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## **POSSIBILITIES OF MATHEMATICAL MODELLING IN THE DYNAMIC TRENDS OF THE ECONOMIC INFORMATICS**

### **Introduction**

Very fast progress of all scientific disciplines and introduction of research results [1], [5] in practice is interpreted as the society dynamics or the civilization values dynamics both in the positive and the negative meaning of the word. Systemic engineering as a philosophic understanding of physical processes determination and cognition of this reality in the field of the “*General System Theory*” (Bertalanffy, 1923), new interpretation of systems as “*environment for management and sharing information between living and non-living organisms (social and technical systems)*” (according to the founder of cybernetics – Norbert Wiener, 1946) is inseparable part of the dynamics.

Definition of the new area of “*Models and modelling theory*” (by numerous authors especially in the second half of the past century) and new views of the active interpretation of mathematical language as a communication tool between systems and expressed in the area of “*Mathematical modelling*” contributed to the rational interpretation of real systems from the point of view of very fast interpretation of the real time in these systems and especially in cybernetic systems supported by modern “*Mathematical theories*” the application environment of the mathematics new concept of “*Artificial intelligence*” and “*Operational research*” are based on and which are gradually introduced in the modern cybernetics development. This modern cybernetics presents important space-time hierarchy of modern management and suitable re-arrangement of the cybernetic status space for optimal processes in the given cyberspace and safe management of processes from the point of view of cybernetics (cyber security) in the real time of the existing physical processes and processes of adaptability, training and learning in the new aggressive means of cybernetic wars, cybernetic aggression, bullying, etc. in the area of “*Theoretical cybernetics.*”

For the sake of the new interpretation of informatics (as the applied cybernetic environment) the paper opts to use the expression used world-wide “*cybernetic space – cyberspace*” as an environment of living and also non-living organisms, where transformations and information communication are used with the purpose of systemic definition of e.g. economic cybernetics and then definition of briefly expressible

recognition (system identification, recognition of scenes and environment of the given system), the created model of definition of the modelling process (with the aim of extremal regulation, optimal management, etc.) and definition of new possibilities to simulate real systems, i.e. especially cybernetic systems with the aim to create modern information society and knowledge society of the future for the application part of the life of the society – new conception of modern economic informatics.

The aim of the paper is to introduce partial results of the project “*Systemic integrated environment for intelligent models designing, modelling and simulations of modern cyberspace of enterprises*” to the professional public as well as the introduction of the topics and suggestions from the Brno University of Technology, EU in Bratislava, and in the enterprises which were analysed.

Based on the analysis [2], [4] of the tasks of the project FP-S-13-2148 (2013-14) the title of the paper “*Possibilities of mathematical modelling in the dynamic trends of the economic informatics*” as a brief expression of the current possibilities of modelling with non-linear dynamics of the defined trends in mathematics (applied – technical cybernetics) in the area if possible economic environment trends with the cybernetic environment (sub-system cyberspace of the so called economic cybernetics) is used.

In the defined cyberspace the fundamental approach is represented by the theoretical background of the systems and the possibilities of systemic integration application with the possibility to create models in the system defined environment of the economics, modelling and simulation of information systems using modern digital computers and especially the use of the new concept of mathematical modelling in the area of economic informatics and the currently estimated fast development of intelligent robotic systems on the background of the new knowledge economy gradually emerging on the civilization scene in dynamics background. The given selected methods of mathematical modelling provide us in the defined cyberspace with a complex view of a possible integration of the exact mathematical modelling and a new view of the future economic cybernetics in the developing of scientific research tasks in this system integrated area and deepening of further development of specialists and their knowledge and explainable practice processes in the necessary trends of economic informatics.

