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GROUP DECISION MAKING WHILE PRODUCTION PLANNING IN A BUSINESS ENVIRONMENT

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ABSTRACT

The aim of the study is to develop the human-machine information technology of group decision making that will allow each service in the enterprise to make the necessary adjustments to the production plan in dialog mode. The problem of the production program optimization of such plant is considered as a two-tier hierarchical system with the usage of system optimization method, which allows to create a human-machine technology of collective decision making. The basic task of this technology is to create matrices in dialog mode that correspond to technical and economic standards and indicators, as well as to establish relationship between them for information coordination. Application of human-machine group decision making procedure in production planning will take into account the interests of all enterprise services and will improve production efficiency through precise planning and reliable resources and components supply, inventory and production technology control.

ГРУПОВЕ ПРИЙНЯТТЯ РІШЕНЬ ПРИ ПЛАНУВАННІ ВИРОБНИЦТВА НА ПІДПРИЄМСТВАХ

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У статті розроблено людино-машинну інформаційну технологію групового прийняття рішень, що дозволить кожній службі підприємства вносити необхідні корективи у план виробництва відповідно до своєї природи та можливостей у діалоговому режимі. Задача оптимізації виробничої програми підприємства розглядається в дворівневій ієрархічній системі з використанням ідеології системної оптимізації, яка дозволяє побудувати людино-машинну технологію прийняття колективного рішення. Основою цієї технології є формування у діалоговому режимі матриць, що відповідають техніко-економічним нормам і показникам, та організація взаємозв'язків між ними для узгодження інформації. Використання людино-машинної процедури групового прийняття рішень при плануванні виробництва дозволить урахувати інтереси всіх служб підприємства, а також покращить ефективність виробництва за рахунок точного й достовірного планування поставок сировини, комплектуючих, контролю запасів і технології виробництва.

Ключові слова: *виробництво, рішення, планування, оптимізація, підприємство.*

Business requirements are increasing every year and business process management is not on the last place in modern circumstances. Enterprises set great number of tasks, including profitability and productivity improvement, customer base increase and losses reduction. Of course, all these can occur simultaneously with the release of new products, introduction of new equipment or even a new plant. Since the activities of any company are associated with the influence of external and internal factors, it is necessary to consider them in production planning process and during production cycle of the enterprise directly.

There is no doubt that the production is a key process of any enterprise. Therefore, production planning and optimization is a subject which has been widely discussed and analyzed for many years. In modern conditions, it has not finished but even has come to the front because of high intensification of production process. So, only those companies which are really concerned with the planning and optimization of their own production process are getting benefits and advantages.

Currently two main forms of production specialization (PS) are used, namely object-specialization and technological specialization. In technologically specialized structure each production unit (PU) specializes on one particular part of the production process. Object specialization is characterized by the fact that every PU performs most part of operations in a technological process.

It is known that technological specialization has the following disadvantages:

1) the difficulty of PU set up for a reasonable production program on the range because a separate position of planning task is a detail-operation, and the main indicator is a normalized task. Under these conditions, there is no proper responsibility of workers for timely and complete products delivery. Also the planning process is complicated because the following limitations should be considered during planning process:

A) total complexity of machining must not exceed the normalized task;

B) the planned target for PU — consumer must not exceed the number of pieces coming from the PU — supplier;

C) the planned target in the number of parts must not be less than the monthly needs.

2) excessive centralization of scheduling and production accounting operational functions in planning controller's department, and as a result, unjustified increase in the staffing of this department;

3) significant complexity of cooperation between PUs;

4) increased time of the production cycle;

5) increased amount of work in progress, which in turn slows the reversibility of funds;

6) the complex regulation process and difficulties in improving quality and reducing defects, because in this production the structure of OP managers is actually responsible for only one technological operation, and not for the quality as a whole;

7) significant difficulties arising from the implementation of cost accounting at the PU;

8) since every PU is strongly associated with other PUs, the shops management operation is reduced to interdepartmental problems solving. This is difficult, because the heads of the shops do not depend on each other.

The advantages of technological specialization include the lack of imbalances in equipment load and difficulties in ensuring full equipment utilization in case of significant change in product mix, as well as the simplification of maintenance and preparation of preventive equipment maintenance.

In turn, the object specialization has the following advantages:

1) the quality of operational scheduling is greatly enhanced by profound differentiation of planning functions between the planned dispatch department, shops and PU, shift planning directly to PU;

2) significant planning and regulation improvement of production between the shops and the PUs;

3) increased responsibility of heads of the departments and workers for timely, quality and complete performance of production tasks;

4) facilitated workforce maneuvering not only within the same profession, but also by widespread application of profession combinations;

5) technical production control is greatly simplified and reduced in volume by centralizing the control of PUs and in some cases by cooperative control deregulation.

