INTEFRATION OF CAPP WITH OTHER CA SYSTEMS

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Abstract: *The paper deals with possibility of integration between CAPP /Computer Aided Process Planning/ and other CA systems in engineering enterprises. It is mentioned dynamic process planning, non-linear process planning and integration CAPP and PPS system based on feedback from PPS system.*
Keywords: *CAPP, process planning*

1. INTRODUCTION

Economic pressures urge manufacturers to make more customised products of high quality, in smaller series, with shorter lead time and of course, without increased costs. Time, production costs and flexibility are becoming rapidly the most strategic topic of companies. Engineering activities realised before manufacturing are very important in term of influencing of mentioned aspects. The engineering drawing and the process planning such as the main engineering activities are critical production cost factors.

Process planning is a result of engineering planning activities of process planners which prepare a list of processes needed to convert a raw material shape as a starting point into a predetermined final shape. The process planning systems are therefore important tools for increasing of efficiency and profit.

The process planning activities are significant means for flexibility, time to market and competitive advantage of enterprise.

2. COMPUTER AIDED PROCESS PLANNING (CAPP)

Process planning as important engineering activity very effects important factors – production cost, flexibility, quality and time to market. These factors impact on competitive advantage as a very important tool of market success. Computer support can markedly help to solve some planning activities. Computer aided process planning (CAPP) is a tool for the automated design of route sheet. The CAPP represents the implemented methodology of process planning in the software package.

3. INTEGRATION OF CAPP WITH OTHER CA SYSTEMS

3.1 Integration of process planning and scheduling

As process planning is one of engineering activities, it is necessary to integrate CAPP system with other activities and corresponding CA systems. Integration between CAD and CAPP

systems is task solved by many universities and scientific units. This integration is resolved to satisfaction. However there is many problem with this task. Geometry recognition as recognition of CAD data and their interpretation belongs to the most complicated tasks in CAD/CAPP integration.
CAD data are often saved in ancient file formats as a DXF, DWG, SAT, SET file. These files enable to save only geometrical data. The needful non-geometrical information (roughness, tolerances, etc.) have to be transfered by the other way.
Integration of CAD and CAPP systems are solved especially by the following ways:

- Standard graphical and geometrical formats (DXF, DWG, SAT, SET). The CA systems support these files however for complex integration they are unfit,
- OLE method (Object Linking and Embedding) known from operating system MS Window
- OLE for Design&Modeling Applications – extension of OLE method suggested by Intergraphem and accepted by DMAC (Design&Modelling Applications Counci) enables to solve integration in CAD/CAM/CAE systems easier way,
- API interface – many application support API interface as tool for integration of CA systems,
- STEP protocol and corresponding Application protocols – protocol is standardised by ISO 10303. It is enabled to integrate all activities and corresponding CA systems during life cycle of product.

The link of CAD systems with CAPP systems has not fully been established. This is partly due to the difference between the features used in the CAD system and those used in the process planning system. There is hardly any CAPP system which can give feedback information on manufacturability issues to the designer.
The product data exchange is most often performed on a low level of detail. In the case of IGES and DXF, the exchange can only be performed on 2D level, the level of technical drawings. When the exchange is performed on the level of solids, the exchange takes place on the level of faces, edges and vertices (in the case of B-rep) or on the level of primitives, their transformations and boolean set operations (in the case of CSG). Product model data exchange is hardly performed on the higher level of features. Presently, the emerging STEP standard (Standard for the Exchange of Product data), aims at the product data exchange on higher levels of abstraction, i.e. the feature level, component level and assembly level.
The cooperative design, one of the key elements in Concurrent engineering, is hardly supported by current CAD systems.

3.2 Integration of process planning and scheduling

Process planning and scheduling have a close link. The process plan involves the time order of manufacturing operations and information of workplace of process operation realisation. The process plan is one of the significant input to the scheduling system. There are several research projects concerned with the problem of a new approach in industrial application. One of industrial problem is to originate a functional link between process planning and scheduling.
The loading situation in a workshop is significantly determined by the selection of resources performed by process planning. Traditionally process planning only considers technological criteria and no logistical goals. To improve collaboration between process planning and scheduling, it is needful to have a close relation between parameters of process plan and the current situation in workshop.
Following are three different approaches for the integration of process planning and workshop scheduling:

- dynamic process planning,
- Just-in-Time process planning,
- Non-linear process planning.

Dynamic Process Planning

The manufacturing of product is not realised according to forward planned process operations. The process operation sequence considering this approach is not known for the whole process at the beginning of part producing. This approach does not determine the complete operation sequence and the corresponding resource allocation at the same time.

After each of finished operation the actual workshop situation is recognised and the best next operation and suitable resource is determined to continue manufacturing of this piece. Some higher level planning has to be carried out to ensure that this process planning approach does not frequently generate dead ends. Dynamic process planning aims and supports full integration and concurrence between process planning and scheduling activities.

