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Model of automated computer aided NC machine tools programming

J. Balic*
Faculty of Mechanical Engineering, University of Maribor,
Smetanova ulica 17, SI-2000 Maribor, Slovenia
* Corresponding author: E-mail address: joze.balic@uni-mb.si

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ABSTRACT

Purpose: Modern companies tend towards the greatest possible automation in all areas. The new control concepts of manufacturing processes required development of adequate tools for the introduction of automated control in a certain area. The paper presents such system for automated programming of CNC machine tools.
Design/methodology/approach: The system is based on the previously incorporated know-how and the rules of it implementation in tool – shop. The existing manufacturing knowledge of industry tool production was collected and analysing. On this bases flow chart of all activities were made. Theoretical contribution is made in systemization of technological knowledge, which is now accessible for all workers in NC preparation units.
Findings: Utilization of technology knowledge. On the basis of the recognized properties it has worked out the algorithms with which the process of manufacture, the tool and the optimum parameters selected are indirectly determined, whereas the target function was working out of the NC programme. We can first out that with information approaching of the CAM and CAPP the barriers between them, strict so far, disappear.
Research limitations/implications: Till now, the system is limited to milling, drilling and similar operation. It could be extended to other machining operations (turning, grinding, wire cutting, etc.) with the same procedure. In advanced, some methods of artificial intelligence could be use.
Practical implications: It is suitable for industry tools, dies and moulds production, while the system was proved in the real tool shop (production of tools for casting). The system reduces the preparation time of NC programs and could be used with any commercial available CAD/CAM/NC programming systems. Human errors are avoid or at lover level. It is important for engineers in CAD/CAM field and in tool – shops.
Originality/value: The developed system is original and was not found in the literature or in the praxis. Developed method for preparation of NC programs is new and incorporate higher level of automation.
Keywords: Automation engineering processes; Computer Integrated Manufacture; NC

1. Introduction

The computer-aided activities in production systems are a condition for survival, competitiveness, more efficient development, higher quality, faster adoption to new requirements. Therefore, it is necessary to build a system that will efficiently combine different groups in the production system and will, nevertheless, leave a feeling of autonomy.

Nowadays, many programme tools are in use helping the technologist to programme the NC machine tools [1-8], follow up and control the CAD/CAM process [9-12] and helping to conceive and design the product depending on the specific requirements [13-15] of the production process and financial capacities of the company. A disadvantage of all these systems is the extent of integration of the entire system, which is the greatest problem to be solved for rational application of all this equipment. The analysis of information flows shows that there are key gaps between the computer-aided design (CAD) and computer aided process planning (CAPP) [16-17]. In the sub-system CAPP the designer's idea converts into the production instruction and is an

intermediary between CAD and CAM, therefore the extension of the problem is so much wider. One of the main causes of bad integration between CAD and CAPP is that the two systems have developed separately. The CAD data bases are conceived numerically. Therefore they are not directly applicable in the CAPP system. In addition, in the transfer of the product model from the CAD into the CAPP system the technological information gets lost, whereas the applicability of the geometrical information is questionable.

To this end, the intelligent designing–technological interface has been conceived to ensure automatic transfer of the geometrical and technological information on the product model from CAD into the CAPP system.

There are scarce systems, which on the basis of the recognized properties automatically work out the NC programme and even those systems are made only for the individual type of machining and not for the complete machining of the product. Therefore, the aim of the task, based on the intelligent designing–technological interface recognizing the properties, is the model which, with respect to the recognized shape, will automatically work out the NC programme that will be a theoretic tool for designing actual systems.

2. Basic algorithm

This basic algorithm is made for milling, drilling and similar operation on machining centres. The blank intended for machining is first conventionally machined to maximum dimensions. Next, the thickness tolerance is checked. If the tolerance is specified, we select the procedure for reaching the required tolerance (Figure 1 and 2).

In the data file of precision machining operations we select the most suitable machining. The applicable valid criteria are:

- price of machining
- time schedule, occupation of machines, depending on the manufacturing time.

If the required tolerance cannot be reached, if the machines are occupied or if the type of machining for reaching the tolerance is not available, we try to hire external services. After the thickness tolerance has been checked, we find out whether there are external properties. If they do not exist, checking of the required tolerances follows and if the required tolerances do not exist, the procedure is inspected. If the tolerances have been specified, we find out whether they have been reached by previous machining, otherwise the procedure for their reaching, such as grinding, is selected.

If external properties exist, the procedure described in C follows. If the answer is negative, we verify if the loop, encircling the external property, is a circle. If it is a circle, the path, described in B, follows. If, however, the loop encircling the external property is not a circle, the path described in I follows and we determine the possible critical points, which might occur during milling.

Then the least distances between the external properties, their heights and the vertical concave radii and the radii at the bottom, if the bottom is oblique, are calculated. The technologist verifies if it is possible to have a shorter milling cutter (different fixing heads), a specially shaped milling cutter. To this end, the tool data files, the tool catalos and Internet are used.