## **1 MATHEMATICAL MODELLING CYBERSPACE**

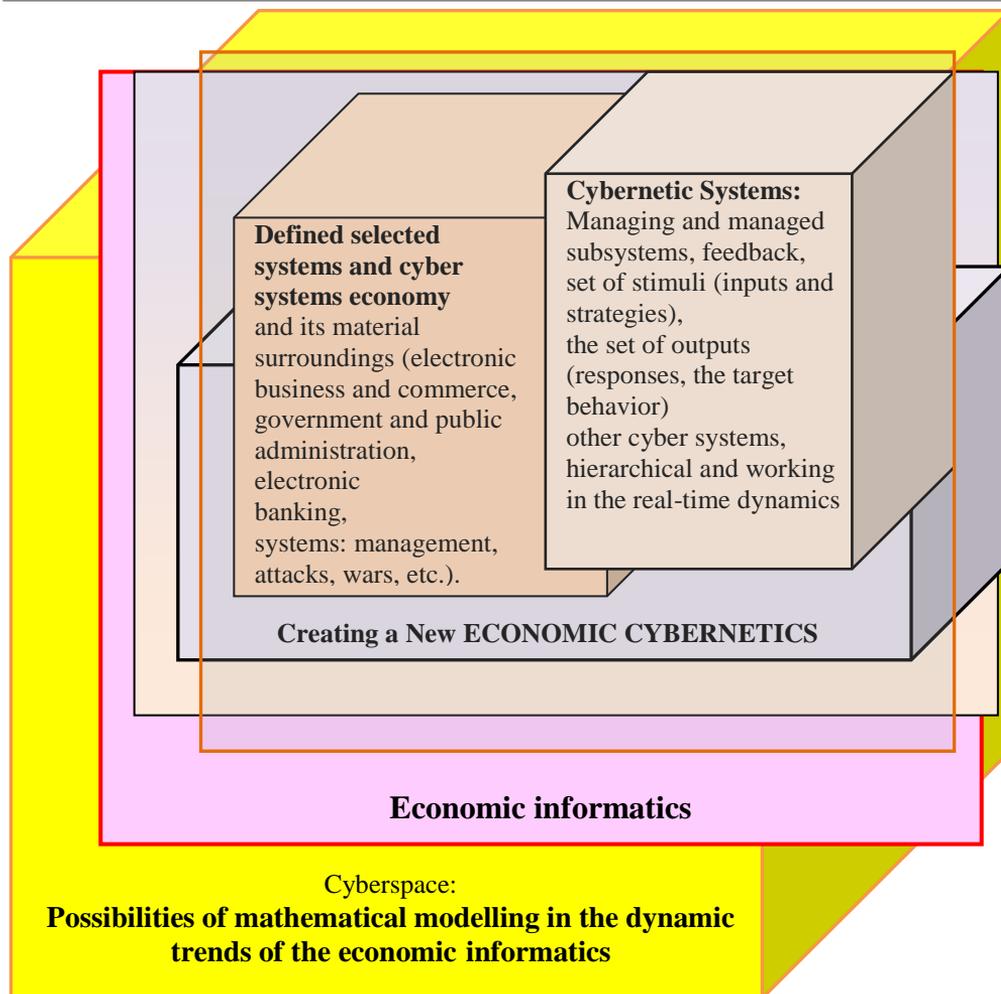
Source material [1], [3] the research is based on is represented by information sources accessible on the Internet from the database systems of selected university libraries and universities, selected virtual libraries and publishing houses, overviews of journals and collections of important conferences and also obtained data in the analysed enterprises.

Information sources profile has gradually been quoted in dozens of articles and conferences contributions as well as in lectures for students and post-gradual students in the applied “Management and economy of enterprise” and “*Economic informatics*”. Important information materials are presented and their evaluation in terms of the level of contribution to scientific disciplines is presented in papers and contributions and they are also part of some doctoral dissertations and theses of habilitation.

Brief description of the project is introduced in Fig. 1, where cyberspace is presented on the background of the model and the possibilities of mathematical modelling in the economic informatics trends dynamics, which is based on the systemic defined level of the selected economic level and important rules of economic trends which are necessary to express the dynamics of possible trends in the whole complex of the structure and behaviour of the systems affecting especially areas of electronic business and commerce, government and public administration of electronic banking and also systems: crisis, attacks, information wars, etc.

