Zeszyty Naukowe Politechniki Częstochowskiej
Budownictwo
ISSN 0526-5916

Zeszyty Naukowe Politechniki Częstochowskiej nr 25 (2019), 55-60
DOI: 10.17512/znb.2019.1.08

Forming of the optimal parameters complex for the production process by means of FlexSim

Olena Gumen[1], Solomiya Ljaskovska[2], Adam Ujma[3]

ABSTRACT:
Global competition is setting new rules for the release and sale of products. Success is possible thanks to the introduction of effective tools in modern information technologies, which allow simulation of the process of production and supply, calculate the time spent and eliminate problematic issues with production, etc. Production planning, the first stage of product creation, is possible through the involvement of modeling. Our work aims to analyze the main stages of creating a simulation model in the FlexSim environment, to determine the interconnected impact of different parameters on the work of individual elements and the technological system in general. The automated technological process is considered as a multi-parameter system where input and output are interconnected. Each element of the process can be defined as a separate model, where the input of the initial data takes place, and at its output, we get the expected action that was programmed. The model created is considered by FlexSim as a system consisting of related parameters. The formed complex of optimal parameters in the production process is applicable, in particular, to the construction industry when solving decision-making tasks.

KEYWORDS:
model; multi-parameter system; information technology; FlexSim

1. Introduction

Information technology is an effective tool that changes the quality of the enterprise. The technological process consists of many factors that interact with each other [1].

Simulation of production processes, transport, and logistics, among others, is a virtual display of the real process for the purpose of in-depth analysis, search for optimal solutions and implementation of improvements. It allows the investigation of personnel and equipment load problems, performance evaluation, efficiency, and creation and testing of improvements.

In the face of constantly growing cost of materials and construction services, as well as electricity, water and land, there is a need to optimize the process of building and operation of the construction object. One of the software tools used for this purpose, in various fields of industry, transport, trade and services including construction, is the software, FlexSim.

For example, in [2] the analysis of the use of the software, FlexSim, for the analysis of the investment process was carried out. This program is used to make decisions in a construction company when solving various tasks, including the selection of contractors and selecting investment projects. For analysis, the FlexSim method is used. It supports the decision-making process in a construction company for solving various problems: selection of contractors, selection of investment projects and the simulation of concrete mix delivery to a construction site.

[1] National Technical University of Ukraine „Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine, e-mail: gumens@ukr.net, orcid id: 0000-0003-3992-895X
[2] National Technical University of Ukraine „Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine, e-mail: solomiam@gmail.com, orcid id: 0000-0002-0822-0951
[3] Czestochowa University of Technology, Faculty of Civil Engineering, ul. Akademicka 3, 42-218 Częstochowa, e-mail: adam.ujma@pcz.pl, orcid id: 0000-0001-5331-6808

Paper [3] discusses the possibilities of using the FlexSim software in the process of building energy modeling (BEM) and the simulation of production processes (MPS). BEM and MPS technologies are closely related to building information modeling (BIM).

The FlexSim program is also used in the pert network planning method used when creating a simplified model of a construction [4]. The graphs and simulations developed are an effective construction management tool. They are simple in execution and are able to eliminate the effects of volatility in construction processes.

Mathematical and geometric modeling helps us to observe the full picture of the working technological system and also the influence of each parameter in particular on the quality of the process. The study of the whole model of the system helps us to get an optimal solution to problems and identify the effective use of resources, etc. In such an environment it is necessary to involve information technology and modeling to speed up executive decisions and decrease time to market.

2. Modeling of the technological process in FlexSim

The following stages need to be executed to create a model in FlexSim environment:

- analysis of the input data for the evaluated model;
- predicting of exceptional situations of the enterprise;
- predicting and modeling of system failures;
- generation, analysis and selection of optimal problem-solving techniques;
- visual design of technological processes;
- leveraging a three-dimensional model of the process.

The steps presented determine the need to characterize the relationship between the parameters of the model under study. According to the basic principles of modeling, the technological process can be represented as a dynamic system [5, 6] (Fig. 1), where:
Inp - the flow of input data, defined by the sum of input parameters that describe the process, and also responsible for the characteristics of each element in particular:

$$Inp = \sum_{i=1}^{s} p_1 + p_2 + \cdots p_i + \cdots + p_s;$$

Chg - the factors that affect model changes that can also be represented by the data flow;
Ctr - the factors, which values depend on the purpose of the technological process and the planned results, as well as external changes made by the operator and may affect the characteristics of the process.

