

IMITATION ABSTRACT MODELS OF PRODUCTION SYSTEMS

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Summary. A term «abstract simulation modeling» is offered and legitimacy of its use is grounded. The example of abstract simulation modeling is resulted.

Key words: simulation model, abstraction, abstract simulation modeling, flexible manufacturing system.

INTRODUCTION

Methods of simulation are widely used in various industries. In many cases, where it is necessary to analyze the production, to predict and manage the performance of production units and the whole production cannot do without the use of models.

However, the development of information models and related software products associated with significant time and financial costs, with the participation of a large number of highly qualified specialists. To reduce the complexity of models developed in recent years certain steps have been taken. The graphical modeling languages such as unified, standard language UML, automated software (e.g., Rational Rose, Star UML, etc.), methods of formation models based on object oriented design and programming, etc. But, despite the positive aspects difficulties in solving this problem remain significant. We need to take new qualitative steps that could significantly change the situation for the better.

RESEARCH OBJECT

This work is aimed at finding new ways to improve the developed models. The focus of these proposals is in increasing the degree of abstraction of models developed.

The degree of complexity of simulation models depends on their purpose. In some cases, it is required to develop models that completely simulate the processes occurring in systems without time-consuming. Such models can be found where it is important to represent clearly the sequence of operations, the possibility of their

combination, etc. This, for example, the work of supermarkets, models for large celebrations and sporting events, etc.

In many cases, especially with regard to industrial enterprises, along with the sequencing of operations we need to determine the time and cost. Here the time factor plays a crucial role in modeling processes.

Models assessing time and cost are also required and the regulation of parameters characterizing the effective performance of enterprises.

This article considers a number of proposals which, in our opinion, could improve the effectiveness of simulation in systems and reduce complexity and cost of their development.

RESULTS OF THEORETICAL RESEARCH

It is known that the production activity of enterprises of different sectoral focus has significant differences. Even within individual enterprises we can easily distinguish different sides of their activities. These are production (core) activities, activities for the preparation of production, economic, marketing, and other activities. Therefore, the use of simulation of the enterprises, which requires taking into account the specific characteristics of production processes, is associated with the construction of many models and related software products. On the other hand, the development of universal models that cover different aspects of the activity relates to their dramatic complexity, increasing the complexity. Such models are difficult to adapt to new conditions.

One promising way for solving the problem of simulation, in our opinion, is to use abstraction in the developed models by which to achieve a high degree of typing in the description of different processes, while maintaining sufficient accuracy of calculations.

Abstraction in the simulation models - a technique which helps in typing in the description of the properties of objects, their relationships, structural features at each level of the hierarchy and the system as a whole in accordance with the intended purpose. By this substantial simplification of the model in describing the process is achieved while maintaining the principle of simulating of the main features of systems.

However, there are a number of questions. First, the concept of simulation is associated with the mapping of specific events, transactions, actions between objects, subsystems, etc., which occur in physical systems. It is known that the more accurately the real processes are displayed in the model, the better the results expected.

Application of the method of abstraction is the task of finding the model representations in systems with different sectoral focus, taking into account the hierarchical structures. To solve this problem it is necessary to perform analysis of different enterprises, as systems with different production processes. As a result of such analysis typical knowledge of the properties of objects in the systems, their interaction, description of the operations, events, etc. should appear. As the result there should be formed an abstract tool for simulation of various manufacturing companies.

In our opinion, the use of the term simulation modeling plays in some sense a negative role in the construction of abstract models. There comes a need to incorporate

in simulation models of the full range of properties, relations, specific to each physical system.

At the same time in the abstract models do not need to use the direct simulation of processes. Information flows, that largely determine the connection in the system, characterizing the time costs in the performance of manufacturing processes are simulated.

The question arises to what extent in the simulation models do we need to simulate the processes, relationships, events, etc. unique to the specific physical systems?

The answer to this question can be formulated as follows. Before we build simulation models of physical systems, it is necessary to identify the properties of physical objects and their relationships, structural and functional features that can be changed in the direction of simplification and typing, but at the same time provide a sufficiently accurate results of the calculations of the work required.

