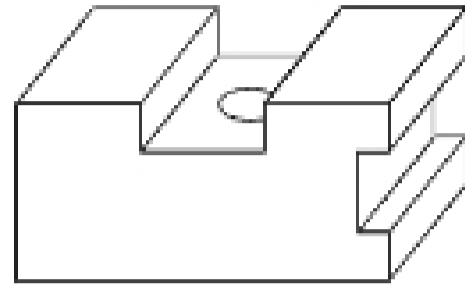


# PROCESS PLANNING



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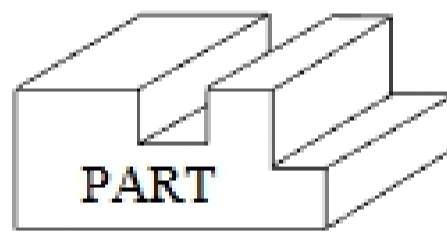
## What is Process Planning?

Methods and tools for getting

from

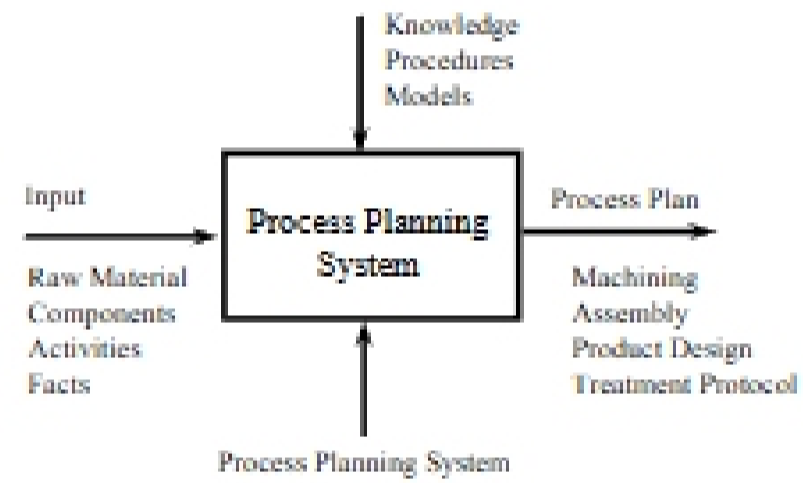


to



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## Process Planning: Overview



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## Machining Process

Process plan determines:

- Sequence of operations
- Resource required
  - machines
  - tools
  - fixtures



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## Process Plan

EXAMPLE

Operation No.	Machine No.	Tool No.	Fixture No.	Feature Removed	Original Representation
1	MC-1	$t_1$	$f_1$	$v_1$	
2	MC-1	$t_1$	$f_1$	$v_2$	
3	MC-1	$t_1$	$f_2$	$v_{2a}$	
4	MC-1	$t_2$	$f_2$	$v_3$	
5	MC-1	$t_1$	$f_1$	$v_4$	



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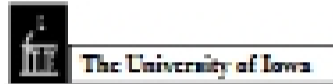
?

**Question:**

Is process planning domain dependent?

**Answer:**

Yes, the domain knowledge depend on the process domain, e.g., machining, assembly, semiconductor process, etc.



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**Basic approaches to automated process planning:**

- Variant approach (GT based)
- Generative approach



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**Phases of Generative Process Planning**

Phase Number	Phase Name	Solution Approach
1	Interpretation of part design data	KB
2	Recommendation of mfg. processes	KB
3	Recommendation of machines, tools, and fixtures	KB
4	Process optimization	OPT/KB
5	Decomposition of manufacturing features	KB
6	Selection of manufacturing features	OPT/KB
7	Generation of precedence constraints	KB
8	Sequencing manufacturing features	OPT/KB

KB: knowledge-based approach

OPT/KB: optimization and knowledge-based approach



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**Features**

1. **Form feature:** a geometric feature of interest to the designer, such as a slot, hole, and so on.
2. **Basic form feature:** refers to the basic geometric feature of a part, usually of the same as the raw material.
3. **Subfeature:** a form feature defined for a basic feature, such as slot, hole, and so on.
4. **Machining feature:** a volume of material to be removed to produce a form feature.



