different decisions can be made on a certain process flow before being implemented in production. This paper aims to model, simulate and analyze a process flow for a workpiece using FlexSim software. It is present the working methodology, results and benefits that can be obtained using FlexSim.*

Key words: *modelling, simulation, machining, process flow, FlexSim.*

1. INTRODUCTION

In recent years, the problem has been raised, more and more, whether factories are flexible enough to produce a wide range of products, to be competitive on the market. For this, the factory must be able to implement in the shortest possible time the necessary changes to create new products. The implementation of new products comes with additional expenses for the manufacturer such as: for production planning, re-engineering, supply of materials, devices, etc. Any manufacturer wants to keep costs as low as possible, which is possible by making the right decisions.

The FlexSim application is one such tool that can help make certain decisions.

Currently there are a few software applications that can perform simulations for different processes. Among them we mention AnyLogic, Simul8, Simio, Plant Simulation, Simcad Pro, Arena. Each of these software presents a series of advantages, depending on the simulations performed. It is difficult to say which of these applications is the best, more comprehensive in terms of types of simulations, easier to use.

The FlexSim software models, simulates and predicts a wide range of systems, from different areas such as: manufacturing, warehousing, material handling, logistics, health and more.

The possibilities of the FlexSim software are presented in the specialized literature for different areas where it is useful.

Thus, in paper [1], an introduction is made to the use of the FlexSim software. Some papers model and simulate technological processing flows, such as [2]. In the paper [3], the problem of Industry 4.0 simulation is addressed through the prism of ontology and flexibility. Another area of interest where FlexSim is often used is warehouse simulation and optimization [4].

When implementing the technology required to make a new product, there are inevitably costs related to investments in the production line, production planning, supply logistics etc. It is necessary to make the right decisions, so that the costs remain as low as possible, but without compromising the quality of the product to be implemented.

FlexSim can visualize and predict the results that arise from changes in the technological flow

This is the reason why FlexSim is a powerful tool that allows the optimization of a system.

The use of FlexSim leads to a reduction in the costs and implementation period required to create a new product.

The objective of this paper is to simulate a technological for an assembly from 6 pieces to be able to answer some questions: how many assemblies can be made in 8 hours, what is the occupancy rate of the operators, what is the degree of use of the machines.

When it is desired to simulate a technological flow, there can be 2 situations:

1) A new technological flow is desired to be implemented, and simulation helps determine the best solution.

2) The technology flow exists, and simulation helps to improve it.

In the present study, a new technological flow is considered. The diagram of technological flow is presented in figure 1.

At the end of the technological flow, an assembly of 6 parts is obtained, of which 3 are processed and 3 are purchased. Of the 3 pieces being processed, the corresponding technological flow will be presented in detail only for one of them. The other 2 pieces are brought from the warehouse.

The movement of parts on the technological flow is carried out by operators or conveyors.

After assembly, the products are stored in a rack with the help of a transporter (5 pieces at a time).

For this we will use the FlexSim software.

In FlexSim, to model and simulate a technological flow, a series of steps must be taken [5]: creating a layout, making port connection, editing the look and behavior for used objects, running the simulation and viewing the results.

2. FLEXSIM USAGE METHODOLOGY

2.1 Create a layout

When creating a model, a source is needed to create items (pieces). Items are waiting to be processed before the operation (process). For this, a queue is inserted before each operation. For moving items (pieces) from one workstation to another, operators or conveyers are used.

2.2 Make port connection

For moving the parts (flow items) in accordance with the technological flow, it is necessary to establish the connections between the ports.

In figure 2, the layout and the connections are presented.

2.3 Edit the look and behavior

For each workstation the processing time is known (assumed as the entry date).

The source for piece 1 corresponds to the cutting operation. The time for cutting a piece is 5 minutes. In figure 3, the properties set-up for the source of piece 1 are presented.

