Journal of Siberian Federal University. Humanities & Social Sciences 1 (2013 6) 85-92
~ ~ ~

УДК 391.7

Application of Simulation for Processes of Planning and Management at the Industrial Enterprise

Olga I. Babina* and Leonid I. Mochkovich
Siberian Federal University
79 Svobodny, Krasnoyarsk, 660041 Russia [1]

Received 09.01.2013, received in revised form 16.01.2013, accepted 23.01.2013

In the paper possibilities of use of a method of simulation for the analysis of administrative processes and planning of the industrial enterprise are analyzed. The variant of simulation model classification of an industrial enterprise is offered. The present paper represents the analysis of materials of researches on application of a method of simulation in business management and planning.

Keywords: simulation, modeling, model, paradigm, simulation software, classification, industrial enterprise, planning, management.

Introduction

Timely and coordinated decision-making on enterprise with regard to changes in economic environment is one of the main challenges in modern industrial management. Today more strict demands related to complication and enhancement of technological and administrative processes owing to what preparation and acceptance of administrative decisions that becomes a more complicated task are made to management and planning by the enterprise. The growing number of the considered alternatives which analysis requires computer decision-making support has been observed (Aristov, 2007).

All these asks for a requirement of extending an area of application of the models which belong to the class of the simulation models. The method of simulation is one of the most accurate and authentic administrative processes in the analysis at the industrial enterprise as in case of model creation it allows to consider operating conditions of real production to its maximum level, i.e. to provide a required level of adequacy of the model displaying specific object of research. The application of this method provides for new possibilities for enhancement of decision-making processes, improving of economic indexes of the enterprise and risk reduction at administrative decisions making.

In present time simulation is the conventional method of research of difficult dynamic systems. It is widely applied not only to the analysis of administrative processes and planning at the enterprise, but also in various areas of science and business. Regular of conferences advocate the activity of this research direction in the countries of Western Europe and the USA (e.g., Winter Simulation Conference, Summer Computer

* Corresponding author E-mail address: babina62@yahoo.com

Simulation Conference, Spring Simulation Multiconference, INFORMS Annual Meeting, International System Dynamics Conference, etc.), symposiums (e.g, Communications and Networking Simulation Symposium, Symposium on Theory of Modeling and Simulation, Military Modeling and Simulation Symposium, etc.), the congresses (EUROSIM Congress, etc.), continuously increasing number of publications, numerous international research projects and communities of simulation modeling (The Society of Modeling and Simulation International, Federal European Simulation Societies and many other), a set of specialized scientific magazines («Simulation», «Simulation: Transactions of the Society for Modeling and Simulation International», «International Journal of Simulation and Process Modeling», etc.).

Simulation in management of an industrial enterprise

The principal scope of simulation is production. The overwhelming majority of simulation models are created at design of new or reconstruction of existing production systems (Tolujew, 2002). Main objectives that an expert in simulation usually pursues when carrying out research of such systems is the analysis of the production schedule and material flows, along with identifying and eliminating the «bottlenecks» in the organization technological and productions (Averill and McComas, 1998).

Thus, the simulation model at some industrial enterprise is the computer software which allows to study the process of functioning of such system by carrying out a computer-based experiments and, therefore, can be read by the virtual version of this enterprise.

For any industrial enterprise it is impossible to develop a universal simulation model, allowing to describe all its fields of activity because of a vast span, complexity and unformalizability of a part of administrative processes. Therefore the most expedient approach to the industrial enterprise is to create a sophisticated simulation models with use of simulation software.

The simulation model is a customized product for each process, and any changes to any part of the model can lead to dramatic changes of the entire model. The simulation model of any object has to be an exact copy of this object, or display some specific characteristic of the object in the abstract format.

Let us define the main activities of the industrial enterprise to which the method of simulation can be effectively applied:

- Simulation of production, design and reengineering.
- Simulation of planning at the enterprise (strategic, tactical, operational), decision-making and monitoring.
- Simulation of marketing processes at the enterprise.
- Simulation of enterprise interactions with the external environment.
- Simulation of financial processes at the enterprise.
- Simulation of personal actions at the enterprise.