In principle, the use of the term simulation modeling could be discarded, replacing, for example, information, or perhaps an abstract modeling. However, this definition of the purpose of the simulation is lost.

In the abstract models we have to go to the various simplifications for typing processes. Simulating processes of real systems in the models can represent some abstract actions with abstract objects. They retain the properties of real processes for certain indicators (taking into account the hierarchical structures), but allow to type properties of models for a wide range of physical systems and to simplify the process of formation of models.

At the same time it is necessary to maintain compliance with specified performance of physical systems with computational results obtained by simulation modeling. This requirement makes it necessary to simulate the physical properties of production systems in abstract models. If the model does not reflect the properties of physical systems, it is difficult to talk about their adequacy. Therefore it is necessary to justify an imitation of action in models of real systems and to accept the legality of the use of the term "abstract simulation modeling".

In this article we attempt to show possible ways of development of abstract simulation models on the example of units of production enterprises.

As an example, production facility - a flexible manufacturing system (FMS), whose scheme is shown in Fig. 1.

In this scheme: RS - robot stacker, C, D- charging and discharging devices, Tel - trolley, A1, A2 - Units, H1, H2 ...- storage devices in front of each unit, IP - intermediate position.

Here multinomenclature processing of products is carried out.

A simplified version of the simulation model can be represented as follows.

Relationship of RS with Tel is via IP. IP may have one or more positions for the products. H1, H2 ... - may also have one or more positions. Waiting time of units depends on the number of positions in the IP and the H1, H2 Let's start with the analysis of the work of warehouse with RS. In the physical system is two objects with different functions. Warehouse consists of a number of cells in which the workpiece stored products, semi-finished products after pre-processing and finished products after final processing. Cells have identification numbers. Each cell receives the product. data

on numbers of cells must be in stock, numbers of products in different states, there must be regular communication with RS.

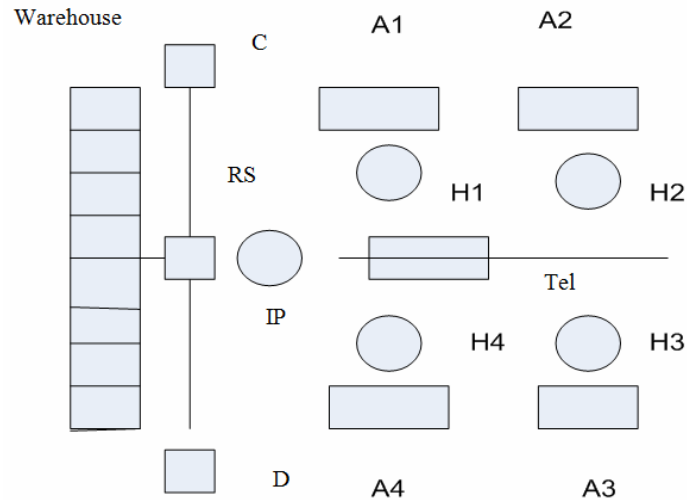


Fig.1 Scheme of the production site of FMS

Robot Stacker (RS) should store in the memory cell address, number of products in the cells, the cycles of operations for the collection and delivery of products in each cell and on the IP. RS communicates with a cart with IP, conveying relevant information to the IP on the product, the current execution time of the previous operation, the shipping address, etc. IP transmits this information further to Tel, Tel to the corresponding H1, H2 ... Then products get on the A1, A2, ..., where processing occurs sequentially on each A1, A2, ... in accordance with the technological route. Further in the same way products are returned to the warehouse.

In this model, the actual processes, relationships and the structure is fully simulated. Below is an example of constructing an abstract simulation model, in which, in our opinion, we can achieve significant simplification and, accordingly, reduce the complexity in its design. Due to what can be expected to lower labor in the abstract modeling?

To answer this question must be considered primarily a hierarchical construction of models of different systems. As has been substantiated [2], each system must distinguish the following levels: functional, structural, parametric and numerical.