The group of input parameters **Inp** that influence the data management process, since every change that is made to the Modeling Process (by **Ctr** data control point implemented) changes the **Inp's** input stream.

The work of an engineer (a process manager) has a significant impact on all stages of data processing. He performs the following functions:

- collect and input of data (Inp);
- decision making in terms of changes in the modeling process, data management (Ctr),
- applying changes to the model upon arrival of additional information during the modeling process as well as changes in external factors that affect the process.

The output data analysis (Ot) should also be compared with the predicted results. So the engineer has a major role in the modeling of whole technological processes [6].

The order of decision making in the designing of a technological process in the FlexSim software environment is present in (Fig. 2).

The modeling of the management of input data, as well as the management of data for each object of the model, forms the main stages of working in FlexSim [7].

The data input stage is preceded by the system verification stage with key information on the process for which the simulation model is being created. The final step is obtaining the output datasets of the technological process.

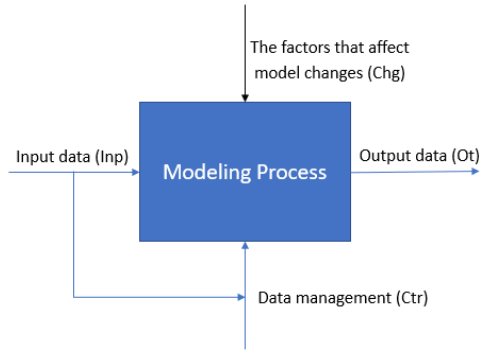

Fig. 1. The control schema of technological processes considering various types of data

The example below demonstrates the solving of a products solving task. An enterprise produces four types of products (type1, type2, type3, type4). The task is to sort the products and put them in special places.

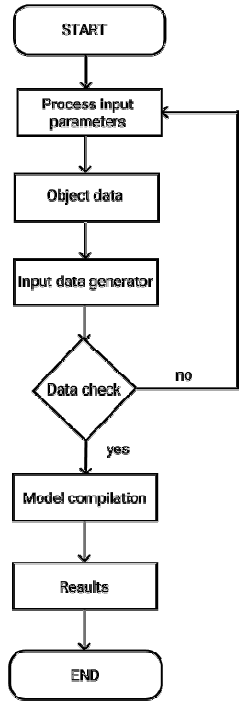

Fig. 2. The FlexSim engineer working model

The following elements of the FlexSim program were used to model this task:

Source, Queue, Processor, Sink, Conveyor

At the input, the first element is **Source**, where we specify the following logic:

Source1 - Source - Flow Item Class - Pallet

In this case, we choose the type of product packaging, which is a pallet.

In the **Flow** section, we specify the number of ports, which is one available port:

Source1 - Flow - Send To Port - First Available

The next stage is the generation of products of different types.

Triggers - On Creation - Set Item Type and Colour

We set the Conveyor 1's logic automatically by connecting only one port. The queue's output was added to the conveyor output, specifying the distribution of items by type:

Queue1 - Flow - PortByCase

This section sorts all products. Products of the same **type1** go to one port, where it is checked for its quality and further moved to the output (Fig. 3). The products of **type2, type3, type4** continue movement along Conveyor2.

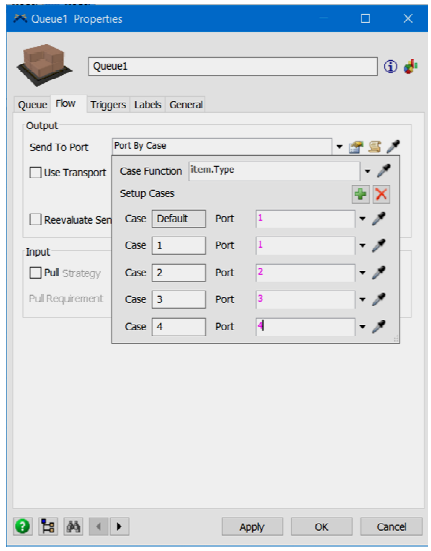

Fig. 3. The stage of products sorting

In the same way, we divide production by type in Queue3: production of type 2 moves to the exit to determine the defect and further to packaging, and production of type 3. Type 4 moves on Conveyor3.

