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THE REVIEW OF METHODS OF MATHEMATICAL AND COMPUTER MODELING OF QUALITY MANAGEMENT SYSTEMS IN ECONOMICS

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Abstract: The article shows the need for models of quality management. A comparative review of different modeling techniques of quality management systems in the economy is presented; the advantages and disadvantages of each method are revealed.

The entire quality management system consists of interconnected, technical, informational, organizational and economic methods and tools influencing the conditions and factors, and hence the quality of the product in the process of its development, production and use.

Modern quality control comes from the fact that the activities of quality management cannot be effective once products are manufactured, this should be done in the course of production. It is also important for quality assurance activities, which precedes the production process. It is obvious, that we cannot do without the existing modeling methods, as they contribute to improving the quality both at the stage of production and that of product design, reduce time and cost, as they use the mechanisms of research, fully replacing the costly experimental work. It becomes possible if the model describes the object of the study precisely and adequately. However, the model can be quite complicated, in particular, the model of the process of creating products. This process consists of many steps, operations, and other acts of moving from the less perfect and complete product to a more specific and complete one. Each step may differ from the preceding and following ones, both in form and content, as well as the duration, place of implementation (different companies or divisions of one company) and many other features.

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In constructing models of such systems one should take into account the original uncertainty data, lack of a clear mathematical description of the variables and parameters used in modeling.

Figure shows the historical development of modeling techniques [3].

Classical modeling techniques, which are conducted through the use of multidimensional differential equations and differential equations, describe the target system as an indivisible object and do not allow modeling multiple objects and interactions between objects. Using traditional methods of mathematical modeling in the study of quality management systems does not bring any substantial results due to the nature of the object.

In the study of complex processes and phenomena modeling techniques that span multiple levels including the aggregate level and at least a narrower one are of greater interest. The first method, which is good at solving this problem, is micro analytical simulation method.

Microsimulation is based on a large random sample of units (a sample of people, firms or organizations). Each unit goes through a series of transition probabilities that determine the possibility that the unit will undergo some changes during this time interval. Once the unit goes through a time interval, the process will be repeated during the next interval, thus, the unit moves within the simulated time.

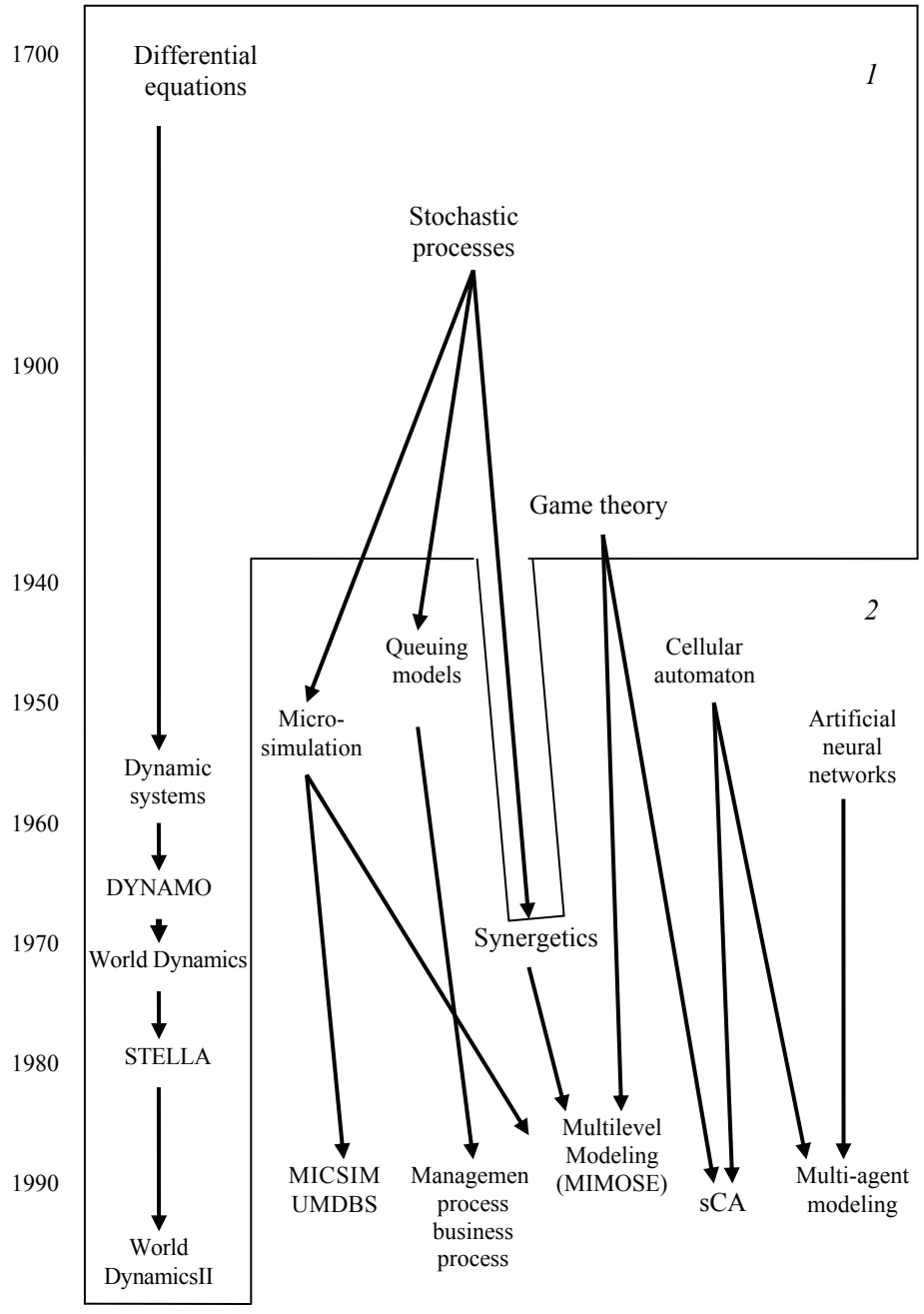
Each unit is considered individually: there is no attempt to simulate the interaction between the units. Motives or intentions of units are ignored.

