INTELLIGENT MECHANISMS OF THE CORPARATION DEVELOPMENT FUNCTIONING AND THE PROCESS OF INVESMENTS

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Keywords: *Corporation, adaptation, intelligent mechanism, multiple criteria decision making, plant, control, Investments, control, corporation, capital drain*

Summary. The paper presents the results of researches and developments of multiple criteria decision making in the Intelligent Mechanism corporation functioning and the process of investments. New paradigm for the corporation adaptation provides new multiple criteria decision making to establish adaptive manufacturing system on the background of its plants. The advancements that occur in both the development and practice of the multiple criteria decision making deals with self-learning and self-organized systems are considered. Drawing from experience gained in implementing intelligent control to a varied range of manufacturing systems, the paper highlights the need for a multiple criteria decision making in the multilevel self-learning and self-organized corporation. Particular attention is directed toward adaptations of the widely used self-learning algorithms in an attempt to increase the effective applicability, range of self-organizing control with the aid of artificial intelligence methodology.
Multiple criteria decision making is used to control the process of the corporation development by means of the investments. New paradigm for new decision about capital drain emphasizes the advancements that occur in both the development and practice of decision making about investment attractiveness of the business and investment climate. The theorem about sufficient conditions of the definite direction of the capital flow between two businesses of the corporation is given. This theorem determines multiple criteria for decision making in the process of investments. With the aid of this theorem measurement means and multiple criteria for monitoring investment attractiveness of the business are found. These multiple criteria are the indicators of the corporate investment climate and simultaneously the function of the parameters both the domestic and the international regimes such as prices, efficiency of investment, taxes, trade and customs rules etc .

1. Introduction

Technological changes provide the progress of the corporation and its plants. But these changes produce also gap between the most effective ("rich") and other ("poor") plants. Many plants have no possibility for learning and adaptation to these changes and need the support from the center of the corporation. Developed corporation provide some efforts to diminish this gap and to improve their functioning. To reduce the risks and likelihood of the corporation instability it is possible to apply adaptive control principles. Adequate adaptive procedures provide identification of controlled object structure and parameters of environment and, finally, generating the decision making use of current information, obtained from the plants, in order to achieve the optimal state of the system as a whole. The poor plants support should correspond to the level of this gap between rich and poor plants in a way used in adaptive control systems.

From the other side, systemic investigation of the problems dealing with the design of the adaptive systems to control corporations, including as the main component analysis and the account of the human factor effect. It should be understood as an activity manifestation of the staff or collectives of the plants (elements of control systems) is caused by the availability of their own aims, not necessary coinciding with the goal of the system in its entirely [1]. Such elements may utilize available information channels connected with the control center in order to improve the current or future state. From the other side, "active" staff deals with the process of this support may predict the results of the adaptive control procedures and to use that knowledge to reach their own aims. In fact, in many cases support given to poor plants had no effect because of the failure of the mechanism used (corruption, distortion of information etc.). For example, one of the important feature of such failure is the activity of the plant bureaucracy used their possibilities to manipulate supporting resources. Progressive adaptive mechanisms for the plants functioning are intended for eliminate this activity.

2. Corporation, plants and technological changes

The technological changes are created by high technologies (high-tech). Advanced technology produces both positive and negative effects of plant functioning. First of all, the technically advanced systems that are in existence, as well as those being built, can be used effectively to help staff to realize the benefits that are possible with the present-day high technology. From the other side, potential of high-tech often is accumulated in a major leading plants. They supply high-tech all over the world. To provide new high-tech it is necessary to realize R&D, know-how etc. That needs appropriate intellectual and financial resources. The prices of high-tech goods and services are mainly not competitive prices because of the monopoly on the results of R&D and know-how. From the other side, price of traditional goods, provided by developing plants, are under strong competitions. For this reason investigations and investments in high-tech are in most of cases preferable. Financial and intellectual resources drain from developing to leading plants. The result of the capital and brain drain is the lack of financial and intellectual potentials in developing plants. It becomes more and more difficult to provide R&D, know-how and new high-tech. Therefore technological development produce economical rupture between leading and developing plants. That provides likelihood of plant crisis, and as a consequence tensions between different plants. This provides obstacles to the realization of a more stable set of relations.

