IME 601 - FUNDAMENTALS OF MFG. ENG.

BULK MECHANICAL PROCESSING — BASIC CLASS NOTES

Class Preparation and Reading Review
This should be completed prior to class

Key Concepts to Be Discussed in Class:

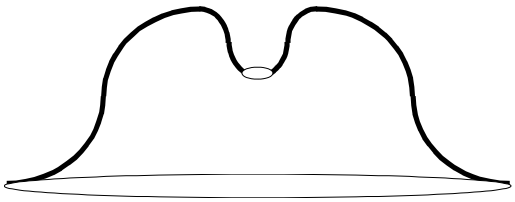
Questions About Subject Matter for Class Session:

Outline

- Manufacture by Mechanical Processing
  - Overview
- Processes
  - Forging
  - Extrusion and Drawing
  - Bending
  - Sheet Metal Processing
- Sequence of Operations
  - Press Operation

Concept Question

- What is a Basic Working Definition of Mechanical Processing?



  - How does this apply the Metals?

  - What Material Properties would one need to be concerned about?

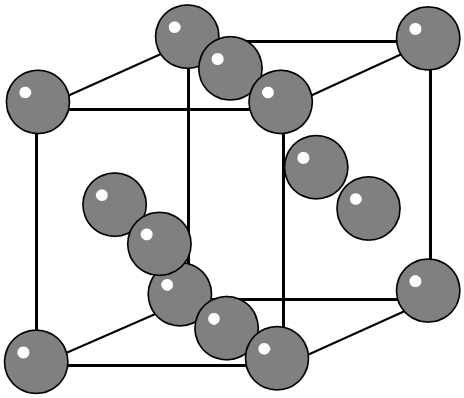
- Describe in Your Own Words the Sequence of Operations Would Be Required to Make the Following Part?

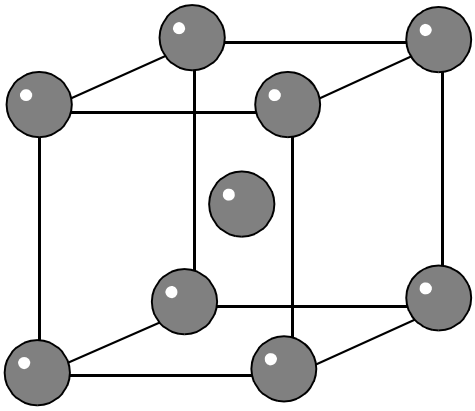
Material Properties

- When Stretched Metals Become
  - Harder
  - Stronger
  - Less Ductile
- When Processed at Elevated Temperature
  - Softer
  - Weaker
  - More Ductile
- Heating and Cooling Metals
  - Similar to Elevated Temperature Processing

Steel (Iron) is the Exception

- At 727°C Atomic Arrangement of Solid Iron Changes
  - More Carbon in High Temperature Form
  - Final Properties are Cooling Rate Dependent





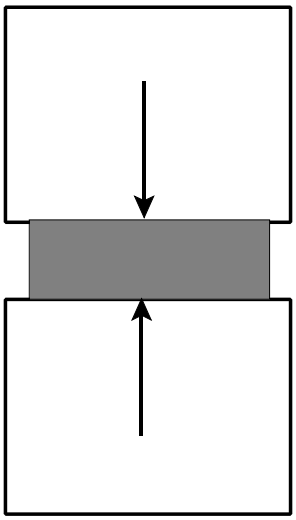
Forging

- Use Compressive Force to Change Shape
  - Open Die
  - Barreling Will Result

$$\varepsilon = \frac{h_0}{h} - 1$$

$$F = K\sigma\ A$$

$$K = 1 + \frac{0.4\mu D}{h}$$



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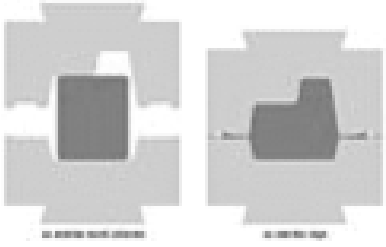
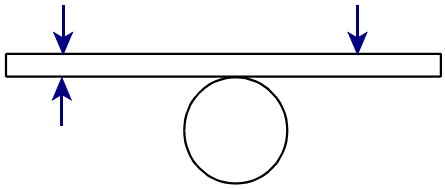
	 Wikimedia Commons