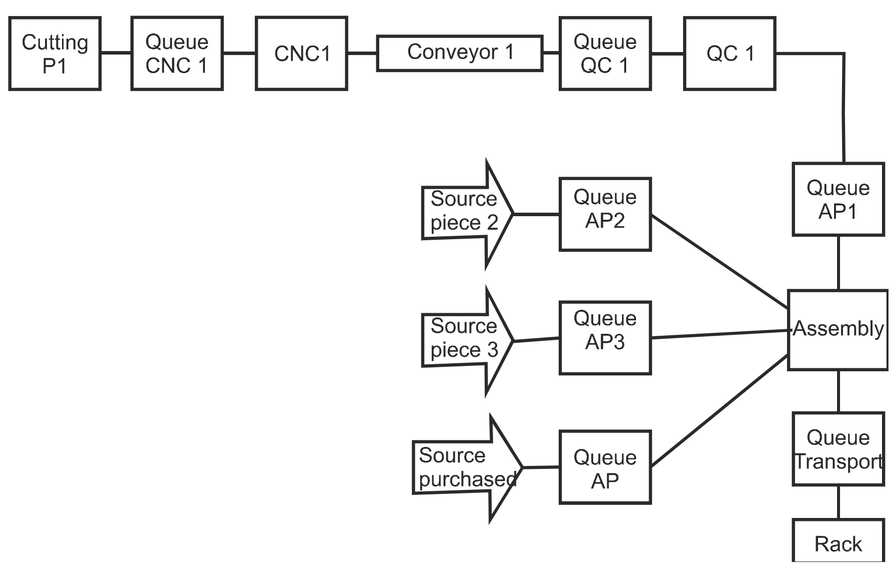

Fig. 1. Diagram of technological flow.

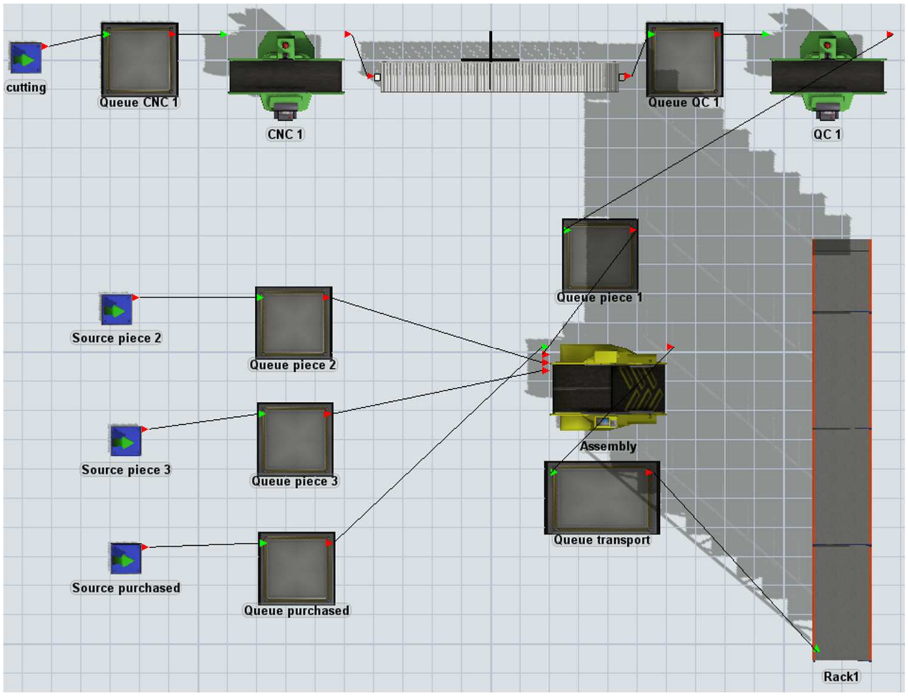

Fig. 2. Layout and connections made in FlexSim.

Figure 4 presents the setup of properties for process CNC1, corresponding to piece 1. It is known that the setup time is 30 seconds (time for the operator to manipulate the piece) and the process time is 4 minutes. For the setup time and process time, a statistical distribution function is used to better approximate processing times. One operator is used for set-up time and the same operator is used for the process time.

The operators that serve different processes are introduced. A CNC operator takes the workpiece from the appropriate queues, services the CNC according to the process properties setting, and then puts the workpiece on the conveyor.