3. Adaptive Mechanism of the of the Corporation Functioning

System researches of organizational systems control sciences include an analysis and taking into consideration of a human factor effect should be understood as an activity of the people or collectives (elements of control system). It is caused by the availability of their own aims, not necessarily coinciding with the goal of the system in its entirety. Such elements may utilize available information channels connected to the center to improve a current or future state.
This approach is based on the analysis of the problem dealing with designing the adaptive mechanism of functioning (AMF) of the two-level organization included the Center on the upper level and the Agent as the farseeing active element on lower level. The role of Center is played by owner. The role of Agent is played by the management of the supported plant. The AMF

includes both adaptive procedure **A** for parameter estimation and procedures of decision making: planning **P**, resource allocation **R** and stimulation **S** (see fig. 1).

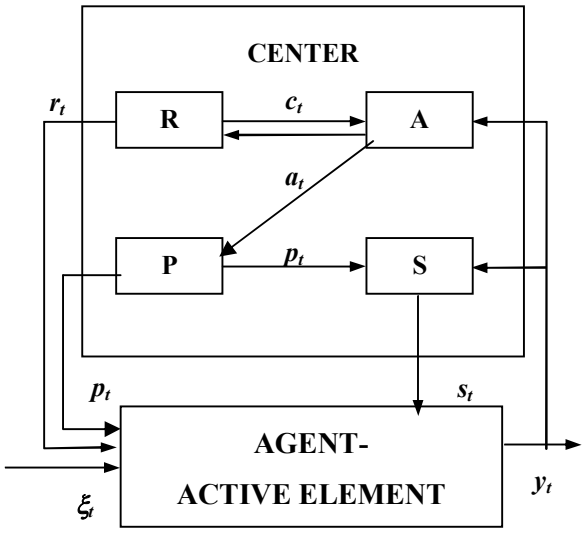

Fig. 1. AMF structure. Here a_t – adaptive parameter,
p_t – plan, r_t – resources, s_t – stimuli, ξ_t – noise, y_t – output, t – time period.

A method to avoid undesirable distortion of information consists of designing the so-called progressive AMF wherein the present value of the Agent long-term goal function corresponding to the solution of the game with the Center increase with the growth of the efficiency of the Agent functioning [2]. The designing of AMF caused the development of the approach based on the obtained problem solutions of progressive AMF synthesis. Burkov and Tsyganov [3] made detail consideration of two AMF main types. The first one is intended for maintaining the processes of the state forecasting, planning and control of the Agent. Under consideration are the adaptive procedures of time series forecasting and designing of regressive model. The second type i.e. rank AMF, is designed to provide information for learning of decision making (classification and pattern recognition). They are used mainly for adaptive estimation of the parameters of the decision making procedure, control and stimulation of the Agent. In some cases both expert adaptive mechanisms derived by Tsyganov [4] can be used.

4. Intelligent Mechanisms of the Corporation Functioning

In the previous item model of adaptive mechanisms for the corporation functioning had been discussed. Real plant regimes are much more comprehensive and need intelligent control systems. Drawing from experience gained in implementing intelligent control to a varied range of large scale systems, Burkov and Tsyganov [3] highlights the need for a multilevel self-learning and self-organized systems. Particular attention is directed toward adaptations of the widely used self-learning algorithms in an attempt to increase the effective applicability, range of self-organizing control with the aid of artificial intelligence methodology. On the other hand, as a rule the possibility to control of a plant in dynamics with no complete information, is based on intelligent information systems (IIS). They realizes model, identification of control objects structure and

outside parameters, predictions, rules of multiple criteria decision making, and forms the base of control actions on the basis of current information, received from the elements, to attain the systems aim on the whole. To avoid information distortion, passed by the elements to the center of the system, it is necessary to consider the problem of information system designing in a total problem of procedures synthesis such as planning, regulation and stimulation accepted in this control mechanism.

In recent years the newly appeared direction in the theory rapidly develops as well as the practice control for hierarchic organizations with a stochastic structure. It has been connected with the designing of the intelligent functioning mechanisms (IFM). The IFM includes IIS, and procedures of planning, regulating and stimulating. In the IFM information received in the process of element functioning is used by the center for multiple criteria decision making and achievement of the systems aim. These IFM ensure possibility to identify the internal structure of elements and their parameters as well as the utilization of internal elements resources in accordance with the center goal. Tsyganov and Shishkin [5] indicate that the main types of IFM are:

- Learning functioning mechanisms,
- Self-organizing mechanisms,
- Expert intelligent mechanisms.

