10th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006

DYNAMIC CLASSIFICATION FOR CAPP SYSTEMS BASED ON GROUP TECHNOLOGY

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ABSTRACT
The paper deals with aspect of classification systems in Computer Aided Process Planning (CAPP) systems based on Group Technology (GT). The classification systems are important part of the GT CAPP. Current known GT CAPP systems utilised only static classification systems. Dynamic classification will be introduced as new method. It can be especially utilised for non-cutting process planning such as casting and forging.
Keywords: CAPP**,** Group technology, classification

1. INTRODUCTION
Group Technology (GT) has a great signification in engineering industry. There is the greatest utilisation of GT in planning activities, especially in process planning. The GT methods are especially utilise in process planning for machining processes. The classification system is very important part of the CAPP (Computer Aided Process Planning) system based on GT. The classification system for machining has static character. It is not needful to change a localisation of classified parts into individual groups. However there is proposal to utilise GT methods also for non-cutting technologies such as casting and forming. The static classification system is not suitable for process planning of non-cutting operations. Therefore there was elaborated a concept design of dynamic classification system oriented especially for non-cutting technologies.
The process planning activities are significant means for flexibility, time to market and competitive advantage of enterprise. The process planning systems are therefore important tools for increasing of efficiency and profit. The CAPP systems give the big productivity and effects to the enterprise. Besides conventional methods of GT there are attempts to apply other advanced methods to increasing the effects and performance of GT CAPP systems. The dynamic classification system is one of approach how improve the effectiveness of CAPP systems.

2. CLASSIFICATION SYSTEMS
A company may make hundreds and thousands of different parts. Because the parts are made in a concrete manufacturing environment, many parts are similar in some way /Fig.1./. Therefore many process plans must be also similar. If similar parts are situated in one group afterward their process plans likely are similar. It is possible to create some groups of parts with similar characteristics. If similar parts have similar processes afterwards utilising this approach get very good economic benefit. The above describing principle of grouping is a basis for GT philosophy.
Process plans utilising is a main idea of utilising of grouped parts. The important task is to determine a similarity of characteristics among the parts. Other problem is to determine which characteristic is relevant and fundamental for part grouping in families. A wide variety of statistical, numerical and optimisation techniques solve the problem of grouping parts into families and machines into cells.
Successful grouping /Fig.2./ of parts into families is a key to implementation of the GT philosophy.

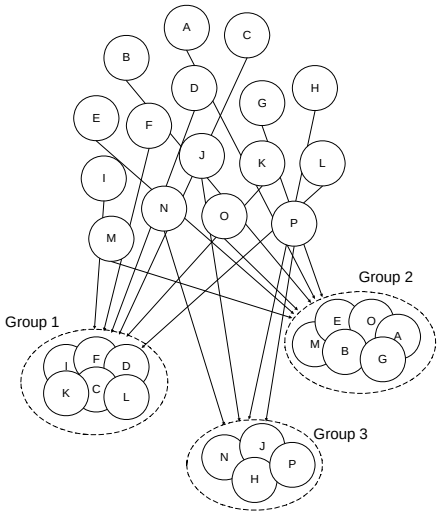

Figure 1. Grouping of parts

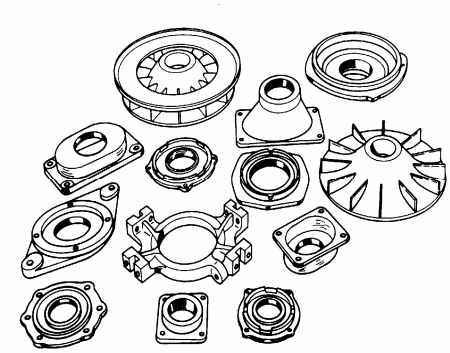

Figure 2. Similar parts situated in one group

3. CAPP SYSTEM BASED ON GT

GT principle is one of principle used in CAPP methodology. The standard plans are created for a family of similar items. In the GT CAPP systems human retrieves the plan for similar components using coding and classifications of parts. The planner edits the retrieved plan to create a variant to suit the specific requirements of the component being planned. This technique is based on the principle that geometrical and technological similar parts have similar process plans. The computer aid is used to assist in identifying similar plans, retrieving them and editing the plans according to the geometrical difference.

The development of a GT CAPP system has two stages: *preparatory and production stage.* During the *preparatory stage*, existing components are coded, classified and later grouped into families. Several methods can be used to form the grouping. A visual classification /Fig.3./ for grouping parts is one of classification approach. The *production stage* is working on process planning for new parts. A new process plan is created in this stage. The new part is coded. A family of parts with similar characteristics is found for the new part. The standard process plan of representative is selected from database. This process plan is edited according to difference of properties of new part and part representative.