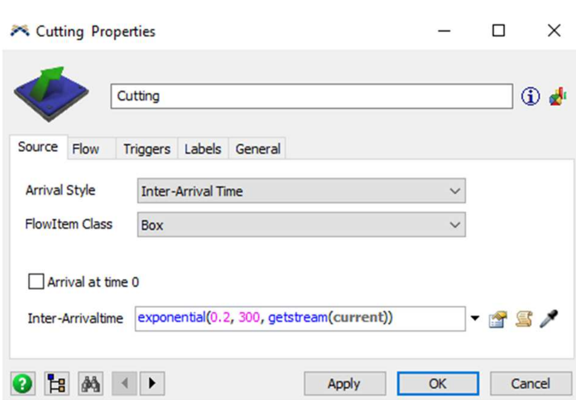

Fig. 3. Properties setup for source of piece 1.

If operators are to be used, at setup process and process time the option of using the operators is checked (Fig. 4.).

Figure 5 presents the options setup for operator 1.

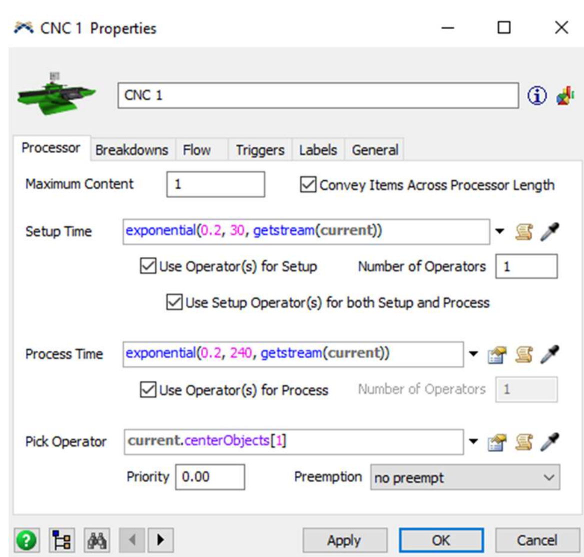

Fig. 4. Setup properties of CNC1 for piece 1.

To be able to run the application, the time for the simulation must be set. In this case it is 8 hours.

In figure 6, the layout of the model before running the simulation is presented.

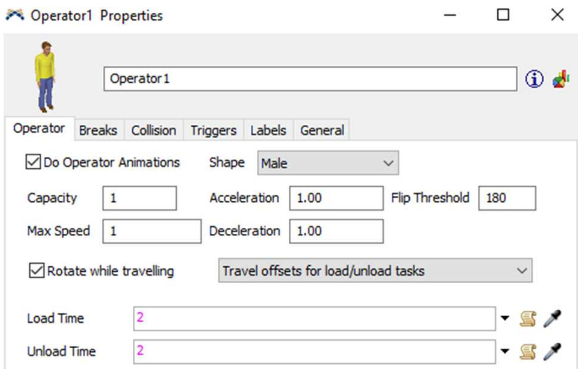

Fig. 5. Setup properties of operator 1.

In the operator properties panel, a lot of properties can be set which allow for the definition of any situation. Loading and unloading times to operate the piece are 2 seconds each. The maximum speed of the operator is set up to 1 m/s. The capacity of the operator is 1 piece at time.

2.4 Run the simulation

After creating the model in correspondence with the established technological flow, it is possible to proceed with the simulation.

