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Integration of the CAD/CAPP/PPC systems

C. Grabowik, K. Kalinowski and Z. Monica

[a]Department of Engineering Processes Automation and Integrated Manufacturing Systems, Silesian University of Technology, Konarskiego 18a, 44-100 Gliwice, PL, email: Cezary.Grabowik@polsl.pl, Krzysztof.Kalinowski@polsl.pl, Zbigniew.Monica@polsl.pl

Abstract: This paper describes a methodology of integration CAD/CAPP/PPC systems. In this methodology the availability of alternative process planning plays the main role. The main advantage of the accessibility of alternative process planning of a product is the fast reacting on a disturbance in the course of the manufacturing process using the reactions knowledgebase – one of modules of the proposed PPC system.

Keywords: CAD; CAPP; Process planning; Multivariant processes; Scheduling

1. INTRODUCTION

Nowadays the development of computer integrated manufacturing systems focuses on integration of all activities in a domain of technical and technological process preparation. The aim of this integration is improving of data and information flows in the enterprise. One of the most critical action in this domain is data exchange between the CAD system and computer aiding planning system (i.g. CAPP/PPC systems). It comes from the fact that 80% of manufacturing costs are generated in the technical production preparation stage, especially in the product design stage. The most of CAD/CAM systems are not able to ensure bidirectional communication between them. In most cases the integration between CAD and CAM systems is realize by means of transformation of a CAD model (representation depending on specified implementation of a 3D model in a CAD system) in the model that is represent as a collection of relations and features (construction representation for planning systems needs). The systems that completely automate all the activities in technological process preparation usually are working fully separated from product CAD model. On the other hand CAPP systems have been developed in the direction of symbolic representation utilization (as input to CAPP system the symbolic representation is given). In the CAPP systems the construction is often represented with the help of [1, 5]:

- object techniques – product model is represented as the collection of objects that represent the particular construction features and set of relation that act on them,
- features,
- frames etc.

2. INTEGRATION OF CAD/CAPP/PPC SYSTEMS

The characteristic of the most enterprises is that they usually have a weak connection between the information systems and the CAD/CAPP/PPC systems. The computer adding planning systems (CAPP/PPC) the most often work in a batch manner (they play a postprocessor role).

It means that all the activities connected with design of technological process and schedule plan preparation are made only when the process of product design is finished. This sequence of design and planning actions is in accordance with traditional sequential model of actions in the design-manufacturing chain (see fig.1).

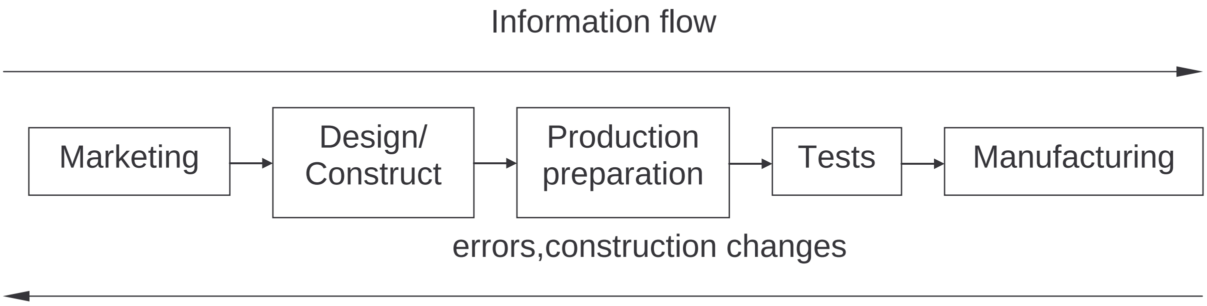

Figure 1. The diagram of a sequential manufacturing process

2.1. Integration of CAD/CAPP systems by means of the features method

A number of operations and machine cuts in a technological process for a product are strictly depended on accessibility of a technological machine, experience of a process engineer in a technological process preparation domain etc. Therefore the particular technological processes elaborated for the same product could differ in process structure. There are two methods in standardisation of a technological process plan for the same product in the enterprise [1, 2, 3]:

- the first method bases on constriction-technological similarity. The searching module is looking for the most similar product from a database, next in the editing module the process plan for the most similar product is adopted in order to meet specification of a new product;
- the second method bases on utilisation of constructional and technological features.

The integration method of design and of technological process preparation basis on analysis and segmentation of product model in a component parts. These component parts are next segmented in elementary constructional surfaces. They are the base components for a process of constructional features preparation. In our work we adopt the following definitions of constructional and technological features [3]:

The constructional feature is the collection of constructional forms and relations that could be established between surroundings and him.

