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FUNCTIONAL MODELING – METHODOLOGICAL BASIS FOR INVERTIGATION OF BUSINESS PROCESSES AT INDUSRTIAL ENTERPRISES

Methodological basis for investigation of business processes at industrial enterprises - functional modeling is presented in the article. Typical functional models of the industrial enterprise activity, which are considered in terms of levels of detail, are developed. Methods for building an organizational business model using organizational and technical structures and mechanisms of functional models are developed.

"Functional model" is the basic concept in the IDEFØ methodology, which, in turn, is based on the "function" concept. The functions are the contents of those elements (blocks), the system model, which is being studied or designed, is built of. In order to create typical functional models of an industrial enterprise, the authors proposed a four-level classification of functions that are modeled by the IDEFØ blocks, which is focused on a wide range of organizational and economic, industrial and technical systems. Classification divides all the functions of such systems into four main and two additional types.

The IDEFØ method is designed for functional modeling, meaning the modeling of object functions execution by means of creating a descriptive graphical model that shows what is done within the system's operation, how it is done and by whom. A functional model is a structured image of the functions of an industrial system or environment, information and objects that link these functions.

The model is build using the decomposition method: from large constituent structures to simple ones. Elements of each level of decomposition are the processes (operations, actions) for processing information or material resources under certain conditions, using the specified mechanisms. Each operation is decomposed into smaller components - actions for processing a certain part of information or material resources under certain conditions using a part of the specified mechanisms. The model's level of detail must satisfy the requirements, specified at the beginning of the process of its building. So, functional modeling, using the IDEFØ method, involves building a series of interconnected, hierarchically organized diagrams that reflect the functions of the enterprise and the relationship between them. Diagrams are built on the basis of a graphical language that includes a limited and a clearly defined set of elements: blocks, arrows, and labels, as a vocabulary.

Keywords: business processes, functional model, IDEFØ model, IDEFØ metod, life cycle.

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ФУНКЦІОНАЛЬНЕ МОДЕЛЮВАННЯ – МЕТОДОЛОГІЧНА ОСНОВА ДОСЛІДЖЕННЯ БІЗНЕС-ПРОЦЕСІВ НА ПРОМИСЛОВИХ ПІДПРИЄМСТВАХ

В статті представлено методологічну основу дослідження бізнес-процесів на промислових підприємствах – функціональне моделювання та розроблено типові функціональні моделі діяльності промислового підприємства, які розглядаються з точки зору рівнів деталізації. Розроблено методи побудови організаційної моделі підприємства з використанням організаційно-технічних структур та механізмів функціональних моделей.

Ключові слова: бізнес-процеси, функціональна модель, модель IDEFØ, метод IDEFØ, життєвий цикл.

Introduction

According to the preliminary analysis of modern methodologies for designing complex systems, the IDEFØ method is the most powerful and effective approach from the IDEF family to investigate existing and build new business processes. IDEFØ (Integration DEFinition language Ø), which is based on the technology of structural analysis and SADT^{TM} design, is both a graphical programming language (syntax and semantics) and a description of a comprehensive methodology for developing functional models. The IDEFØ model represents the way the system functions are executed and interact with each other. The IDEFØ method, used for system analysis, provides the experts of relevant specialties with engineering approaches for [1 – 14]:

Performance of system analysis and design at all levels for systems that consist of human resources, equipment, materials, computers and informational flows for large industries, systems or subject areas.

Development of relevant documentation together with the development of the system as a basis for integrating new systems or improving existing ones.

Link between analysts, designers and users.

Reaching an agreement between the systems development teams, providing them with a single information base for understanding processes.

Development of corresponding architectures for industrial analysis, information design and resource management.

RESULTS

"Functional model" is the basic concept in the IDEFØ methodology, which, in turn, is based on the "function" concept. The functions are the contents of those elements (blocks), the system model, which is being studied or designed, is built of.

In the IDEFØ methodology the function is interpreted as the transformation of the input into the output under the influence of control and by means of a mechanism (Fig. 1).

