ECONOBOTICS – A NEW FRAMEWORK FOR THE ENTERPRISES DEVELOPMENT

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Abstract. *In the present paper a new scientific field regarding the development, design and management of the modern enterprises, namely* ***econobotics*** *is considered.*
The fundamental concepts of the domain are: the econobotics or competitiveness space, the econobotic problems, and the econobotic systems, that are introduced and defined in a synergistic integrated context.
Based on these definitions the framework for the design and development of the enterprises as econobotic systems is constructed, and also other econobotic systems are identified.
The results determine the scientific area of econobotics as the context for future enterprise's design, development and management from a new perspective of heterogeneous evolution that may lead to positive mutations in creating a global adaptive and intelligent context compatible to the future processes and phenomena induced by globalization.

Keywords: *econobotics, econobotic problems, econobotic systems, intelligent enterprises, competitiveness, enterprises management, complexity.*

1. Introduction

Enterprises represent complex systems created and developed by humans in the extended competitiveness environment. Their evolution conducted to specific basic functions and generated knowledge and experience that determined corresponding scientific fields for modeling, simulation, design, and development of the enterprise and their external and internal environments.

Recently, econophysics and complexity sciences became domains that identify and model the corresponding laws for economic simulation, process understanding, enterprise's behaviour, based upon the large area of physics and mathematics.

In this context, the present paper considers and defines the scientific area of ***econobotics*** in order to model, simulate, design, develop, and

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manage the enterprises and their environments in the econobotic / competitiveness space.

Econobotics will consider the enterprise as a complex and heterogeneous system able to solve specific problems – econobotic problems.

The definitions of econobotics, econobotic problems, econobotic systems will be established, and accordingly the design and development framework for creating new enterprises as econobotic systems in the competitiveness world will be obtained.

2. The econobotic / competitiveness space

Considering the competitiveness representation as in figure 1 [1], results that a three dimensional (3–D) space can be defined by wrapping the dimensions and parameters attached to the enterprises' reality and evolutions into the following three global dimensions:

- ***the technical dimension,*** *T*, corresponding to the offered products and services, and the processes attached to them according to their life-cycle. technology etc.;
- ***the social dimension,*** *S*, corresponding to the humans – users or not, society, natural environment etc.;
- ***the economic dimension,*** *E*, corresponding to the economic aspects, finances, costs, profits, etc.

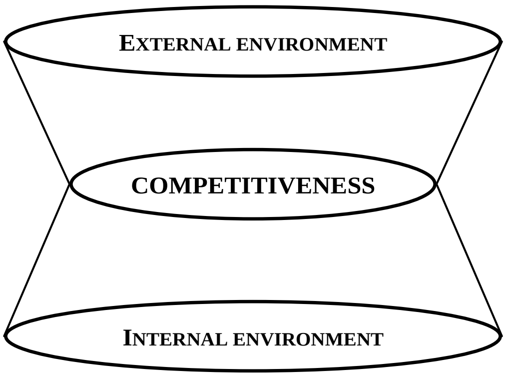

Figure 1. [1] The competitiveness representation as the interface between the external and internal environments of an enterprise.

Thus, the econobotic / competitiveness space is determined by the *T*, *S*, *E* dimensions and will be represented (fig. 2) by the model of reference system $OTSE = \{0\}$ regarding to which all the econobotic systems, including the enterprises, and the components of their internal and external environments will be represented. The econobotic / competitiveness space will be denoted as the *TSE* space.

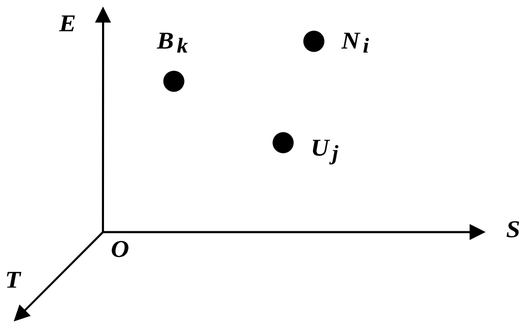

Figure 2. The econobotic / competitiveness space: N_i – enterprises and other econobotic systems; B_k – products and services on the market; U_j – resources and other econobotic objects.

3. Econobotics – definition and context

Econobotics is a modeling, simulation and development framework that represents the use of the enterprise's capabilities in performing modifications of the competitiveness environment through actions and evolutions based upon information acquisition, processing and decision.

Observation. The competitiveness environment and its configurations will be represented in the econobotic / competitiveness space of figure 2.

