Organizational specificity of batch production enterprises of processing industry

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Abstract. This article deals with the approaches to the management of batch production in enterprises of processing industries. The advantages of batch production in comparison with piece production and continuous production are proved in the text. The authors show the mechanism of parallel or consecutive production line management. The comparison of key parameters of batch production in foreign and Russian enterprises is carried out in the article. The authors describe similarity and difference of batch production at the enterprises which are characterized by the discontinuity of production cycle with an exact calculation of temporal parameters of the stages of direct labor process. This comparison is made according to the methodology of similarity determination of the elements of production management in its various types and primarily in batch and piece production. Three variants of productive process modernization of the batch production are analyzed in the text of the article. Their integrating efficiency is assessed using such parameters as annual production volume of output, production cycle continuity, level of prime equipment load.

1. Introduction
The improvement of production systems under the conditions of dynamically developing economy and increase of their flexibility and high market adaptability become an important issue nowadays. Various approaches to modernization of production systems today vary significantly and consist of new managerial techniques that improve management of separate operating processes by means of the elimination of “extra” costs of production and by means of the production range expansion at industrial enterprises [1]. Furthermore, elimination of risks and introduction of risk management are an additional important factor and a part of aforementioned new managerial techniques [2].

Modernization of models of continuous and batch production acquires considerable significance under the existing conditions. In this respect it is necessary to analyze the possibilities of the use of batch production techniques at the enterprises of process industries. It is indispensable to assess their efficiency with respect to the strategic goals of enterprises. These are: introduction of new technologies, growth of the flexibility of processes for the satisfaction of quickly changing demand, diversification in the limited period of time. Simultaneously, introduction of new forms of production management is to be correlated with the expenses for their development and the integration within already working production lines.

At the modern stage of development high technologies require considerable investments, long cycle of introduction and on the contrary, the competition demands the fastest production of the wide range of goods [3]. Nowadays flexible production systems capable of changing over to new goods manufacturing in the short time with fractional modernization and readjustment of the equipment emerges full blown [4].

In this respect integration of manufacturing of various types of goods on a single technological line gains particular significance [5]. The use of batch production contributes to this issue to a great extent. Actually batch production is characterized by a relatively simple way of the innovations’ introduction
into the operating process. And general-purpose equipment which is typical for batch production is the most flexible for readjustment as it accelerates new technology developments assimilation. At the same time production management can be carried out with fewer costs that has a positive impact on the terms of the return on investment. Meanwhile the batch production makes the system more flexible relative to the fluctuations of the market demand, and to the continuous production systems.

Depending on the technology used at a specific enterprise it is possible to use hybrid models of production organization which combine the advantages of continuous and batch methods [6]. Indeed as a rule, the processing is carried out with the use of continuous flow of materials and suppliers according to specified tasks. However if an enterprise expects to diversify the output and to minimize the investments into the installation of new equipment, it is possible to organize a discontinuous flow of batch process (multi-item changing flow line). In particular, such an approach can be implemented in enterprises specializing in the production of construction materials.

2. Results and discussion

The use of such models can be analyzed on the example of the enterprises producing the construction bricks. The major part of the brick making plants existing in the South of Russia have a continuous automated (completely or partially) production line manufacturing only one type of commodity. “Volzhskiy kirpichnyi zavod” (Volzhskiy brick making plant) is one of such factories which can be taken as an example or a prototype. This model is economically viable by the decrease in the production cycle, reduction in expenses per unit of output and by other factors. But market circumstances require the growth of the range of output for the capture of new market segments [7]. For instance it is reasonable to branch out into a new type of production i.e. facing bricks together with the production of construction bricks or ceramic brick M150. At the classical model of industrial management it will require the construction of a new production line that in its turn will be combined with high investments [8] or shutdown or readjustment of the existing line that will make a simultaneous production of various types of production impossible.

The classical technological pattern of brick production is presented in Figure 1. The process includes the placement of raw material into the feeding unit, its dosage and directing into low and high roll mills for stone and metal separation. Then comes the flow into the mixing unit for making the clay sufficiently humid, pressing and cutting of clay bricks, its further drying and burning. When it is not possible to organize a continuous synchronized process of new commodity manufacturing, it is indispensable to introduce the batch method of production what will require a partial modification or modernization of the production technology line [9].

Such a modernization can be carried out in various variants. In the first case, in order to save the investments, production can be organized in such a way that batches are produced in a continuous way together with the readjustment of equipment for every product. Another variant implies mixing up of the batches of raw materials of various products and its incessant processing until a definite stage of process is achieved. After an intermediary storage (it requires modernization of the equipment), the process keeps up for various batches with the readjustment of the same equipment. The third variant implies the purchase of additional equipment for the simultaneous processing of batches of various products at different stages of production [10].
Figure 1. Flow chart of the continuous automated process of the production of construction brick at an enterprise.

