BUILDING KNOWLEDGE ABOUT STRATEGY FOR GROWTH: SYSTEM DYNAMICS APPROACH [1]

Stanislava Mildeová
Ingeborg Němcová
University of Economics in Prague

Abstract

Various social (and ecological subsystems), shaping our world, are inter-related in a very complex manner. Globalization brings with it a large increase of interactions, the complexity of the decision-making problem grows, the number of unstable and disturbing effects in the competitive environment rises. We can not keep up with this level of mutual interdependence when developing our mental capabilities. We are only able to understand a small number of variables in mutual interaction and cannot imagine dynamic consequences. Many models allow the determining of the optimal solution for the given moment. We make a decision and we cannot verify how this decision will influence the system in the future. Every system shows dynamic properties. Our mind is not able to link together all the relationships between individual items (moreover, we often do not know which items), nor to imagine their development in time. If we want to understand the complexity of the EU economy and the behavior of the system within the process of time, we have to understand its structure. This includes defining the elements of the system and marking their mutual relationships. Understanding based on learning the structure of the system and its implicit formulation is the beginning of innovative thinking, and detecting the proper reasons of the problems. The main aim of the paper is to contribute to the topic of building knowledge about strategy of growth with a discussion of a strand of systems theory: System Dynamics. The authors will try to develop a theoretical knowledge and made practical recommendations for the use of system dynamics methods in EU conditions, especially for decision making support in problems which are related to complex social systems with a high level of complexity. Feed-back loops are recognized as the main methods for describing the problems of growth of the EU. It points out the possibilities of using the principles and tools of system dynamics methodology, as well as the limits of system dynamics. The turbulent global economic environment of the EU economy requires changes in thinking and behavior. The further purpose of the following paper is to discuss the possibility for improving systems thinking and for the support of "complexity thinking". It is useful to provide some kind of system detachment and information on how system dynamics helps in solving complex problems within complexity in the economic environment, mainly with respect to the integration. According to their usual long-run orientation, the simulation system dynamics models are often used for various purposes – testing of the decision-making strategies and policies. The paper will emphasize the importance of system dynamics applications for the simulation of decision-making processes, strategy learning, better possibility of predicting the behaviour of complex systems (information "ex ante" and not only "ex post") and the possibility of the system's long-term optimization. It is obvious that we can not consider any solution to be the correct one and it is necessary to preserve the holistic view while respecting the fact that every approach has its contributions and limits.

Keywords:

System dynamics approach, knowledge society, strategy for growth, complexity, EU system.

Introduction

The paper is based on scientific publications and practical experience which show that human systems thinking and understanding of dynamic relations is not sufficiently evolved, and that traditional training does not fulfill the requirements set by the complexity of social systems. (Mulej, M., 2005)

Jay W. Forrester: "Many of the stresses in modern life arise because people feel buffeted by forces they neither understand nor know how to control. Such sense of helplessness can be traced to not understanding

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the systems of which we are a part. Events that seem capricious when viewed locally are often understandable when seen from a broader systems perspective." (Forrester, J.W., p.9, 1994)

Non-systematic interferences with this system result in only seemingly working solutions, which combat the effect of the problem, but not the cause, and numerous examples from practice confirm that these solutions often bring long term problems. (Sterman, J.D., 2000), (Breierova, L., 1997)

In the context of these necessities we will discuss how to solve specific problems in systems with dynamic complexity and possibilities for the implementation of system dynamics models as a useful tool for describing the problems of growth of the EU. System dynamics methodology is founded on a systematic approach based on a rational cause and effect relationship. Even if the real world exhibits a large measure of complexity, it can be recorded in a system dynamics model. But it is not so simple, and it is still an open question in theory and practice. (Schwaninger, M., 2006).

At the same time this seems to be significant, reflecting important changes connected with the membership of the new countries in the EU, and the functioning of the internal market as a new challenging environment for companies. (Mildeová, S., Němcová, I., 2005), (Stričík, M., 2008) It is typical that modern ITC contributes to a significant acceleration in the flow of information. (Doucek, P., Novotný, O., 2009). The new environment, and the related complexity and turbulence of the international environment, necessitates changes of managerial behavior.

