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IMPROVING THE QUALITY OF THE INDUSTRIAL ENTERPRISE MANAGEMENT BASED ON THE NETWORK-CENTRIC APPROACH[1]

The article examines the network-centric approach to the industrial enterprise management to improve the efficiency and effectiveness in the implementation of production plans and maximize responsiveness to customers. A network-centric management means the decentralized enterprise group management. A group means a set of enterprise divisions, which should solve by joint efforts a certain case that occurs in the production process. The network-centric management involves more delegation of authority to the lower elements of the enterprise's organizational structure.

The industrial enterprise is considered as a large complex system (production system) functioning and controlled amidst various types of uncertainty: information support uncertainty and goal uncertainty or multicriteria uncertainty. The information support uncertainty occurs because the complex system functioning always takes place in the context of incomplete and fuzzy information. Goal uncertainty or multicriteria uncertainty caused by a great number of goalsestablished for the production system.

The network-centric management task definition by the production system is formulated. The authors offer a mathematical model for optimal planning of consumers' orders production with the participation of the main enterprise divisions. The methods of formalization of various types of uncertainty in production planning tasks are considered on the basis of the application of the fuzzy sets theory. An enterprise command center is offered as an effective tool for making management decisions by divisions.

The article demonstrates that decentralized group management methods can improve the efficiency and effectiveness of the implementation of production plans through the self-organization mechanisms of enterprise divisions.

Keywords: production system, network-centric management, optimal planning of production, enterprise command center

Introduction

The paper [1] points out an urgent need to increase the quality of decisions made at all levels of the state legal regulation. According to the classification proposed in [1], we examine the lowest level of the state legal regulation, namely, the level of the market agent, which is the industrial enterprise.

At the level of the industrial enterprise, the functions of the state legal regulators (SLR) are performed by internal regulations, rules, standards, instructions, orders, etc. [1], not contradicting legislative acts and other legal documents adopted by authorized state bodies, and binding upon all participants of social and economic processes of the industrial enterprise.

To increase the quality of decisions made in current conditions of unique variety and variability of social and economic processes, the industrial enterprise SLRs must provide for generation and development of decentralized management methods.

Production System

A modern industrial enterprise may be considered as a large and complex system (production system)[2], representing the aggregation of goal hierarchy, decision-making hierarchy and business process hierarchy (internal hierarchies) (Fig. 1).

Following the concepts of papers [2, 3, 4, 5], the large system shall be understood to mean the aggregation of significant number of hierarchically associated complex systems consisting of social (groups of people) and technical elements (machines, equipment and technical devices) having a

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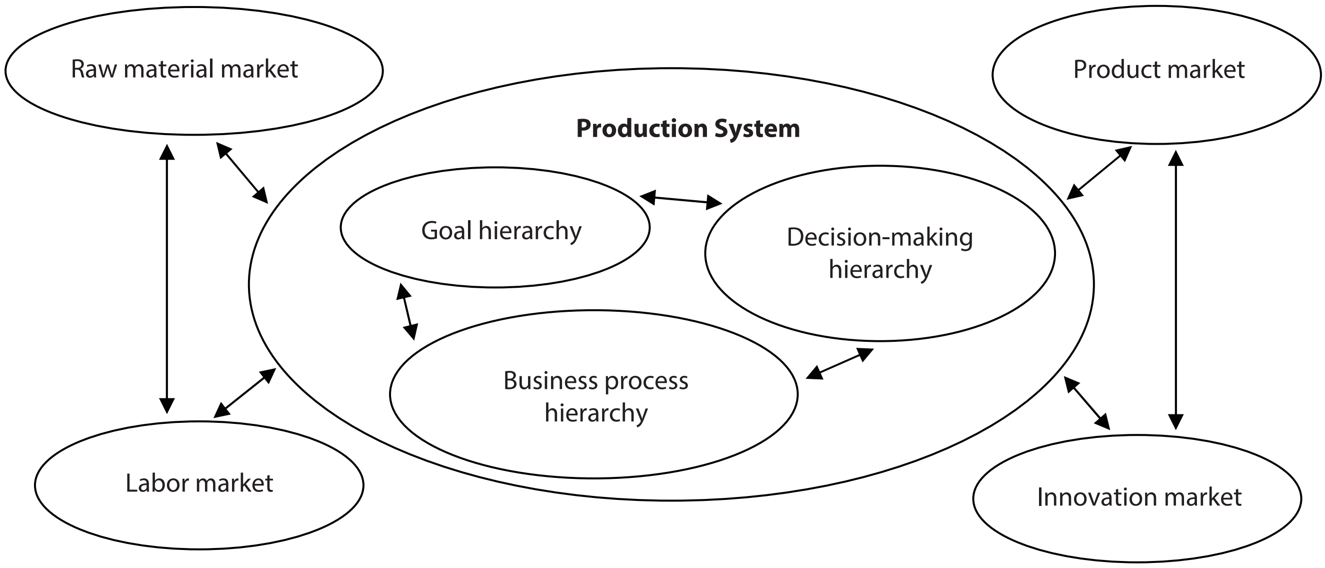