Along with the advantages in the field of production planning, object specialized production system also has benefits in another cases:

1) reduced time of production cycle by reducing the so-called interoperable break and parts movement in production process;

2) improved product quality.

Also it must be noted that in addition to advantages, object specialization has some disadvantages:

1. The possibility of imbalances in PU loading and difficulties in ensuring full utilization of equipment in case of a significant change in product mix for the program;

2. Complex service organization and preventive equipment maintenance;

3. The need in more pieces of equipment, etc.

When developing automation systems in manufacturing, trade, services and other enterprises, insufficient attention is paid to the optimization, including implementation of optimal production plan, optimal transportation plan, efficient delivery schedule, optimal pricing policies, etc. All of these issues may allow companies to use available opportunities effectively and correctly, while getting maximum profit or maximum possible performance, according to goals of the enterprise.

The purpose of optimization is an effective use of existing information as a powerful tool in decision making support. In general, optimization is a process of finding the optimal production decisions and business objectives using mathematical models. The primary optimization objective is to maximize or minimize the required parameters in the decision making process and directly in the production process organization. The best solution is selected by using certain optimization criteria among all alternative options. Also we need to take into account the specific conditions specified by the real problem limits (for example, the elapsed time, cost).

The main optimization methods are logical, physical or economic-mathematical modeling. Economic-mathematical modeling is the most widely used method for management decisions optimization. The most commonly used methods for optimization of problems solving are linear and nonlinear mathematical programming methods (modelling), which have high accuracy and flexibility of application.

Optimization problems can occur in all areas of the economy and production, namely in technological process, logistics, traffic management and production planning.

In general, there are several levels of the production planning process. Each one solves its particular problem:

Business planning. The task is to determine the production volumes for budgeting. Different scenarios are modeling for the long-term strategic decisions. Planning horizon ranges from one to several years.

Portfolio optimization. The task is to decide which products should be produced, taking into account current prices, production and raw material costs. It allows to avoid loss-making routes and maximizes the use of profitable ones. Planning horizon ranges from one to several months.

Operational planning. The task is to readjust the optimization of profiles, to create plots for shops and plans for interdepartmental integration. It allows to maximize yield by reducing the number of readjustments, increase customer's satisfaction by meeting deadline supplies and reduce production cycle. Planning horizon ranges from a week to a month.

Production planning includes following areas:

Materials: planning the procurement of raw materials, components, and spare parts in the right quantities and specifications at the right time from the right source at the right price; purchasing, storage, inventory control, standardization, variety reduction, value analysis are the other activities associated with materials.

Methods: choosing the best method of processing from several alternatives.

Machines and equipment: manufacturing methods are related to production facilities available in the production systems; it involves facilities planning, capacity planning, allocation and utilization of equipment, machines, etc.

Manpower: drawing on the manpower with appropriate skills and experience.

Routing: determining the flow of work material processing in the plant and sequence of operations or processing steps.

In the modern world, the effective management and system analysis of production system objects are the most important challenges caused by increased production volume, traffic streams, increased assortment and amount of material resources that are supplied, processed and stored. At the same time, existing approaches based on optimization problems solving in most cases cannot be effectively used because the information about the parameters of the production system is usually inaccurate, incomplete and subjective. Besides, the significant dimension of the problem also negatively affects the creation of effective solutions.

The desire to consider the majority of the key factors when evaluating the efficiency of production systems obviously leads to the need for multi-objective optimization methodology. However, the use of multi-objective approach is constrained by such factors as criteria differing and mixed criteria (quantitative and qualitative criteria, the latter tend to dominate); besides, certain criteria belong only to certain functional services of a company.

Thus, the importance of the subject is defined by the need to perform a system analysis of production chains through the development of new models and methods of multi-criteria group decisions. These models should also take into account the

fact that the expert opinion and relationships in the production process must be considered in the production planning process.

Based on the above, an enterprise is examined, where the production process is organized on the basis of object specialization. Shops of such plant (enterprise) are focused on production and assembly of machine components or final products. These products go to adjacent shops for subassembly or they are the final products of the plant. Decomposition of complex technical products may be up to 10 levels. Each plant can produce its products on its own equipment and can use other component parts of other shops or businesses. Some products can be manufactured with different technologies, using different materials. Also, in general form this problem should be taken into account as an area feasible region, specified by the object properties (availability of necessary equipment, materials, labor) and as the tolerance region, specified by directive guidelines (government contracts, future plans, etc).

