Robot Building I (Kit details +)

Overview of the kit parts,
Discussion of possible uses of the materials.
Do's and do not's with components.
What's allowed for parts on your robot.
Tools
Other topics as time allows.
Q&A

SAFETY FIRST

This presentation does not cover proper safety. DO NOT do anything unsafe and always work with proper adult mentors and supervision when doing any robot fabrication.

THE Reference doc:

- BEST Returnable kit list
- Consumable kit list

Now included as part of the rules document

Also available under BEST File manager, Kits

(good for printing)

KITS CHANGE EVERY YEAR

Step 1, see what's different, new

What's covered in this presentation MAY NOT be all components

Fasteners

• As with everything, only what's in the kit is legal
•Exception: Teams may substitute shorter screws of the same type and grade.

•Learn the fastener names.
•Use the right fastener for the job
•**Use the right tool for the fastener**
•Do not exceed available quantities

Machine Threads:
•¼-20 *
•10-32 *
•8-32 *
•4-40
•2-56

Pipes and fittings

- ¾, 1”, 4” PVC and related fittings
- PVC Glue
- ½” metal conduit

Wood stock

- 3 plywood thicknesses (with ranges)
- Plywood can be any grade (2018)
- 1x4
- Dowel

Hardware

- Corner and angle brackets
- Hinges
- Screen door spring
- Lazy susan/turntable
- Plumber strap (metal pipe hanger)

Electrical

- Wire
- Bullet Terminals
- Mini/limit switches
- Heat shrink tubing
- Wire management – cable ties

Misc

- Masking Tape – only thing that can touch returnable
- Duct tape – any color OK
- Friction tape, electrical tape
- Glue – wood, epoxy
- Velcro
- Nylon string
- Bicycle inner tube
- Bicycle brake cable
- Rubber bands

Important extras not in the kit

- Cardboard (2400 in^2)
- Clothes pins
- Cans, hangers, more epoxy
- Pennies (think weight)
- CDs
- 25 extra small cable ties or clips, or wraps that can be used on wiring (only)
- Team custom part

You can do almost anything to/with any consumable item

Basic Tools

- Phillips Screwdrivers: #0, #1, #2.
- Bitdrivers recommended, power drivers helpful
- Small flathead screwdriver for wire terminal blocks
- Center punch
- Tape measure
- Flat ruler, machinists ruler
- Combination square
- Carpenters square (24”) Recommend Alu.
- Hacksaw, Wood saws
- Hammers
- Needle nose pliers
- Sandpaper

Tools, cont.

- Allen wrenches (2, or 3 sizes max). Long handled are helpful
- Grill lighter (for “cutting” nylon string)
- Heat gun
- 11/32” combination wrench
- ¼”, 3/8, 5/16 wrenches
- Clamps (C clamps, Bar clamps)
- Worktable with replaceable work surface
- Pair if welding vice grips
- Soldering iron for motor interfaces (low usage but needed)
- Handheld drill. Cordless recommended
- Power driver
- Wire cutters
- Scissors

Drills and Taps

- 1/4 “ drill assortment, undersize and oversize
- Drill index
- Taps for each of the 3 larger machine screw sizes:
- ¼-20, 10-32, 8-32
- Tap wrench/handle
- Tap size drills (10-32= 5/32”,8-32= #29, ¼-20=#8)

- Tap and drill bit sources:
- Pep-boys
- www.mcmaster.com
- www.msc.com

Centering bits and tools

Compliance

- “Impress us” points for a Bill of Materials (BOM)
- Do not exceed quantities
- Do not use non-kit materials
- Follow rules for returnable kit do’s and don’ts
- Be under weight
- Be under size
- Don’t design to 24” and 24 lbs, design to 23 and 23
- Figure your scale will weigh light
- Do clean wire management
- “Table virtual box”


A box for
checking size
compliance.

Q&A (as time allows)

Next Session

Robot Building II (Mechanics +)

Goals:
To expose you to some tooling and processes that may be used as well as present examples of mechanics and locomotion.

This slide presentation is not all inclusive, only finite examples.
Thinking “outside the box” is what will make you a formidable competitor.

