RoboJackets

CAT®

THE ARTHUR M. BLANK FAMILY FOUNDATION

2007 TE Sessions
Fabrication and Safety

October 23, 2007

www.robojackets.org

Machinability

What does machinability mean?

- Design your parts so they can actually be made
- No intersecting or interfering holes
- Parts fit together properly

Keys

- Good design discipline
- Keep records of designs and changes
- Make sure machinists are aware of changes!

Drafting

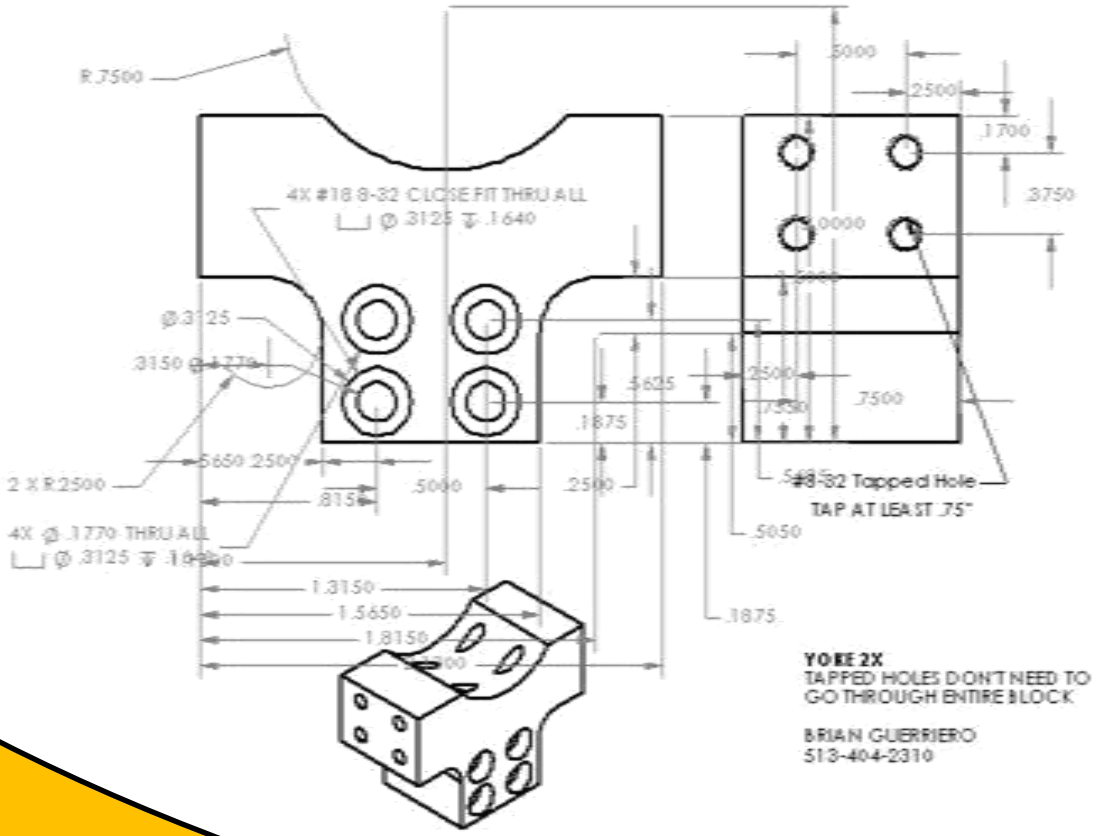
What does drafting mean?

