Proceedings of the 16th International Conference on Manufacturing Systems – ICMaS
ISSN 1842-3183
University POLITEHNICA of Bucharest, Machine and Manufacturing Systems Department
Bucharest, Romania

STATIC AND DYNAMIC CLASSIFICATION OF ENGINEERING PARTS FOR CAPP SYSTEMS

Ivan KURIC, Fedor KÁLLAY, Ľubomír ŠOOŠ

Abstract: *Classification of engineering parts is very important activity especially in process planning. It is one of important methods utilised in group technology approach for computer aided process planning. The paper deals with methods of classification. Special attention is given to dynamic methods of part grouping as a new method of classification. The dynamic method especially extended possibility of engineering part classifying for process planning of non-cutting processes (forging, casting, etc.)*

Key words: *dynamic classification, CAPP, group technology*

1. INTRODUCTION

A company may make hundreds or thousands of different parts. Because the parts are made in a concrete manufacturing environment, many parts are similar in some way. Each part is made according to a process plan. Therefore many process plans must be also similar. If similar parts are situated in one group (part family), their process plans are similar as well. It is possible to create some groups of parts with similar characteristics. If similar parts have similar processes afterwards utilizing this approach get very good economic benefit.

Classification is methods for grouping the engineering parts to the individual groups. The classification is basic method for computer aided process planning (CAPP). The correct grouping is assumption for trouble free session with CAPP system. The classification systems have mainly static character. A dynamic classification of grouping part seems to be a good tool for classification of parts produced by non-technology process operations /forging, casting, etc./.

2. COMPUTER AIDED PROCESS PLANNING

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 manual process planning is often a tedious and time demanding engineering process. There is an effort for these activities to be supported by computer. Computer support can markedly help to solve some planning activities. CAPP system is software for the automated design of route sheet. The CAPP represents the implemented methodology of process planning in the software package.

The advantage of automated manufacturing process planning is undisputed. There are two approaches for creation and processing of process plan based on computer support [1, 8]. The first approach is based on Group technology (GT) utilizing (*variant method*), the second approach is the exact mathematical principle based on modelling of part, manufacturing knowledge and process plan (*generative method*).

Variant CAPP is based on the concept that similar parts have similar process plans. The computer is used as a tool to assist in identifying similar process plans, as well as in retrieving and editing the plans to suit the requirements for specific parts. Variant CAPP is related to part classification and GT coding. In these approaches, parts are classified and coded based upon several characteristics or attributes. A GT code can be used for the retrieval of process plans for similar parts.

3. CLASSIFICATION OF ENGINEERING PARTS

The application of GT is primarily based on the concept of part families (grouping parts into families).

We very often use catalogues and documents with classified and grouped data. A good example is the coding and classification of books in a library catalogue. Another example is the telephone directory. There are great deals of other examples of classification systems in real life. Everyone knows that grouping of similar data in individual groups is an effective and useful activity.

Additionally, parts that look different from a design perspective may in fact be processed in a similar way. In most cases, the emphasis is to identify families of parts that can be manufactured in a standardized and simplified manner. How does one identify the characteristics of a part that warrant it being placed into one family and not other? Identifying and forming part families is fundamental for achieving high levels of standardization and simplification.

There are two basic methods of grouping the part families utilized in CAPP systems [5]:

- Manual Visual Classification,
- Classification and Coding.

Manual visual classification or sometimes called visual or graphical classification system (Fig. 1) is often realized according to graphical classification systems. Planner compares a new part with representative parts drawn in individual cells of the table.

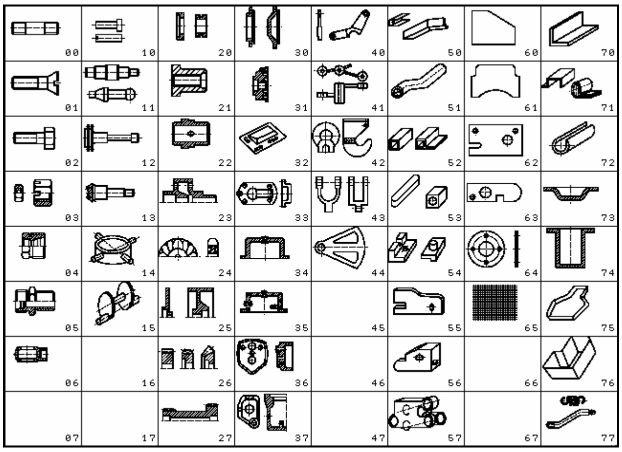

Fig. 1. Graphical classification system.

