DEVELOPMENT OF AN ALGORITHM FOR AUTOMATIC CUTTING TOOL SELECTION

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Abstract

An inexperienced technologist will have to spend a lot of time to select a cutting tool, so a neural network for cutting tool selection is needed. To create a neural network, we need to understand the algorithm, how to select the tool now. The purpose of this paper is to analyse domestic and foreign sources in the selection of cutting tools. The methodology in this study is to find an algorithm from all possible sources. Each source found is analysed to find the algorithm. A block diagram has been developed, and this is the algorithm itself to create an automatic selection of cutting tools. These publications have shown that work in the direction of automatic selection of cutting tools is ongoing and are of scientific and practical interest. But the majority of works have declarative character with the absence of such important information as: criteria of criteria of cutting tool selection, results of approbation, influence of selection results on the cost of technological operation. on the cost of technological operation.

Keywords: cutting tool, algorithm, automation, cutting tool selection

I. Introduction

At machine-building enterprises, workpieces are processed on metal-cutting machines with cutting tools. Nowadays there is a large number of manufacturers of cutting tools and each has a wide range of foreign cutting tools produced and supplied. The total nomenclature of modern cutting tools in some cases numbers in the thousands for specific types of machining. Selection of a suitable cutting tool by an engineer is a regular technical task and is carried out on the basis of advertising materials or production experience. The biggest problems in selection of cutting tools can be experienced by small machine-building enterprises due to the absence of a highly qualified specialist or lack of production experience.

Traditionally, enterprises approach the issue of tool selection in different ways: they select tools from the catalog of a tool manufacturer, turn to an engineering company, and sometimes use what is purchased by the purchasing service without a technical specification. Such approaches can lead to the fact that in reality an unsuitable tool may be used, with low durability or high cost. Selecting the optimum, or at least rational cutting tool, is a widely demanded task that, if done correctly, will result in machining with the required productivity, cutting tool consumption and acceptable cost

Artificial neural network solutions are becoming more and more advanced and popular, so we can assume that in the future artificial neural networks will be widely used due to a better understanding of their underlying principles. In our goals and objectives, we need a neural network to assist the technologist and select the right cutting tool. To properly train artificial intelligence, we need to understand how cutting tools are selected for certain operations in general.

Nomenclature of cutting tools is determined on the basis of analysis of shapes, dimensions, required accuracy and roughness of main and additional surfaces, taking into account the type of selected workpiece. The basis for selecting the tool nomenclature is the rules of machining the main and additional surfaces of workpieces (surface transitions, tool paths, modes, etc.).

The choice of cutting tools lies in the experience of the technologist, but there are also reference books for calculating cutting modes [1,3,5,6], which include the choice of cutting tools, as well as in training manuals [2,4] are given criteria for the choice of cutting tools. Today, the choice of cutting tools can be made by catalogues [7]. The selection criteria differ, but not significantly.

Despite the advantages of automatic selection of cutting tools in catalogues, it is not in wide demand among not large productions, yes we can say large productions rarely use this system because it does not show the economic benefits and durability of the tool.

The purpose of this paper is to analyses domestic and foreign sources in cutting tool selection, to determine the cutting tool selection algorithm.

A more in-depth study of this issue will give an understanding of what criteria are important for the selection of cutting tools to create a programmer and facilitate the work of inexperienced technologists.

II. Methods

The choice of cutting tools is in limbo because in manufacturing plants the choice lies in the expertise of the technologist. Today there are a large number of tools and a large number of manufacturers, and it is not clear whether a given tool will be effective. Technologists spend a lot of time experimenting with this or that tool. And it should not be excluded that there may not be an experienced technologist. An inexperienced technologist will have to conduct experiments again, as there are no records on the tool. To summarize, it will be necessary to spend a lot of time for the inexperienced technologist to conduct experiments and it will be permanent. It is possible that some data is kept by the companies, but this is not disclosed. The purpose of this paper is to analyses domestic and foreign sources in the selection of cutting tools.