Thus, econobotics represents:

- an open and heterogeneous scientific area in the development and management of the enterprises;
- a management strategy applied for the optimal design, development and evolution of the modern enterprises;
- a complex solution for flexibility, adaptability, effectiveness, quality, and intelligent capabilities of the enterprises, based upon the competitiveness objectives and representations;
- a systemic representation of the enterprises and their environment in a specific space (i.e., the econobotic / competitiveness space, the *TSE* space);
- a synergistic integration of different scientific, engineering, economic, social, etc. domains, in order to develop complex and heterogeneous models for the enterprises.

In these conditions, ***econobotics*** represents the multidimensional and multifunctional technological context of developing solutions for the design of the enterprises together with their corresponding processes, such that they are able to develop the competitiveness reality through perceptions, decisions, and actions / evolutions in and/or upon the *TSE* space corresponding to their environment.

4. Econobotic problems and econobotic systems

The main concept in developing an enterprise according to the econobotics framework is the ***econobotic problem*** that must be determined and specified in order to further determine its conceptual solution as the ***econobotic applications.***

Definition* 1.** Let be $C_i = C(t_i)$ a configuration in the *TSE* space and $C_k = C(t_k > t_i)$ a goal configuration in the same space, if the transition $C_i = C(t_i) \to C_k = C(t_k > t_i)$ is obtained through actions in and/or upon the environment in an interaction context with the reality through perceptions and decisions, than $C_i = C(t_i) \to C_k = C(t_k > t_i)$ is an ***econobotic problem.

Considering definition 1, the following types of econobotic problems are presented below:

1. *The navigation problem* (fig. 3) is determined by the configurations: $C_i = C(t_i)$ representing the current position of the enterprise in the *TSE* space, and $C_k = C(t_k > t_i)$ – the goal configuration to be attained. The transition $C_i = C(t_i) \to C_k = C(t_k > t_i)$ realization implies actions in the *TSE* space, such that the goal is attained by interactions with the reality through perceptive information regarding the environment, and decisions relatively to the types of actions, and plan of action.

Thus, the navigation problem is an econobotic one.

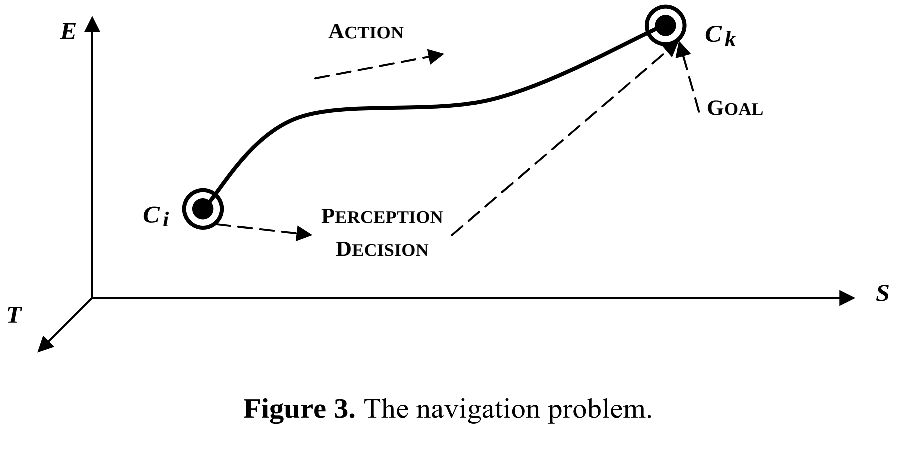

Figure 3. The navigation problem.

2. ***The tracking problem*** (fig. 4) is described by the following components: N_1 − the enterprise representing competition for N_1; $\Gamma_1 = \Gamma_1(t)$ − the determined, predicted or estimated trajectory of N_1 in the *TSE* space; N_2 − the current enterprise; $\Gamma_2 = \Gamma_{2t}(t)$ − the tracking trajectory of N_2 in competition in the *TSE* space.

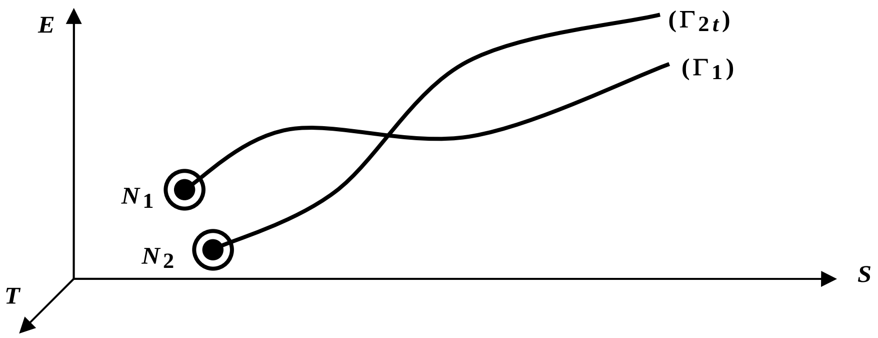

Figure 4. The tracking problem.