The next method used to establish part families is to examine the parts and then classify and code each part into a group with similar attributes. Classification is the process of identifying and establishing the various classes or divisions that exist for a set of parts based on relevant attributes.

Classification is realized after the coding process. Coding is assigning of symbols to the part properties. Symbols constitute the code that ambiguously describes the properties of a part. Several similar parts may have an equal code. By decoding process we don't know exact geometrical and other properties (Fig. 2).

When deciding on GT coding scheme, there is a considerable amount of initial investigation and planning to be done. The first step is to determine what need exists for a formal GT coding or relational data base system. For example, is the system going to be used primarily by design engineering for storing and retrieving parts? Does manufacturing engineering need the system for forming part families or only for storing and retrieving manufacturing process plans? Some coding systems are only useful for variety reduction and design information storage and retrieval and do not have the capability to stand independent procedures to find part families for cell formation. This is because codes typically group parts that have geometrical similarities but differ in tolerances and/or batch sizes, hence the parts should be processed on a different type of machines.

Similarly, some types of codes may not group together parts having dissimilar design features, although they are processed on the same set of machines.

The key question to address is how will the coding system simplify operations and eliminate waste?

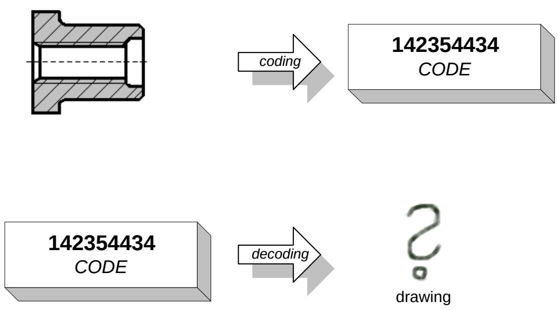

Fig. 2. Coding and decoding of part.

The justification process has to consider both initial costs and operating costs of a GT coding system. Initial costs typically include the computer hardware, software license fees, user training, part coding and entry expenses.

Ongoing operating costs include computer and data base maintenance, computer time and supplies, and training. These costs have to be weighed against the expected benefits, both tangible and intangible. Because most commercial GT coding and classification software is now marketed as part of a total information system addressing the issues of CA integration.

Many people do not understand GT and classification and coding systems and therefore do not feel comfortable in recommending their use. Essentially this is a fear of change.

The initial investment in capital and personnel is quite high and the reported or expected benefits are neither guaranteed nor immediately attainable.

Classification is the process of identifying and establishing the various classes or divisions that exist for a set of parts based on relevant attributes. However future manufacturing systems will be increasingly more dynamic.

They have to be able to rapidly respond to changing conditions by concurrently balancing and optimizing multiple manufacturing constraints. There is a effort to realize automatic classification which will be more flexible and efficiency.

Besides benefits of classification there are also some disadvantages. It is possible to state the following advantages and disadvantages of the classification [4, 6]:

Advantages:

- A good coding and classification system provides design process and process planning activities with a system that is more flexible, simplify and effective.
- Standard routings facilitate the development of tooling groups, NC program groups and standard setups for part families.
- Production planning and control can be simplified.
- Because production planning can be simplified, it can be more comprehensive.
- Production scheduling can be simplified.
- Machining cells can reduce in-process inventory, resulting in shorter queues and shorter manufacturing throughput times.
- Improved machine utilization yields shorter setup times and better scheduling.
- Part family data facilitates improving plant layout, which in turn can reduce materials handling costs.
- Purchasing can be more effective. It is easier to choose the proper vendor because the many different parts and materials have been grouped into families, which reduce the complexity of the problem.
- Management can be more effective because the environment has been simplified.

All of the above items should lead to lower costs and many will facilitate improved quality.

Disadvantages:

- Installing a coding and classification system requires a large amount of time and effort.

- If communication between design engineering and manufacturing is poor, difficulties may be encountered in installing a coding and classification system. It may not be very successful.
- There are no accepted GT standards. Consequently, there is no common implementation approach and implementation is often difficult.
- Grouping of machines may lead to poor utilization of some machines in the group.
- Large costs may be incurred in rearranging the plant into machine cells or groups.
- GT concepts require changing how people work, therefore employee resistance may be encountered.

Without strong support from top management, implementation of classification will be difficult.

4. STATIC CLASSIFICATION

The GT methods are especially utilise in process planning for machining processes. The classification system for machining has static character. It is not needful to change classified parts into individual groups. It is possible to meet also with two level classification systems (Fig. 3).