The model and the original are interconnected by some matched conditions, i.e. this is about the adequacy of the model of the original. It is fair to say that the model and the original are homomorphic to each other [1–6, 11, 12]. This means that everything that exists in the model is present in the original. The converse proposition is incorrect. Thus, the functional model is the image of a real system (the original), described in a graphic language, and reflecting the functions, performed by the system, and relations (links) between them.
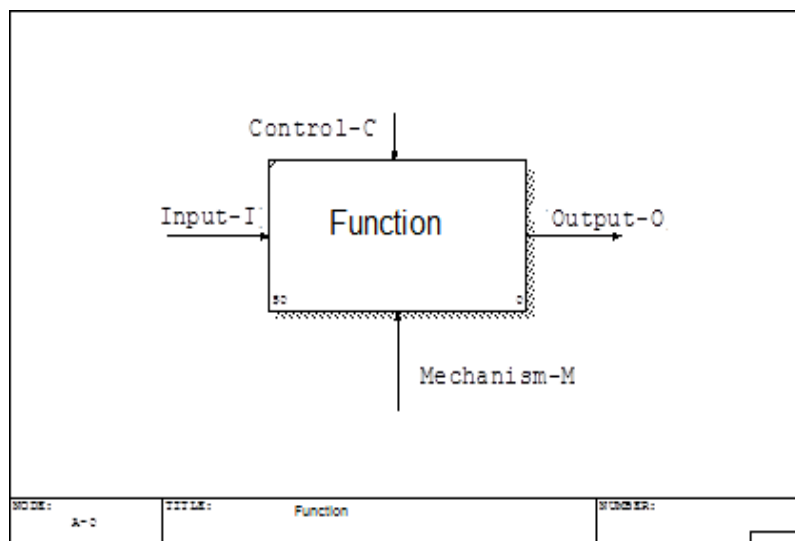

Fig.1. Graphical interpretation of the function, as a transformation, in the IDEFØ methodology

The IDEFØ method is designed for functional modeling, meaning the modeling of object functions execution by means of creating a descriptive graphical model that shows what is done within the system's operation, how it is done and by whom. A functional model is a structured image of the functions of an industrial system or environment, information and objects that link these functions.

The model is build using the decomposition method: from large constituent structures to simple ones. Elements of each level of decomposition are the processes (operations, actions) for processing information or material resources under certain conditions, using the specified mechanisms. Each operation is decomposed into smaller components - actions for processing a certain part of information or material resources under certain conditions using a part of the specified mechanisms. The model's level of detail must satisfy the requirements, specified at the beginning of the process of its building [1, 3, 6].

So, functional modeling, using the IDEFØ method, involves building a series of interconnected, hierarchically organized diagrams that reflect the functions of the enterprise and the relationship between them. Diagrams are built on the basis of a graphical language that includes a limited and a clearly defined set of elements: blocks, arrows, and labels, as a vocabulary.

Development of typical functional models of the industrial enterprise.

In order to create typical functional models of an industrial enterprise, the authors proposed a four-level classification of functions that are modeled by the IDEFØ blocks [1, 3, 11], which is focused on a wide range of organizational and economic, industrial and technical systems. Classification divides all the functions of such systems into four main and two additional types.

Main types of functions.

Activity is a set of processes that are executed (performed) in succession or/and in parallel and transform multiple material or/and information flows into multiple material or/and information flows with other properties. In the IDEFØ model activity is described by the A0 block on the main context diagram A0.

When modeling large industrial enterprises, which are multi industry structures, engaged in various types of activity that can be reflected in the additional contextual diagram A-1 of the functional model. In this case, the general model of such a complex structure consists of a number of models, each of which relates to a particular type of activity.

Process (synonym: business process) is a set of operations, performed in succession or/and in parallel, and transform the material and/or information flows into corresponding flows with other properties. The process proceeds in accordance with the directives of management, which are based on the objectives of the activity.

Operation is a set of actions, performed in succession or/and in parallel, and transform objects that are included in the material and/or information flow into the corresponding objects with other properties.

Action is a transformation of a property of a material or information object into another property. The action is performed in accordance with the command, which is a part of the directive for execution of an operation, using the necessary resources and observing the restrictions, imposed on the operation.

Additional types of functions:

Sub-activity is a set of several processes as a part of an activity with a common objective.

Sub-process is a group of operations as part of the process, connected technologically or organizationally.

The concepts of the basic processes, introduced above, form a natural hierarchy of blocks on the IDEFØ-diagrams during decomposition, involving four levels of it. However, when analyzing complex types of activities, intermediate levels of decomposition, based on using additional functions, may be required.

