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# About Perspectives Of Simulation Technological Processes Functioning With Using System-Object Approach Node-Function-Object

**Alexander G. Zhikharev, Sergey I. Matorin, Natalia O. Zaitseva,**

*Evgeniy M. Mamatov, Roman P. Gachov*
*«Belgorod State University»*
*Russia, 308015, s. Belgorod, Pobedy st., 85*

**Abstract**

In the article the new formal description of system as the triune element consisting of a node, function and object is considered. It allows to consider the model of system in terms of NFO approach as imitative.

**Keywords:** systems approach "Node-Function-Object", graphic-analytical simulation, calculation of processes, theory of objects, the formal representation of system.

## Introduction

As experts say, it is easier to create difficult system, than to analyze it and understand how it works. Concerning this fact, one of the main directions of research and design of difficult systems in different applied areas is use of simulation modeling. It is determined, first and foremost, by permanent extension of area of simulation modeling applications, principally at the expense of such directions as business processes, marketing, logistics, control of finance, social and economic processes, etc. Secondly, by the extension of the informal framework, accepted in the appropriate modeling languages, with classical models of operations analysis and calculus mathematics. Thirdly, by raising a technological effectiveness level of simulated systems with the use of visualization tools, animation tools and also CASE - technology. What is more, intellectual vested interest states: administrative processes and workflow for dynamic systems management must be accompanied by the simulation modeling from the inception phase of their formation, development and deployment [1].

Up to date languages and instruments of simulation modeling gained momentum in the form of visual modeling aids, where the researcher operates not with commands and operators of language, but the objects presented in the graphic form.

Visual modeling aids partially erase a problem of simulation modeling languages, but, at the same time basic ones from them remain, for example, mastering by the researcher the abstract terms used in these means. Visualization of simulation models creation process and also visual representations of simulation results are very important tasks, because the presence of convenient interactive tools for models creation makes the simulation modeling user-friendly and consequently competitive. The majority of the existing systems of simulation modeling possess interactive instruments of models construction, with the result that the user at the output receives a visual model of some process which reflects the progress of its execution or existence.

There are numerous examples of known program systems of simulation modeling, confirming the specified tendency, such as: Actor Pilgrim, RDO, SIMPAS, Process Charter-l.0.2, Powersim-2.01, Ithink-3.0.61, Extend+BPR-3.1, ReThink, GPSS World, AnyLogic, ARIS, Micro Saint, Arena, AutoMod, WITNESS, ProModel и т.д.

The existence of a big set of the program systems of simulation modeling based on various theories and approaches, in turn, testifies the existence of still unresolved problems in the sphere of simulation modeling, what expresses, in particular, in complexity of an adequate assessment of the modeled system description and the interpretation of results.

Last-mentioned allows to speak about the relevance of researches in this sphere, and, first of all, from the point of view of the solution of the task of computer visual (graphic-analytical) models conversion into simulation models.

We will consider the version of the formal description of system using the theory of objects [2-6] allowing to transform the static description of system into a simulation model with possibility of research of system behavior in different environmental conditions.

## Main part

The research, being carried out by the authors, is based on the original system(system-object) approach «Node – Function - Object» (NFO-approach: http://ru.wikipedia.org/wiki/Узел-Функция-Объект) [7, 8]. The method and algorithm of systems analysis named for brevity sake NFO analysis is a development and formalization of NFO approach. For the purposes of automation of NFO analysis exploitation the NFO-toolkit CASE - software tool was designed and realized (the certificate of Russian Agency for Patents and Trademarks No. 2006612046, http://www .ufo-toolkit.ru).

This instrumentation is knowledge-oriented CASE software tool of support the processes of system-object visual graphic-analytical simulation and the analysis.

It provides the representation of any system in the form of three-element construction of "Node-Function-Object", i.e. in the form of an NFO- element. Thus "Node" is a cross point of input and output connections (flows) in structure of the developed system, "Function" – the process of conversion of an input to an output, i.e. the process providing balance of the "inflowing" and "following" flows in node connectivity, "Object" – the substance realizing this function in this node [9].

The NFO elements, arranged in different configurations, form the interaction diagrams of elements which allow to visualize the functionality of system elements of higher levels. Thus, the developed system is represented in the form of hierarchy of an NFO elements. This representation allows to consider different aspects of reviewing of this system (structural, functional, substantive) in one system object model – NFO model.

The hierarchy of an NFO elements and their configurations which UFO-toolkit supports, is based on classification of connections (flows) intersections of which form the nodes. Simulation of any system begins with the specialization of basic classification of connections under specific data domain. The abstract class "Connection (L)" in basic classification of connections is shared on subclasses "The material connection (M)" and "Information connection (I)"; the class of the material connections shares on subclasses "Material connection (S)" and "Energetic connection (E)", a class of information connections – on subclasses "Connection on data (D)" and "The controlling connection (C)".

NFO-elements can be stored in special NFO-libraries for support of component approach to simulation of systems. Libraries represent conceptual models of the appropriate areas or business branches in which their structural, functional and substantive characteristics are stored. Herewith libraries may contain not only single NFO elements, but also their hierarchies that allows to reuse ready subsystems and systems. Consequently NFO library represents the knowledge base of a special configuration in which the NFO elements corresponding to certain classes of systems are stored.