Important part of the task is to define precisely the spatially arranged (n-dimensional matrices) for controlling and controlled subsystems of cybernetic systems without which the existence of “*living and non-living organisms*” is impossible, feedbacks, sets of impulses (inputs and strategies), sets of outputs (reactions, target behaviour) and further important and significant cybernetic systems which are hierarchically organized and working in the dynamics of the real time of the newly emerging economic cybernetics. Including the systemic concept and systemic integrable environments necessary for future intelligent models creation, simulation of learning economic cybernetics models and in the future forming the base of the status space of gradual obtaining of experience arising from modelling and simulations so that the environments will be formed – as well as in other areas of the society – by unmanned environments eliminating administrative or unqualified (unjustifiable) economic decisions.

Preparation of specialists on every level of economic literacy will be focused to achieve this goal; especially related to the knowledge area of university graduates with respect to literacy related to informatics (or applied informatics interpreted in the context of social and technical environment). In this environment, important role will be played by reduction of boundaries between the social and technical environment (new cybernetic system – the contemporary computer and its peripherals, and a HUMAN BEING – user in the sense of the human-machine relation) while in the simulation process both parties will learn and obtain knowledge so that a suitable “*learning environment*” is formed. To achieve this, it is necessary to create conditions for the new concept and interpretation of “*possibilities of mathematical modelling in the dynamic trends of economic informatics*” now.



**Figure 1:** Systemic expression of the cyberspace of the possible background of the economic informatics dynamic trends models

