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The Process Approach to Economic Systems Interaction Modeling

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Abstract

In a paper presented one of approaches to the economic systems interaction modeling is considered while innovations introduction, merge, formation of joint ventures, etc. on the basis of the system paradigm, proposed by J.Kornai specifically for economical system, and further generalized and developed by academician G.Kleiner from Central Economics and Mathematics Institute of Russian Academy of Sciences.

According to G.Kleiner's concept, the set of economic systems includes 4 types of systems: objective, environmental, project and process systems. These types of systems differ essentially by their properties (temporal and spatial) and by its functioning pattern, each system type has unique role and responsibility domain in the economy.

Interaction of systems is considered within a framework of this system paradigm.

Based on the definitions and the functional responsibility, the role of processes as an interaction maintenance is studied.

Thus, processes are a multidimensional category with the following inherent characteristics:
- The functional responsibility for operation;
- The functional links structure determining the interaction mechanisms;

- Functioning of processes is subordinated to the certain objectives corresponding to the interaction purposes of economical objects.

Considering process as a mean of systems multidimensional interaction modeling, within the framework of Kleiner system paradigm, the minimal configuration of inputs and outputs of the system - intermediary (process), including controllable and observable influences from the system - environment and the system - project is established.

The classification of processes - systems by pattern, functional attributes and the interaction mechanisms of economic systems is proposed in the presented paper.

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General interaction of the real world objects can be modeled as interface of versatile systems, including, socio economic (SES) ones. Obviously, such interaction assumes availability of some general system paradigm providing compatibility of interaction languages in space and in time, as well as basic openness of systems.

The primary goal of this research is systematization of notions regarding the systems, that have various nature and features, interaction mechanism in a complex system paradigm with the purpose of adequate processes modeling occurring in them and, as the consequence, the reasonable management of last ones.

In J.Kornai's economic system paradigm[1] the socio economic world is considered as an aggregate of the intersected, encapsulated into each other and interacting subsystems. Academician G. Kleiner has expanded fundamentally and further developed Kornai's idea.

According to G.Kleiner, there are 4 types of systems in general: object, environmental, project and process ones. These systems types, are different, in principle, by their nature, basic features and location within the modern economy operation and can be classified by following attributes:

- Duration (limited, unlimited);
- Spatial location (determined localization, absence of spatial borders)[2]. (Fig. 1)

The selected criteria are basic from the point of view of the analysis since they result from the system's definition. The basic attributes and operations of various economic systems types are presented in Table 1.

Some features of the these systems:

The object is characterized by a spatial determinacy. In particular, the enterprises, organizations can be considered as an object. In some cases it is possible to assume the made product (service) as an object.

The environment is a site of processes course (systems interaction). In time and space aspects, the environment differs from object by its spatial indeterminacy. Thus situations of ambiguous reference of this or that system to a concrete type are possible.

The project is a plan of the future operations (actions) or algorithm of processes and has features of an information system. The project is characterized by the temporal parameter (time is limited) and a material component, including, the determined spatial characteristic.

Process is associated with a procedure. In some sources process is understood as a course, development of some event, sequential change of states in development. Besides the highlighted features, process describes a set of sequential operations for achievement of some result.

According to ISO standard 9000: 2000 any activity, or the activities complex, where resources are used for transformation of inputs into outputs,

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[1] Kornai J. 1998. *The System Paradigm.* William Davidson Institute Working Papers Series 278, William Davidson Institute at the University of Michigan

[2] Kleiner, G.B. (2007) 'System Paradigm and Economic Policy'. *Obshchestvennie nauki i sovremennost (Social Sciences and Modernity),* 2-3: 99-114.

can be considered as process. Thus, process is a set of interconnected and interacting types of activities, transforming 'inputs' into 'outputs'.

Authors of the business processes reengineering concept M.Hammer and J.Champy introduce the following definition: «*a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer*»[1]. The term 'consumers' is considered here as external consumer (the end-user of result), as well as internal consumer (other process or its part).

Taking into account the definition and the functional responsibility, processes are the systems - intermediaries providing interaction. Thus, any interaction of systems proceeds through and by means of processes.

