

MME 345
Foundry Engineering

July 2018 Term



MME 345
Lecture A:01

Introduction

1. Materials processing technology

Ref: M.F. Ashby, Materials Selection and Alloy Design, Elsevier, 2011
Ch 13: Process and Process Selection

Topics to discuss today

1. Introduction
2. Classification of process
3. Selection of process

1. Introduction

- Process is a method of shaping, joining, or finishing material.
 - sand casting, injection molding, fusion welding, and electro-polishing are all processes;
 - there are hundreds of them.
- The **choice of a process**, for a given component depends on the **design requirements** i.e.
 - the material of which it is to be made;
 - its size, shape, and required precision; and
 - how many are to be made

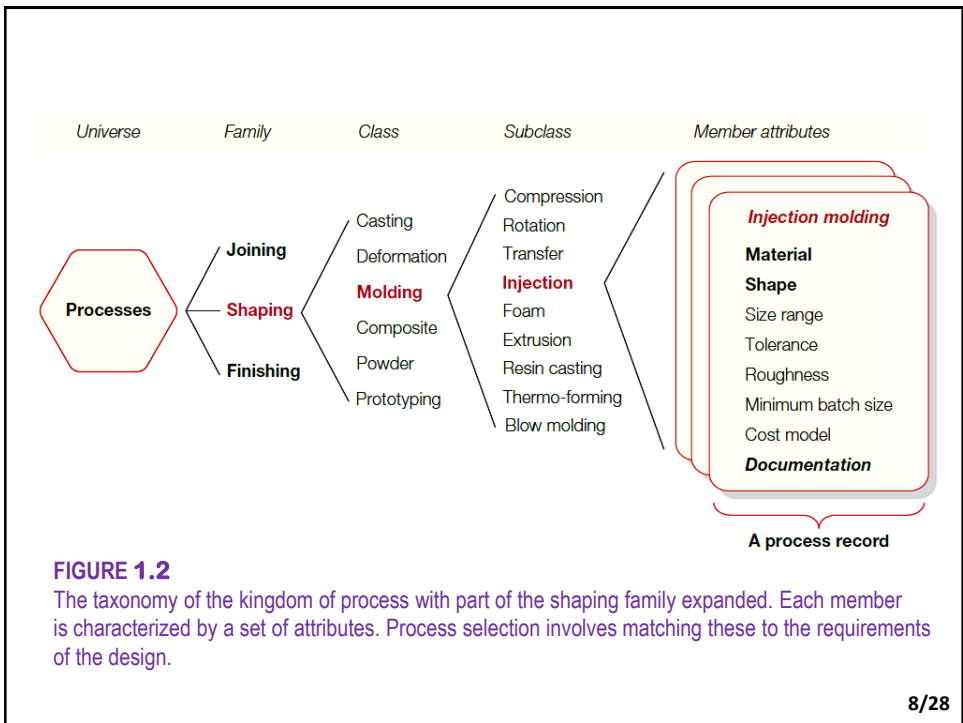
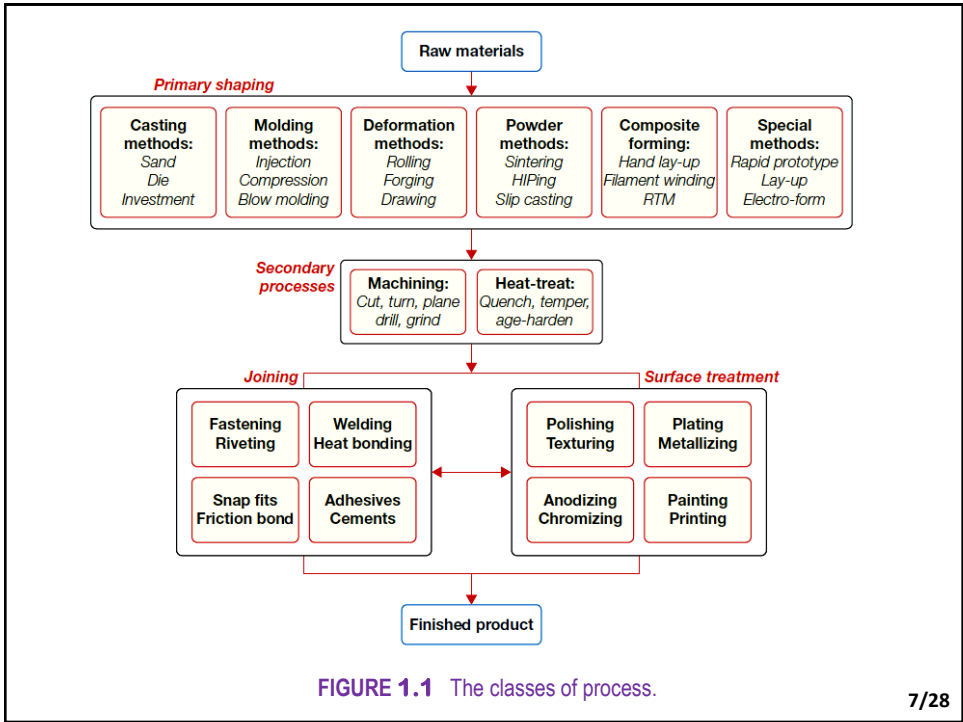
- Processing has **dual functions**:
 - ① The obvious one is that of shaping, joining, and finishing.
 - ② The less obvious one is that of property control.
 - metals are strengthened by rolling and forging
 - steels are heat-treated to enhance hardness and toughness
 - polymers are drawn to increase modulus and strength
 - ceramics are hot-pressed, again to increase strength

