The formation of the optimal production program as an element of raising competitiveness of the enterprise

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Abstract. The raising competitiveness of the enterprise involves the introduction of new technologies of production and management, which are focused on constant updating of products, on significant improvement of its quality, and also control over the appearance of the product range. This paper proposes an approach to the formation of optimal production program enterprises with complex use of raw materials as a necessary element of competitiveness. On its basis are built the models of single-product and multi-product optimization using dynamic programming method.
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Introduction

The enterprise, as basic structure-forming element of the economy, which, interacting with other enterprises, determines the relationship model of economic entities, the legal environment of the state, and also satisfies consumer demand. Balanced policy of management of organization is necessary for any enterprise in conditions of market, consumer environment to remain competitive.

Any enterprise, certainly, is seek to increase results and indicators of its activity, which leads to the necessity of increasing the competitiveness of products and requires improving the work of all departments and services of the organization. In such situation, competitiveness acts as the most important factor of the plant safety, which allows it to survive in "the harsh conditions of reality" and provides the subsequent effective development.

Tools for solving problems of increasing competitiveness can serve the integrated approach for the development and construction of control system by the product range [1]. And important from the standpoint of improving the management of the organization is a systematic and planned work to managing of this aspect of activity. Therefore the management system of product range should be considered not only from the point of view of operational management, but also should be necessarily developed a strategic approach, that is any solution of operating subject in this field should be taken not only from the point of view of current interests, but also in terms of how it affects the final goal. This approach requires the complex analysis of all organization activity, market environment and, on the basis of a rational combination of results the analysis of objects, concentration of efforts on the decisive directions. Certainly, the management system of product range impossible to separated from the real terms activity of enterprise, specifics of its profile and it is always directed on the solution of the defined circle of tasks, which include [2]:

– customer satisfaction;

– optimization of financial results of the company – formation of assortment is based on the expected profitability;

– conquest of new customers by expanding the scope of of the existing production program;

– observance of the principle of flexibility by diversification of activity fields of the enterprise and inclusion in its structure of non-traditional sectors for him;

– observance of the principle of synergism, assuming expansion of areas of production and services of company, linked by a technology-specific, common qualified personnel and other logical dependence.

Complexity of formation of control system by the product range is to the necessity of decision of whole circle of tasks, requiring acceptance not only objective decisions, but also unobvious decisions, adopted in the conditions of risk and uncertainty. Therefore mathematical modeling is a reliable tool and possibility for "fitting" of decisions on a concrete economic situation. And the wide variety of methods of economic-mathematical modeling allows noticeably increase considerably efficiency of the developed system, allows dramatically reduce possibility of erroneous decisions, leading to decrease in profitability and competitiveness of production [3, 4].

Building of effective model, allowing to consider all aspects and the directions of formation of the product range, can become means, which will allow to optimize decisions on product range and expenses on its release. In order to develop and build the model must be correct determination of the competition strategy, coordinated with conditions of a concrete industry, skills and capital, which has a specific enterprise. As tools for development and creation of model would be application of the dynamic programming, which allows to reveal features of functioning of economic object, and on this basis to predict the future list of product groups.

In article, the authors offer economic-mathematical model of formation of optimum production programs in a given period of planning taking into account enterprise capacities [4]. Implementation of the model is made by the example of the enterprise with complex processing of raw materials.

The primary part

The main objective of offered economic-mathematical model is optimization of expenses at the enterprise of processing of complex raw materials by correlation of demand with the current volumes of processing of raw material. The processing of raw materials should be balanced, i.e. the current production capacity must be maximally high-usage, and demand on products is satisfied in full. After all if demand exceeds production capacities, competitiveness of enterprise falls, consumers find another supplier, and in case of failure of production absence of supplies can lead to loss of customers. [5]. And if production capacity exceeds demand, the enterprise works on storage, i.e. inventory storage costs increase abrupt, which can lead to decrease its production possibilities.

For any enterprise demand and production capacity are always corrected. As a rule correction of demand is temporary and is achieved by changing the prices of products. And capacity adjustment assumes periodic and expeditious change of volumes of release for the most exact accordance to demand at the market. Demand varies smoothly and can take any value. And manufacturing capacity can not increase abrupt, and if increases, then discretely. For any enterprise question arises: to what extent and when to change the manufacturing capacity, in order to enterprise costs associated with the production and storage of stock, were minimal? The mathematical model of process is presented in fig. 1.