Majority of CAPP systems based on GT is intended for manufacturing process planning. It is sufficient for the manufacturing process to create classification system 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 system.

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 technologies /such as forging (Fig. 4) and casting (Fig. 5)/ are different as cutting technologies, there is need to take other view on utilisation of GT in this area [3].

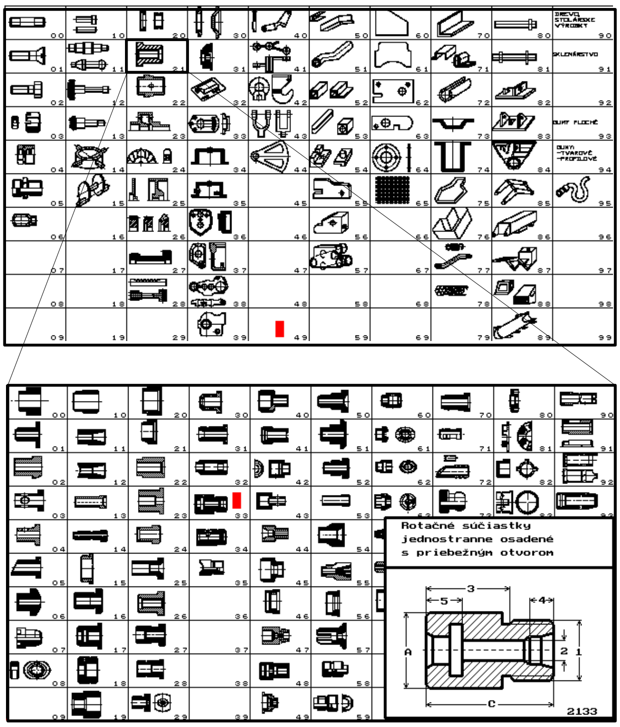

Fig. 3. Two level classification systems.

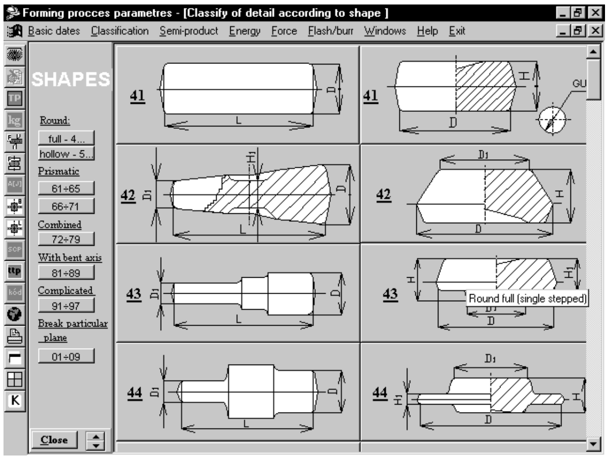

Fig. 4. Classification system for forging.

Fig. 5. Classification system for casting.

5. DYNAMIC CLASSIFICATION

As the static classification system is not suitable for process planning of non-cutting operations, therefore there is a concept design of dynamic classification system oriented especially for non-cutting technologies (Sugar, 2000).

The dynamic classification is based on *flexible classification system* [7]. The engineering parts are *dynamic grouped* to the individual groups according to classification aims. For example the engineering parts will be dynamic grouped to the family 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 [2]. *Clustering techniques* have been applied to a wide variety of research problems. The term cluster analysis actually encompasses a number of different classification algorithms.

The principle of dynamic classification is evident on Fig. 6. and Fig. 7. The parts are flexible and dynamic grouped according selected criterions. It is still appropri-

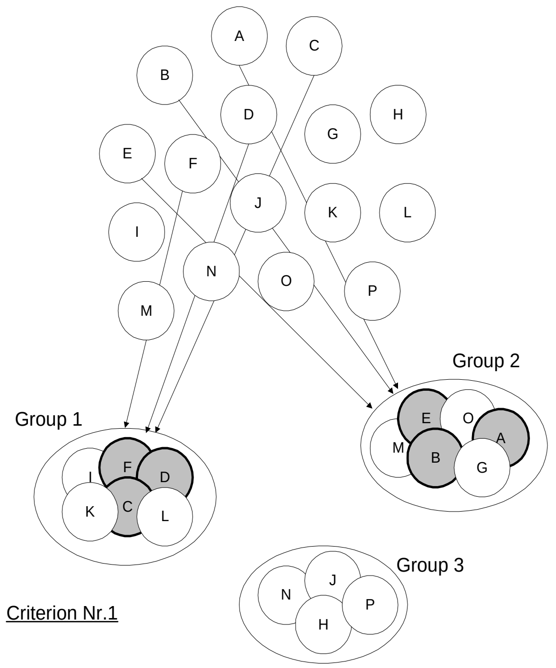

Fig.6. Dynamic classification – step 1.