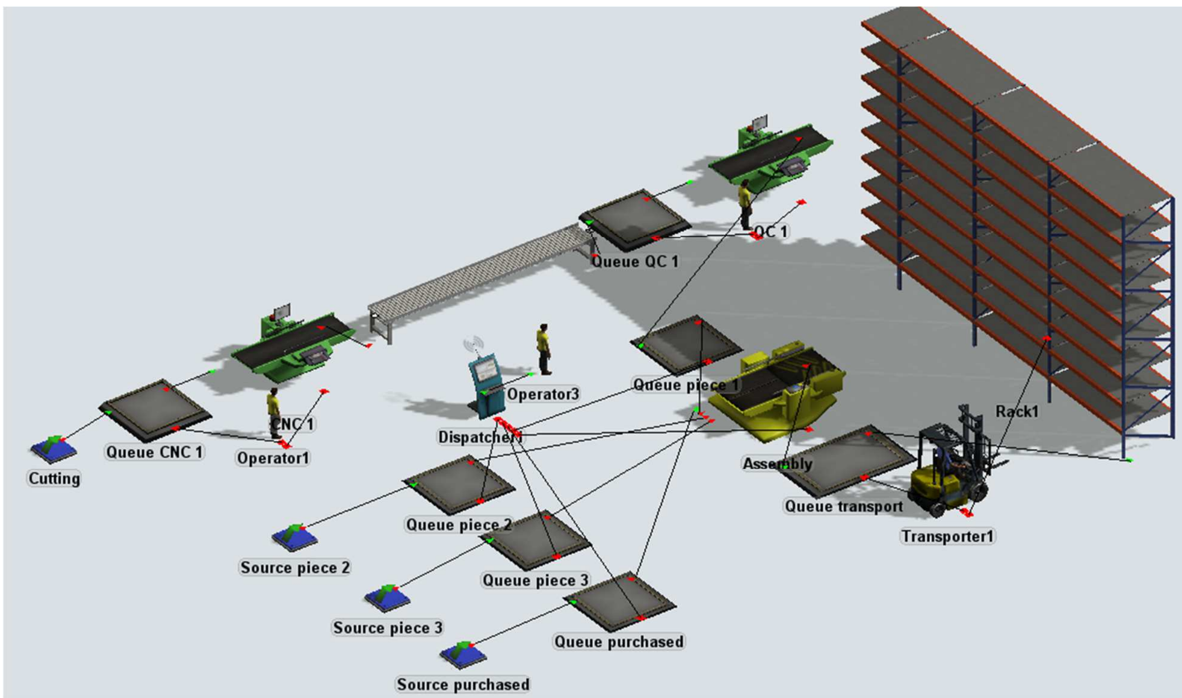

Fig. 6. The layout of the model.

The operators and their connections can be observed.

There are a number of 3 operators, one for CNC, one for quality control, and one for assembly.

3. RESULTS

After running the simulation, different information about the technological flow can be obtained.

A dashboard is used to obtain reports with the data of interest.

Figure 7 shows the state pie with information about idle, setup, processing, collecting, waiting for transport.

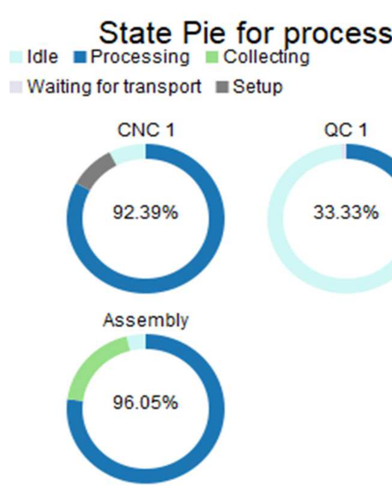

Fig. 7. Degree of use for equipment.

It can be seen that the degree of use of processes are: 96.05% for assembly, 92.39% for CNC1 and 33.33% for quality control 1.

3.2 The degree of use of the operators

It is important to know the degree of occupation of the operators, both to avoid unused time and to avoid their overload.

Figure 8 shows the time allocation for operators: travel empty, travel loaded, idle, loading, unloading, offset travel empty, offset travel loaded—a whole series of times corresponding to the situations in which an operator may be.

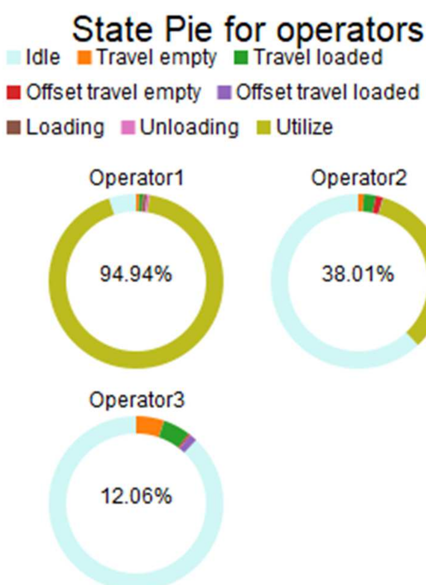

Fig. 8. Degree of use for operators.

