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Mechanisms of Organizational Behavior Control: A Survey

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Basics are surveyed of a version of mechanism design theory tailored to solve management problems. The concept of a mechanism of organizational behavior control is introduced. Methodological grounds of the theory are discussed along with mechanisms classification. Mechanism implementation process is characterized. Also, basic mechanisms are sketched, which help solving important management problems on all stages of management cycle. An example of the mechanism of incentive-compatible planning is considered.

Key words: mechanism design, management theory, organizational behavior.

Introduction

In XXI century economics is transforming into the economics of knowledge. Contemporary trends in management science consider workforce not as just a "yet another production factor" (in line with land and capital), but promote it at least to the status of intangible asset, which possesses rational economic behavior with the abilities of self-regulation and self-development. The reason is that employees' decisions, based on their skills and highly influenced by their motivation, now play the crucial role in a value added chain. Business process management (BPM) [1] and business process reengineering (BPR) [2] techniques did not cover motivational and decision-making aspects of business processes and, thus, they alone were insufficient to drive corporate reengineering efficiently. We claim that it is lack of attention paid to employees' behavioral response to changes was the main reason of BPR projects failure[1].

The major differences between a complicated technical system and a human (or a collective) as a control object are condensed in the concept of activeness.

The first aspect of activity consists in human ability of independent goal-setting. A technical system has no interests beyond interests of its designer. But employees in an organization do pursue their own objectives, which can be inconsistent with objectives of the organization.

The second aspect lies in human ability to choose actions independently; in particular, an employee can deliberately manipulate information (when he or she finds it profitable) and/or not fulfill the assigned plans and orders (again, if this promises some benefit).

The third important aspect of activity is the ability of reflexion regarding his or her personal activity and activity of the other subjects (including the ability of forecasting their behavior).

In this paper we survey the approach, which allows accounting systematically for the phenomenon of activity of employees in organizations. The approach is based on the methodology of systems and control sciences, and widely employs results of mechanism design – a branch of game theory, which deals with conflict situations involving the principal and a set of active agents (usually, in the presence of asymmetric information).

Mechanism design theory delivers a solution to management problems in the form of a control mechanism, i.e., a formalized routine of decision-making. For a control mechanism to keep efficiency in the presence of active agents, it must be robust to information manipulation, plan non-fulfillment and other aspects of activeness. The main challenge of mechanism design in

[1] The citation attributed to M. Hammer "…I was reflecting my engineering background and was insufficient appreciative of the human dimension. I've learned that's critical…" is in line with the above proposition.

management is search of the so-called correct mechanisms, which assure both interests coordination for all organization employees including stakeholders, management, and workers, as well as motivate them to report true information, which forms the basis of any efficient decision.

To adopt mechanism design to practical problems of business administration we developed a tailored and, in some aspects, more straightforward theory. The main goal of this paper is to provide the reader with basic methodological and technical grounds of control mechanisms in organizations.

In Section 1 we briefly explain a formal scheme of accounting for behavioral response by the principal (a manager in an organization). The art of management is positioned as ensuring the desired behavior of subordinates. In Section 2 models of organizational behavior are considered in the context of the production and management activity. In Section 3 we introduce different types of mechanisms in an organization classified by the element of the organizational system model being affected by the mechanism. In Section 4 we describe an applied technology of mechanism analysis, synthesis, and implementation in an organization. In Section 5 the toolkit of mechanisms developed during last decades is briefly sketched, while in Section 6 an example of a mechanism to control employees' behavior is described in more detail.

1. Principal-Agent Model

Consider a formal scheme of making a management decision by the Principal (a manager in an organization). The problem of the Principal is to analyze the available information and to choose the decision relevant to the current situation; so, the management decision appears to be the action of a principal. The Principal compares possible options (feasible decisions) and their consequences and then chooses the best one. If the decision touches interests of the other persons (employees or some external parties), to predict properly the consequences of his or her decisions the principal has to forecast the response of such counterparties, with subordinates being the most important ones, a certain decision.

A subordinate (an individual or a team) possesses exactly the same abilities and comprehension as a principal. Indeed, they have personal preferences and interests; they make decisions and perform actions. The only difference is that the situation for a subordinate includes a decision made by the principal. The action of the subordinate, being it predicted or real, is accounted by the principal when making decisions. So, we obtain the simplified scheme of interaction between the principal and the subordinate (see Fig. 1).

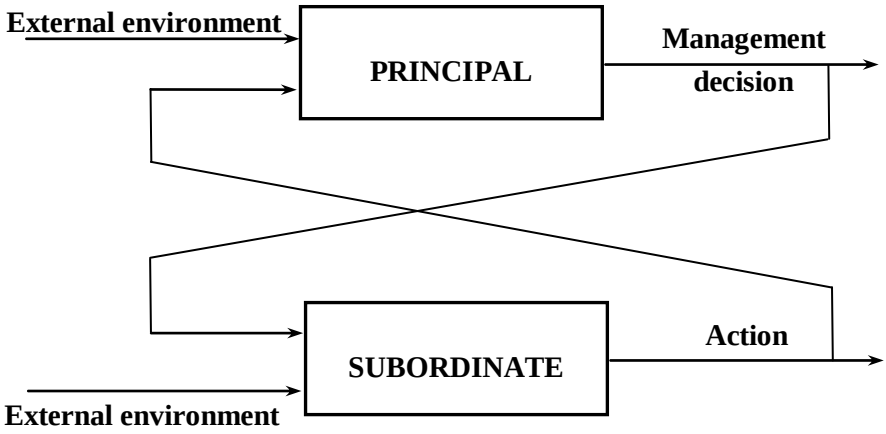

Fig. 1. The scheme of interaction between the principal and the subordinate

In terms of control theory [4], we have a control subject (a manager) and a controlled system, i.e., a control object (a subordinate). State of the control object depends on external disturbances, actions of the control subject and, probably, on actions of the object, see Fig. 1 (if the control object appears active, especially in organizational systems).

