Modeling as a tool for reengineering the enterprise production processes

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Abstract. Effective reengineering of the main activity of the enterprise requires a systematic approach, covering all stages from project preparation to its implementation. The article shows the algorithm for reengineering the production processes of the enterprise and its implementation on the example of one of the leading manufacturing enterprises of the Krasnoyarsk Territory, Russia. The algorithm includes the construction of structural-functional models using the AllFusion Process Modeler (BPWin) software environment common in Russia and simulation based on the Arena product. A user can develop a technological process or process flow diagrams, as is usually done when describing “as-is” business processes or when designing a “to-be” business process, and then export them to Arena applying these tools together. Reengineering of the main processes according to the proposed stages of the methodology helps to evaluate their effectiveness before making direct changes.

1. Introduction

A systematic approach, covering all stages from preparation to implementation for effective reengineering of core business processes is required, [1]. Reengineering of the main business processes according to the proposed steps of the methodology helps to evaluate its effectiveness before making direct changes in the main business processes. It can prevent significant losses of funds with negative efficiency [2, 3].

The transition to a process approach in management is a long, expensive and extremely complicated procedure requiring impressive investments, time-consuming, and most importantly, the determination of the enterprise management to carry out the implementation project from beginning to end, in spite of any obstacles [4, 5]. Nowadays, the transition to process management is necessary for the successful operation of the organization, not only in the near future but just now [6, 7].

2. Business processes reengineering

The developed scheme of the stages of the reengineering methodology for the main business processes is presented in Figure 1. Four basic principles of effective business process reengineering are considered as the basis for the development of the reengineering methodology for the main business processes.
Figure 1. Algorithm for reengineering business processes for a manufacturing enterprise.
The transformation should concern the essence (foundation) of the process. At the same time, all established rules and norms of the existing processes at the enterprise must be discarded. The most important matter is concentrating on how it should be.

OJSC KRP “Biryusa” is currently the largest manufacturer of refrigeration equipment in Russia. The company improves the system of business processes constantly in order to compete with domestic, and especially with foreign manufacturers.

The management of OJSC KRP “Biryusa” started the process of transition to a process approach in managing the organization to increase the efficiency of work. It can help to implement the proposed methodology for moving to the process approach in enterprise management.

At the first stage of modeling it is necessary to determine the boundaries and composition of the elements of the studied system, determine the purpose of the simulation, select the type of model and the intended scope of its use, and define a “point of view” and model constraints.

The development of models includes the ABC analysis, containing such steps as creating cost centers for each function, definition of cost carriers for each function, determination of the operation cost, determination a cost object [3].

A business process of assembling a refrigerator is considered from the point of view of a technologist. The business process “assemble the refrigerator” is independent on the volume of production. Therefore, the operation hours of the main production workers as carriers of costs, the operation hours of the equipment and a number of purchased items required to perform the function were chosen.

Consider these steps as an example of a lower-level process "complete assembly". The costs of its implementation are united into three main cost centers such as additional wages; basic salary; deductions for social needs. Therefore, the cost carrier for the “complete assembly” business process is only the opening hours of the main production workers.

After that, it was necessary to determine the criteria for achieving the goal of improvement. The main criterion is cost reduction. In addition, important criteria are the reduction in the assembly time of a unit of production (which should entail its cost reduction), as well as the quality of the product. Then it was necessary to determine the last criterion according to a number of rejects at the assembly stage. It was proposed to carry out the following major changes in the design and assembly technology of the refrigerator as to replace the split case of the refrigerator with one-piece, carry out the main assembly of the refrigerator on the conveyor.

3. Business processes modelling

It was decided to use the assembly time of the refrigerator model, the cost of the product, the amount of production defects, customer satisfaction (realized through an increase in demand under the previous conditions of production and marketing) as the main indicators of the efficiency of business processes. Since the work on improving the business processes of the plant on the basis of the process approach is unique for him, it was decided to limit himself to these performance indicators of business processes at the first stage of the project.

The analysis of the “as is” model shows that the most cost-intensive function of the business process of assembling the Biryusa-228 refrigerator is a “direct assembly” function (68.57 rubles). The detailed functions are “to carry out operations with the main parts and assembly units” (48.42 rubles), “to prepare to complete the assembly of the refrigeration unit” (25.21 rubles), “to refuel the refrigeration unit” (16.59 rubles).

The working group decided to move on to improving the business processes of the “as is” model, and to conduct the third stage of the methodology for the transition to a process approach, i.e., development of the “to be” model.

At the third stage, “to be” models of Biryusa assembly business processes were developed, and a comprehensive analysis of their performance was carried out.