- Technical Drawings of parts to be fabricated
- Specify all relevant dimensions and tolerances
- Make drawing readable! Machinists can't read minds

Keys

- Dimension parts in only one unit (in. or mm)
- Don't overlap dimensions
- Callout hole sizes and threads
- Show 3 views of part (Top, Right, Front)

Drafting
Poorly drafted part



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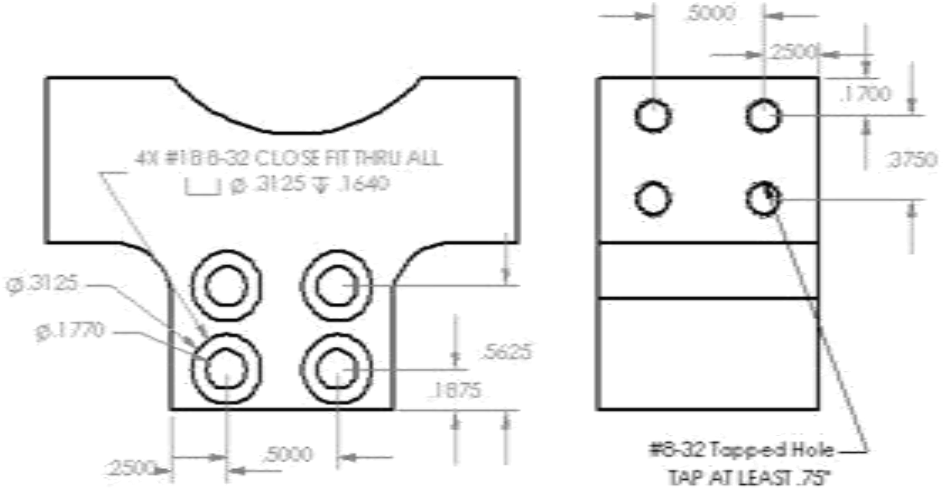
Drafting
Well drafted hole callouts



YOKE 2X
TAPPED HOLES DON'T NEED TO GO THROUGH ENTIRE BLOCK

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SAFETY

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Safety

General

USE COMMON SENSE!!
IF YOU HAVE TO THINK TWICE, ITS NOT SAFE!!!

NEVER WORK ALONE

Rules

OBEY THEM OR GET OUT

Safety

- **Accidents cause more than just pain**
- **Accidents will cause significant risk to your team**
- **Administration who hear about accidents will try to shut you down**

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Safety

Glasses vs. Face Shields

Glasses protect your eyes in the direction you're looking

Face shields double protection, plus protect from Sides, but not ok alone

Side shields must be worn on prescription glasses

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Safety

Welding Masks

Welding masks must be worn while welding

Shades are from 7-14
Higher number is darker
Arc welding (TIG, MIG, Stick) – 10-14 shade

Gas welding (Oxy-Act) – 7-10 shade

Safety

Clothing & Hair

Shoes:

- **BAD: sandals**
- **OK: soft shoes**
- **GOOD: boots**
- **BETTER: steel toed boots**

Clothing:

- **BAD: tank tops and skirts**
- **OK: tee shirts and shorts**
- **GOOD: long sleeved shirts and pants**
- **BETTER: heavy snug shirts and jeans**

Hair:

- **BAD: long flowing hair**
- **OK: long hair pulled back**
- **GOOD: short hair**
- **BETTER: no hair**

Safety

Gloves

Plasic and Latex:

- **Used for chemical handling**
- **Also used for sanitary issues**

Heavy Leather:

- **Used for welding**
- **Also for handling hot material**

Rubber lined fabric:

- **Good for general use**
- **Keeps hands clean**
- **Protects from sharp edges**

Safety

Ear Protection

When to use:

- Grinding on steel (especially thin gauge)
- Using air tools

Ear Plugs:

- Comfortable
- Cheap
- Easy to use
- Effective

Ear Covers:

- Bulky
- Effective
- Worn over ears

Safety

Chemicals

Dangers:

- **Fumes**
- **Overspray**

Protect:

- **Eyes (glasses)**
- **Mouth (mask)**
- **Skin (gloves)**

Spills:

- **Alert a teacher**
- **Make sure air is safe**
- **Sop up with litter or sawdust**

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Safety

Air Quality

Dust:

- **Sanding and cutting wood, plaster or drywall creates dust**
- **Fine particles are suspended in air**

Protection:

- **Dust masks must be worn**
- **Dust inhalation will cause respitory damage**

Prevention:

