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MODELING OF MANUFACTURING PROCESSES USING A PETRI-NET

Filonenko K.G., Vysloukh S.P.

National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute», Kyiv, Ukraine

The production system is a system of industrial production's organization, which consists of production means and objects, production processes and labor, the joint operation of which allows the products' production of consumer value.

Modern industrial and technical systems - automatic lines, robotic complexes, flexible production systems and other types of technical objects that operate in various fields of engineering, are complex in structure, layout and system organization of technological, auxiliary machines and other technical means, interconnected and function in a certain interaction, and the more coherent this interaction, the higher the productivity and other output technical and economic indicators of such systems [1].

Solving the issues of material's rational use and labor resources, increasing the efficiency of equipment requires the increase of scientific validity for production management's methods. Creating a competitive new technology involves the implementation of various diverse solutions. In these conditions, the transition to widespread use of economic and mathematical methods and models, which provide the choice of the best management option in terms of resource savings, increase the design efficiency and modern competitive products' production [2].

At present, great attention is paid to the improvement of equipment, but in essence, the autonomous performance of the equipment and its perfection does not take into account the size of the batches, the time spent on the transfer of parts between the machine tools. The most significant costs in the technological chain come from production. Static modeling does not provide a complete answer to many questions. The way out of this situation is the transition to complex (simulation) modeling of production processes, the model creation.

Such a model can be "played" in time for both a single test and multiply tests. Typically, simulation models are built to search for an optimal solution in terms of resource constraints, when other mathematical models are too complex. Modeling a production system is used when conducting experiments with a real system is impossible or inappropriate. The simulation of production processes connects all areas of products' production: the production process' development, the production process' modeling and technological preparation of production, as well as production management [3].

Traditional modeling systems are not able to take into account all the complex control influences and simulate their effects. Therefore, to implement a complex system of production process that can assess the influence of control factors in real time, it is advisable to combine the effective means of system formal description and the possibility of such a modern tool as simulation modeling.

Simulation modeling, as an instrument for the experimental study of complex systems, covers the methodology for creating system models, algorithmic methods and means of program implementation of simulators, planning, organizing and executing on computer simulations experiments, machine data processing and results' analysis. In this case, the dynamic and stochastic characteristics of real processes are reflected in the model using specially designed procedures. It should be noted that the range of imitation application on a computer is extremely wide - from the concrete forms of enterprises' activity to imitating the whole country's economy. The object of modeling may be industrial, logistics, transport and other systems. Modeling of production systems allows: to identify and eliminate problems that are manifested at the start-up stage in advance and would require financial and temporal costs; reduce investment in production at the same productivity parameters; Conduct optimization of production and choose the most rational solution from a multitude of options [4].

Thus, the manufacturing process' development is preceded by the study of the product' design, which ends with the assembly of technological schemes of general and parts' assembly. The technological scheme of assembling contains information on the structure and order of attachment of the product elements, the assembly units' completeness and connections. When developing the route technological process of assembly on the basis of assembly scheme, the content of assembly operations is set in such a way that at every workplace, as possible, a homogeneous in character and technologically completed work is performed. In the future, the construction of the assembly scheme serves to identify and elaborate the development of operations, the definition of types of work, assemblies and other parameters that form the description of assembly operations.

Since the object of modeling in this case is not only the connections between the elements, but processes that occur at the same time, it is necessary to apply a model of a special kind: structural-functional, which simultaneously reflects the structure and functioning of the object being modeled. One of the best options for creating a mathematical model in this case is the graphs using. The most universal method of working with graphs can be considered the theory of networks Petri - an effective tool for modeling discrete processes. [5]. The main features of Petri's networks are the

ability to display parallelism, asynchrony, hierarchy of simulated objects in simpler ways than using other simulation tools [6].

Among the main advantages of Petri's networks, one can note that they allow with accurate accuracy to represent ramified, parallel, cyclic processes, possessing means of analysis, as well as simulation in real time. The simulation process can be divided into two stages: formation of structure and model parameters based on the properties of the original system (object of management);. imitation experiments to achieve the required value of the quality system performance indicator.

The quality of the system is evaluated based on the numerical values of the chosen optimality criterion. The main means of optimization in network models are the rules of priority, which choose one of the given quantities of permitted operations by a predefined principle. It should be noted that with the use of priorities it is impossible to indicate that the optimal solution has been obtained from several possible ones. It is proved only that when applying the priority rules the value of the optimality criterion is better than without their use. Thus, Petri's networks formalize the concept of an abstract system - a dynamic structure of events and conditions. In the general theory of networks, the Petri apparatus is considered as one of the methods of systems' network simulation. Here are introduced more general network models. Their sole basis forms the notion of an inexplicable oriented network of conditions and events that describes only the static structure of the system. The most common in the range of dynamic network models is a conditionally affiliated system, which is a network, supplemented by the rules of changing conditions as a result of the events implementation. Petri's network can be considered a concretization of conditionally an eventful system [7].

Thus, using an imitation modeling, you can perform an unlimited number of experiments with different parameters. Simulation allows you to describe the structure of the system and its processes in its natural state, without resorting to the use of formulas and strict mathematical dependencies.

It is also worth noting that simulation allows taking into account the maximum possible number of environmental factors to support decision making and is one of the most powerful means of analysis. The necessity of its application in the domestic practice of managing production processes is due to the peculiarities of our economy, which is characterized by dependence on non-economic factors and a high degree of uncertainty.

The simulation results can be supplemented by probabilistic and statistical analysis and, in general, provide the manager with the most complete information on the influence degree of key factors on the expected results and possible scenarios for the development of events.

As an example, by applying the theory of Petri's networks, an appropriate program was created in the Plant Simulation system, which allowed the creation of simulation models for loading the equipment of the automated section in the mechanical processing of the housing part.

The resulting simulation result showed that when using Petri Networks it is possible to reduce the idle time of the equipment and rationally distribute the load between the machine tools.

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