Levels of decomposition, which detail the actions, can be naturally considered to consist of elementary or simple functions. The hierarchy of functional models is closely connected with the decomposition levels (Fig. 2).
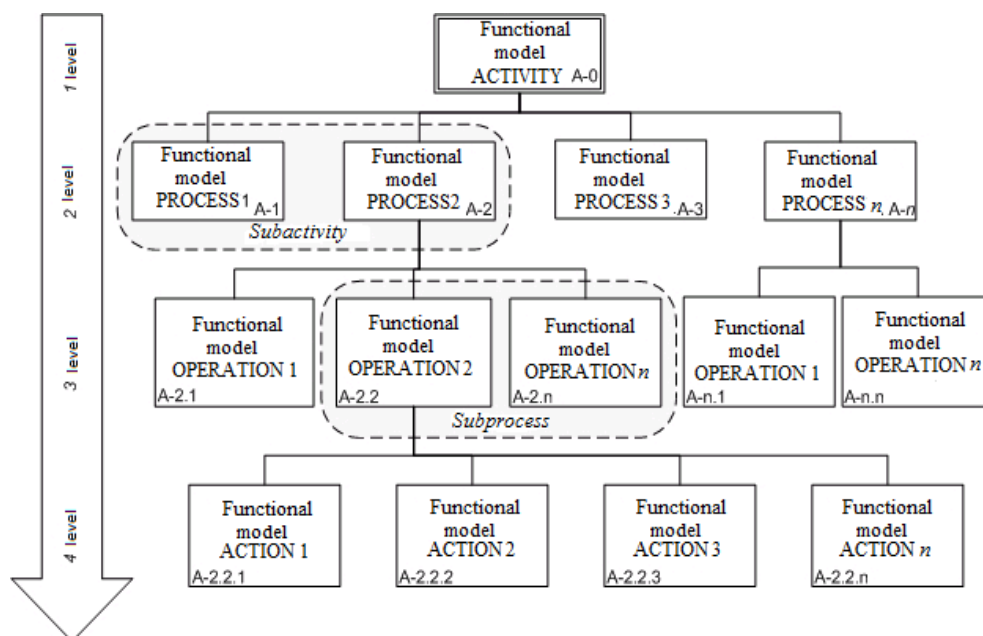

Fig.2. Hierarchy of functional models

The model of the first level describes the activity of the enterprise within a set of basic and additional (supporting) processes (sub-activities) from the point of view of management, organization and interaction between them; and as an independent model of this level - a functioning model of the quality management system.

The model of the second level describes the structure of all main and additional processes (processes of output of all types of products and process planning) within a set of operations or sub-processes. In order to build functional models of this level, it is necessary to identify the processes, the owners of the processes and the boundaries of responsibility of process owners. This task is fundamentally new for enterprises with a vertical control system. The peculiarity of models of this level is that the model must be built, basing on the life cycle (LC) of certain products.

The models of the third describe operations (groups of operations – sub-processes) of elements of the product LC within a specific set of actions (or a set of operations in the case of a sub-process). These are primarily the operations (sub-processes) of marketing, analysis, signing of contracts, design and technological preparation of production, procurement and inventory management, all types of control and testing of products (including input control), implementation of specific technological operations, packaging and storing end products, transportation, management of supporting equipment (including metrology), collection, storage, processing and analysis of information, etc. A complete list of operations (processes) is formed for each enterprise individually. These groups of operations (sub-processes) are described in methodical and working instructions, technical processes.

The point of view is formed by the chief specialists: chief industrial engineer (designer), production managers, managers of the minimum technological production units – managers of workshops, laboratories, bureaus, etc.).

The model of the fourth level describes elementary actions within the specific operations (sub-processes), which are performed with the help of equipment and specialists of the enterprise. Models of this level, as a rule, consist of one block (this is the minimum level of decomposition) and are described by quantitative characteristics.

It should be noted that the models of the second, third and fourth levels allow us to formalize processes, operations and actions from a mathematical point of view that allows us to proceed to their quantitative estimates.

Development of the organizational model of the enterprise.