3.3 Statistical information about parts and assembly

At the beginning of the work, it was desired to find out the number of assemblies which can be processed in 8 hours.

Number of stored assembly

Object	Input	Output
Rack1	70.00	0.00

Fig. 9. Degree of use for operators

For this, it is necessary to see how many assemblies end up in the rack (Fig. 9.).

You can find out the waiting stay times for part 1 during the technological flow (Fig. 10.).

It can be seen that the longest average waiting time for part 1 is at CNC1.

Staytime for part 1

Object	Avg Staytime	Min Staytime	Max Staytime
Queue CNC 1	1541.12	4.64	3385.18
Queue QC 1	75.82	2.67	685.54
Queue piece 1	686.68	3.48	2858.12

Fig. 10. Staytimes for part 1

4. DISCUSION

After analyzing the statistics generated in FlexSim, conclusions can be drawn regarding the increase in production for the 8-hour period.

The degree of loading on processes is over 90%, both at CNC1 and at assembly. If you want to increase the number of assemblies, there are 2 options:

1) reducing the time required for assembly,
2) introduction of another assembly point.

In the second case, it is necessary to process several pieces of type 1, which would require the introduction of the second CNC1. It would also be necessary to use 2 more operators, one for CNC1 and one for assembly.

With the existing technological flow, the use of a second assembly operator would not increase production, because the first operator does not have a high degree of utilization either. From figure 8, it can be observed that the assembly operator has a utilization rate of 12%. This fact happens because the operator is waiting for type 1 parts to arrive for assembly.

Related to the operators, it can be seen from figure 8 that operator 1 is used in a proportion of 95%. Operator 2 from quality control is used in proportion of 38% and the equipment is used in quality control in a proportion of 33% (figure 7). This means that the quality control equipment and operator can be used for other processes during the 8 hours.

5. CONCLUSION

The use of FlexSim software allows for the modeling, simulation and analysis of different types of systems related to a wide range of domains.

After running the simulation, it results that:

1) In 8 hours, with the actual configuration of technological flow, 70 products (assemblies) can be made.

2) The degree of use for operators is: operator 1: 95%, operator 2: 38% and operator 3: 12%.

3) The degree of use for equipment is: CNC1: 92%, quality control: 33%, assembly: 96%.

4) The average stay time for the part 1 piece at the queues is: 1541 s to CNC1, 76 s to quality control, 687 s to assembly.

FlexSim can be successfully used both for the simulation of an existing technological flow implemented in the factory with the aim of bringing improvements to it, as well as in the event that it is desired to introduce a new technological flow to see the resources necessary for its implementation in reality.

With the help of the FlexSim software, any changes made to a technological flow can be visualized and predicted before the changes are implemented in real life. This fact allows reducing the implementation time of the new technological flow, decreasing the costs related to the implementation and obtaining the desired results that were previously simulated in FlexSim.

FlexSim is a work tool that comes to help decision makers when they want to improve an existing process or implement a new process. A series of scenarios can be simulated until the desired result is reached. The best decisions can be made for a given situation.

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MODELAREA, SIMULAREA ȘI ANALIZA FLUXULUI TEHNOLOGIC PENTRU O PIESĂ UTILIZÂND PROGRAMULUI FLEXSIM

În prezent se pune tot mai mult accentul pe flexibilitatea producției, în sensul realizării unei game largi de familii de produse, costuri cât mai mici de producție, livrarea de produse în cantitatea, calitatea și cantitatea cerută de beneficiar. FlexSim este un soft 3D care modelează, simulează, prezice și vizualizează sisteme într-o gamă largă de industrii cum ar fi: producție, depozitare, sănătate, manipulare de materiale, logistică etc. Scopul lucrării este utilizarea softului FlexSim pentru modelarea, simularea și analiza unui flux tehnologic utilizat pentru realizarea unui reper prelucrat prin așchiere. Astfel se pot lua diferite decizii privind înainte de a fi implementate, sau îmbunătățirea unor fluxuri tehnologice deja existente.

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