Fig. 1. *Structural model of large production system*

certain degree of organization and independence combined according to adopted goal hierarchy by means of organization and various associations (energetic, material, information) to provide purposeful functioning of the system as a whole.

According to system classifications proposed in papers [6, 7, 8], the complex system will be the system, the model of which does not have sufficient information for efficient management.

The production system functions surrounded by product, raw material, labor and innovation markets (see Fig. 1). The production system interacts with these markets sharing information, material and labor resources.

The external environment for the production system is a society being at a certain level of development, pursuing some goals and interacting with the production system through political, economic and social institutions.

The production system must continuously adapt to changes occurring in its environment, by modifying and developing its internal hierarchies.

The integral parts of the production system are individuals and their groups [9]. Therefore, the production system may be considered as the organizational system [10], solidifying people, which collectively implement some program or goal, and act on the basis of certain procedures and rules. The specific element of the organizational system is a decision maker (DM). DM is an individual or the group of individuals entitled to make final decisions on selection of one or several control actions [11]. DM is a main element of the organizational system, determining the progress of management solutions, decision efficiency and timeliness.

In addition, the production system includes the sufficient number of technical (passive) elements and subsystems [10]. Therefore, the production system may be considered as a particular case of social and technical system [12], where the technical system directly implementing production operations serves as a management object, and the management subjects are product consumers and all social groups concerned with the successful functioning and development of the production system: owners, investors, personnel, suppliers, society in whole.

In this paper, the example of the production system is a modern industrial enterprise consisting of the aggregation of interrelated sales, manufacturing and supply divisions (production system), which are combined by a shared purpose aimed at the implementation of the production plan for finished products in a predetermined volume and within predetermined times (Main Production Schedule, MPS) [13, 14].

Normally, production system management is centralized, for example, by the executive director and his deputies. However, all the crucial decisions related to the work planning, organization and control of the above enterprise divisions are made out of these divisions and are by no means always the most effective and efficient in terms of the performance of the MPS. In this regard, the relevant task is searching for decentralized production system management methods capable of improving the efficiency and effectiveness of the implementation of the MPS. This task can be solved on the basis of the network-centric approach[3] that includes the formation of self-organizing distributed group management systems[4] [15, 16, 17].

In this paper, the network-centric management means the decentralized enterprise group management. A group means a set of enterprise divisions, which should solve by joint efforts a certain case that occurs in the production process. Network-centric management involves more delegation of authority to the lower elements of the enterprise's organizational structure, providing them with a complete information pattern, the discretion to make decisions on their own in order to achieve the shared goals.