Queuing models. The basis of this modeling approach is the role of "case", which changes the state of the system. This distinguishes it from other modeling techniques. The system components are called objects, each of which has attributes (properties). The system state changes to the case. Time in discrete models is neither continuous, nor it passes in equidistant discrete steps. Events are planned in the "agenda" – the list of all the events that must be defined in due time. Past events are automatically deleted from the list. Events may generate new events and paste them into the agenda. In terms of discrete models of the case, there are at least three different kinds of objects, namely, servers, clients and queues. The states of servers, queues, and customers depend on past states. The conventional discrete simulation of the case considers all the events separately. In complex models there will be a lot of cases, and a lot of interaction between them (that is, when a case will identify the other one). These types of programs are quite difficult to read, debug and modify.

Discrete methodology can also be used in other contexts. In microanalytical simulation models it can be used to avoid re-computing of the state of micro units, which are known to be constant for a long time.

What is outside the methodology of discrete random models is adaptive behavior on the part of clients. Although clients are called "dynamical objects" in discrete modeling their behavior during the simulation does not change.

If microsimulation approach considers the unit of analysis, as isolated objects, multiagent approach allows modeling the interaction between the units. The method consists in describing each element of the system, describing the environment and human interactions. The rules are divided into three types: the interaction of individuals with each other, the interaction of the individual with the environment and the influence of the environmental on itself.



The development of well-known approaches of modeling:
1 – models based on the use of equations; *2* – modeling techniques, which are conducted through the use of an object, event or agent

Creating a model involves describing the society of artificial agents in the form of an object in a programming language. The requirements of this object are the procedures that describe all the actions of the agent. All agents of this type form a class of objects. Thus, there exists a collection of similar objects, described by one class. The environment is described by some object, with all

possible actions assigned to it. In the modeling process different initial conditions are set for each object-agent and the behavior of all agents is studied in a single environment. The results of modeling are obtained by averaging the results of each agent, which can be presented as graphs or charts.

It should be noted that this method is designed for computer simulation rather than mathematical one, which leads to certain difficulties associated with the analysis of the model. However, this method is inherently based on statistical information processing. The result of simulation is nothing but mathematical expectation of a random variable.

The advantages of this modeling approach include visualization of the results of modeling and simple description of the rules of interactions. But it is necessary to note one important disadvantage, namely, the researcher should know and be able to program in an object programming language.

In the study of complex systems models of "neural networks" are widely used. The set of nonlinear interconnected neurons operating in parallel can accurately describe and predict a variety of phenomena, processes and management systems. The process of teaching "neural" networks simulates the processes of adaptation and optimization of complex systems. We should also mention another useful feature of the "neural" networks, namely, they enable to describe, simulate and predict any empirical data: quantitative and qualitative data, as well as data of mixed nature, which is partly quantitative and qualitative [2].

Multiple simulation involves simultaneous and parallel simulation on a set of simulation models, such as multi-agent models and "neural" networks. Some models can be implemented using multi-agent approach, the other on "neural" networks, etc. A variety of multiple simulation is a multi-level hierarchical simulation where at the same time at different hierarchical levels several simulation models function [1].

When choosing one or another way of constructing models one should be guided by, first of all, the conditions and characteristics of the task which will determine the nature of the source data, as well as requirements for the accuracy of the final result. It is clear that the choice of complex, even progressive methods of solving simple problems has a negative impact on the effectiveness of this solution and makes the choice unjustified.

The use of modeling techniques will enable firstly, to get a visual representation of the formation processes of the product quality, and secondly, to conduct research in the field of quality engineering without costly experiments, and thirdly, to form a complete picture of the processes occurring in the enterprise (company), and include the description of the organization activities in separate offices with an accurate, concise, easy for perception and analysis description of the system as a set of interacting components and the relationships between them.

Thus, models of quality management are the reflection of the interaction of all services of the company in design, manufacture and operation of products. It is a tool that is required to create a full-scale process control systems, including the organization of control processes and quality control. Continuous improvement and overall product quality meeting customer requirements is impossible without it.

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Обзор методов математического и компьютерного моделирования систем управления качеством в экономике

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Ключевые слова и фразы: качество продукции; методы моделирования; модель управления качеством; система управления качеством.

Аннотация: Показана необходимость создания моделей управления качеством. Проведен сравнительный обзор различных методов моделирования систем управления качеством в экономике и установлены достоинства и недостатки каждого метода.