Systems interaction model in a system paradigm it is depicted in a Figure 2:

- Systems 'object' and 'project' are placed into 'environment' and interact both between themselves, and with the environment;

- Interaction of all systems types occurs via processes,

- Process represents the complete, dynamic system having the functional elements and structure.

Here integrity is understood as equilibration of all functions of a system-process, consolidated by the interaction purpose (criterion function). The dynamics assumes structural and functional variability of process in time.

Thus, processes are a multiaspect category in which the following characteristics are inherent:

- functionality;

- structural properties of the functional links, defining the interaction mechanism;

- purposefulness of process.

The above mentioned attributes determine classification of processes by three criterions:

- features of systems interaction,

- mechanism of systems interaction,

- functional feature of systems interaction. (Fig. 3).

By the features of interaction processes are subdivided by:

- Internal processes - occur and circulate inside each of systems (depicted on a Figure 4 as A),

- External processes - occur on a systems interaction level (depicted on a Figure 4 as B).

It is possible to define following processes by the character of the interaction mechanism:

- Physical,

- Chemical,

- Informational,

- Organizational,

- Social.

The last ones gain particular importance while socio economic systems

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[1] Hammer M.& Champy J. (1993). *Reengeneering the Corporation: A Manifesto for Business Revolution*. London : Nicholas Brealey Publishing.

interaction analysis.

The following types of processes can be defined by the functional criterion of systems interaction:

- Metabolism,
- Reproductions,
- Evolutions,
- Harmonizations,
- Differentiations,
- Replications.

It is obvious, that harmonization and differentiation processes are invariant and are common for both internal and external systems interaction. At the same time, each type of system interaction has its unique (specific) kind of process according to the functional classification: evolution, a reproduction and replication correspond the internal character of systems interaction, whereas processes of a metabolism has an external character.

The purpose and mechanism of interaction process realization are shaped, being influenced by the project-system and surrounding environment-systems (fig. 5).

From the point of view of the set-theoretic approach to systems modeling[1], process-system can be defined as follows:

$$\{x_1, x_2, z_i\} \rightarrow y_j \tag{1}$$

Where z_i - a vector of design factors (state) of process,

$x_1 = \{x_1^1, x_2^1, \ldots x_{m1}^1\}$ - set of valid input values,

$x_2 = \{x_1^2, x_2^2, \ldots x_{m2}^2\}$ - set of valid values of the environment, influencing the process;

$z_i = \{z_0, z_1, \ldots z_i\}$ - set of valid values of the process-system's parameters

$y_j = \{y_1, y_2, \ldots y_j\}$ - set of acceptable values of the process' output parameters.

In this case the process description can be represented by two functions:

1) φ - the transition function, reflecting the influence of all inputs on a state of process Z,

$$x_1 \times x_2 \times z_0 \overset{\varphi}{\rightarrow} z_1 \tag{2}$$

2) ψ - the output function reflecting a relation of process' output parameters, as functions of its inputs, of a current and initial state of process (Z_1 and Z_0):

$$x_1 \times x_2 \times z_0 \times z_1 \overset{\psi}{\rightarrow} y \tag{3}$$

In an analytical form:

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[1] Ferreirós, J. (2007). *Labyrinth of Thought: A history of set theory and its role in modern mathematics*. Boston: Birkhäuser.

$$\begin{cases} z(t) = \varphi\,[x_1(t), x_1(t), z(t)] \\ y(t) = \psi\,[x_1(t), x_2(t), z(t), z(t-1)] \end{cases} \qquad (4)$$

Practical application of the described model lays, first of all, in an economic interpretation of input sets, outputs and states of process with the subsequent resolution of functions (1) and (2) using the theory of sets method.

Thus, Kleiner`s system paradigm reflects in a most comprehensive way all range of typical systems (models) in a spatial and temporal coordinates of reality.

Processes are the universal systems-intermediaries providing both internal and external interactions of versatile systems.

The set-theoretical model of system-process enables to describe the interaction mechanism of versatile objects of a system paradigm, interaction channels and languages universality.

Let's consider an example of systems interaction in a situation with innovation as the project-system.

Definitions of innovation as a term are, in essence, understood as a concrete object of introduction and result of this process, that corresponds to the concept of an innovation as project-system. In a system paradigm context, an innovation (as a project) being interacting with object-system (recipient system) gives an object qualitatively new attributes, that were not characteristic to it before.