Uncertainty in the Production System

The combinative origin in the production system functioning may be the goal hierarchy (see Fig. 1). This hierarchy represents a set of main requirements for the functioning and development of the system concerned both from external consumers and organizers (managers) and contractors (technical personnel). However, due to a large dimension and complexity of the production system, it is almost impossible to formulate all requirements for its optimal functioning and forecast its development precisely. Therefore, construction of the goal hierarchy formulating optimal requirements both for the system itself and its separate elements is an important task of the research and modeling of production systems, the solution of which requires the application of modern mathematical apparatus. In such case, it is necessary to take into account that not only the set of technical effectiveness indexes, but also a so-called human factor, play a critical part in functioning and development of production systems. In other words, the goal hierarchy of the production system is an aggregation of various technical indicators (usually clearly formalized) and indefinite, often contradictory preferences of various social groups (consumers, managers, contractors), having an impact on the system functioning and development and, in turn, on the decision-making hierarchy. This circumstance sufficiently complicates the goal hierarchy construction and mathematical description of production system functioning optimality criteria.

To achieve the management goals, it is important that DM receives the objective, complete and up-to-date information on the system functioning. However, for production system it is not attainable, because they relate to the class of complex systems, managed in the context of incomplete information. This circumstance makes the task of production system goals achievement more complex.

Distinctions of production systems described above lead to the fact that these systems have to function under uncertainty, which sufficiently complicates description and solution of management tasks arising in these systems. It is possible to emphasize the following types of uncertainty typical for production systems [18]:

1. Information support uncertainty. The complex system functioning always takes place in the context of incomplete and fuzzy information. This is due to the availability of a great number of random factors, subjective opinions and conflicting interests having an impact on production system functioning.

2. A goal uncertainty or multicriteria uncertainty caused by a great number of goals set before the production system. These goals are often contradictory and time-varying.

Network-Centric Management in a Production System

According to [16] a group of smart (capable of independent decision-making) elements of the production system will mean sales, manufacturing and supply divisions of an industrial enterprise that operate in an ambient environment created, in particular, by markets of products, raw materials and labor, that are able to receive information on this environment, respond to the changing environmental state and interact with each other to achieve the shared goal, for example, to implement the MPS.

Note that solving a particular task helping to achieve the goal can involve not all the divisions of the group. In this case, implementing the group management needs solving the following subtasks:

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— forming an active part of the group — a cluster as a set of divisions that has been created for a particular task;

— the optimal (in a sense) distribution of functions and available resources of the production system between the group divisions, as well as the redistribution of these functions and resources as the situation changes;

— implementation of the functions by divisions included in the cluster;

— mathematical and information support of the management decisions made.

For example, in the event of failure to implement the MPS or unscheduled urgent orders, one or more production divisions can either attract additional workforce (organize additional shifts or engage additional workers from outside) to produce additional volumes of products, or agree with the supply divisions purchases of lacking products from other producers, or agree, through sales divisions, an increase in product output dates acceptable for consumers. In other words, an effective management decision can be found by self-organization in network cooperation.

When the production system uses decentralized management, the divisions are solely responsible for performing the MPS. In this case, we can speak of self-organization of those divisions that have the ability to make independent decisions, i.e., that are smart elements of the production system.

According to [16], the self-organization of the production system will mean the process of the autonomous formation of the optimal structure and its optimal functioning algorithm in accordance with the intended purpose of the system described by some quality criterion, subject to the constraints defined by the enterprise's resources and the external conditions. This, in turn, makes it necessary to set a mathematical problem of the optimal control.

Setting of Network-Centric Management Tasks

Setting of network-centric management task in production systems may be considered as a specific case of setting proposed in the paper [16].

Suppose, some $\mathbf{P}$ group consisting of N subdivisions P_i, $i = \overline{1, N}$, performs MPS, i.e. fulfills finished product requirements M of consumers B_k, $k = \overline{1, M}$. The condition of each subdivision P_i is described by $\mathbf{S}_i(t) = [s_{1i}, s_{2i}, \ldots, s_{li}]^{\mathrm{T}}$, $i = \overline{1, N}$ vector, where s_{ji} vector components may designate quantities of finished products shipped, components released or materials purchased by each subdivision. The condition of each consumer B_k is described by $\mathbf{E}_k(t) = [e_{1k}, e_{2k}, \ldots, e_{wk}]^{\mathrm{T}}$, $k = \overline{1, M}$ vectors, where e_{jk} vector elements may designate quantities of finished products of the certain type received by each consumer. Suppose, to perform MSP, each subdivision P_i, $i = \overline{1, N}$ may spend some resource pool $\mathbf{A}_i = \{A_{1i}, \ldots, A_{2i}, \ldots A_{mi}\}$, $i = \overline{1, N}$, where A_{ji} vector components may designate materials, components, finished products, labor and financial resources. By spending resources, subdivision P_i, $i = \overline{1, N}$ may change the condition of consumers and other subdivisions. In general case, these variations with time are determined by the systems of the following type:

$$\dot{\mathbf{S}}_i(t) = F_i(\mathbf{S}_1,\ \mathbf{A}_1,\ \ldots, \mathbf{S}_N,\ \mathbf{A}_N,\ \mathbf{E}_1,\ \ldots,\ \mathbf{E}_M),\ i = \overline{1, N}, \tag{1}$$

$$\dot{\mathbf{E}}_k(t) = F_k(\mathbf{S}_1,\ \mathbf{A}_1,\ \ldots, \mathbf{S}_N,\ \mathbf{A}_N,\ \mathbf{E}_1,\ \ldots,\ \mathbf{E}_M),\ k = \overline{1, M}. \tag{2}$$

Some restrictions may be imposed on the condition of subdivisions and consumers, as well as on actions of subdivision in certain situations, generally determined by the inequality systems:

$$\mathbf{G}(\mathbf{S}_1,\ \ldots, \mathbf{S}_N,\ \mathbf{E}_1,\ \ldots,\ \mathbf{E}_M) \le 0, \tag{3}$$

$$\mathbf{D}(\mathbf{S}_1,\ \mathbf{A}_1,\ \ldots, \mathbf{S}_N,\ \mathbf{A}_N,\ \mathbf{E}_1,\ \ldots,\ \mathbf{E}_M) \le 0. \tag{4}$$

Meaningfully, these inequalities may designate restrictions to consumers' requirements, bills of materials, material, labor, financial resources and production capacities at the production system's possession.

Suppose, it is necessary to complete some target task $\mathbf{T}_\mu \in \Xi$, where Ξ is a set of goals, which this group of subdivisions is focused on. The example of $\mathbf{T}_\mu$ may be a negotiation of deviation from the component production plan under $\mathbf{f}_\mu = \{f_{1\mu}, f_{2\mu}, \ldots\}$, where $f_{j\mu}$ elements may designate qualitative or time deviations from the plan. For that purpose, it is necessary to spend some set of resources $\mathbf{R}_\mu = \{R_{1\mu}, R_{2\mu}, \ldots, R_{r\mu}\}$, where $R_{\nu\mu}$ elements may designate quantities of resources of a certain type. Upon that, each of $R_{\nu\mu}$ resource may be spent by P_i subdivision with $q_{i\mu}(R_{\nu\mu})$ expenses in monetary or time terms. Then, it is necessary to form the subdivision cluster $P_i \in \mathbf{P}$, $i = \overline{1, n}$, $n \le N$, which upon restrictions

(1)–(4) will bring the extreme value to the optimality criterion of $\mathbf{T}_\mu$ target task completion, one of the possible versions of which may be represented as

$$J_\mu = \sum_{i=1}^{n}\sum_{v=1}^{r} q_{i\mu}\left(R_{v\mu}\right) \to \min,$$

Here n is a number of subdivisions included in the cluster for completion of $\mathbf{T}_\mu$ target task due to self-organization in the production system.

Exemplary Problem of Network-Centric Management

In order to meet to the fullest degree customer requirements, the industrial enterprise faces a crucial task to maximize the responsiveness to orders coming from existing or potential customers. In terms of contents, this problem is as follows. Suppose the enterprise receives from a customer an order for several product types. Then, the customer determines constraints concerning the amount, timing and price of each product type. In addition, the customer can determine the priority of all product types. The enterprise must, within the predetermined deadlines, either accept the customer's terms and conditions, or make counter offers for the quantity, timing and price of the products. In this case, the enterprise takes into account its interests concerning profits, the importance of the customer, as well as constraints concerning the production capacity and physical resources. In the worst case, the enterprise refuses completely to produce all product types for the customer.

