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Bormatenko N. V., Leading Economist (Segater LLP, Dnipropetrovsk)

SYSTEMS – SEMIOTIC ENTERPRISE ARCHITECTURE

The article analyzes the existing conceptions of the enterprise architecture and offers systems-semiotic one. The results are based on using the methodology of vertical knowledge integration, paradigm model of innovation development and systems-semiotic paradigm of sign constructions.
***Keywords*: enterprise architecture, ontology of sign constructions, methodology of vertical knowledge integration, paradigm model of innovation development, systems-semiotic paradigm.**

Introduction. Existing products, under enterprise architecture (EA) trade, describe EA objectives (prevention of IT and business disintegration, improvement of enterprise's adaptive possibilities through continuous transformations etc.), give general recommendations or consult personnel of a business client depending on the situation. In other words they answer the questions: «Why is EA necessary and how to create and use it?», but they do not explain what EA represents. At best, EA structure includes everything that somehow relates to business: objectives, strategies for their achievement, business processes, data structures and other. But, like one cannot see the wood for the trees, one cannot understand the meaning of EA notion, and without it objectives and methods turn to be unclear.

According to the methodology of vertical knowledge integration (VKI), directed at fortifying the scientific foundation of pure heuristic innovations, in order to solve this problem, it is necessary to answer what the enterprise is and what the information, defining the essence of information technologies, is. In this respect, for systems-semiotic solution of EA problem, a model of paradigm innovation development (PID) is applied. Within its frames, there is a systems-semiotic paradigm of a sign as an objective essence, which claims no absolute universality, but has to guarantee the possibilities for arranging experience gained through IT application in economy and business and, at the same time, is a result of comprehending this vast and not fully understood experience.

Definition of the problem. To generate an objective and functional EA conception, which would define what EA is, before deciding why it is necessary and how to create and apply it.

Obtained results. Many respected scientists agree that IT application productivity in economy and business do not correspond to their potential

and expectations, related to it. In particular, R. Solow noted that there was paradoxically no data, proving the productivity of IT application in business. This fact was called the productivity paradox of information technology (IT). R. Strassmann, despite the years-long serious efforts, could not contradict and concluded that the reason for the productivity paradox of IT lied in that IT was used incompetently [1]. P. Drucker wrote: «On specifics, we dissenters disagreed, of course, as "experts" always do. But, all of us agreed on one thing: The computer would, in short order, revolutionize the work of top management. It would, we all agreed, have its greatest and earliest impacts on business policy, business strategy and business decisions. We could not have been more wrong. The revolutionary impacts so far have been where none of us anticipated them: on operations" [2]. Despite the expectations "…information technologies never placed new and unexpected questions and offered new and unique strategies", he states further there.

The problem of productivity paradox included a lot of problems, which are constantly tried to be formulated and solved. F. Brooks saw a problem of "silver bullet" as a solution, which can ensure the growth of labor productivity by no less than an order of magnitude. After 30 years, despite obvious achievements in programming techniques, he noted that "silver bullet" had not been found and suggested it being absent in principle. The time just aggravated the problem, thus proving Brooks were right when thought that it was in the interaction between program and results of its work with economy, and not in programming work of a computer, processing data.

G. Booch, a co-author of object-oriented analysis and design (OOAD), was perfectly right when made the essence of program the basis of the solution of information development issues. He suggested considering it as an object (not as an algorithm), which in its turn has a corresponding object in domain area. However, the meaning of object, which G. Booch gives, can refer to anything, including algorithm. Booch's program-object is also a simplified copy (model) of object in domain area, performed in mental material [3]. This way, it can refer to their similarities or existence of different "worlds", but not to the ties between them.

T. Berners-Lee, the creator of "worldwide web", thought that in order to solve the information development issues, it is necessary to consider more fully the meaning (semantics) in data processing, i.e. use semiotics, the main component of which is semantics [4]. Another researcher D. Sova is also sure in semiotics productivity at creating ontologies (describing domain areas) [5].

A. Naumenko proposed Triune Continuum Paradigm (TCP) [6], which he tried to apply in order to teach developers how to build models of any re-

ality fragment, named a domain area of the program. But he left unclear the essence (ontology) of programs, without what the notion of program domain area is undefined. J. Zachman believed that it was necessary to prevent disintegration of IT and business by uniting them in the form of enterprise architecture (EA) [7].