The organization's management model can be represented in terms of a system paradigm in a following way (Fig. 6).

The project is represented as a set of Key Factors of Success (KFS_1, KFS_2, KFS_3, KFS_n) and, in that specific case, is, in fact, an innovation, radical or modified from the point of view of object operation.

Object is the organization represented by a certain set of Business-Units ($B\text{-}U_1$, $B\text{-}U_2$, $B\text{-}U_3$ … $B\text{-}Um$).
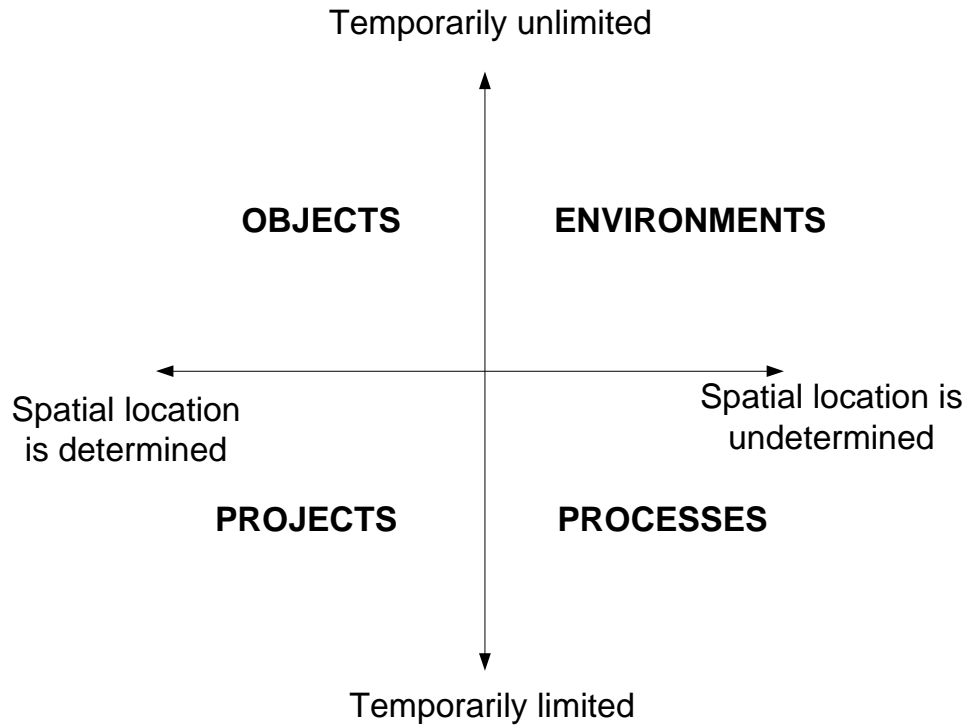
In a context of a system paradigm system are open and, hence, interact with the environment.

Management of object (business) according to the goals set by the project, is realized by means of processes which are classified by such criteria as character, mechanism and functional attribute of interaction. Result of interaction (processes realization) is a detection and fixation of the goal achievement benchmarks.

Thus, process modeling of the organization functioning in a system paradigm context allows to detect intrinsic links between systems and to describe their interaction mechanism from the viewpoint of declared goals realization, as well as to establish a system parameters hierarchy as a w hole with the purpose of its equilibration (integrity) maintenance during interaction.