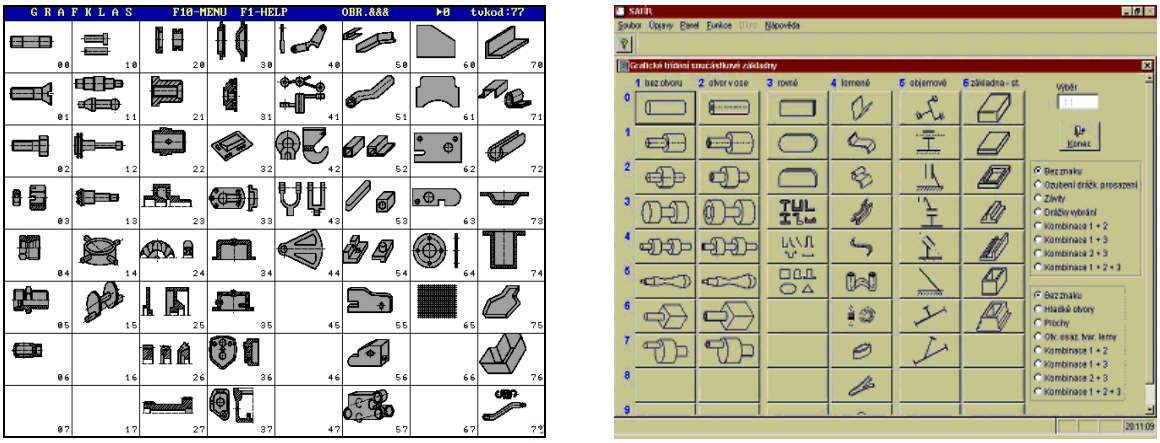

Figure 3. Graphical classification systems – visual classification of two commercial CAPP systems

There are many good examples of GT applications in CAPP area. In Slovak and Czech industry, the GT is the most applied approach of CAPP systems.

4. GT FOR NON-CUTTING TECHNOLOGIES

CAPP systems based on the GT are very good elaborated especially for process planning of cutting technologies. The *non-cutting* (chipless*) technology* area (welding, casting, forming) is not so supported by the current GT CAPP systems. Utilising of cutting tools and other equipment are different in non-cutting technologies as in the cutting technologies. The similar engineering parts (produced by non-cutting technologies) belonging to family, will have the similar technological conditions and similar utilised instruments and equipment. The order of process operations is not important.

It is also possible to meet with classification systems based on graphical classification /Fig.4./. Graphical classification system are based on geometrical properties, especially the basic geometry of parts is considered. The geometry is very responsible for process design but it is necessary to continue in classification according non-geometry properties /Fig.5./ such as accuracy, weight , etc.

It seems that the current known classification system (static classification) are not so proper for utilisation for process planning of non-cutting processes.

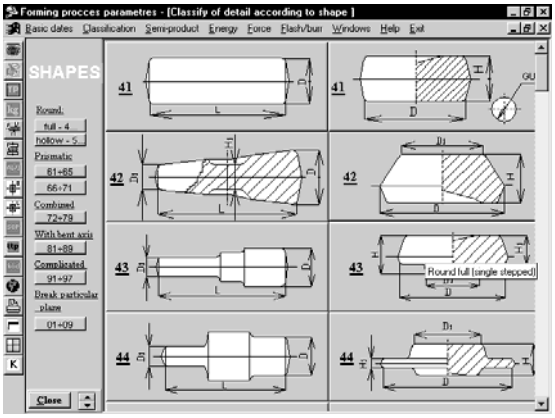

Figure 4. Developed visual classification according the geometrical properties

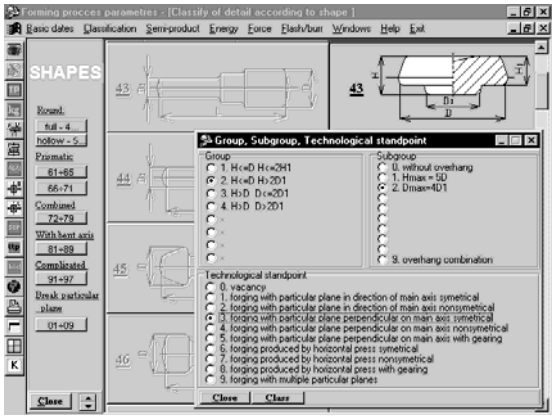

Figure 5. Developed classification according the non-geometrical properties

5. DYNAMIC CLASSIFICATION METHODS FOR GT CAPP SYSTEMS

The classification system is very important part of the CAPP system based on GT. It is possible to state that correct classified part is assumption for correct retrieved process plan. Therefore it is very needful to create the proper classification system. Majority of CAPP systems based on GT is intended for manufacturing process planning. It is sufficient to create classification system for the manufacturing process which will be only filled up. There is no need for changing the number of groups, change localisation of individual engineering parts in individual groups. Therefore it is possible to consider these classification systems as static systems.