The planning period is T. Duration of a separate step of planning Δt, and number of equal time steps n. The value of demand for products V_t in model may be discrete (a) or continuous (b). The nature and form of the curve $V_t = f(t)$ defines the method for solving the model. If we define demand as a discrete value, then we can apply methods of solving problems for discrete systems. In the case of continuous demand, we can use the methods of solution for continuous processes. The planning period is T. Duration of a separate step of planning Δt, and number of equal time steps n. The value of demand for products V_t in model may be discrete (a) or continuous (b). The nature and form of the curve $V_t = f(t)$ defines the method for solving the model. If we define demand as a discrete value, then we can apply methods of solving problems for discrete systems. In the case of continuous demand, we can use the methods of solution for continuous processes. The paper proposes a model, in which the amount of demand is discrete. The value u_t it determines the intensity of production in time period t_i. Minimum change in production volumes Δu, maximum volume of release u_{max} and minimal volume u_{min}. Minimal volume u_{min} of production program provides effective work of enterprise, and maximum volume u_{max} reflects the value of total production capacity. The value x_t will determine the level of reserves in the period t. The meaning of this variable is calculated based on the volume of production u_t, the size of the demand V_t, the considered period t, and level of a stock of the previous period x_{t-1}: $x_t = x_{t-1} + u_t - V_t$. Volume production u_i is determined based on the volume of demand V(t) and stock levels x(t) at the time t, so $u_i(t - t_i) + x_i(t - t_i) = V_i(t - t_i)$. Separately taken time period t with the main indicators of production is presented in fig. 2.

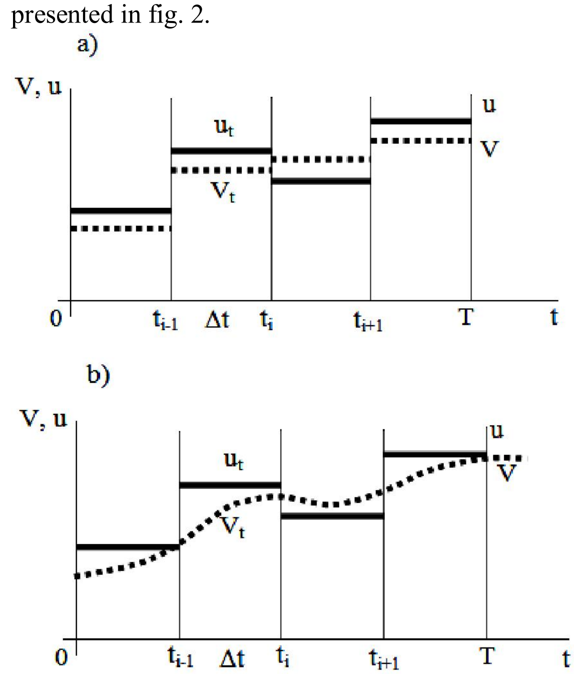

Fig. 1. Graphic model of process: a – discrete system, b – continuous system

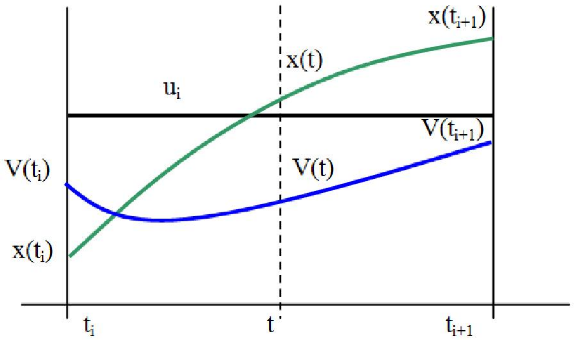

Fig. 2. Main indicators of model

For formation of the production program it is necessary to consider not only demand, but also to keep records of sales plan in the concrete period. If the enterprise has concluded contracts for the supply of its products, production program must fully meet the needs, and also provide sufficient stock of production in case of underperformance of the put plans [6]. Production capacity most often determines possibilities of the enterprise. After all if production capacity more than a sales volume, the underutilization of capacity leads to inflated costs for production. Otherwise, it is necessary to increase the production capacity of the enterprise or to reduce sales [7]. It is well-known that the formation of "portfolio" of orders or sales plan focuses on the size of the market, consumer demand, individual customer orders, applications for dealers, applications of wholesale buyers. The portfolio of orders on the basis of applications and contracts establishes total planned supply products in natural and value terms, graphics shipment of products to customers, stocks of finished products in stock, etc.