Keep the designs simple as possible (KISS)
Do not reinvent the wheel, use and improve existing designs
Adapt existing designs or subdesigns to new problems
Build a library of team solutions

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Tools II

Recommended tools

- Basic tools already covered +
- Scale (Sams club)
- Jig Saw. Orbital motion recommended.
- Drill Press
- Hole Saws (discuss usage) Wire brush
- Vise
- ¼-20 Die

Advanced/Deluxe tools

- Band Saw
- Metal bandsaw
- Chop saw
- Table Saw
- Z bender
- Metal brake
- Belt Sander
- 4” side grinder with cutoff wheel

- Mill
- Lathe

Advanced deluxe tool sources, info

Harbor Freight portable bandsaw and SWAG offroad stand
https://www.youtube.com/watch?v=F3YsWeH3Beg
https://www.harborfreight.com/10-amp-deep-cut-variable-speed-band-saw-kit-63444.html
http://www.swagoffroad.com/SWAG-V40-Portaband-Table_p_63.html

1x30 belt sander
https://www.harborfreight.com/1-in-x-30-in-belt-sander-60543.html

A Z-bender tool (available at RC model shops).

Letter size drills allow for fine adjustments for holes for the 1/4” rods (I use between the B and the F sizes a lot).

Servo's and proper usage

- A servo is a positional motor
- Limited turning range
- Your software tells it where to move to and it does
- It is not designed as a “clamping” device
- Program the servo to move to more than one position for more than one need
- If they emit their spirit smoke, they are dead.
- Their internal shafts will bend
- Servo tester
- Servo design tip (on board)

Actuators

- Things that “grab”
- Try to minimize your grabbers size
- Don’t overdo it. Sometimes 2 points of contact is enough. 3 almost always is. Think about your own fingers and how you grab.

Interfacing motors

- The most common interface is a “hub”.
- Most common hub is a set screw based hub
- If hand-locating screw holes, make a hole pattern with one hole tha tis intentionally “off”. Minimize risk of cross threading when your part is attache dto the hub. The odd hole locates part in same orientation.
- DO USE the provided hardened socket head cap screws for set screws