Dynamic process planning provides flexibility for the process plan according the current state of the workshop. The approach avoids all unnecessary planning effort on unused alternatives. Disadvantages are that only local sub-optima can be achieved because only a very limited time horizon is considered at the time of decision making.

Just-in-Time Process Planning

Just-In-Time is well known and an effective and popular method for product planning and control. *Just-In-Time process planning* is started just before the first manufacturing step. It is a very good alternative for re-using previous process plans or creating process plans weeks before manufacturing. The new planning approach takes the actual workshop situation into account for decision making about the resources used for manufacturing a part.

This process planning approach is realised in the CAPP system PART, developed at the University of Twente in the Netherlands. The PART system is a commercial software system that is distributed by CONTROL DATA. The other commercial DTM-CAPP system, distributed by Somatech, contains similar planning features.

Advantages of this approach are that a well balanced workshop load can be achieved and it is not required to plan alternative routes in detail that are not used later. The result of this process planning is a conventional linear process plan that can easily be exchanged with existing MRP or workshop control systems.

Disadvantages of this approach are that a process planning session is started for a complex part with many operations, the actual workload is hardly predictable. If the load with is a mix of complex parts and simpler parts, it is not possible to achieve a planning optimum. Also the re-use of process planning information from previous manufacturing is not possible as the individual part may be manufactured each time in a different way.

Non-linear Process Planning

A basis for the new approach is linear process planning which also includes manufacturing alternatives or possible changes in manufacturing sequence. Several alternative routings or sequences of operations are combined in a net structure. Netted process plans are called *non-linear process plans*. The required initial process planning effort is high. The non-linear process plan gives full flexibility to optimally load resources and also to re-allocate jobs in case of unforeseen disturbances.

Non linear process planning approach is used in the FLEXPLAN and COMPLAN software system.

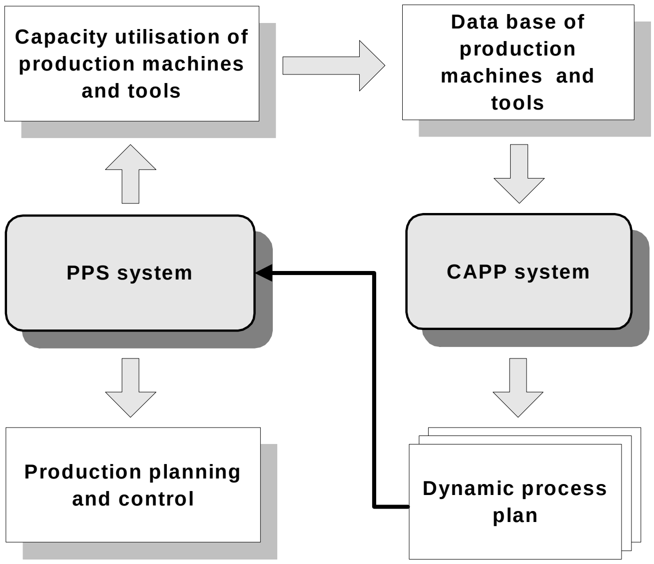

Fig.1 Principle of dynamic process planning

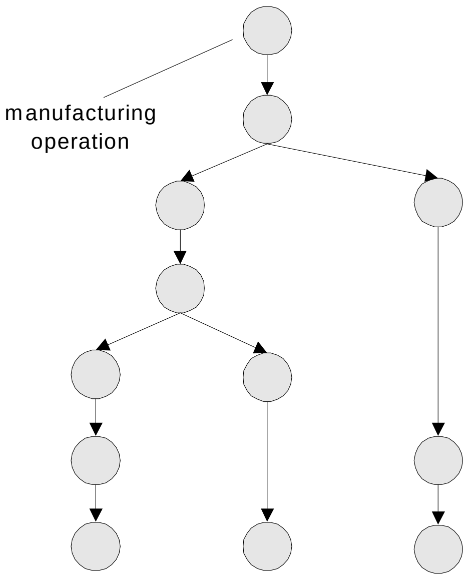

Fig.2 Non-linear process plan

4. CONCLUSION

Process planning research is an extremely varied subject area. Currently there are some well developed applications. New process planning research will be placed in the concurrent engineering context and will be closely linked with the developments in engineering design and production control.

The computer aided process planning is not a simple matter. A single algorithm cannot model the complexity of the thinking process of an experienced human planner.

Development in the CAPP is possible share to the following areas:

- *information technology methods*, e.g. neural network, fuzzy sets, object oriented approach, genetic programming, etc.,

- *methodology of CAPP*, e.g. expert planning methodology, parametrizing of process plan, Theory of Group Technology, etc.

The article was made under support of Grant Agency VEGA – project Nr.1/0046/03 "Elaboration of parametrisation and associativy methods for automated process planning based on group technology – contribution to the flexible preparatory stage of production"

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