5/28

2. Classification of process

- **Primary shaping processes** - create shapes
 - casting
 - moulding
 - deformation process
 - powder methods
 - methods for forming composites
 - special methods (e.g., rapid prototyping)
- **Secondary processes** - modify shapes or properties
 - machining (which adds features to an already shaped body)
 - heat treatment (which enhances surface or bulk properties)
- Below these come **joining** and **surface treatment** or **finishing**

6/28



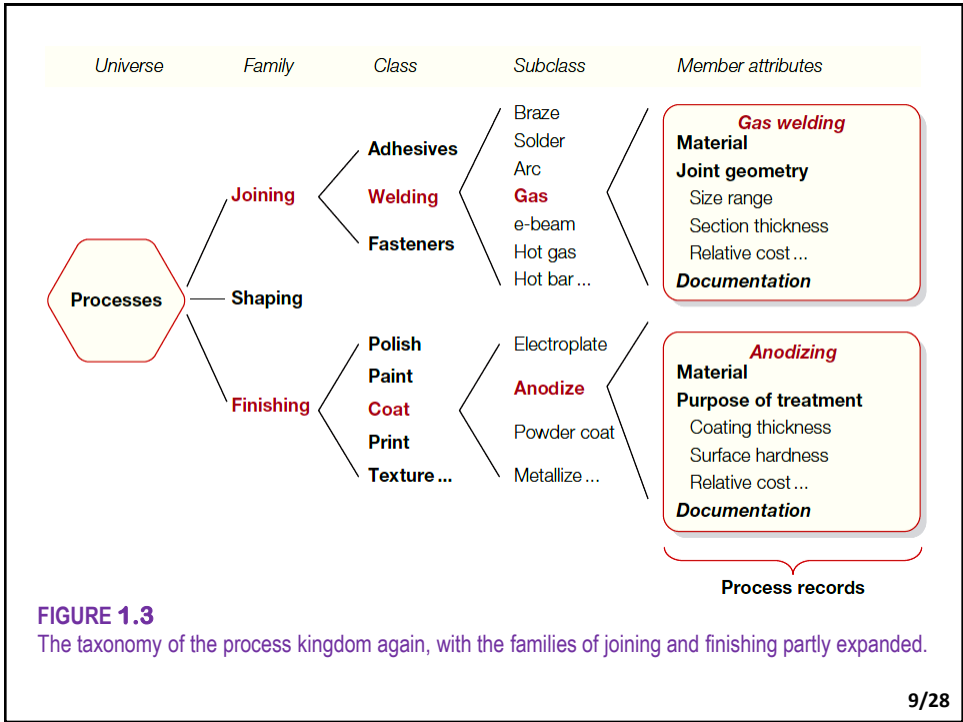


FIGURE 1.3
The taxonomy of the process kingdom again, with the families of joining and finishing partly expanded.

