IME 100 - MACHINING I

BASIC CLASS NOTES **OCTOBER 28, 2015**

Reading Review and Class Preparation

This should be filled out prior to class.

Key Concepts to Be Discussed in Class:

Questions About Subject Matter for Class Session:

So What Why Who Cares?

- Often We Need to Remove Material to Finish a Part
- Various Processes
  - Lathes
  - Milling
  - Drilling
  - Others
- Key Principles
  - Power and Energy Consumption
  - Tool Life and Productivity

Outline

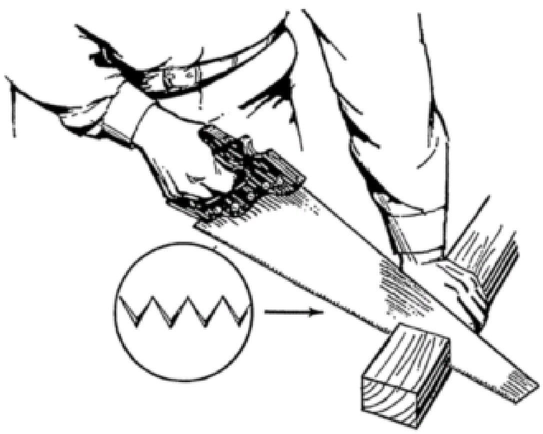
- Key Principles
- Machining Processes
- Reference (Pictures)
  - Kalpakian S.: Manufacturing Engineering and Technology; Addison Wesley, © 1995
  - W. R. Riffe

<u>Concept Question</u>

- Write a Working Definition of Machining
- Apply this to the Processes to Be Discussed this Class Session
    - What Are They ?
    - How Are They Similar ?
    - How Are They Different ?

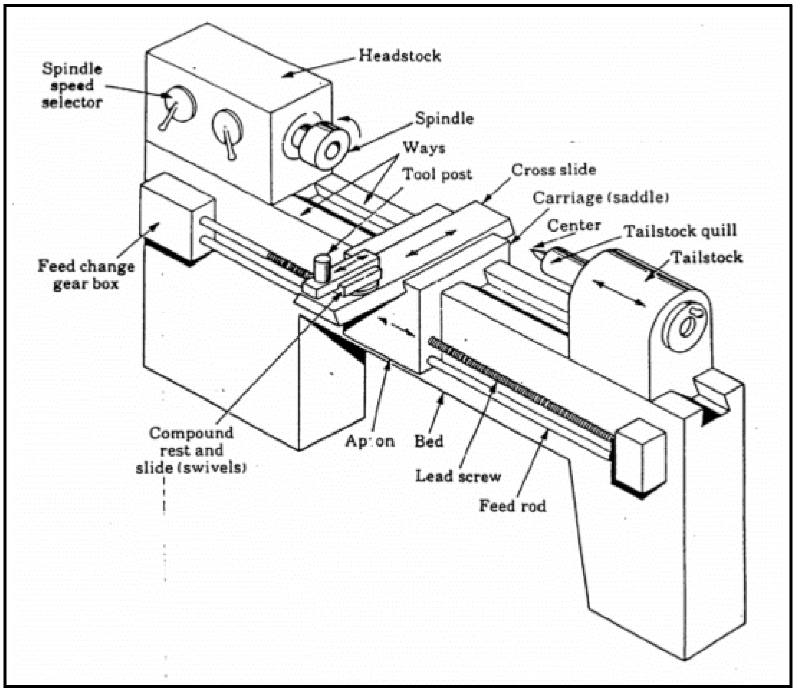
Sawing and Drilling

- Common Experience
  - Fix Work Piece and Move Tool

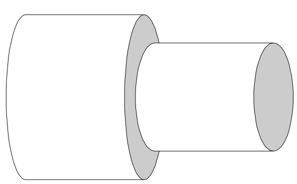
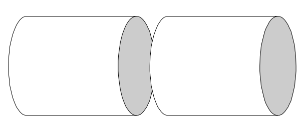
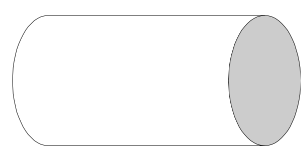
Sawing	Drilling
 **Wikimedia Commons**	 **Wikimedia Commons by Włodzimierz Wysocki**

<u>The Lathe</u>

- Rotate Workpiece
  - Use Tools to Remove Material
  - Turning
  - Parting
  - Facing
  - Drilling
  - Boring

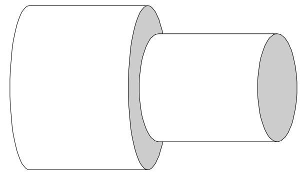


<u>Lathe Operations</u>

<u>Turning</u>	<u>Parting</u>	<u>Facing</u>
Remove Material From Surface 	Separate Material 	Remove Material From Face 

Material Removal Rate (Turning)

