B CAPP EVOLUTION, DIVERSIFICATION, AND CLASSIFICATION

This appendix covers the following topics matter:

- CAPP Classification (Figure B.1),
- Process Planner's Ways of Thinking,
- CAPP Systems and Users' Perspectives
- CAPP Systems Difficulties and Benefits, and
- Statistical Perspectives on CAPP Systems

B.1 CAPP Classification

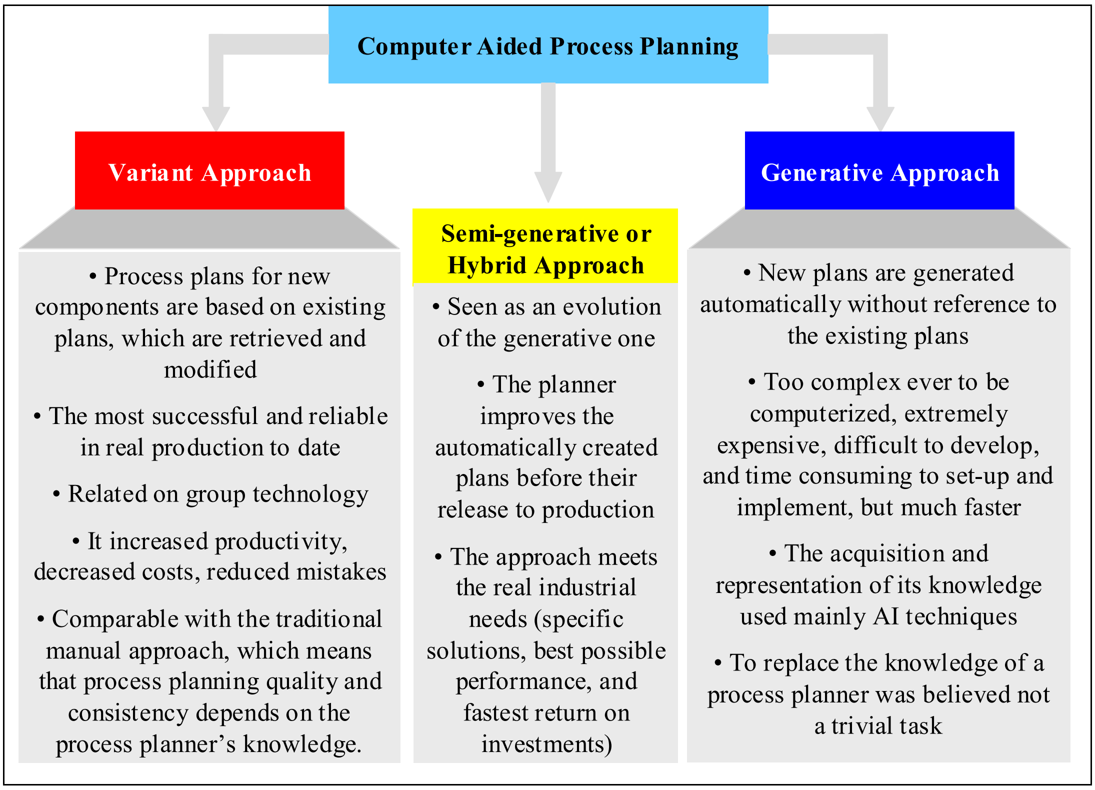

Figure B.1 CAPP classification: The source of the process plans was the key method of CAPP systems classification (Alting and Chang 1989, Zhang 1994, Hugh 1994, Cay and Chassapis 1997, and Rozenfeld and Kerry 1999)

B.2 Process Planner's Ways of Thinking

Process planner's ways of thinking includes the following steps:

- Identify essential documentation such as Internal Works Order (IWO), Material Data Sheet, internal quotation, and any other pertinent documentation.
- Interpret engineering drawing: understand part functions and specifications; determine if its requirements are reasonable and manufacturable.
- Determine the stock by assuring its quality, and minimum machining to reduce the manufacturing costs and lead-time.
- Select manufacturing processes and the equipment to use based on their availability and capacity (size, accuracy, economy, and production rate), and company's production strategy.
- Determine machining datums by understanding and considering the combined influence upon the accuracy of the final product of drawing datums and surfaces used for orientation and fixturing during manufacturing.
- Determine operation sequence based on a company specific strategy for a defined group of parts, shapes, and dimensions.
- Determine fixturing, only if necessary, used to hold the components while they are being machined.
- Select cutting tools and inspection equipment, and finally,
- Release the completed engineering pack documentation to the work shop.

B.3 CAPP Systems and Users' Perspectives

It has been observed that the users of CAPP systems were discouraged by and not willing to use systems that require much time and effort to prepare and enter the required data, are cumbersome to use, use black boxes that they do not understand, and are not consistent with their gained experience (ElMaraghy 1993, Hugh 1994). At the same time, they preferred CAPP systems that are flexible, adapted to their company's products, procedures and practices, and included assistance tools that focused more on synthesis, rather than analysis (Tables B.1).

Table B.1 Systems characteristics and users' perspectives (ElMaraghy 1993)

System	Description
Modular	Be modular in order to incorporate some of the new trends such as generic, rapid, distributed and/or reactive planning
Transparent	Be transparent in order to facilitate the understanding of its structure, behaviour and outcome by its users
Extensible and Adaptable	Be extendable and adaptable to new applications and facilitate the inclusion of new data bases and knowledge, as well being customisable
Knowledgeable	Provide effective knowledge acquisition, representation and manipulation mechanisms as well as means to check the completeness and consistency of that knowledge
Human	Keep the human in the loop, to participate in decision making, provide heuristics as needed and supplement the system's ability
User Interface	Provide an excellent user interface to support effective interaction by facilitating inputs, producing outputs and reports in flexible formats and display the results graphically
Integrated	Be effectively integrated with both design and production planning and control
Easy	Easy to install and use, and fast

B.4 CAPP Systems Difficulties and Benefits

The difficulties of CAPP systems were mainly considered to be the design features extraction, where CAD systems did not considered requirements for automated process planning and contained insufficient or hidden data (Zhang, 1994), and the fact that the designer was not always aware of the production constraints and company's limited resources.

Also, CAPP introduction was considered to bring benefits, which combined could improve not only the productivity, consistency, clarity, accuracy, and quality of the process planning activity itself, but also improve various related activities such as a direct link to engineering release systems, product data management (PDM), or enterprise resource planning (ERP) systems (Zhang, 1994).

Therefore, CAPP, with its greatest significance in small-batch discrete parts manufacturing (Maropoulos 1995, Feng and Zhang 1998), has extended to domain other than metal removal (ElMaraghy, 1993) such as electronics, furniture manufacturing, and chemical processes (Zhang, 1994a), rapid prototyping (Joneja et al., 2000), tactile computer coordinate measuring machine (CMM) (ElMaraghy, 1993), flexible manufacturing systems (FMS) (Lo and Lin, 1999, Shukla and Chen, 1997), surface micromachining for MEMS (Micro-Electro Mechanical Systems) (Cho et al., 2002), computer numerical control (CNC) pumped-concrete placement (Kunigahalli et al., 1998), and environmentally conscious machining (Srinivasan and Sheng, 1997).

B.5 Statistical Perspectives on CAPP Systems

Statistical data about CAPP systems was rare and sometimes misleading. Although it was predicted that 80% of US manufacturing companies would apply CAPP systems by the end of the 1980s, in fact, no more than 10% of them had applied CAPP by the mid-1990s and seldom with success (Alting and Zhang 1989, ElMaraghy 1993, Zhang et al. 1999). As a result, it was indicated that CAPP traditional approaches were not a way to create a total CAPP system (Kryssanov et al. 1998) and no longer met the requirements of modern manufacturing (Feng and Zhang, 1998).