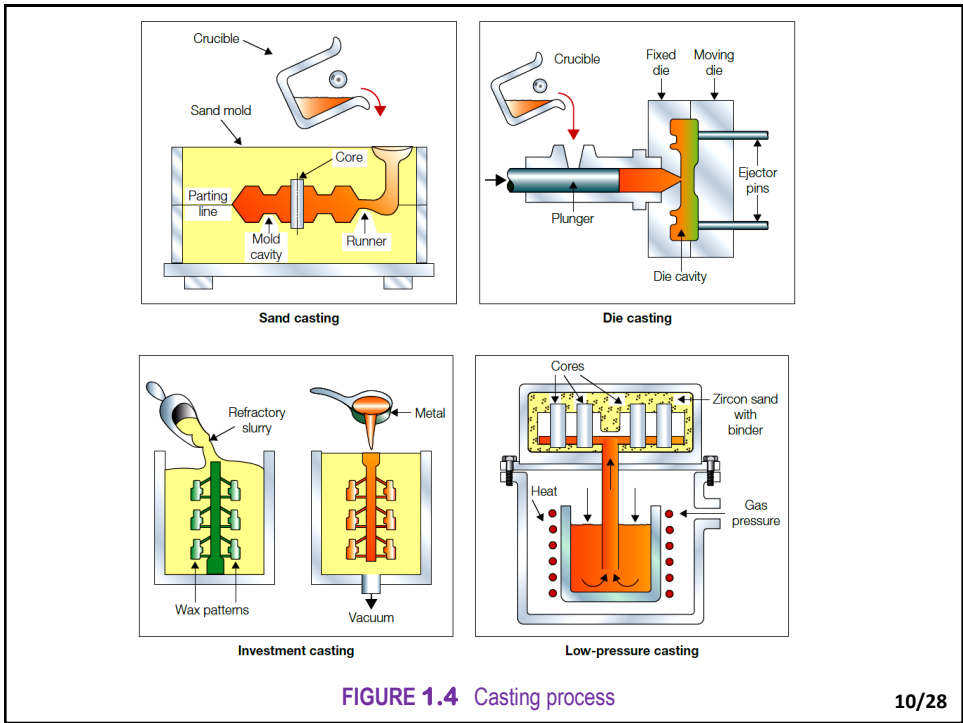


FIGURE 1.4 Casting process

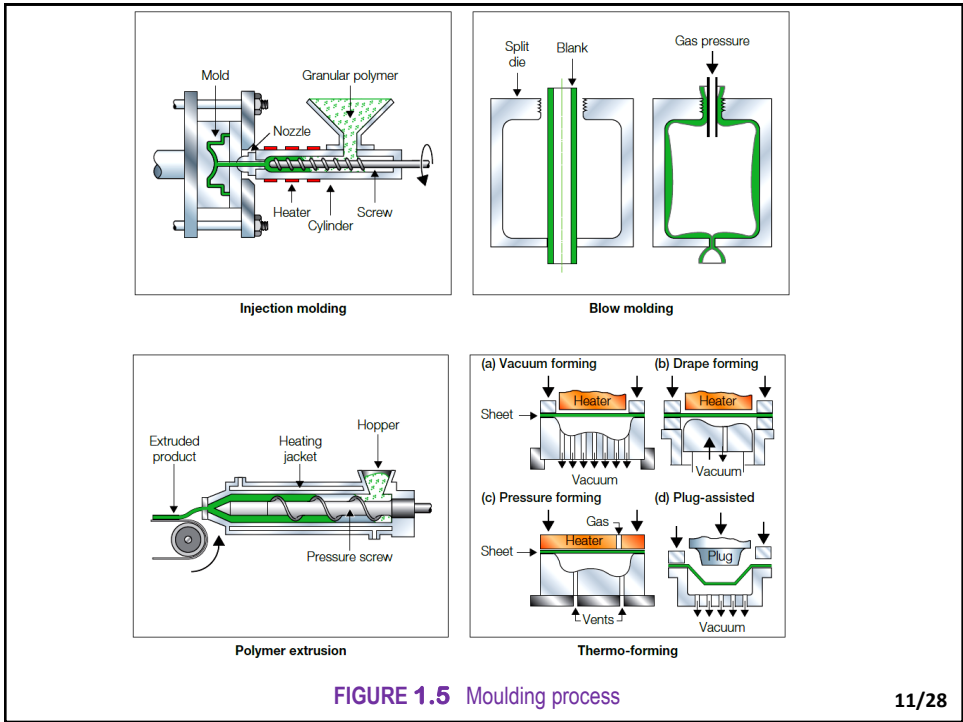


FIGURE 1.5 Moulding process

