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Computer assistance in the technological process efficiency analysis

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ABSTRACT

Purpose: Technological process is a basic determinant of correctness of industrial company's functioning on the market. In this connection they should treat with the priority all activities connected with technology, technology management and controlling, that is with their continuous improvement.
Design/methodology/approach: The created model made it possible to analyze the chosen technological processes for the sake of efficiency criteria, which describe the relationships: operation – material, operation – machine, operation – man, operation – technological parameters.
Findings: The in this thesis conducted analysis includes hypothetical technological processes of producing typical machine pieces. Within their scope also the nonmaterial parameters of technological process have been taken into account, which resulted from arts of applied samples and projecting of the technological process.
Practical implications: One has worked out an application that allows to analyze the efficiency of technological process in aspect of nonmaterial values and has used neuronal nets to verify particle indicators of quality of a process operation. Indicators appointment makes it possible to evaluate the process efficiency, which can constitute an optimization basis of particular operation.
Originality/value: As a result of this analysis gained data enabled to optimize the technological process by estimating influence of the analyzed parameters on the whole of process and optimization conducting of any process.
Keywords: Production planning and control; Technological efficiency; Optimization; Neuronal nets

1. Introduction

Informatization and computerization of wider and wider scope of activity is one of the most important current development trends of an enterprise. Production engineering, engineering discipline dealing as well with rules of product and process designing as with basics of controlling, exploitation, organization and managing of production processes, is in more and more wider scope depended on methods of computer assistance [1,2,3,4,10,14,15].

Very important aspect of factory development is continuous and systematic analysis of production process, namely technological process. Nowadays each enterprise, that wants to exist on the market must be competitive, and the product it is producing must be perceived as competitive in comparison with other of this type, so that it will draw the attention of a potential customer, and after buying it he should be satisfied enough and through this won't look for replacement by the competition. In order to fulfil expectation of a customer, and at the same time bring profits, an enterprise has to produce product of high quality, by a good price, in the possible shortest time. To reach this stand one has to aim at improvement of production conditions so that the technological process will be possibly the most optimal and effective one. Optimization can be gained by continuous process control and its

estimation. Information that are collected in this way allow to select production parameters, get a product, that will meet the customers and company management expectations [1,2,3,4,10].

2. Methodology of research

Presenting the essence of technological process and its components, we can not forget about the important function of human- technologist and what we require from him. Also the problem of technological process efficiency has to be discussed. If one wants to fully control the technological process, an enterprise has to assess influence of different changes of production parameters on the course of technological process in a maximally quick way. Value that allows to determine the influence of changes on the process is its efficiency. But problem of efficiency can not be discussed without relation to the ways and possibilities of its measure. In order to analyze each process we use different efficiency indicators, that each time can create other concept of efficiency of the whole process [5,7,9,11,12,13].

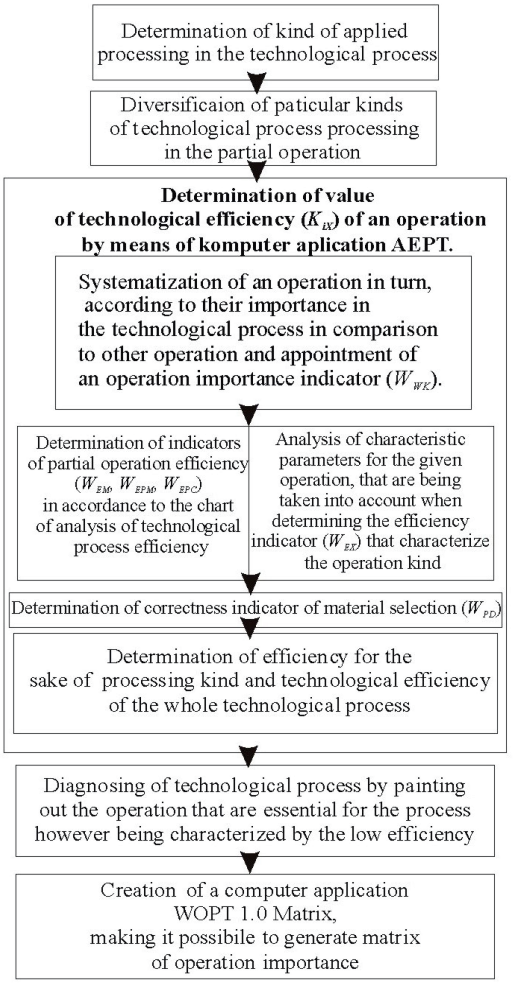


Fig.1. Stages of technological process analysis

Measuring the efficiency of technological process one has to determine value of technological efficiency indicator (K_{tX}) of an operation, by evaluating indicators of partial efficiency (Fig. 1); correctness of material selection (W_{PD}), efficiency of material (W_{EM}), efficiency of machinery work (W_{EPM}),, efficiency of humans work (W_{EPC}), efficiency that determine the kind of an operation during processing (W_{EX}).[6,7,13]

Then we can determine the efficiency for the sake of kind of applied processing and technological efficiency of the whole technological process (E_{PT}).

