Unit-4

Introduction to Computer Aided Process Planning

Computer Integrated Manufacturing (CIM)

- **Computer Aided Design (CAD)**
  - 2D
  - 3D
  - Concurrent Engineering
- **Computer Aided Process Planning (CAPP)**
  - Variant
  - Generative
- **Computer Aided Manufacturing (CAM)**
  - CNC
  - Robotics
  - Material Handling
  - Just in Time (JIT)
  - Group Technology
  - Flexible Manufacturing Systems

What is process planning?

- Recipe/Algorithm/Step-by-step instructions
- Fast Food Chain
- Same taste everywhere from NY to New Delhi
- How do they do it?
- Customization in formal dinner restaurant

Manufacturing Environment

- Role of the master machinist in small batch manufacturing
- Manufacturing is more complex than cooking yet the planning for it is similar
- Job shop: group machines which perform same operation together
- Routing of parts through the various departments
- Process plan defines the route
- Reduction in the necessary skill of operator can be achieved by using a detailed process plan

Formal Definition

"Process planning can be defined as an act of preparing processing documentation for the manufacturing of a piece, part or an assembly"

- depending on the production environment can be
  - Rough
  - Detailed
- When process planning is done using a computer : "Computer Aided Process Planning"

- Manufacturing a part to meet design specs.
  - Selection of initial block
  - Sequence of operations
  - Selection of machine, process
    - Surface finish
    - Quality
    - Tolerance
    - Hardness
    - Life
    - Cost

A Rough Process Plan

Route Sheet	by: T.C. Chang
Part No. S1243 Part Name: Mounting Bracket	
workstation	Time(min)
1. Mtl Rm	
2. Mill02	5
3. Drl01	4
4. Insp	1

Figure 1.1 A rough process plan

A Detailed Process Plan

PROCESS PLAN ACE Inc.

Part No. S0125-F
Part Name: Housing
Original: S.D. Smart Date: 1/1/89
Checked: C.S. Good Date: 2/1/89

Material: steel 4340Si
Changes: _____ Date: _____
Approved: T.C. Chang Date: 2/14/89

No.	Operation Description	Workstation	Setup	Tool	Time (Min)
10	Mill bottom surface1	MILL01	see attach#1 for illustration	Face mill 6 teeth/4" dia	3 setup 5 machining
20	Mill top surface	MILL01	see attach#1	Face mill 6 teeth/4" dia	2 setup 6 machining
30	Drill 4 holes	DRL02	set on surface1	twist drill 1/2" dia 2" long	2 setup 3 machining

Components of Process Planning

- Selection of machining operations
- Sequencing of machining operations
- Selection of cutting tools
- Determining the setup requirements
- Calculation of cutting parameters
- Tool path planning and generation of NC/CNC programs
- Design of Jigs/Fixtures

Process Planning in different environments

- In tool-room type manufacturing
  - "make part as per drawing" is sufficient
- In metal-forming type operations
  - The process planning requirements are embedded directly into the die.
  - Process planning is fairly trivial
- Job-shop type manufacturing requires most detailed process planning
  - Design of tools, jigs, fixtures and manufacturing sequence are dictated directly by the process plan.

Requirements for process planner

- Must be able to analyze and understand part requirements
- Have extensive knowledge of machine tools, cutting tools and their capabilities
- Understand the interactions between the part, manufacturing, quality and cost

Traditional process planning

- Experienced based and performed manually
- Variability in planner's judgment and experience can lead to differences in the of what constitutes best quality
- Problem facing modern industry is the current lack of skilled labor force to produce machined parts as was done in the past
- Hence Computer Integrated Manufacturing and Computer Aided Process Planning

Advantages of CAPP

- Reduces the demand on the skilled planner
- Reduces the process planning time
- Reduces both process planning and manufacturing cost
- Creates consistent plans
- It produces accurate plans
- It increases productivity

Approaches to CAPP

- Variant
- Generative
- Automatic

Variant Process Planning

"based on the valid conjecture that similar parts will have similar process plans"