At the functional level of physical systems, different functions are implemented in different ways and means. Different ways of implementing functions correspond to the information models of some computational operations. If physical systems, each way - a new approach to the implementation of functions, from the point of abstraction - a few sets of typical operations.

For example, in foundry, forging, mechanical shops of different ways of processing products used. But from the standpoint of modeling in each workshop we

need to perform sets of computing operations, which have no fundamental differences. We can say that each unit receives a request for information from the previous unit, performs some computational operations, and reports the obtained results to the following units.

With regard to the structural level, the situation is much more complicated. First, the structure found in a variety of physical systems that determine the diversity of their properties and models. Secondly, the properties of objects in the systems, the nature of their relationship is a great variety. And if you do not take any measures to their ordering at the structural level, the parametric and numerical levels, this diversity will increase sharply.

The choice patterns are influenced by the following factors: technological and design features of the processed products and the number of items, the complexity of the processing routes and their similarities to each other, the presence of feedbacks in the routes, the cycle time of processing of products in the workplace, etc.

In analyzing the various structures was possible to establish the following:

- Various schemes of technological routes of processing of products can be represented as a sequence of related objects. If objects on the route are repeated (there are feedbacks), they represent a new facility, preserving identity. Temporary operation of these facilities are carried out taking into account predetermined sequence (according to the technological route), without temporal overlap each other.

- Then the presence of parallel connections between the objects can be converted into equivalent serial connection. In more complex cases (parallel-sequential, feedback, etc.) they can also be converted into serial connection;

- All objects in the models perform the same operation: the transfer request prior to the object, obtaining information from the previous facility, the transformation and storage of required information requests received from the subsequent object if there are multiple requests - to select the object with a minimum of the current time, transfer information for the object. An analysis of the different objects it turns out that such a sequence of actions will be a model for different objects; is applies not only objects on the sites but also sites in the shops and workshops in the enterprise;

- Start in the processing of products (the receipt and issue) it is advisable to carry out the parties in the sequence defined schedule. Scheduling, in our opinion, you can perform a similar procedure. Quantity of products simultaneously in stock, is determined by storage capacity. The priority for the next launch details of RS is the current execution time of the previous operation of any details;

- Priority of products moving from position to position is determined by the current time, the appropriate implementation of the previous operation. This current time is transferred from object to object (including the products to the object and back), and it monitored time spent by each unit (operating, support, downtime due to failures and because of other objects, etc.). This information is stored in the facilities and then passed to the database.

Significant simplification of the model work units can be achieved through consolidation of functions in different locations. The idea is that operations are carried out in models of information flows, rather than with real objects, as in the physical system. And to keep track of time spent we do not always need to have full information

about the objects and operations in real systems. Simply select the amount of information needed to solve the problem.

Consider the concrete possibilities of abstraction of operations from the work area (Fig. 1).

Instead of two storage facilities, and RS (Fig. 2.1). you can leave only one object - RS, presenting it as a set of moving pieces (Fig. 2.2).

It may be several parties in the blank depending on the actual capacity of the warehouse. In the RS it does not make sense to enter the cell, to identify them, track the status of cells at each time. Just control over the flow of information about the details of a given sequence, its transfer to other facilities site and return after the execution of operations on other objects. Thus decreasing the number of existing objects (instead of two - one), the cells are removed from the warehouse identification and monitoring of their condition. Instead, the operation of transportation procurement at the IP takes place in a model of information transfer to the next object.

Similarly, you can leave one object - Tel. 2, instead of the IP and Tel 1 introduced it as a set of a certain number of positions for work pieces (Fig. 3.1. and 3.2.). Tel abstract object, which does not correspond to properties of a real object, is introduced from the standpoint of a physical system. However, the idea of bodies in the form of several positions makes it possible to simulate the features of transport operations in the physical system.

Selecting multiple items instead of one can be explained by the desire to reduce the time spent on downtime when performing transport operations. The more positions, the less chance of downtime. However, one should bear in mind the rising cost of Tel.

