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THE INFLUENCE OF REAL CUTTING CONDITIONS ON THE CORRECTION OF CATALOGUE CUTTING SPEED

Summary. The paper presents the metod of corection of cutting parameters for turning which have been established or the basic of catalogue data. This approach is based on the Taylor equation concerning cutting speed and tool life as well as on the assumption that each technological process is different. The information concerning the actual tool live given by the first few workpieces in production is used to identify the actual exponent and constant or in the Taylor equation ($T=C_T \cdot v^{-s}$) in technological environment concerning machine tool - tool - workpiece (M-T-W).

1. Assumptions and tasks

Taking into account the development of production automation the need for building software integrating particular steps of manufacturing has emerged. CAD and CAM systems are connected by introduction of CAPP systems. Among various tasks CAPP should establish which machining parameters should be used in a process as well as which machines are capable of performing this process. Without an effective system to provide machining data CAPP will fail. Traditionally the cutting parameters are selected using catalogue recommendations provided by tool manufactures [4], [5]. Sometimes the experience of engineers and machine tool operators play the significant role. But as it should be expected, the problem is how to increase production efficiency and cut production cost. To do this it seems to be necessary to treat each process individually. The authors agree that one can select correct cutting parameters using catalogues but they are of the opinion that these parameters should be corrected using the information given by monitoring the first few workpieces in production.

The key factor is the cutting speed. Having established the depth of cut and the feed it is possible to change the tool life by changing the cutting speed.

The basic assumptions in a proposed method are:

- tool life in agreement with Taylor formula

$$T = C_T \cdot v^{-s} \quad (1)$$

- mathematical models of an economical tool life (T_E) and a tool life for maximum production (T_W)

$$T_E = (s-1)\cdot\left(\frac{K_n}{K_m} + t_{zo}\right) \quad (2)$$

$$T_M = (s-1)\cdot t_{zo} \quad (3)$$

K_m - machining cost
K_n - tool cost per tool life
t_{zo} - tool change time [min]
s - exponent of Taylor formula

- this method should be efficient for a fixed set of a machine tool, tool and workpiece (M - T - W)

Since catalogue data are average data for various kinds of machined materials and they have been created as a result of tests conveyed on unknown kinds of machine tools it can be assumed that cutting data could be improved when we use the results of test cuttings in established conditions for a fixed set of (M-T-W). What is more, it can be assumed that since the tool manufacturers average catalogue data the global dependence $T = f(v)$ in the whole range of useful cutting speed may differ from the local dependence (Fig.1) If we select cutting speed using catalogue data we are supposed to move along a line 1, hence if we machine a workpiece with cutting speed v_1 we expect to get a tool life T_1. However, due to the difference between the actually machined material and the material for which the catalogue data were prepared or a different machine tool, the real dependence $T = f(v)$ may represent line 2.

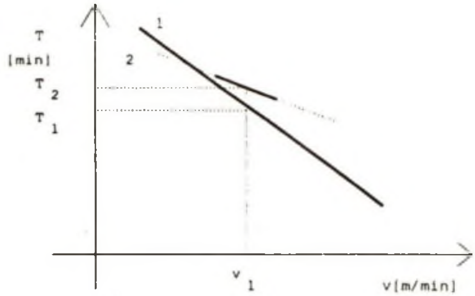

Fig.1. Examples of tool life - cutting speed dependances according to the Taylor equation

So, the real tool live for machining with cutting speed v is T_2. It is obvious then that a method for testing and correcting selected cutting data which enable to choose the cutting speed in such way that we get a tool life that we want is desired.

2. The method and algorithm

Fig. 2 shows the steps leading to the identification of a constant C_T and an exponent s of the Taylor equation in a real conditions of machining. Graphical representation of this equation ($T = C_T \cdot v^{-s}$) in a logarithmic coordinates system $T = f(v)$ is a straight line which equation is:

$$\log T = -s \log v + \log C_T \tag{4}$$

$$y = ax + b \tag{5}$$

First, the method assumes that a constant C_T has been estimated not correctly. This constant includes factors concerning features of machined material and factors concerning the machine-tool. The starting point is a machining test with cutting parameters set on the basis of catalogue recommendations. Then, having checked the constant C_T, the second test takes place so as to establish a new exponent s.