Preparatory stage

- GT-based part coding
  - Families of similar parts are created
  - Family matrix
- A process plan is to manufacture the entire family is created

Variant Process Planning

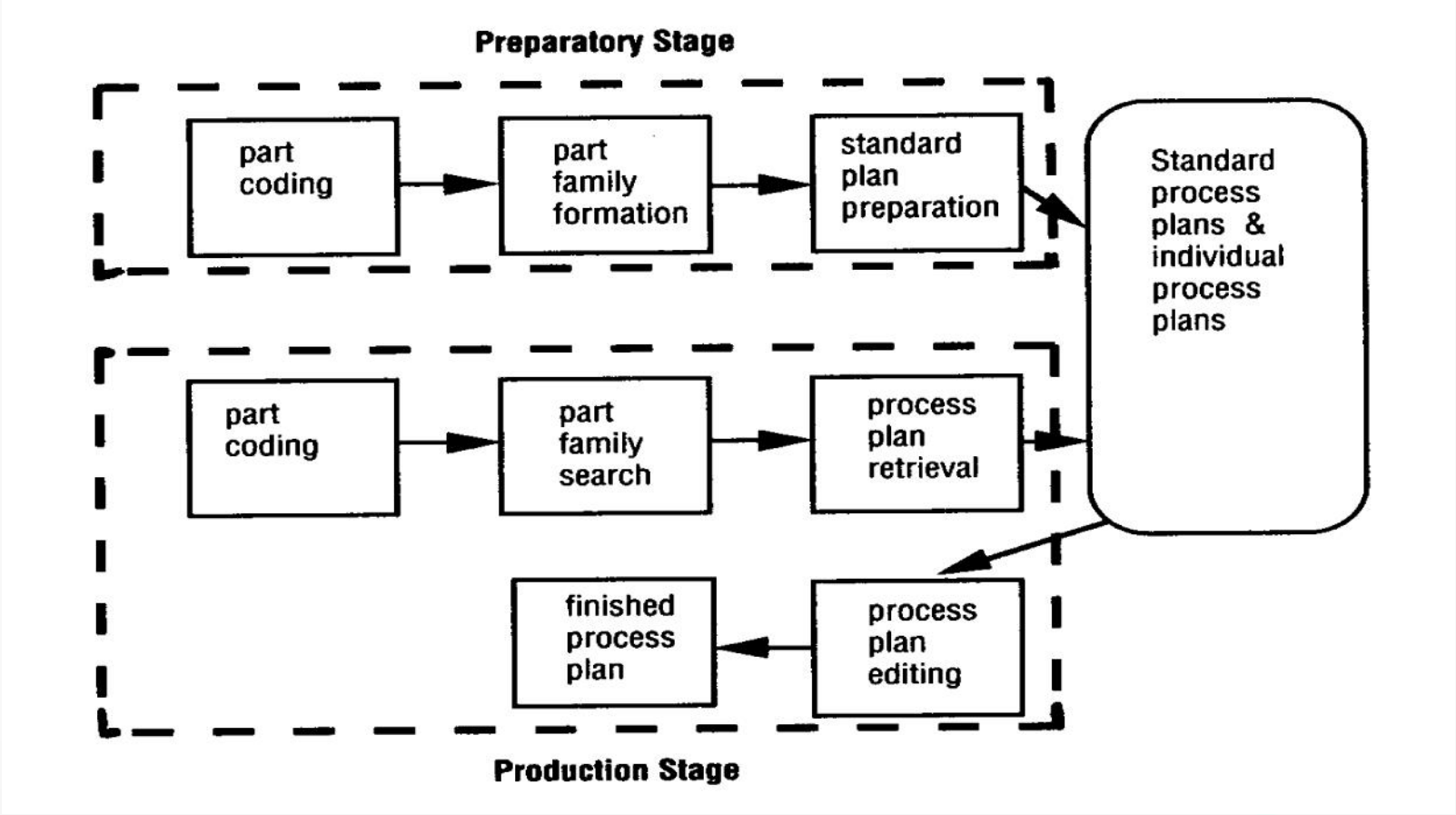
Production Stage

- Incoming part is coded
- Part family is identified
- Process plan is edited to account for the different needs of the part