Sorting is carried out in the same way for the products of type 3 and type 4. In result, we obtain the following solution to the problem in the environment FlexSim2019 (Fig. 4).

Figure 4 contains elements such as Processor and Slink. The processor is a quality control station, and Slink is the output of already proven products.

Therefore, to qualitatively simulate any task or process, a qualified designer needs to be engaged. Considering the importance of process logic input, taking into account the specificity of products and type of production, it is necessary to collect a certain amount of data about the technological process, enter the information received and check the data.

For a detailed analysis of the data and the processing of process information, we have proposed a scheme containing three stages [1, 7]:

- model - describes the data entered, changes in the process;
- view - an interface, displaying the entered information in the process;
- controller - the data is taken by the engineer, who informs the model about the changes made.

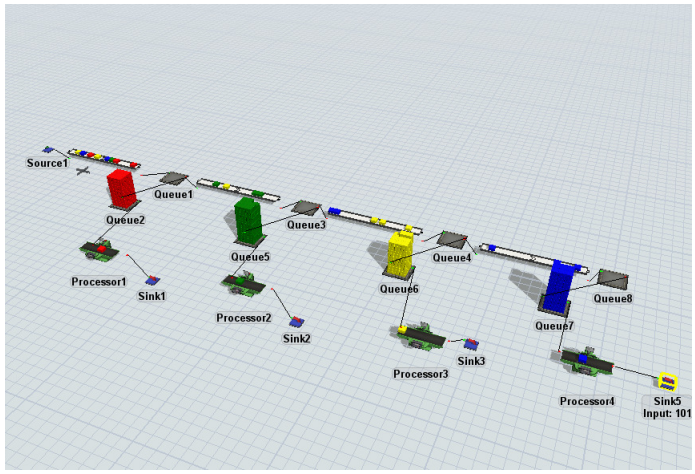

Fig. 4. The solution to the problem in the environment of FlexSim2019

In this design scheme, the behavior of the system depends on the Model stage, while the Model stage does not depend on either representation or behavior.

For the technological process, the stage of submission refers to the formulation of a task that an engineer receives as a project manager to familiarize himself with its features. The model is one of three stages of design, which consists of interrelated parts: data type, motion dynamics, movement and change of objects over time. The Controller - the logical part - consists of the main sub-stages:

- profit & loss analyses;
- optimization of the main stages of the technological process.

Figure 5 is a diagram showing some interconnections between different parameters of the three stages of designing technological systems in the FlexSim environment.

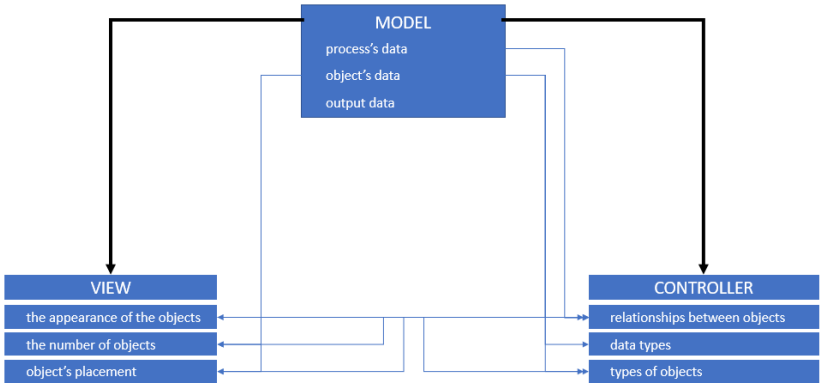

Fig. 5. The interconnections between different parameters of the three stages of technological system design

The above-described principle of building a decision-making and data analysis system gives an opportunity to optimize the process of production, packaging and sorting in manufacturing.