Model of technological efficiency analysis of the technological process of gland is based on created efficiency indicators discussed for the sake of following criteria: material, machine, human, technological process simultaneously taking into account the kind of processing and determination of optimization plan that allows continuously improving of the analyzed technological process [6,7,13].

2.1. Automatization of determination of technological processes

Determination of individual efficiency indicators by means of computer application AEPT.

Thanks to the AEPT program it is possible to get the final report that will present the analysis of technological efficiency for the given process. Algorithm of data introducing complies with the model of technological efficiency determination (fig. 1) [6, 7, 13].

The algorithm of AETP of data introduction is consistent with the model of technological efficiency determination [6, 7, 13].

3. Creation of computer application matrix WOPT 1.0

Taking into account the model of analysis of technological efficiency (fig.1), and especially the step, in which matrix of operation importance in the technological process has to be built, one has created a computer application matrix WOPT 1.0.

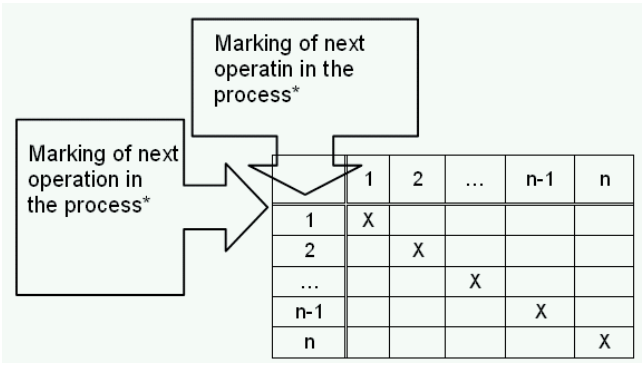
Determination of indicator of operation importance (W_{WK}) is an inherent element of analysis model of technological efficiency concerning the technological process. Indicator of operation importance (W_{WK}) was created on the basis of operation importance matrix. Building of matrix allow us to determine importance of particular operation, is based on determination of significance of the analyzed operation (K_{rz}), that is determined in relation to other operation (Fig. 2). [6,7,13]

Determination of value of operation importance (K_{rz}) is being realized by establishment of importance of the analyzed operation with reference to all operation that occur in the technological process, and mainly [6,7,13]:

- when the analyzed operation is more important as the comparable one – it gets the value of K_{rz}= 1 is written down in matrix
- If the importance of comparable operation for the technological process is equal it gets the value of K_{rz}= 0,5;

If the importance of the analyzed operation is higher than the comparable one, however the comparable operation has a determined meaning, in this moment the operation being analyzed has the value of K_{rz}=0,75.

Matrix WOPT 1.0. program allow to generate in a quick way matrix of operation importance, that is taking place in following stages;



* marking of operation according to the symbol in technological process card.

Fig. 2. Operation importance matrix in the technological process [6]

I stage – after setting in motion the program from menu "Technological process" we choose the function "new.." in order to select operation from which consist the analyzed technological process, then from menu "technological operation" we choose the function "add…"

II stage – then we choose operation from the list, which are involved in the analyzed technological process

The program automatically attributes number to a chosen technological operation.

III stage – after approving technological process with the "OK" key, the matrix of operation importance is generated.

The program allow also to copy the content of matrix to other computer applications, besides in "matrix of operation importance menu" exist such a possibility to edit the basic matrix of operation importance, what follows changing of operation names and also change of weight importance.

4. Report on researches results

We have characterized the technological process of gland made of bronze CuSn10, next we have conducted the efficiency analysis on the basis of technological efficiency analysis model with the use of AEPT program and Matrix WOPT 1.0 computer application.

Careful observation and detailed description of technological process of gland allowed to collect and determine the necessary data to conduct an analysis of technological process efficiency according to the model of technological efficiency analysis as a result of which we can characterize general and particular efficiency of the whole process.The available model of technological efficiency analysis is based on particular efficiency indicators that characterize operation, taking into account following criteria: operation – material, operation – machine, operation – human, operation – technological parameters. The conducted technological analysis would make it possible to show the influence of particular criteria on the process efficiency. Analysis of technological efficiency included following stages: detailed list of processing kinds applied in the technological process, division of particular processing kind of technological process into component operation, systematization of operation according to their importance in technological process on the basis of importance matrix and determination of indicator of operation importance (W_{WK}), determination of value of technological process efficiency of an operation (K_{Ix}) (determination of indicators of particular operation efficiency (W_{EM}, W_{EPM}, W_{EPC}) according to the schema of technological efficiency analysis of a process, analysis of characteristic parameters for a given operation that are taken into account when determining efficiency indicator (W_{EX}) that characterizes the operation kind, determination of material selection correctness indicator (W_{PD}), efficiency determination for the sake of processing kind and technological efficiency of the whole technological process (E_{PT}).

Most stages of technological efficiency analysis of the process consist in mathematical calculation that can significantly complicate the analysis in the case of complex technological process, and automatically big volume of analysing data. This arduous process can be automated thanks to computer application. Taking into account the model of technological efficiency analysis of gland, and in particular the step, in which we have to determine importance of particular operation in the technological process, one has created computer application in the Microsoft® Visual Studio 2005 program – Matrix WOPT 1.0, which makes it possible to generate matrix of operation importance.