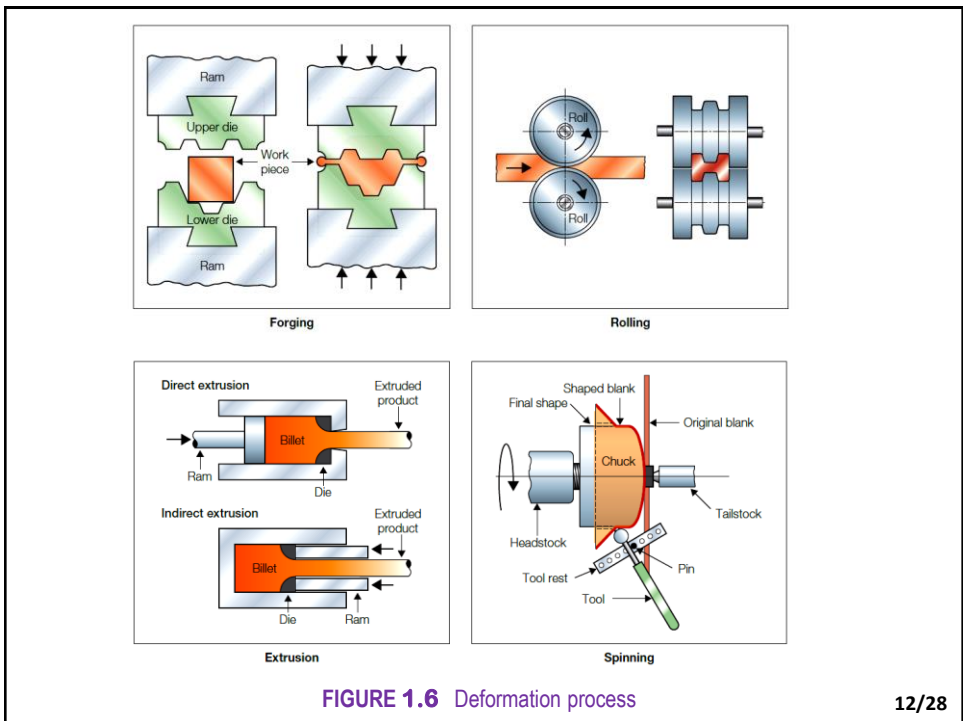


FIGURE 1.6 Deformation process

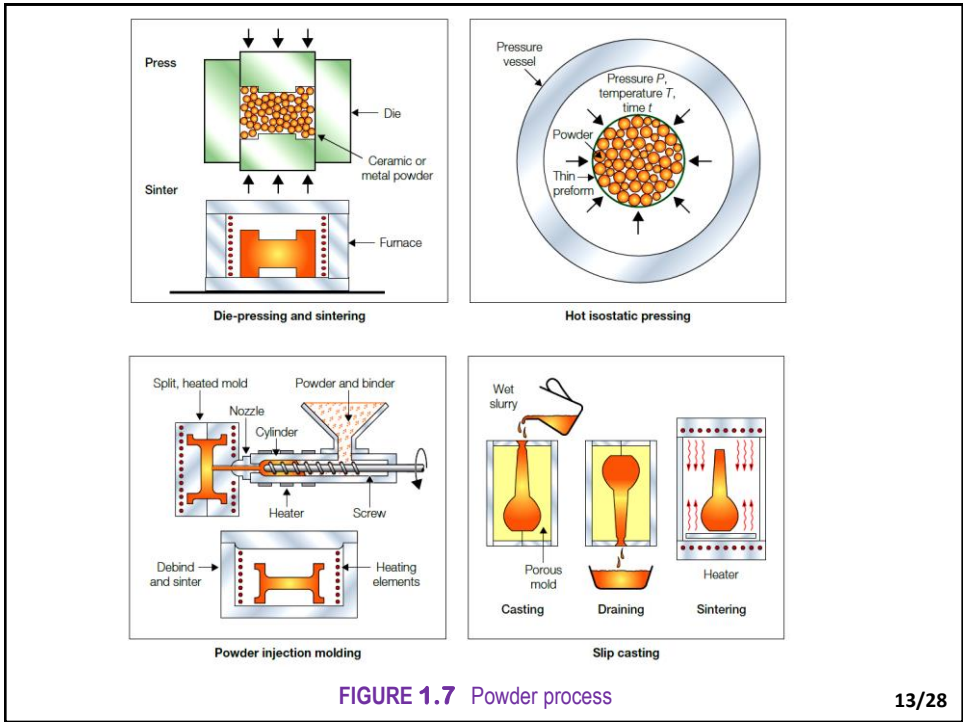


FIGURE 1.7 Powder process

