

COGNITIVE APPROACH AND ITS APPLICATION TO THE STRATEGIC MODELLING OF ENTERPRISES

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One of the most difficult problem for management which works out the company development strategies, is the understanding of complicated causal chains, that determines the influence of external and internal conditions of the enterprises on aims and characteristics of worked out strategies. Nowadays this problem is getting more complicated by growing difficulty and instability of economic environment, which cause the numerous uncertainty and risks.

In these conditions application of popular support instruments meets with serious difficulties and restrictions. The necessity of new instruments occurs – instruments which are adequate to creative character of today's management that is based on research approach and long-term dynamic analysis of strategic decisions.

Ideas and methods of cognitive modelling (new direction in analysis theory and management complicated ill-structured problematic structures) open wide opportunities for creating new instruments.

In the paper is explored main definitions of cognitive modelling, its basic instruments – cognitive charts and their analysis methods. Meanwhile is offered dynamic analysis method of strategies, which consider the characteristics of enterprises activity in today's conditions. This method can be used for optimal strategy search in context of possible dynamics of external and internal factors of enterprises. The example of application of the method is also discussed.

The paper consists of three parts and one conclusion. The first parts reflects common characteristics of cognitive approach and strategy modelling, the second one shows common scheme of task of strategy working out from position of “model theory” of intellectual decision-makers, in the third part the example of application of cognitive approach to enterprises strategy modelling is given.

1. Common characteristics cognitive strategy modelling

Cognitive approach is a method of studying and managing situations basing on formation and study of cognitive models (cognitive charts). Cognitive chart is a structure (network) of cause and effect relations between the components of the system under survey and its surrounding environment, reflecting the conception of management person(s) about the structure and functioning of this system. The components of cognitive chart are:

1) basic factors – concepts characterizing the system and its surrounding environment according to the management person(s), as well as cause and effect relations between basic factors.

Such a factor division let realise wide range of model experiments, for instance,

- construction of different strategy versions,
- to prognose the utility's behaviour (its goal form) for every strategy version,
- to prognose the utility's behaviour in various dynamics of external environment factors and etc.

The level of factor activity and factor interaction strength are assessed by linguistic scale mentioned below:

Table. 1. Linguistic scale for assessment of sign and interaction strength of cognitive chart factors.

X	Linguistic assessment (Z)
0,1	VERY_LOW VERY_LITTLE VERY_WEAK
0,3	LOW LITTLE WEAK
0,5	MEDIUM MODERATE
0,7	HIGH GOOD STRONG
0,9	VERY_HIGH VERY_GOOD VERY_STRONG

Although the term “cognitive approach” began to be used from 1960s actively, the elements of this approach were used lots of years ago. These elements were used during the scientific schools such as behaviorists, mentalists and etc. However, the difficulties in clarifying the behavioral events on the basis of “stimulus-reaction” made the behaviorists to apply to interim variables such as “cognitive map”. In the late 1950s and beginnings of 1960s the psychologists who were inspired with the successes in the field of computer, started researching the information processing by human intensively and offering the models for their explanation, which were the “prototypes” of cognitive approach. Cognitive approach was born in the research field of cognitive processes, which led to

establishment of cognitive psychology. However, it went through the different fields of science and at the moment is on one of the main dominating approach almost in the all spheres of the science.

Cognitive revolution happened in 1950-1960s. The first cognitive research center was established in Harvard in 1960. This date is indicated as development of cognitive science (cognitology), which includes philosophy, cognitive psychology, neurophysiology, anthropology, linguistics and theory of artificial intellect.

The latest direction of this approach is connectionism, which describes cognitive system like the network of correlative elements. However, this direction is not wide-spread yet.

The main issue of the representatives of cognitive approach was proof of the important role of the knowledge in human behavior. One of these representatives is J. Piage, who was researching the cognitive stages of children development.

P. Jane was calling her cognitive approach to the personality as "behaviorist" and was paying more attention to the role of self-control. According to his approach self-control considered to be the result of permanent contact of individual with surrounding him/her people.

According to U. Naysner the cognition exists in every act of the person: in feelings, mind, thinking, imagination and etc.

A specific feature of the cognitive modeling method differing it from traditional methods is the possibility of conducting multi-factor and multi-criteria analysis and management of development of ill-structured situations (combining vitally important stages of divergence, convergence and transformation of project cycle (J. Jones)) that is not possible through traditional mathematical calculations.