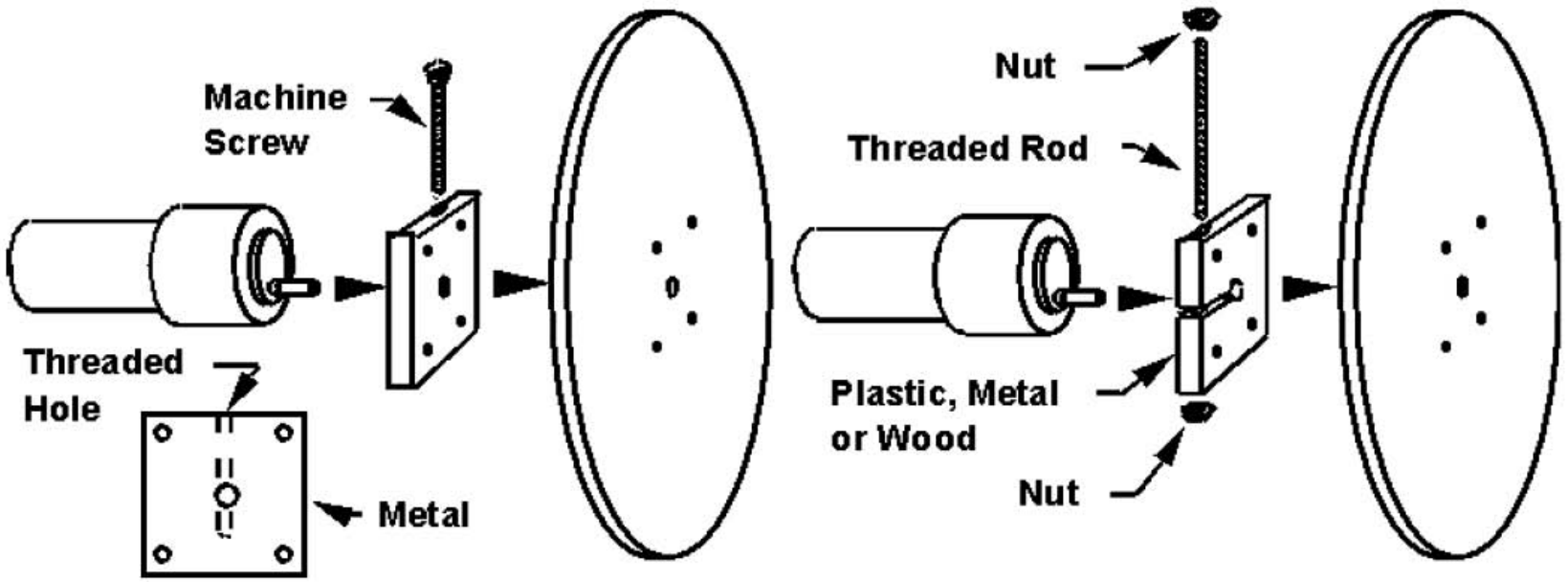
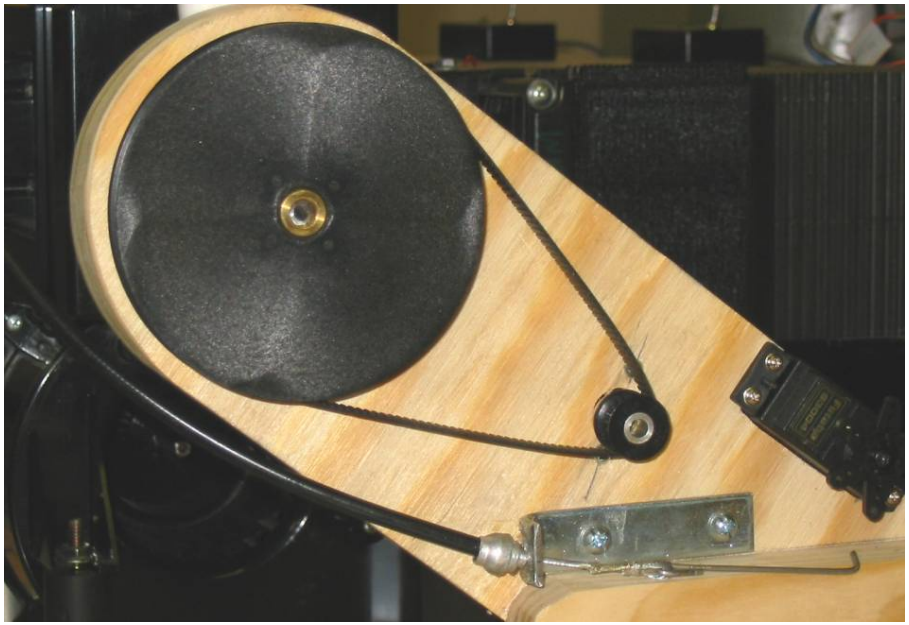
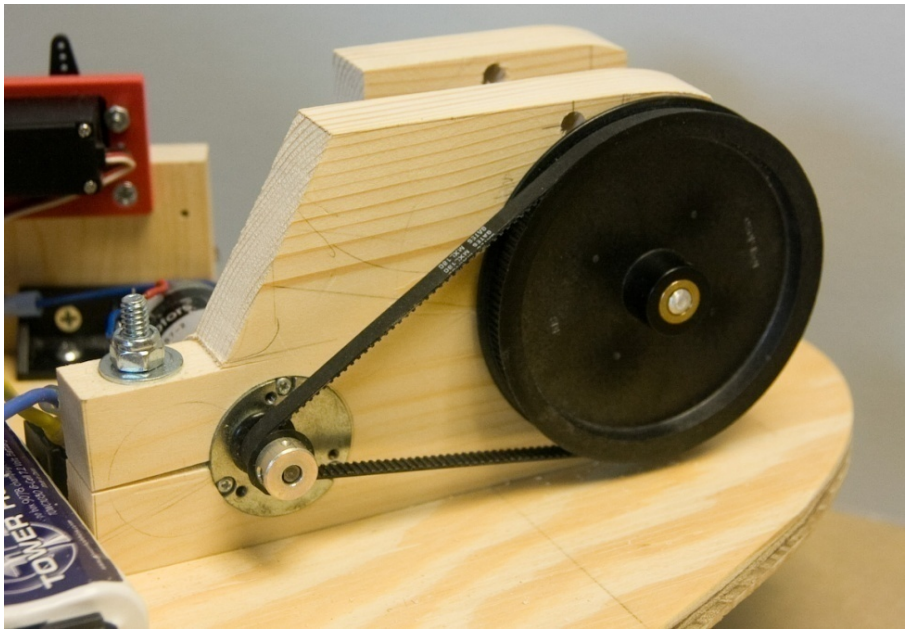


Figure 6: Two Suggestions for Mounting Wheels.