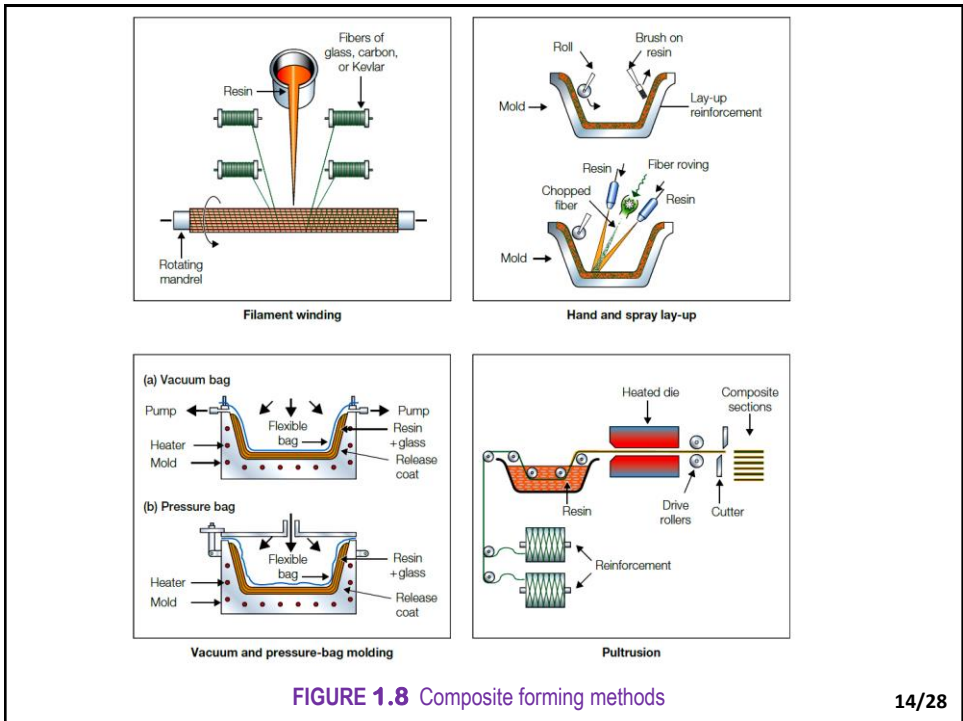
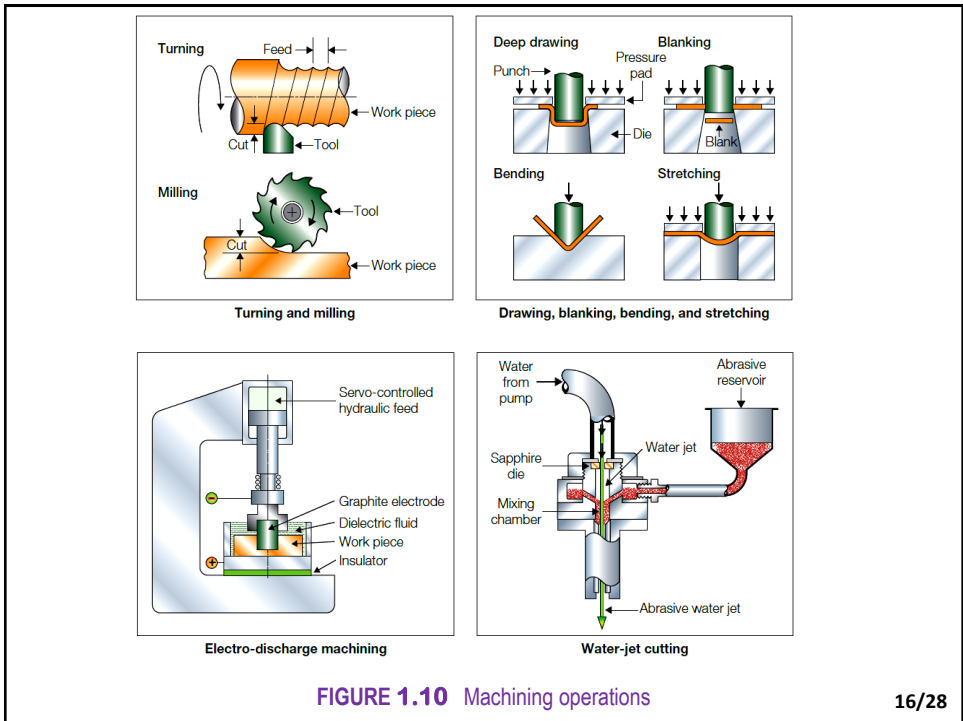
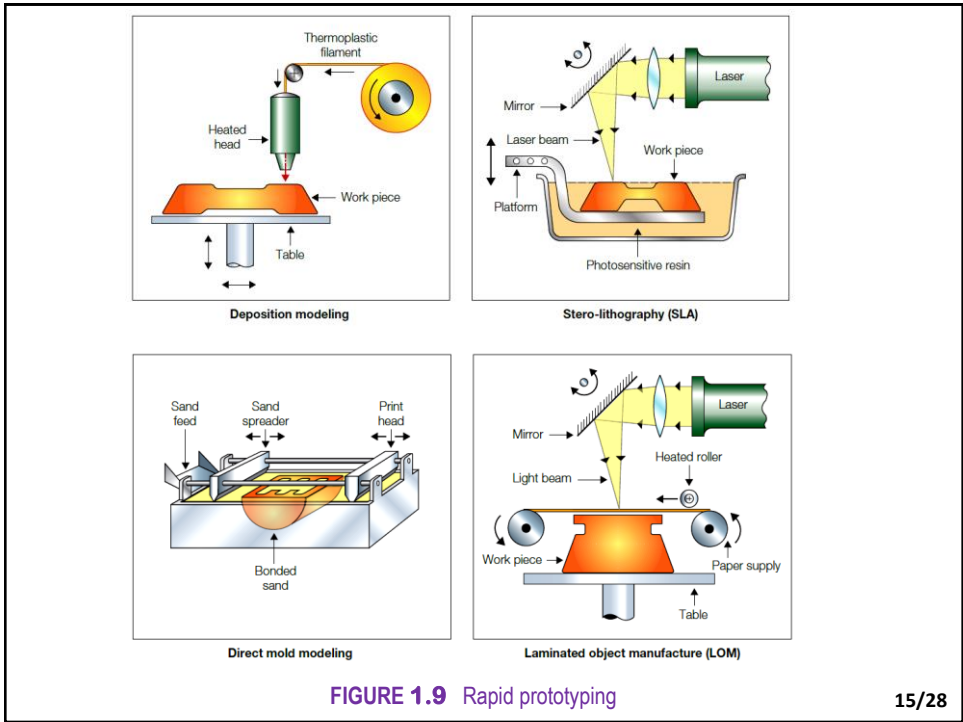