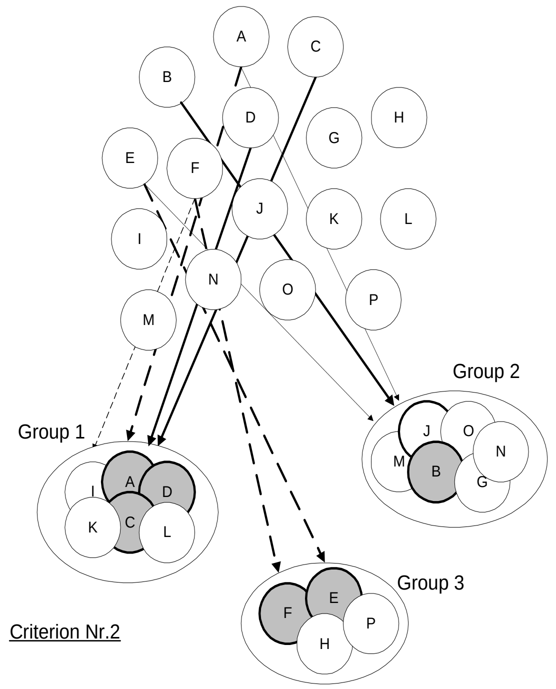

Fig.7. Dynamic classification - step 2.

ate to utilise the visual classification as it is very simple and effective method however with flexible possibility the grouping the parts according actual demands.

There is a development of dynamic classification systems and GT CAPP SW on the University of Zilina.

6. CONCLUSIONS

Classification system that more precisely reflects flexible demands is needed. Dynamic classification has been used to categorize product properties according actual demands. During past years the classification systems in CAPP systems utilize static classification. The static classification system doesn't reflect the important changes in the factory.

The building of dynamic classification system utilized in GT CAPP is time demanding and very labour task. The task requires 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.

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

REFERENCES

[1] Chang, T.C. (1990). *Expert process planning for manufacturing*. Addison-Wesley Publ., Massachusetts, USA.

[2] Varga G., Dudas, I. (2000). *Intelligent Manufacturing System for Productions of Sophisticated Surfaces,* MicroCAD 2000, Proceedings of the International Computational Scientific Conference, pp. 99-104, February 23-24, 2000, Miskolc

[3] Varga G., Dudas, I. (2000). *Intelligent Manufacturing System for Production of Helicoid Surfaces.* Gep, 2000, Vol. LI. No. 9, pp. 44–46.

[4] Marcinčin, J.N. (2000). *Integration of CAPE (Computer Aided Product Engineering) to CIM structure*. In: Proceeding Automation, 12.-14.5.2000, pp.265-268. Warszawa,

[5] Šugár, P. (2000). *Similarity of objects and processes of machine production*. Zvolen, Publishing center of Technical University.

[6] Peterka,J., Janáč,A., Šugár,P. (1996). *The aspects of building of CAD/CAM system workplace on the department of machining and assembly*. In: Zborník DAAAM, pp.329-330, 17.-19.10.1996, Vienna.

[7] Kuric, I. (2006). Static and dynamic classification systems. *Proceedings of 11th Int.DAAAM Workshop "CA Systems and Technologies"*, pp. 113-118, ISBN 3-901509-56-9, Cracow, 2.-4.10.2006, Cracow.

[8] Kuric, I.; Matuszek, J. & Debnár, R. (1999) *Computer Aided Process Planning in Machinery Industry*, Politechnika Lodzka, ISBN 83-87087-00-9, Bielsko Biala.

Authors:

PhD, Eng. Ivan Kuric, Professor, University of Zilina, Faculty of Mechanical Engineering, Univerzitna 1, SK-010 26 Zilina, Slovak Republic,
E-mail: ivan.kuric@fstroj.utc.sk

PhD, Eng., Fedor Kallay, Assoc. Professor, University of Zilina, Faculty of Electrical Engineering, Univerzitna 1, SK-010 26 Zilina, Slovak Republic,
E-mail: kallay@fel.utc.sk

Eng., Ľubomír Šooš, Assoc. Professor, Slovak University of Technology, Faculty of Mechanical Engineering, nam. Slobody 17, 812 31 Bratislava, Slovak Republic,
E-mail: lubomir.soos@stuba.sk