All listed examples have internal contradiction. It supposes that while IT simulates their domain areas (business), they are similar to them, and any disintegration (bonds breaking) between IT and business and hence the necessity for closer integration (linkage) are out of question. Besides, all approaches to issues are functional, and not ontological. They search for answers on "Why?" and "How?" questions and pay no attention to the questions "What is an enterprise, architecture, program, information, data, knowledge etc.?"

The topic covered is mutual for economy and IT, since sign constructions belong both to economic and information technological objects. As R. Coase noted "In standard economy theory a consumer is a set of preferences, a company is cost curves, and the exchange happens in institutional vacuum. That is why, we get individuals without human properties, companies – without internal organization and exchange without markets" [8] (cited from [9]). R. Coase believed that there was a problem of economy ontology, which is represented today as a number of economic entities, but not business facilities (enterprises, companies, corporations etc.). From one side, IT requires proper comprehension of their purpose and application objects. At the same time, economy should determine the place and role of information (sign) constructions in their objects' structure. Thus, in order to identify enterprise architecture, it is necessary to define first what the enterprise represents as an object, that in its turn suppose having answers about sign construction essence and role.

As to the second EA component, which is architecture, we turn to the statement of Italian semiotician Umberto Eco:...our approach to semiotics allows us to see in architecture sign a signifier, where its own functional purpose serves as signified"[10]. This way, according to U. Eco any object indicates its own architecture. However, in case of complex objects such as enterprise, it requires special sign constructions in the form of documentation system, knowledge and database etc. U. Eco continues and mentions main features of architecture optimality: "In the notions of communication theory, the principle of functional form means that form should not only make the exercise of corresponding functions possible, but also have to signify it so obviously, so that its exercise would be a matter not only performable, but also desirable, orienting in the context of the most appropriate communication with the object" [10].

Counting the aforesaid, our basic statement will be that enterprise is a sign construction, architecture is its constructive and productive abstraction, in other words the result of abstraction from minor attributes, a principal scheme. However, existing humanitarian semiotics solves issues of communication improvement, and not of sign constructions. As a result, it is often neglected as an independent science and narrowed down either to the set of methods of interdisciplinary researches or to logic or psychology. Companies, which use semiotics in economy, try to find in it answers how to act in brand, marketing and advertising management, without asking questions what sign constructions, they have to deal with, represent [11].

In this respect, it became necessary to develop systems-semiotic conception (model) of a sign or systems-semantic paradigm (SSP). Its prototype is systems-semiotic conception (SSC) of software [12]. SSP and SSC base on bilateral and real sign comprehension. It means that sign is built basing on physical entities, some of which act as a signifier (syntax), and other – as signified (semantics). As statistic signifier can relate to dynamic or multiple signified, in order not to lose generality, notions of temporal (dynamic) and multiple objects were introduced [13].

On the basis of SSP, a systems-semiotic model of bonds between computer programs and business was developed. Program in it is a semiotic object (message), where program text is a signifier, and temporal object – computer, processing data, is a signified. This way, the program describes computer work on data processing. Though, modeling of a program domain area can be discussed only in particular cases, when existing data processing, which needed to be realized with the help of other means, is used as domain area. Such areas are of no special interest. They are better called objects or informatization areas, whereas area of interest of data users should be called domain areas. If the user is a manager, the domain area coincides with the object of management. Despite the common cliché, the program is obviously not directly related to the domain area, and is connected with it through data, which it gets from the user and returns after processing. In this case, data is a signifier (syntax), and the domain area is a signified (semantics) within the sign construction, which is semiotic representation of the economic entity (enterprise, business company, corporation, business organization etc.)

Methodological basis for mentioned ideas is a methodology of Vertical Knowledge Integration (VKI), which is an alternate for physicalism, trying to answer all “What” questions within physics limits, and functionalism, answering “What it is for” and “How to do it” questions without having scientifically grounded answers on “What” questions. Unlike them, the VKI

methodology aims at the synthesis of ontological, with physics being one of the ontology development stage, and functional approaches. In this case, ontology ("physics") of information development is defined by semiotics, which is understood as a "science about sign ontology" [14]. One of the implementations of VKI methodology is a model of PID (paradigm innovation development) [15], that, while resolving practical problems, which are out of the scope of natural sciences paradigm, uses proposition and implementation of new paradigms – tentative theories, corresponding to fundamental philosophic abstraction requirements (implementation of understood, reasonableness, practice productivity) [16].