Based on the objectives of the tasks, in order to determine the methodology it is necessary to analyses all possible sources for this research. The first method is to analyses manuals for the selection of cutting tools [1, 2, 3, 4, 5, 6]. Usually guides on the calculation of cutting modes and in them the tool selection is determined by maps.

In the reference book of Guzeyev V.I., Batuev V.A., Surkov I.V. [1] the tool selection starts with the choice of the machine tool. Next, the material of the cutting part of the tool and the method of fixing the insert are selected. Based on the machining conditions, the angles in plan view are selected. Other geometric parameters of the cutting part are determined (back angle, front angle, shape of the front surface, chamfer width along the main cutting blade, radius of cutting edge rounding, radius of the cutter tip). The normative period of durability of the selected cutting tool is given.

In the textbook by Pozdnyakova I.V. [2] the choice of tools begins with the equipment. Next, the material of the cutting part and the material of the holder are selected. Based on the equipment, the cross-section of the holder is selected, which is suitable for the machine. The type of cutter, cutter design, insert angle, structural dimensions of the cutter, insert number and dimensions, shape of the front surface and sharpening of the cutter are selected. Finally, the geometric parameters of the

cutter, the permissible wear on the back surface and the resistance are selected.

In the reference book on metal cutting processing [3], tool selection is done sequentially by selecting the type of cutter, the shape of the front surface, the angle of sharpening of the cutter, and the geometric parameters of the cutting part of the cutter.

In the textbook by M.A. Bolotov, A.N. Zhidyaev, N.D. Pronichev and A.I. Khaimovich [4], the cutting tool is selected by sequentially choosing the insert mounting system, the size of the holder and the shape of the insert, the geometry of the insert and the material grade of the cutting part, the dimensions of the insert, the value of the radius at the top of the insert.

In the reference book of Baranovsky Yu. [5] the type and design of the cutter, material of the cutting part, material of the holder and its geometrical parameters, angular parameters of the cutting part of the cutter and durability period are selected.

In the reference book of machine-building technologist Kosilova A.G. and Mesheryakov R.K. [6], the material of the cutting part is selected, and then the assortment of cutting tools according to GOST is presented. The tool itself is selected based on the qualification of the process engineer.

The second method is the analysis of catalogues of different companies. The analysis of modern catalogs of cutting tools of various manufacturers has been carried out: Sandvik [7], ISCAR [8], Mitsubishi [9], Kennametall [10], Walter [11], Dormer Tools [12], SEKO [13], Korloy [14], OKE [15], VIRIAL [16], KZTS [17]. The methodology of tool selection is generally identical: the choice starts with holders (dimensions in cross-section, length), inserts (shape, dimensions) and the way of their fastening. Next, the material of the cutting part and chipbreaker is selected based on the material of the workpiece. Then the cutting pattern is selected. Further selection of suitable tools is left to the technologist. Some manufacturers have the option of selecting tools via online services. The third method is to analyses all possible articles on tool selection [18, 19, 20, 21, 22].

The authors [18] proposed an approach for automatic selection of a special cutting tool for machining complex surfaces, based on a 2D drawing. This approach was implemented by creating a program using a self-learning network (ResNet), which is able, from the available database of drawings of complex surfaces, to select the tool Fig. 39. The working principle of the developed software was also presented.

The novelty of the work is the emergence of a new method of automatic cutting tool selection, as well as the creation of software using a self-learning network. It significantly increases the efficiency of production preparation and facilitates the work of the technologist. However, the decision on the final selection of cutting tools is left to the technologist, and the main criteria for the selection of cutting tools and the economic justification of this choice are not specified.

The author's work [19] analyzed publications that showed various methods of providing automated selection of cutting tools, namely: the creation of an algorithm with an implemented database containing all the necessary information about cutting tools; introduction of a self-learning network (neural network) into the selection algorithm; algorithm of automated selection of cutting tools on 2D drawings; application of mathematical models in algorithms.

The authors [20] present a method for automating the technological preparation of production, including the calculation of cutting modes and the selection of optimal cutting tools. An algorithm is proposed in the form of a block diagram, on the basis of which specialized software is developed that allows creating a database of cutting tools, machined materials, taking into account the parameters of the cutting part of the tool, the criteria of tool operability, surface quality, productivity and cost-effectiveness in calculations. However, the work has a declarative character and the main criteria for the selection of cutting tools, the validity of their selection and practical confirmation of the performance of this software are not disclosed.