A problem of the control subject consists in performing control actions (or, management decision, see Fig. 1) to ensure a required state of the control object. This is done on the basis of information on external disturbances (or external situation).

Generally speaking, the art of management lies in ensuring the desired behavior of subordinates. Consequently, the principal wants to select a mechanism such that subordinates choose desired actions.

The problem is decomposed into, first, the analysis problem (given a behavioral model of a subordinate, find actions he or she would select under a certain control mechanism), and, second, the design problem (find a mechanism assuring the desired subordinates' actions according to a given behavioral model). Solving the design problem requires the ability to solve the analysis problem.

Hence, the principal should forecast behavior of subordinates as their response to his or her management decision. Interaction demonstrated in Fig. 1 represents a "closed loop." Let us replace the principal with a control mechanism, viz., a management decision procedure used by the principal. The inputs of this procedure are given by external environment and an action of a subordinate, while the output is a specific management decision. Thus, we have the structure presented by Fig. 2; here the control mechanism determines management decisions made by the principal.

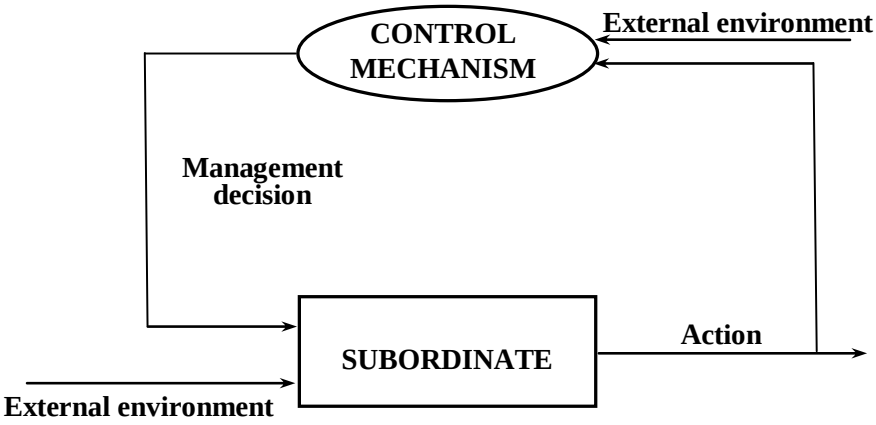

Fig. 2. Control mechanism

2. Models of employees' behavior

Control theory considers a control object as passive one, possessing no individual preferences and information. The constraints imposed on his or her activity are unique and defined by the planned state, while the action (actual state) coincides with the plan. Control of a passive object consists in assigning "plans" or in specifying the requirements to actual state, i.e., to the results of activity. In fact, there is no need in control subject's pondering whether a passive control object performs the plan or not! The model of a passive object seems natural for technical systems. But, more surprisingly, many management theories imply that subordinates surely strive to implement the orders (in other words, it is assumed that the actual state equals to the planned one).

Planned and actual states may not coincide due to the following reasons:

– presence of uncertainty (uncontrolled external factors that influence the result of the employee's activity, making it differ from his or her action);

– employee's activity.

Both aspects should be considered when solving problems of management in organizations.

The following fact has been emphasized earlier. The ability of employees to set goals, to choose actions independently, is reflected by the concept of activity of the control objects (agents) in organizational systems. It implies that the agents have certain opportunities and scope for independent goal-setting and making decisions regarding their actions. This is done, first, within the framework of the full-fledged structure of activity. Next, we list the effects of activity: data manipulation, choosing a state varying from the plan, a negligent behavior, etc. These effects should be considered when designing and applying control mechanisms. Efficient control makes it necessary to model agents' behavior, i.e., to predict their reaction to specific control actions.

Thus is done using a concept of utility maximization, known in economics as the model of "economic man behavior" (we will use the term "agent" as a synonym). An agent acts (reports information, chooses actions, and so on) to maximize his or her utility. The stated concept has turned out fruitful and gained a dominating role in mathematical economics, decision theory and other scientific directions focused on the models of human behavior.

As a rule, two types of economic agents (economics subjects) are identified, notably,

- an economic subject of the market (the examples are an organization, a holding company, a firm, a corporation);
- employee(s) of an economic subject.

For both types of agents, the utility is typically represented by "economic profit," that is, the difference between "revenue" and "costs." Yet, the content and methods used to represent the income and costs depend on the agent's type.

Suppose that a department or a separate organization is studied; its revenue and costs are calculated in a management accounting system. The utility could be derived from the operational income according to the results of business activity (under the adopted policy of management accounting).

