A thick black L-shaped frame surrounds the text. The top horizontal bar is on the left, the left vertical bar is on the left, and the bottom horizontal bar is on the right, with a vertical bar on the right side.

**BASIC MATERIALS
SCIENCE AND
MACHINING
MATERIALS**

Materials Science

- Branch of Engineering dealing with properties of materials
- Opening: Why might this be important for Mechanical Engineering?

Key Vocab Terms to Learn

- Machining – Using a machine to alter a material
- Fabricating – Creating a part
- Malleable: Ability to bend without breaking
- Ferrous: magnetic
- Brittle: hard but liable to break/shatter
- Speeds & Feeds: When cutting a material, how fast the blade should move (**speed**) and how fast to push (**feed**) the material

Materials Overview



Wood
Types
Properties
Machining
Metals
Types
Properties
Machining
Plastics
Types
Properties
Machining

Wood - Types

- Soft woods – Generally cheaper and more common
 - Pine
 - Cedar
- Hard woods - Look fancier and more expensive
 - Cherry
 - Oak
- Specialty woods
 - Balsa wood: light weight
- How it's commonly bought
 - Plywood
 - Strips (example: an 8 ft. piece of 2x4 wood)



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Properties of Wood

Pros	Cons
<ul style="list-style-type: none">• Easy to work with• Cheap• Easy to obtain• Can stain/paint easily	<ul style="list-style-type: none">• Heavy/bulky• Not weather-resistant unless stained• Warps/weathers• Flammable

- Other properties
 - Non-electrically conductive nor magnetic
 - Soft relative to metal

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Machining with Wood

Big takeaway: Can be machined easily with a wide variety of tools

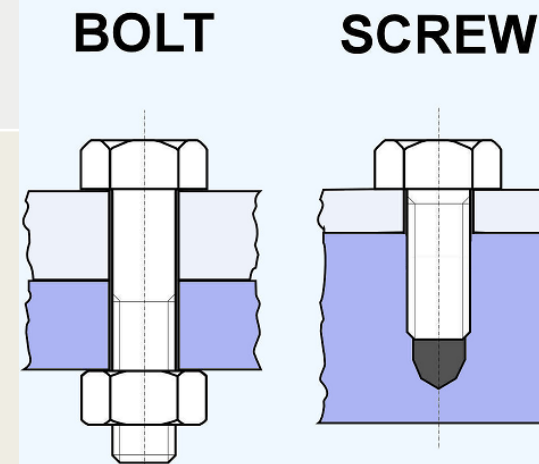
Common Methods of Machining

Cutting/Drilling

- Table saw, band saw, jig saw
- Wood blades have large “teeth” as wood is relatively soft
- Hand drill, drill press
- Mostly any drill bit will work
- High-speed & high-feed or low-feed & low-speed

Binding

- Nearly anything works
- Screws and bolts easy to apply
- Most glues are effective as wood is porous

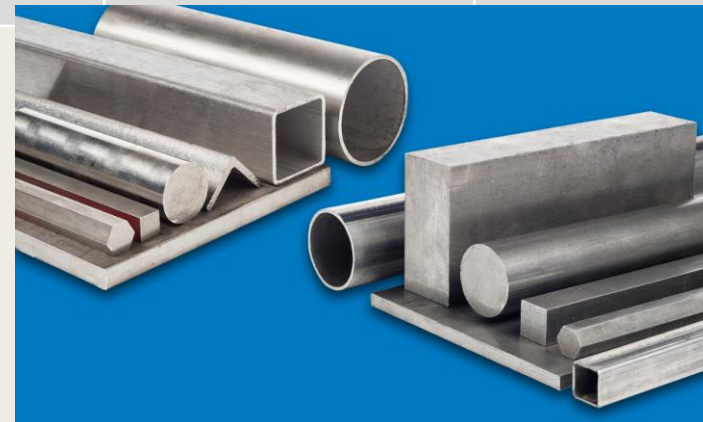


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Types of Metals

• Iron	Steel	Stainless Steel	Copper	Aluminum
<ul style="list-style-type: none"> • Magnetic • Easily rusts • heavy 	<ul style="list-style-type: none"> • Magnetic • Contains iron and carbon • Strong but heavy • Easy to machine 	<ul style="list-style-type: none"> • Some magnetic, some non-magnetic • Similar to steel, but non-corrosive and non-rusting 	<ul style="list-style-type: none"> • Weakly magnetic • Highly conductive (used in most wires) • Cheap • Very malleable 	<ul style="list-style-type: none"> • Weakly magnetic • Cheap • Light weight • Less malleable than most metals

- How it's commonly bought
 - Sheets
 - Strips
 - Scrap pieces



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Properties of Metals

Pros	Cons
<ul style="list-style-type: none">• Can be conductive/magnetic• Very strong and durable• High strength/weight ratio• Heat/weather resistant	<ul style="list-style-type: none">• Expensive• Heavy• Hard to machine

- Other properties
 - All are conductive
 - Malleable (can be bent)