Bending



- Apply a Bending Stress and Deform Material
  - Bending Stress
  - Strain in Part
  - Bent Area Harder
  - Design for Spring Back

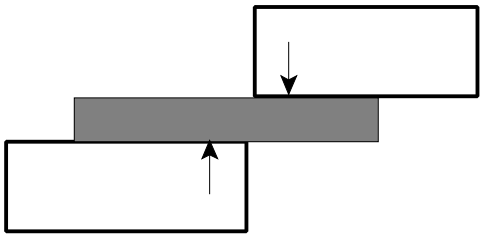
$$\varepsilon = \frac{1}{(2R/T)+1}$$

$$\sigma = \frac{Mc}{I}$$

Shearing

- Applying Sufficient Force to Separate Metal
  - Punching
  - Blanking

$$F = 0.7tl\sigma_{UTS}$$



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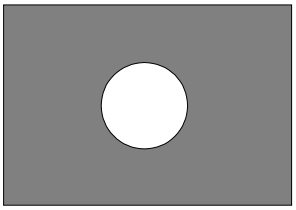
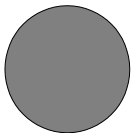
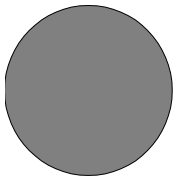
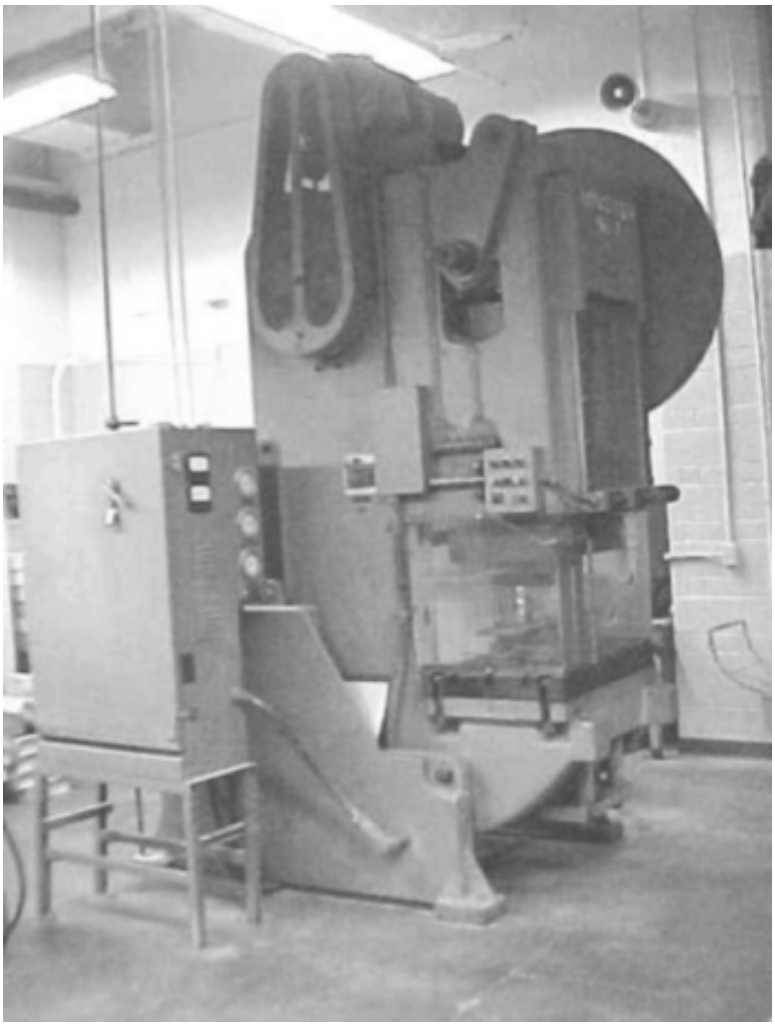




