Modeling the management of fluctuations in stocks in production

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Abstract. The article describes a simulation model that describes the fluctuations of the system. It is possible to track changes of fluctuations in stocks levels, as well as in production. Fluctuations occur when the behavior of the model deviates above or below the equilibrium point. If the oscillations damp, they will become less and less and eventually disappear in the absence of an external force that stimulates them. This model was built with the help of the program Powersim Studio 7 Express. The input interface of the model is shown. It includes such data as “Equipment correction time”, “Changing timeout”, “Inventory”, “Equipment” and “Expected demand”. This model contains three constants, two auxiliary variables, two drives and three streams. An experiment was conducted on the input data. As a result of the experiment an output interface was created and it includes such graphs as “Behavior “Expected Demand”, “Order Level” and “Production” during the simulation” and “Comparison of “Equipment” and “Required Equipment” during the simulation”. According to these graphs, it is possible to track the actual and necessary equipment used in production, as well as understand how much needs to be produced to cover the discrepancies between stocks and desired stocks, as well as expected consumer demand.

1. Introduction

When an organization is experiencing an increase in demand, it can only increase its production if it has equipment capable of coping with this growth.

This topic is relevant now because each top manager of the enterprise needs to know at what production values his company will develop, and what values can be neglected.

It is necessary to study the relevant literature to build this simulation model.

The article “Simulation modeling of business processes and economic systems” by I.N. Bolshakov identifies cases where it is necessary to use simulation modeling:

- To obtain and track their dynamics in any emergencies associated with possible risks and when conducting experiments with discrete-continuous models of complex economic objects.
• To manage a complex business process, when a simulation model of a managed economic object is used as a tool in the outline of an adaptive management system that is created based on the information (computer) technologies [1].

The second case is suitable for investigation because managing the process of tracking fluctuations in stocks and in production is a complex process.

The author writes that the simulation model helps to study the systems that we either analyze or design, according to the operational study scheme, which contains the key stages that interact with each other. We just need to set a task, develop a model, use a program to implement a simulation model, give an accurate assessment of the modeling, draw up a plan for the implementation of future experiments and only then consider decision making.

It is necessary to use the Powersim Studio 7 Express program to build this model.

Consider another article under the title “Modeling of business processes in modern organizations” by the authors Pecheritsyna I.O. and Grinavtseva E.V. They define such a concept as business process modeling.

Business process modeling is an activity where various models of the functioning of organizations are formed, various processes, the relationships among them, information systems, personnel, resources and much more are described [2 - 4]. This is a kind of map for all participants in business operations [5]. It is important to understand that modeling activity involves creating a model that adequately reflects the real object, i.e., an organization. The problem of modeling systems is of no importance. In practice, situations most often arise where there are defects in the data tables [6]. Often, in modern practice, a concept of “Business process” is used when simulating management and production processes in the activities of enterprises.

It is possible to develop an effective organizational structure for their management understanding what business processes are carried out in the company. The lack of a process approach to management can lead to spontaneous results. They can not be used and analyzed due to the difficulty of reproduction.

Technological processes proceed continuously in time, but measurements of the input and output characteristics of the process occur discretely. The following feature is related to the discreteness of control, which should be taken into account when identifying the problem. Input and output variables can be measured at different time intervals [7].

At this moment, business process simulation has reliably entered the practice of implementing business promotion programs. It is well known that any activity should begin with planning, long before the first step in the chosen direction [8]. A specific business model makes it possible to facilitate significantly the solution of urgent problems in modern conditions facing almost every enterprise, for example, fluctuations in stocks and production. Let us develop our simulation model so that we can track this process.

2. Creating constants, drives, and auxiliary variables
It is necessary to define those constants that will need to be entered to model the process for a more understandable construction of the simulation model. The simulation model will contain three constants. They will be used to calculate the values of auxiliary variables or threads. These constants will be as follows:

- “Equipment correction time”. This constant will contain a value indicating the number of weeks (wk) required for equipment repair.
- “Inventory”. This constant will contain a value indicating how many weeks (wk) will an inventory take place.
- “Changing timeout”. This constant will show how many weeks (wk) are needed for a change in the waiting time for customer demand.
Let us create auxiliary variables. Such variables contain calculations with other variables. The simulation model will contain two auxiliary variables:

- “Required Equipment”. This variable is auxiliary, since its value directly depends on “Expected Demand” and “Inventory”. Get the amount (wdg) of the necessary equipment to satisfy “Production”.
- “Order speed”. This variable is auxiliary, since its obtained value calculated by the formula affects “Supplies” and “Changing the expected demand”.