If an agent is an individual employee, the management accounting system stores income, but not efforts exerted by the agent to perform the operational activity and corresponding costs. Moreover, the information system does not weight costs against the income. Thus, it is necessary to compare efforts and costs with rewards received by the agent. This sort of relationship is set by virtue of different supervision techniques, timing, as well as by the search for analogs. A specific situation being analyzed, one should choose an approach enabling the simplest and the most accurate definition of the agent's effort function and utility function.

The principal is also an "economic man." He or she also has a utility function, but has different possibilities to implement his or her activity (in particular, management authorities). The principal also has internal constraints, utility, awareness and actions. The principal's action consists in choosing a control mechanism, i.e., the relationship between control actions and actions of the agent.

The major difference between the principal and agent lies in that the former possesses management authority; notably, he or she has the right "to make the first move" by establishing activity actions (a control mechanism) for the agent. The principal's utility generally depends on the actions of the agent, i.e., control efficiency is determined by the utility of the principal (representing the interests of the whole organizational system) gained as the result of agent's activity.

Therefore, the mechanism in the described environment specifies a "legislative, regulating and mandatory base," i.e., the rules and procedures involved to perform actions of the principal and the agent during implementation of processes and projects. Moreover, control rises to the level of meta-control, to formation of the "rules of the game," conditions of the agent's

functioning and motivation. In a certain sense, the principal appears an architect of social and economic rules and a meta-player.

According to the general model [4], an economic agent is described by four basic parameters aggregating the procedural components of his or her activity:

1) **constraints and norms of activity**;
2) **an utility function**;
3) **awareness**;
4) **action** of the agent (it is chosen on the basis of his or her awareness under existing constraints and utility). The action indicates of the agent's state and, to a considerable degree, determines the **result** of his or her activity.

Under the existing constraints, economic agent has two types of possible actions. They are:

- reporting information on uncertain parameters to the principal and/or to other agents;
- choosing an action (production output, time consumed, etc).

In fact, what is the incentive-compatible control of an economic agent? The matter concerns, e.g., the fact that the principal never exactly knows the agent's subjective estimate function of his or her actions. In other words, the principal does not know how much the agent is willing to do for $1 reward. Low level of motivation results in no productivity growth. Starting from a certain moment (exactly when the reward exceeds the agent's subjective estimate of his or her efforts), productivity increases. Next, a moment comes when the principal no more benefits from raising the reward (costs to motivate additional efforts are greater than gains of productivity growth). Roughly speaking, three intervals of rewards appear; the principal's task lies in balancing the interests to make the situation convenient for him or her and for the agent (this is done over the admissible interval with respect to the costs and productivity). Evaluating such balance of interests requires joint actions of economically rational persons (the principal and the agent). Their common aim is making a decision that would be more efficient than in the case of independent actions, based on their individual interests. Thus, a mechanism of control in an organization is a sort of a "visible hand", which drives self-interested actors toward socially desirable outcomes.

Consider the case of a single principal and several agents. Now the agents immediately choose their actions given the mechanism set by the principal. As soon as interests of agents differ, they appear to participate is a certain conflict. The model of such conflict situations is given by the game theory [5], which uses different concepts of equilibrium (e.g. Nash equilibrium) to predict the outcome of conflict. So, the set of equilibrium outcomes of a game is considered as a behavioral response of a controlled system to a management decision in the case when a system consists of several agents.

The assumption that the agents' action coincides with the output of his or her activity makes a sort of simplification. Actually, the result may vary from the action due to uncontrolled factors, namely, actions of the rest agents, the state of external environment, etc. In other words, the result of the agent's activity generally depends on his or her action, actions of the other agents and impact exerted by the external environment. Then, to predict agent's behavior in the case of a single agent the principal employs the hypothesis of expected utility maximization, which implies that an agent chooses his or her action to maximize the expected utility function obtained by averaging agent's utility over realization of random states of external environment. In the case of several agents the concept of Bayesian Nash equilibrium [5] or informational equilibrium [6] is employed to account for unknown external parameters. The case of asymmetric information in principal-agent models is also studied in detail by the contract theory [7].

So, game-theoretical and optimization models of human rational behavior allow analyzing the response of a control object to certain control action and form the basis of the synthesis phase of control mechanism design.

3. Methods of control in organization

Above we defined control as purposeful impact on control object. Yet, organization represents an intricate control object. Hence, one should clarify the internal structure of an organization as a control object; in other words, it is necessary to find out what entities inside an organization can be influenced by the control actions (so as to change state, more specifically, the behavior of the organization). Those components of organizational system being modified during the process (and as the result) of control are known as objects of control. Expressing any complicated system as a complex of interacting elements makes a certain model. Therefore, below we introduce the model of organizational system [4].

Organizational system (OS) is described via specifying

- **staff** (employees, their groups and collectives, its **members**);
- **structure** (a set of informational, control, technological and other relations among the OS members);
- **constraints and norms of activity** imposed on OS members; they are institutional, planned, technological and other of constraints and norms of individual and joint activity;
- **Goals and preferences** of OS members;
- **information**, i.e., data regarding essential parameters being available to OS members at the moment of decision-making (choosing the strategies);
- **sequence of operations** (of data acquisition and choice of actions by OS members).

The staff determines "who" is included into the system; the structure describes "who interacts with whom, who is subordinate," etc. Finally, feasible sets define "who can do what," goal functions represent "who wants what," and information states "who knows what."

