

IE-352
Manufacturing Processes (2)
Summer – 2013

Lecture 7: Manual Process Planning

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Industrial Engineering Department

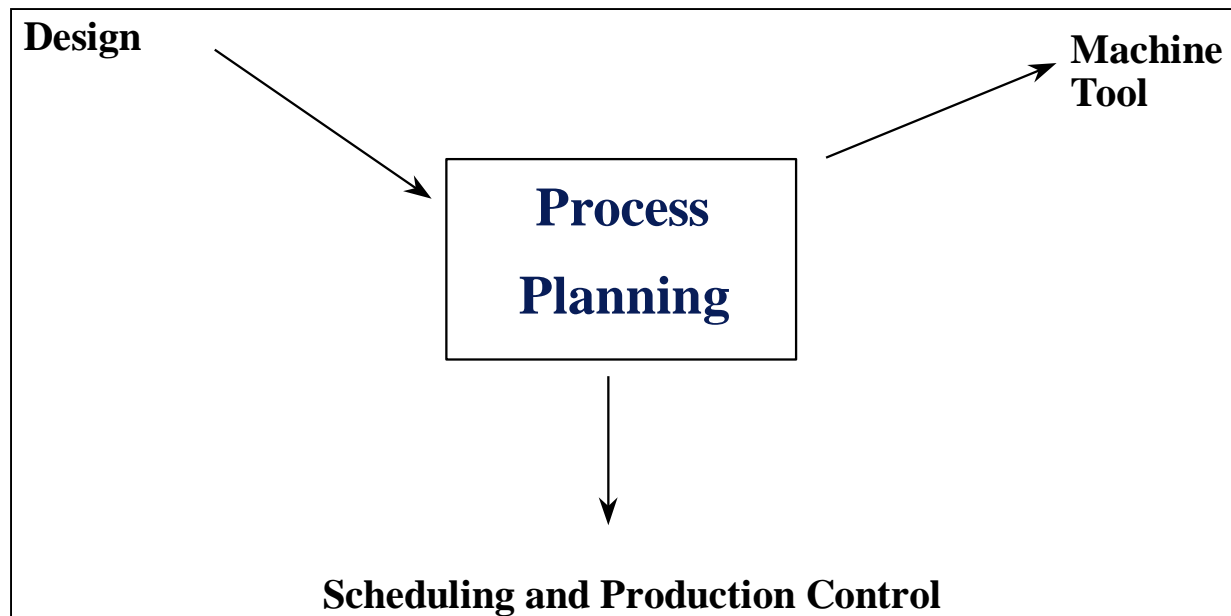
King Saud University

Process Planning

Process planning is also called: manufacturing planning, material processing, process engineering, and machine routing.

Process Planning: is the function within the manufacturing facility that establishes which processes and parameters are to be used to convert a part from its initial form to a final form predetermined in an engineering drawing.

It is the act of preparing detailed work instructions to produce a part.



The person who develops the process plan for producing a workpiece is often called the process planner.

The functions included in process planning are:

- Raw material preparation
- Processes selection
- Process sequencing
- Machining parameter selection
- Tool path planning
- Machine selection
- Fixture selection

Factors affecting process plan selection

- Shape
- Tolerance
- Surface finish
- Size
- Material type
- Quantity
- Value of the product
- Urgency
- Manufacturing system itself
- etc.

There are two approaches to carry out the task of process planning:

- 1- Manual Process Planning
- 2- Computer Aided Process Planning (CAPP)

Manual Process Planning

In order to prepare a process plan, a process planner has to have the following knowledge:

1. Ability to interpret an engineering drawing.
2. Familiarity with manufacturing processes and practice.
3. Familiarity with tooling and fixtures.
4. Know what resources are available in the shop.
5. Know how to use reference books, such as machinability data handbooks.
6. Ability to do computations on machining time and cost.
7. Familiarity with the raw materials.

To prepare a process plan, the following are some steps that have to be taken:

1. Study the overall shape of the part, to identify features and all critical dimensions.
2. Thoroughly study the drawing. Try to identify all manufacturing features and notes.
3. Determine the best raw material shape to use if raw stock is not given.
4. Identify datum surfaces. Use information on datum surfaces to determine the setups.
5. Select machines for each setup.
6. Determine the rough sequence of operations necessary to create all the features for each setup.
7. Sequence the operations determined in the previous step. Check whether there is any interference or dependency between operations. Use this information to modify the sequence of operations.
8. Select tools for each operation. Try to use the same tool for several operations if possible. Keep in mind the trade-off on tool-change time and estimated machining time.
9. Select or design fixtures for each setup.
10. Evaluate the plan generated and make necessary modifications.
11. Select cutting parameters for each operation.

