Fabrication and Safety

September 30, 2008

www.robojackets.org

Overview

- Design fundamentals
- Tool use basics
- Design considerations / constraints
- Safety tips
- Electrical considerations

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Machinability and Drafting

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Machinability

What does machinability mean?

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

Keys

- Think about how the part will be made when drafting
- Keep records of designs and changes
- Complete drawings before fabrication!
- Make sure machinists are aware of changes!

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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
- Don't duplicate/forget dimensions
- Callout hole sizes and threads
- Show 3 views of part (Top, Right, Front)

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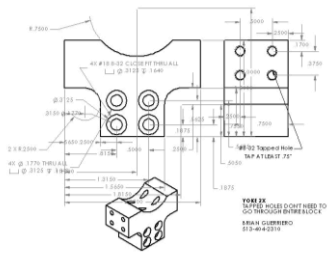
Drafting

Poorly drafted part



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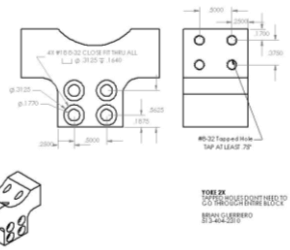
Drafting

Well drafted hole callouts



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Safety

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Safety

General

- Use common sense!
- If you have to think twice, it's not safe!
- NEVER WORK ALONE!

Rules: OBEY THEM OR GET OUT

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Safety

Clothing & Hair

BAD	Ok	Good	Best
Open Toed Shoes	Shoes	Boots	Steel Toed Boots
Tank tops	T-Shirts	Long Sleeves	Heavy shirt
Skirts	Shorts	Jeans	Snug Jeans

Tie Back Long Hair

NO: Dangling Jewelry

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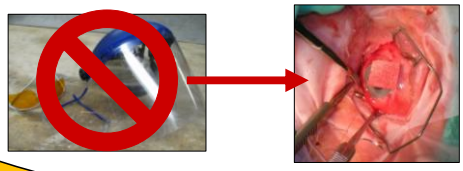
Safety

Glasses and Face Shields

ALWAYS WEAR SAFETY GLASSES!!!

Face shields: protect face. Must also wear safety glasses

Side shields must be worn on prescription glasses



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Gloves

Latex and Plastic	
Chemical and dirt resistance, good dexterity	Poor abrasion resistance, **NO HEAT – BURN RISK**
Leather	
Good heat and abrasion resistance	Poor chemical resistance, moderate dexterity
Cloth and Leather	
Good / moderate dexterity, good abrasion resistance	Poor chemical resistance, moderate heat resistance

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Safety

Hearing Protection

When to use?

Grinding
Using air tools
When it is loud!

Ear Plugs	
Cheap, compact	May be awkward to some
Ear muffs	
More effective, reusable	Bulky, expensive

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Safety

Chemicals

Dangers:
- Fumes - Poison
- Burns - Flammable

Protect:
- Eyes - glasses
- Lungs - mask
- Skin - gloves, clothing

Spills:
- Alert teacher
- Make sure air is safe
- Sop up with litter or sawdust

Keep all Material Safety Data Sheets (MSDS) on hand!

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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 respiratory damage

Prevention:
- Cut outdoors!!
- Vacuum
- Moisture (wet sanding)

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Machinery Hazards

- DO NOT touch moving parts!

- Machined parts get hot!
  - Chips and tooling too!
- Maturity
  - No horseplay in the shop
  - No throwing tools
  - No fighting

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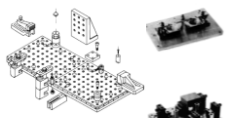
Fixturing

What is fixturing?

- Make sure workpieces are securely affixed to the tool
- Use a vise or clamps
- Proper fixturing prevents inaccuracies caused by vibrations



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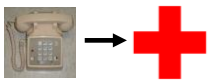
First Aid

Injuries

1. Call for help
2. Get the first aid kit



When to get help - ALWAYS

- 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

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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

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Fabrication – Drilling

Handheld Drills	
Convenient, easy to use	Inaccurate
Drill Presses	
Accurate, Powerful	Restricted to parts which can fit

- Use lubrication
- Nice long chips are good
- Squeaking means speed too high and not enough oil

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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