It should be noted that the boundaries of application of simulation for the industrial enterprise for the present have not been finalized: at the present day this method has developing, in this connection new areas of its application arise.

Simulation of planning processes at the industrial enterprise

Simulation represents an effective method for task solving, that encompassed all levels of planning – from strategic to operational and production scheduling (see Fig. 1). In planning the term «simulation» is interpreted as modeling a real production and economic situation and

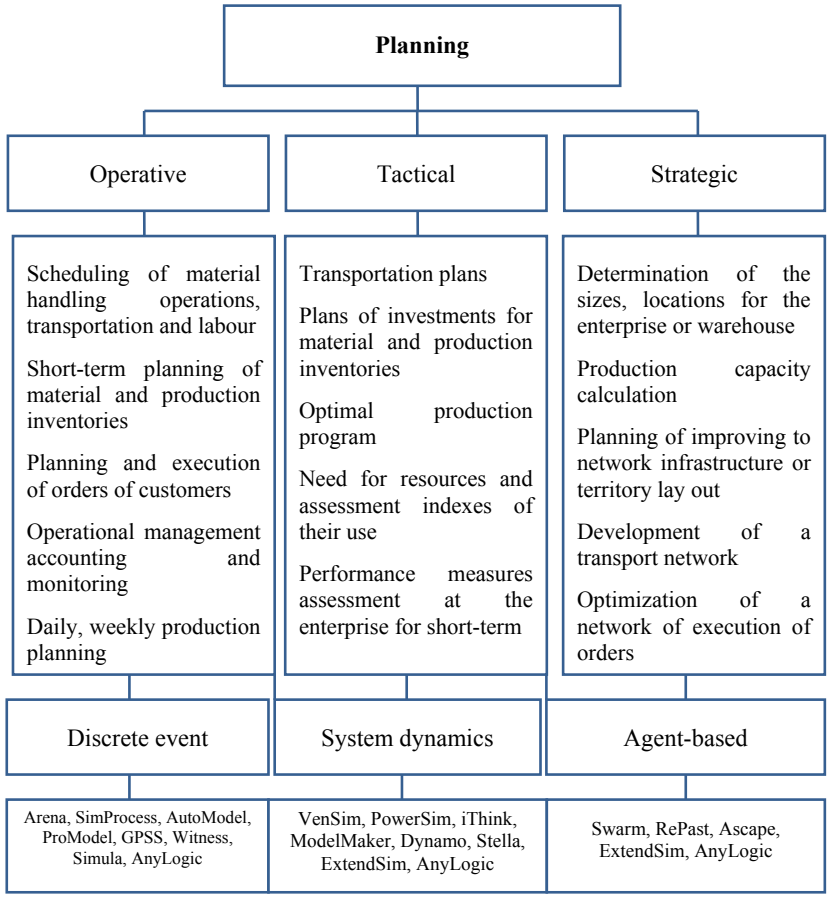

Fig. 1. Planning of activities of the industrial enterprise

experimenting with this model for the purpose of coming up with a ground for the plan decision (Ilyin, 2004).

Simulation is applied for planning of assembly operations, the organization of repair of the equipment, operation of service stations, the analysis of processes of relocation of loads, research of productivity of use of the equipment, a timeliness assessment service of orders, in case of control of technological processes, design of a new production section, determination of number of workers on a production section, etc.

Simulation of planning processes at the industrial enterprise allows test processes at the enterprise in case of shortage of its resources that gives the chance to avoid possible risks (consequences) in case of unsuccessful experiment. Besides, simulation approximation allows to test the selected option without a necessity of carrying out real experiments with the enterprise, and also provides the multiple analysis of alternate strategy of control that facilitates decision-making process, and allows to reveal bottlenecks in organization and administrative structure of the enterprise (Sterman, 2000).

As it is clear from the figure 1, there are some paradigms (approaches) to design of the simulation models displaying processes in such systems: systems dynamics according to Forrester, discrete event simulation and agent-based (Karpov, 2008). Each of these paradigms

is applied and promoted by the specialists of different schools. Besides, they correspond to the different abstraction layers in case of model creation that causes application of this or that approach. The informative review of the modern paradigms in simulation can be found in papers (Borschev, 2004; Karpov, 2008; Sidorenko and Krasnoselsky, 2008).