Control in OS, being interpreted as an impact on the controlled system to ensure its required behavior, may affect each of the listed parameters. Hence, taking the focus of control (the parameter of OS, which is modified during the process of control and as a result of control) as the basis of classification of control in OS, we obtain the following methods (types) of control [4];

Staff control deals with the following issues: who is included into the organization or department, who should be dismissed or recruited? Generally, staff control either includes the problems of personnel training and development. For example, the well-known model of signaling [8], one of the seminal models in contract theory, when considered from the principal's point of view, can be treated as a mechanism of staff control, which allows a principal to implement a rational hiring policy in the presence of hidden information.

Structure control is as a rule performed in parallel to staff control. It provides answers to several questions, viz, what functions should be performed by whom, what participants are subordinate to whom, who should control and be controlled, what information should be transferred and acquired, etc. Mechanisms to control structure are not well studied formally at this moment, although a number of competing models exists of a management hierarchy in a firm (see the surveys in [9], [10]).

Institutional control appears to be the most stringent; it consists in that the principal restricts the sets of feasible actions and results of activity of the subordinates (in a purposeful way). Such restriction may be implemented via explicit or implicit influence (legal acts, directives, orders, etc) or mental and ethical norms, corporate culture and so on. Numerous variations of resource allotment mechanisms (with auctions being a very special case) commonly met in public institutions give us a good example of institutional control mechanisms [4], [11].

Incentive control is in a certain sense "softer" than institutional one, and consists in purposeful modification of the preferences of control object (the subordinates). The described modification could be performed through introduction of a certain scheme of penalties and/or rewards for choosing specific actions and/or attaining definite results of activity. Job contracts

for individual employees and teams are a good example of incentive schemes, which lie in the very core of any organizational activity [4], [7].

Against institutional and motivational counterparts, informational control appears the "softest" (indirect) type. It lies in formation of control object's awareness such that the decisions made on its basis are the most beneficial to control subject. This sort of mechanisms is used in organizations from ancient times, but in recent years they started a new life with development of social networks in Internet [12].

4. Technology of Control Mechanism Design: From Models to Policies

The version of mechanism design we suggest for organizational management technically is close to the mechanism design, which forms the grounds of modern social choice theory and agency theory. The only difference is a systematically promoted pragmatic normative approach – in contrast to a standard descriptive approach of economic theory any conflict is a priori considered in the view of a single part, i.e., a client. Not-withstanding formal resemblance of mathematical models, motivation of the research often varies, mostly limited to optimal mechanism design (i.e., construction of the best mechanisms in the view of a principal), whereas efficiency (in the sense of welfare economics) is overshadowed.

Under a given control mechanism, one may separate out three major stages of designing and implementing management decisions, notably,

1) data acquisition for decision-making;

2) decision-making process;

3) implementation of the decisions made.

Let us characterize each stage in greater detail.

1. Data acquisition for making decisions. Information required for making decisions may be acquired by the principal from the agents. The principal should be on the watch for untrue information (the agents may either "color up the truth" or "get dramatized"). No doubt, the principal would desire to have a certain control mechanism when economic agents (as rational "economic men" with individual preferences striving to maximize their utility function) benefit from being fair. The stated mechanisms are known as fair play mechanisms (strategy-proof mechanisms).

However, when the agents benefit from truth-telling? The only situation is when information reported by no way harms them. This is the underlying property of fair play mechanisms.

2. Making decisions. At the second stage, the principal should make an efficient decision. If the principal is unable to succeed, he should improve himself (otherwise, he will be definitely replaced by another principal). Thus, a key component here consists in management capabilities of the principal.

3. Implementing the decisions made. Finally, the third stage is intended for implementation of the decisions made by the principal. The principal is then exposed to the danger of non-fulfillment (or incomplete fulfillment) of the decisions. Mechanisms where agents benefit (again, according to their individual preferences) from implementing the decisions of the principal are said to be incentive-compatible.

An incentive-compatible strategy-proof mechanism is a correct mechanism. Surely, an ideal situation is when a correct mechanism appears optimal (i.e., the most efficient).

The mechanisms studied are adapted to managerial practice. For instance, despite their formal reducibility to a social choice problem (in a certain statement), resource allocation problems and auctions are traditionally considered separately, as the ones arising at different stages of organizational control cycle.

Now turn from the theory to the practice. Who should solve the above-stated problems of mechanism analysis and synthesis? The first alternative is for the principal to solve both problems involving the templates and personal experience. The second alternative is to design a control mechanism with the aid of some sort of external consulting.

Almost any control problem in an organization can be stated formally in the following way. Find feasible control actions ensuring maximum efficiency (such control is called optimal). To succeed, one should solve an optimization problem, notably, choose optimal control (optimal control actions. This is the most general setting. Consider a general technology of solving the problems of this sort, which covers all the stages (from organizational system modeling to implementation of the model in concrete regulations); see Fig. 3 where inverse links between the stages are omitted for better clarity.