The constructional feature contains the two information i.g. geometrical form and characteristic point of insertation.

The technological feature is the collection that consists of the initial and the final state of the technological form and actions that transforms it from one to other.

The technological feature contains following information: geometrical form, a process plan for the geometrical form, allowances, cutting tools, technological parameters etc. In order to implementation of this method the following actions are necessary:

- decomposition of product construction and discrimination of machined surfaces,
- synthesis of a new product.

In the decomposition and discrimination stages an analysis of the products construction and their technological process is made.
After decomposition of construction an analysis of technological processes (discrimination of machined surfaces) for the constructional features is made. Base on the construction decomposition and technology analysis processes the open tree structure of the constructional and the technological features is made.
There is a possibility for development of this tree structure with the help of adding new constructional and technological features. The process of tree development the most often is making due to lack of the proper constructional feature for product modelling process and technological feature for technological process preparation.

2.2. Technological process preparation

In the proposed method the product model is described as a set of constructional features (elementary constructional feature, constructional form etc.) that are interlinked themselves. The definition of a technological feature results that technological object could be understand as a sum of constructional feature and its manufacturing technology. In the most papers from the domain of integration of technical and organisational actions, especially about integration of CAD/CAM systems we don't know from whom the technological process is derived [1, 2]. In our integrated environment the technological objects that are represent the particular parts of technological process are made with the help of CAPP system. This CAPP system is realised as knowledgebase system. The technological process design starts from transferring product model from a CAD system (*SolidDesigner*) in the CAPP system by means of the dedicated transfer protocol. The product model is given as a set of constructional features in the CAPP system.

The rules of the technological process design are strictly depended on the kind of the family product (bodies, shafts, sleeve etc.) therefore is very difficult to elaborate the CAPP system that will be able to aid technological process preparation for all families of products. Our system aids technological process preparation for the bodies family. There aren't any limitations from CAD system side (the database of constructional features maybe develop without limits), therefore in the CAD system we are able to design any complex products. Possibility of CAPP system will be increase with the help of knowledgebase modification. In this case the proposed system will be able to aid technological process preparation for shafts etc.

3. THE PRODUCTION SCHEDULING AND RESCHEDULING WITH THE MULTI-VARIANT TECHNOLOGICAL PROCESSES CONSIDERATION

In real manufacturing numerous disturbances appear and make difficult or impossible to perform planned assumptions. Therefore, the real production often differs from planed and the first-prepared schedule has to be corrected. Process of adapting an existing schedule to a new situation is called "rescheduling". The scheduling/rescheduling uses data both from organisational (dates, terms, quantities – acquiring from PPC systems) and technical (technological processes – from CAPP systems) production planning. One of the characteristic futures of CAPP systems is that the result of technological process planning can contains no single, but set of alternative routes (variants) of technological process. The current production conditions and accepted schedule evaluation criterions should decide which variant of process from this set has to be executed. If necessary, it also enables to change realised variant in the production realisation stage. The proposed method represents a predictive-reactive and event-driven approach to rescheduling.

3.1. The method of production rescheduling

The actions taken at production flow planning (predictive scheduling) and production flow control (reactive scheduling) stages are distinguished in the method. In the first step of production flow planning, for each machining procedure particular machine is assigned. If possible to execute a machining procedure on more than one machine then additional variants of technological process realisation are created. Next, the values of characteristic features for each processes realisation variant are determined. Above data make possible to create the set of feasible schedules (according to different routes of processes in current production conditions). The multicriterial evaluation method is used for selection the best schedule [6] that is introduced for realisation.

The introduced schedule is executed until a disturbance appears in the production system. The first action after an event (a disturbance) appearing is the identification of its parameters. After that the set of rescheduling algorithms is selected from all available rescheduling algorithms (knowledge base). As the result of using reschedule algorithms the set of possible schedules is generated. Next, the best schedule is selected from this set. In rescheduling can also be used criteria that take into consideration value changing of some schedule parameters in a new schedule.

4. CONCLUSIONS

The knowledge about alternative processes routes, prepared on planning stage, expands flexibility of production control systems and enables increasing efficiency of the production rescheduling for given set of evaluation criterions. The method enables modifying schedules in presence of more than one disturbance simultaneously but they have to be sequenced. In this case the process of obtaining solutions is not more complicated. Each disturbance is threats individually and cause rescheduling actions. The need for modification occurs when some event in production system makes impossible to execute a current production schedule. Besides, according to the method the rescheduling can be introduced every time when needed – it means that the event definition could be extended: overflow of tolerance of some important production indicators (e.g. efficiency) also can be understood as a disturbance.

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