Learning functioning mechanisms (LFM) provide the possibility of estimating the parameters of the organizational potential in its dynamics, supplying more information to plan the output indices at the account of learning processes. Self-organizing mechanisms should combine learning and planning for output plant indices (the way it is done in LFM) with the control of plant inputs, i.e. direct influence on the potential of an plant. In expert intelligent mechanisms (EIM) the knowledge base is the part of IIS. EIM combines learning with indistinct and qualitative commands from the center and control on these commands basis. To design such mechanisms it is necessary to create hierarchic computerized systems with such intelligent possibility as multi-level learning and multiple criteria decision making. The knowledge base consists of:

- main knowledge base includes well-known dependences, multiple criteria for decision making, any accurate data and the results of individual and collective expertise,
- system of knowledge acquisition functioning in an interactive mode with the decision makers who are responsible for a problem solution and answering the question: “what may actually happened, if…?”.

With respect to EIM synthesis the idea of theoretical results consists in the fact that with the sufficiently flexible information usage to solve problems of planning, control and incentives the optimum will be reached. As a result – there appears the possibility of potential identifying on extra basis of received information and gradual slow output to the required level of development. The developed approach is directed to creation of EIM, including procedures of analysis and forecasting of plant potential with a high degree of approximation and procedure of decision-making. The approach suggested to the solution of the problem of adaptive control for the plant regimes implemented by Grishutkin and Tsyganov [5] to management of the intangible technologies.

Let us consider corporation included plant which provides microelectronic wares. Customers order small series or some examples of these wares. Let us describe intelligent mechanism of this corporation functioning on the market. Below we consider both a theoretical approach and practice of Experimental Corporation for Scientific Device Production to create flexible manufacturing systems to adapt to market conditions. Property of adaptively realized on the background of system integration, includes CAD/CAM and management systems. In this complex

intelligent functioning mechanism module principle is used. That means complex IFM consists of learning, self-organizing and expert intellectual mechanisms of functioning.
First of all consider the system of support multiple criteria decision making concerning taking order to provide some microelectronic wares. This system of the multiple criteria decision making includes two subsystems: economical efficiency estimation, and technical efficiency estimation. Both economical and technical efficiency estimations are based on results of preliminary computer applied design of concrete microelectronic ware. Technical efficiency estimation subsystem include multiple criteria decision making, i.e. aggregation of the technological estimation, R&D level, level of quality, manufacturing capacity, period of manufacturing, etc. Economical efficiency estimation subsystem although include multiple criteria decision making and is based both on direct costs calculations and the value of price offered by customer.
Necessary data are obtained from the customer order, special data base, includes prices on set of parts, needed to provide the product by this order, different manufacturing costs and expenses (such as work, fuel, raw materials) and special knowledge base including different norms. These data and knowledge are introduced into corresponding local learning functioning mechanism to produce local quantitative efficiency estimation, and modified norms will be used for local estimation in a future. They are calculated by appropriate learning procedure of knowledge acquisition. These outputs of local learning functioning mechanism are the same times the inputs of corresponding local expert intelligent mechanisms. Then outputs of EIM are both qualitative estimation (rank), and norms for ranking in a future, calculated by appropriate procedure of learning pattern recognition. This procedure is an important part of knowledge acquisition. Local ranks in different areas are joined by special multiple criteria decision making procedure used knowledge base that gives the complex rank of given order. Complex rank and local ranks and estimations create the background for acceptance or rejecting the order.
On the second stage, in case of acceptance the order, CAD of the microelectronic wares take place. It is realized on the background of local computer network. On the third stage, CAM takes place. There is a special intelligent mechanism to control direct costs. First of all, necessary data are obtained from the described data base, includes different manufacturing costs and expenses (such as work, fuel, raw materials) and special knowledge base including norms of this costs and expenses. These data and knowledge are introduced into corresponding local learning functioning mechanism to produce both local quantitative estimation of costs and expenses, and modified norms, will be used for local estimation in a future. These norms are calculated step by step, by appropriate learning procedure of knowledge acquisition. These outputs are the same times the inputs of corresponding local expert intelligent mechanism. Then outputs of EIM are qualitative estimation (rank) of costs and expenses, and also modified norms for ranking in a future, calculated by appropriate procedure of learning pattern recognition.
Local ranks in real time are processing by special multiple criteria decision making procedure used knowledge base that gives the complex rank of manufacturing costs and expenses. Complex rank and local ranks and estimations create the background for intelligent information systems, monitoring and controlling of manufacturing costs and expenses.