PROCESS PLAN

- Also called : operation sheet, route sheet, operation planning summary, or another similar name.
- The detailed plan contains:
 1. Route
 2. Processes
 3. Process parameters
 4. Machine and tool selections
 5. Fixtures
- The level of details in the plan depends on the application.
- *Operation*: a process.
- *Operation Plan* (Op-plan): contains the description of an operation, including tools, machines to be used, process parameters, machining time, etc.
- *Op-plan sequence*: Summary of a process plan.

Example process plans

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

Detailed plan

PROCESS PLAN					ACE Inc.
Part No. <u>S0125-F</u>			Material: <u>steel 4340Si</u>		
Part Name: <u>Housing</u>					
Original: <u>S.D. Smart</u> Date: <u>1/1/89</u>			Changes: _____ Date: _____		
Checked: <u>C.S. Good</u> Date: <u>2/1/89</u>			Approved: <u>T.C. Chang</u> Date: <u>2/14/89</u>		
No.	Operation Description	Workstation	Setup	Tool	Time (Min)
10	Mill bottom surface 1	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 surface 1	twist drill 1/2" dia 2" long	2 setup 3 machining

Rough plan

Part Features Identification and Processes Selection

A wide variety of manufacturing processes are used to produce a workpiece.

These processes can be classified as:

- Casting processes
- Forming and shaping processes
- Machining processes
- Joining processes
- Finishing processes

The machining processes include:

- Drilling (drilling, counterboring, countersinking, deep-hole drilling, etc.)
- Boring
- Tapping
- Milling (face milling, end milling)
- Turning (facing, straight turning, taper turning, parting, etc.)
- Threading.

Many features must be considered in selecting machining processes. They include:

1. Part features.
2. Required dimensional and geometric accuracy and tolerance.
3. Required surface finish.
4. Available resources, including NC machines and cutting tools.
5. Cost.

Part features

A part feature is the distinctive geometric form or shape to be produced from raw material; thus it determines process type, tool types (shapes and size), machine requirements (3-, 4-, or 5-axis), and tool path.

There are two types of part features:

1. **Basic features:** are those simple forms or shapes that may require only one machining operation. They include holes, slots, pockets, shoulders, profiles, and angles.
2. **Compound features:** are those that consist of two or more basic part features. For example, the combined result of two holes with different diameters.

EXAMPLE: MACHINING PROCESSES SELECTION

Select the machining processes for the part shown in the figure given in the next slide. Assume that the required dimensional accuracy and surface roughness are within the process capability of drilling and milling operations. The four sides of the raw material have been premachined to the required dimensions.

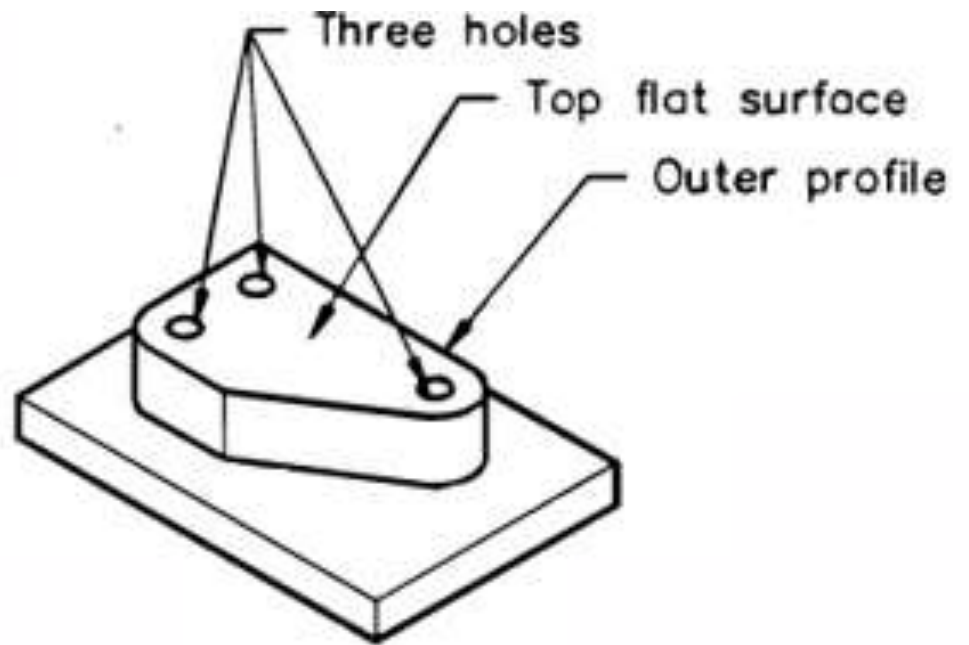
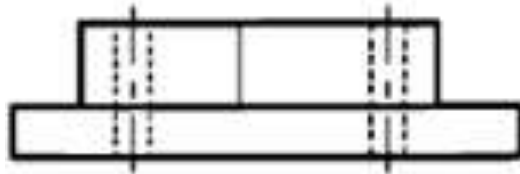
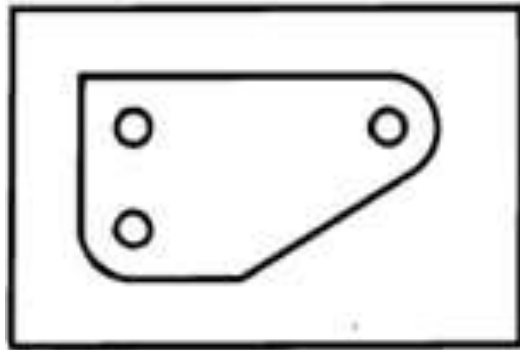
Solution