- The first stage (model construction) consists in **description** of an organizational system (first and foremost, control object) and in its modeling, i.e., specification of staff, structure and functions of the modeled system.
- The second stage (model **analysis**) lies in studying the behavior of control object under different control actions.
- The analysis stage being completed, one may apply control theory methods to solve the formulated control problem. First, **solving the direct control problem**, i.e., synthesis problem for optimal control actions (find a feasible control ensuring the maximal efficiency). Second, solving **the inverse control problem** (find a set of feasible controls rendering the OS to the desired state). It should be emphasized that generally this stage causes major theoretical difficulties and seems the most time-consuming for the researcher.
- Having obtained the set of solutions to the control problem, one should move to the fourth stage, notably, study their stability. Stability analysis implies solving (at the very least) two problems. The first problem is to study the dependence of optimal solutions on parameters of the model; in other words, this is the analysis problem for **solution stability**. The second problem turns out specific for mathematical modeling. It consists in theoretical study of **model adequacy** with respect to the real system; such study means efficiency evaluation for those solutions derived as optimal within the model when they are applied to real OS (due to modeling errors the solutions may vary from the model).
- Thus, the above-mentioned four stages constitute general theoretical study of OS model. Using the results of theoretical study to control real OS requires adjustment of the model (i.e., **identifying** the modeled system and carrying out a series of **simulation experiments**; these are the fifth and sixth stages, respectively). In many cases the stage of simulation appears necessary due to several reasons. First, far from always one is able to obtain analytical solution to optimal control synthesis problem and to study its dependence on parameters of the model. Note that simulation may represent a certain tool to derive and assess the solution. Second, simulation allows for verifying the validity of hypotheses adopted to construct and analyze the model. In other words, simulation gives additional information on the adequacy of the model without conducting natural experiment. Finally (and this is the third reason), employing management games and simulation models for training aims lets the managing staff master and test the suggested control mechanisms.
- The closing is, in fact, the seventh stage, or the stage of implementation; it includes training of the managing staff, implementation of control mechanisms (designed and analyzed at the previous stages) in real OS, with subsequent efficiency assessment of their application, correction of the model, and so on.

5. Toolkit of Control Mechanisms

Management activity is traditionally divided into stages, which form the cycle of management. One of most popular divisions belongs to classic of regular management Henry Fayol, who detached five stages: planning, organizing, commanding, coordinating, and controlling. In the course of management theory development the role of proper employees' motivation was also emphasized.

Every stage gives rise to a number of complex management problems. Most of them involve principal-agents interactions of some sort, and, thus, require adequate support in the form of organizational behavior control mechanisms.

The following list of mechanisms summarizes briefly the authors' long experience of both academic studies and consulting projects. The mechanisms are separated into four stages of management cycle (Fayol's stages of commanding and coordinating are replaced to motivating, which is more important for employees' behavior management) – see Fig. 3 – and address the major management problems, which arise on the appropriate stage.

This brief description is intended to give the reader general expression about the set of problems covered by mechanisms of employees' behavior control and some flavor of mechanism design approach to address these problems (see the detailed description of mechanisms in [4]). The list presented below is not complete, but, of course, basic mechanisms do not cover all the variety of management problems. At the same time, these basic mechanisms can serve as bricks in designing numerous complex mechanisms of organizational management, which are based on combinations of a comparably small set of ideas.