The wide development of simulation as means of the analysis entailed a row appearance by simulation software, simulation models of industrial enterprise specially intended for creation both multipurpose, and specialized on industries. These systems of simulation considerably facilitate process of model design v.s. the universal programming languages. Thus, for creation of simulation models of industrial enterprise, except an approach, it is necessary to select simulation software, corresponding to the task of development of a simulation model of industrial enterprise.

The most widespread software products based on the concepts of discrete event simulation are Arena, ExtendSim, AutoMod, ProModel, GPSS, WITNESS, SIMUL8, QUEST, Anylogic, Enterprise Dynamics, Plant Simulation, and on a method of systems dynamics – Vensim, iThink, ModelMaker, STELLA, Powersim and AnyLogic are. The most known systems of agent-based simulation are AnyLogic, Swarm, RePast and Ascape. In a pattern of dynamic systems MatLab, LabView, VisSim and Easy5 prevail. A relevant review of the modern approaches on simulation software in operation is provided in the paper (Lychkina, 2000).

In case of operational planning task-solving, a discrete event paradigm of simulation is generally applied; tactical – discrete event simulation and systems dynamics; strategic – systems dynamics and agent-based simulation. The choice of a paradigm of simulation automatically causes also a choice of simulation software.

So, the simulation of processes of planning at the industrial enterprise with the use simulation software is an effective remedy for study of their functional structure, that allows to optimize the strategy of development, to enhance methods of planning and control and to increase performance efficiency of the enterprise as a whole.

Classification of simulation models of an industrial enterprise

Simulation models in general and simulation models of an industrial enterprise in particular can be classified in various ways. For example, in R. Shennon's classical paper (Shennon, 1978) devoted to simulation classification of basic types of simulation models is given. The following typical groups of models are specified:

- Static and Dynamic.
- Determined and Stochastic.
- Discrete and Continuous.

Classification of simulation models (Baldin and Utkin, 2008) is offered based on the way of system time management (the mechanism of system time).

According to the experiment purpose the following simulation models were determined (Hudjakova and Lipatov, 2006):

- Estimation of factors influence on a productive indicator.
- Estimation of mutual influence of factors.
- Optimizing experiment.

Descriptions of these typical groups are considered in the References below (Shennon, 1978; Hudjakova and Lipatov, 2006; Baldin and Utkin, 2008). It is necessary to notice that simulation models of an industrial enterprise can be classified based on the same characteristics.

Besides, the simulation models of the industrial enterprise can be classified by the following characters:

- Modeling paradigm.

- Abstraction level.
- Modeled activity spheres of an enterprise.
- Adequacy degrees of model.
- Environment relation.
- Planning period.
- Operation mode.
- Character of research.
- Use scenario.
- Enterprise type.

According to the applied paradigm of modeling, simulation models are classified as:

- System dynamics.
- Discrete event.
- Agent-based.
- Dynamic systems.

As for the abstraction level, simulation models can be divided into:

- High level.
- Average level.
- Low level.

The abstraction level is a level by which it is possible to define what is important and what is not in the course of modeling. At the low level the behavior of separate objects is modeled. The high abstraction level does not deal with individual objects in itself, as a rule, but only with their quantities and aggregated indicators.

As it has already been noted earlier, the simulation models are usually built only for one or several kinds of processes that were selected. Depending on the choice the simulation models of the industrial enterprise can be classified according to the spheres of activity:

- Production, designing and reengineering.
- Planning processes at the enterprise (strategic, tactical, operative).
- Decision-making processes and control.
- Marketing processes at the enterprise.
- Interaction processes of the enterprise with an environment.
- Financial processes at the enterprise.

As for the adequacy degree, models are subdivided into:

- Full models when the model is fully adequate to the studied object of modeling (for simpler systems).
- Approximation models when a model does not reflect some aspects of functioning of the modeled object that is characteristic of the majority of models.

In relation to environment simulation models of the industrial enterprise are subdivided into:

- Internal enterprises describing the structural and functional organization of the enterprise.
- External enterprises describing interaction with external (in relation to the enterprise) environment.

Simulation models can be classified also based on the planning period into:

- Long-term.
- Intermediate term.
- Short-term.