As seen in Figure 1. Tel services units A1, A2 .. across storage devices H1, H2. For Tel it is a complicated case of interaction of objects. On the one hand, there is a gradual transition of products from one unit to another in accordance with the route processing (the presence of feedback conventionally not considered). On the other hand, Tel services units in parallel mode. When you receive information from several units Tel selects the next unit to serve on some priorities. This priority may be the current time of the operation on a particular unit. The earlier the unit has finished the operation, the higher the priority for his services. This property is not necessary to other sites, although necessary at the site could be two RS with the same functions or to appear more structural complexity. In any case, it makes sense to attribute to each object property can choose another site for collaboration on priority. This unification is achieved in describing the operations of the various objects.

As for A1, A2, .. with H1, H2 .., then each unit with a storage device can be a single object in the form of different sets of positions. Number of positions for each unit is determined by the calculated value of the capacity storage devices (fig. 4.1. and 4.2.).

The scheme presented unit A1 from storage devices in the form of rotating machinery. During processing, the details D1 Tel truck can pick up the finished parts and load the next work piece. What has for the operation of bodies will reserve the time corresponding to the processing time details on A1. Depending on the ratio of time Tel and aggregates the estimated number of positions in the storage ring will be different. Definite effect on the number of positions will provide the reliability of equipment.

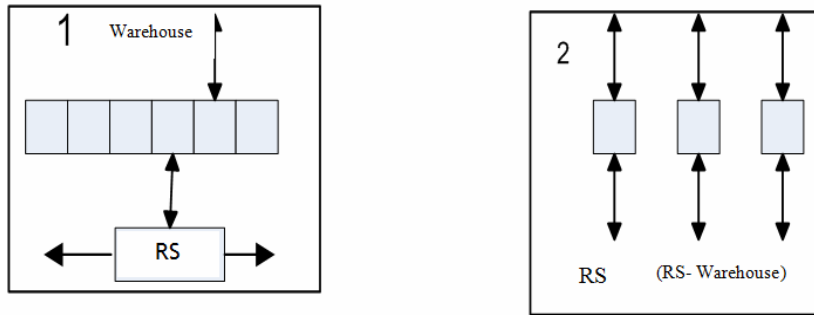


Fig. 2 Scheme of the "Warehouse" - RS- 1 and the equivalent circuit of the "RS"- 2



Fig. 3. Scheme of work "IP - Tel- 1 and the equivalent circuit of the "RS"- 2

In the equivalent circuit features of an operation are the following.

Each of the identical position works independently, but consistently. If you are running one position (is processing information), the second position can not work. However, at this time to the second position may be filed next billet, which is awaiting its turn for processing. From the point of view of time expenses submitted two schemes in Fig. 4.1. and 4.2. are equivalent. However, the algorithm works on the second scheme is much simpler. Moreover, all objects in the area are of similar schemes.

It may be noted another peculiarity of the facilities at the site. The time spent on the transformation of information in the RS, - is a real time system for transportation of parts from a warehouse in the IP and vice versa. A similar operation in Tel - is the transportation of parts from the IP to the unit and back. Transformation of information in units - is conditional on the transfer time of parts of the unit to Tel and vice versa. In this line of argument is the deviation of model types from the actual amount of time, i.e. there is no complete simulation process. However, this convention does not affect the calculation of actual time spent. On the other hand, the logical sequence is obtained when performing the same operations on different objects. This standardization of processes in the interaction of different objects is achieved.

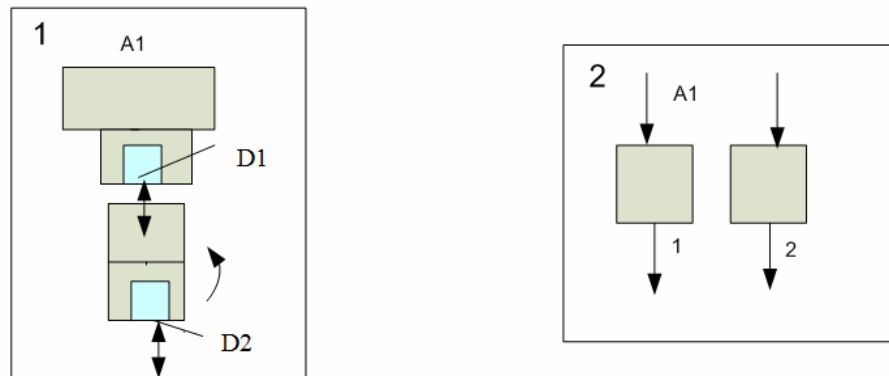


Fig. 4. Scheme of work unit A1 and storage devices and equivalent circuit of A1 (2)