In order to solve this problem, it is necessary to develop a mathematical model that would generate a certain set of options for the customer's order accommodating the interests of the customer and the enterprise. This model should allow:

— calculating several options for the customer's order specifying the quantity and timing, price and profits for each product type or issuing a conclusion on the complete inability to fulfill the customer's order;

— calculating the amount of production capacities and physical resources required to perform all or part of the customer's requirements.

The initial data for the model are:

— the customer's order including the quantity, timing, price and priority of each required product type;

— regulatory reference data on the product composition and manufacturing technologies;

— data on the enterprise's product cost;

— data on the market value of the enterprise's products;

— a utilization plan for the enterprise's production capacity and physical resources.

Suppose the customer has placed with the company the j-th order for N product types in the amount of q_{ij}, $i = \overline{1, N}$. Here, j is a unique order number, generated in a continuous manner for all customers. And the j-th order identifies definitely the customer, i.e., using an order number we can always identify: which customer has placed it, what is necessary to determine the importance of the customer and the enterprise's pricing policy in respect to the customer.

Suppose that the ith products required for the jth order can:

— either be produced by the enterprise in time in the amount of q_{ij}^e at the price $p_{ij}^e(q_{ij}^e)$ with the cost $c_{ij}^e(q_{ij}^e)$ and profitability $\Delta_{ij}^e = q_{ij}^e(p_{ij}^e(q_{ij}^e) - c_{ij}^e(q_{ij}^e))$;

— or be purchased by the enterprise from other producers in the amount of q_{ij}^s at the price $p_{ij}^s(q_{ij}^s)$ with the cost c_{ij}^s and profitability $\Delta_{ij}^s = q_{ij}^s(p_{ij}^s(q_{ij}^s) - c_{ij}^s)$ (in particular, we can assume $c_{ij}^s = c_{ij}^e(q_{ij}^e)$);

— or be produced by the enterprise with a deviation D_{ij} of the deadline not exceeding a certain known allowable deviation of D_{ij}^* in the amount of q_{ij}^b at the price $p_{ij}^b(q_{ij}^b, D_{ij})$ with the cost $c_{ij}^b(q_{ij}^b)$ and profitability $\Delta_{ij}^b = q_{ij}^b(p_{ij}^b(q_{ij}^b, D_{ij}) - c_{ij}^b(q_{ij}^b))$. If $D_{ij} > D_{ij}^*$, then, the enterprise refuses to produce the ith products under the jth order for the customer.

In this case, the profitability of the i-th products in the j-th order Δ_{ij} is calculated as follows: $\Delta_{ij} = \Delta_{ij}^e + \Delta_{ij}^s + \Delta_{ij}^b$, and the total profitability of the j-th order Δ_j is calculated as follows: $\Delta_j = \sum_{i=1}^{N} \Delta_{ij}$.

In accordance with the regulatory reference data on the product composition and manufacturing technologies, we set known the following values:

— capacity requirement for each of the M equipment types per product division R_{li}, $l=\overline{1,M}$, $i=\overline{1,N}$, based on processing routes;

— the need in each of the K key materials per product division S_{ki}, $k=\overline{1,K}$, $i=\overline{1,N}$ based on the product specification;

— available capacity for each equipment type P_l, $l=\overline{1,M}$ according to the production plan;

— the available quantity for each of the key materials T_k, $k=\overline{1,K}$, based on the data on the inventory status and the procurement plan.