- **Cut outdoors!!**
- **Vacuum**
- **Moisture (wet sanding)**

Safety

Machinery Hazards

Moving Parts

- **Don’t touch any moving parts**
- **Spinning bits are very sharp**

Fingers:

- **Fingers are easily cut and ripped off by blades**
- **Keep your fingers AWAY from sharp objects**

Maturity:

- **No horseplay in the shop**
- **No throwing tools**
- **No fighting**

Safety

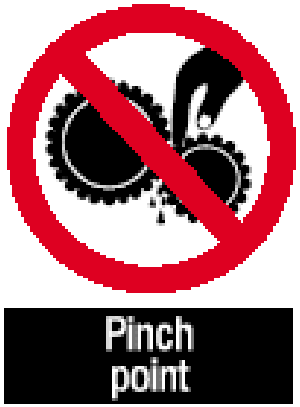
Machinery Hazards

Pinch Points

- **Some machinery parts will pinch**
- **You can become caught in a machine**
- **Wear proper clothing**

Fingers:

- **Keep fingers away from pinch point dangers**
- **Be Alert!**



Safety

Machinery Hazards

Hot Parts

- **Machined parts will be hot!**
- **Especially after cutting and grinding**

Gloves

- **Wear appropriate gloves when handling hot parts**

Tools

- **Drill bits get hot too!**
- **Chips are also hot**
- **Quench in water to cool parts down**

Safety

Machinery Hazards

Fixturing

- **Make sure workpieces are affixed to the tool**
- **Use a vise or clamps**

Vibration

- **Proper fixturing prevents inaccuracies caused by vibrations**

Danger

- **Improperly fixtured parts can fly out of clamp and cause injuries**

Safety

First Aid

Injuries

- Call for help
- Get the First Aid kit

When to call for help

- Notify an adult or teacher immediately
- Don't hesitate to dial 911

First Aid Kit

- Must be located in an open, accessible area
- Make sure it is stocked
- Know where it is

Safety

First Aid

Bleeding

- Apply pressure
- Wrap with a clean bandage
- Go to ER if bleeding does not stop

Shock

- Massive blood loss will cause shock
- Body's defensive mechanism
- Keep person warm and awake
- Dial 911

Fire

- Know where your fire extinguisher(s) are
- Make sure they are charged
- Don't hesitate to use it!!!

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Safety

First Aid

Falls

- If person is unconscious call 911
- Don’t move them, will cause worse injuries

Broken bones & joints

- Area will swell massively and be very painful
- Call 911
- Don’t move the person or body part until help arrives

Sprains and strains

- Don’t move the joint
- Put ice on the swelling
- Ibuprofen (Advil) will help pain and swelling
- Keep weight off of injury

Safety

Activity

15 MINUTES

1. Where is your First Aid Kit?
2. What's in it?
3. Where is your fire extinguisher?
4. What other safety equipment do you have?

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FABRICATION

Fabrication

Basics

Drills

- **Make sure drill bits are spinning the right direction (clockwise)**
- **Use sharp bits**

Safety

- **Eye protection is always required**

Common Sense

- **If you don't think it's a good idea, don't do it!!!**

Fabrication

Drilling

Drilling

- **Drill bits remove material quickly**
- **Drill bits are not precise**

Lubrication

- **Drilling creates a lot of heat and friction**
- **Oil helps disperse heat and protect bits**
- **Always use oil while drilling in metal**

Fabrication

Drilling

Speed and Bit size

ALUMINUM: 800-1000 RPM

STEEL: 300-800 RPM

Chips

- **As drill bit size increases, cutting speed must decrease**
- **Increased bit diameter requires more power to turn**
- **Watch chip formation**
- **Nice long chips are good**
- **Squeaking means speed too high and not enough oil**

Fabrication

Drilling

Drills

- Two types
- Handheld Drills
- Drill Presses

Handheld Drills

- Convenient
- Easy to use
- Battery or corded
- Inaccurate

Drill Presses

- Restrictive to parts that can fit
- Powerful
- Accurate

Fabrication

Drilling

Accuracy

- Center punch your marks before drilling
- Drill pilot holes
- Step up drill bit sizes to make a large hole
- Ex. ½" hole:

  Center punch mark

  Drill ¼" hole, then 3/8", then ½"

Thick material

- Peck drill
- Drill a little bit, pull out
- Keep oil in the hole
- Don't let drill bit get too hot

Large bits (> ½")

- Use only in lathe or mill
- Bits are too big for handheld drills
- Material removal rate too high for drill press

Fabrication

Drilling

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Fabrication

Cutting

Cutting

- **Material is removed along direction of blade travel**
- **Powered and Manual**

Manual (Hacksaw)

- **Simple & quick**
- **Can be accurate if part is fixtured properly**
- **Safe**

Powered (Bandsaws and Circular saws)

- **Quick**
- **Accurate**
- **Dangerous**

Fabrication

Cutting

Materials

- **Cut metal, plastic or wood**

Metal

- **Aluminum: Toothed blades only**
- **Steel: Abrasive blades**

Plastic

- **Large toothed blades**

Fabrication

Cutting

Rotary Saws

- One round blade with multiple teeth
- Toothed or abrasive

Chop saws

- Blade is moved into the fixed workpiece

Table saws

- Plastic and wood only
- Workpiece is moved into spinning blade

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Fabrication

Cutting

Milling

- Good for cutting thick plates

Shears

- Good for cutting thin plates

Hacksaws

- Good for quick cuts

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Fabrication

Cutting

Fabrication

Grinding

Why Grind?

- **Grinding removes a small amount of material**
- **Leaves a smooth surface finish**
- **Creates a lot of heat**

Surfaces

- **Grinding surfaces are like thousands of small saw teeth**
- **Sandpaper, stone, or files**

Rated in "Grit"

- **Higher number means finer grinding surface**
- **Lower number means more material can be removed**

Fabrication

Grinding

Grinders

- **Benchtop**
- **Handheld**

Bench Grinders

- **Workpiece is ground in the spinning wheels of the stationary tool**

Angle and Die grinders

- **Handheld tools grind on stationary workpiece**
- **Can also be used to cut steel with cutting disc**

Fabrication

Grinding

Safety

- Eye and ear protection
- Face shield

Steel and Aluminum

- Do not grind aluminum
- Aluminum melts and sticks to grinding wheels

Fabrication

Fabrication

Milling

Reasons to Mill

- Material removal
- Accurate hole placement
- Multi-axis machining

Types of Mills

- Vertical (most common)
- Horizontal

Tooling

- Endmills
- Facing bits
- Drills & Reams

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Fabrication

Milling

Basics

- Tool remains stationary
- Workpiece moves with table
- x,y,z axes

CNC

- Computer Numeric Control
- Allows precise shapes to be cut quickly

Precision

- Properly fixtured parts can be machined up to 0.0005” accuracy
- Material removal rates must be controlled to maintain precision