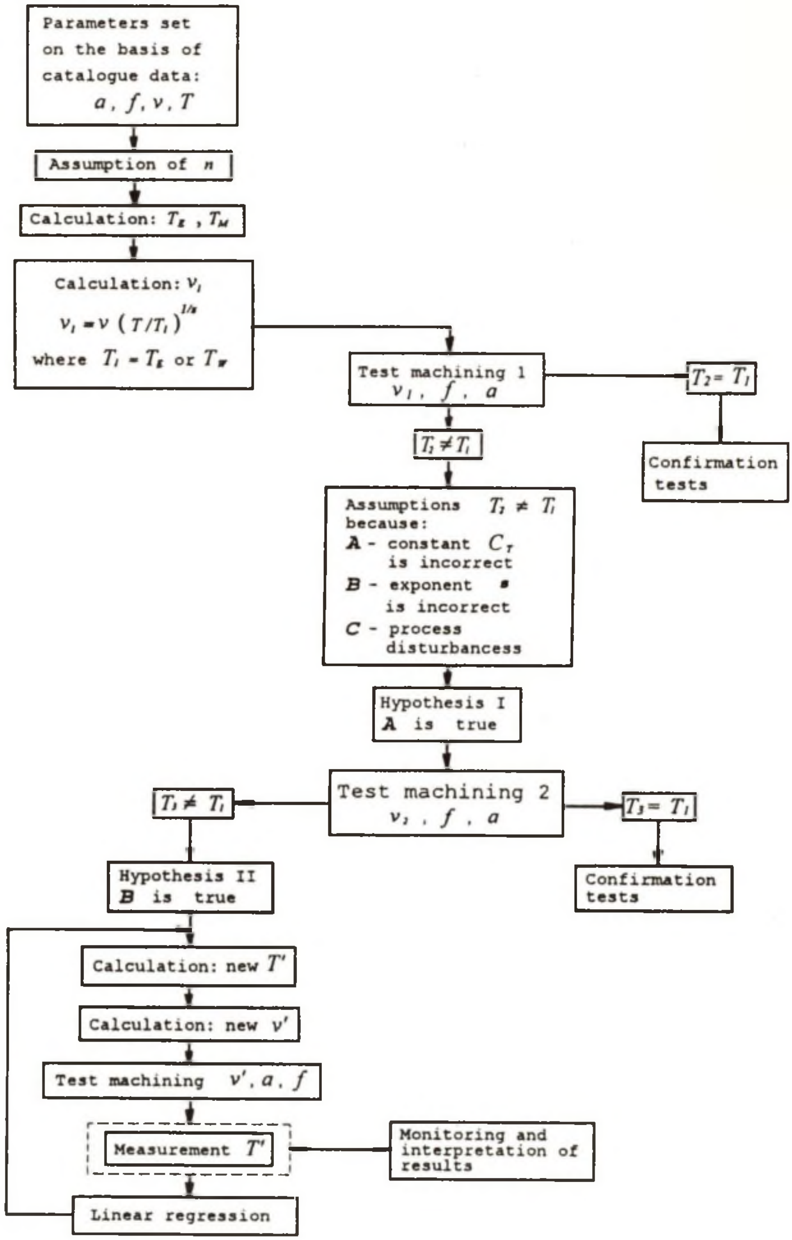

Fig.2. A simplified algorithm of cutting parameters identification in a real production conditions

This leads to a new value of T_E or T_W according to equations 2 or 3 and a new cutting speed. Subsequent tests should be performed to confirm established values. Fig. 3 complements fig. 2 by presenting consecutive steps taken in agreement with the algorithm.

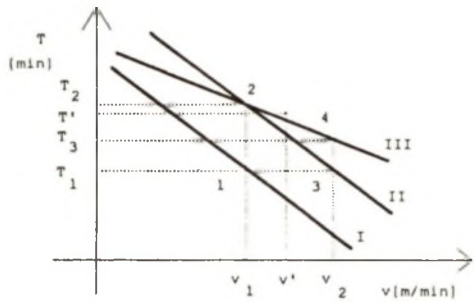

Fig. 3. Example of procedure for the selection of cutting speed on the basis of the result of test machining

Points 1, 2, 3 and 4 present tool life values calculated and obtained from test machining. Line I is based on a tool manufacturer data and lines II and III are successive test approximations of the Taylor equation. To estimate a tool wear some factors indicating changes of a quality of a workpiece may be taken into account. The described method and some other works conveyed at the Production Engineering Institute [1], [2], [3] (e.g. automated classification of machined materials) serve as a theoretical background for a computer system concerning the selection of machining data for turning. The system is intended to work for traditional and CNC lathes.

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