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The technology of the strategic goal-setting and monitoring of a system development on the basis of cognitive mapping

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Abstract

The cognitive mapping methodology is a suitable soft computing technique for analysis and simulation of dynamical ill-structured systems and situations. This paper proposes a technology of the strategic goal-setting and monitoring of a system development on the basis of cognitive mapping. The technology combines heuristic cognitive mapping technique with formal quantitative analysis.

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Keyword: ill-structured system and situation; goals setting of development; monitoring; decision making; cognitive map.

1. Introduction

Quantitative Management offers a systematic and scientific approach to problem solving and decision making in complex situations of uncertainty and conflict. This approach focus on finding optimal (best) answer for a problem by using quantitative models and methods based on them. One significant component of the quantitative management approach is the availability of objective information about the problem and possible solutions for the development of appropriate mathematical models and methods.

In real situations, one can often face the problem consisting in not only and not so much in making the choice between alternative solutions as in analysis of situation for revealing real problems and causes of their appearance. Understanding of problem is indispensable precondition for finding admissible solution. At this stage experienced advisers and analysts are involved in work, and arsenal of applied methods, as a rule, includes heuristic expert methods (brainstorm, interviewing, etc.).

Modern decision maker's situations became significantly much more complicated, they are characterized by fast variability, interaction of a set of diverse and interdisciplinary factors (political, social and economic,

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scientific and technical, technological, etc.). The essential part of factors is weakly formalizable since their measurement is itself a complex problem, and their interaction in a situation often has an unobvious character. In addition, these situations are characterized also by the presence of active stakeholders whose beliefs and interests lead to variety of the directions of the situation development. These situations are classified as ill-structured [1]. The number of factors describing such situations can be measured by tens and all of them are plaited in a web of cause and effect dependences. It is extremely difficult to see and realize the logic of development of events on such multifactor field and at the same time it happens to change the goals and make decisions on the measures providing development of a situation in the necessary direction.

This limits applicability of traditional methods for finding optimal (or even satisfactory) solution to control problems for ill-structured systems and situations, where the formulation of a quantitative mathematical model may be difficult or impossible [2, 3]. One of the causes is lack of objective information on condition of ill-structured system in conditions of weakly controlled and varying environment.

Uncertainty of development goals of ill-structured system and criteria for choosing control solution can also be noted. As a rule, dissatisfaction with current condition of system is realized by a decision maker, but his knowledge of causes and possible means of changing situation in ill-structured system are fuzzy and conflicting. Numerous studies of decision making processes confirm that the decision maker (or expert) does not think and does not make a decision only in quantitative terms. He manipulates qualitative information in form of hypotheses (assumptions), intuitive concepts, and semantic images. He sees the solution finding process as, first of all, searching of solution idea, where quantitative estimations play auxiliary role.

Thus at the practical decision-making based on formal models and methods and applied to complex and ill-structured situation control, formalization of representations of people (experts, analysts, decision-makers) about a situation, its problems, and even about people's goals and interests inevitably turns to be the essential stage of the problem solving. Therefore, in researches on formal problem solving methods it is spoken with increasing frequency, especially in recent decade, about the cognitive approach, cognitive researches, cognitive mapping of complex objects, problems, situations, even human representations (see, e.g., [3-7]).

In this paper, we present the technology, which is in the development stage. Today, the technology includes a open set of approaches and techniques aimed at early stages of solving system development problems in ill-structured situations: diagnosing problems and dynamic goal-setting in the framework of strategic planning and management. Dynamic goal-setting supposes the formation and argumentation of the strategic goals of the system development and the directions of their achievement; and the possibility of their correction based on the monitoring of the situation. The technology is applicable to objects of different scale (enterprise, corporation, region, state, military organization, etc.).

2. Description of the technology of the strategic goal-setting and monitoring of a system development

We present a scheme of the process of the strategic goal-setting and monitoring of a system development within the framework of the following limitations:

- the type of the situation model describes stable situations in which there are steady states by factors;
- only parametric control of the situation is considered without a change of the map structure.

2.1. The situation model

The situation model is a cognitive map with initial values of factors and some other parameters. *Cognitive map*. In this work term "cognitive map" refers to the family of models representing the structure of causal (or, that is the same, cause-effect) influences of mapped situations, objects or systems. Formally, the obligatory base of all models of the family is a directed graph, which nodes are associated with factors (or concepts) and arches are interpreted as direct causal influences (or causal relations, connections, links) between factors.