Understanding the application of system dynamics principles provides the managers with a powerful tool for the securing of suitable strategies in company management and for the business policy. Highly complex problems found in business practice (Sterman, J.D., 2000), could be solved with system dynamics, for example: looking for an optimal strategy, support for communication between stakeholders, planning, the possibility of testing impacts of variable scenarios, or principles of sustainability, where holism comes up. (Yamaguchi, K. ,1997) It also helps to "widen the horizons" for possible variants of solutions, while keeping a global view on the management strategy process. (Němcová, I., Larcon, J., .P, 1998). It contributes to getting over mental barriers and to stimulating the strategic thinking of a manager.

System dynamics methodology

Systems dynamics belongs to the servo mechanic thread and it was originally developed by Jay. W. Forrester (Forrester, J. W., 1961) to help in the managerial decision-making process. It deals with the behavior of systems as they change in time.

The analysis of the advantages and weaknesses of system dynamics begins with the following questions: "What knowledge can be obtained by creating the system dynamics model and its practical application to completion of the changes needed in the system" and "What is the role of the learning process with implementation of these changes in the real world?"

System dynamics help us to grasp the knowledge we have about the particularities of the world around us. It is a discipline which aids our better understanding of the EU systems; in order to understand behavior in complicated situations; to better recognize structures that are not evident and to see those that are fundamental for understanding complex situations.

John D. Sterman: "System dynamics is a perspective and set of conceptual tools that enable us to understand the structure and dynamics of complex systems. System dynamics is also a rigorous modeling method that enables us to built formal computer simulations of complex systems and use them to design more effective policies and organizations." (Sterman, J.D., 2000)

In recent years the system dynamics concept has changed because of its inclusion in a number of more general system thinking concepts and systems methods. These attempts moved system dynamics from the hard concept to a much softer paradigm. (Forrester, J. W., 1992)

In the sixties the original system dynamics concept was very focused on mathematical modeling and the replication of real world behavior using clear positivist/objective approaches. Such a philosophical paradigm is called "hard system dynamics". Some authors included system dynamics between functionalistic, deterministic, and hard managerial disciplines. (Forrester, J. W., 1991) Today system dynamics has left functionalistic beginnings, and has been moving toward phenomenology and approaches close to interpretative and learning paradigms. (Forrester, J. W., 2007)

System dynamics model

Model building with stock and flow diagrams or (and) causal loop diagrams, and simulation, is at the core of system dynamics. Dynamic modeling and simulation help us to understand how things work. It help us to avoid mistakes and expand our mental models, so we can understand causalities, causes and their effects. (usta, M., 2007)

Reality changes in real-time. System dynamics models, in contrast, change in compressed time, which allows us to see future possible developments. The simulation allows us to look into the dynamic complexity based on an interaction between components. Through the simulation we are able to control time. (Mildeová, S., Vojtko, V., 2006)

We found system dynamics models to be an environment in which it is possible to think and invent new ways of solving complex problems. It represents a shift from the view of the world as a set of action –

reaction relationships to a mutually interconnected dynamic process. This enables us to think about what is going on around us in a different way. (Mildeová, S., 2003)

We see that an improvement in our ability to solve problems is a necessary presupposition for the ongoing development of cognition. How can we reach the required shift in thinking and the development of cognitive thinking? How can we understand important characteristics of complex systems such as feedback and delay?

Simulation with systems dynamics models improves the cognitive process, allows the enhancing of our mental models, and can help us with the desired shift in reasoning. (Mildeová, S., 2006) Based on such improvements we can expect plenty of benefits in various areas – from sustainable development of companies and society, to applications overlapping the frontiers of different fields, e.g., polities and economics.

As opposed to using mental models separately, the computer system dynamic models enable us to take advantage of the use of dynamic characteristics, including feedback activity, and so provide logical outputs. Thanks to the execution of simulations, they give us the unique opportunity to understand the complex impacts of delays and nonlinear relationships.