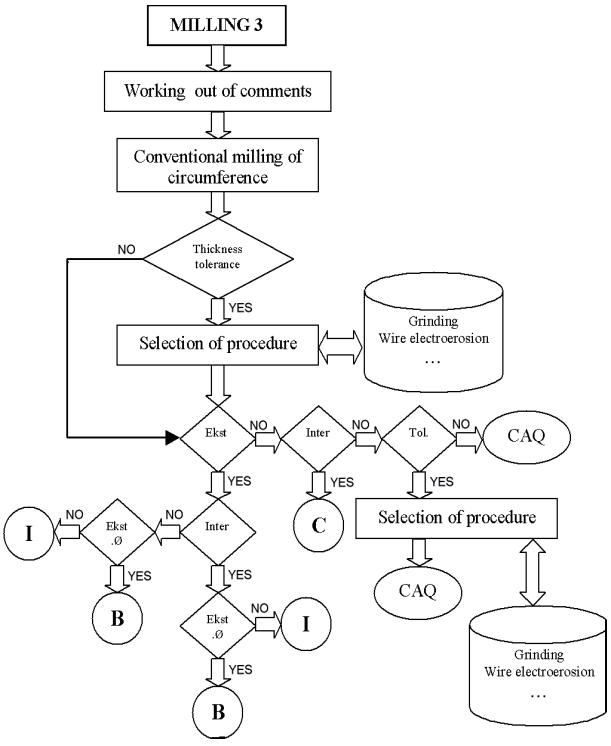

Fig. 1. Basic algorithm for milling – case A

If a new tool is made or ordered, it is necessary to make the cost and time estimate and to decide in the basis of it whether it pays to make or order a new tool. If we have decided on a special tool, it must travel as a piece of information up to working out of the programme and into the tool base so that the cutting parameters can be determined. In this way the programmer knows with which tool he must make the critical point and also has already available the cutting parameters.

If all tools are available (condition 3), MILLING D follows, but before starting to make the programme we must verify the tolerances and determine the machining operation to reach them. If the selected machining is milling a comment must be added as to what must be especially verified in order to reach the required tolerance on the machine and in programming. Even when the machining allowances must be left, it is necessary to write in the form of a note where the allowance must be left and how large. The size of the allowances is determined together with the procedures for reaching the tolerance, since the previous machining must leave a certain allowance when all these processes have been carried out, working out of the programme executed in MILLING D follows.

In case all tools are not available it is necessary to verify first (condition 17) if the conditions of eroding such as occurrence of micro crack have been satisfied. If the conditions of eroding have not been satisfied, it is necessary to change the CAD model or to first alternative machining. When the conditions of eroding have

been satisfied, the algorithm Milling+Ee is continued. Here it is necessary to state in the note the data on the point of eroding and, identically as in case of MILLING D, everything concerning the tolerances and possible allowances. The next operations are making of the NC programme for the milling machine, manufacture of the electrode from the CAD model, machining of electrode and milling and eroding, which is executed in Milling+Ee.

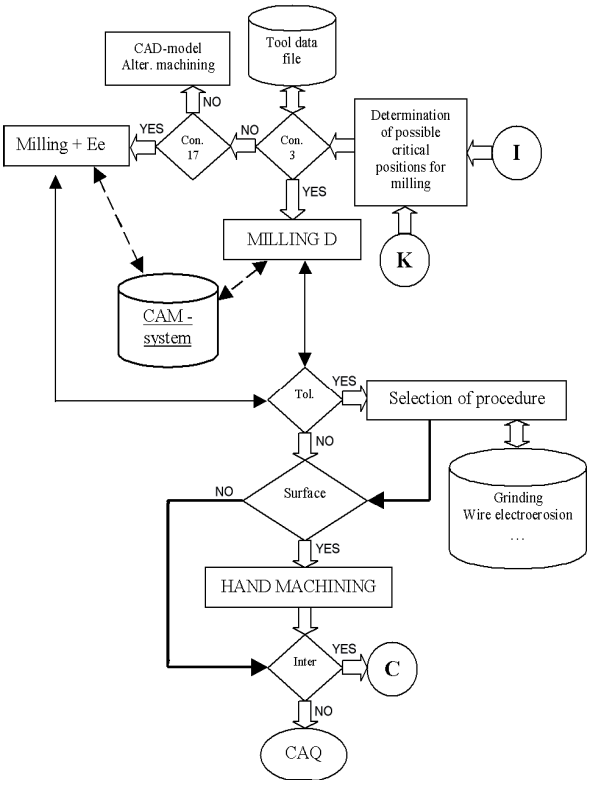

Fig. 2. Algorithm for milling – case 3B

If the procedure for reaching the tolerance is not milling, the appropriate machining process is selected from the base of precision machining such as grinding, wire electro erosion, for which a special algorithm is made, etc.

The next stage in the machining process is manual machining, which is applied in case the product must be polished or adopted to another assembly on a certain place. In the tool making, for example, the engraving surfaces are polished and the seats of shifting inserts are adapted. In the end, manual machining is executed for all product properties together. It is supposed that the programme will remember the places and for the properties which must be manually machined and will make a list of properties to be manually machined.

At the end of the loop before inspection the question arises once again whether the internal properties exist. If the answer is negative, the product inspection follows. This question arises because in this way it is not necessary to make a special loop, if both external and internal properties occur, but the loop B and C and/or I and C are used.

3. Conclusions

On the basis of the recognized properties it has worked out the algorithms with which the process of manufacture, the tool and the optimum parameters selected are indirectly determined, whereas the target function was working out of the NC programme. The model is based on the system for recognition of properties and is independent of the CAD system. The CAD/CAM system Pro Engineer version 2000i was used, so that also the algorithms are adopted to this system.

We can first out that with information approaching of the CAM and CAPP the barriers between them, strict so far, disappear. Unfortunately, designing and production planning in many companies are excessively separated. Modern production requires designing from the technological points of view and from the point of view of technologies allowing to the designer the greatest possible freedom in the product modelling.

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