Practica -Blanking

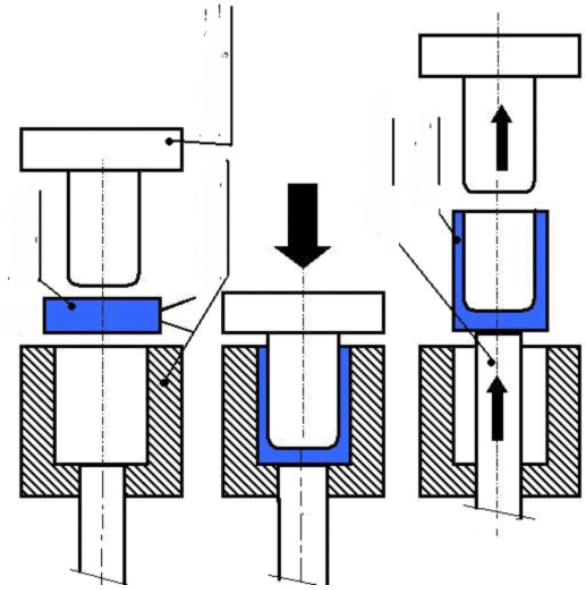
- Use Blanking Press
  - To Form Circular Blank





Deep Drawing

- Force Metal to Take Predefined Shape
  - Bowl
  - Housings



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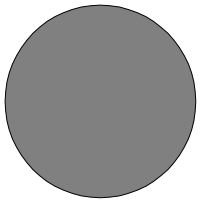
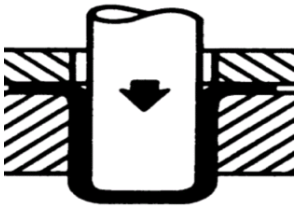
Practica - Deep Drawing

- Use Deep Drawing Press
  - Turn Circular Blank Into Bowl





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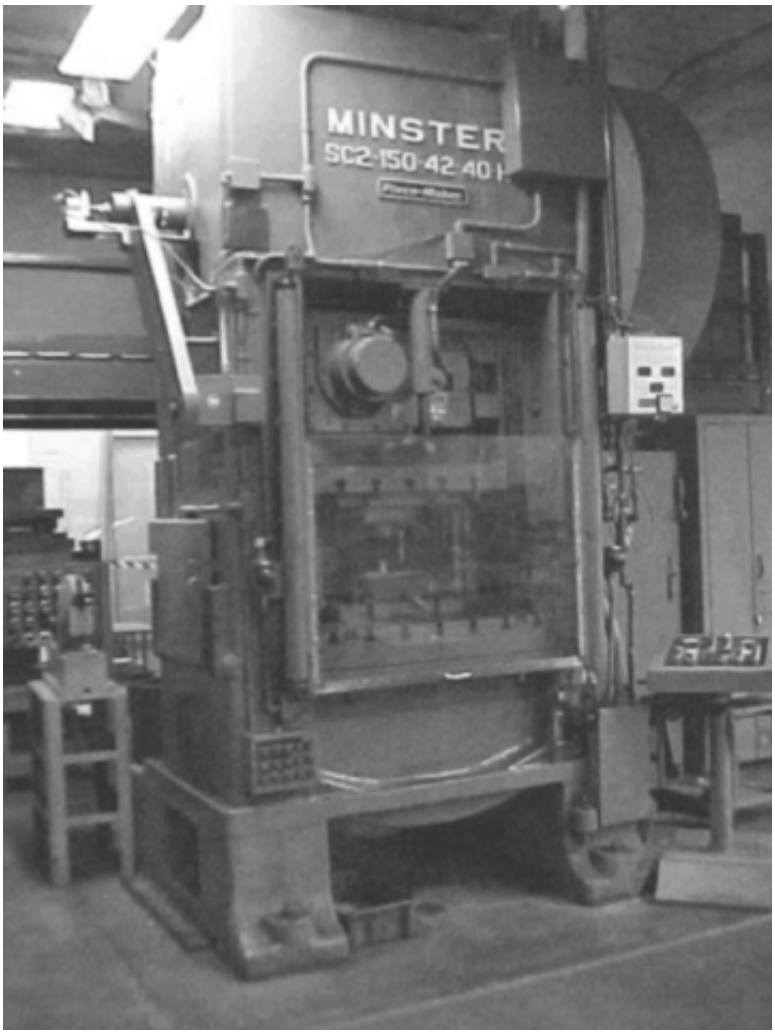
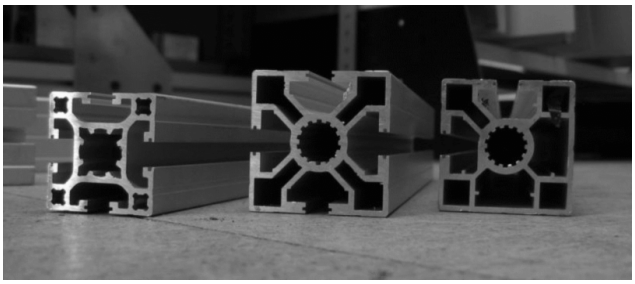