5. Multiple Criteria Decision Making about Investments

The technological changes are created as by high technologies (high-tech) so by appropriate investments. They produce both positive and negative effects of corporation evolution. First of all, the technically advanced systems that are in existence, as well as those being built, can be used

effectively to help staff to realize the benefits that are possible with the present-day high technology. From the other side, potential of high-tech now is often accumulated in a major leading corporations. They supply high-tech all over the world. To provide new high-tech it is necessary to realize R&D, know-how, investments, etc. That needs appropriate intellectual and financial resources. The prices of high-tech goods and services are mainly not competitive prices because of the monopoly on the results of R&D and know-how. From the other side, price of traditional goods, provided by corporations of the developing countries, are under strong competitions. For this reason investigations and investments in high-tech are in most of cases preferable. Financial and intellectual resources drain from developing to leading corporations. The result of the capital and brain drain is the lack of financial and intellectual potentials in developing businesses and countries. It becomes more and more difficult to provide R&D, know-how, investments and new high-tech. Therefore technological development produces economical rupture between leading and developing corporation&businesses. That provides likelihood of corporation crisis, and as a consequence tensions between different businesses. This provides obstacles to the realization of a more stable set of domestic, regional and international relations.

One of the important ways to diminish a gap between leading and developing businesses is to minimize capital and brain drain. Let us consider the problem of capital drain. The concept of control mechanism of corporation derived by Tsyganov [6] is applied to manage capital flows between leading and developing business (or between leading and developing corporations). The mathematical approach used the modified model of the developing active element described by Burkov and Tsyganov [1]. Under consideration is the corporation provides two business processes. Potential of each business rises in accordance with the equation:

$$q_{it+1}=A_i q_{it}+B_i u_{it}, \quad q_{i0}=q^*_i$$

where q_{it} – potential (value of capital stock) of i-th business, $i=1,2$, u_{it} –investments in i-th business in period t, A_i and B_i - positive coefficients, t - number of period, $t = 0,1,...T-1$. The profit of each business is:

$$z_{it} = C_i q_{it},$$

where C_i is profit per unit q_{it}, $C_i>0$, $i=1,2$. The total profit of the corporation is:

$$z_t = z_{1t} + z_{2t} = C_1 q_{1t} + C_2 q_{2t}$$

Total investments of the corporation u_t are equal to the total profit:

$$u_t = u_{1t} + u_{2t} = z_t$$

The purpose of allocation of these investments is to maximize present value of the corporation:

$$W = \sum_{i=1}^{2} \sum_{t=0}^{T-1} \rho^t z_{it} \xrightarrow[u_t]{} max$$

where ρ is a discount rate, $\rho<1$, T - horizont for business planning (farseeing) of the corporation.

Theorem. Total investments in period t, $1 \le t \le T-1$, are allocated in the business 1 (i.e. $u_{2t} = 0$), if:

$$I_{1t} > I_{2t}, \; I_{it} = A_i B_i [1-(\rho C_i)^t] / (1-\rho C_i), \; i = \overline{1,2}. \quad .$$

This theorem gives sufficient conditions about of the definite direction of the capital flow between two businesses. It determins multiple criteria about investments (MCAI):

$$I_{it} = A_i B_i [1-(\rho C_i)^t] / (1-\rho C_i), \; i = \overline{1,2}, \quad t = \overline{1,T-1}.$$

With the aid of the theorem and MCAI measurement means and criteria for monitoring of the capital flow can be found. If MCAI satisfied the condition of the theorem then it should be income of the investments in business 1, and outcome of the capital from business 2 in the period t, $t = 1,...,T-1$.

Statement. The business 1 is called as the capital attractor if all the investments are allocated in this business:

$$u_{2t} = 0, \qquad t = 1,...,T-1$$

Consequence 1. The business 1 is the capital attractor if:

$$I_{1t} > I_{2t}, \quad i = \overline{1,2}, \quad t = \overline{1,T-1}.$$

If MCAI satisfied the condition of consequence 1 then it should be stable income of the investments in business 1, and outcome of the capital from business 2 in each period t, $t = 1,...,T-1$.

6. Parameters of the Investment Attractiveness of the Business

In this approach MCAI $I_i = (I_{i1},...,I_{iT-1})$ is the vectors indicator of the investment attractiveness of the i-th business in the corporation. Let us determine parameters of the investment attractiveness of the i-th business. Suppose that q_{it} – value of capital stock; z_{it}–income. Then $A_i = 1-\alpha_i$, where α_i – coefficient of the depreciation of capital stock;

$$B_i = E_i (1 + s_i),$$

where E_i – efficiency of investment, s_i – coefficient of the support of investment in i-th business. Profit per unit

$$C_i = [(1-h_i)(1+u_i)P_i v_i - 3_i] G_i - \alpha_i$$

where: P_i - world market price, h_i - income tax, u_i – custom tax, v_i – rate of exchange of i-th currency; $3_i(m_i)$ – cost of factor production: $m_i = \{m_{il}, l = \overline{1,L}\}$ - tariffs on heat, electricity, energy, tronsport etc.; G_i – efficiency of capital stock;

$$D_i = 1 - r_i (1 - a_i \alpha_i C_i^{-1})$$

a_i – depreciation tax credit, $0 \le a_i \le 1$, r_i - net income (profit) tax.