The principal base of systems –semiotic architecture (SSA) synthesis, formed during the analysis of experience gained in the process of economy's information development, includes the following statements:

– Brooks' first principle: program is a message, which programmer sends to the computer, in other words program is a semiotic object;

– Brooks' second principle: program has nothing, except data processing. In other words, program can model only data processing processes (to be their "calque");

– Cybernetics principle: at the first stage of decomposition, the enterprise appears to consist of an object and management system, from which data-processing system (DPS) is separated;

– Systems-semiotic principle: data relate to the object of management as a signifier to a signified, to management system as primary material and management tool, to DPS as objects of processing;

– temporality: dynamic "entities", consisting of objects connected in cause-effect relations (processes), can serve as signified parts of signs;

– multiplicity: multiplicity of objects, united by certain similarity (availability of common properties) can be signified parts of signs;

– linguistic principle: data simultaneously belong to at least 4 description languages: description language of enterprise as an object of management (DLOM), descriptive language of user's information responsibilities and needs (DLUR and DLUN), descriptive language of data as objects of processing (LDP);

– Saussur's principle: language consist of language itself (grammar and vocabulary) and speech (statements), composed from words according to grammar rules;

– Principle of program independency from data semantics: data-processing program code depends on relations from data parts (data structure) and do not depend on their semantics;

– Principle of data structure independency from language vocabulary: data structures depend on language grammar and do not depend on its vo-

cabulary;

– Principle of ontological incompleteness: full objective (ontological) representation of socioeconomic object leads to the endless recursion (each gained representation can be viewed as a part of the represented object) and, thus, is almost impossible. Rational edge between objectivity and subjectivity should be defined proceeding from the current task;

– Principle of ontological priority (human-being, substance, vehicle, message etc.) and functional plan dependency (client, visitor, objects and means, goods, personnel etc.);

– Principle of topological invariance: socioeconomic system, particularly enterprise can be presented as a sign construction – a core, the structure of which keeps topological coherence (its own resemblance before and after changes), despite number increase, decrease or replacement of its component elements.

First two principles, which SSA bases on, are called after F. Brooks, who really proposed them [17]. Though he did not continue developing them, they gave us confidence that the chosen direction was right.

SSA, built on the above listed principles, is a maximum simple and open to changes structure of an enterprise as a sign construction, which is presented as a data system, divided into the core and the variable components, consisting of mutually independent elements. SSA purpose is to ensure minimum costs (maximum efficiency) during coordination of object of management, managing system and data processing system at enterprise establishment, as well as changes of goals and conditions of its functioning, in other words while enterprise development by making some transformations.

One of SSA main elements is description language of an enterprise as an object of management (DL OM). It is divided into language of atomic statements about facts and "language of indices".

For example, it can be a language defined with following points:

– Object model of management consists of individuals *{i};*

– Individuals are divided into categories, each of which has a connected set of properties ($p_1,p_2,..p_n$);

– Operations with individuals lead to events **(*e*),** which change subset of individual's properties connected with this event. Events take place in certain location (*l*) in a certain moment of time ***(t)***.

– Data element of individual level – atomic statements:

$$S=\{i;e;t;l;p_1,p_2,...,p_k\}. \quad (1)$$

DL OM can be presented as relational database. In this case, it contains a table-list of individuals. Each individual is characterized by multiple events, each event – by multiple properties, which are updated in this event.

The events appear because of cooperation between individuals; however, the user can be interested only in one of the individuals participating in the event. Each property is characterized by domain area.

One more SSA element is a language of indices. The indices are sums (integrals) of function numbers, arguments of which are event time and location, individual's properties and logic functions of statements:

$$R_j\ (T, L) = \sum f_j\ (e_j; t_j; l_j; p_{j1}, p_{j2}, ..., p_{jk}\ , B(S = S_j)), \quad (2)$$

where

$S_j = \{i; e_j; t_j; l_j; p_{j1}, p_{j2}, ..., p_{jk}\}$, a $e_j; t_j; l_j; p_{j1}, p_{j2}, ..., p_{jk}$ – fixed value of types of events, moments and location of its performance, individual's properties;

$B(S = S_j)$ – Boolean (logic) function;

$f_j\ (e_j; t_j; l_j; p_{j1}, p_{j2}, ..., p_{jk})$ equals to calculated value or defined constant, if $S = S_j$ (B – true) and to zero otherwise;

T – defines timeframe, to which the exponent ($T = \{tj\}$) relates;

L – defines multitude of locations in generalized space, to which the exponent ($L = \{ lj\}$) relates.