The corresponding configurations for figure 4 are $C_i = C(t_i) = \Gamma_1(t)$, and $C_k = C(t_k > t_i) = (\Gamma_1(t), \Gamma_{2t}(t))$, such that the solution of the tracking problem $C_i = \Gamma_1(t) \to C_k = (\Gamma_1(t), \Gamma_{2t}(t))$ implies:

- perceptions regarding N_1 and its evolution $\Gamma_1(t)$;
- decision regarding the actions to be taken by N_2 and the necessary trajectory $\Gamma_{2t}(t)$;
- actions executed by N_2 in the *TSE* space in order to realize the established evolution of N_2, $\Gamma_{2t}(t)$.

Thus, the tracking problem is an econobotic problem.

3. ***The fusion problem*** (fig. 5) represents an interception of an enterprise N_1 having an evolution $\Gamma_1 = \Gamma_1(t)$ by the enterprise N_2 through a corresponding trajectory $\Gamma_{2i} = \Gamma_{2i}(t)$, such that after the intersection moment t_j, $U(t_j) = \Gamma_{2i}(t_j) \cap \Gamma_1(t_j)$, the new generated enterprise N_{1-2} will have the evolution $\Gamma_{1-2} = \Gamma_{1-2}(t)$.

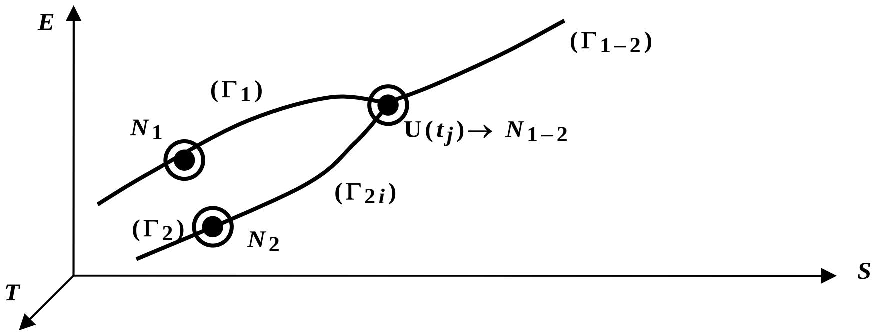

Figure 5. The fusion problem.

The transition to be solved is:

$C_i = C(t_i) = (\Gamma_1(t), \Gamma_2(t)) \rightarrow$

$\rightarrow C_k = C(t_k > t_i) = (\Gamma_{2i}(t)\ ,\ U(t_j) = \Gamma_{2i}(t_j) \bigcap \Gamma_1(t_j) \mapsto N_{1-2}\ ,\ \Gamma_{1-2}(t \mid t \geq t_j)),$

where the solution implies:

- perceptions of N_1 and its evolution $\Gamma_1(t)$;
- decision regarding the interception trajectory $\Gamma_{2i}(t)$, such that at the moment t_j the intersection of fusion is produced: $U(t_j) = \Gamma_{2i}(t_j) \bigcap \Gamma_1(t_j)$ and the reconfiguration of N_1 and N_2 into the new enterprise, N_{1-2} is performed;
- actions in the *TSE* space in order to execute $\Gamma_{2i}(t_j)$, $U(t_j)$, and reconfiguration of N_1 and N_2 into the new organization N_{1-2} with the new evolution $\Gamma_{1-2}(t \mid t \geq t_j)$.

Thus, the fusion problem is an econobotic problem.

At the conceptual level, the solutions for econobotic problems represent ***econobotic applications*** and their implementations are achieved by ***econobotic systems*** that are systems able of perception in the *TSE* space, decide and plan upon the necessary actions to be taken, and perform these actions in and/or upon the corresponding environment in the *TSE* space.

Considering the above conclusions, results that the enterprise is an econobotic system, and accordingly may be designed and developed by identifying the corresponding econobotic problems, and establishing the conceptual solution as the ***econobotic application of the enterprise*** (EAE) that represents the prototype level at which simulations will be performed and the final solution will be validated.

