The role of automation in improving the quality of enterprise business processes

A V Bataev¹ and I S Davydov²

¹Peter the Great St. Petersburg Polytechnic University, Polytechnicheskaya, 29, St.Petersburg, 195251, Russia, bat_a68@mail.ru
²National Technology Initiative Center for Advanced Manufacturing Technologies based on the Institute of Advanced Manufacturing Technologies of Peter the Great. Petersburg Polytechnic University Polytechnicheskaya, 29, St.Petersburg, 195251, Russia

Abstract. The enterprise has to determine and manage numerous and interrelated activities for successful work and to maximize profits. According to the international standard ISO 9001-2011, the activity using resources and managed in order to transform inputs to outputs can be considered as a business process. Using a process system in an organization along with their identification and interaction, as well as process management aimed at obtaining the desired result, can be defined as a “process approach”. The object of this study is a business process that is one of the key concepts of the international standard ISO 9001-2011. This standard establishes the requirements for quality management systems and describes the principles of applying the process approach, the essence of which is continuous process management. The article deals with the individual business processes in the enterprise and their subsequent task automation with using information technology. An automated application was proposed within the study that provides automatic search for part sizes that do not correspond to the tolerance field, automatic construction of control charts of average values and ranges, as well as calculation of process reproducibility indices.

1. Introduction
Enterprise performance requires special attention to business process management. To do this, models and process charts are made up, audits are conducted and their performance is analyzed. As practice shows, there are problems associated with the coordination of functions between divisions, document management, and the high cost of time for performing the same operations. The solution to such problems is often included in the list of short-term goals of the enterprise. [1-2]
Employees of the enterprise, who have to constantly work with large amounts of data, take direct participation in the creation, maintenance, control of all processes. It is possible to reduce the workload of employees aimed at supporting business processes through automation. One can automate both one process and several processes, while creating a single information space at the enterprise.
Employees of the enterprise, without which it is impossible to manufacture any products, take direct participation in the creation, maintenance, control of all processes but the degree of human participation in business processes can be reduced by automation.
Automation is the application in the production of technical facilities, methods, and control systems that exempt a person from direct participation in production processes.
The purpose of automation is to increase productivity and labor efficiency, improve product quality, and human working conditions. [3]
The tasks of automating business processes become increasingly relevant. This is due to analyzing the effectiveness of business processes and determining the causes of identified inconsistencies in most cases, it turns out that the main problem of modern enterprises is the lack of automation and databases to systematize the accumulated information [4]. A large percentage of routine operations, which are manual input, search, data analysis, become a source of errors, loss of time, and a decrease in employee motivation in general.
The main means to solve the problems of automating business processes is the implementation of information technology and the development of special programs and modules.
The implementation of such programs in various functional units allows making the information accumulated at the enterprise clear, accessible, and structured, as well as reducing the share of the human factor and unnecessary paperwork. [5]

2. Key research findings

2.1. Tasks for automating business processes
The main criterion for the functioning of the process approach is the continuous management of processes and their optimization.
Business processes are divided into three groups:

1) Main processes. They serve as the basis of the enterprise. Processes add value to the consumer. For example, manufacturing, logistics, marketing and sales, procurement, etc.
2) Supporting processes. They provide the activity of the main processes. For example, technical support, accounting, staffing, equipment maintenance, etc.
3) Control processes. The main function is the management of the enterprise. For example, economic planning, strategic development, paperwork, etc.

Automation covers all business processes operating at the enterprise. It can be used to solve both local tasks at the level of one small business function, and larger tasks covering a whole chain of interconnected business processes. [6-8]
Automation of accounting, client accounting, document management was most widespread, since they are precisely connected with the processing of large volumes of information.
Procedures for automating business processes can be divided into three types, which are presented in Figure 1.

![Figure 1. Types of business process automation.](image-url)

1) Automation of the process.
In this case, one or two specific tasks are solved within one department, related to the simplification of work with individual documents. For example, the development of software modules for graphing,
2) Automation of several processes.
This type of automation covers two or more processes and is achieved through specially designed programs, which usually include a database for accumulating and storing information, input and data exchange forms, and reports for analyzing these data.

Enterprises independently develop client-server applications for order management, procurement, internal audit documents, statistical data processing, production planning, etc.

3) Automation based on the creation and implementation of special systems covering a complex of interconnected business processes.
Such automation systems allow us to make all processes transparent and to monitor the progress of production in real-time and competently manage the enterprise, while receiving maximum profit. [9]

2.2. Creation of automated applications within a single business process
A stable production process ensures the quality of engineering products. The stability control of the technological process is implemented on the basis of the standard GOST R 50779.42-9.