Fabrication

Milling

Endmills

- Cut vertically or horizontally
- High material removal rates

Facing tools

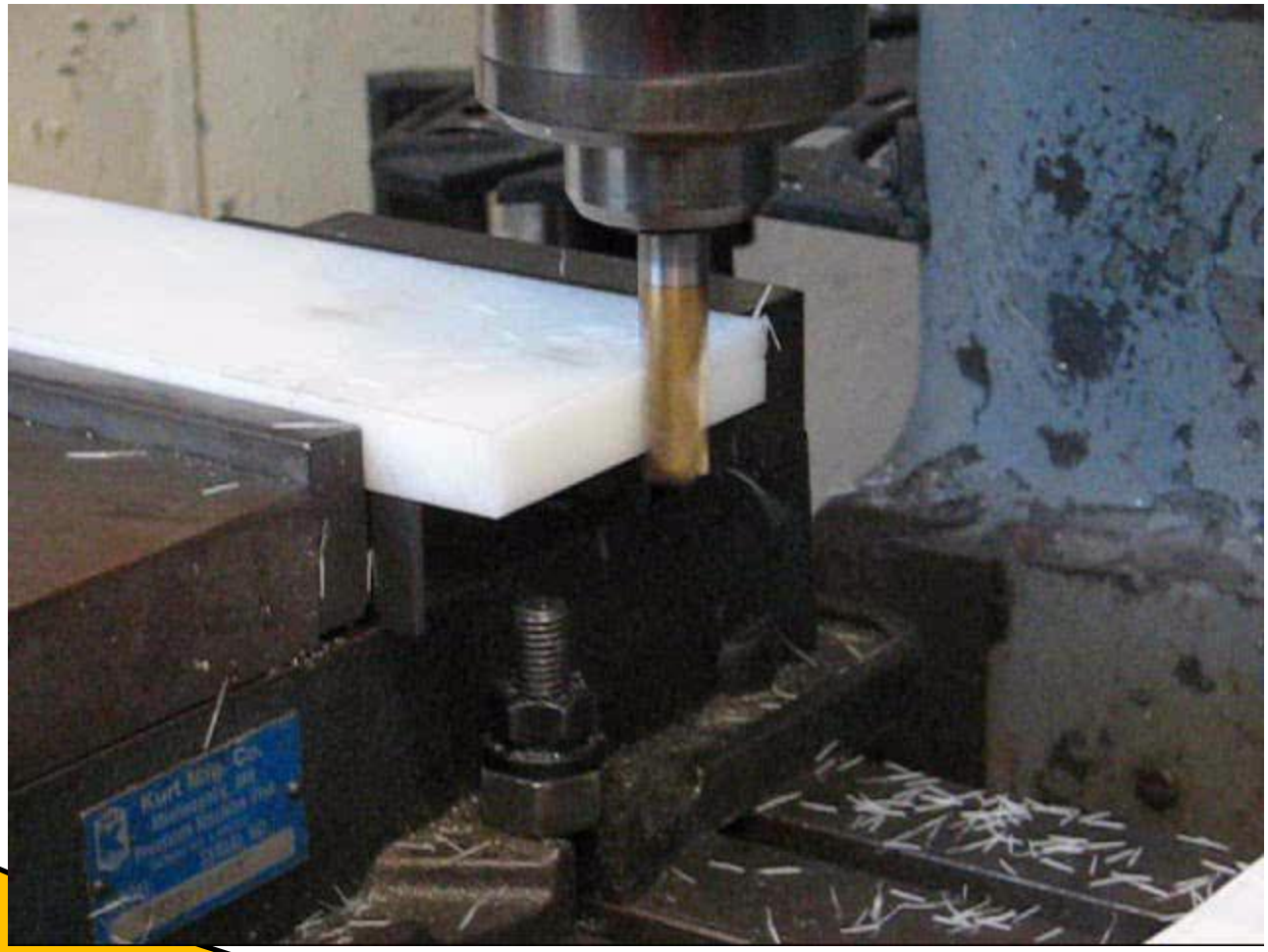
- Remove uniform layer of material from horizontal surface

Reams

- Create an accurate hole diameter from a drilled hole
- Slow

Fabrication

Milling



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Fabrication

Turning

Reasons to Turn

- Material removal
- Accurate round parts
- Make couplings
- Cut threads

Types of Lathes

- Metal
- Wood

Tooling

- Turning inserts
- Parting bits
- Single point cutting bits
- Drills & Reams

Fabrication

Turning

Terminology

- **Chuck**
- **Toolpost**
- **Tailstock**
- **Saddle**
- **Crossfeed**
- **Center**

Gearing

- **Lathes are geared to cut threads at a certain distance per revolution**
- **Constant feed rates provide good accuracy and surface finish**

Fabrication

Turning

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Fabrication

Tapping

Reasons to Tap

- Cut threads inside a hole
- Screw pieces together

Tap sizes

- Thread size is nominal diameter of bolt
- Also measured by Threads Per Inch
- Ex: ¼” x 20, ¼” x 28