Comparison to other approaches

Required holistic system understanding is supported by the application of a simulation that is not connected only with system dynamics methodology. Various simulation approaches could be used for the simulation of economic systems. Several of them are based on a system of mathematical equations, the coefficients of which are based on historical data. The solution of the equations is usually named as the optimal solution to the problem. The optimum is a maximum (of profit, turnover etc.) or a minimum (of costs, time). (Mildeová, S., 1994)

The approach based on historical data (for example econometrics) is a powerful tool for decision support; however the conditions when it was first used were different from today. (Čancer, V., 2006) It shows that predictions based on statistics are becoming less precise in the turbulent environment of today. Methods for understanding and predicting system behavior with a model cannot only be based on statistical data anymore, but also on an understanding of the structure influencing the system‘s behavior. For the modeling of the unstructured complex system of today, the behavior of which exhibits dramatic dynamics, it is necessary to use a different tool, or to combine various approaches and integrate the econometric models in a dynamic framework. (Smith, P. C., Van Ackere, A., 2002), (Adda, J., Cooper, R., 2003)

By using system dynamics for the modeling of systems we can eliminate the linearity frequently occurring in econometric models. System dynamics understands non-linearity as one of the major features of complex social systems. We believe that due to non-linearity, detailed and dynamic complexity, and the difficult determination of the target function in complex economic systems, the usual hard optimalization methods are usable only in a limited manner. However, this should not belittle their potential contribution, especially in heuristic approaches.

Multi-methodology concept

The dynamics of the economic environment, and its internal contradictions, make using extrapolation and classical prognostic methods impossible. For the modeling of the unstructured the EU complex system of today, the behavior of which exhibits dramatic dynamics with unpredictable impacts, it is necessary to use a different tool, to combine various approaches or to integrate them.

It means, for example, to accept the multi-methodology concept which is a method that combines and connects techniques, methods and methodologies from the same, and also different, paradigms of system thinking. (Mingers, J., Brocklesby, J., 1997) Such synthesizing and dialectic methodology, which arose out of a combination of two widely used system-based methodologies – soft systems methodology (Checkland, P., Scholes, J., 1999) and system dynamics - is soft system dynamics methodology (Lane, D., Oliva, R., 1998), (Rodriguez-Ulloa, R., Paucar-Caceres, A., 2004). This corresponds with the fact that recently the system dynamics concept has converted to the general procedures of system thinking movement and systems methods (Umpleby, S., Lucy, L., 2005); premises of system dynamics today leave their functionalistic beginnings tied to epistemology, and move toward phenomenology to approaches close to interpretative and learning paradigms. This process is very augural, and system dynamics is one of the most promising methods for solving complex problems. (Forrester, J. W., 2007)

Limits

At the same time however, being aware of the limitations of system dynamics methodology is necessary. The limits of systems dynamics models in form of computer models, are currently well known. (Sterman, J. D., 1991) Another problem in model creation is that a real soft system, and especially a complex social system, cannot be explicitly described with absolute accuracy. Unless we set a purpose of the model in advance, we will run a large risk of including an unnecessarily large number of variables in the model. The model would become nontransparent and would present only a “dirty mirror” of the system it was supposed to depict. The model is not the system, it is only its depiction. Some authors directly warn against such analysts who recommend modeling the whole system instead of the problem. (Sterman, J.D. 2000)

Sometimes agent-based models are built instead of system dynamics modeling techniques, particularly in order to simplify the implementation of critical discrete events. Also there is increasing interest in combining the agent based and system dynamics modeling methods.

Conclusion

The world is getting more complex. Globalization as a processes of integration brings a high level of complexity. The term complexity signifies large increase of interactions, the number of unstable and disturbing effects in the competitive environment rises. The complexity of the EU economy and the growing complexity of an economic system of the EU members necessitates the application of modern approaches, including systems theories as well. It is important to remember that the systems movement has many roots and one of the strands of systems theory is system dynamics.

Although other methods may lead to understanding of behavior patterns too, we can conclude that using system dynamics models enhances the process for understanding the complexity of social systems, and facilitates the decision making process. Decision-making in economic integration frameworks is a complex activity, the recognition of the impact of various policies is very complicated.

Systems dynamics has been chosen for understanding the problem in its dynamic, frequently trans-disciplinary, context. We founded system dynamics models to be an environment approaching problems in national economy from an international point of view.

System dynamics can contribute to the experiments and study of real economical processes and that it can be used for various simulations. The impact on the new member states of the EU could be demonstrated on higher competitiveness of post-communist countries in the upcoming EU environment, higher resource allocation efficiency, consequences of various market structures, etc.

Keeping in mind the current limitations of system dynamics, we can consider the systems dynamics methodology an adequate method, and systems dynamics models suitable tools to support improvements in decision making in the long run and a significantly shorter learning process respected system changes of complex environments, connected with both e*conomic transition* and economic integration,

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