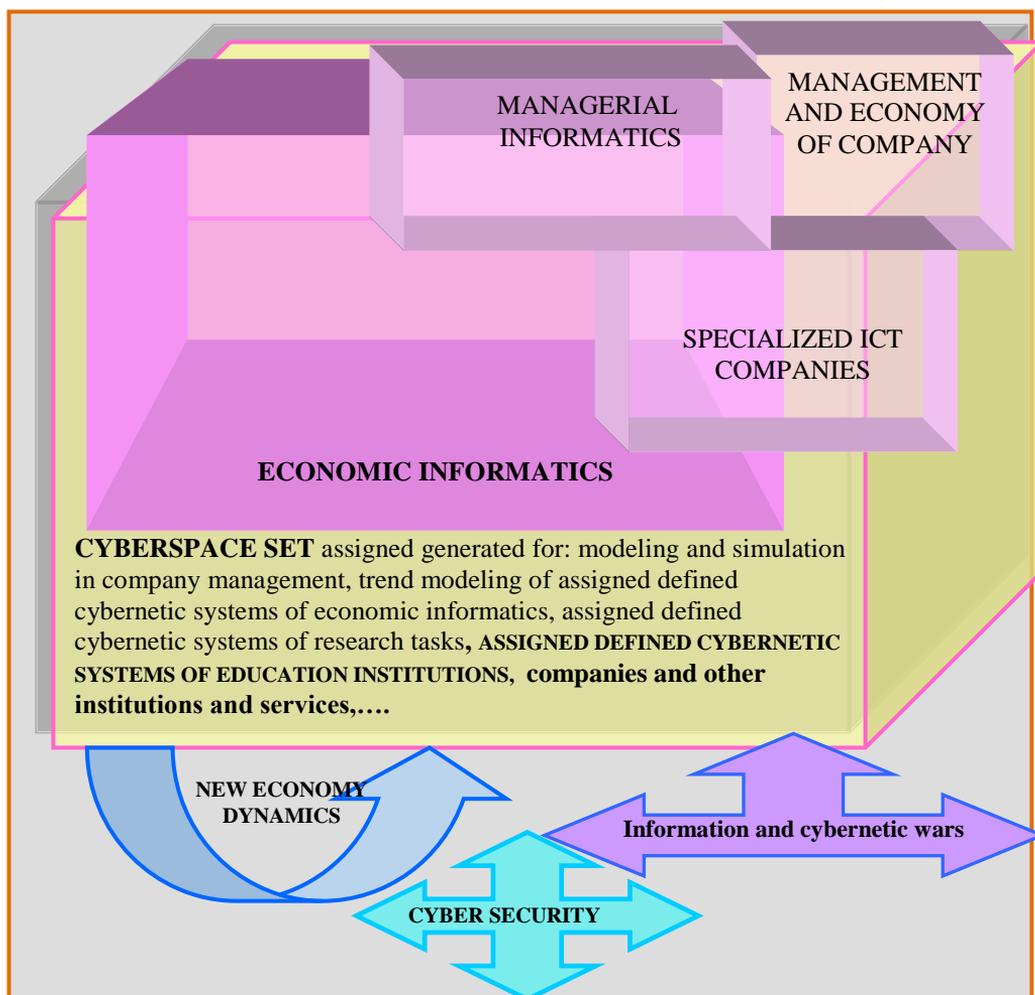
Source: the authors

## 2 ECONOMIC INFORMATICS IN THE NEW ECONOMY CYBERSPACE DYNAMICS

Schematic expression of the suitably incorporated “*Economic informatics*” is illustrated in Figure 1 and it is in the context of system understanding of the multi-dimensional concept of cybernetic systems considering other dimensions of inner and outer “*lifetime*” of cybernetic sub-systems and feedback connections, which are designed from the perspective of modern understanding of newly introduced cybernetic space for the purpose of expressing the economic informatics of the civilized world’s new economy.

**In the context of this research, mathematical modelling is interpreted as environment for the acquisition of values (“states”) of the mentioned environment to assess the existing quantifiable quantities and measurable indicators for modelling (e.g. optimizing management processes, or information data mining, or knowledge acquisition from the initial information set for knowledge bases) and later for acquisition of intelligent adaptable environment in the economic cybernetics.**

An important moment in the research was the assessment of these initial new mathematical modelling conditions regarding the complex concept of “*Economic informatics*”, “*Managerial informatics*” and application branch of recognition process in the area of “*Management and Economy of company*” briefly shown in Figure 2.



**Figure 2:** Systemic expression of intellectual environment in the cyberspace of possible dynamic trend model background of economic informatics.

Source: the authors

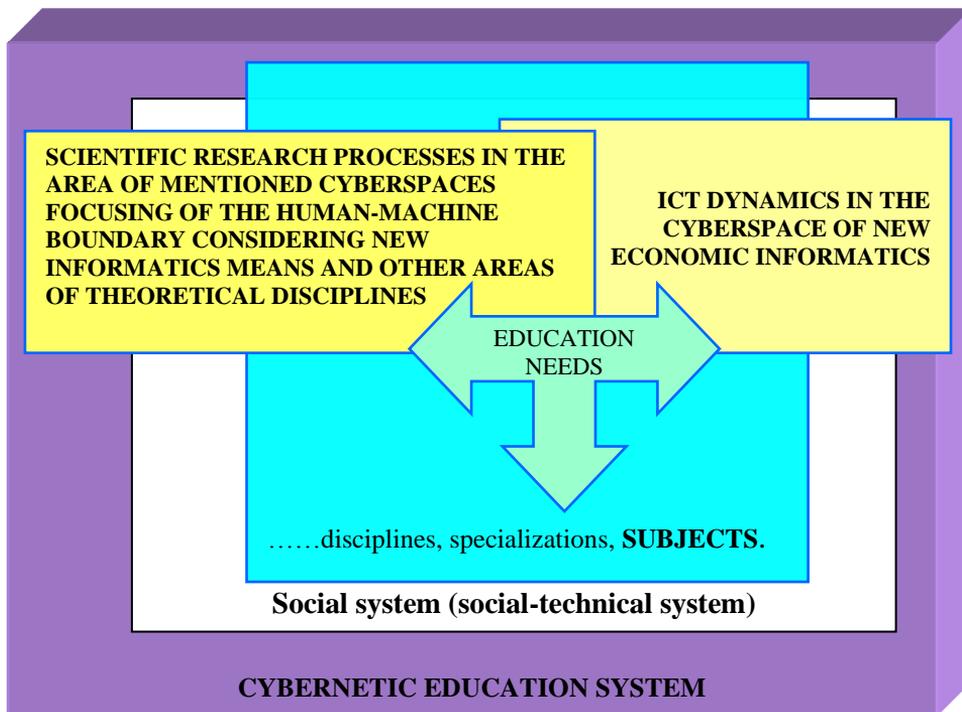
## **2.1 ICT Dynamics in the new economic informatics cyberspace**