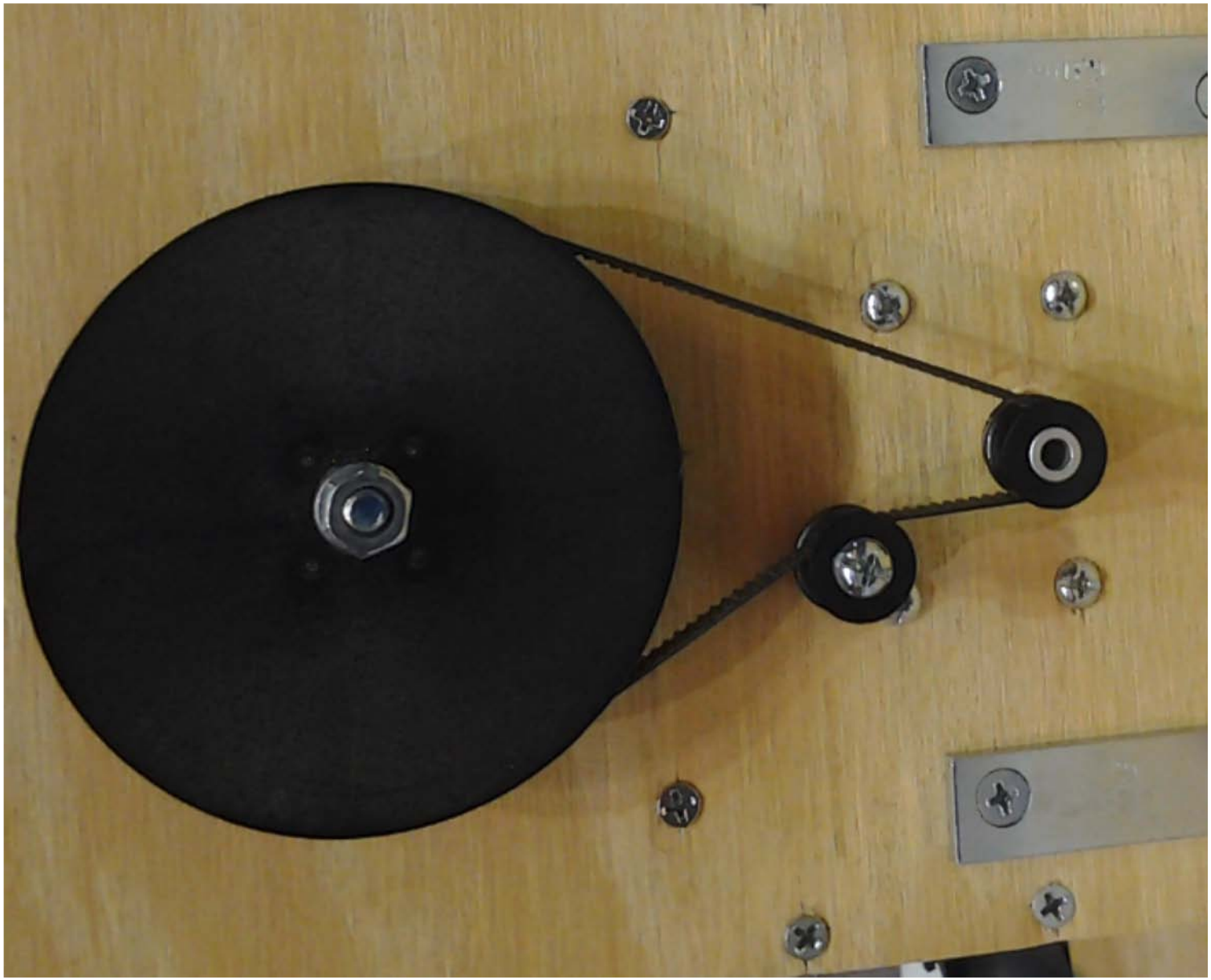
Standard wheel hub mount (note the relief holes in the wheel to allow for better wrench access).

Pulley Kit





Good pulley usage



Wire Management

- Do it.
- Route your wiring neatly and in a logical fashion. A neatly wired robot is easier to troubleshoot or repair during competition.
- Protect your servo connections with Painters tape
- Use cable ties and keep wires in control, away from moving parts. Allow proper slack to prevent back and forth bending and wire breakage
- Route wires inside tubes, keep neatly coiled inside body.
- Try not to bundle sets of wires so a component can be removed without having to undo a rats nest.

