N. P. Buslenko

STATISTICAL MODELLING METHOD
(Metod statisticheskogo modelirovania)
Moscow, "Statistik" Publishing House, 1970, 112 pag.

In a limited-volume work included in the series "Mathematical Statistics for Economists" the known expert in statistical modelling of complex systems synthetises in a successful form, which is simultaneously accessible to economists possesing some knowledge in the field of mathematical statistics, the categories and structural notions of the approached problem. This book joins the author's early published works "Monte-Carlo Method", "Mathematical Modelling of Production Processes on Electronic Computers" (1964), "Complex System Modelling" (1968) and others.

The author starts from the premise that alongside with the increasing of the socialist economy complexity, its management becomes an object of mechanization and automation, which can be only carried out by using electronic computation techniques. The basis of electronic technique utilization in collecting and processing economic information in management systems of economic and production processes, is made up of mathematical models. As the stage of solving some problems is overstepped, a particular part is played at present by the statistical modelling method.

Why is there on the order of the day just the statistical modelling method? This is due to the fact that — as a consequence of the giant leap recorded in science and technology — in the national economy there appeared and are appearing big production, technological, energitical, information, a.s.o. processes, which take the form of extremely complex systems, comprising a huge number of constitutive elements, parts, subassemblies. In these conditions a particular importance devolves upon the system analysis, the system's structure problem, the interaction of constitutive elements, the interaction of the system with the environment, a.s.o. If we also take into account the stochastic character of big sistem running, determined by the action of a great number of random

factors, it becomes obvious that "classical" mathematical methods are inadequate and inapplicable. The adequate investigation method in approaching big systems is therefore the mathematical modelling method. Its essence consists in simulating on computer the complex system running , in the sequence of the elementary moments, characteristic of the modelled process. Simulation is carried out with the help of forming random numbers on the computer. Thus the mathematical model of the complex system running process is an algorithm, achieved on the computer, which — the system's parameters and the intial states being known — allows the computation of all characteristics necessary to solve some practical problems, as: estimation of efficiency, liability and of other system properties, the complex system management quality, and its improvement. The algorithm's existence — and this is essential — permits, not only the quantitative, but also the qualitative investigation of the system.

Starting from these theoretical premises, the author presents the essence of the Monte-Carlo method (according to his terminology, the statistical attempt method), as well as the way of carrying out and transforming random numbers (Chap. I and II).

In the III-rd chapter — actually devoted to the book's central problem — the application of the statistical attempt method (Monte-Carlo method) to the complex system modelling is described. The mathematical model is understood as a total of relations, which express the links of the process state characteristics with the system parameters, the initial information and the input conditions. In practice, stochastic processes are often studied, whose state characteristics are given as random functions.

In the general case, with the help of the mathematical model, one well-definedly determines the probability distribution for the process state characteristics (when the probability distribution for the initial conditions is given), the system parameters and the disturbances acting upon its elements.

The process mathematical model is worked out as a result of its formalization, by formal description, with a preset degree of approaching reality.

The mathematical model can be used in various ways, among which the most valuable, from the cognitive viewpoint, is the process modelling on computer. This consists in reproducing phenomena, by conserving their logical structure and their development in time. To this end, the mathematical model is transformed into modelling algorithm. When this algorithm is carried out on computer, the investigated process is simulated. There exists a certain analogy between computer process modelling and its experimental investigation.

In N.P. Buslenko's opinion, modelling is carried out on following stages:

1. *Verbal description of problem's content*, consisting in: emphasising the process qualitative and quantitative characteristics, integral repro-

duction of the logic of events and phenomena composing the process, description of the information flow necessary to management, determination of process characteristics wherefrom the necessary data can be obtained, a.s.o.

2. *Working out the formalized scheme.* It is especially necessary when the model cannot be directly created on basis of verbal description. The formalized scheme is, in fact, a strictly formal presentation of the essence of processes taking place in the system. The interdependences and links, established in the first stage, are "wrapped up" in mathematical form. The laws characteristic of the system are written down as equations. The values of the magnitudes determined upon modelling, the system's parameters, initial conditions and input data are specified; usually, they are given in form of tables or graphs. Sometimes, in this stage, experimental investigations are also necessary.

2. *Drawing up the mathematical model.* The writing down in analytical form of all interdependences is concluded, the logical diagrams are presented as inequality systems, all data concerning the process are "wrapped up" in analytical form. The tabulary data or data presented by graphs in the previous stage, are approximated and presented in a form appropriate for carrying out calculations. It is obvious that the model is the better, as it more correctly reproduces — under the form of a formal description — the investigated process.

The modelling algorithm is then written in the form of an operational scheme, with the help of arithmetical and logical operators. On this basis is worked out the computation or simulation program.

The statical modelling method is used as an instrument for analysing complex systems, for carrying out experiments, optimizing processes, simulating management processes, optimizing the centralization and decentralization degree in management processes, a.s.o. With a view to improving the modelling quality, certain special indicators are selected, which characterize the quality of the function's running. Such an indicator is the system's efficiency, by which one understands the appreciation of the degree of adapting the system to the tasks it has to perform.

Further on, in chapter IV, statistical models of mass attendance (serving) are presented. Concluding (in chapter IV) a concrete case of motor-car traffic modelling is given, a case approached in its whole complexity and treated up to obtaining practical results.

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