3. Conclusions

In a highly competitive environment, it is necessary to find optimal ways of designing technological processes, leveraging large volumes of data, finding discrepancies of input information,

rapidly adapting to changes in production processes, saving time and resources, all of which require the involvement of modern information technologies. The key figure is a qualified engineer, project manager, who coordinates and leverages all the necessary information about the process and data on each object. Taking into account the interrelationships between the different parameters of the three stages of model design, it is possible to provide a qualitative sorting of information, data, changes made to the process, all of which will provide significant cost and resource savings.

References

[1] Malets I., Liaskovska S., Prydatko O., Martyn Y., Information technology of process modeling in the multiparameter systems, IEEE Second International Conference on Data Stream Mining & Processing (DSMP), Lviv 2018, 177-182.

[2] Dziadosz A., Konczak A., Review of selected methods of supporting decision-making process in the construction industry, Archives of Civil Engineering 2016, LXII, 111-126, DOl: 10.1515/ace-2015-0055.

[3] Garwooda T.L., Hughesa B.R., Oatesb M.R., O'Connora D., Hughesc R., A review of energy simulation tools for the manufacturing sector, Renewable and Sustainable Energy Reviews 2018, 81, 1, 895-911, DOI: 10.1016/j.rser.2017.08.063.

[4] Forcael E., González M., Soto J., Ramis F., Rodríguez C., Simplified scheduling of a building construction process using discrete event simulation, 16th LACCEI International Multi-Conference for Engineering, Education, and Technology: "Innovation in Education and Inclusion", 19-21 July 2018, Lima, 1-11, DOI: 10.18687/LACCEI 2018.1.1.194.

[5] Gumen O.M., Martyn Je.V., Spodynjuk N.A., Ljaskovs'ka S.Je., Informacijni grafichni zasoby podannja prostoru temperaturnogo polja promyslovyh budivel', Visnyk Hersons'kogo nacional'nogo tehnichnogo unyversytetu, HNTU 2017, Vyp. 3(62), 2, 269-273.

[6] Topilnytskyy V., Rebot D., Sokil M., Velyka O., Liaskovska S., Verkhola I., Kovalchuk R., Verkhola I., Dzyubyk L., Modeling the dynamic of vibratory separator of the drum type with concentric arrangement of sieves, Eastern-European Journal of Enterprise Technologies 2017, 2/7(86), 26-35.

[7] http://en.flexsim.pl

Tworzenie optymalnych parametrów procesu produkcyjnego z wykorzystaniem programu FlexSim

STRESZCZENIE:
Powszechnie występująca globalna konkurencja wymaga stosowania nowych zasady organizacji produkcji, dystrybucji i sprzedaży produktów. Osiągnięcie sukcesu w tym względzie jest możliwe dzięki wprowadzeniu skutecznych narzędzi informatycznych, które pozwalają symulować proces produkcji, dostarczać dane i obliczać czas na wytworzenie produktu, eliminować problematyczne miejsca w produkcji itp. W przypadku planowania, będącego pierwszym etapem tworzenia produktu, można osiągnać najlepsze efekty dzięki zastosowaniu modelowania. Modelowanie procesów technologicznych polega na tworzeniu modelu i relacji między różnymi elementami tego procesu w przestrzeni i w czasie. Celem pracy jest analiza głównych etapów tworzenia modelu symulacyjnego przy wykorzystaniu środowiska FlexSim. Polegała ona na określeniu wpływu wzajemnych relacji różnych składowych na wytworzenie poszczególnych elementów i cały ciąg technologiczny. Zautomatyzowany proces technologiczny jest traktowany jako system wieloparametrowy, w którym wejścia i wyjścia są ze sobą ściśle połączone. Każdy element procesu można zdefiniować jako osobny model, dla którego odbywa się wprowadzanie danych początkowych, a na jego wyjściu otrzymuje oczekiwane zaprogramowane działanie. Model, który został stworzony, jest traktowany w programie FlexSim jako system składający się z powiązanych parametrów. Zaproponowane podejście, mające na celu uzyskanie kompleksu optymalnych parametrów procesu produkcyjnego, znajduje zastosowanie zwłaszcza w budownictwie przy rozwiązywaniu procesów decyzyjnych.

SŁOWA KLUCZOWE:
model; system wieloparametrowy; technologia informacyjna; FlexSim