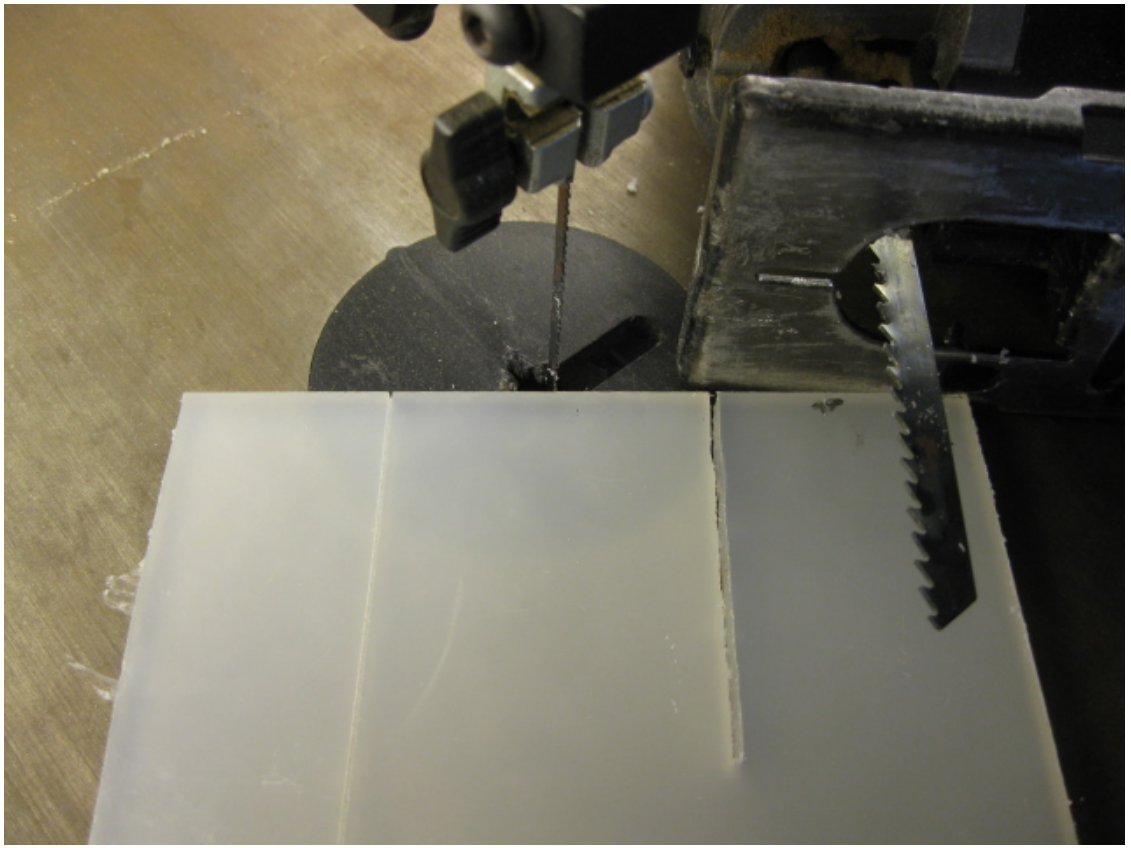
Fabrication Tips

- Use the 1/2” plywood for “base/body”. Holds wood screws better
- If necessary cut down screws for attaching to the motor front plate
- Leave excess material when possible (and trim later)
- Make jigs
- To avoid a tapered hole in aluminum, drill near full size first and then drill to final size
- Pre-drill for wood screws, drill diameter should be about the same as the inner thread diameter (prevents wood from splitting)
- Be careful when cutting off screws in plastic, the screw will get hot and melt the plastic (can hold a cold wet rag on the far side, or ice)

Fabrication Tips
(polypropylene sheet)

- Can be difficult to cut with a reciprocating saw (self welds)
- For a reciprocating saw use an aggressive blade (few teeth) with a wide cut at a slow speed (avoid heat build up)
- Cuts well with a band saw

Scroll saw cut on left has self welded. The saber saw cut on right, using the blade shown, remained open.



Fabrication Tips
(polycarbonate “Lexan”sheet)

- Can also be difficult to cut with a reciprocating saw (self welds)
- For a reciprocating saw use at least a medium blade at a slow speed (avoid heat build up)
- Cuts well with a band saw
- Can be cut with chop saw or table saw, but go slow to avoid brittle fracture
- Can be heated and formed
- Will get bubbles in the plastic if it is over-heated or has to much internal moisture
- For forming a simple bend
  - Clamp plastic at the desired bend line
  - Heat along the bend line with a heat gun (moving constantly)
  - Apply pressure often to make the bend without over-heating the plastic

Fabrication Tips
(polycarbonate “Lexan” sheet)

Fabrication Tips
(PVC pipes AND PVC sheet)