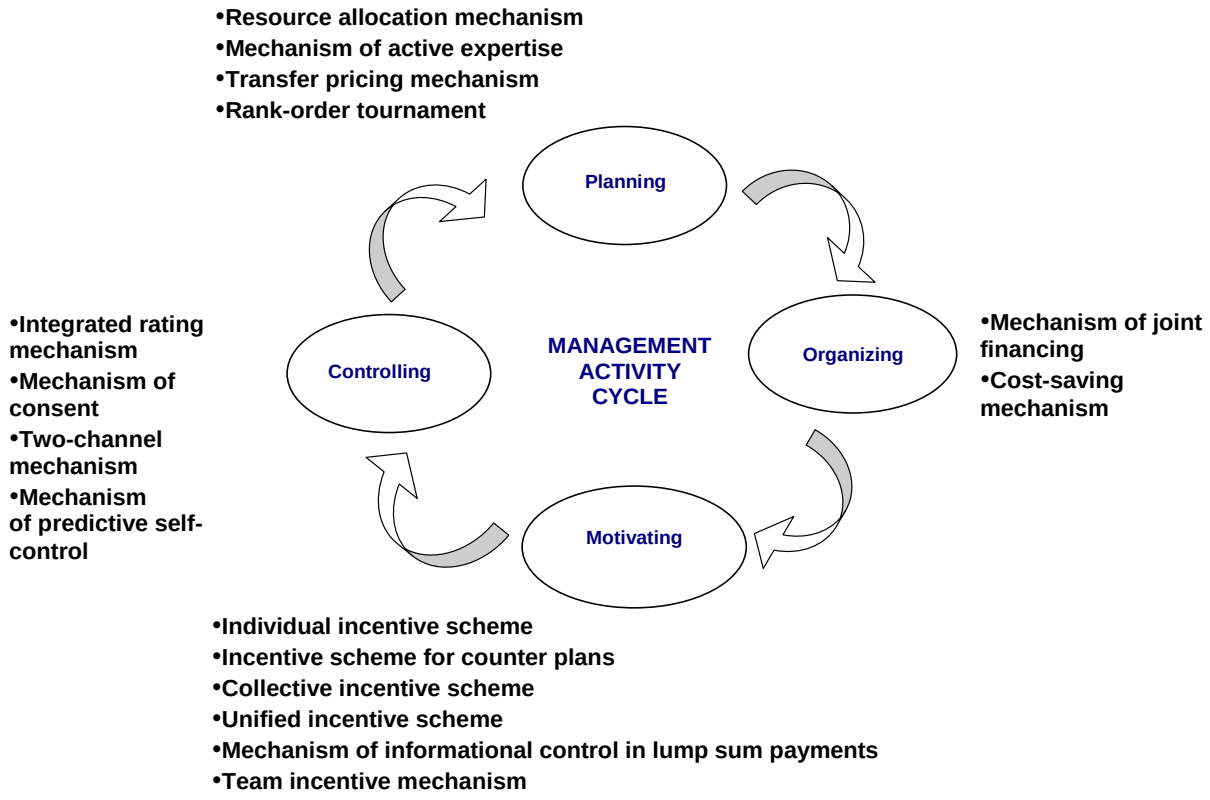

Fig. 3. The complex of control mechanisms within a Fayol's management cycle

5.1. Mechanisms of Planning

The resource allocation mechanism allows distributing scared resource (typically, budget funds, but also production plans, water, etc) among agents to maximize total efficiency of resource usage in the presence of lack of information about agents' abilities to use resource efficiently (depending on situation this may be real demand for resource, local production capacities, etc). The properly designed mechanism ensures credibility of agents' reports. We suggest using variations of a sequential resource allocation scheme [4], [11] to guarantee maximum efficiency while keeping truth-telling property.

The **mechanism of active expertise** supports managers in many common situations when a decision is made on the basis of opinions of some experts. It is always a big problem to find a

competent expert in the field, but very often no external experts can be involved at all, while independency and equity of internal experts is open to questions. The mechanism of active expertize minimizes the consequences of possible opinions' distortion by motivating experts' truth-telling. A class of median schemes [4], [13], [14] is shown to solve the problem of truth-telling, in contrast to typically employed variations of an averaging scheme.

Transfer prices (also known as internal or corporate prices) help to distribute profit between production units in a corporation, but also provide a tool for high performance compensation and incentive compatible planning. Units report their production plans, while the principal balances external demand with local production capabilities adjusting internal prices. The mechanism of transfer pricing establishes relation between the total manufacturing plan and the internal price per unit of manufactured good. When the number of agents is large enough the properly designed **mechanism of transfer prices** ensures, first, reporting real production plans (which units are interested to fulfill) and, second, efficient plan allocation between production units.

An idea of a contest is used in a **rank-order tournament mechanism** to select most efficient project portfolios. The simplest tournament reduces to the following procedure. First, for every candidate project its total discounted cost is calculated and the effect of the project is estimated. Second, projects are ordered by effect to cost ration in the descending order, and included in a portfolio until the budget runs out. This tournament procedure is also called the cost-benefit analysis. Tournaments differ in the procedure of winners' selection. For example, in a more complex mechanism a knapsack problem [15] is solved for the set of project cost-effect pairs.

5.2. Mechanisms of organization

The **mechanism of joint financing** helps to share federal funds with that of local authorities to implement complex regional programs. Mechanisms of this sort are used in public-private partnership to finance socially oriented projects. The same idea works well in corporations, when, for instance, some local projects of performance improvement are jointly financed both by corporate center (by the principal) and at the local level (by the agents). Project costs are reported by the agents, and the whole amount of a central fund is allocated proportionally to the reports, while the remainder of the reported cost must be covered by the agent.

Cost-saving mechanisms are intended to motivate an agent to improve efficiency of his or her activity as much as possible. The mechanism stimulates an agent to keep high quality of the output with minimum costs. Cost-saving mechanisms are based on the following general concept. Assume that agent's profit depends on variables of two types, viz., parameters selected by an agent (e.g., costs) and parameters specified by the principal (e.g., a flexible norm of profitability, pricing coefficients, taxation coefficients, and so on). The mechanism design problem is to choose the values of principal-driven parameters for agent's profit to grow with the costs decrease; this should be either accompanied by price reduction. In other words, net profit of an agent should rise when costs fall; in contrast, the product price should decrease.

5.3. Incentive Mechanisms

An **individual incentive scheme** serves, firstly, for motivating agents to choose actions being beneficial to a principal and, secondly, for increasing the employees' intensity of labor and motivating them to achieve better production results. The idea is that the employee's wage includes a tariff (a fixed part) and a bonus (a variable part). The latter depends either on (measurable) intensity of his or her labor, or on the results of his or her activity (the intensity being immeasurable). Adjusting the mechanism allows for attaining the required performance of the employees with minimum payments.

When an agent is paid merely for fulfillment (or overfulfillment) of the plan assigned by a principal, the agent is not interested in having a high ("tight") plan. The reason is performing it would require additional efforts (costs) of the agent. For instance, an agent may inform the

principal of his or her preferences, eo ipso reporting his or her estimate of the plan (referred to as a "counter plan"). Within the framework of **incentive scheme for counter plans**, an agent is given rewards for reporting counter plans that better meet the principal's interests (yet, are "tighter" for the agent).

A **collective incentive scheme** is designed for situations when a principal turns out unable to separately observe the action of every agent (the principal merely knows a certain aggregated rate, e.g., the result of collective activity). Imagine that the principal can evaluate the minimum costs to-be-incurred by the agents to achieve the required result of collective activity. In this case, the efficient incentive scheme takes the following form. The minimum costs of each agent are compensated (provided that the result of collective activity agrees with the requirements of the principal). Moreover, sometimes the principal has no costs related to observing individual actions of every agent; thus, the principal's workload to acquire and process information is substantially reduced.