Figure 2 provides us with the evidence that the economic managerial informatics will be more involved in the research activity as a subject as well as object in the changes process based on the development dynamics of mathematical models and modelling and also it is evident from the quickly developing new material environments and physical principles for purely fundamental changes in the existing ICT.

Technology and material changes for the ICS will be as follows: from solid to crystalline and gaseous form, from molecular to micro-particles, from silicon to carbon materials to cellular environments. From complex communication environments to new neuron forms of highly specified adaptable environment of digital and other environments – to new cybernetic secure and self-organizing environments on bionic level. Furthermore, from complex mathematical models to creating new modular oriented transformations to various environments, e.g. to optic and opto-electric modules and their coordinated systems and their new transformations of images and sounds to user forms of bionics.

## **2.2 Specially defined options of mathematical modelling in the cybernetic education system**

In Figures 2 and 3 options of defined cyberspaces are defined in brief as well as their system interconnection and also options for their integration into new environment, e.g. knowledge economics.



**Figure 3:** Cybernetic education system definition in the ICT dynamics, economic informatics, social system and composition of university subjects for professionals of possible focus in the applied informatics.

Source: the authors

Current analysis, executed within the solution of specific research tasks for selected research and education environments, clearly illustrates the future of applied informatics and specially created subspace of economic informatics. The given profiles imply that:

- Research processes will be based on areas of **rules interpretation and regularity of theoretical disciplines** at all levels of cybernetic education of professionals (creators of all forms of information society), users, providers, etc.
- Further important sub-system will compose from the above mentioned **area of modern dynamics of developing ICTs in the process:**
  - of constructively developing and **system interpreted ICT tools** for the application in various disciplines and the focus will be on education based on understanding of realized rules and regularities in the practical applications,

- of parallel use of ICT tools for the cybernetic system of education and development of **lifelong learning** of all mentioned profiles of social system,
- **use of mathematical model generation and modelling including simulations** to support the mentioned education:
  - with the goal of the **optimal use** of realized cybernetic systems introduced into practice,
  - with the goal of active participation in the training and learning of the entire social-technical environment with further goal of **adaptive intelligent cybernetic system generation** for the knowledge economics,
  - with the goal of active **support of quality electronic business** and commerce,
  - with the goal of active activity of secured cybernetic system by the **cyber-security** means (with the knowledge of theoretical disciplines of cybernetic education) and suppressed **cybernetic wars environments** (cyber-attacks under the knowledge of theoretical background of these information weapons origins and the information generated critical situations in the world).

### 3 DISCUSSION

Partial conclusions of the research provide us with food for thought and confirming directions of the realized work at universities and also specialising study programs materials. The existing proportions of theoretical disciplines in the economy economics are important and especially very good systemic information background means understanding in the company management. The constructions of applied informatics for user needs are very interesting.

From the mentioned themes expressed from the point of view of cybernetics in this article, it is evident that the development of applied informatics (economic and other) will result in the strengthening of mentioned theoretical disciplines (systems, cybernetics), mathematical modelling (modern mathematical modelling of cyberspace management structures in technical and economic environment) and perfect understanding of physical principles and theoretical foundations for the modern communication environment based on the information theory.

## **Acknowledgment**

The paper is a partial outcome of the specific research project „*ICT and Mathematical Methods Application For the Enterprise Management*” and the thematic part of the project: „*Systemic Integrated Environment For Designing Intelligent Models, Modelling and Simulations of the Enterprise Modern Cyberspace*” Internal Grant Agency of the Brno Technical University, registration no. FP-S-13-2148 (2013-14).

