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RESEARCH, METHODS AND APPROACHES IN CAPP SYSTEMS FOR CUTTING AND NON-CUTTING TECHNOLOGIES

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ABSTRACT
The paper deals with aspect of Computer Aided Process Planning (CAPP) systems in mechanical engineering area. The paper presents some elaborated and developed methods and module for CAPP. The self-teaching module for CAPP system and selective classification method will be introduced.
Keywords: CAPP**,** process planning, selective classification, teaching CAPP

1. INTRODUCTION
The computer aided process planning (CAPP) represents the implemented methodology of process planning in the software package. The CAPP includes all process planning activities needful to realisation of the design of the process plan. The 2 methods for CAPP systems - variant and generative process planning methods are long time known. The new approaches such as dynamic classification, selective classification, fuzzy approach and self-learning approach are elaborated by research team in University of Zilina. The CAPP methods oriented on non-cutting technologies are not so elaborated such as process planning for machining operations. This area is also elaborated in the University of Zilina.

2. SYSTEM VIEW ON CAPP
There are two basic approaches for creation and processing of process plan based on computer support and advanced planning methods:

- *variant process planning* based on Group Technology utilizing,
- *generative process planning* based on exact mathematical modelling.

There is necessary to elaborate CAPP methodology for variant and generative process planning as concrete system will be designed and made according it. As the two planning approaches are different, as well the CAPP methodology for variant and generative methods will be unequal.

The *methodology for variant approach* consists of the following main activities and tasks:

- Design and creation of classification systems,
- Identification of engineering properties and grouping the parts to the groups,
- Coding of engineering parts,
- Retrieval of similar engineering parts and modification of process plan.

The *methodology for generative approach* is based on mathematical modelling of product, machine tools, cutting tools, fixtures and mathematical modelling of manufacturing knowledge and manufacturing operation. The methodology is influenced by the following methods of individual modelling tasks:

- Process planning: forward or backward planning strategy,
- Engineering knowledge: forward or backward chaining of knowledge,
- Micro and macro planning strategy,
- Optimisation of manufacturing operation: one or multi-criterion optimisation.

3. CLASSIFICATION METHOD BASED ON SELECTION OF PROPERTIES

Besides the basic methods based on grouping was elaborated several approached focused on methods extending the possibility of group technology. Research team (from university of Zilina) is oriented especially on elaborating of methods of the following topics:

- parametrisatrion of process plan,
- relations between parametrised manufacturing operations and parametrised design features,
- intelligent analysis of retrieved process plan,
- dynamic grouping and dynamic classification,
- method of selective classification /Fig. 1./ of engineering parts.

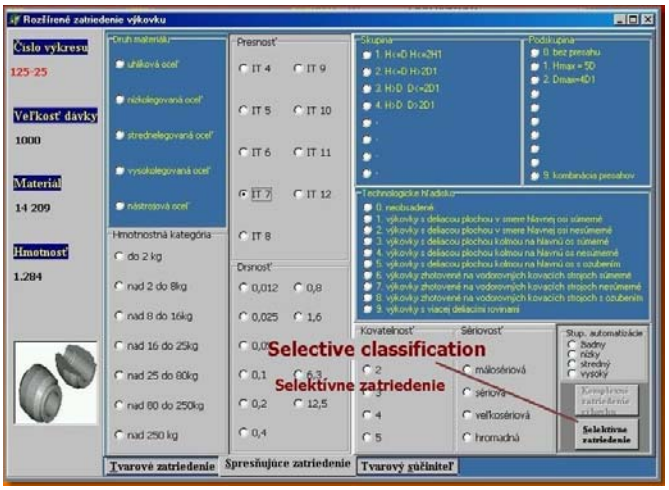

Figure 1. Developed selective classification according important part properties

Utilising Group Technology principle in CAPP system is very popular and effective method. Planner executes the process plan in the two steps – firstly he must select representative part for a new part. Secondly the planner must modify the retrieved process plan. New part has to be identifiable to one of created group of classification systems.

There are 2 possibilities of new part classification:

- it is single valued and identifiable with some group - properties of new part and properties of parts from group are very similar and there is no inconsistency. Retrieved process plan from group is afterward modifies. Modification of process plan is realised according the difference of properties of new part and representative part.
- New part is NOT single valued and identifiable with some group – that means properties of new part are too different from properties of GT representatives. Either new part could be new GT representative for alternatively new group or it is considerable to state level of similarity and to continue in looking for the most similar properties.

The problem of the second task /new part is not identifiable to some group/ consists of the following questions:

- Mathematical statement, identification and determination of similarity. Some product properties are more easily determined /material properties, roughness, tolerance, etc./ and other properties are more complicate determined /e.g. geometry/.
- Determination of level of similarity – level of property similarity influences the level of modification of retrieved process plan.
- Statement of significance of similarity level - it is important to consider with specific and definite of similarity level. If the properties (new part and GT representative) are too different, it has no meaning to retrieve and modify the process plan.