The **unified incentives mechanism** is employed in situations when a principal has to motivate large groups of agents, to involve "democratic" management methods and to decrease the amount of processed data. Under unified incentives, the relationship between the reward and labor intensity of the agents (alternatively, the results attained by them) is identical for all agents. In several cases, the described unification leads to no loss of efficiency, while the wages fund is spent in an optimal way. Yet, unified control may be inefficient, when non-consideration of individual features of the agents results in inefficient spending of financial resources. A special case of unified incentive scheme is represented by competition incentives mechanism.

The mechanism of informational control in incentive problems is involved when a principal possesses complete information (in contrast to agents). Since the latter choose their actions based on individual awareness, the principal may impact on their actions by manipulating information; in other words, the principal may modify awareness of the agents, e.g., by means of informing every agent of the intensity of labor and/or plans of the rest agents.

The **team incentive mechanism** serves to motivate groups (e.g., a production area, a department, a shop floor, a team, etc) with collective organization of work (taking into consideration individual contribution of every employee). Incentive procedures for team members are based on bonus fund distribution according to their labor participation factor .

5.4. Controlling mechanisms

In **integrated rating mechanisms** one passes from a detailed description of a complex object (involving numerous indicators and parameters) to an aggregated description based on few generalized characteristics of the object. These mechanisms allow for regular monitoring and timely estimating (taking into account priorities of a principal) the results of the object's activity and changes within the object. Note that such changes take place during operation of the object or depending on the impact exerted by an external environment.

The **mechanism of consent** is intended for coordinated distribution of financial resources among several possible directions of investment. For this, expert commissions are created; each commission generates a coordinated decision concerning the ratio of financial funds to-be-spent on a given direction to that of a fixed (basic) direction. We emphasize that the number of commissions should be by unity less than the number of directions. Using information acquired from all expert commissions, a distribution of financial resources is defined among all directions; the idea is making the ratio of financial funds (to-be-spent on a specific direction) to that of the basic direction equal to the estimate of the corresponding expert commission. The mechanism ensures truth-telling of the commissions.

The primary concept of a **two-channel mechanism** lies in simultaneous involving two channels of decision-making. Motivating actions are based on comparative analysis of the efficiency levels of the decisions suggested by different channels. Notably, rewards are evaluated for every channel. The first channel makes a decision. Certain alternatives exist for the second channel; it could be either an active channel (decisions are worked out by human beings) or an

advising (a computer-type, a "normative") channel. In the latter case, suggestions are used to establish the norms of control efficiency (to compare the actual efficiency of the decisions made by the first channel).

Mechanism of predictive self-control is intended for well-timed informing a principal of possible deviations (from a plan) in the agents' activity. The earlier the principal gets aware of possible deviations from the plan (e.g., in due dates, financial investments, etc), the more efficient and well-timed would be his or her decision (e.g., additional measures to eliminate deviations and reduce losses, or plan correction); note the agents report deviations.

The matter is that the penalties of the agents (in the case of plan correction) depend on the moment the agents report of the correction (they are smaller if the report is early); moreover, these penalties are less than in the case of plan non-fulfillment.

6. An Example of the Mechanism: Incentive-compatible Planning

Due to limited space we leave the detailed description of the whole toolkit of organizational control mechanisms for future papers, and just give references to the papers with detailed description of the models and techniques used to solve various problems of control mechanism analysis and synthesis. Below we give just an example of a single incentive mechanism used to boost planning accuracy due to accounting for employees' incentives.

As it has been mentioned, an **incentive-compatible mechanism** is remarkable for that the agent benefits from performing the plan. The following questions arise then:

1. Does the principal need exact fulfillment of the plan by the agent?
2. If yes, how could it be ensured?

The first question appears not as easy as it could seem. For instance, consider the utility function of the agent defined by the difference between his or her income $0.5\,y$ (the agent gains 50% income) and the penalty for plan nonfulfillment: $\frac{1}{4}(x-y)^2$; here y denotes production output of the agent expressed in money (the sales volume), while x means the plan. This function is shown in Fig. 4.

Simple computations indicate that the agent benefits from choosing the action $(x + 1)$, i.e., he or she would strive for overfulfilling the plan by the unity. Hence, if the principal requires $y = 5$ units of products (exactly this quantity, since the residual amount exceeds demand), he or she should assign the plan $x = 4$. We underline that the plan differs from the action which is desired by the principal! Such situation is common in control of active agents. The principal has to predict their behavior and assign the plan based on the forecast. The described mechanism is not incentive-compatible (the agent does not perform the plan). Nevertheless, *sensus communis* suggests that it would be good to have incentive-compatible mechanisms.

Fortunately, there exists a wide range of the incentive/penalty functions such that **optimal plan is proven to be incentive-compatible**. An example is provided by Fig. 5.