Systems are classified depending on types of input and output connections. The following types of input connections are considered: manufacturing, providing (material, energetic and informing), managing – and the following types of output connections: product, information, waste. It allows to select the following classes of organizational systems: manufacturing, transport and distributive, – for each three subclasses are considered: "substances", "energies" and "information".

NFO-element represents the three-level description of system which seize the system structure(Nodes), system functioning (Function) and system content (Objects). We will consider the formal representations of NFO-element using the theory of objects [2, 4].

In calculation of objects [2, 6] an abstract object represents a set of fields and methods. Using of a method of object is a method call, change of a method is a redefinition. A field – a special case of a method (a constant method). Change of field value is a special case of redefinition of a method. Methods are executed in the context of some object (have an object reference). Thus, formally in calculation of objects any abstract object "o" is presented in the following form:

$$o = [l_i = b_i^{i \in 1,..n},\ l_j = \sigma(x_j) b_j^{j \in 1,..m}],$$

where “li” represents the fields of objects, in which the characteristics of the object „o“ are written; lj - methods of this object, where in brackets their arguments, and behind the brackets results of their operation are specified. We will apply the means of calculation of objects to the formal description of NFO- element from the point of view of its nodal object [10].

For example, we will consider NFO-element which object occupies the functional units having the input flows designated as a?i, and the output flows designated as a!i (see fig. 1). These designations in the manner of the theory of processes emphasize that fact that flows consist of objects which by them are transferred (flows) from one node (object) to another. Thus, the object G of the considered NFO-element represents an entity which due to its functionality transforms input stream objects a?i in output stream objects a!i.

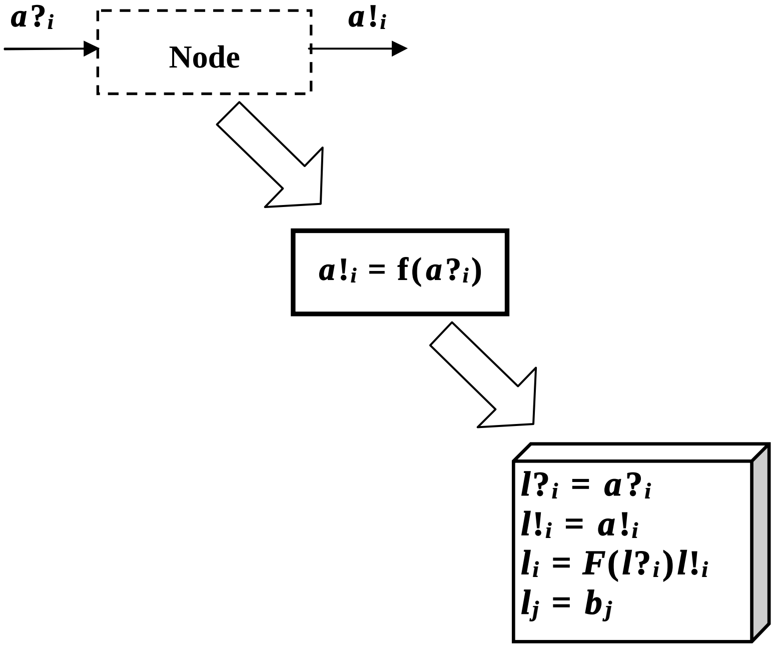


Figure 1 - NFO- element from the point of view of calculation of objects..

According to the rules of calculation of objects mentioned above this nodal object of G (and, therefore, the appropriate NFO element) can be formally presented in the form of the following expression:

$$G = [l?i = a?i, l!i = a!i; li = F(l?i)l!i; lj = bj],$$

where:

l?i - a field of nodal object (can represent a set or collection of objects), which contains value of input stream objects of a? i and, respectively, has the same data type;

l!i - the field of nodal object (can represent a set or collection of objects) which contains values of output stream objects of a! i also has the same data type;

li – the method of nodal object (can represent a set or collection of objects) transforming input stream objects of a node into output ones.

lj - a field of nodal object (can represent a set or collection of objects), which contains the main characteristics of this object (bj).

Presenting the system (NFO-element) in the form of the construction shown in a figure 1 an opportunity occurs within the NFO approach to implement not only static representation of system, but also to show dynamics of functioning of system due to "revitalizing" of function of NFO - element, by the description of its functioning, namely, the conversions of input parameters into output ones. Revitalizing of function can be reached at the expense of use, for example, the most simple scripting language in which composition of operators is necessary to include the following constructions:

- operator of creation of a variable;
- operator of assignment of value to variable;
- the operator of a condition (in the classical form of the organization);
- iteration statement (in the classical form of the organization);
- mathematical operators of addition, subtraction, multiplication and division;
- logical operators.