Salient points of variant process planning

- Easy to build, learn and use
- Experienced process planners are still required to edit the process plan
- Cannot be used in an entirely automated manufacturing system without additional process planning

Variant Process Planning



Generative Process Planning

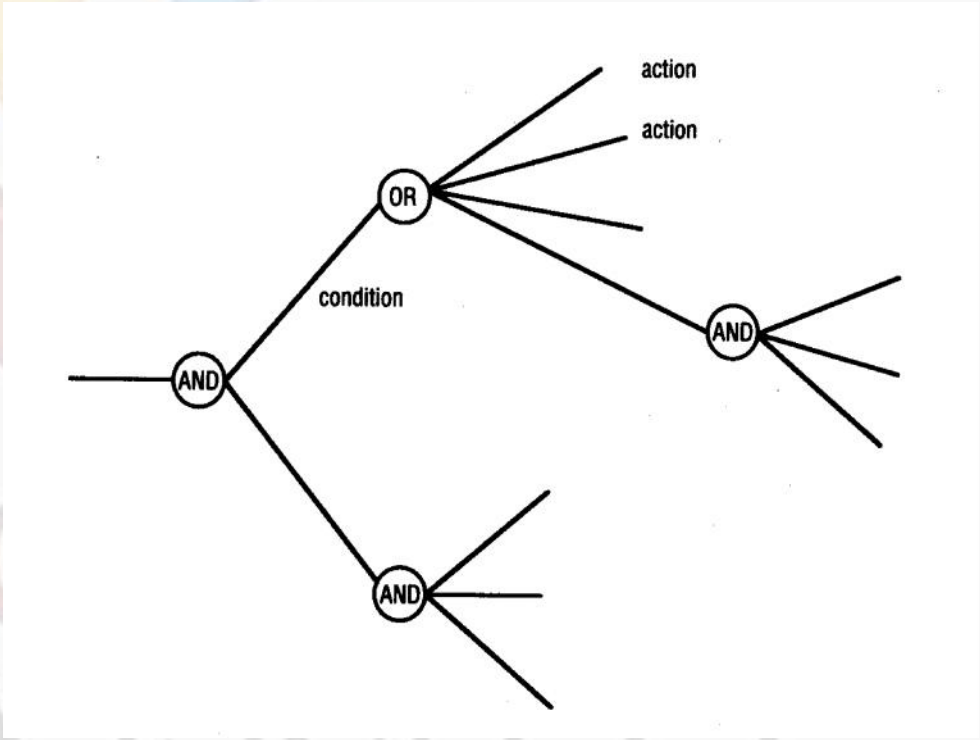
"a system which automatically synthesizes a process plan for a new component"

Requires

- Part description
  - Part to be produced must be clearly and precisely defined in a computer compatible format (OPITZ,AUTAP)
- Manufacturing databases
  - Logic of manufacturing must be identified and captured
  - The captured logic must be incorporated in a unified manufacturing database

Generative Process Planning

- Decision making logic and algorithms
  - Decision trees
  - Expert Systems:
  - AI based approaches