Having analyzed the shortcomings of the Biryusa-228 refrigerator model, a working group developed some innovative technological solutions, the main of which are improving the design of the
appearance of the model, and most importantly, the transition from the prefabricated case design to the one-piece one. This is due to such indicators as the acceleration of the assembly process of the refrigerator, cost of its design, and modernization of the manufacturing technology of the cabinet. The introduction of a new technology will reduce the cost per unit.

Thus, the improvement of the model assembly process is carried out according to the following methods. Reengineering is carried out on subsections that are changing dramatically, i.e., transferring the main assembly of the body from the floor to the conveyor (a new conveyor line is introduced), excluding sub-sections of transportation, assembly and debugging of doors outside the refrigerator assembly area, as well as reconstruction of some workplaces. The improving methodology (based on the ISO 9000 family of standards) is applied to all other business processes. They reduce the time of the main and auxiliary processes. It directly reduces cost, and the introduction of new areas of responsibility for process owners and a new job description system affects motivation staff to conscientious performance of their duties, which reduces the percentage of manufacturing defects.

The assembly process of the model is carried out in 5 areas (Table 1).

| Plot Number | Plot Number | Process Number | Process Type |
|-------------|-------------|----------------|--------------|
| 1           | Options     | 1.1            | complete assembly | A |
| 2           | Axle and bottom mounts | 2.1 | reload cabinet | A |
|             |             | 2.2            | axle mount       | M |
|             |             | 2.3            | stick a label    | M |
|             |             | 2.4            | bottom fixing    | M |
|             |             | 2.5            | Overload the case | A |
| 5           | Quality control | 5.1 | check the light | A |
|             |             | 5.2            | test on skep     | A |
|             |             | 5.3            | eliminate defects in the assembled refrigerator | M |
|             |             | 5.4            | bearer control   | A |
|             |             | 5.5            | Reload the refrigerator | A |

Each process has its own set of operations:

- Complete set, i.e., a complete set of components and spare parts for the assembly process is formed.
- Fixing the axis and the bottom, i.e., with the help of bolts, a bottom is fixed to the cabinet and the axis is mounted.
- The main assembly, i.e., the compressor, the condenser is fastened, evacuation, filling with freon, etc.
- Final assembly, i.e., installation of doors, countertops, testing, debugging and elimination of minor defects of the refrigerator.
- Quality control, i.e., checking the integrity of the electric circuit, testing on the electronic control system, eliminating defects in the assembled refrigerator, and bearer monitoring.

A working group forms a list of the main functions of the assembly process of the Biryusa refrigerator to create a structural-functional “to be” model.

The methodology for constructing the structural-functional model “to be” is similar to the methodology for constructing the model “as is”. The boundaries of the developed system are
the boundaries of a new business process for assembling the Biryusa refrigerator of the shop of OJSC KRP "Biryusa", and the elements are the functions of this business process. The purpose of the "to be" model is to describe the business process of assembling the Biryusa refrigerator after its improvement.

The description of the "to be" model, as in the construction of the "as is" model, is given from the technologist point of view. Therefore, the authors are only interested in the technological cost of the product. The cost of each function is calculated based on the resources necessary for its implementation in monetary terms (by cost center). The total cost of the "assemble the refrigerator" function, amounting to 73.31 rubles, is included in the total cost of manufacturing the Biryusa refrigerator.

Using the BPWin tool, the "to be" process model is developed using the "as is" model construction algorithm. At each level of decomposition, the corresponding diagrams are built. An example of one of which is shown in Figure 2.

The analysis of the "to be" model shows that the function "direct assembly" (68.68 rubles) is the most expensive function of the business process of assembling a refrigerator. Of the functions detailing it is "carry out operations with the main parts and assembly units" (43.44 rubles); of the functions detailing it is "finish operations with external parts and assembly units" (19.13 rubles); of the functions detailing it is "assemble the installation surface" (6.41 rubles).

4. Business processes simulation modelling

Based on the simulation model, one can build the most accurate and effective methods of analysis and forecasting business process performance indicators. One of the most effective simulation tools is the ARENA system that helps to build simulation models, analyze the results of such playback.

It is optimal to use a set of notations that display information, functional and simulation models for a more complete presentation of the studied business processes of the organization. Replacing a real experiment with simulation modeling can reduce the costs required for research.
Let us transfer the model from a structurally functional format to a simulation one. Then the business process of interest will be as follows (Figure 3).