Creation of a matrix that allow us to determine importance of particular operation is based on determination of importance of the analysed operation (K_{rz}), that is determined in the relation to the other operation. Matrix WOPT 1.0 program permits to generate the matrix of operation importance for the chosen technological process very quickly. Next stages of the model of technological efficiency analysis have been pointed out by the use of AEPT program (Analysis of Technological Process Efficiency) It made it possible to conduct the detailed analysis in result of which we get the final report covering data coming from the technological process and calculated values: indicator of operation importance (W_{WK}), particulars indicators of efficiency, efficiency for the sake of processing kind. The detailed analysis of technological process of gland that has been carried out with the use of computer application hasn't showed places in the process, where we should increase value of technological efficiency, because E_{PT} = 0,9308. Results f detailed analysis of all particular efficiency indicators (W_{EM}, W_{EPM}, W_{EPC}, W_{EX}, W_{PD}) has been presented on the fig.3. [6] The next analysis stage was diagnosing of technological process by pointing at the operation that are essential for the process however being characterized with a low efficiency. From the fig.3 results, that 10, 1, 7 operation are the most crucial for the process, and from the fig3, that the most effective are 8, 11 and 5. Analysis of the data presented on diagrams is a basis to eventually conduct the efficiency optimization starting at the most important operation which at the same time has low efficiency [6, 8]. On the basis of particular efficiency indicators we have determined technological efficiency indicators of particular operation, which have the minimum value of 0,83, that is in accordance to the universal scale of relative status profitable value. Maximum values of indicator of technological efficiency of an operation (Kix) are following: for operation No 11 (making 3 openings when installing) K_{11X} =0,9694 where indicator of operation importance is W_{WK} =0,60, for the operation No 8 (exit milling) K_{8X} =0,9665, where W_{WK} =0,70, however for the operation No 5 (cast shotting) K_{5X}=0,9635 where, W_{WK}=0,25.

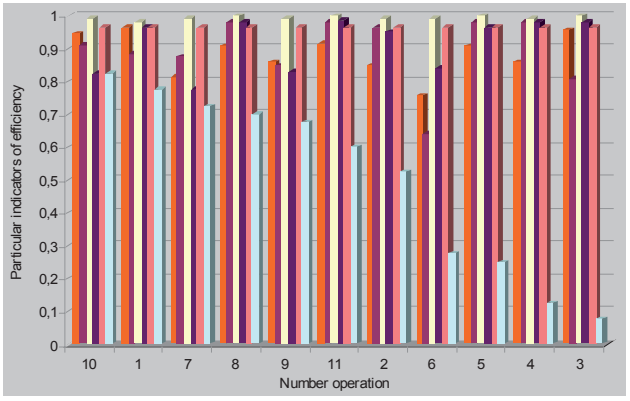


Fig 3. Particular efficiency indicators of technological process of gland Operation systemized in accordance to the operation importance indicator (W_{WK}) (W_{EM}- indicator of material efficiency , W_{EPM} – indicator of machinery work efficiency, W_{EPC}- indicator of human work efficiency, W_{EX} – indicator of efficiency characterizing the given operation, W_{PD} – indicator of material selection correctness, W_{WK}- indicator of operation importance)

Final stage of the analysis was to determine technological efficiency taking into consideration kind of the applied processing (E_{fzw}, E_{ou}). Lower value reached efficiency of loss processing E_{ou}= 0,9252, however higher value reached efficiency of cast creating of gland E_{fzw} = 0,9457. On the basis of determined efficiency for the sake of applied processing we have pointed out technological efficiency E_{PT} = 0,9308.

Results of technological efficiency analysis of technological process of gland prove that the chosen model of technological efficiency analysis makes it possible to improve the process continuously by the technological analysis, and application of computer assistance makes it possible to automate the process of efficiency analysis, and finally controlled improvement of technological processes.

5. Conclusions

The current production technique is based on two main achievements; computer and microelectronic, that made it possible to increase the speed, elasticity and efficiency of modern design, production and production control.

Most important is correctness and modernity in study of technological processes in flow processing of cars, motorbikes, bicycles, electric motors parts etc. machines that are produced in dozens and hundreds pieces yearly. Technological processes have to be prepared carefully in details.

Mechanisation, automatization and computerisation of these processes, invention of new processing and installing method allowed us to make such a progress, that today e.g. the whole processing and installing time of all operation of a car produced in a massive way took a dozen or so hours, when earlier it took some or a dozen or so thousand hours. Designing the production process it is necessary to the into account all component processes – from the supplier to the end customer, and not to forget about researches and development. As these processes create cells of production range, that has to be designed and realised in order to get a significant effect – customer satisfaction and company profit.

The essence of optimization of technological processes is the level of optimal value, however we can not forget that the most important is how this value ill be reached t.i. determination of efficiency of searching process. Optimization can be divided into 2 stages: efficiency increasing and reaching the optimal value, what means that the main aim is improvement [6,8].

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