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THE APPLICATION OF GROUP TECHNOLOGY FOR THE PRODUCTION TIME ESTIMATION

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Abstract: The development of industry, transport, communications and technology results in tougher competition, i.e. the process of globalization is manifested. Small and medium enterprises (SME) which are greatly affected by this process are expected to accept or to refuse the received offer in a very short time. Consequently, it is impossible for a small enterprise to create a technological process in order to obtain production times. The idea of the authors of this paper is to develop a classification system of parts by means of group technologies. In the next step, an application to enable the production time estimation, and consequently the production costs estimation, for each family of parts will be developed.

Key words: Group technologies, estimation of production times, CAM, code classification.

1. INTRODUCTION

At present, a lot of customers send a drawing or a 3D model to enterprises and expect to get the production costs and delivery times in answer to their enquiry. Due to a very short time at their disposal to provide answers, manufacturers cannot define the whole technological process with defined production times and the product price. In most cases, manufacturers give an approximate offer, with an assumed product price and the production times based on their experience and on what they can see on the drawing. The authors of this paper have an idea to develop a classification system of parts by means of group technologies. By using this system, the parts would be classified into families of parts. For each family, an application for the production time estimation, and consequently for the product cost prediction, will be developed. The paper presents

application for the production time estimation developed here is intended only for shafts. The application only uses the example of the external turning, and it is oriented toward SMEs, i.e. toward private owners because small and medium enterprises have a large share in the total production in Croatia. The basic features of the single-item production and the small-scale production (Antolić, 2007) are:

- A great number of demanding positions in small batches,
- Short delivery times,
- Tendency to approximate the prices achieved in mass-production.

2. CLASSIFIER OF PARTS

As there are a large number of different parts in production systems, the aspiration towards a classification system has led to the development of group technologies.

The group technology has two approaches. The first approach is to group parts according to the production plan so that the machine layout in a plant follows the technological process of the production of a particular group of products. This approach uses the visual method, production flow analysis and cluster analysis (Jurković & Tufekčić, 2000). The second approach is used for grouping parts according to their geometry and technological features. In this approach each part is given its code digit which is used to identify similar parts. Classification and codification systems are used in this approach. This paper deals with the latter approach in which all parts will be given a code digit which classifies them into a particular family of parts.

1. DIGIT		2. CODE DIGIT FOR CATEGORY		3. DIGIT MATERIAL		4. SURFACE ROUGHNESS DIGIT AND TOLERANCE CONVERTED INTO SURFACE ROUGHNESS		5. L/D DIGIT RATIO		
ROTATIONAL PARTS	0	symmetric	0	discs and rings		0	steel		0	L/D ≤ 3 2 clamping; face machining
	1		cylinders and shells		1	aluminium		1	L/D > 3 2 clamping; face machining and machining of centre hole	
	1	nonsymmetric	2	shafts		2	copper			
			3	shorter rotational parts with eccentric surfaces		3	castings			
			4	shafts with eccentric surfaces						

Fig 1: Classifier of rotational parts (Opetuk, 2007)

3. APPLICATION FOR THE ESTIMATION OF PRODUCTION TIMES

In the application model, the authors of this paper have come up with the idea to divide the shaft into basic shapes (Opetuk, 2008.) as it is not easy to estimate the time required for the production of a shaft. This part of classification refers to the fine and rough profiling machining because the number of passes during turning is not the same; therefore, the division of the shaft into basic shapes makes this process of production

time estimation easier. To estimate the production time it is necessary to calculate the time required for the production of each basic shape, and the sum of all these times will give the production time per piece. The application was tested by using the CAMWorks software to calculate the production time per piece required for the manufacture of 20 shafts. This production time per piece was then compared with the estimated production time per piece obtained by the Excel application.

3.1 Application for the calculation of base data

In addition to the above mentioned application for the calculation of the production time per piece, an application for

the calculation of the following cutting conditions was developed using Microsoft Office Excel:

- Spindle speed – n [RPM],
- Cutting speed – v_c [m/min],
- Surface roughness – Ra [μm],
- Required machine power – P_c [kW],
- Metal removal – V [cm^3/min].

3.2 Application for the calculation of production times for shafts

The application for the calculation of the production time per piece for shafts is made by using Microsoft Office Excel. This application consists of the following 10 worksheets, i.e. the typical turning processes with respect to the surface:

- Machine data,
- Face machining,
- Machining of centre hole,
- Profiling – straight,
- Profiling – tilt,
- Slot machining,
- Radius machining,
- Threading,
- Support time,
- Production time per piece t_1 .

The order of worksheets in the application follows the order of operations in the technological process. The production time per piece comprises the following times:

- Machining time,
- Rapid time,
- Support time.