In this case, the constraints on manufacturing capacities and materials to produce the jth order of the customer may be as follows:

$$\sum_{i=1}^{N} R_{il}\left(q_{ij}^{e}+q_{ij}^{b}\right)\le P_l,\ l=\overline{1,M}, \tag{7}$$

$$\sum_{i=1}^{N} S_{ki}\left(q_{ij}^{e}+q_{ij}^{b}\right)\le T_k,\ k=\overline{1,K}. \tag{8}$$

In this case, the amounts of funds that can be spent to purchase the products Z_i, $i=\overline{1,N}$ are assumed known, and the constraints on the purchase of products from other manufacturers for the order of the j-th customer can be as follows:

$$q_{ij}^{s}p_{ij}^{s}\left(q_{ij}^{s}\right)\le Z_i,\ i=\overline{1,N}. \tag{9}$$

The importance of the j-th order W_j is determined by the importance of the customer for the enterprise — I_j and may further depend on the profitability of this order Δ_j. Then, the importance of the ith products in the jth order V_{ij} is set by the customer.

Now, the mathematical formulation of optimizing the production of orders received can be as follows.

Suppose there is the j-th order for N product types in the amount of q_{ij}, $i=\overline{1,N}$. We need finding such quantities q_{ij}^{e}, q_{ij}^{s} and q_{ij}^{b}, that would provide with the constraints (1)-(5) the extreme values of the following criteria:

— profitability

$$\sum_{i=1}^{N}\Delta_{ij}\to\max, \tag{10}$$

— importance

$$\sum_{i=1}^{N}W_j\left(I_j,\Delta_j\right)V_{ij}\to\max, \tag{11}$$

— just-in-time delivery

$$\sum_{i=1}^{N}D_{ij}V_{ij}\to\min. \tag{12}$$

It should be noted that the problem can be similarly set for multiple orders from different customers as well as for competing orders already included in the production plan. In these cases, the expressions (7), (8), (10) to (12) will contain the amounts under the j-th orders.

The solution of the multicriterion optimization problem can result in a set of admissible optimal solutions (for example, a Pareto set). To select the most suitable solution for the whole production system, it is proposed to use the mechanism of group decision-making by experts of the enterprise divisions in the network-centric management model. To this end, experts across the enterprise, in the case in hand, those of sales, production and supply divisions, will conduct an additional analysis of the proposed options of the Pareto set of solutions. Obviously, each option under consideration involves a varying degree of participation of each division. The following options of solutions are possible as shown in a qualitative manner in Fig. 2, where q is the quantity of production; t is the time; t^{*} is the receipt date of the order:

— the order can be fully executed by production divisions through additional labor and capacities, the cost of production being increased and the profitability of the order being decreased, respectively (Graph 1 in Fig. 2);

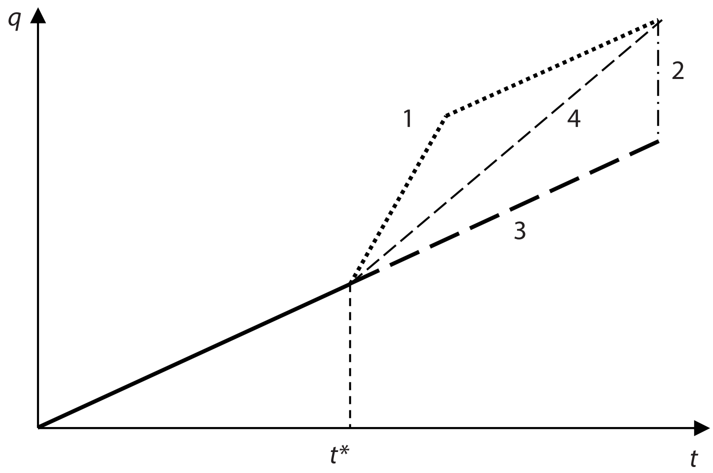

Fig. 2. *Alternate solutions for execution of an order*

— the order can be fully executed by supply divisions through purchases of the products required from other manufacturers, but at a higher price than the cost, the profitability of the order being decreased, respectively (Graph 2 in Fig. 2);

— through the efforts of sales divisions, an agreement with customers may be reached as to postponing their order to the following planning period, but with delay damages or discounts due to the late execution of the order and a corresponding decrease in the profitability of the order (Graph 3 in Fig. 2);

— an integrated solution can be found where all the divisions will participate in the execution of the order in a varying degree (Graph 4 in Fig. 2).

