PalArch's Journal of Archaeology of Egypt / Egyptology

# SIMULATION MODEL AS A TOOL TO OPTIMIZE THE OPERATION OF THE PROCESSLINE FOR MANUFACTURING CONSTRUCTION PRODUCTS

*Akishev Karshyga[1], Bykov Petr[2], Aringazin Kapar[3], Zhanserik Shoshay[4], Karpov Valeriy[5]*

[1,2]Toraighyrov Pavlodar State University, 140008, Pavlodar, Lomov Street, 64

[3]Candidate of Technical sciences, prof. Director, LLP, Ecostroynii-PV, Republic of Kazakhstan, 140010, Pavlodar, Kamzin str. 45

[4]Senior lecturer Department of Metallyrgy, S. Toraighyrov Pavlodar State University, 140008, Pavlodar, Lomov Street, 64

[5]Doctor of technical Sciences,K.G. Razumovsky Moscow State University of Technologies and Management (FCU), Russia, Moscow, Zemlyanoy Val St, 73

[1]Akmail04cx@mail.ru, [2]Bykov_petr@mail.ru, [3]Kapar47@mai.ru, [4]zhanserik@inbox.ru, [5]V.Karpov@mail.ru

**Akishev Karshyga, Bykov Petr, Aringazin Kapar, Zhanserik Shoshay, Karpov Valeriy.Simulation Model As A Tool To Optimize The Operation Of The Process Line For Manufacturing Construction Products-- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(10), 2491-2499. ISSN 1567-214x**

**Keywords: simulation model, visualization, special events, algorithm, structurally functional model, interface, object-oriented paradigm, modelling algorithm.**

## ABSTRACT

The article discusses the practical application of a method of simulation modeling for the object of studying the processline for manufacturing construction products using industrial wastes. The purpose of the study is to optimize the operation of the processline for manufacturing construction products using industry-related wastes and to develop the tools for calculating the productive efficiencyof the processline of production, with variable nomenclature of construction products, concrete mix composition, scenarios of production technology, with the possibility of determining raw material resources of an enterprise.

The novelty of the study lies in using the simulation method in the construction industry, particularly, in the production of construction products. There has been described the functional operation of the model, the algorithm and the software product "Simulation model of the processline for manufacturing construction products" written in the object-oriented programming language C++ in theBorland environment, used in practice in the"EcostroynNII-PV" LLP. An overview of the state of the use and the trends in the development of the simulation method abroad and in the CIS countries are given.The article will be useful to all those engaged in the research on simulation techniques.

**Keywords:** simulation model, visualization, special events, algorithm, structurally functional model, interface, object-oriented paradigm, modelling algorithm.

## INTRODUCTION

The age of digitalization affords persons the opportunity, without leaving home, to embody any action in the virtual world that can reflect a real process, a movement. Depending on the desired result, a static or dynamic simulation can be suggested. Such visualization helps to understand the parameters, modes, and limitations.

Simulation modelling helps in setting upmultiple parameters of the process line operation, the conveyor speed, the operating time of individual units, the capacity load, the accuracy of batching, the parameters of automatic equipment, without being present at the production site. The operation of any processline is associated with the operation of the equipment of various types necessary to ensure the production of the final product. In this case, the object of study is a technological process of manufacturingconstruction products using industrial wastes. Despite the available passport data, in a real-life situation, no one can say how many products a particular process line can manufacture, and what their quality is, what time it will take, what volume of raw materials is needed, what the concrete mix composition is, , what the actual productive efficiencyof the process line and the effectiveness of production are. To optimize the operation of the process line, it is necessary to simulate various scenarios, to take into account different conditions, and to determine the optimal mode of capacity load.

The overseas research and development in the area of simulation has grown every year, with many conferences and symposia devoted to this issue [1]. Moreover, any even minor project and production facility,that require reconstruction, must necessarily have a simulation model as part of the documents [2].

In Russia and the former CIS countries, the simulation techniques are still not as developed as in the Western world. There are a few industries that employ simulation modeling, namely, food industry, aircraft engineering, metallurgical industry, building materials, and production management. As for conferences, there are 3 conferences in Russia that pay attention to the issues of simulation modeling [3]. It is very unfortunate that to date in Kazakhstan the questions relating to the research studies that utilizesimulation modelling methods,have not been represented in the mainstream press, there is not a single specialized conference devoted to such a promising direction as studying complex dynamic systems.