Calculation of production capacity provides reasonable calculation of the production program. As a rule, on the basis of these calculations revealed internal reserves of productivity growth, possibility of technical re-equipment, reconstruction and expansion of operating capacities, and also construction of new production units.

Fig. 3 shows the general scheme of the optimal production program.

Necessary initial material of considered model is formed information base on the entire process of processing complex raw materials. Information base must include the total amount of raw materials for processing, volume fractions of an exit of products, the maximum and minimum production capacity of the enterprise, the estimated prime cost of oil products, stock rate before the planning period, the total amount of capacities for storage of finished products and the cost of storage of a unit of production.

The method of the dynamic programming is chosen as means of decision of the formulated model, in which search of the optimum production program is multistep process [8, 9]. At each step determined operating influence (output), which should take into account the implications for future results. The last step (the last planning period) is determined without consequences. Knowing the initial inventory level x_0, can, apply conditional optimal solution in the first step, go to the second, from the second to the third, etc. The result will be obtained by optimal control (production volume) for the entire forecast period, which will result in the minimum value of the objective function (cost).

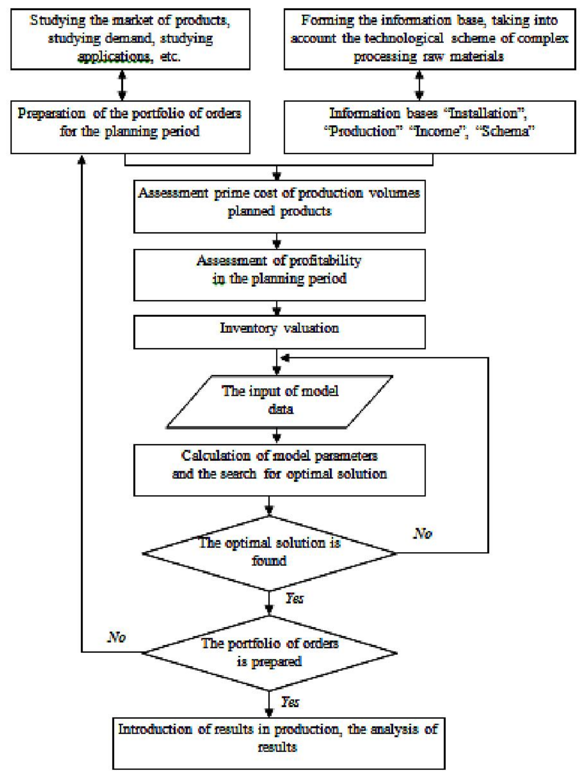

Fig.3. The scheme of formation of optimal production program

The main indicators and mathematical model of single-product optimization:

$$Z = \sum_{t=1}^{n} z_t = \sum_{t=1}^{n} \left(u_t \cdot cc_t + x_t \cdot cz_t\right),$$

recurrence relation

$$z_t(x_t) = \min\{z_t(x_t, u_t) + z_t(x_{t-1}) \mid x_t = f(x_{t-1}, u_t)\} =$$
$$= \min\{(u_t \cdot cc_t + x_t \cdot cz_t) + z_t(x_{t-1}) \mid x_t = x_{t-1} + u_t - V_t\}$$

the limitations of the model:

$u_{min} \le u_t \le u_{max}$; $\sum_{t=1}^{n} u_t = U$;

$\sum_{t=1}^{n} u_t = \sum_{t=1}^{n} V_t$; $0 \le x_t \le x_{t\,max}$,

where n – number of planning periods; t – current planning period; U – amount of raw material (oil); x_t – remainder of the oil product in the storage period t;
x_{max} – maximum capacity of storage; x_0 – initial stock of oil product in storage;
u_t – volume of production of period t; u_{min} – minimum production capacity;
u_{max} – maximum production capacity; V_t – demand of period t; cz_t – cost of storage ton of oil product.

