ACCOUNTING AND FINANCE

INSTRUMENTS OF ANALYSIS AND MODELLING OF THE PRODUCTION SYSTEMS

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Abstract: *The diversity of products and by-products, which may be launched in production in different successions, the practically endless possibilities to divide up the orders, the diversity of machines and equipment, the complexity of some of the technological processes, the great number of involved resources, all these lead to a great number of possible varieties and to the difficulty to model the phenomena. The projection of modern production systems must ensure an integrated modelling and efficient methods of evaluation. In order to ensure the adequate modelling of the needs of complex systems, discrete models were conceived, among which an important part have as their basis the Petri nets.*
Keyword: *resources, production systems, Petri nets*

Introduction

The complexity of issues relative to operative production planning created the necessity to appeal to their economic and mathematical modelling, as the single instrument able to create optimum or suboptimal solutions [1]. [4].

The fundamental objective of the production operational management is to fulfill the plans of physical production from the point of view of delivery terms, quantities and contracted structures on assortments. Thus, the objective function of the general model of the process of production operational management may be defined [2], [5]:

$$\min F = \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{p} C_{ij}^{k} P_i T_i \,,$$

where: C_{ij}^{k} quantity of products i, planned with priority j in period k;

P_i price of product i;

T_i penalty for failure to obey contractual clauses;

p is the number of periods,

m is the number of priorities,

n is the number of products.

The successive method used to combine the technological operations has the advantage of ensuring the continuous functioning of machines and jobs during the whole period of time the batch of parts is processed, and it has as a disadvantage the long operational cycle due to the waiting for parts to each operation (till the whole batch is processed at that operation) [2].

The projection of modern production systems must ensure an integrated modelling and efficient methods of evaluation. In order to ensure the adequate modelling of the needs of complex systems, discrete models were conceived, among which an important part have as their basis the Petri nets.

Petri nets are *bipartite graphs* which offer an elegant and rigorous modelling framework from the mathematical point of view of dynamic systems with discrete events [4],[5].

Petri nets have three fundamental advantages:

- *simplicity* (it appeals to a reduced number of basic concepts, but which may be combined in a great variety);
- *generality* (different types of semantics may be relatively easily associated to them: sequences of finite or infinite transitions, sequences of multitutes of transitions, traces, processes);
- *adaptability* (small changes in the classic model of Petri nets lead to special models which may surprise aspects such as: temporisation, probability and uncertainty able to make them useful for sectors as varied as possible).

Modelling of production systems

The production systems without continuous states or in transition may be described as systems with discrete events, where a modality is that with Petri nets. In the case of modelling and analysis of these systems, Stochastic Petri nets are an extension of Petri nets which present a large area use in production.

The corectness of the state of the modelled system may be checked through the techniques of the qualitative analysis as well as through the techniques of quantitative analysis. The quantitative properties are derived from the digital simulation and analysis, and it shows the performances and dependences of the analysed system. The projection of the process is more secure through the analysis and evaluation of the properties of the system. The optimization is possible through the evaluation and comparison of the evolution with instruments specific to different varieties of the model [6].

In [3] (MOSYS) the system of production is described by the functional specifications of the behaviour, tabular plans and, optionally, schematic descriptions. The functional specifications models the flow of material and the stages of production. The structural restrictions associated to different steps of production cannot be modelled graphically. There is this kind of situations when a machine uses more than a work plan.

In [4] (GRAMAN) there are offered separate modellings of the production path and the structure of the production system. The structure of the system is specified with default construction blocks.

From the architectural point of view, a production system is structured on three levels, namely [6]:

- The general structure of the system, which specifies the physical constitutive parts;
- The work plan, which describes the work flow;
- The control system, which implements a policy to strengthen the bahavioural conditions (for example, to avoid jams).

The modelling technique of the production systems uses [6], [7]:

a) Basic blocks, which represents: process, buffer zone, transport, entrance, exit.

b) A collection of standard modules of Petri nets, as for example, machines, components of the means of transportation, storage components.

c) A standard collection of operators of Petri nets, which has as a goal to generalize the relationships between the components of a production system. From these operators we mention Single Synchronization, Multiple Synchronization, Then, ThenAnd, Join etc.

In the structural model the connection/link arcs describe the resources of the production system and the possible flow of materials. The horizontal lines in the interior of symbols separate the structural information from the functional information of the model. The name of the resources is written in the symbol above the line. In order to avoid confusions, it is not advisable to have several resources with the same name.

The interior of the graphic symbols contains the resources described by their names from the structural model. The name of the processing phases may be found under the line. From the graphic description it may be deducted *what* and *where* is realized in the processing phases [7].

The arcs between the graphic elements describe the order in which are executed the processing phases. Each arc is labelled with what must be manufactured and the current status. It is not allowed more than one successor in a model for the work plan. The options between two or several different parts of the work plan are exceptions. These are modelled through the block that contains the question sign.

The basic blocks make possible the representation of the elements of the production systems and their functionality. In [56] there are used additionally symbols for test, assembly and disassembly operations. The assembly and disassembly operations are special cases which also may be modelled at their turn.

In [3] (MOSYS), it is considered a separate modelling of the structure of the production system and the work plans. Both parts of the model use the same construction blocks. At the opposite pole, in [4] (GRAMAN) there are used different forms of modelling for the structure of the production system (construction blocks) and the production programs (Petri nets).

Moreover, in the case of the structural model of the production system, the phases of production must be specified in a work plan (it describes the sequences and attributes of all necessary phases of production) for each part.

Further information regarding the way of realization are given by the atrributes of the elements in the model. To be remembered that the attributes of the work plan describe the current phase of production [6], [7].

Conclusion

By using Petri nets other symbols with special function may be easily added, if necessary. To each current basic block several attributes correspond. An attribute, like a variable in the programming language, is given by a name, type and value [7].

References

Boldur, Gh., Stoica, M.,Ciobanu, Gh.,(1974) – *”Programarea operativă a producţiei în intreprinderi industriale”,* Studii şi cercetări de calcul economic şi cibernetic.

Moldoveanu, G., (1999) – *”Managementul operaţional al producţiei”*, Editura Economică, Bucureşti.

Spur, K., Mertins, K., Wieneke-Toutaoui, B., Rabe, M., (1989)– *“MOSYS-a planning system for manufacturing and assembly planning”*, Simulation in Manufacturing 5, Bedford,, IFS.

Teodorescu, N., Boldur, Gh., Stoica, M., Stancu-Minasian, M. I., Băncilă, I., (1972) – *”Metode ale cercetării operaţionale în gestiunea întreprinderilor”*, Editura Tehnică, Bucureşti.

Unguru, I., (1998) – *”Managementul producţiei întreprinderii”*, Editura Lumina Lex, Bucureşti.

Vittorini, V., Basile, F., Chiacchio, P., Mazzocca, N., (2004) – *”Modeling and logic controller specification of flexible manufacturing systems using behavioral traces and Petri net building blocks”*, Journal of Intelligent Manufacturing, Springer Netherlands, 351-371.

Zhou, M. C., DiCesare, F., Rudolph, D. L., (1992) – *“Design and Implementation of a Petri nets based supervisor for a flexible manufacturing system”*, Automatica, vol 28, no 6, 1199-1208, Pergamon Press Ltd.

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