Thus, the description of system by means of NFO approach will take on the appearance on as it`s shown in a figure below:

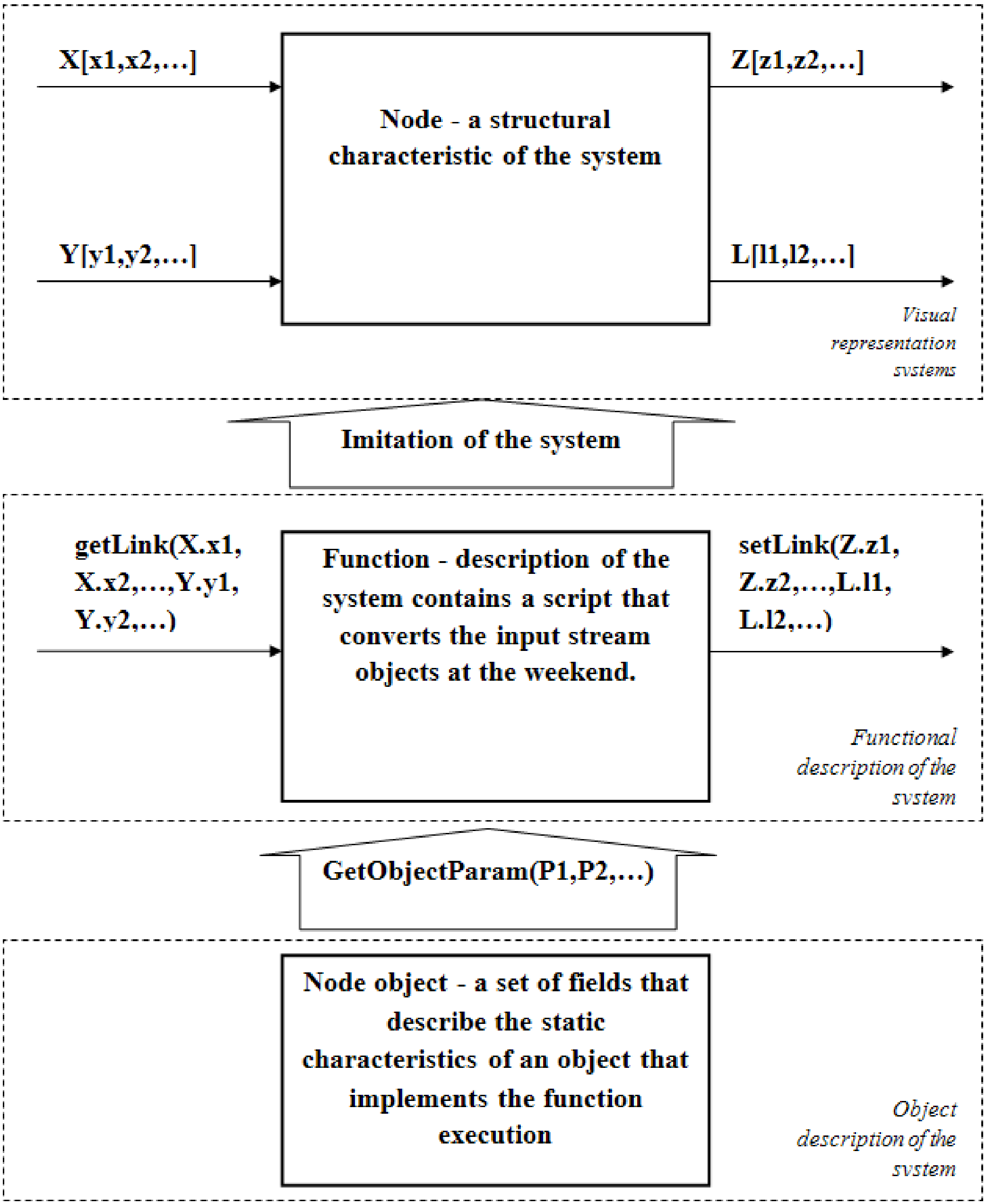


**Figure 2 –** Structure of simulation of system functioning represented by means of NFO – element

Apparently from a figure 2, the organization of simulation of system functioning presented in NFO-element form has, as well as NFO element, three presentation levels. The first level – visual representation of system (that the user sees on the monitor screen ). On this level the model of system is built from the separate nodes of system connected between themselves by some stream objects of X, Y, Z, L.

The second level - the description of functioning of system by means of operators of scripting language, and the predetermined methods take place here:

- getLink (X.x1, X.x2,…, Y.y1, Y.y2,…) – allows to receive values of characteristics of input stream objects;
- setLink (Z.z1, Z.z2,…, L.l1, L.l2,…) – allows to set values to characteristics of output stream objects;
- GetObjectParam (P1, P2,…) – allows to receive values of characteristics of nodal object that corresponds to the third level of the system description – object level.

## Conclusion

Thus, there is an opportunity to describe function of system either by means of its further decomposition on subsystems of lower level, or if the necessary level of decomposition is reached, by means of constructions of some scripting language. We will actually receive the organized simulation model of system consisting of the separate executed units of the program.

## Outputs

The considered three-level description of system will allow to build simulation models of processes, taking into account their structural, functional and object characteristics that, in turn, will allow to receive a full-fledged simulation model of system with possibility of study of its functioning in time.

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