The main indicators and mathematical model of multi-product optimization:

$$Z = \sum_{t=1}^{n} z_t = \sum_{t=1}^{n}\sum_{j=1}^{m} z_{tj} = \sum_{t=1}^{n}\sum_{j=1}^{m}\left(u_t \cdot r_j \cdot cc_{tj} + x_{tj} \cdot cz_{tj}\right),$$

recurrence relation

$$z_t(x_t) = \min\{z_t(x_t, u_t) + z_t(x_{t-1}) \mid x_t = f(x_{t-1}, u_t)\} =$$
$$= \min\left\{\sum_{j=1}^{m} z_{tj}(x_{jt}, u_{tj}) + \sum_{j=1}^{m} z_{tj}(x_{j(t-1)}) \middle| x_{tj} = f(x_{j(t-1)}, u_{tj})\right\} =$$
$$= \min\left\{\sum_{j=1}^{m}(u_t \cdot r_j \cdot cc_{tj} + x_{tj} \cdot cz_{tj}) + \sum_{j=1}^{m} z_{tj}(x_{j(t-1)}) \middle| x_{tj} = x_{(t-1)j} + u_{tj} - V_{tj}\right\}$$

the limitations of the model:

$u_{min} \le u_t \le u_{max}$; $\sum_{t=1}^{n} u_t = U$;

$\sum_{t=1}^{n}\sum_{j=1}^{m} u_{tj} = \sum_{t=1}^{n}\sum_{j=1}^{m} V_{tj}$; $0 \le x_{tj} \le x_{tj\,max}$,

where j – type of oil product; x_{tj} – the remainder of the oil product j in storage of period t; x_{maxj} – the maximum capacity of the storage for oil product j; u_{tj} – output of oil product j of period t; u_{min} – the minimum production capacity; u_{max} – the maximum production capacity; V_{tj} – the demand of period t for oil product j; r_j – volumetric share of oil product yield; cc_{tj} – prime cost of ton of oil product j; cz_{tj} – the cost of storage ton of oil product j.

The presented mathematical models allow to carry out planning of the optimum production program, which provides performance the portfolio of orders in full volume and exactly in time, leads to the minimum stocks in storages of oil products, conducts to gradual accumulation of volumes of processing and to smooth change of expenses, raising competitiveness of the enterprise [10].

Models also allow to estimate expenses on realization of any program for processing of initial raw materials. As a result of computer realization they allow to give a quantitative assessment of vector optimum refining of oil, volumes of the prepared oil product, volumes of average monthly storage of product, and also expenses of every period of planning and the general minimum costs of implementation of the production program.

Conclusion

The realized model have a number of advantages, which can be formulated so:

– models allow to produce optimal strategy of producing of products on an enterprise;

– models provide decrease in volumes of storage of ready oil products;

– models optimize costs of production of ready oil products;

– models optimize costs of production realization;

– models take into account the dynamics of change of prime cost of product;

– models allow to define the most optimum range of products depending on quality of initial raw materials;

– models optimize distribution of production resources and capacities for satisfaction the orders of portfolio;

– models is the means providing increase of competitiveness of the enterprise.

The developed computer models can be added with various restrictions as to the volume of processing of raw materials and release of a certain product, and on the level of supply, or in demand size. The developed models can be applied for any enterprise with the complex use of raw material for the purpose of improving competitiveness.

The results of numeral modeling can be used both for planning of the optimal productive program, and for making of strategy of producing of products taking into account demand and situation at the market of the finished product. Also models allow to consider dynamics of change of prime cost of products, possibility of adjustment of volume fractions of an exit of products depending on quality of initial raw materials and change of expenses for storages of finished goods.

And computer realization of economic-mathematical model allows to estimate efficiency and reliability of the developed decision on formation of the production program and allows to pass all stages of modeling without loss of production, forces and material resources.

Use of computer equipment and standard software as a tool of adaptation of a method of the solution of the formulated task and its realization can give the powerful economic effect, which is repeatedly paying back expenses for research of a problem of management, introductions of computer realization and practical use and as a result increase of competitiveness.

Inference

Formation of the optimal production program involves minimizing the cost of raw materials processing and balanced release of finished products. This paper describes a model of a single-product and multi-product optimization the production program. Results of modeling allow to estimate both cumulative costs of the entire period, and costs of production and of storage by each type of production. The model allows building the plan of volumes of processing of raw material taking into account production capacities and volumes of storages, and also demanding for ready oil products. The approach offered authors to formation of the production program is a reliable tool, providing not only optimization of the cost, but also is a necessary element for increase the competitiveness of the enterprise.

Gratitude

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