The authors [21] present an algorithm that recognizes the topography of the part and determines the best set of tool diameters for cavity milling. Since a relatively large tool diameter reduces the milling time but cannot cover all the corners, on the other hand, a small tool that can

cover all the corners requires more time for milling. As a result, this algorithm showed a reduction of about 17% time for roughing the workpiece. In addition, the algorithm saves time spent in analyzing the geometry and deciding which tools to use. However, the paper does not provide an economic justification for cutting tool selection and technological criteria for tool selection.

The authors' publication [22] presents a database containing all necessary information on tools, as well as on quick-change non-transferable inserts for them and recommended cutting modes. The database is based on Mitsubishi Carbide catalog. An application in C# programming language was developed for convenient work with the database and quick retrieval of necessary information in the form of a table. The algorithm of the application was described. However, from the conclusions of the work it is not clear what level of automation of this system, the main criteria for the selection of cutting tools and its economic justification.

Allocation by method it was necessary to understand the cutting tool selection algorithm itself, more reasonable and working algorithm on selection for further programmer creation. The programmer, which will be used by a non-experienced technologist, will program the algorithm that will be selected in this study.

Many sources have been analyses for tool selection and exactly justified in the selection very few and almost everywhere the economics and durability of the tool is not considered and this study needs to be investigated further. From the analysis at the moment the reference books and catalogues which adequately select the tool are indicated.

III. Results

Since the developed algorithm is aimed at solving the problem of automatic tool selection, the reduction of labor intensity of technological design occurs at this stage. Economic efficiency of design automation consists of four factors: increase in labor productivity; decrease in production costs; reduction of preparation and production time of products; increase in the quality of products and processes.

Labor productivity is ensured by:

- Elimination of the stage of studying catalogs and manual determination of tool parameters.

Reduction of production costs is ensured by:

- Exemption of skilled workers from non-creative labor;
- Increasing the efficiency of CNC equipment utilization due to the use of the most productive tools.

Reduction of terms of preparation and production of products is provided by:

- Acceleration of development of technological documentation.
- Reducing the cycle of technological preparation of production.

The results are presented in the form of a flow chart (see Figure 1).

Using the reference book for assigning cutting modes, the initial data for the initial stage of algorithm development were determined, the initial data ensuring correctness of cutting tool selection, such as: shape; machining stage; workpiece qualification; cutting tool qualification were determined.

An algorithm has been developed that takes into account the principle of CAM systems and the procedure for selecting a cutting tool from a directory. This algorithm consists of eight stages, which contain about twenty-two steps that provide automatic selection of cutting tool in CAM-system.

IV. Discussion of results

Analysis of publications has shown various methods of providing automated selection of cutting tools, namely: creation of an algorithm with a embedded database containing all necessary information about cutting tools; introduction of a self-learning network (neural network) into the selection algorithm; introduction of an algorithm with an automated cutting tool selection system. tools; introduction of a self-learning network (neural network) into the selection algorithm; algorithm for automated selection of cutting tools based on 2D drawings; application of mathematical models in the algorithms.

These publications have shown that work in the direction of automatic selection of cutting tools is ongoing and are of scientific and practical interest. But the majority of works have declarative character with the absence of such important information as: criteria of criteria of cutting tool selection, results of approbation, influence of selection results on the cost of technological operation. on the cost of technological operation.

Thus, it can be concluded that the topic of automatic selection of cutting tools in automated production systems is promising. The topic of automatic cutting tool selection in automated production systems is a promising one and there is a need for a holistic approach to its development, based on clear technological criteria of cutting tool selection, economic justification of this choice and the possibility of its application in automated production preparation systems. The created automated system of cutting tool selection allows to significantly reduce the time and quality of work related to the selection of cutting tools. The software system recognizes the design and manufacturing model of the part from the drawing and 3D model, selects a suitable cutting tool according to this model and then determines the optimal tool parameters.