Methodology of cognitive modeling is addressed for analysis and decision-making in complicated situations. This methodology was suggested by Axelrod. (Axelrod R., 1976). It is based on modeling of experts' subjective imaginations about situation.

Cognitive modeling is a periodic process and consists of several interrelated stages main of which are: cognitive structuring and development of cognitive model of surveyed situation; structural analysis of cognitive model of situation; scenario based modeling of development of situation.

A. Cognitive structuring. Identification of factors characterizing internal situation in the company and external processes (social and economic, political, technological and etc.) influencing its development. The cognitive structuration stage is formed as a cognitive chart (CC) describing a set of basic factors of the company and cause and effect relations between them. At present general feature for all works of cognitive approach is a cognitive chart as digraph (symbol or weighed) over a range of factors. (Pospelov D.A., 1986)

For each factor its value (or tendency of change) characterizing the subject, event or process associated with the given factor is determined. For cause and effect relations character and strength of interrelation between basic factors is determined. Values of appropriate variable are given on the basis of a linguistic scale, i.e. in words in a native language and each is denoted by a corresponding figure in the interval (0;1).

In this stage on the basis of set of basic factors also are determined: subset of target and subset of controlling factors, also, initial values and tendencies of change of basic factors. Factors relating to the company or to external environment, which the management of the company may influence on, are selected as controlling factors.

The basic factors are selected by **PEST-Analysis**, which divides these aspects into 4 main groups:

Policy

Economy

Society

Technology

B. Structural analysis of cognitive chart. This analysis is implemented to study structural features of CC which are important from the point of view of management practice. Such features include:

1) Non-conflicting purposes. The main point of the non-conflicting purposes vector is to ensure that desired change of some target factors does not result in undesirable change of others.

2) Non-conflicting purposes and controlling factors. Managing the situation is the change of controlling factors to the extent that would result in desired change of target factors, i.e. in the direction of planned dynamics. In connection with this, effectiveness of influence of controlling factors on targets of the company and conformity of

controlling factors with the targets of the company is surveyed. Acceptable effectiveness of controlling factors is determined by the degree and character of their influence on the target factors. Conformity of controlling factors with targets vector means that no change of them should cause change in any of the targets in undesired direction.

At present a range of mathematical methods of structural analysis of CC has been developed.[4] However, in practice, structural solutions achieved through these formal and mathematical methods require interpretations in the subject field, which are not always possible.

B. Scenario modeling of development of situation. This is conducted for comparative analysis of development of situation in different incoming managing impacts. Modeling may be conducted in self-development and controlled development situations. Development dynamics is modeled using F. Roberts' apparatus for linear dynamic system. (Pospelov D.A., 1986) *Self-development* implies maintaining existing tendencies of factors and in essence, it is extrapolation of current situation taking into account mutual influences of basic factors. *Controlled development* of situation implies purpose targeted influence on one or several controlling factors. Impulsive change of current value of the factor which is transferred to other factors through the chains of impacts serves as management.

Modern concepts of cognitive approach to the management (purposes and crucial definitions, CM structuring principals and adequacy criteria, types of CM and their analysis methods) are described in [2, 3, 4, 5]. In the framework of these concepts cognitive strategy modelling is strategy modelling based on cognitive charts (CC), which search for optimal strategies of the company. CC – is explicit model which reflects subjective ideas (individual or collective) of experts about conceptual structure of researched company strategy and its external environment.

For set of basis factors are set the subset of goal factors of the company X^c ($X^c \subseteq X$) and subset of managerial factors X'' ($X'' \subseteq X$) of internal and external environment of the company. The content of these factors are determined by well-known strategic diagnostics methods (PEST-analysis, SWOT-analysis and etc.). The existing CC analysis methods are oriented on the problems such as strategic dynamics prognosis of the company in unstable surroundings, scenario analysis and search for optimal strategic solutions, retro perspective analysis of adequacy of CC and etc.

Systemization of CC and their analysis methods, structure and reliability assessment principals, which make it possible to block typical mistakes of explication of expert knowledge (Dermer D., 1997) and to raise adequacy of CC are given in (Abramova, 2007).

Depending on conditions and restrictions of strategy working out task the appropriate CC types and their analysis methods can be chosen.