So MCAI is the function of the parameters both the domestic and the international regimes such as prices, efficiency of investment, taxes, trade and customs rules etc. Changing some of these parameters it is possible to determine direction of capital flow between businesses. The set of these parameters may be used to establish desirable direction of capital flow is called investment climate. Let us consider the statement of the investment climate.

7. Investment Climate

Investment climate (K) is the set of the parameters used by the Center to choose desirable direction of capital flow between businesses. This flow is directed to the most attractive business. In this approach MCAI $I_i = (I_{i1},...,I_{iT-1})$ is the vectors indicator of the investment attractiveness of the i-th business. So the set of parameters of MCAI $I_i = (I_{i1},...,I_{iT-1})$ determines the investment climate:

$$K = \{ \alpha_i, a_i, h_i, r_i, s_i, u_i, v_i, m_i = \{m_{il}, l = \overline{1,L}\}, \ i = \overline{1,2}\}$$

So investment climate K is the function of the parameters both the domestic and the international regimes such as prices, efficiency of investment, taxes, trade and customs rules etc. Let us consider the corporation operating in different branches of economy. Then business in branch, were investment climate is better, has biggest investment attractiveness. In this business income of investments takes place, etc.

8. The Capital Drain and the Corporation Regimes

Important indicator is the total quantity of capital drain from the business should be calculated as a difference between outcome and income of the investments in different businesses, branches of economy or countries. This indicator is the function of the MCAI parameters both the domestic and the international regimes such as prices, efficiency of investment, taxes, trade and customs rules etc. Information about MCAI $I_i = (I_{i1},...,I_{iT-1})$ may provide indication of leading events for various corporations that may describe conditions of normal, alert, and emergency operation for various potential trouble spots in the world. Possible courses should be developed for action to resolve situations corresponding to alert and emergency operation. Various possible alternative actions can be explored. Through the use of models, simulations, discussions with knowledgeable experts from both the businesses involved, as well as with third-party experts, it should be possible to get various impressions of what may be the possible outcome of alternative actions. In the adaptive mechanism there are special procedures used for adjusting of parameters corporation regimes to control capital flow. For example, Tsyganov [4] considered simulation of progressive adaptive mechanisms of multistage negotiation based on the new information technologies. Incentives and motivations for cooperation may be developed. In each of the businesses involved the staff responsible for the decision-making that causes a capital flow can be provided with various incentives for keeping the capital from the flight. In real situations capital and intellectual flows are managed by the special corporation procedures and mechanisms. They are called by Young [7] and Krasner [8] an international regimes. Coates and Seamen [9] indicate that international regimes are closely linked with domestic political and economical procedures and mechanisms. Total mechanism to control capital and intellectual flows includes both international and domestic regimes. For example, detailed description both these regimes, dealing with capital flows through joint ventures, had been given by Tsyganov [10].

Conclusion

Usually provision of ability to control complex corporation in its dynamics with incomplete information is, as a rule, based on application of multiple criteria decision making and adaptive control. From the other hand, control of hierarchic corporation systems implies the consideration of a special type of human factor - elements activity connected with the availability of the elements own goals. The center obtains information from the active elements in the course of their functioning and uses it for estimating their states to reach the aim of the control. But the farseeing active element may predict the center controlling action and chooses its states in such a way that its effects on the results of state estimation and adaptive control to maximize its own goal function. For this reason the problem of the designing of progressive adaptive functioning mechanism (including estimation, planning, resource allocation and stimulating procedures) for the hierarchical corporation should be taken into account. This paper presents the results of researches of intelligent mechanisms of the corporation functioning and their developments for multiple criteria decision making to establish adaptive manufacturing systems on the background of CAD/CAM systems.

Technological changes and investments provide the progress and simultaneously produce rupture between leading and developing businesses, corporation and countries. Provision of ability to manage corporation in its dynamics is based on application of control theory. The theorem about sufficient conditions of the definite direction of the capital flow between two businesses determines multiple criteria about investments (MCAI). With the aid of MCAI multiple criteria for investment attractiveness of the business are found. MCAI is the function of the parameters both the domestic and the international regimes such as prices, efficiency of investment, taxes, legislation, etc. These parameters determines investment climate. Choosing investment climate it is possible to manage capital flow between different businesses, corporation and countries.

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Поступила: 22.09.09.