At the same time, many experts in simulation modeling in Russia admit that the past decade has seencertain changes for the better [4,5]. Some small and medium enterprises have begun to use more actively the method of simulation modelling in their activities. The main trends in the up-to-date simulation method at the WinterSimulation Conference [6, 7, 8, 9, 10, 11,12] have showed that its future development involves: object-oriented simulation systems, embedded simulation, optimization supporting applications , modules of resource planning tasks at the enterprise [3 ]. To keep up with the current trends in the development of the simulation method, there should be opened and developed a school of simulation in Kazakhstan with training of specialists in relevant universities in the country.

### *Purpose of the study*

The aim of the study is to optimize the operation of the process line for manufacturing construction products using industrial waste, as well as to develop the tools for calculating the productive efficiencyof the process line for manufacturing, when producing a variety of construction products, of different concrete mix compositions and with various production process scenarios, with potential determination of the required raw materials to organize the effective functioning of an enterprise.

***Methods for developing a modeling algorithm for the processline for manufacturingconstruction materials***

To develop a modeling algorithm for this research object, a principle of special states (events) and a methodology of object-oriented programming [13] were applied. The theoretical background of simulation in various economic sectorsis described in sufficient detail [14,15,16,17,18]. In work [19], a mathematical model of the transport process of movement is described, but there is not any developed simulation model. Possible scenarios of technological processes during manufacturing construction products are given in [20].

To visualize the events and formal objects, a functional model of the process line was considered, and three classes of objects were distinguished: OA0, OA1, OA2 (raw material feeding, preparation of concrete mix and production of a ready-made product). Such a simulation model makes it possible to configure many parameters of the process line and to determine how the process equipment components interact with one another. One object z0, z1, z2 is assumed per each class (preparation of concrete mixtures and transferring them to vibrocompression machine). A list of events is therewith compiled for the simulated system that are tied to the system objects and allow working with them on a real-time basis, what eliminates the occurrence of serious errors. Clearly the simulation has its limits, the input data are not always so suitable, so accurate. Here it is important to revise and adjust the model in due time to make sure that it accurately reflects possible limitations.

## RESEARCH RESULTS

To solve the problem of optimizing the process line for manufacturing construction products, the authors have proposed a modeling algorithm developed on the basis of the structural-functional model of the process line for manufacturing construction products [20], which allows visualizing the technological process of functioning of the process line for manufacturing construction products.

Based on the modeling algorithm, a software product”Simulation model of a process line for manufacturing construction products with the use of industrial waste” was developed[21].

Figure 1 shows the functional model of thetechnological system simulation model. The z0 unit through theD-0 batcherensures the formation of a dry mixture made of components stored in the C0-C4 containers. The amount of each component is supplied by the D-0 batcher(sand, crushed stone, bauxite sludge, metal sludge, ash, lime) according to the mixture composition. This dry mixture is fed until it reaches the specified volume V (dry mixture volume). All the while, the formation of the mixture is underway in the z0 unit. As soon as the volume of the mixture in the B-1 container becomes equal to V, the z0 unit goes into a waiting state (for as long as the

B1 container is freed), and the z1 unit is turned on, which,through the use of the D-1 and D2 batchers supplies the remaining components (cement, lime, plasticizer, water) to the B-1 container according to the composition until the volume of the mixture becomes equal to V2 (the total volume of the mixture with all components). Here, the mixture is stirred and then transferred to the B-2 mixer by the T-1 conveyor where it is stirred during a specified time. All this time, the z1 unit is considered busy until the B-1 container is freed. Upon completion of stirring, the z2 unit is turned on,enabling the feeding of the mixture into the forming matrix and the production of a ready-made product.

The main window of the program is shown in Figure 2.