- Need to Calculate
  - Cutting Speed
  - Material Removal Rate
- Not Simply rpm (N)



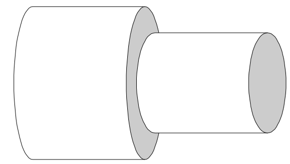
Cutting Speed (V)	Material RR (Q)
$$V = N\pi D$$ D = Diameter	$$Q = Vdf_r$$ d = Depth of Cut f_r = feed rate (length /rev)

Energy Requirements

- Material Removal Requires Energy
  - Specific Energy (U) = Energy/Volume

$$P = UQ$$

Material	U (J/mm^3)
Al Alloys	0.4-1.1
Cu Alloys	1.4-3.3
Steel	2.7-9.3
Stainless Steel	3.0-5.2
Ni Alloys	4.9-6.8



Team Problem

- How Much Power is Required For the Following Operation on an Aluminum Part?
  - Operating Speed 800 rpm
  - Original Diameter 25mm
  - Depth of Cut 0.3mm
  - Feed Rate 1.5×10^{-3} mm/rev

- Determine Cutting Speed (V)

$$V = N\pi D$$
$$= \left(13.3\frac{rev}{s}\right)\pi(25mm)$$
$$= 1.0\times10^{3}\,\frac{mm\;rev}{s}$$

- Determine Material Removal Rate (Q)

$$Q = Vdf_r$$
$$= \left(1.0\times10^{3}\,\frac{mm\;rev}{s}\right)(3mm)\left(0.25\frac{mm}{rev}\right)$$
$$= 785\frac{mm^3}{s}$$

- Determine Required Power (P)

$$P = UQ$$
$$= \left(0.7\,\frac{J}{mm^3}\right)\left(785\frac{mm^3}{s}\right)$$
$$= 550W$$

Assume that Ni instead of Aluminum were to be used and that no additional power is available. The minimum rpm possible is 650. What is the new depth of cut?

Tooling

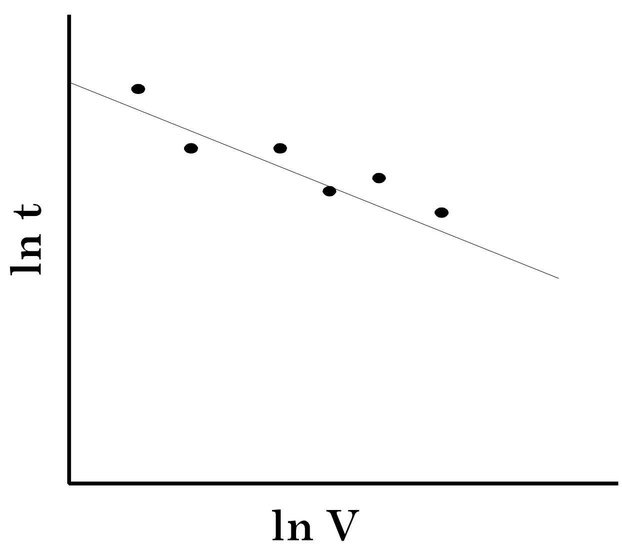
- Tools Usually Made From Hard Materials
  - High Speed Steel
  - Cemented Carbides
  - Ceramics

Material	Cost	Cut Speed	Wear
High Speed Steel	Low	Low	Poor
Cemented Carbide	Moderate	Moderate	Fair
Ceramics	High	High	Good

Tool Life

- Tools Will Wear Out
  - Taylor Equation

$$Vt^n = C$$



$$\ln t = \frac{1}{n}\ln C - \frac{1}{n}\ln V$$

Team Problem

- The Tool Has a Part Life of 8 hrs
  - If I Double the rpm the Part Life becomes 2 hrs
  - What if I Only Increase the rpm by 50%

- Importance of C

$$Vt^n = C$$

$$V_1 t_1^n = V_2 t_2^n$$

$$\left(\frac{t_1}{t_2}\right)^n = \frac{V_2}{V_1}$$

$$n = \ln\left[\frac{\frac{V_2}{V_1}}{\frac{t_1}{t_2}}\right] = \ln\left(\frac{2}{4}\right) = 0.7$$

- Why Calculation of C is Not Required

$$\left(\frac{t_1}{t_2}\right) = \sqrt[n]{\frac{V_2}{V_1}} = \sqrt[0.7]{1.5} = 1.8$$

- time = 4.4 hrs
  - So Doubling RPM Reduces Part Life from 8 hrs to 2 hrs
  - Raising RPM to 1.5x Original Reduces Part Life from 8 hrs to 4.4 hrs.

Assume tripling the cutting speed reduces the tool life by a factor of six? How much would the tool life be reduced by increasing the cutting speed to six times (twice the tripling speed).

<u>Drilling and Boring</u>

- Rotate Work Piece and Make Hole
  - Drilling - Make Hole
  - Boring - Expand Hole