Extrusion

- Push a Material Through a Die
  - Reduce Cross Section
  - High Pressure
  - Elevated Temperature



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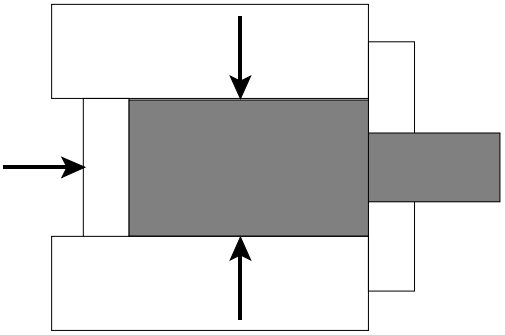
Copper
500C k=260MPa
800C k=100MPa



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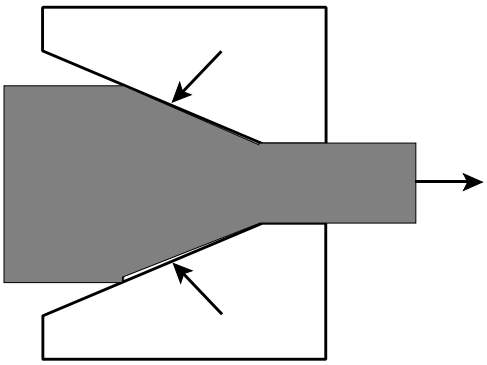
$$F = A_0 k \ln\left(\frac{A_0}{A_f}\right)$$

Wire Drawing

- Reduce Cross Sectional Area By Pulling Through a Die
  - Wire or Rod Formation
  - Elevated Temperature



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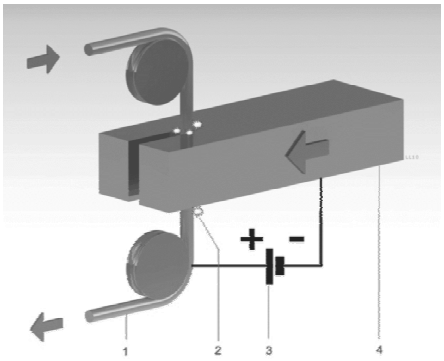

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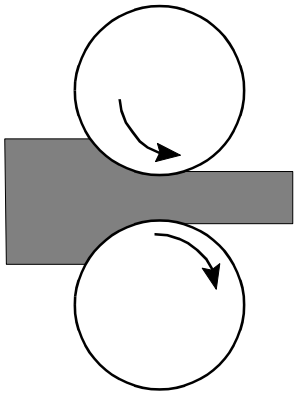
Rolling

- Reduce Cross -Sectional Area by Rolling Stock
  - First Stage in Most Sheet Metal Processes



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$$t_0 - t_F = \mu^2 R$$

$$\varepsilon = \frac{t_0}{t_f} - 1$$

$$F = \sigma w \sqrt{R\left(t_0 - t_f\right)}$$

$$P = \left(2\pi N\right)\left[wR\left(t_0 - t_f\right)\right]\sigma$$

In-Class Exercise

- What Mechanical Properties (from a stress-strain curve) are important for each of the following processes

Process	Impt Mech Props	Why?
Forging		
Extrusion		
Wire Drawing		
Deep Drawing		
Bending		
Shearing		

Summary
- Mechanical Processing is A Key Manufacturing Technique
- Sheet Metal Forming a Key Technology
- Knowledge of Materials Required
- Reference
  - Dieter G. E. : Mechanical Metallurgy; McGraw Hill © 1986
  - Groover M. P. : Fundamentals of Modern Manufacturing Systems; Wiley, ©2010

After Class Review
Summarize Key Concepts and List Further Questions
Review Notes and Make Links to HW Problems

Key Concepts	HW Connections	Questions