Vector X_i^f of the final products for *i*-shop is $i \in I$ (I — number of shops), that is defined by its equipment specialization. Considering the components which are the parts of product X_i^f, vector X_i of i-shop products is calculated by the formula:

$$X_i \geq K_i X_i^f - X_i^{mts}, \tag{1}$$

where K_i — configuration matrix (number of product $x_i \in X_I$ in product $x_i^f \in X_i^f$), X_i^{mts} — vector components of i-shop which come from different shops and (or) different enterprises through logistics.

The composition of vectors X_i^f, X_i and matrix K_i also include alternative manufacturing variants of individual products and their components.

Final products X_j^f of the shops may be included to vectors X_j^f, $j \in I$ of other shops and (or) to vector X^f of enterprise final products, which is formed as:

$$X^f = UX_j^f \tag{2}$$

The structure of the general production program planning models of the company or workshop includes the following models (example based on shop) [9]:

- Technological — formed by technological standards of production:

$$A_i X_i \leq B_i, \tag{3}$$

where A_i — technological standards matrix of manufacturing products; X_i — production volumes of certain products; B_i — funds of equipment and staff time restrictions.

- Technical and economic parameters that are generated by manufacturing product cost parameters:

$$C_i X_i \geq T_i, \tag{4}$$

where C_i — cost indexes matrix of manufacturing products X_i by technical and economic performance; T_i — progressive limitations of these indicators.

- Logistics, which is formed by the cost norms of raw materials and other resources for production X_i by types of resources, and limitations on the available volumes of resources;

$$S_i X_i \le M_i, \tag{5}$$

where S_i — cost norms matrix of raw materials and other resources; M_i — restrictions on the available volumes of these types of resources.

- Assembly, which is formed by bundling standards of final product X_i^f, and their limitations characterize the lower release limit of X_i.

$$X_i \ge K_i X_i^f - X_i^{mts}, \tag{6}$$

where K_i — assembly matrix of final products X_i^f.

The problem of optimization of the production program of a plant is considered as a two-tier hierarchical system [10] with the usage of system optimization [11], which allows to create a human-machine technology of collective decision making. This technology is based on the creation of matrices in dialog mode that correspond to technical and economic standards and indicators, on establishing relationship between them to coordinate information of the components, ratios of certain types of production, costs of different resources, opportunities and reason of alternative production of some components (parts). Configuration matrix columns are final shop goods, and the lines are component parts X_i which are made in the shop. The intersection indicates the number of relevant components that make up the final product. If the accessory is also the final workshop product, at the intersection of its column and row we put 1 and in the other lines we put 0.

Alternative options of final products are also represented in the matrix. As a result, the matrix dimension increases: the number of columns by the number of alternative methods of final product manufacturing; rows by the number of component types.

For an optimal plan creation it is necessary to make adjustments to the matrices solving production problems at different stages:

- initial formation of optimization model;
- (if incompatibility problem arises) definition of inconsistent restrictions, ways of their elimination and determining the appropriate actions;
- shop plans coordination — we define the weak points of the production facilities.

The iterative and phased process of matrix adjustment requires the creation of appropriate methods and tools. The availability of such assets will provide a dialog mode for mathematical methods of formalized procedures and will build flexible technology of planning problems solution with compliance in coherent shops production and businesses in general.

Conclusions

Efficient production planning is the basis of successful operation of any manufacturing company. The analysis of decision-making methods in planning has showed that existing methods cannot adequately handle incomplete and contradictory information from different sources and, therefore, it is necessary to create new methods that will consider these factors during the production planning process.

The process of group decision making will overcome the antagonism between the different services and the resulting plan will be coordinated with all the services

that will make it more effective and reasonable. Optimization of production planning has only advantages for the enterprises, because it results in: increased profit; increased productivity; increased efficiency of labor; increased quality of applied solutions; increased product quality; reduced risks.

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ГРУППОВОЕ ПРИНЯТИЕ РЕШЕНИЙ ПРИ ПЛАНИРОВАНИИ ПРОИЗВОДСТВА НА ПРЕДПРИЯТИЯХ

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В статье разработана человеко-машинная информационная технология группового принятия решений, которая позволит каждой службе предприятия вносить необходимые коррективы в план производства в диалоговом режиме. Задача оптимизации производственной программы такого предприятия рассматривается в двухуровневой иерархической системе с использованием идеологии системной оптимизации, которая позволяет построить человеко-машинную технологию принятия коллективного решения. Основой этой технологии является формирование в диалоговом режиме матриц, соответствующих

технико-экономическим нормам и показателям, а также организация взаимосвязей между ними для согласования информации. Использование человеко-машинной процедуры группового принятия решений при планировании производства позволит учесть интересы всех служб предприятия, а также улучшит эффективность производства за счет точного и достоверного планирования поставок сырья, комплектующих, контроля запасов и технологии производства.

Ключевые слова: *производство, решение, планирование, оптимизация.*