It should be noted that the above-mentioned problem can be significantly simplified by reducing it to a linear programming problem. To this end, it is sufficient to use as prices p_{ij}^e, p_{ij}^s, p_{ij}^b and costs c_{ij}^e, c_{ij}^s not the functions of the respective quantities but constants, and treat the problem as one-criterion one with an objective function of the type (10).

Uncertainty Formalization

The task of optimal production planning subject to uncertainties on goals and information support is a multicriteria task of discrete optimization in fuzzy setting and may be formulated as follows [19, 20]: find solutions $x_p \in X_p \subset R^n$, bringing the extreme point to target functions, $J_i(x)$, $i = \overline{1, L}$, for example,

$$J_i(x) = \sum_{j=1}^{N} \lambda_j f_j^i(x), \quad i = \overline{1, L}, \; f_j^i(x) = \left(\phi_j(x), \; \mu_j(y_j), \; \alpha_j, \; s_j\right),$$

where $\phi_j(x)$ is a scalar function reflecting the sense of criterion;
$\mu_j(x_j)$ is a fuzzy set membership function [11];
y_j is a fuzzy set support element $V_j = \{\phi_j(x): \mu_j(\phi_j(x)) > 0\}$;
α_j is a criterion norm, determining minimum allowable limit for $\mu_j(y_j)$, $\alpha_j \in [0; 1]$;
s_j is a relative priority of criterion, determining the necessity of its use, particularly, s_j may accept values "not important", "neutrally", "important", "very important";
λ_j are numeric equivalents of priority s_j;
at inactive constraints

$$C_m(x) = \left(\phi_m(x), \mu_m(y_m), \alpha_m, s_m\right) \le 0, \quad m = \overline{1, M},$$

and active constraints

$$g_k(x) \le 0, \; k = \overline{1, K},$$

forming the tolerance range X_D of control vector x.

The image of this mathematical setting is given in Fig. 3.

To compare the fuzzy number upon the fuzzy setting of the task, it is possible to use various ranking indexes [21, 22, 23, 24]. Special ranking indexes [18] may also be used to compare generalized (complex) optimality criteria in multicriteria tasks of production planning.

For example, based on some partial optimality criteria of the production plan J_1, J_2, …, J_n it is possible to construct the generalized (complex) optimality criterion using extended fuzzy set over

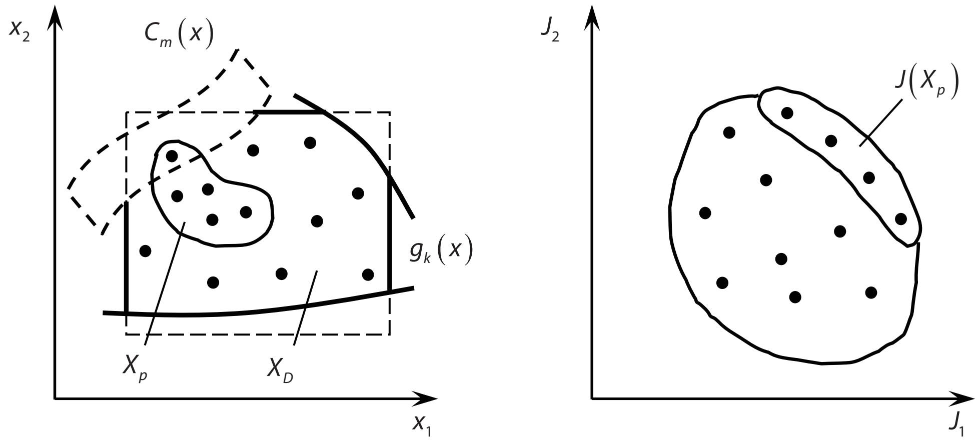

Fig. 3. *Multicriteria optimization task set fuzzily*

partial optimality criteria $J_r = \{\mu_1 / J_1; \mu_2 / J_2; \ldots; \mu_n / J_n\}$, where $\mu_i \in [0; 1]$, $i \in \overline{1, n}$, is an expert assessment of ith criterion significance. Definition of μ_i, $i \in \overline{1, n}$, values, in this case, is a result of group decision making in the form of expert group polling.