For the calculation of production times, one uses the formulae which are used in the standard process of creating a technological process (Gačnik & Vodenik, 1990). Figure 2 presents how the application works.

The application model has the following limitations:

- The model can be applied to rotational work pieces, i.e. shafts;
- The model is limited only to external turning;
- The operations of milling, grinding, etc., have not been taken into account in the model.
- Profile machining, or more precisely, radius machining is included into the application as part of the profiling – straight. Approximately, the error would be less than 0.1 % since it is a small segment of the shaft and its influence on the production time per piece is negligible.
- Another limitation is the x-axis machining which is not taken into consideration in this application. It can be accounted for by the fact that the sequence of basic shapes in fine and rough profiling should be defined.

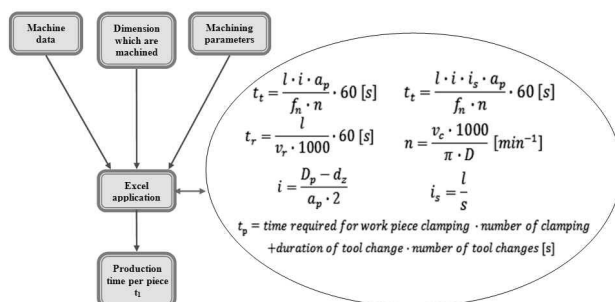


Figure 2. Mode of work of the application

4. CONCLUSION

This application gives good estimation of production times; therefore, it could find its application in the teaching process where students could use it for the estimation of production times of their work pieces. This application is not fully

automatic and the user, i.e. the student, is expected to interact with this application while using it. In addition, the application can be used in industry, with the single-item and the small-scale production, for the estimation of the production time per piece of shafts. Figure 3 shows the differences between the production times per piece obtained by the Excel application and those obtained by the CAMWorks software.

The application could not be fully automated if one wanted to do it. The part that could be automated is the recognition of basic shapes, i.e. machining operations. In order to achieve this, a system that would automatically recognize these shapes, i.e. operations, should be developed on the basis of 2D and 3D models. The part that cannot be automated is the data input, i.e. the input of parameters related to machining and to the machine into the application because these parameters depend on the type of the machine applied, on the shaft material, on tools, etc. As far as the generalization of the model is concerned, i.e. the introduction of operations of milling, boring, grinding, etc., into the application, it can be achieved by adding worksheets referring to these operations. Using this application, one can achieve considerable savings when estimating the production times per piece. The estimation of production times per piece by using this application takes 15 minutes regardless of what is used as the basis: a 2D drawing or a 3D model. Savings in time are 4 times greater with respect to the CAMWorks when a 3D model is involved and 5 times greater when a 2D drawing is involved. If CATIA, less user-friendly and more complicated than CAMWorks, is used as the CAM software, savings in time are 6 times greater for the 3D model and 7 times greater for the 2D drawing. Thus, the time required for the estimation of production times is reduced; as a result, the price is also reduced.

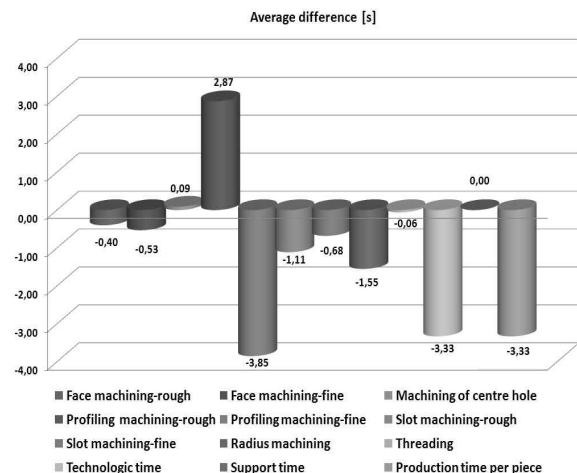


Fig 3. Average difference in production times per piece

5. REFERENCES

- Antolić, D. (2007). *Estimation of the product production times by using regression models, (in Croatian)*, Master's thesis, University of Zagreb, FAMENA, Zagreb, ISBN 86-7059-085-9
- Gačnik, V. & Vodenik, F. (1990). *Design of process planning, (in Croatian)*, Tehnička knjiga, Zagreb
- Jurković, M. & Tufekčić, Đ. (2000). *Technological processes – design and modelling, (in Bosnian)*, Faculty of Mechanical Engineering, Tuzla
- Opetuk, T. (2008). *Development and model application production time estimation for rotational parts, (in Croatian)*, Master's thesis, FAMENA, Zagreb
- Opetuk, T. (2007). *Application of group technology in the design of process planning, (in Croatian)*, Graduation thesis, FAMENA, Zagreb