Based on an operating mode simulation models are subdivided into:

- Interactive mode at which a user operates modeling time, by changing the entrance data at each stage.
- Non-interactive (package) mode where the initial data are fixed throughout simulation, and advancement and the trainee is just user.

By the character of research simulation models of the industrial enterprise are subdivided into:

- Theoretical are the models designed for theoretical study of processes of functioning and management of the industrial enterprise aimed at understanding and studying the general tendencies of development and enterprise functioning.

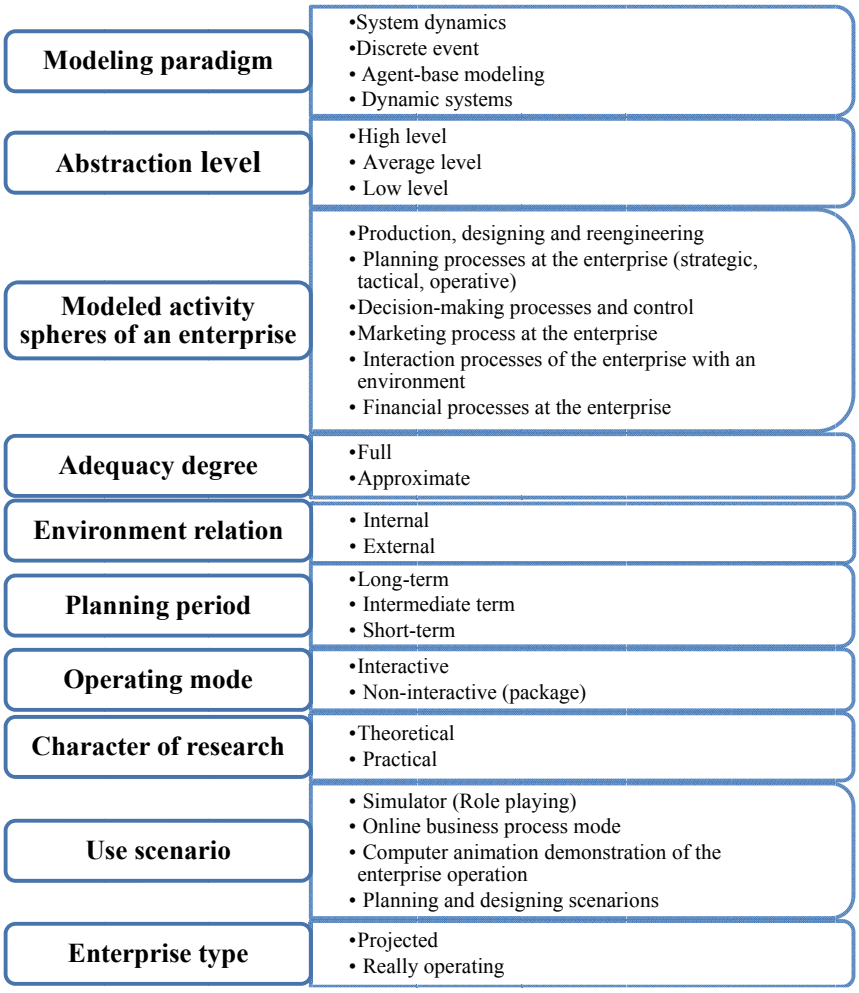

Fig. 2. Variant of classification of simulation models of an industrial enterprise

- Practical are the models intended for practical (real)use, which data can be used for cardinal changes of functioning and management of the industrial enterprise.

Under use scenario simulation models in management practice are divided into:

- Simulator (Role playing).
- Online business process mode.
- Computer animated demonstration of the enterprise operation.
- Planning and designing scenarios.

It is necessary to notice that development of the simulation models assumes teamwork of a customer with the developer of the model in which result interests of both parties are reached, but for this purpose both the developer and the customer are to understand exactly to what they aspire and what finally they want to receive from such cooperation.

The last one from considered points of classification is an enterprise type. By this character, simulation models can be classified as:

- Projected.
- Really operating.

An author's variant of classification of simulation models of the industrial enterprise, based on various classification characters is presented in Fig. 2.