Let us create variables that accumulating changes (drives). Such variables contain values that with each set of the flow change with the cumulative effect. The simulation model will contain two drives:

- “Equipment”. Simulation will take place until this drive reaches a certain amount (wdg) of equipment.
- “Expected Demand”. Simulation will take place until this drive reaches a certain value of customer interest per week (wdg/wk).

The values of all created constants can be changed depending on the situation at the enterprise. These constants represent the input interface of the simulation model.

3. Input interface
The input interface of the simulation model is the data that goes to the input of the system. These data include those values by which auxiliary variables will be considered, accumulators will be accumulated, and a simulation model will be built.

The model input interface is shown in Figure 1.

![Figure 1. Input data on user interface.](image)
It is necessary to enter values only in constants and select the necessary units of measurement for our simulation model.

4. Modeling stock and production fluctuations
The flow with the pace will be used in the simulation model. Flows will be controlled using the tempo variable connected to it, which is usually an auxiliary variable. The simulation model will contain three streams:

- “Production”. This auxiliary variable contained in the stream is calculated from the values “Expected demand”, “Required equipment”, “Equipment” and “Equipment correction time”. It will contain the amount of inventory that is produced per week (wdg/wk).
- “Supplies”. This auxiliary variable contained in the stream directly depends on “Order speed”. It will contain the amount of inventory that comes by deliveries per week (wdg/wk).
- “Changing the expected demand”. This auxiliary variable contained in the stream is calculated from the values “Order speed”, “Expected demand” and “Changing timeout”. It will contain the interest of the client, which is generated per week (wdg/wk).

It is through the flow that the simulation model will work. All variables and drives will transfer their values through the streams, while the streams, in turn, will calculate the necessary values and return them to a particular model object. Each of the flows changes the value of a variable or accumulator, by means of an auxiliary variable, which, in turn, includes calculations with other variables.

The block diagram of the simulation model contains exactly all the elements that were created earlier. It is a complete picture of the model, on which the simulation process itself will be built.

The block diagram of the model is shown in Figure 2.

![Block Diagram](image)

**Figure 2.** Created block diagram for model “Model of fluctuations in stocks and in production”.

The figure presents how the modeling process takes place and how the objects of the model influence each other. We can trace all those dependencies of variables on a stream or drive.
5. Output interface

All dynamic variables will be deducted, relative to the data that was entered into the input interface after the model starts. Charts will also be built based on all received data.

Let us derive to the output interface of the two graphs: “Behavior “Expected demand”, “Order level” and “Production” during the simulation” and “Comparison of “Equipment” and “Required equipment” during the simulation”.

Consider the resulting chart “Behavior “Expected demand”, “Order level” and “Production” during the simulation”. This graph is shown in Figure 3.

![Figure 3](image)

**Figure 3.** “Expected demand”, “Order level” and “Production” during the simulation.

The possibility of comparing time series “Expected demand”, “Order level” and “Production” are of great interest. It is clear if the decision-making policy we modeled is working.

An increase in “Order speed” forces the postponement of changes to both “Production” and “Expected demand”.

The graph shows that the “Order speed” suddenly increases after 20 weeks. “Expected demand” follows slowly and after a few weeks it adapts to a new level of orders. “Production”, however, suddenly increases with increasing in “Order speed”.

Consider the graph “Comparison of “Equipment” and “Expected equipment” during the simulation”. This graph is shown in Figure 4.

![Figure 4](image)

**Figure 4.** Comparison of “Equipment” and “Required equipment” during the simulation.

The graph shows the (actual) “Equipment” and “Required equipment”. The required equipment increases immediately when the “Order speed” increases, but due to a delay in the “Production”, the “Equipment” first decreases, then sharply increases and reaches the same level as the “Required equipment” at the end of the simulation.
6. Conclusion
While the article was writing, a simulation model “The model of fluctuations in stocks and production” was built. All the objects of the system that are necessary for the correct construction of the simulation were identified.

On the output interface, the model shows a comparison of the behavior of “Expected demand”, “Order level” and “Production” during the simulation and a comparison of “Equipment” and “Expected equipment”. Due to this simulation model, it is possible to trace all the data that is so difficult to calculate without simulating the process.

Now, with increasing or decreasing demand, it will be much easier for an organization to track the actual and necessary equipment to produce enough to cover the mismatch between stocks and desired stocks, as well as expected customer demand.

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