![Simulation model of the “Quality control” business process in ARENA.](image)

The joint use of Arena and the integrated BPwin, which supports different notations for business processes modeling help to create a comprehensive package of tools and notations to describe in details the organization's business processes when moving to a process approach to enterprise management. In accordance with the chosen criterion for achieving the goal, reducing the cost of assembling the refrigerator, one can compare the “as is” and “to be” models. Table 1 shows that there was a decrease in the cost of assembly of the refrigerator. This can be explained by the fact that before the assembly was carried out stationary at a special site, and now it is carried out on the conveyor. In general, the cost of assembling the refrigerator decreased by 6.3 rubles, which is 9%.

5. Business processes efficiency analysis
It can be seen from Table 2 that some functions of the business process of assembling the refrigerator decreased by 12%, and the amount of data by 30%. Some parallel operations increased (by 40%). It had an impact on the assembly time of one refrigerator. The assembly time of one refrigerator will decrease by 10 minutes, that is, by 24 production capacity will reach 24,000 units per year, while the cost of assembling the annual program will be reduced by 3%. The totality of changes in these key indicators is a positive trend, since it is increasing the production of refrigerators without increasing costs, and make big profits. Having analyzed the changes made on the models of business processes, it is possible to state that the “to be” model we have obtained is more effective taking into account some indicators. The costs of assembling the refrigerator are reduced; the time for assembling a unit of production is reduced. It means that we can state a real improvement in the selected indicators of the “to be” model business processes we have examined in comparison with the “as is” model.
Table 2. Evaluation of the effectiveness of changes in business processes.

| №  | Parameter Name                      | Model “as is” | Model “to be” | Deviation | Growth rate, % |
|----|-------------------------------------|---------------|--------------|-----------|---------------|
| 1  | Number of functions, units          | 156           | 115          | -41       | -26           |
| 2  | Amount of data, units               | 87            | 61           | -26       | -30           |
| 3  | The number of parallel operations, units | 20          | 28           | 8         | 40            |
| 4  | Assembly time, min. / pcs.          | 41            | 31           | -10       | -24           |
| 5  | The cost of assembling one refrigerator, rubles / pcs. | 79,61       | 73,31        | -6,3      | -9            |
| 6  | Annual release program, units / year | 22000       | 24000        | 2000      | 14            |
| 7  | The cost of assembling the annual program, rubles / year | 1751420     | 1759440      | -8020     | -0,5          |

One of the objectives of this work is to show the ways of introducing a process approach to the management and organization of a machine-building enterprise. Using the methods of modeling the business processes of the organization, and using the means of functional and simulation modeling, based on the most effective tools and notations the “as is” and “to be” models were developed.

The fourth, final, stage of the methodology should be implemented at the enterprise taking into account managerial, organizational, technological features. In this paper, we do not give detailed recommendations on this subject, intending to continue research on this stage of the methodology. However, thanks to close cooperation with specialists and the Biryusa plant management, we succeeded not only in recommending our developments for future implementation, but also in seeing some results of transformations of the organizational structure and technology of the Biryusa model assembly process.

The practical significance of the study lies in the possibility of determining the costs of assembling the refrigerator and managing them. The “to be” model was created in close contact with specialists of OJSC KRP “Biryusa”, and as a result of parallel work to upgrade the technological process of assembling the Biryusa model refrigerator, it became possible to introduce our developments in a real production process.

Within six months, the conveyors were dismantled in separate sections of the assembly of the Biryusa model, and the technological process for assembling the new Biryusa model was prepared. In addition, the entire technological process of manufacturing the previous model has undergone changes, especially in terms of manufacturing the body of the product (however, in this work we consider only the assembly area).

6. Conclusion

In the course of the work, a part of the main business processes was described at the enterprise, and a system of new job descriptions was developed and implemented. A quality control service was modernized, and measures were taken to reorganize the enterprise’s organizational structure. All this allowed OJSC KRP “Biryusa” to pass the certification procedure of the international standard ISO 9001: 2000 in the following areas: “Development, production, sale and maintenance of household refrigerators, commercial refrigeration equipment and hermetic refrigerant compressors”. The audit of the certification body of the company TUV Management Service GmbH provided evidence that the requirements of ISO 9001: 2000 have been met.

The main difference of the new model was its technological features (one-piece cabinet body, external design), improved characteristics of the model in terms of basic indicators, while the cost and
assembly time of a refrigerator’s production unit were reduced. The share in the annual program for
the release of the new model of the total number of refrigerators and freezers increased from 7% to
11%. In accordance with the calculations of the working group, some defects in the assembly process
were reduced.

Thus, the transformations of the production part, accompanied by the introduction of a quality
management system, as well as the beginning of the transition to process management are an
important and significant contribution to the implementation of the process approach to enterprise
management.

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