2. Conceptual scheme of strategy working out task

Conceptual scheme of common task of the ill-structured objects management was offered by acad. D.A.Pospelov. Strategy development task is a particular case of common task and in terms of cognitive approach it can be presented as following:

$$P(G, M); S^0 \xrightarrow{U(P)} S^c,$$

where $P(G, M)$ – is full task knowledge, including G – cognitive chart of the task, M – strategy development methodology, which includes chart structure and analysis methods and scheme of issue solution management; S^0 – company's current state; S^c – company's goal state; $U(P)$ – economic strategy that determine strategic steps sequence, leading from S^0 to S^c .

Goal state S^c is formally presented as $C = (X^c, D(X^c))$, where $D(X^c)$ – is vector of dynamics assessment of goal factors, which determines desirable changes of goal factors:

$$D(x_i^c) = \begin{cases} (+1), & \text{if increase of importance and speed of goal factor } x_i^c \text{ changing is desirable,} \\ \approx 0, & \text{if stabilization of goal factor } x_i^c \text{ is desirable,} \\ (-1), & \text{if decrease of importance and speed of goal factor changing } x_i^c \text{ is desirable.} \end{cases}$$

Depending on character of macroeconomic environment (stable/unstable) two task versions are possible: static and dynamical. In static version search for effective strategy conclude in selection of one of the strategic step leading from S^o to S^c . In dynamical version search for effective strategy conclude in selection of strategic steps sequence leading from S^o to S^c .

The search is realized by model experiments on strategy CC in regimes of self-development and controlled development (direct and inverse problem) of economic situation. This and other analysis methods are used: “impact analysis methods“, “dynamics analysis methods“, “scenario analysis methods“, “management impact search methods“ and etc.

Applied versions of dynamic analysis models, especially dynamic analysis models of company’s strategy require the adjustment of the “strategic step” definition. Each of strategic steps is action which changes the situation. The changes on each step can be realised by operators, which are described in the Table 1. Herewith the list of operators is divided into sign cognitive chart (SCC) and balanced cognitive chart (BCC).

Table 1. Operators of strategic steps

Operators	Types of CC	
	BCC	SCC
1. Change of some managing top sign in particular time.	●	●
2. Amendment in some new tops and new arches in particular time.	●	●
3. Change in some arch sign in particular time	●	●
4. Change in some arch weight in particular time	●	
5. Amendment of a new arch among existing tops.	●	●

Using these operators management can construct numerous strategic alternatives, which reflect various scenes of situation development. As soon as the fixed quantity of strategic alternatives is determined, you can define the structure of strategy selection problem. It may have different formulations and configurations of target form of PC. For example,

1. Finding optimal strategy (the shortest, the cheapest and etc.) which meets normative restrictions in some parameters of utility’s internal and external environment
2. Finding a strategy, which maximizes (minimizes) the meaning of some tops (for instance, profit of enterprises, market share of enterprises, product quality, pollution of environment and etc.) in case of restrictions in signs of some other tops (for instance, financial resources, time resources, human resources and etc.)
3. Finding a strategy, which doesn’t let every variable of entity have very big or very little meaning. (it is called “dynamically stable” strategies).

The strategy building process ends with achieving expected result, which is the possibility to achieve a condition appropriate to the goal form of PC in particular restrictions situation.

3. Examples of cognitive strategy modelling

The attempts of cognitive strategy modelling we made were concerned with the solution of management tasks in three research projects:

Project 1. Strategy perspective assessment of offshore-oil company, functioning conditions which are characterized with typical current tendencies: slump of world oil prices, global financial crisis, increase of governmental impact, toughening of ecological standards. The work was implemented together with Petroleum Engineering Department of A&M Texas University (College Station, Texas, USA) in the framework of constructive cooperation agreement.

Project 2. Exposure of crucial competences for strategic development task of telecommunication companies, which deal with development, installation and service of industrial, administrative and medical information systems, iP- and CTi- systems – telephoning for communication statement and corporative clients. .

Project 3. Management efficiency analysis in poultry enterprises of one of the holdings. The task was specified by critical situation, which occurred due to the increase of raw materials and feed prices, decrease of finished product prices, the raise of competitive pressure, the difficulties in obtaining of commercial credits, lack of qualification of managerial staff, drop of income share, which is considered for refinancing of the enterprises (especially because of corruptibility of controlling units and etc.).