5. Functions and specific processes of the enterprises as econobotic system

Considering the above definitions of the econobotic systems, the following main functions of the enterprise are identified:

- F_1 – perception;
- F_2 – decision;
- F_3 – information and data processing;
- F_4 – actions execution in the *TSE* space;
- F_5 – the competitiveness environment evolution in the *TSE* space;
- F_6 – the human factor behaviour.

In order to solve specific econobotic problems, these functions are synergistically integrated through communication, collaboration, co-working, self-organization, and self-structuring, as in figure 6, where the interaction elements, between $F_1 \div F_6$, $\omega_{ij} = (\varphi_{ij}, \psi_{ji})$, form the informational set:

$$I = \omega_{ij} = \{(\varphi_{ij}, \psi_{ji}) : \varphi_{ij} \neq 0, \psi_{ji} \neq 0, \forall i \neq j, i, j = \overline{1,6}; \\ \varphi_{ij} : F_i \,|\, F_j \to F_j \;;\; \psi_{ji} : F_j \,|\, F_i \to F_i\} \tag{1}$$

such that, if one of the functions F_i, $i = \overline{1,6}$ is not performed $(\neg F_i)$, or if I is not formed $(\neg I)$ then the global function of the enterprise as econobotic system is not fulfilled.

In relation (1), $F_\alpha \,|\, F_\beta$, $\alpha, \beta = i, j$, $\alpha \neq \beta$ represents the set of actions of function F_α in the presence of the set of actions of function F_β.

The necessary condition for self-organization and self-structuring is that each function F_i, $i = \overline{1,6}$ is connected with at least another different function from the set $\{F_1, ..., F_6\}$.

In figure 6 are presented two functional architectures of econobotic systems, applicable to enterprises, according to the previous definition.

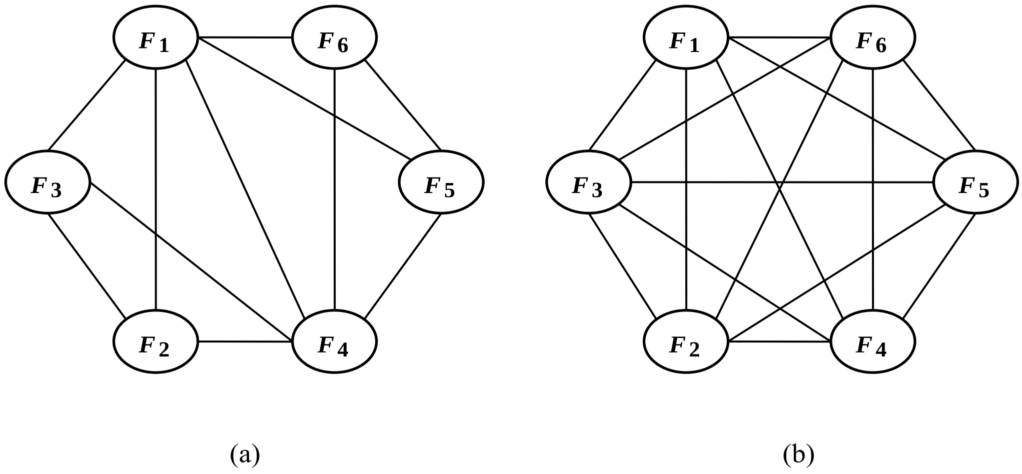

Figure 6. The synergistic functional context of the enterprise as econobotic system: (a) partially connected structure; (b) totally connected structure.
$F_1 \div F_6$ – the functions of the econobotic system.

In these conditions, the following dominant processes of the econobotic systems, and implicitly of the enterprises, are determined as following:

1. ***Environment identification in the TSE space*****:** establishes the states and configurations of the environment related to the econobotic problem to be solved.
2. ***Communication with the environment and the human factor in the TSE space*****:** data and information transfer between the econobotic system, environment, and human factor in solving the specific econobotic problems.
3. ***Decision*****:** determines the necessary actions necessary to be performed in order to solve the econobotic problem, together with their performance specifications, and attains the goal configuration in the *TSE* space.
4. ***Production*** / ***Solution implementation*****:** actions execution and thus effectively solving the econobotic problem.
5. ***Learning and experience accumulation*****:** information, data, knowledge and experience integration in structures that can be used later in solving specific or new econobotic problems.
6. ***Control / Management*****:** tracking and evaluating the specific parameters of actions, and minimize the deviations from their performance specifications imposed by the desired configuration in the *TSE* space.