## **Conclusion**

Cybernetic view of the mentioned problem has its foundation briefly illustrated in this article and it will have its foundation in the rational solution of mentioned intelligent environments based on new technologies so that the existing digital environment of cyberspace enables the new understanding of theoretical physical environments as well as the applications in the knowledge economy.

The above mentioned approaches of the possible mathematical modelling provide in the existing cyberspace a complex view of the possible integration of exact mathematical modelling and the new view of economic cybernetics in the development of scientific research tasks in this system integrated area and in the perfecting of further development of the knowledge education of professionals and explainable processes of practice in the necessary directions of the economic informatics.

## **Key words**

information and communication technologies (ICT), economic informatics, economic cybernetics, cyberspace, mathematical modelling

## **JEL Classification**

C02

## **LITERATURE**

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## RESUMÉ

V článku ve stručnosti uvádíme některé současné a zásadní vývojové tendence, které vidíme především v posláních nových informačních a komunikačních technologií s ohledem na dynamický rozvoj nové ekonomiky a uplatňování moderního kybernetického pohledu na „řízení a sdělování v živých a neživých organismech“ ve zcela novém pojetí kybernetického prostoru a v oblasti moderní aplikované kybernetiky. V tomto kyberprostoru bude zásadním přístupem teoretické pozadí systémů a uplatnění systémové integrace s možností tvorby modelů v systémově vymezeném prostředí ekonomiky, modelování a simulace informačních systémů na moderních číslicových počítačích, a to především s využitím nově pojatého matematického modelování v oblasti ekonomické informatiky a současného rychlého rozvoje inteligentních robotických systémů v dynamice znalostní ekonomiky. Uvedené vybrané metody matematického modelování dávají v zavedeném kyberprostoru komplexní pohled na možnou integraci exaktního matematického modelování a nového pohledu ekonomické kybernetiky v rozvíjení vědeckovýzkumných úkolů v této systémově integrované oblasti a v prohloubení dalšího rozvoje vzdělávání odborníků ve znalostech a zdůvodnitelných procesech praxe v potřebných směrech ekonomické informatiky. K možnému modelování dávají vybrané matematické metody v zavedeném kyberprostoru komplexní pohled na možnou integraci exaktního matematického modelování a nového pohledu ekonomické kybernetiky. Z uvedených námětů vyjádřených kybernetickým pohledem v tomto článku vyplývá, že rozvoj aplikované informatiky bude znamenat posílení především v teoretických disciplínách, matematickém modelování a dokonalém chápání fyzikálních principů a teoretických východisek pro moderní komunikační prostředí na základě teorie informace. Tento příspěvek je dílčím výstupem řešeného projektu specifického výzkumu.

## SUMMARY

In this article there are briefly mentioned some current and fundamental development tendencies mainly in the role of the new information and communication technologies considering the dynamic development of new economy and the application of modern cybernetic view of the “*management and communication in the living and inanimate organisms*” in the entirely new concept of cybernetic space and the area of modern applied cybernetics. In this cyberspace there will be fundamental approach the theoretical background of systems and the possibilities of application of system integration

with the possibility of model generation in the system defined environment of economics, modelling and simulation of information systems using modern digital computers mainly using newly incorporated mathematical modelling in the area of economic informatics and current fast development of intelligent robotic systems in the knowledge economy dynamics. Mentioned selected methods of mathematical modelling in the introduced cyberspace provide a complex view of the possible integration of exact mathematical modelling and the new view of economic cybernetics in development of scientific research tasks in this system integrated area and perfecting the further development of education of professionals in knowledge and the explainable practical processes in necessary directions of economic informatics. Beside the possible mathematical modelling there is in the incorporated cyberspace provided the complex view of the possible integration of exact mathematical modelling and the new view of economic cybernetics. From the themes expressed by the cybernetic view in this article it is evident that the development of applied informatics will mean the strengthening of theoretical disciplines, mathematical modelling and perfect understanding of physical principles and theoretical foundations for the modern communication environment based on the theory of information. This contribution represents a partial outcome of the specific research project solution.

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