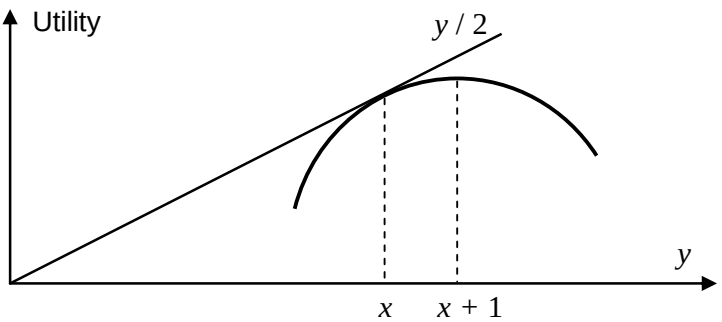

Fig. 4. The utility function of the agent in an incentive-compatible planning mechanism

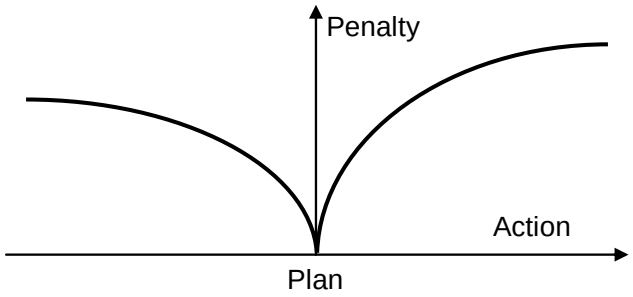

Fig. 5. An example of the penalty function

Such functions have been shown to possess optimal (in the view of the principal) incentive-compatible plan. Thus, the ideology of optimal planning is being replaced with the ideology of **optimal incentive-compatible planning**. The plan should be optimal exactly over the set of incentive-compatible plans (beneficial to the agents).

Fig. 6 demonstrates an example of the set of incentive-compatible plans, where the agent is equally penalized for the plan non-fulfillment or overfulfillment.

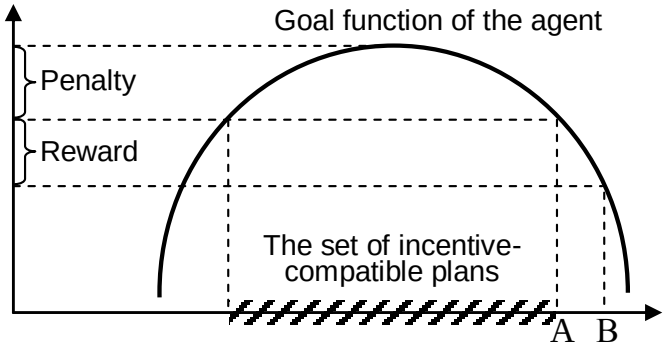

Fig. 6. An example of the set of incentive-compatible plans

One easily observes that any plan belonging to the set of incentive-compatible plans is beneficial to the agent. If the principal is interested in maximal production output, the optimal plan corresponds to the point *A* in Fig. 6. For further increasing the output, the principal has to either enlarge the penalty or pay a reward for the plan fulfillment. In the latter case optimal incentive-compatible plan is defined by the point B in Fig. 6.

Increasing the penalties or rewards corresponds to growing **centralization of control**, since the set of incentive-compatible plans is enlarged and the principal possesses better opportunities for assigning the plans. Therefore, growing centralization of control may improve the efficiency of functioning in an organizational system. However, an infinite growth of centralization is clearly impossible; first, it requires infinite resources of control and, second, it may contradict the existing social norms, as well as the democratic and autonomous norms of control.

7. Conclusion

Thus, the theory of behavior control mechanisms reviewed in this paper is positioned as a branch of control science (more specifically, cybernetics) which deals with control in the so-called active systems. The elements of active systems are people possessing individual interests, being able to choose actions independently and to manipulate information. In fact, the subject of the theory is systematic accounting for activity phenomenon in control problems based on systems approach and using the methods and results of operations research and game theory. The primary task is designing efficient mechanisms of organizational control.

Game-theoretic modeling appears one of the basic research methods used by the theory. As compared to modern economic theory, application of game theory in the theory of control mechanisms is different. Pragmatic normative approach (a game conflict is a priori considered in

the view of a single part, i.e., a client) is typical, in contrast to standard descriptive approach in economics (when a conflict is viewed indirectly).

Therefore, the basic idea consists in combining maximum usability in formulation of organizational control problems with wide adoption of formal models (including game-theoretic ones). Still, to solve a complex applied problem of improving the efficiency of project management, we supplement the mechanisms of employees' behavior control with optimal project planning or supply network optimization techniques.

The subject of the theory coincides with that of management theory; nevertheless, the corresponding methods have dramatic differences. Management theory seems much flexible in the description of psychological aspects, while mechanism design brings all psychological factors to the concept of rational behavior based on utility theory. Many implications of management theory and organizational theory per se supplement formal analysis (performed by mechanism design theory) with empirical components that could not be embedded in modern formal models, yet are relevant during implementation of theoretical results.

For instance, incentive mechanisms with monetary rewards are successfully supplemented with motivation theories, such as F. Herzberg's motivator-hygiene theory [16] or W.G. Ouchi's theory Z [17] and others.

Integrated rating mechanisms provide a certain tool to design control systems for company efficiency based on different concepts, such as management by objectives by P. Drucker [18] or balanced scorecards by Norton D.P. and Kaplan R.S. [19].

Thus, we are sure that blending mechanism design with management theory may serve as a bridge of the formal theoretical results towards managerial practice.

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