Three part features can be identified from the part drawing:

- Top flat surface
- Outer profile
- Three holes

The recommended machining processes for these features are

- Face-milling the top surface
- Rough-milling the outer profile
- Finish-milling the outer profile
- Center-drilling the three holes
- Drilling the three holes



PROCESSES SEQUENCING

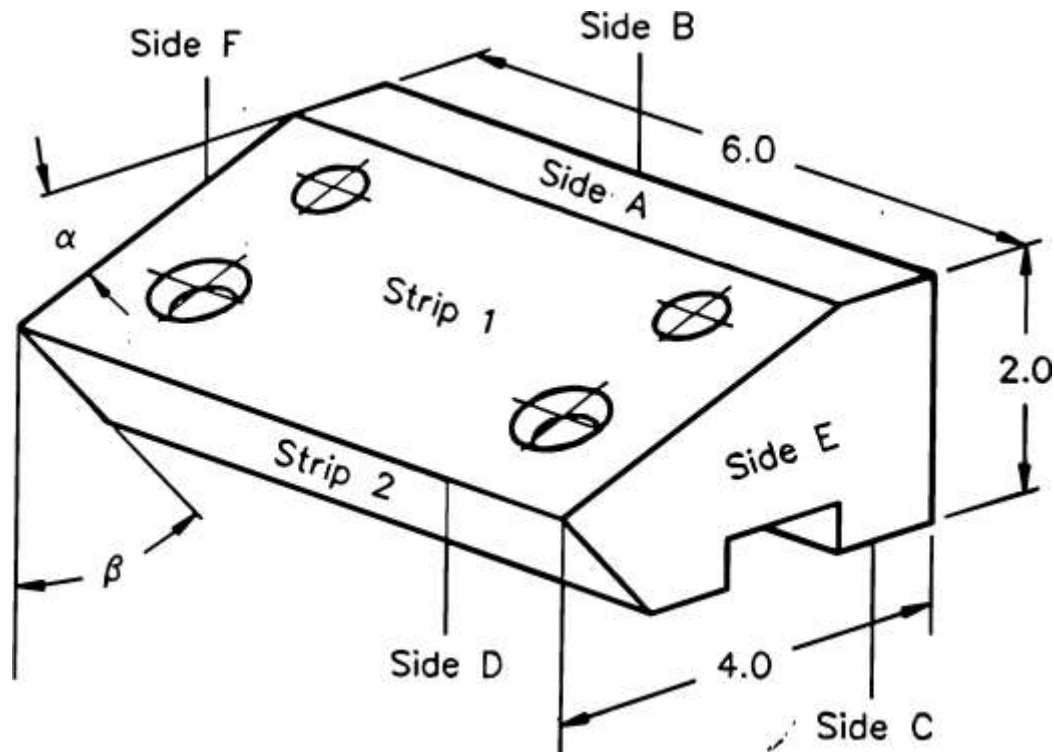
The sequence of operations is determined by the following three considerations:

- 1. Datum surfaces should be machined first if multiple workholding setups are required.** If possible, datum surfaces should be premachined in a manually operated machine to facilitate work-piece locating and clamping. In those cases where two or more holding setups are required, rough datum surfaces are preprocessed in a manually operated machine and then used as setup references to produce finished datum surfaces for the final workholding. This ensures the accuracy of the finished part.
- 2. Surfaces with larger area have precedence.** Larger surfaces tend to be more adaptable to disturbances resulting from machining operations.
- 3. Feature interference should be avoided.** Feature interference occurs when the machining of one feature destroys a requirement for the production of other features. This happens when there is interaction or dependency between machining operations.

EXAMPLE:

PROCESSES SEQUENCING

The figure below shows a workpiece in which some features are interrelated. The workpiece has five basic features: a through slot in side C, two angle strips, and two through holes on strip 1 that are perpendicular to side A. The compound features are two tapped holes perpendicular to strip 1. Develop the process sequence for producing the part.



Solution

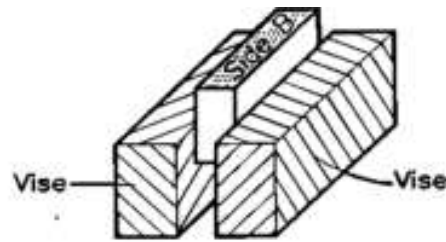
The raw material is cut from a block stock with dimensions 6.25 x 4.25 x 2.25 in.

Studying the part features reveals that the two through holes on strip 1 interact with the formation of angle α and the slot in side C interacts with the cutting of angle β . Machining angle strip 1 first will cause difficulty in drilling the two holes, so the two holes must be produced before angle strip 1. Likewise, making angle strip 2 first will cause difficulty in setting up the workpiece to produce the through slot, so the slot has to be machined before angle strip 2 is made.

The recommended processes sequence is described below:

1. Setup A for machining side B .
2. Setup B for machining sides A and E as well as drilling two holes on Side A .
3. Setup C for machining sides C and F as well as cutting the slot in side C .
4. Setup D for cutting angle strip 1, drilling two tap holes, and tapping the two holes.
5. Setup E for cutting angle strip 2.

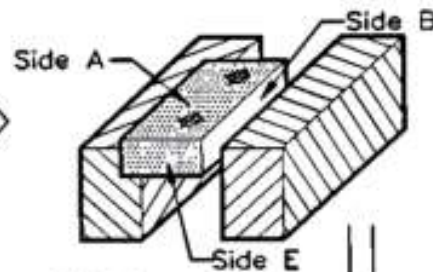
Setup A



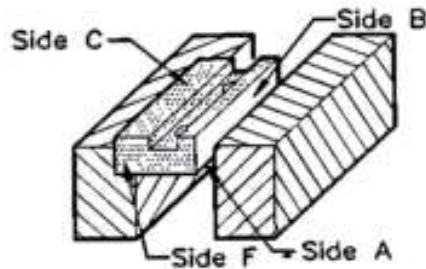
- Face side B

Setup B

- Face side A
- End mill side E
- Drill two holes



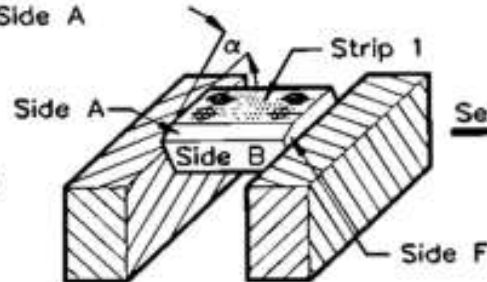
Setup C



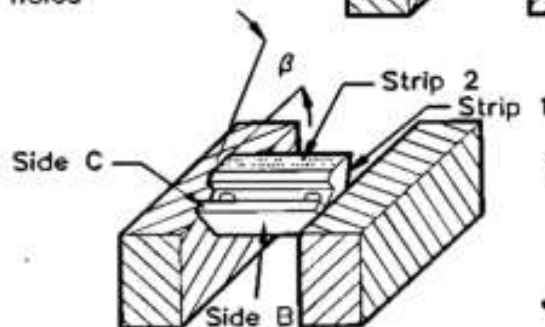
- Face side C
- End mill side F
- End mill the slot

Setup D

- Face angle strip 1
- Drill two tap holes
- Tap two holes



Setup E



- Face angle strip 2