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Machining with Metal

- Big Takeaway: Tough to Machine, but very strong

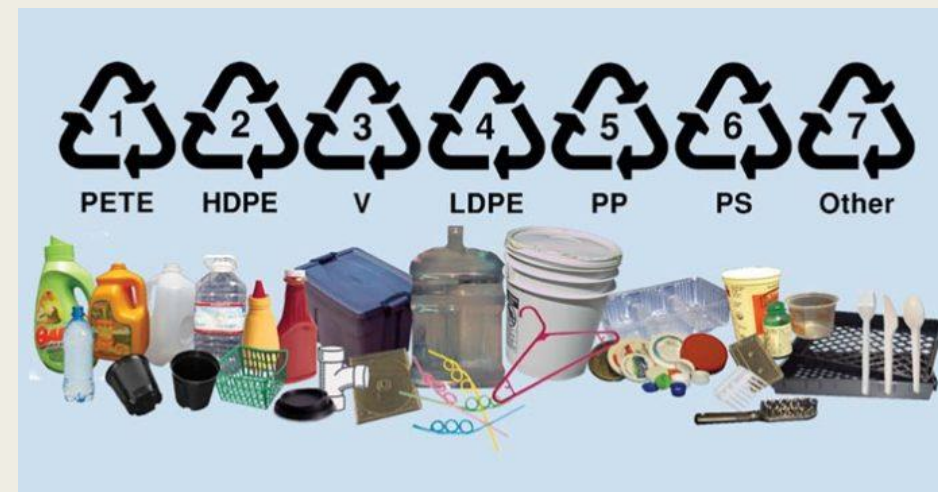
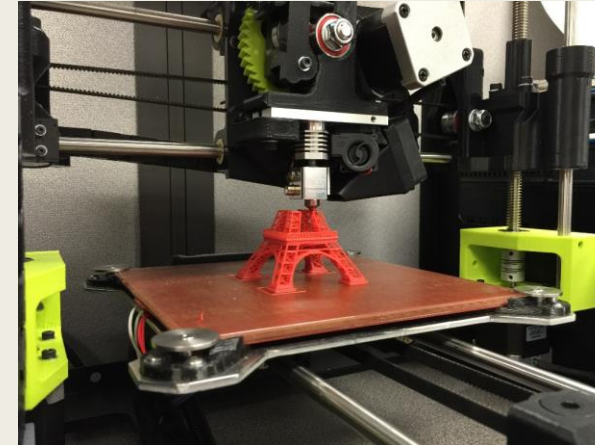
Common Methods of Machining	
Cutting/Drilling	Binding
<ul style="list-style-type: none">• Specialized tools needed (angle grinder, special metal blades)• Lathe, mill• Metal blades have small “teeth” due to the hard nature of metal• Metals warp with heat from cutting• Caution needed with metal shards and heat• High-speed & low-feed	<ul style="list-style-type: none">• Bolting requires extreme precision as metal has no “give”• Can’t screw/nail into metal like wood• Few glues work as metal is non-porous• welding



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Types of Plastics

- A wide variety – Too many to count and new types are regularly created
- A couple ones to know:
 - PVC: Rigid and used for piping
 - Polypropylene: Commonly used in plastic bottles
 - Teflon: Very strong and heat resistant
- How it's commonly bought
 - Scrap pieces
 - Online ordering for special plastics
 - 3D printing or Injection Molding



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Properties of Plastics

Pros	Cons
<ul style="list-style-type: none">• Can be 3D printed or molded into unique shapes which are difficult to machine with wood/metal• Can be very cheap on a large scale• Weather resistant (hence non-biodegradable...)	<ul style="list-style-type: none">• Often brittle and difficult to machine• Specialized plastics are expensive• Non-biodegradable• Many melt/warp with heat

- Other Properties
 - Usually brittle
 - Highly variable in its properties

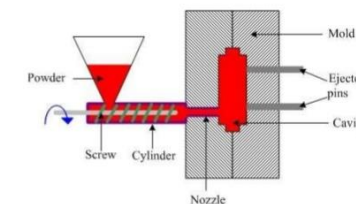
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Machining with Plastics

- **Big Takeaway:** Highly variable in properties for specialized applications and often tricky to machine. However, their ability to be cheaply molded into highly precise parts has led to their widespread use

Cutting/Drilling	3D Printing & Injection Molding	Bonding
<ul style="list-style-type: none"> • Most are very brittle and easily snap • Usually soft and require little force to cut/drill • High speeds often ideal • Generally very small teeth on blades/bits due to brittle nature 	<ul style="list-style-type: none"> • Allows for the creation of highly detailed and precise parts • 3D printing (Cheap for a few parts, expensive on a large scale) • Injection Molding: melting plastic in a mold. (Expensive initial cost to create mold then very cheap) 	<ul style="list-style-type: none"> • Some too brittle to screw into, but bolting works well • Wide range of specialized plastic glues • Glues stronger than metal

How Does Injection Molding Work?



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Other Materials

- Composites
 - Made of two or more significantly different materials
- Ceramics
 - Made from clay hardened by heat (think bricks)

Your Task

- Create a Graphic Organizer Comparing the benefits and tradeoffs of using different materials
 - Template available on my blog
- Research and choose a **specific** material
 - On the back of your graphic organizer (or another piece of paper) look up:
 - specific properties
 - Common uses/applications
 - cost
 - Advantages and disadvantages