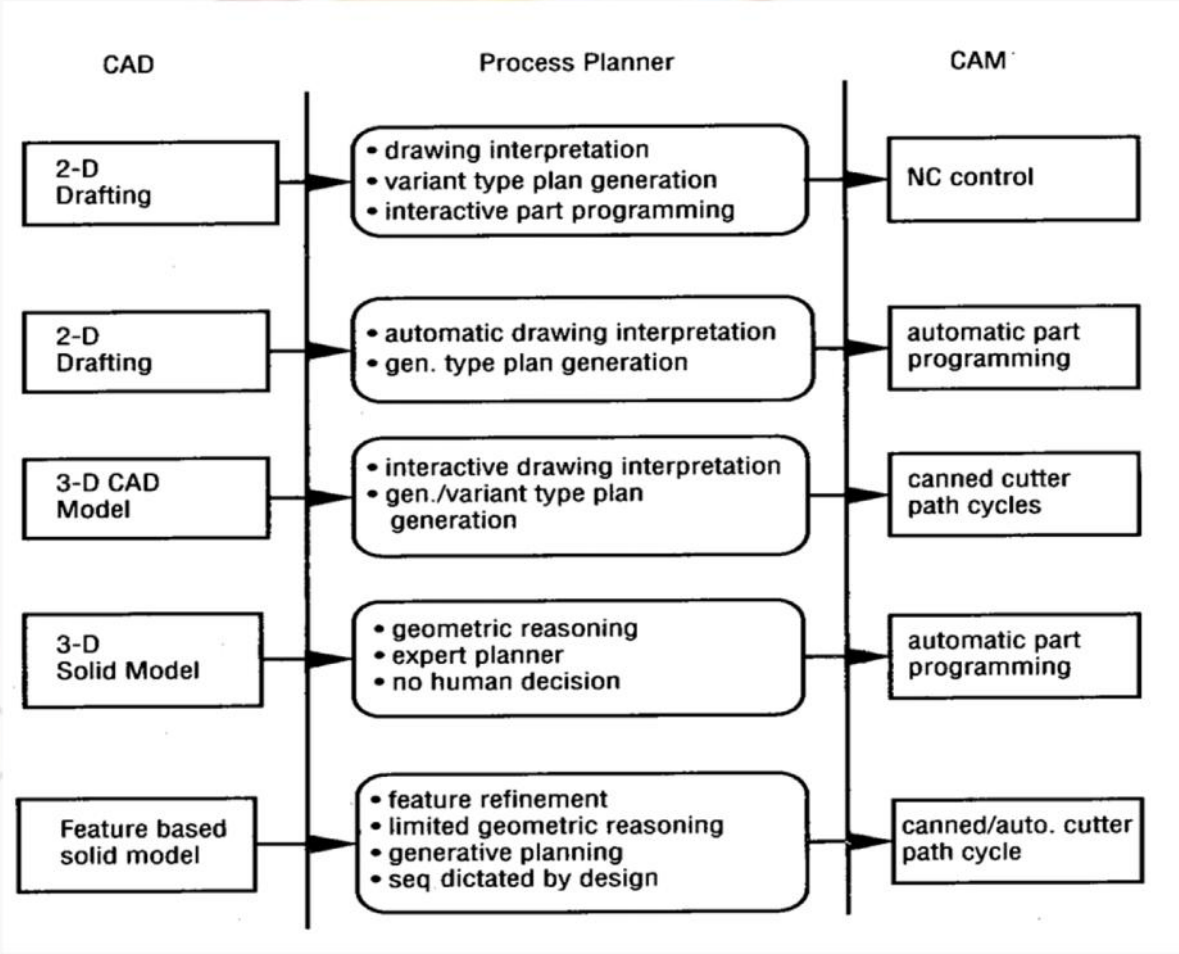
Automatic Process Planning

" generate a complete process plan directly from a CAD drawing"

Requires:

- Automated CAD interface
  - Take a general CAD model (3D for unambiguous data) and develop an interface to develop a manufacturing interface for this model : Feature Recognition of CAD
  - Design the parts with available manufacturing features : Feature based CAD
  - Dual: useful features of both approaches
- Intelligent (computer based) process planner

Some process planning approaches



SUMMARY

- CAPP is a highly effective technology for discrete manufacturers with a significant number of products and process steps.
- Rapid strides are being made to develop generative planning capabilities and incorporate CAPP into a computer-integrated manufacturing architecture.

SUMMARY

- The first step is the implementation of GT and coding.
- Commercially-available software tools currently exist to support both GT and CAPP.

SUMMARY

- As a result, many companies can achieve the benefits of GT and CAPP with minimal cost and risk.
- Effective use of these tools can improve a manufacturer's competitive advantage.

References

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Expert Process Planning For Manufacturing

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- Publisher: Addison-Wesley Publishing Company