All the functions, included in the above mentioned classification, are in hierarchical subordination according to the "top-down" principle: activity-sub-activity-process-sub-process-operation-action. According to the IDEFØ methodology, each function is performed using a mechanism. In most systems, analyzed using functional

models, such mechanisms are organizational and technical structures [1–8]. The analysis of such systems shows that there is a clear correspondence between the hierarchy of functions (transformations) and the hierarchy of mechanisms (Fig. 3).

Using the above mentioned hierarchy of functional blocks, we define the elements of the hierarchy of mechanisms [1–5].

Organizational and technical system - organizational structure, human resources and a set of technical equipment, necessary to carry out activities.

Organizational and technical subsystem is a part of the organizational and technical system that ensures the progress (sub-activity).

Organizational and technical complex (module) – is a part of the organizational and technical subsystem, designed to perform the operation.

Organizational and technical block is a part of the organizational and technical complex that ensures the execution of the action.
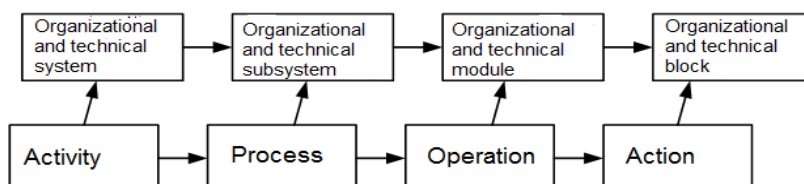

Fig.3. Relations between functions and mechanisms

The correct building of the model, without an a priori binding to the "organization", provides the opportunity to link its functions at different levels of decomposition with the objects of organizational and technical structure, which act as mechanisms. In this case, the organizational and technical structure becomes the result of a functional modeling. In sufficiently detailed functional models, which are developed as part of a process approach to building business processes at the enterprise, it should be possible to restructure the mechanisms during the enterprise activity, meaning the possibility to reengineer the production and/or business processes.

It should be noted that there is a link between the hierarchy of mechanisms (blocks of organizational and technical structure) and structural subdivisions of the enterprise that allows us to develop an organizational model of the enterprise (Fig. 4).
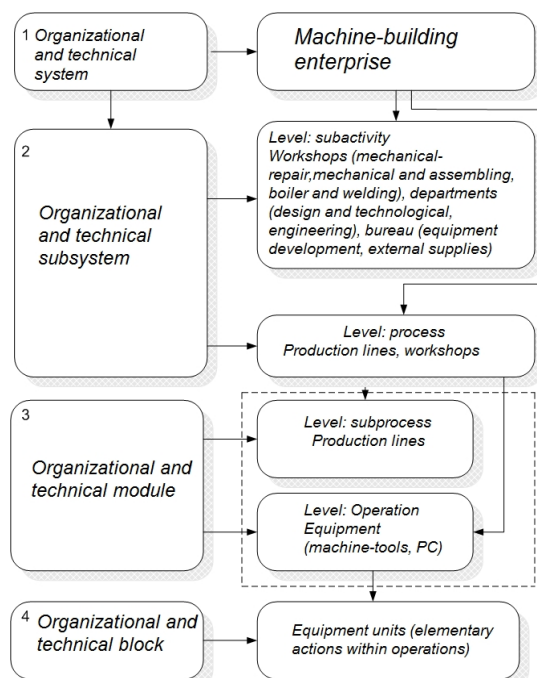

Fig.4. Organizational and technical structure as a basis for development of the organizational model of the enterprise

The above scheme is simplified (quite general) and requires the clarification for its practical use, depending on the specific operating conditions of the enterprise. The proposed approach for building an organizational structure (model) of an enterprise is nothing more than a practical implementation of a process-oriented approach for building management systems that are flexible from the point of view of efficient and rapid restructuring of business processes, in accordance with dynamic changes of the sales markets.

In this case, the organizational model (organizational structure) of the enterprise is developed to ensure the effective implementation of business processes, aimed to achieve the strategic objectives of the enterprise.

In other words, the process-oriented approach allows uniting separate, fragmented efforts of business units to perform specific functions within the framework of its strategic objectives.

Conclusion

The methodological basis for investigation of business processes at industrial enterprises - functional modeling is considered; typical functional models of the activity of industrial enterprise that are considered from the point of view of the levels of detail, are developed. Methods for building an organizational model of an enterprise, using organizational and technical structures and mechanisms of functional models, are developed.

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