The provision of the system integrity formed as a result of its subsystems interaction (introduction of some innovations, for example) is the major criterion of innovations acclimation rate.
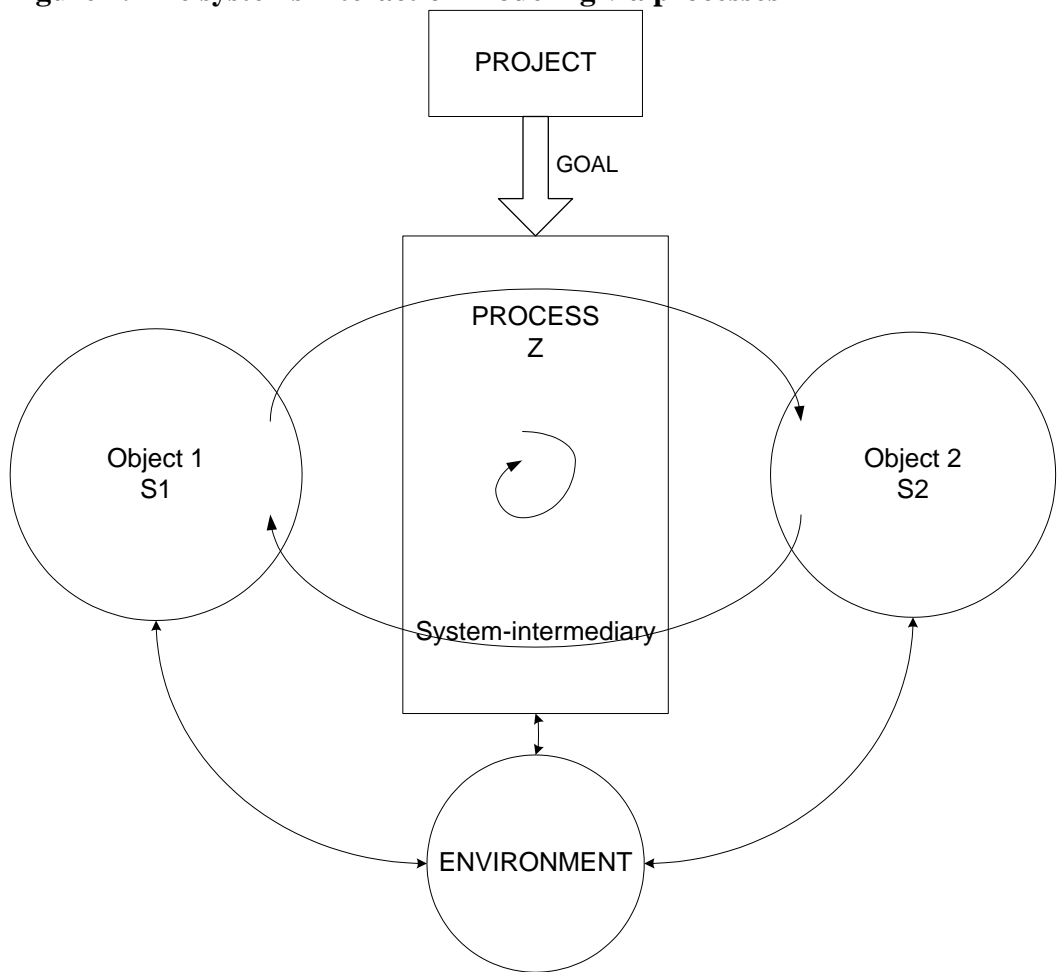
Figure 1. Basic typology of economic systems