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**Features  
(continued)**

5. **Basic machining feature:** a volume of material to be removed from the raw material to obtain a basic form feature.
6. **Elementary machining feature:** a volume of material obtained by decomposing the basic machining feature, or a volume of material that corresponds to a particular subfeature that is not decomposable.
7. **Machining feature:** consists of one or more elementary machining features that are removable in a single tool pass.



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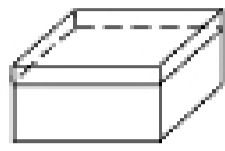
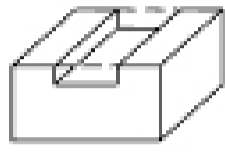
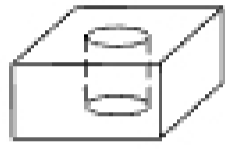
**Discussion of Process Planning Phases**

**1. INTERPRETATION OF PART DESIGN DATA**



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### Sample Form Features and the Corresponding Machining Features

Geometry	Form feature	Machining feature
	Plane	Block
	Slot	Block
	Hole	Cylinder

### Methods of Features Representation and Recognition

- Syntactic pattern recognition
- State transition diagrams
- Decomposition approach
- Knowledge-based approach
- Constructive solid approach
- Graph based approach

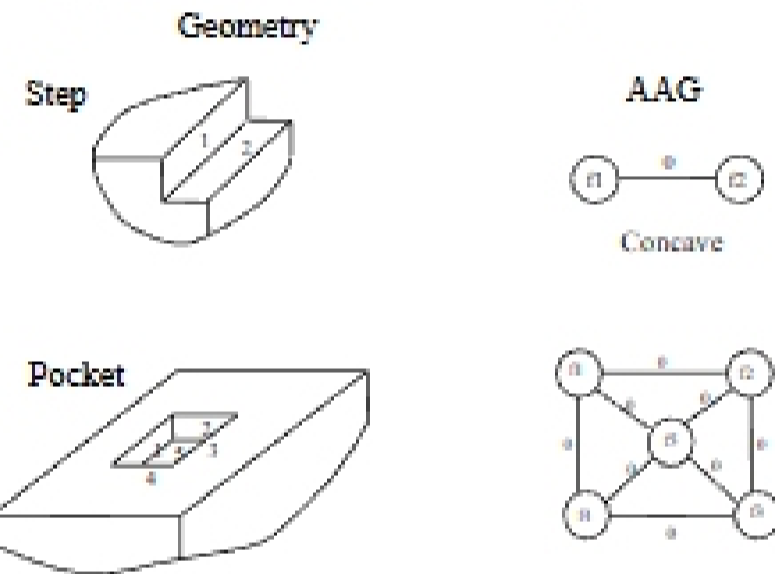
### Knowledge-Based Feature Recognition

#### Rule 1

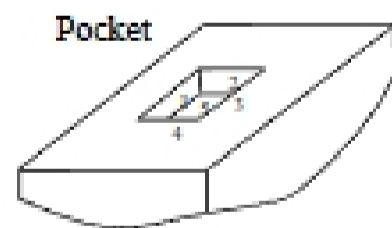
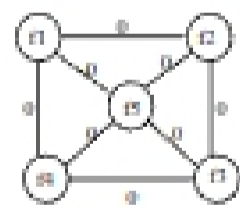
IF a hole entrance face exists  
 AND the face adjacent to the entrance is cylindrical  
 AND the next adjacent face is a plane adjacent to the cylinder  
 THEN the feature is a simple blind hole

Form feature

### Graph Based Feature Recognition



### Example: Rule for the recognition of a pocket



#### Rule 2

IF the graph is cyclic  
 AND it has exactly one node with the number of incident arcs equal to the total number of nodes - 1  
 AND each other node is incident to exactly 3 arcs  
 THEN the corresponding feature is a POCKET

### Example: Manufacturing features jointly with dimensions and tolerances

