Simulation Systems of Small and Medium Batch Production: 
The Functions and Structure

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Abstract—This paper formulates the tasks that can be solved by the simulation systems of small and medium batch production. The author defines the requirements to the simulation systems of the given production class and describes the strategy and parameters of sampling tests on different stages of an industrial process and, besides, the sequence of experiments execution.

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1. INTRODUCTION

Simulation in the area of production processes is widely used when experimenting with a real system appears impossible, but it is necessary to determine the most effective ways of industrial process (IP) organization and design, perform production sequencing and scheduling, control the material flows and maneuver the human resources [1–3]. Application of simulation methods is more efficient in the conditions of small and medium batch production. The optimal job schedule in the sense of technical and economical indices should be worked out depending on the factory structure, the stock of orders, the graph of their fulfilment, the conditions of equipment, raw materials stocks, half-finished products and inventory, and available human resources. In these conditions, a production process should be not only economical efficient, but flexible and easily adjustable to market requirements.

Special-task simulation systems utilize the programming languages GPSS, Modula-2, Simula, Simscript, SLAM, Pascal, C, C++, Java. Within the scope of the object’s simulation model, such systems allow a user creating the specified structure of a production complex, describing the material flows and the functions of single modules, presenting the results of fulfilled calculations in an admissible form, etc. However, for small and medium capacity factories often suffering from the deficit of high-qualified specialists in information technology and programming, adaptation of a simulation system to a concrete production process seems almost impossible. They need simple and user-friendly program systems, where all these functions are realized by an intuitive graphical interface.

Simulation systems in operational control of small and medium batch production will assist to solve the following tasks:
—rapid reorganizing and replanning of production in accordance with customer’s requirements and the conditions of production, material and human resources and inventory;
—time saving in orders’ fulfilment and reducing inventory stocks;
—raising of the probability of complete orders’ fulfillment according to the terms of contracts;
—increasing the utilization factors of process equipment;
—reducing production costs and rejection rate;
—improving stuff qualification through operational experience gained with the simulation model.
Simulation systems oriented to wide usage in the production of electronic equipment and instrument making must meet a number of specific requirements.

1. The capability of carrying out simulation experiments with due consideration of testing operations, as electronic equipment production provides for numerous testing operations at different stages of an IP. The simulation system must allow a user choosing the strategy of testing operation execution, adjusting different process parameters and applying different testing equipment. Moreover, the simulation system must include various calculation algorithms for the probability and costs of reject output and cycle time.

2. The simulation process must be carried out in real calendar time, as modern production implies IPs with different duration. The system must incorporate the capabilities of graphic input and adjustment of real calendar production time taking into account weekends and holidays, the number and duration of production shifts, breaks, and afterhours.

3. The capability of managing human resources in the simulation model, as at different time moments a same specialist possibly performs one or several process operations, serves one or several production modules simultaneously depending on production needs.

4. The capability of carrying out simulation with different level of detail of a production process (an extended production model, some complex of objects or even a process operation and each unit of equipment). Any structural unit from the specified hierarchy of production models can be chosen as the object of simulation. The capability of choosing different algorithms, operation modes of

![Diagram](Fig. 1. The conversion scheme of input, output and variable data for production, transport and testing operations of a modeled system.)