The suggested classification of simulation models of an industrial enterprise allows to group the available simulation models and to allocate certain categories which are characteristic by a number of general properties, according to an accepted method of classification. Besides, the classification allows to chose a suitable model taking into account certain characters and orientation to the task in view of modeling of the chosen methods of division, and also helps to get oriented in the variety of simulation models of the industrial enterprise.

Summary

In the article possibilities of use of a method of simulation for administrative processes and planning of the industrial enterprise are analyzed. The method of simulation allows to describe and investigate complex production systems subject to heterogeneous risk factors and influence of many arbitrary random factors, provides the multiple analysis of alternate strategy of control that facilitates decision-making process, and allows to reveal bottlenecks in organization and administrative structure of the enterprise.

Implementation of simulation in management and planning system the industrial enterprise facilitates optimization of strategic, tactical and operational and functional options of effective functioning and maximize the level of economic stability (Bayramukova, 2008).

References

1. Aristov, S.A. (2007). Simulation decision support systems. Economy and mathematical methods, 3 (43), 74–84.
2. Averill, M. Law & McComas, G. Michael. (1998). Simulation of manufacturing system. Proceedings of the 1998 Winter Simulation Conference, pp. 49–52.
3. Baldin, K.V. & Utkin, V.B. Informatsionnie tekhnologii v ekonomii [Information systems in economy]. Moscow, Publishing-trading corporation «Dashkov and Ko», 2008, 395 p.
4. Bayramukova E.I. (2008). Use of methods of simulation modeling in case of an assessment of risks and a control process optimization at the industrial enterprises, Economy and the right, 12 (85), 315–320.
5. Borschev, A. (2004). Practical agent-based simulation and its place in an arsenal of the analyst. Exponenta PRO, 3–4 (7–8).
6. Hudjakova, E.V. & Lipatov, A.A. Imitatsionnoe modelirovanie ekonomicheskikh protsessov v agrarnikh i promishlennikh kompleksah [Simulation of economic processes in agrarian and industrial complex] Moscow, Publishing center MSAU, 2006, 186 p.
7. Ilyin, A.I. Planirovanie predpriiatiia [Planning at the enterprise: textbook]. Moscow, New knowledge, 2004, 635 p.
8. Karpov, Yu.G. Isuchenie sovremennykh paradigm imitatsionnogo modelirovaniia v programmnoi srede AnyLogic [Study of the modern paradigms of simulation in the software of AnyLogic]. Computer tools in education, 4, 2008, 3–14.
9. Lychkina, N.N. (2000). Modern technologies of simulation and their application in information business systems. Banking technologies, 9, 15–24.
10. Shennon, R.D. Simulation of systems – an art and a science, Moscow, World, 1978. 418 p.
11. Sidorenko, V.N. & Krasnoselsky, A.V. (2008). Simulation in science and business: approaches, tools, application. Business informatics, 2, 52–57.

12. Sterman, J. Business Dynamics: Systems Thinking and Modeling for a Complex World, Irwin/ McGraw-Hill, 2000. 450 p.
13. Tolujew, Y.I. Zapiski semuliatsionista liubiashchego i uvazaiushego GPSS [Notes of the simulation person loving and respecting by GPSS]. Pervaia vserossiiskaya konferentsiia po imitatsionnomu modelirovaniiu I ego prilozheniyakh v nauke i promiyshlennosti "Imitatsionnoe modelirovanie. Teoriya I praktika" (Proc. 1st All-Russia scientific and practical conference on simulation and its application in science and the industry "Simulation. Theory and practice"). St. Petersburg. 2002.

Применение имитационного моделирования для поддержки процессов планирования и управления на промышленном предприятии

О.И. Бабина, Л.И. Мошкович
Сибирский федеральный университет
Россия 660041, Красноярск, пр. Свободный, 79

В статье анализируются возможности использования метода имитационного моделирования для анализа процессов управления и планирования промышленного предприятия. Приводится вариант классификации имитационных моделей промышленного предприятия. Настоящая статья представляет анализ материалов исследований по применению метода имитационного моделирования в управлении и планировании предприятием.

Ключевые слова: имитационное моделирование, моделирование, модель, парадигма, программное обеспечение для имитации, классификация, промышленное предприятие, планирование, управление.