In addition, the use of automated tool selection system allows to increase the efficiency of equipment utilization by selecting the most productive tool. the gain in productivity is from 5 to 50%. It is not possible to give an exact estimate for this parameter, as it strongly depends on the human factor and is random in nature.

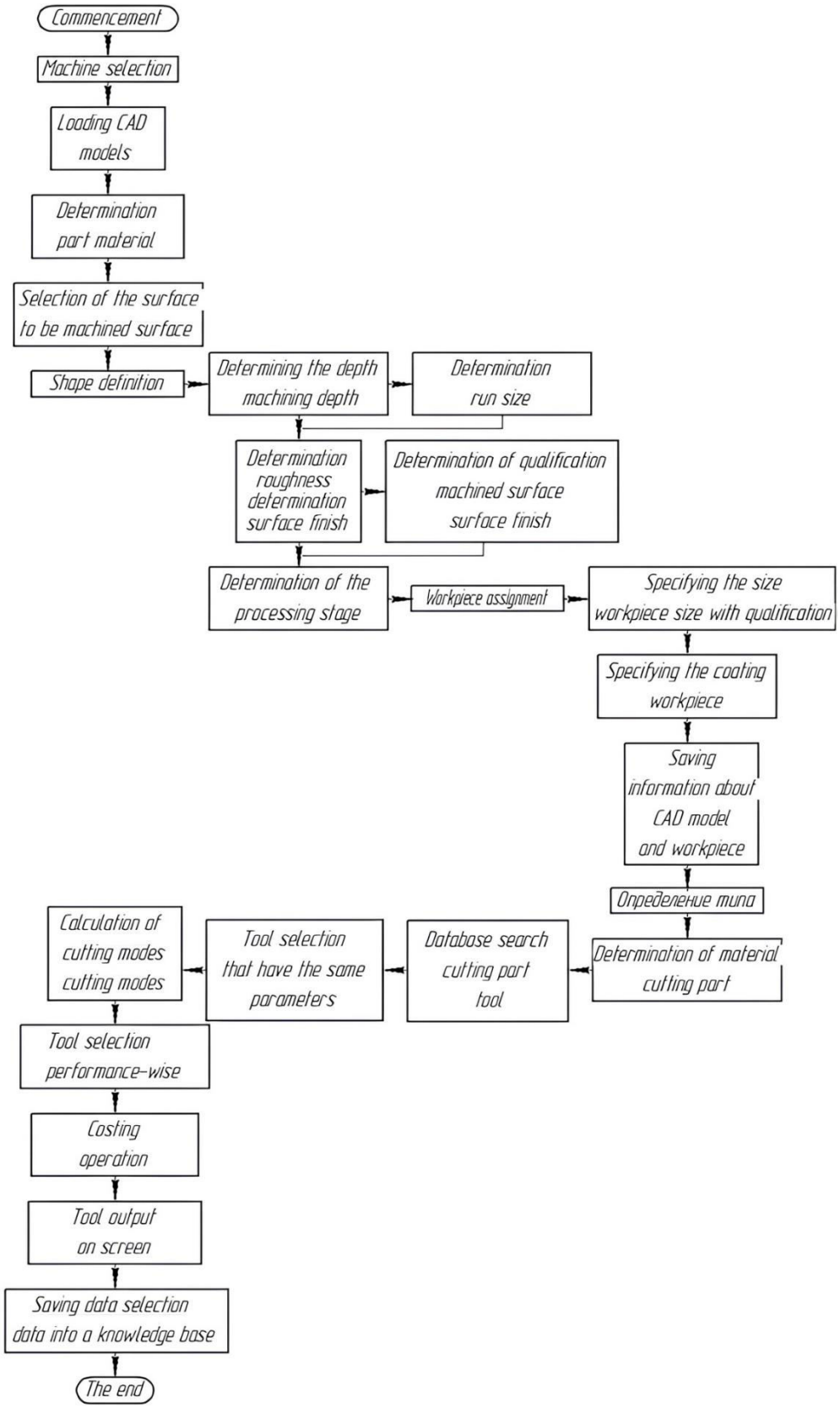

Figure 1: *Block diagram of the algorithm*

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