Now let's learn brief characteristics of developed cognitive models for above mentioned projects. The main characteristics of developed cognitive models are: business-strategies, defined due to the results of strategic diagnosis of enterprises; structure type of cognitive chart, describing the logic of concept; cognitive chart building and analysis methods; the scale of signs and pace of cognitive charts factor changes.

Characteristics of models, which were developed in the mentioned projects, are described in the Table 1.

Table 1. Characteristics of CM, developed in Projects 1, 2, 3

Number of Project	Business-strategy concept	Structural type of CC	CC building and analysis methods	Scale of factor and tendencies assessment
Project 1.	“Resources-oriented” (Grant R., 1987)	Graph	<i>Building methods:</i> SWOT-analysis. PEST-analysis. Implicative repertory gratings of S. Hinkle. Interaction matrices <i>Dynamics analysis:</i> Models of lineal dynamics of F. Roberts. Scenario-analysis method.	Bipolar-linguistics Grade 5
Project 2.	“Competency school” (C. Prahalad, G. Hamel, 1990)	Matrices (Abbasov A.M., Karayev R.A., Safarli I.I., 2008)	<i>Building methods:</i> Isicava Diagrams. VRIO-analysis (Barney J., 1987). Business-process model eTOM.4.0 (Intern. Telecommunication Union/Standardization Sec-tor). “Consumer opinion model” (IBM, US). “Resources model” (American Society For Quality, US). <i>Impact analysis:</i> Fuzzy casual matrices analysis (Abbasov A.M., Karayev R.A., Safarli I.I., 2008). Hierarchy analysis method of T. Saati.	Linguistics Grade 9
Project 3.	“Migration strategy” (Kleyner H. B., Tambovtsev V.L., Kachalov R.M., 1997)	Graphs	<i>Building methods:</i> SWOT-analysis. PEST-analysis. “Competitive analysis model” (M. Porter, 2003). Methods of psycho-semantics and multidimensional non-metric scaling. (M. Davidson, 2003). <i>Dynamics analysis:</i> Dynamics quality models based on time rules and logic.	Bipolar-linguistics Grade 5

5. Conclusion

The experiments of cognitive strategy modelling development and testing in the above-mentioned projects showed that in practical tasks of economic spheres cognitive modelling faces the same issues which the other intellectual technologies meet. These are “the width of problem definition”, robustness by “paradigm shift”, necessity of specialist-mediator (knowledge engineer, meta-interpreter-cognitologist, specifier), necessity of support means in development and maintenance stages and etc. In general, the experiments of cognitive strategy models development and testing showed the following:

1. In case of strategy modeling general principals of cognitive map building offered in (works of Institute of Management Problems of RAS, 2007) requires modification which reflects methodological characteristics and concept determined by enterprises of strategic planning [1, 10].
2. Cognitive strategy modelling acquires a practical importance only in the framework of strategy planning methodology which includes phases of macro-economic and marketing analysis (Karayev R.A., 2004). Ignorance of these phases reduces cognitive strategy models into mathematical objects which are far from reality of economic practice.
3. The issue of selection of scheme of problem solution management caused wide discussion. Firstly, we applied the scheme offered by specialists of Institute of Management Problems of RAS (Avdeyeva Z.K., Kovriga S.V., Makarenko D.I., Maksimov V.I., 2007). However, the analysis showed that particular scheme realizes “situation-decision” algorithm type, i.e. realizes not strategic, but reactive style of management and can't be used for

generalization of economic strategy in unstable environment. For such kind of problems are needed the schemes which realize “situation-strategy-decision” algorithm type. Consequent researches showed that the issue of development of such scheme type is not trivial and it can be considered as one of directions of further improvement of cognitive approach.

4. Cooperation with employees of the enterprises showed that they didn't have well-defined opinion regarding adequacy and efficiency of cognitive strategy map. Beside of it, 8 of 11 displayed active interest and considered that cognitive modeling – is perspective and useful technology. Our observations showed that cognitive modeling is useful support means, which stimulates perceptive and creative activity of strategy developers in harder phase of “strategic thinking” (Mintzberg H., 1994) – in phase of strategy synthesis.

5. Set of methods of structural-conceptual formalization of cognitive maps directed to the increase of reliability of cognitive models, can be enhanced at the expenses of including popular methods developed for analogous purposes in industrial and architectural projecting theory, in experimental psychology and knowledge engineering.

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