To improve the quality of manufacturing parts at a machine-building enterprise, a procedure for selective dimensional control was created, by which eight samples of castings obtained in each of the nests of the mold were periodically selected. Measurement data was entered in the checklists - MS Word format files. However, the post-processing of the results was not automated. [10]
To solve this problem, an application was created that automatically searched for dimensions of parts that did not correspond to the tolerance field, automatically built control charts of average values and ranges, as well as calculated the reproducibility indices of the processes Cp and Cpk. [1, 11]
The application for building control charts is an MS Excel file. The first sheet of the file - a table with the results of measurements of the controlled parts obtained in each nest of the foundry mold (control sheets), is manually filled by the operator. Figure 2 shows a view of the control sheet for slot 1.

![Figure 2. Type of checklist.](image)

The process of detecting defects after entering measurement results and constructing control charts is automated using the VBA programming language. When entering dimension values in the control sheet, this value is compared with the controlled size recorded in three cells. The nominal dimension value is indicated in the cell of the “Main Projection” column, the lower tolerance field - in the “LTL” column cell, and the upper tolerance field - in the “UTL” column cell. If the value of the monitored parameter is outside the tolerance field, the corresponding MS Excel table cell is highlighted in red. [12]
Control charts are built for each controlled size. The values of average sizes and ranges for building charts are calculated according to measurements of controlled sizes. Figure 3 shows the algorithm for constructing charts of average values and ranges.

![Algorithm for constructing control charts](image)

**Figure 3.** An algorithm for constructing control charts.

When the "Create charts" button is clicked, the number of controlled sizes is automatically determined by the data of the checklists [13]. Next, an array of the form array (1 To pos, 1 To all) is formed for each size, where pos is the number of positions and all is the number of sizes obtained during control. The first three numbers of each line of the array correspond to the nominal size, upper and lower tolerance fields, respectively.

To build control charts for each controlled size, a new sheet is automatically created in the MS Excel workbook with a name that matches the position number indicated in the list of controlled part sizes. After the array is formed, sheets with the name “pos.” are automatically created, into which an empty template table is copied for entering the control results. The data for calculating the average values and ranges for the groups corresponding to the nests of the foundry mold are entered in the template columns, 8 values - in each one. To this, the data array of the first sheet “Sheet1” is transposed. Values of nominal
sizes, upper and lower boundaries of the tolerance field are also automatically entered in the corresponding cells. The resulting table of input data for calculating the average values and range for groups is presented in Figure 4.

The program fills in the templates of sheets "pos№" and the construction of control cards in sequence. After filling in the template, the number of groups is automatically calculated and the average value, range, and standard deviation for the entire data sample are calculated for each group. These values are automatically recorded in a table cell.

Based on the obtained data, the values of $C_p$ and $C_{pk}$ are calculated by the formulas:

$$C_p = \frac{U'TL - LCL}{6\sigma}$$  \hspace{1cm} (1)

where $U'TL$ is the upper tolerance limit; $LTL$ is the lower tolerance limit; $\sigma$ is the standard deviation.

$$C_{pk}(P_{pk}) = \min[PPU; PPL]$$  \hspace{1cm} (2)

PPU and PPL are upper and lower process suitability indicators.

PPU and PPL are calculated using the formulas:

$$PPU = \frac{U'TL - \bar{x}}{3\sigma}$$  \hspace{1cm} (3)

$$PPL = \frac{\bar{x} - LTL}{3\sigma}$$  \hspace{1cm} (4)

where $U'TL$ is the upper tolerance limit; $LTL$ is the lower tolerance limit; $\bar{x}$ is the average value; $\sigma$ is the standard deviation.

The results of the program are presented in Figure 5.
3. Conclusion
Today, information technology is implemented to raise all the processes of managing an industrial enterprise to a new qualitative level and ensure the achievement of new horizons in all areas of activity; When the work is done in accordance with the requirements of the standard GOST R 50779.42-99 (ISO 8258-91), automated statistical control of the production of automotive components was organized at the machine-building enterprise; The results of the calculations and the constructed control cards can be used to interpret the casting process; The introduction of an automated application has improved the quality of manufacturing parts of automotive components by preventing defects; The cost-effectiveness analysis allows us to conclude the feasibility of introducing an automated application that would pay off within twelve months.

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