Improvement of Information Processing Quality in Preproduction Engineering Efficiency Assessment

To cite this article: L N Bakanovskaya and I A Chekardovskaya 2016 IOP Conf. Ser.: Mater. Sci. Eng. 154 012018

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Improvement of Information Processing Quality in Preproduction Engineering Efficiency Assessment

L.N. Bakanovskaya and I.A. Chekardovskaya

Industrial University of Tyumen, 38 Volodarskogo st., Tyumen, 625000, Russia

E-mail: mila27@tyuiu.ru

Abstract: The article has considered the method of obtaining, analyzing and processing of expert information using modern software environment of MATLAB computer mathematics that will allow increasing the efficiency of decisions about the expected economic performances (the desired profitability and the desired output of products).

1. Introduction

Currently, the necessity of using modern methods and algorithms of computer information processing [1-4], effective in preproduction engineering in automatic mode and in calculation of sensitivity to production items, is undeniable. This is especially necessary when making “managerial decisions” on optimization of production strategies, production costs reduction [5], revenue increase, and reduction of production cycle duration, etc. In designing products, the methods of obtaining, analyzing and processing of information (the degree of prototypes possession [6]) tend to remain the same; in other words, solving the problem of model data processing is the “bottleneck” limiting further development of product design automation and efficiency improvement in the development of new economically profitable algorithms of production. The results of both analytical and descriptive prototyping largely depend on proper organization and planning of scientific works, collection, analysis, visualization and interpretation of the obtained data. The consistency and efficiency of such studies are of particular relevance in connection with the development of the common concept of production. Thus there is an urgent need to develop automated applications to the existing subsystems (e.g. [7]), capable of processing the available and incoming data in online user mode, as well as allowing to design predictable systems under the expert-technologists’ assumptions (hypotheses) proved by formalized statistical methods. Expert systems have already shown their efficiency in many fields of human activities. In this regard, the task of development of expert modules (artificial intelligence systems) for economic issues of garment production is urgent.

2. Research

Optimization-analytic tasks almost always have ambiguous, "fuzzy" decision. The technologist formulates a hypothesis about the desired profitability of production or planned production on the basis of the existing awareness on the sales market, and then proves it with experiments and observation. The use of various tasks of linear programming and discrete optimization, in particular, when making decisions, is quite common [8]. There are many mathematical criteria to prove or rule out the hypotheses put forward by the expert-technologist, among which is the production cost reduction at the calculated sensitivity. When proving a hypothesis and defining important features the expert faces the task of creation on their basis of the description and evaluation system, suitable for use in practice by the technologist and the Economic Department of the company. But the use of expert systems specialists is not always available at the enterprises of the sewing industry. A program, simple in mastering and management, will provide for a solution to this task without additional costs.

Engineers’ automated workstations (AWS) should possess compatibility with newly created software systems for their use in scientific research and real optimization practice. Currently, there is a certain number of methods for expert systems synthesis, developed on the basis of linear programming...
methods, discrete optimization, decision tree, clustering, multiple linear regression, as well as with the help of genetic algorithms, neural networks and fuzzy logic. There is a significant number of unified software products for statistics, data analysis and expert systems synthesis (e.g., MS Excel, “Statistica for Windows”, MAPLE, MATLAB and many others), having a large application scope. Of the above software tools the MATLAB computer mathematics environment is distinguished as the most developed, primarily due to the fact that it comprises modern algorithms of fuzzy logic means construction and the problems of neural network optimization and training [9]. The MATLAB software environment is an interactive system; it is open and enables implementing complex algorithms of data analysis. In addition, MATLAB has a GUI application (graphical user interface) enabling the creation of flexible applications with a suitable user interface, in particular, experts-technologists oriented. Having many specialized functions, this software can be used to automate the required calculations in almost every field of science and technology.