Temporarily unlimited

OBJECTS   **ENVIRONMENTS**

Spatial location   Spatial location is
is determined   undetermined

PROJECTS   **PROCESSES**

Temporarily limited

Table 1. Attributes and operations of various economic systems types

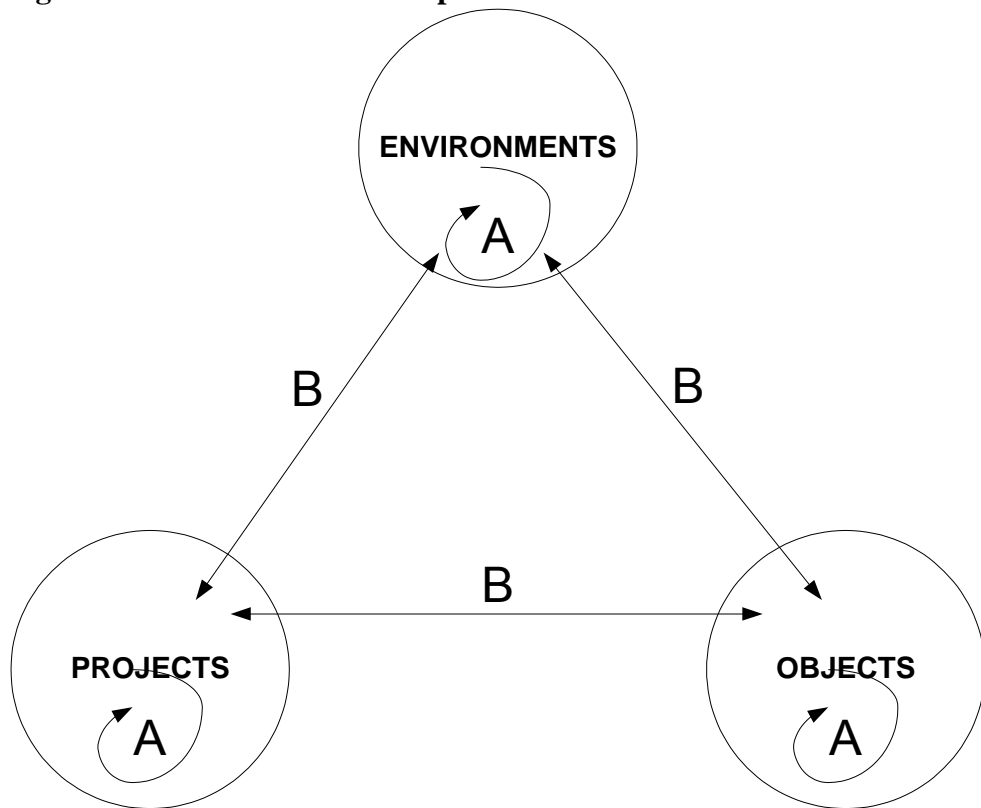| System type	Attributes	Operations
Object	A specificity, Stability, productivity	Origination, Production
Environment	Uncertainty, Materiality	Ambiguity decreasing, Distribution
Process	Conversion, transformation, adapting	Association, translation
Project	Brevity, a concreteness variability	Creativity

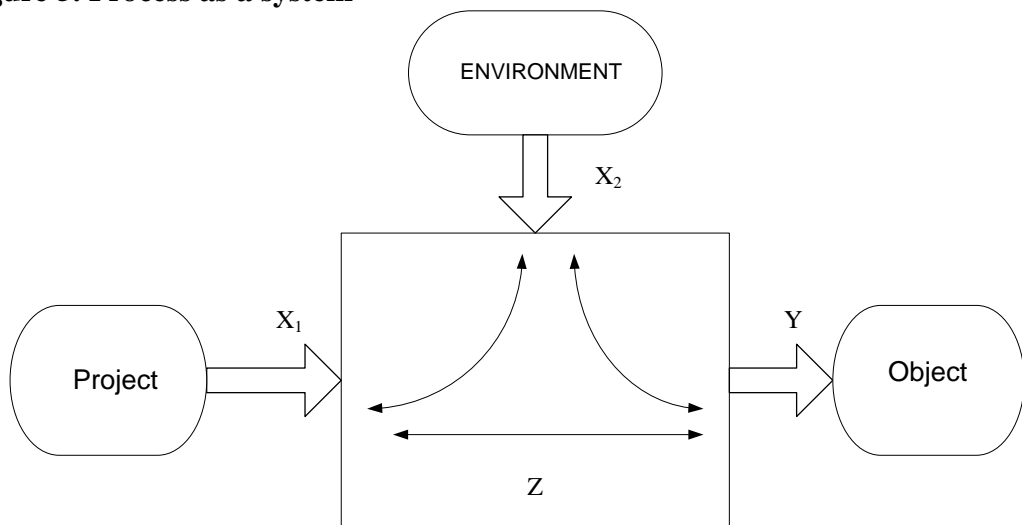**Figure 2. The systems interaction modeling via processes**

PROJECT

GOAL

PROCESS
Z

Object 1
S1

Object 2
S2

System-intermediary

ENVIRONMENT

Figure 3. Classification of processes

Processes classification ATTRIBUTES

1. Systems interaction character

2. Interaction mechanism

3. Functional attribute of systems interaction

PROCESSES

Internal (type A)

External (type B)

Physical / Chemical / Social / Organizational / Informational

Evolution (System's attributes changes on the basis of self organization mechanism)

Reproduction (Recreation of major system functioning conditions)

Differentiation (Internal diversity provision)

Harmonization (Internal unity provision, coordinated operation and development of internal subsystems)

Replication (Generation of alike systems)

Metabolism (Exchange with environment)

Differentiation (External environment diversity provision)

Harmonization (Coordination with environment, synchronization)

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Figure 4. Internal and external processes

Figure 5. Process as a system

Figure 6. The organization's management model in terms of a system paradigm