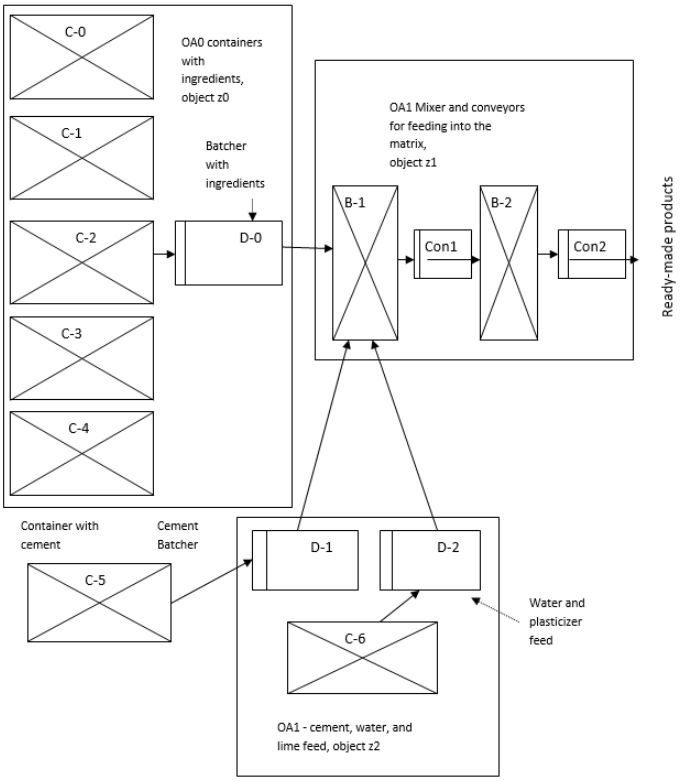


**Figure 1- Functional model of the simulation model of the technological system**

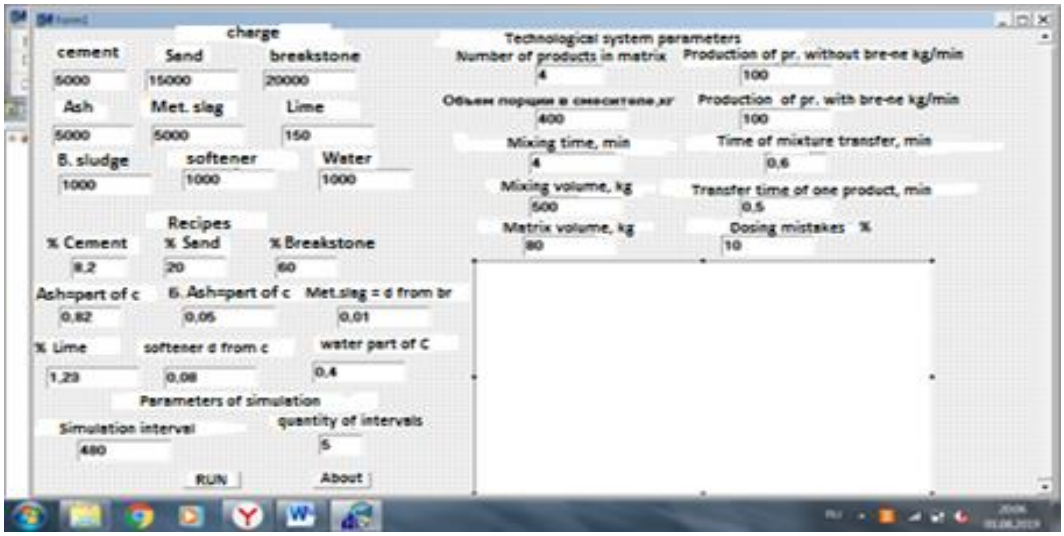


Figure 2−The program's main window

The input data to simulate the process of manufacturing a hollow wall stone are presented in table 1.

As can be seen from Figure 2, the window of the software product interface provides all weight and time parameters of the technological process, as well as the data on raw materials, concrete mix compositions, simulation intervals, batching errors, what ensures good visualization of the technological process of manufacturing construction products and makes it possible to increase the efficiency of the process manufacturing line thanks to the variation in different parameters of the simulation model.

*Table 1.*Input data to simulate the production of the hollow wall stone weighing 20 kg

| Concrete mix composition | Amount of raw materials, kg | Processline parameters | Simulation parameters |
|---|---|---|---|
| Cement Percentage (8.2); Percentage of sand (20); Percentage of crushed stone (80); Ash -cement proportion(0.82); Bauxite sludge - cement proportion(0.05); Metallurgical slag -crushed stoneproportion (0.01); Percentage of lime (1.23); Plasticizer - cement proportion(0.08); Water -cement proportion(0.4). | Cement (5000); Sand (15000); Crushed stone (20,000); Ash (5000); Metallurgical slag (500); Lime (150); Bauxite sludge (100); Plasticizer (1000); Water (1000). | Number of products in the forming matrix (4); Batcher productive efficiency for dry mix (without cement and water) (100 kg / min); Mixer volume capacity (500 kg); Cement batcherproductive efficiency(100 kg / min); Mixing time, (4 min); Time for feedingthe mixture into the matrix, (0.6 min); Time for transferring one product to the output, (0.5 min); Matrix volume (400 kg);Batch volumein the mixer (400 kg); Batchingerror (10%). | Simulation interval/run (480 min); Number of implementing runs (5) |

In Figure 3, the results of the software product operation for 5 iterations,each of 480 min, are displayed.