ALUMINUM: 800-1000 RPM
STEEL:300-800 RPM

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Fabrication – Powered Saws

Chop / Miter Saws

- Use toothed blades for plastic wood and soft metals (aluminium, brass)
- Wait for blade to spin up before cutting
- Do not use excessive force

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Fabrication

Cutting - Hand Tools

Lubricant will help with hacksaw

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Fabrication – Grinding

- Grinding removes a small amount of material
- Leaves a smooth surface finish
- High grit = fine, low grit = coarse
- Creates a lot of heat
- NO ALUMINUM

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Fabrication – Milling

- Reasons to Mill
  - Accurate material removal and hole placement
  - Multi-axis machining
- Basics
  - Tool remains stationary
  - Workpiece moves with table
  - x,y,z axes
- Tooling
  - Endmills
  - Facing bits
  - Drills & Reams

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Fabrication - Milling

- Endmills
  - Cut vertically or horizontally
  - High material removal rates
- Facing tools
  - Remove material from horizontal surface
- Reams
  - Create an accurate hole diameter from a drilled hole
  - Slow

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Fabrication - Turning

- Reasons to Turn
  - Material removal
  - Accurate round parts
  - Make couplings
  - Cut threads
- Tooling
  - Turning inserts
  - Parting bits
  - Single point cutting bits
  - Drills & Reams

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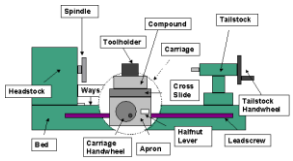
Fabrication - Turning

- Terminology
  - Chuck
  - Toolpost
  - Tailstock
  - Saddle
  - Crossfeed



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

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Fabrication – Tapping

- How to Tap
  1. Consult tap table
  2. Drill the proper hole
  3. Lubricate hole
  4. Insert and turn tap 2-3 rotations
     1. Reverse direction to break chips inside hole
     2. Turn 1-2 turns, reverse ½ turn, repeat

Take it slowly! Breaking a tap is a bummer! & $$

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Electrical Basics

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Circuit Elements

- Wire – Connects circuit elements
- Switch – Interrupts current flow
- Fuse/Breaker – interrupts *excessive* current flow
- Battery – Stores electrical energy chemically

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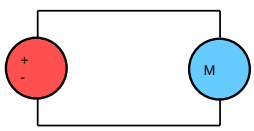
Wire

- Connects circuit elements with (ideal) zero resistance
- Strict rules in FIRST
  - Gauge (ga, awg)
  - Color
- Activity



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Wire Colors

BLACK IS ALWAYS GROUND
WHITE IS POSITIVE
RED IS POSITIVE

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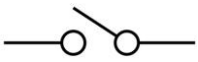
Switch

- Interrupts the flow of current
- Electronic switches
  - FETs
  - Relays (SPIKEs)
- Activity



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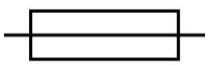
Fuse/Breaker

- Interrupt *excessive* current flow
- Strict FIRST rules
- ESSIENTIAL SAFETY DEVICE



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Battery

- Stores electrical energy chemically
- Strict FIRST rules
- Lead Acid
- Use the charger they give you
- Charge at 2.4 V / Cell

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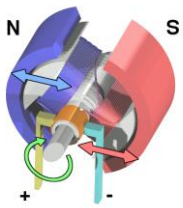
How DC Motors Work



- DC voltage in coil turns armature into an electromagnet
- This magnetic field interacts with the stators
- Producing a rotational force on the armature
- Commutation changes and process repeats

Force varies with applied voltage!

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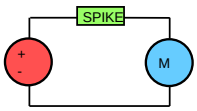
Switch/Relay

- Easy
- Unidirectional
- (Bidirectional)
- Slow (relatively)
- Mechanical (possibly)



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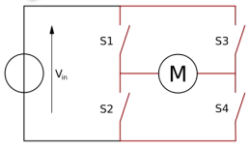
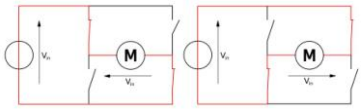
H Bridge



- Vary speed
- Direction change
- Solid state



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FIRST Electronics

- Strict rules
  - SAFETY
- Most parts supplied
- External Circuit – area of innovation
- Additional sensors

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FIRST Elect Diagram