Therefore, over the years, the scope of process planning was constantly changed due to: the new demands in product development practice (CIRP conference, 2002); relevant considered information (Brissaud and Maropoulos, 2002); level of detail (Eversheim, 2002); where and when the human interfered in the process

(Dépincé, 2002); the need to increase its efficiency and flexibility (Tönshoff and Woelk, 2002); and due to the need to wider the scope of application, enhance the links with other activities, and better interact with and support the human planner (Brissaud, 2002).

Furthermore, because existing systems have required mainframe computers which were too expensive and complicated for shop floor use and too expensive for small and medium companies (Marri et al., 1998), it has been suggested to develop the functionalities of the various company levels by applying object-oriented programming techniques (Zhang 1994), define suitable data structures and interfaces with other systems, and achieve the right balance between manual user interaction and automation of tasks (Maropoulos, 1995) (Figure B.2).

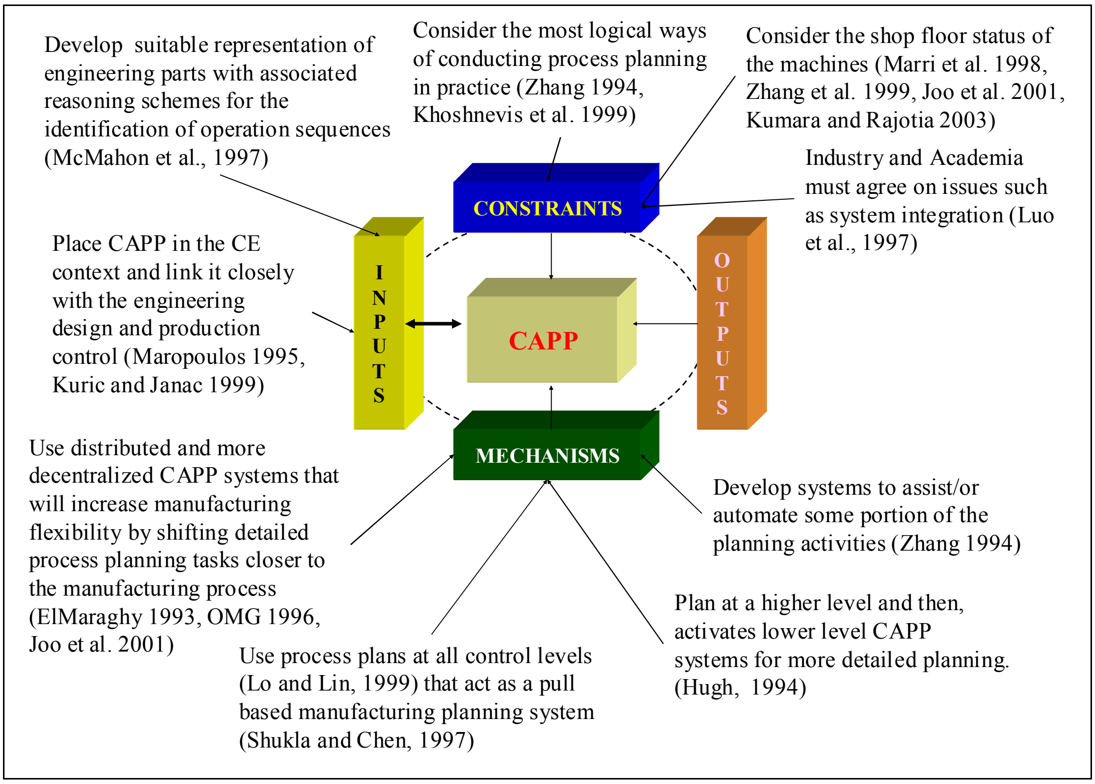

Figure B.2 Suggestions for future CAPP systems