This problem was elaborated on SQL methods. The developed selective classification according important part properties /Fig. 1./ was utilised in CAPP system for rapid cost valuation and in CAPP

for non-cutting technologies. The elaborated method gives an intelligent support for process planner. The statement of level similarity takes planner according his experience and knowledge.

4. ELABORATED CAPP METHODS FOR NON-CUTTING TECHNOLOGIES

CAPP systems based on the GT are very good elaborated especially for cutting technologies. The non-cutting 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 basic idea of the GT is possible to utilise for non-cutting technologies however by other way. 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.

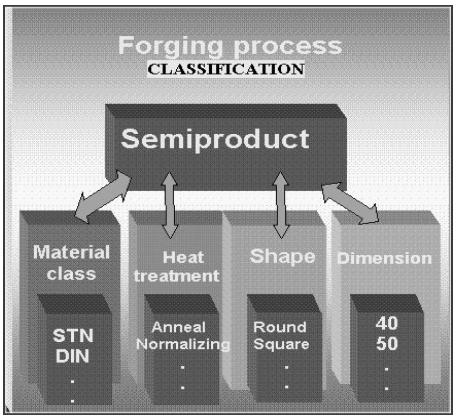

Figure 2. Classification of semiproduct

The modification and calculation of technological parameters are the most important in area of GT utilisation in non-cutting technologies. The other important process planning activity is determination semiproduct. There is also elaborated the classification methods of semiproducts with respect database of corresponding technological parameters /Fig. 2/. It is possible to state, that automatic semiproduct design is complicated problem, which requires more detail analyse. There are partial differences between machining technologies and non-cutting technologies. Fom example in forging process, the same part can be produced from many different sizes of starting billets, allowing for a wider variety of inventoried grades. That means that analysis of starting material dimensions and weight is very needful.

5. ELABORATED SELF-TEACHING CAPP MODULE

The major activities of process planning are based on logic and knowledge. The process planner makes decisions during various steps of planning. The planner often applies heuristic solving methods, knowledge, experience and intuition. Many years of practice and knowledge of researched area are often of the most importance in the decision process.

One of the developing modern approaches is the implementation of human learning capabilities in CAPP systems. The developed method /Fig. 3./ give to CAPP systems teaching capabilities.

The designed process planning system uses two approaches for planning - generative and variant. The basic approach is generative. The developed generative-variant hybrid system is based on feature modelling. For describing the part a GT code is applied. Individual process operations are generated for each feature of the part. Selection and determination of process operations is realised on basis of logical and heuristic approach. The variant approach of CAPP system is used in the module of process operation selection. For concrete GT code is recommended process operation from manufacturing knowledge base. The process planner according to his experience can select some process operation from his knowledge base. The selected process operation with the corresponding GT code is subsequently stored in knowledge base. In this manner the CAPP system has teaching capability.

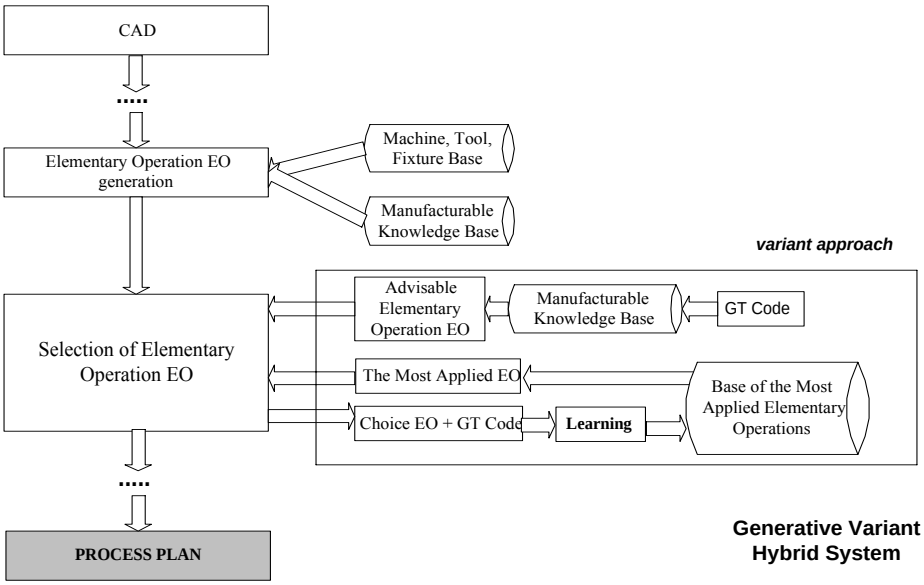

Figure 3. Section of developed self-teaching CAPP system

6. CONSLUSION

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. Besides conventional methods of CAPP there are attempts to apply other advanced methods to increasing the effects and performance process planning.

The above mentioned topics and developed methods are especially 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.

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