  ¼” bolt, 20 threads per inch

  ¼” bolt, 28 threads per inch

Lubrication

- Always oil taps
- Slow cutting produces a lot of friction

Fabrication

Tapping

How to Tap

- **Drill the proper hole**
- **Consult tap table**

- **Turn tap 2-3 rotations**
- **Reverse direction to break chips inside hole**
- **Turn 1-2 turns, reverse ½ turn, repeat**

Fabrication

Tapping

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Fabrication

Activity

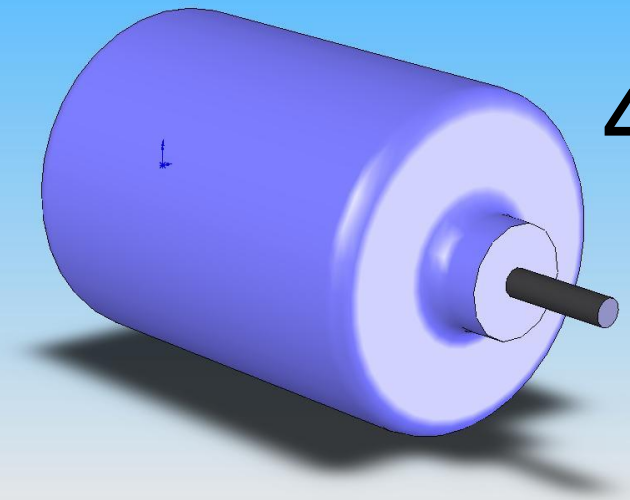
45 MINUTES

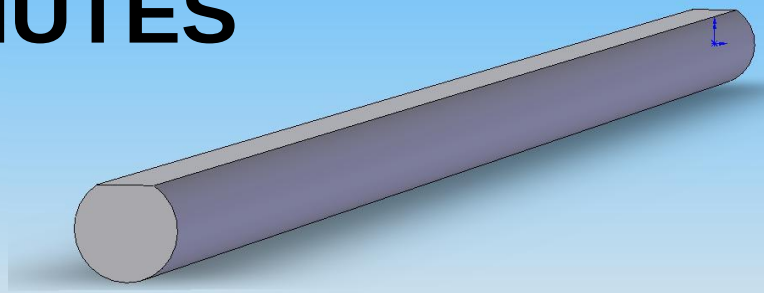
1. **Design a coupling**
2. **Connect this motor shaft to this gear shaft**
3. **Detail the machining processes involved**
4. **Draw and dimension your design**

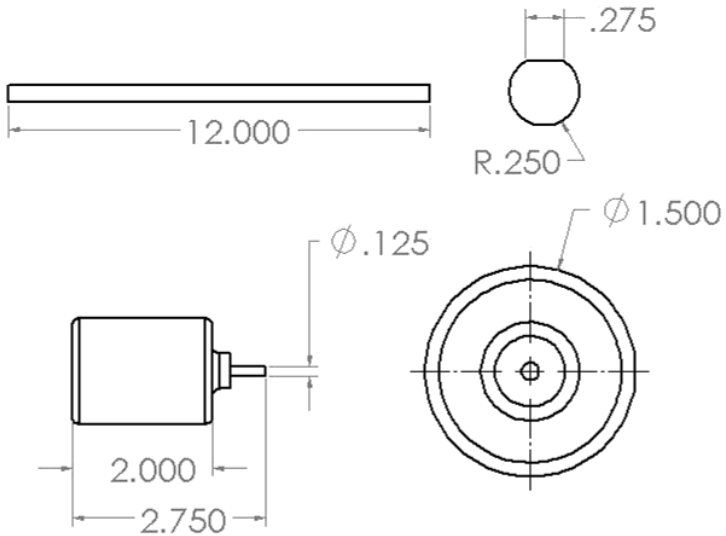
Fabrication

Activity

45 MINUTES







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http://www.robojackets.org

For more information contact the RoboJackets.
(contact info available via the web)

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