Based on the above, in the present work the MATLAB computer mathematics environment has been selected as the main development means of the expert evaluation program module. The production cost of a series of garments and the desired output for a specified period (figure 1 a. b) are used as initial data, where \( Z_i \) is the amount of expenses on all counts, \( n \) is the number of items, \( V_{opt} \) – optimal output, \( E \) - efficiency:

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{No} \ n/n & \text{Article the cost on manufacture of the product} & \text{Expenses are minimal, thousand of rubles} & \text{Expenses are maximum, thousand of rubles} & \text{Sensitivity, thousand of rubles / piece} & \text{Expenses expected thousand of rubles} \\
\hline
1 & \text{Wages of workers} & 8.00 & 18.00 & 10.00 & -3000.34 \\
2 & \text{Development of standard design} & 1.50 & 3.00 & 1.50 & -449.75 \\
3 & \text{Technology of manufacturing} & 1.00 & 2.00 & 1.00 & -299.83 \\
4 & \text{Fabric (including accessories)} & 0.58 & 2.50 & 1.92 & -577.02 \\
16 & \text{Zi} & 11.08 & 25.50 & 14.42 & -4326.35 \\
17 & \text{n, thousands of piece} & & & 1.00 & \\
18 & \text{Voptimal, piece} & & & & 300.83 \\
19 & \text{Effectiveness, \%} & & & & 56.53 \%
\hline
\end{array}
\]

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{No} \ n/n & \text{Article the cost on manufacture of the product} & \text{Expenses are minimal, thousand of rubles} & \text{Expenses are maximum, thousand of rubles} & \text{Sensitivity, thousand of rubles / piece} & \text{Expenses expected thousand of rubles} \\
\hline
1 & \text{Wages of workers} & 8.00 & 18.00 & 10.00 & -2931.95 \\
2 & \text{Development of standard design} & 1.50 & 3.00 & 1.50 & -439.49 \\
3 & \text{Technology of manufacturing} & 1.00 & 2.00 & 1.00 & -292.99 \\
4 & \text{Fabric (including accessories)} & 0.80 & 2.50 & 1.70 & -498.99 \\
16 & \text{Zi} & 11.30 & 25.50 & 14.20 & -4163.42 \\
17 & \text{n, thousands of piece} & & & 1.00 & \\
18 & \text{Voptimal, piece} & & & & 293.99 \\
19 & \text{Effectiveness, \%} & & & & 55.69 \%
\hline
\end{array}
\]

**Figure 1.** MS EXCEL work window with initial data

In the work [1] the choice of initial data for the main means of software module development has been justified and their usefulness proved without losses for the production; which enables to achieve not only the breakeven point but also monitoring the manufacturing process throughout the entire life cycle of preproduction engineering.
Based on the results of MATLAB calculation, with the imported initial data, a graph (figure 2) of organizational-technical and economic indicators is constructed according to the production efficiency evaluation method developed by the authors [2].

Figure 2. Calculation visualization with graph construction.
Based on the application of the most effective calculation methods for manufacturing a series of apparel, the analysis of the operation of LLC "Fashion Studio "Silhouette" (Tyumen) and LLC "Profile" (Tyumen) has been accomplished. The sensitivity for each of the above indicators has been defined, and based on the visualization of graphical and mathematical proofs [1, 3] the production efficiency – expenses sensitivity relationship has been clearly defined. In this case 40-60% of preproduction engineering economic efficiency based on the information processing quality has been implied.

3. Conclusion

Study of the methods of obtaining, analyzing and processing the information about preproduction engineering using one of the developed MATLAB computer mathematics environments has been implemented that will enable prototyping and enhancing production efficiency on the basis of modern scientific research and "managerial decisions" made by the expert-technologist.

The work has also solved the following problems by calculating the production cost of two enterprises (small-scale ones with the output of a series of more than 100 units): the sensitivity of each expense to the produced units has been defined; cost reduction efficiency depending on the expense item at each of the operations has been identified. The efficiency of preproduction engineering increases for both "Fashion Studio "Silhouette" (with cost reduction by 9%) and "Profile" (with cost reduction by 13%). The optimized use of the available resources and the improvement of the information processing quality will provide for the efficiency of preproduction engineering.

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