Topologic openness, characterized by efficiency at readjustment of enterprise's sign structure, which resulted from changes of user's goals and area of interest, are achieved with the following properties of SSEA:

– Absence of logic restrictions for increasing the number of individuals' classes within the object of management;

– Logic capability for unlimited expansion of individuals' vocabularies (classes of events, properties and property values) in individuals' description languages;

– Logic capability for unlimited increase in number of input and data display forms, as well as their characteristics;

– Independence of code kernel from data semantics.

Being the result of the application of VKI methodology and paradigm model of innovation development, SSA is a complex solution, value and content of which disclose on the philosophical, theoretical (systems-semiotic), technological and business level. With unchanged principal statements, SSEA supposes the development particularly in the following directions:

– Creation of invariant (insensitive to changes) sign (semiotic) model (core) for managing the enterprise functioning and transformation, which makes a form to present the knowledge about company objectively and informatively;

– Creation of basis for the development and mutual integration of program applications and management information systems (MIS);

– The creation of agile MIS, capable to transform under business and

management pressure, which in their turn face pressure from competitive environment and market. Shift to "agile" low cost re-engineering forms, which do not affect enterprise core, in other words its architecture;

– Implementation of SSA in information program and methodical support;

– The creation of MIS, capable for the expansion and changes of their functionality, for generation of new organizational and managing forms by "inventing" within SSA, that will in its turn increase business and management potential. New conditions for patenting similar inventions;

– Increasing productivity of IT application in economy and business, due to their adaptiveness and unification on the basis of data structures and program code;

– The development of commercial product in the form of package of information and program and methodical tools for SSA establishment in enterprises-clients;

– Shift from modeling SSA with the help of relational data structure to more limited systems-semiotic structures and to the creation of appropriate data base management systems, which guarantee maximum efficiency of calculation operations;

– Creation of specialized systems-semiotic computers and operational systems.

It is crucially important for the given results that out of multiple sign conception, proposed by philosophers and scientists for centuries, the sign paradigm as two-sided (signifier and signified) essence (bilateralism) was chosen. This approach differs from unilateralism, which narrows a sign down to the relation between signifiers, and from approaches based on "semiotic triangles", which includes in sign definition a subjective factor of consciousness, generating and conceiving something as a sign.

Conclusions. Joined-up thinking on entire economic entity (enterprise, business company, corporation etc.) distinguishes objects with clear or unclear objective or subjective idea through data, as well as data set, which are often difficult to decide which object they relate to. Data always serve as signifiers, though they can be signified (sign components). It is obvious that any economic entity can function without data. However, data has sense only as part of sign. In this case, all enterprise objects, including data by itself, act as relevant and potential signifiers. It enables to view the enterprise as a complex sign (sign construction), whose high priority is to arrange ties between signifier (syntax) and signified (semantics) parts, and which bases on architecture – invariant principal semiotic enterprise scheme.

At the same time, an enterprise is a dynamic and developing object,

presentation of which in a static view could be compared with the design of eternal engine. Completely another is required from systems-semiotic architecture: it should ensure continuous optimization of sign construction with minimum objectively conditioned level of costs, in other words with maximum efficiency. Within systems-semiotic architecture, the solution of this problem bases on a number of principal theoretic statements, gained from the experience of economy and society information development at that moment.

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Рецензент: д.е.н., професор Сазонець І. Л. (НУВГП)

Борматенко Н. В., провідний економіст (ООО Сігейтер, Дніпропетровськ)

СИСТЕМНО-СЕМІОТИЧНА АРХІТЕКТУРА ПІДПРИЄМСТВА

Стаття аналізує існуючі і пропонує системно-семіотичну концепцію архітектури компанії. Одержані результати засновані на використанні методології вертикальної інтеграції знань, парадигмальної моделі інноваційного розвитку і системно-семіотичній парадигмі знакових конструкцій.
***Ключові слова*: архітектура підприємства, онтологія знакових конструкцій, методологія вертикальної інтеграції знань, парадигмальна модель інноваційного розвитку, системно-семіотична парадигма.**

Борматенко Н. В., ведущий экономист (ООО Сигейтер, Днепропетровск)

СИСТЕМНО-СЕМИОТИЧЕСКАЯ АРХИТЕКТУРА ПРЕДПРИЯТИЯ

Статья анализирует существующие и предлагает системно-семиотическую концепцию архитектуры компании. Полученные результаты основаны на применении методологии вертикальной интеграции знаний, парадигмальной модели инновационного развития и системно-семиотической парадигме знаковых конструкций.
***Ключевые слова*: архитектура предприятия, онтология знаковых конструкций, методология вертикальной интеграции знаний, парадигмальная модель инновационного развития, системно-семиотическая парадигма.**