Figure 2 presents the first variant of the modernization of the process which implies the consecutive (or in connection with the incoming orders) alternation of the batches of different products (ceramic and facing bricks) with the readjustment of every type of equipment (mixing unit, press, cutting apparatus, water pump). Batch B comes into processing, after that batch A goes partially into the storage where the drying of the clay brick in the natural environment takes place and partially it goes into the tunnel kiln for gas drying.

The main tasks of the production management at the given type of modernization come down to the determination of batch sizes for various products and the period of their alternation, calculation of the time of the start of the batch production, time of the technological cycle taking into account the period of readjustment of the equipment. The advantages of the method are minimal investments and diversification of output. Additional expenditures are connected with the increase in complexity of planning and labor costs.
Figure 2. The first variant of the production modernization of two types of products with the use of batch methods.

In figure 3 the second variant of the modernization of the production process of the construction brick is shown.

The given variant implies the equipping of the clay mixer with an additional section for an intermediary reservation (and if necessary for an additional mixing up) of some parts of raw material. Before this stage the raw material for products A and B is mixed and goes into the processing simultaneously. After sending batch A of clay brick for drying and for readjustment of the equipment the processing of the batch B starts. The batch of clay bricks comes from the section of the intermediary reservation in the mixer. The process can be organized in smaller batches which reduces the storage costs per unit of output.

The main tasks of the production management are: determination (calculation) of optimal batch sizes and period of batch alternation, scheduling of the start of the batches production and technological cycle of batches.
Figure 3. The second variant of modernization of production of two types of products with the use of batch methods.

Figure 4 shows the third variant of the production modernization of the brick manufacturing at an enterprise. It comes down to the purchase of additional equipment and specifically of the presses and cutting apparatuses for the organization of a synchronized parallel processing of various products. Raw material for products A and B is processed together and gets into the mixer equipped with the output channels into various devices (press and cutting apparatuses). Further the process is going in a parallel way until the burning stage at which the waiting time of the raw material of one of the batches in the expectation of the release and reset of the kiln takes place.

The mentioned method is the most investment intensive but at the same time allows organizing a parallel or simultaneous processing (at almost all stages) of two products at relatively low costs. The main tasks of the production organization are reduced to the determination of the optimal batch sizes, period of technological cycle of the batches’ processing taking into account the time of waiting and readjustment of the equipment [11].
Figure 4. The third variant of modernization of the production of two types of product with the use of batch methods.

It is possible to assess the efficiency of modernization of the production system on the basis of the comparison of three analyzed types taking into account such criteria as flexibility of the process and output differentiation, expenditures on production management, length of the production cycle, level of the equipment load, costs per unit of output (Table 1).

Table 1. Assessment of the efficiency dynamics of the production system after the introduction of batch methods.

| Criteria                        | Indices of the efficiency of a production system |
|---------------------------------|-----------------------------------------------|
| Variants of the modernization   | The first | The second | The third |
| Flexibility of the process      | Low       | Middle     | High      |
| Differentiation of the output   | Middle    | Middle     | Middle    |
| Production management costs     | Low       | High       | Middle    |
| Production cycle length         | High      | Middle     | Middle    |
| Machine load                    | Middle    | Middle     | High      |
| Costs per unit of output        | Middle    | Middle     | Middle    |

The assessment of the suggested variants of modernization which is shown in the table is made on the basis of average quantitative indices chosen for the efficiency assessment and is presented as a qualitative assessment at threshold limit values.
3. Conclusions
On the basis of the data mentioned above, the conclusion can be made that the first variant of the modernization process provides the achievement of the strategic goals of an enterprise in the sphere of increase in output range with the minimum investment. The expenditures for the production management at this variant are the lowest. However economic efficiency of the process is low as the production cycle turns out to be the longest one.

The second variant of changes allows increasing of flexibility of the process at the expense of a partial modernization of devices i.e. relatively small capital investments. The mentioned type of changes significantly increases the complexity of the production management as it requires calendar scheduling for small batches of various products including the waiting time at two stages of the process.

The third variant is characterized by the highest capital intensity as it implies the purchase of additional equipment. At the same time it has the highest flexibility and the economic efficiency of the process allowing organizing a continuous flow of raw material for two products almost at all stages of production. On this basis this variant can become more preferable.

Thus it is worth mentioning again that the batch production is characterized by flexible technology, universal equipment and relative simplicity of the introduction of innovations into the process [12]. It meets the market requirements in the output of a variable, quickly changing production and it can be integrated into the existing process without significant investments. Meanwhile the parameters of the batch production process (general-purpose equipment, relatively small volume of production, discontinuity of the process and so on) influence the flexibility of the process and variety of the output, lengthen the production cycle and require additional expenditures for the industrial management, including the costs of the full load of the machinery of the enterprise.

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