6. The design framework of the econobotic systems

Due to its complexity, heterogeneity and synergistic integration, econobotic systems will be developed and designed in the framework determined by (fig. 7):

EB1. econobotic problem identification and specification in the *TSE* space;

EB2. development of the econobotic application that represents the solution for the problem determined at EB1, and that consists of the corresponding model of evolution processes and actions that must be performed in the *TSE* space;

EB3. functional design of the econobotic system;

EB4. structural design of the econobotic system;

EB5. global solution simulation and evaluation;

EB6. solution implementation, respectively econobotic system construction;

EB7. econobotic system's dynamic evolution in TSE space and continuous developments.

The main econobotic systems that can be developed according to the framework presented in figure 7 are:

- product oriented enterprises;
- service oriented enterprises;
- human factor in an working environment;
- any organization that generates influences upon the competitiveness environment in the *TSE* space;
- any decisional and acting entity regarding the competitiveness environment in the *TSE* space.

In this context, resources represent objects in the TSE space, upon which the econobotic systems act.

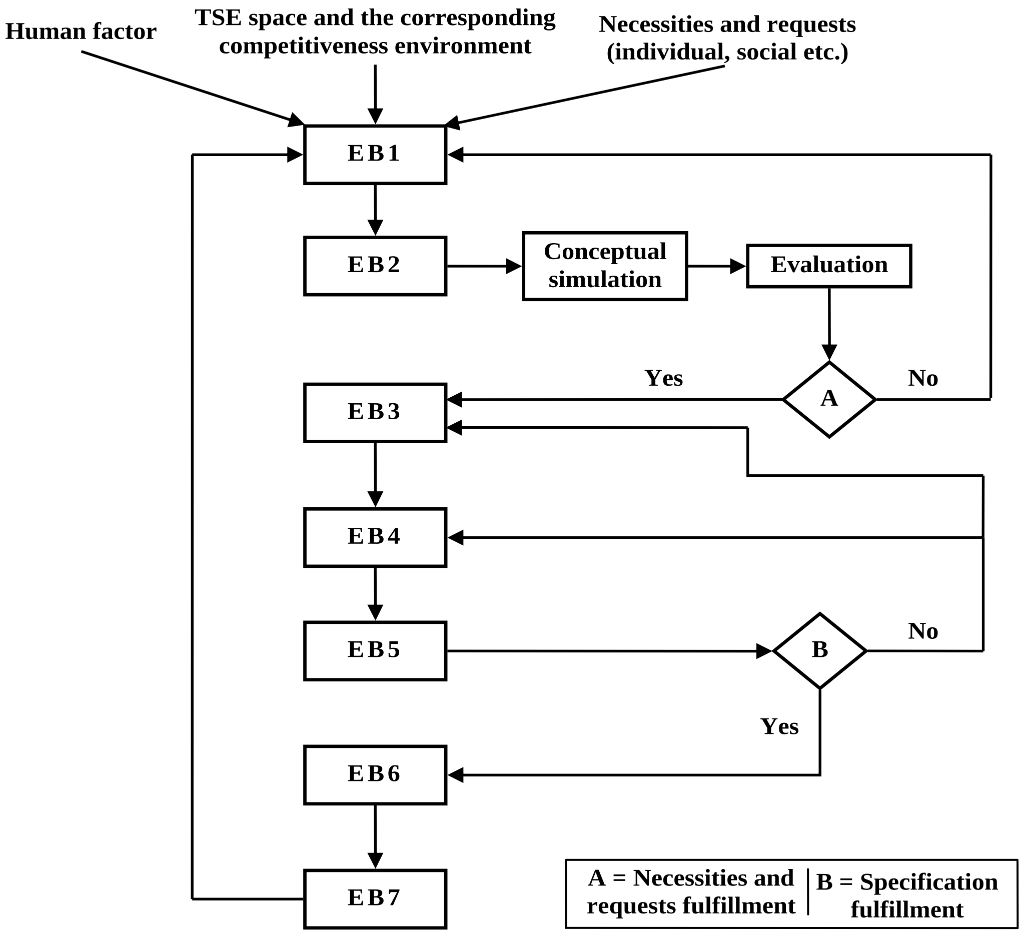

Figure 7. The design framework for the econobotic systems.

7. Conclusions

Econobotics is a new research field considered by the present paper, aimed to model the complex context of competitiveness in which enterprises and other organizations evolve.

From this point of view, econobotics is defined together with its fundamental concepts: the *TSE* space, the econobotic problem, and the econobotic systems.

The enterprises are highlighted as one of the most important type of econobotic systems, and accordingly, the general development and design framework of econobotic systems may be applied in enterprise's development, design and management.

The paper represents the research results in developing integrated models for representing and design the future enterprises in a complex technical, social, and economical space, the *TSE* space.

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