FIGURE 1.8 Composite forming methods



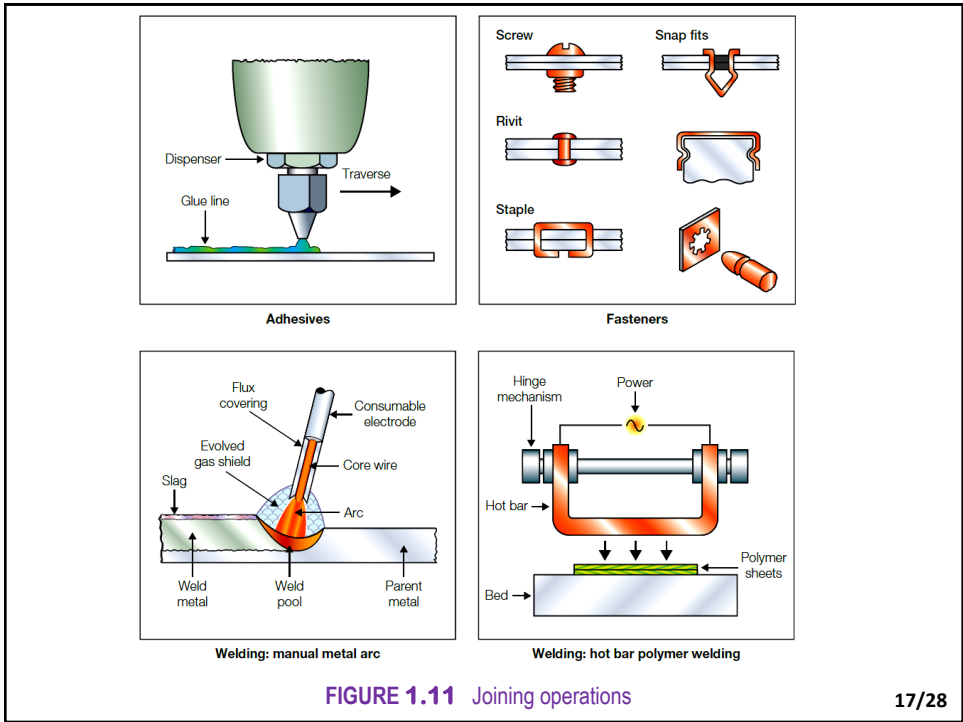


FIGURE 1.11 Joining operations

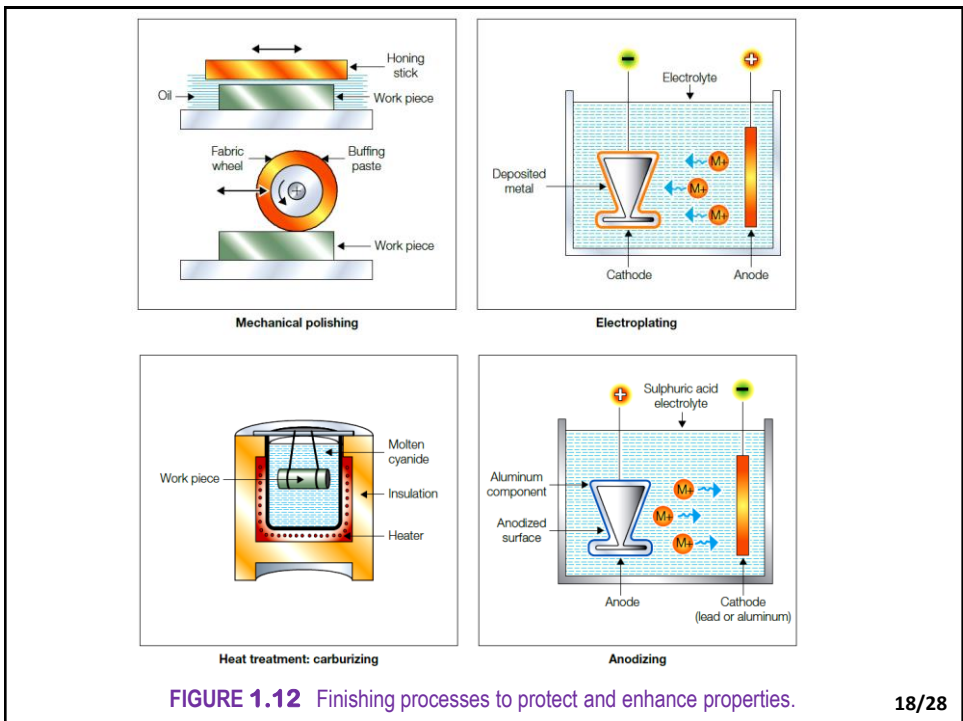
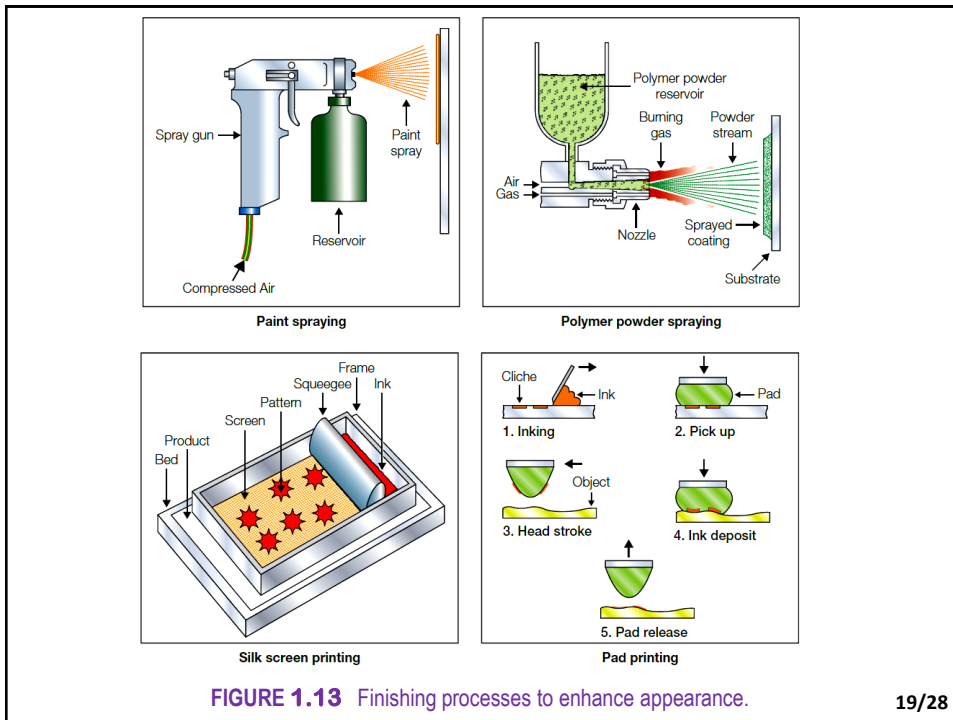


FIGURE 1.12 Finishing processes to protect and enhance properties.