If necessary, the extended fuzzy set J^r also allows taking into account the opinion of the expert group head. For this purpose, it is sufficient that the head sets variation intervals of significance assessments μ_i, $i \in \overline{1, n}$, and the ranking index, using which generalized optimality criteria J^r must be compared. Thus, it is possible to take into account the interests of various social groups, included in the decision-making hierarchy of the production enterprise, more adequately.

Situation Center as a Network-Centric Management Tool

To organize the process of group decision making, it is proposed to form one of three organizational structures: committee, hierarchy and polyarchy [25], within which, the complex assessment of each possible variants is performed, as well as a selection of the best industrial enterprise, suitable for all subdivisions based on the selected model of group decision making. The efficient group decision-making tool may be an Enterprise Control Center (ECC) [26].

ECC shall be understood to mean a man-machine system, including the area (hall, room, office) equipped with communication means (videoconferencing, conferencing) and other tools of interactive presentation of information, designed for the on-line management decision-making by experts, control and monitoring of industrial and organizational production processes, as well as the analysis of possible situations based on the intelligent technologies of management decision making support.

The situation shall be understood to mean a certain condition of the system under the study, which occurred or may occur both due to changes in the system itself and due to external effects. For example, the situation will be the production system condition upon receipt of the new order or abrupt changes in the market situation, which requires sufficient changes of a large number of processes in the system. Upon that, each situation is marked by its set of situation tasks, each of which supposes various resolution scenarios to achieve the desired goals. Here, the situation task shall be understood to mean a problem occurred in a certain situation and requiring a comprehensive solution. For example, the situation task is an assessment of capability for performance of the urgent and large order or execution of new MPS.

The remarkable thing is that the certain situation is often marked by the presence of uncertainty, caused by incompleteness of information on process behavior conditions and by the uncertainty of parameters characterizing and describing this process. A solution of situation tasks is connected with the analysis of certain situations, reflecting changes occurring in the system, evaluation of indeterminate forms and generation of a sequence of possible actions (scenarios) focused on the resolution of occurred problem. Each solution of the situation task provides for interaction of a large number of system elements and processes. Therefore, the set of models characterizing both processes themselves and their interaction is required for the solution of the situation task. In addition, it is necessary to develop the management decision support algorithm. This algorithm is built on the group decision-making mechanism implicating the use of both centralized and decentralized management methods. Upon that, each decision must be based on the objective data obtained on-line, for example from the enterprise information system. Basically, the question is the implementation of management informational support and intellectualization mechanisms, which are the methodological foundation of ECC creation collectively with the group decision-making mechanism.

Particularly, in order to solve the above-mentioned network-centric management task, the experts of the industrial enterprise may vary the task parameters (order significance, product cost, order schedules, etc.) and carry out an analysis of possible solutions at various initial data using ECC technical support and software.

Thus, ECC is a powerful tool to increase the quality of management decision-making and formation of management competences in the industrial enterprise management amidst quick changing production condition and market situation. For this purpose, ECC must solve the following tasks:

— object status monitoring with forecasting of the situation development based on the analysis of incoming data;

— support of management decision making based on mathematical modeling and using of information analysis systems;

— expert assessment of decisions made and their optimization;

— management in a crisis situation;

— generation of management competences.

Conclusion

The application of network-centric, i.e. decentralized group management methods allows sufficiently increase the quality of management decisions made in the industrial enterprise.

The decentralized group management methods are able to improve efficiency and effectiveness in the implementation of production plans due to the application of mechanisms of self-organization of enterprise subdivisions on behalf of the enterprise itself and its customers.

To set and solve optimal network-centric management tasks, it is possible to use mathematical modeling methods amidst various types of uncertainty.

The situation center of the industrial enterprise may be an efficient tool for the network-centric management implementation, and will also promote formation and development of enterprise experts' management competences.

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