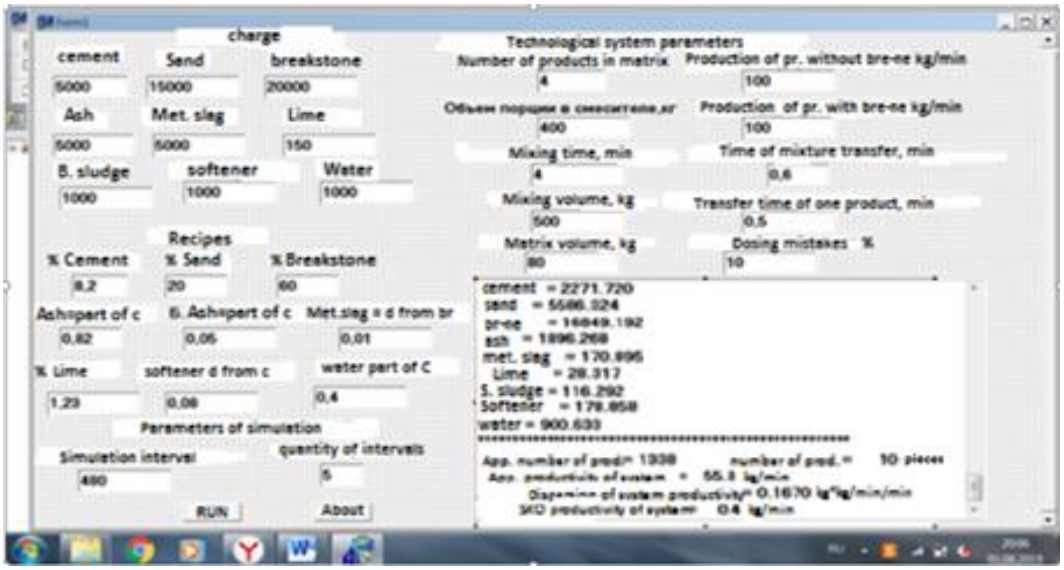

Figure 3−The result of the program run for five iterations

The data have become available on the productive efficiency of the process line for the480-min time interval from the operation of the software product “Simulation model of the process line for manufacturing construction products”. Here, as it has been previously noted, objective and subjective factors should be taken into account.. In this case, the result of using the simulation model allows us to infer that for a given type of the product and for a given time interval, the process line is able to optimize the operation by increasing the operating time of the process equipment, changing the parameters of the technological system, of raw materials when using adequate concrete mix compositions, by manufacturingeasily producible products. A user-friendly interface of the program allows making adjustments in parameters, compositions, raw materials on a real-time basis, what does not take much time, moreover, the program can be utilized for a wide range of construction products and technological processes.

## DISCUSSION OF THE STUDY RESULTS

The studies related to the application of simulation methods in the construction industry are considered in works [22,23,24,25]. The studies involve solving logistic, managerial, transportation problems, modeling of the composition of construction materials. There are works where mathematical modeling methods are utilized to study the individual components of the process equipment [26,27].

Most authors use the GPSS World simulation system in their works, what is,first and foremost, due to the availability and relatively low price of the software product. In addition, foreign systems and modeling packages are now in use to model production systems in Russia. When developing simulation models, some authors utilize such universal languages as FORTRAN, C / C ++, Delphi [3].

Until today, the application of the simulation method to study the technological process of manufacturing construction products using industrial waste has not been adequately elucidated in print media.

## CONCLUSION

From examining the process line for manufacturing construction products, a software product “simulation model of the process line for manufacturing

constructionproducts"has been developed that makes it possible to determine the actual productive efficiency and to enhance the operation of the process line for manufacturing construction products, through introducing real weight and time parameters of the technological process (system),based on optimal capacity load, application of high-quality raw materials, potential utilization ofdifferent types of industrial waste, use of adequate compositions of concrete mixtures, with possible determination of the necessary raw material resources of an enterprise to ensure the achievement of key performance indicators.

The developed software product "Simulation model of a process line for manufacturing construction products»has been utilized for practical purposes in the EcostroyNII-PV LLP. The company is engaged in manufacturingconstruction products using industrial waste.

This paper has been prepared as part of Subproject No. APP-SSG-17 / 0290P "Innovative Technologies of using Solid Industrial Wastes from the Heat Power and Metallurgy Industry Enterprises of the Pavlodar Region in manufacturing Construction Materials», funded under the scope of the Project "Incentives for Efficient Innovations», supported by the World Bank and the Government of the Republic of Kazakhstan.

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