19/28

3. Selection of process

- A process has certain **attributes**; they describe the things the process can do.
they can be thought of as the "properties" of a process, just as the material attributes of strength, ductility, conductivity and so on are the properties of a material.
- The common process attributes are: size, shape, complexity, precision, surface roughness, etc. (**Table 1.1**).

20/28

Table 1.1 Attributes of processes.

Process attributes	Definition
Materials class	Material to be processed, characterised by melting point T_m and hardness H .
Size	Minimum and maximum overall size, measured by volume V or weight W .
Shape	Aspect ratio, web thickness-to-depth ratio; surface-to-volume ratio.
Complexity	Information content, symmetry, etc.
Tolerance	Dimensional accuracy or precision T .
Roughness	Surface finish measured by RMS surface roughness R .
Surface details	Smallest radius of curvature at corner.
Minimum batch size	Minimum number of components to be made.
Production rate	Time to produce one component; cycle time.
Cost	Cost per component.

21/28

- A design for a component or assembly calls for a certain profile of these attributes, not for a process per se; any process which meets the profile will do.
- The problem, then, is that of matching the attribute profiles of available processes to that specified by the design.
- The correct process selection involves finding the best match between process attributes and design requirements.
 - This depends on how material, shape and processing interact with each other (Fig. 1.14).

22/28

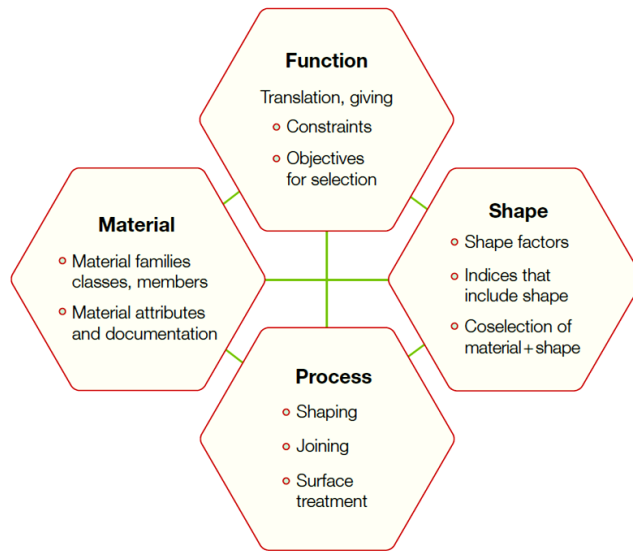
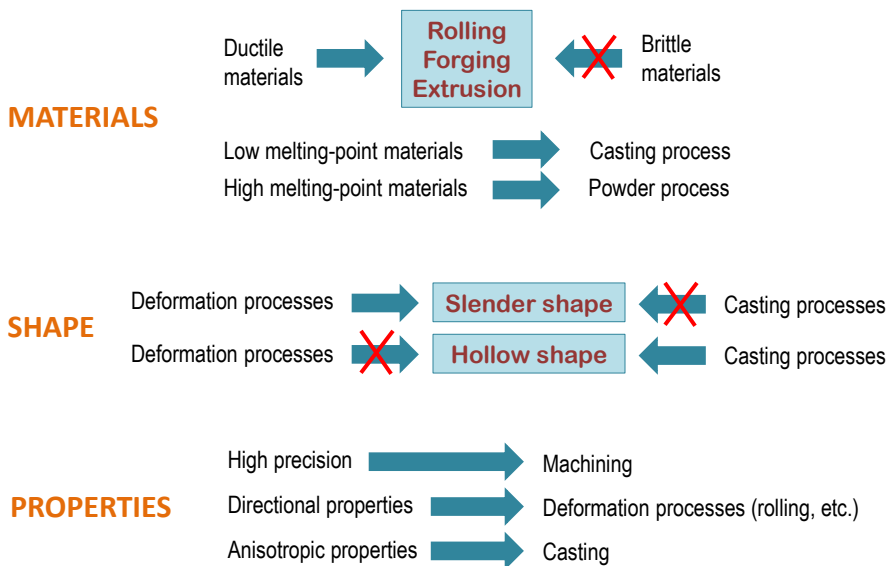


FIGURE 1.14
 Processing selection depends on materials and shape.
 The "process attributes" are used as criteria for selection.

Examples of Material - Shape - Property - Process Interaction



Examples of Process - Property Interaction

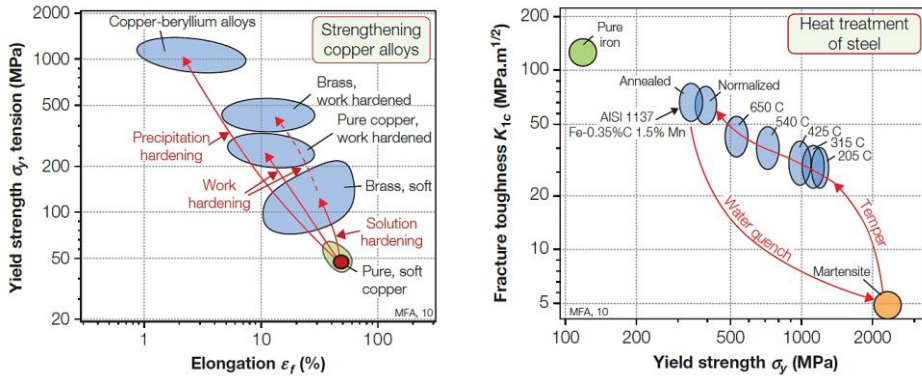


FIGURE 1.15 Enhancement of properties using different processes.