However there is a big demand to utilise the GT also for other technologies and not only for machining process planning. As the characteristic of non-cutting processes (such as forging and casting) are different as cutting processes, there is need to take other view on utilisation of GT in this area. University of Zilina elaborated a concept design of dynamic classification system oriented especially for forging and casting as theses processes are similar.

The dynamic classification is based on flexible classification system. The engineering parts are dynamic grouped to the individual groups according to classification aims /Fig.6. and Fig.7./. For example the engineering parts will be dynamic grouped to the individual groups according the total costs or operational total times, number of produced parts, series, etc. There is a mathematical method - cluster analysis - which seems to be a very good candidate for support of dynamic classification system creation. Clustering techniques have been applied to a wide variety of research problems. The term cluster analysis actually encompasses a number of different classification algorithms.

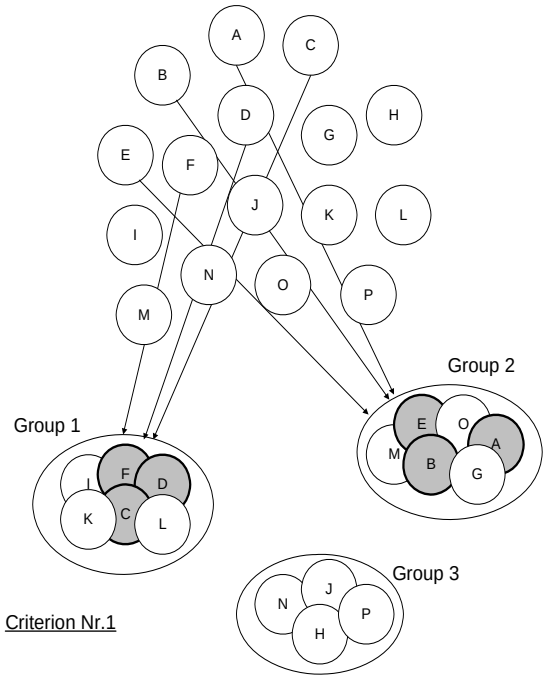

Figure 6. Dynamic classification according 1st criterion

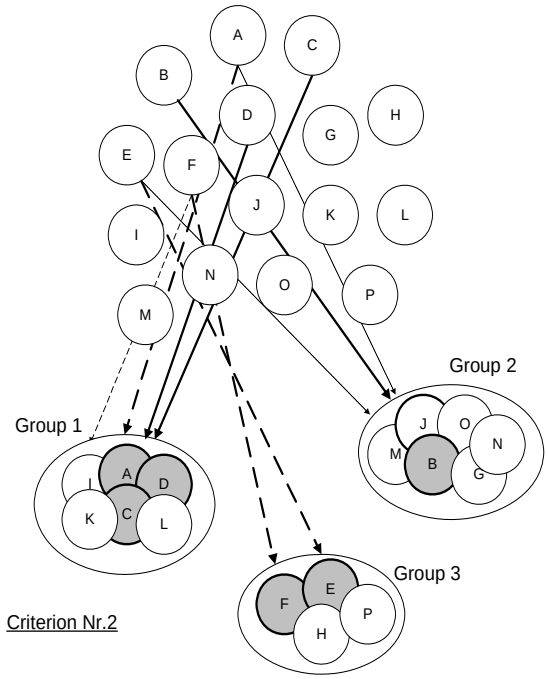

Figure 7. Dynamic classification according different criterion

The principle of the dynamic classification is evident on figure 6 and figure 7. The parts are flexible and dynamic grouped according selected criterions. It is still appropriate to utilise the visual classification as it is very simple and effective method however with flexible possibility the grouping the parts according actual demands.

6. CONSLUSION

The above mentioned topics are elaborated as PhD thesis. The building of GT CAPP system is time demanding and very labour task. The CAPP tasks require the theoretical elaborating, working out the serious methodology of process planning and used advanced programming technique. It seems that dynamic classification method is very effective and flexible method of part grouping for casting and forging process planning. The dynamic classification improves effects and productivity of the CAPP systems based on GT utilised for process planning of non-cutting processes.

Note: The article was made under support projects AP 4/0002/05, VEGA 1/3201/06 and KEGA 3/3147/05

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