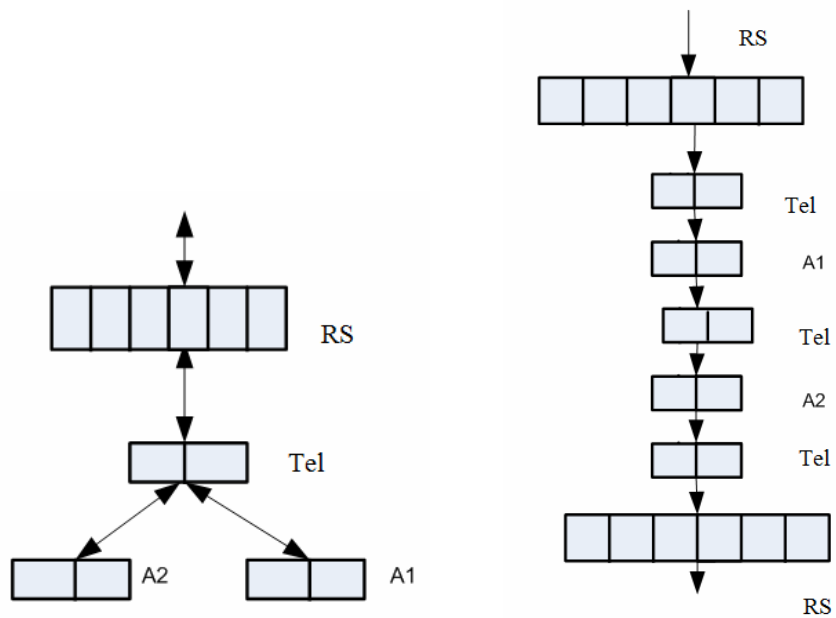


Fig. 5. Abstract scheme

Fig. 6. Scheme of interaction of objects in the area in the form of successive bonds

The cycle time implementation of these operations RS, Tel, aggregates is determined with the help of cyclograms of these objects. For RS- a cycle of loading and execution handling operations with a warehouse and transportation of goods from a warehouse in the IP and vice versa, for bodies - is a cycle of traffic between the IP and

aggregates. This Phone selects priority areas of transportation products. For units - a cycle of processing parts. For all objects recorded time to recover after failure.

Full equivalences scheme is shown in Fig. 5. Number of positions in objects, RS, Tel, A1, A2, may be different, and the number of the objects themselves may also be different.

However, sets of operations are similar to those sites.

CONCLUSIONS

Thus, the scheme of interaction of objects in the area (Fig. 6.) is an example of abstract simulation models. This scheme can simulate the work of production departments and enterprises of different sectoral focus. Templates relationships of objects and standard algorithms of their work remain. Number of objects in successive chains may be different; the number of chains in the units may also differ. But the templates are stored and suggest that the complexity and, consequently, the cash cost of construction of models and related software products will be significantly reduced.

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ИМИТАЦИОННЫЕ АБСТРАКТНЫЕ МОДЕЛИ ПРОИЗВОДСТВЕННЫХ СИСТЕМ

Коробецкий Ю.П., Соколова Я.В., Дорошко В.В.

Аннотация. Впервые предложен термин «имитационное абстрактное моделирование», обоснована правомерность и необходимость его использования. Показаны пути разработки имитационных абстрактных моделей на примере подразделений производственных предприятий.

Ключевые слова: имитационная модель, абстрактное имитационное моделирование, гибкая производственная система.