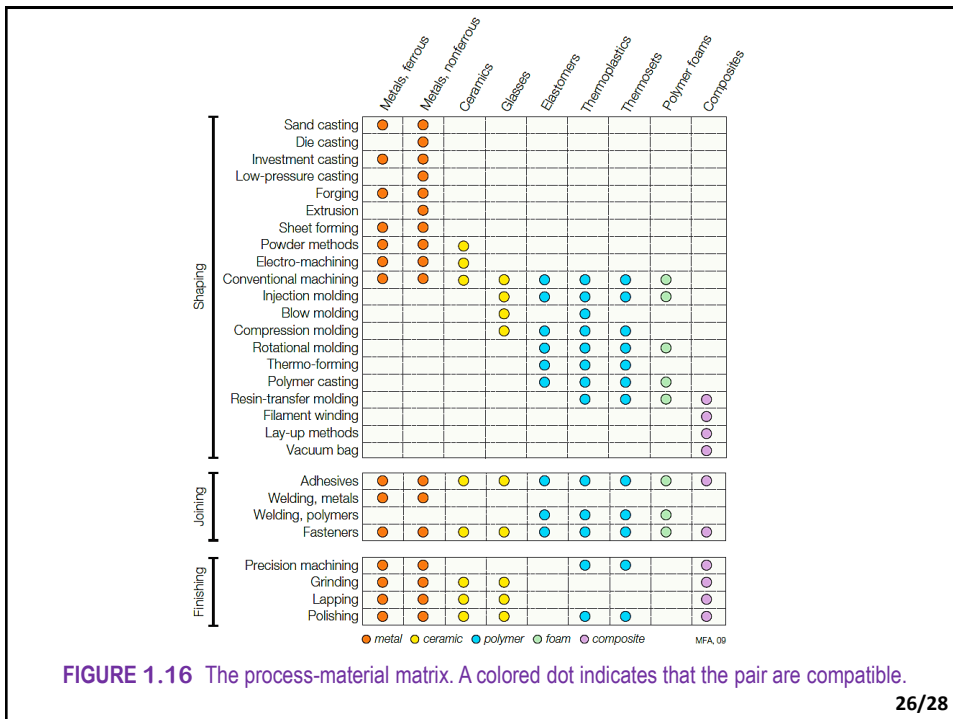


FIGURE 1.16 The process-material matrix. A colored dot indicates that the pair are compatible.

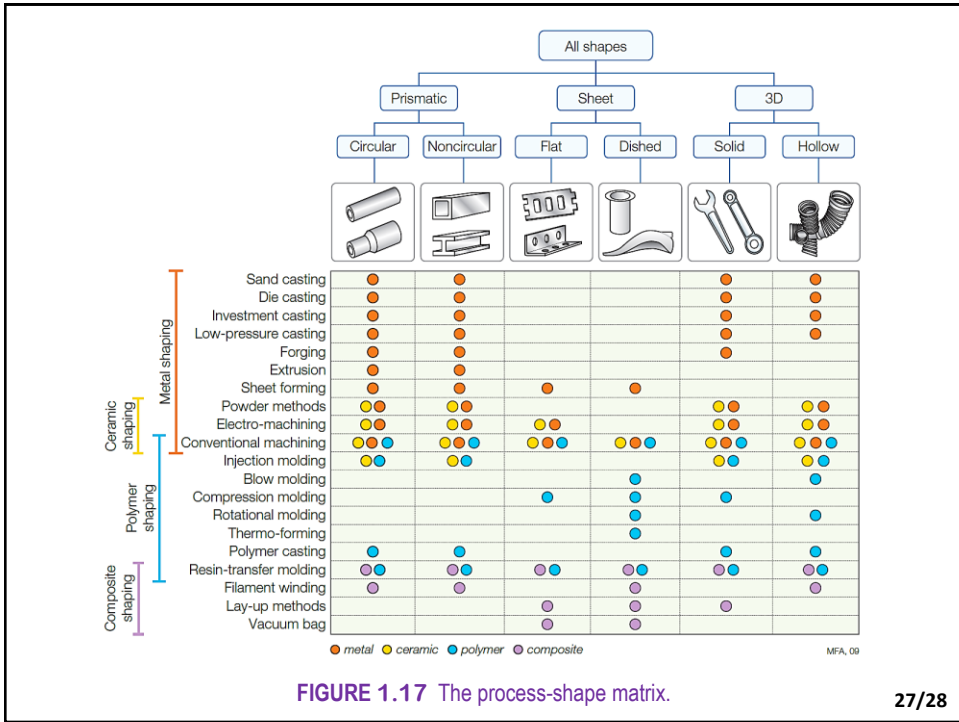


FIGURE 1.17 The process-shape matrix.

Next Class
 MME 345, Lecture A:02

Introduction

2. Casting as a metal forming process