CAPP

Computer Aided Process Planning
Manufacturing Planning

• Production planning
  – scheduling
• Process planning
  – manufacturing process selection & sequencing
• Operation planning
  – operation parameters
Process Planning

• responsible for the conversion of design data to work instruction
• the process of determining the methods and the sequence of producing a workpiece to a finished part or component
• concerned with the selection of suitable processes and tools
Process planning functions

- Interpretation of product design data.
- Selection of machining processes.
- Selection of machine tools.
- Determination of fixtures and datum surfaces.
- Sequencing the operations.
- Selection of inspection devices.
- Determination of production tolerances.
- Determination of the proper cutting conditions.
- Calculation of the overall times.
- Generating of process sheets including NC data.
Process Planning - output

- operation's instructions
- tooling requirements
- routing
Process planners

• create and modify the process plans
• create and maintain information on manufacturing capabilities
Flow of Manufacturing Information

- Create and Maintain Process Plans
- Documents & Standards
- Process Plan
- Plan File
- MANUFACTURE
- Tooling
- Drawing
- Machine
- Time
- Process
- Quality Control
- Tool List
- Route Card
- Material Control
- planners' functions
- capabilities
CAPP - approaches

- Variant approach
- Generative approach
Variant CAPP systems

- Similar parts will have similar process plans
- Using computer to identify similar plans, retrieve plans and edit the plans to suit the requirements for specific parts
Variant CAPP systems

• In order to adopt a process planning system based on the variant approach, it is necessary to do the following preparations:
  – GT classification and coding
  – GT part family formation
  – Standard plan preparation
Variant CAPP - disadvantages

- Difficult to construct a good standard plan
- Difficult to maintain consistency in editing practices
- Not able to adequately accommodate various combinations of geometry, size, precision, material, quality, and shop loading
- Extensive keyboard activity required to enter and modify plans
- Lack of transportability of the system
- Significant online database requirements to accommodate stored plans and all their modifications
Variant CAPP - conditions

- The product design is fairly stable
- Lot size is medium to high
- Parts within a family are of similar size
- Material type is the same for all members of the family
- Few engineering changes are normally made
Generative CAPP

- does not depend upon standard plans
- able to construct an optimum fabrication sequence of its own accord through a series of more refined and sophisticated decision algorithms which operate with much greater detail than those of a variant system
Generative CAPP

- A generative process planning system is a system which automatically generates a process plan for a new component
- Knowledge of manufacturing is required for generative process planning
- Possible to construct an optimum operation sequence
- Allows the rapid and consistent generation of revised plan when new processes, equipment, methods, and tooling are introduced into the system
Generative CAPP system

• 3 main components:
  – Part representation
  – Process decision making and algorithms
  – Manufacturing databases
Generative CAPP - part representation

• Existing drawing and CAD model representation are not suitable
  – Geometric model - low level geometric entities with design intent only

• Feature Technology
  – Feature model - higher level entities with engineering intent
Feature technology

• Automatic feature recognition

• Feature-based design
Decision making in CAPP

• Decision making logic for process selection and sequencing
• including process selection, machine selection, tool selection, etc.
Decision logic in automated CAPP

- Decision tree
- Decision table
- AI techniques
  - knowledge-based systems
  - case-based reasoning
Decision tree

C1  C2  C3

Conditions  Actions

Y  Y  Y  A
Y  N  B
Y  C
N  N  D
Y  E
Y  N  F
Y  N  G
N  N  H
## Decision table

<table>
<thead>
<tr>
<th>Conditions C1</th>
<th>Y Y Y Y N N N N N</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td>Y Y N N Y Y N N N</td>
</tr>
<tr>
<td>C3</td>
<td>Y N Y N Y N Y N N</td>
</tr>
<tr>
<td>Actions</td>
<td>A B C D E F G H</td>
</tr>
</tbody>
</table>
## Decision table - example

<table>
<thead>
<tr>
<th>Conditions</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
<th>R9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is raw material casting?</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2. Is raw material forging?</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>3. Is raw material black bar?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>4. Is raw material bright bar?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>5. Is batch size greater than 50?</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>6. Is outside diameter greater than 50.0mm?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Actions</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
<th>R7</th>
<th>R8</th>
<th>R9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Allocate to saw</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Allocate to lathe</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Allocate to machining centre</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IF-THEM rules

IF

feature is a hole
diameter <= 50 mm
surface finish (roughness (µm)) 0.8 - 1.6

THEN

machining operations: drilling, rough reaming, finish reaming
Direction of planning

• Forward planning
• Backward planning
Manufacturing Databases

- CAD data
- feature library
- process capabilities
- machine tool library
- cutting tool library
- machinability database
- fixture library; etc.
Generative CAPP - advantages

- It generates consistent process plans rapidly
- New components can be planned as easily as existing components
- It has potential for integrating with an automated manufacturing facility to provide detailed control information.
Generative CAPP - implementation

- The logic of process planning must be identified and captured
- The part to be produced must be clearly and precisely defined in a computer-compatible format
- The captured logic of process planning and the part description data must be incorporated into a unified manufacturing database