- Easy to cut (does not self weld) and form (with low heat)
- If heating, do not use an open flame and use a well ventilated area (will give off VOC's)
- If heating a small area, a heat gun works well; an oven at 200° F works well for larger pieces
- The 4" sewer pipe makes nice plastic sheet when cut and flattened
- To prevent a pipe from collapsing when bending
  - Place a coil spring inside that matches the pipe ID
  - Cover end with tape and fill with sand
- The material will split if you try a bend radius that is too tight (minimum bend radius ~ material thickness)
- Cooling with a wet rag or a bucket of water can speed things along once a desired shape is achieved

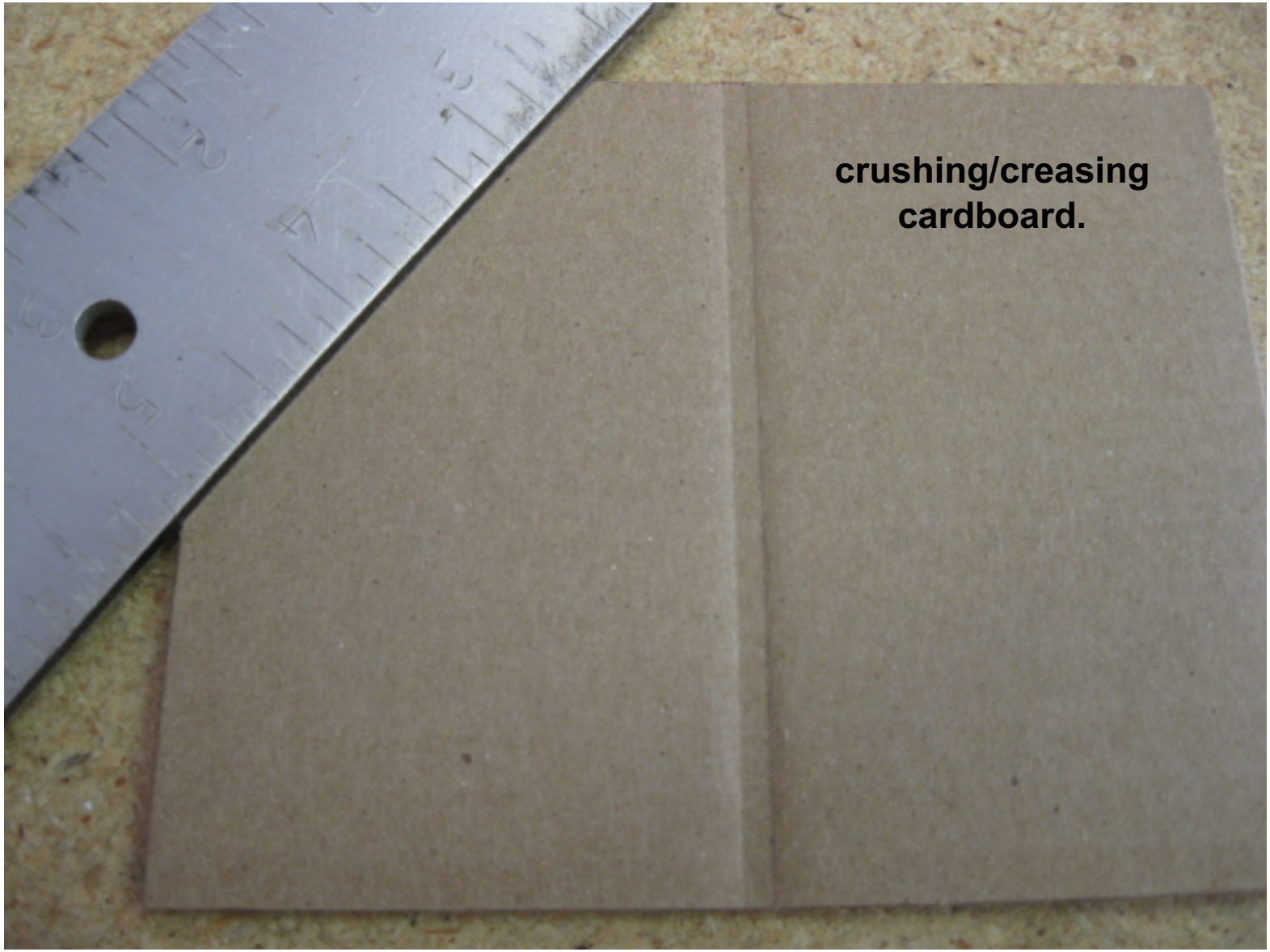
Bending PVC.

Fabrication Tips
(anodized aluminum IGUS rod)

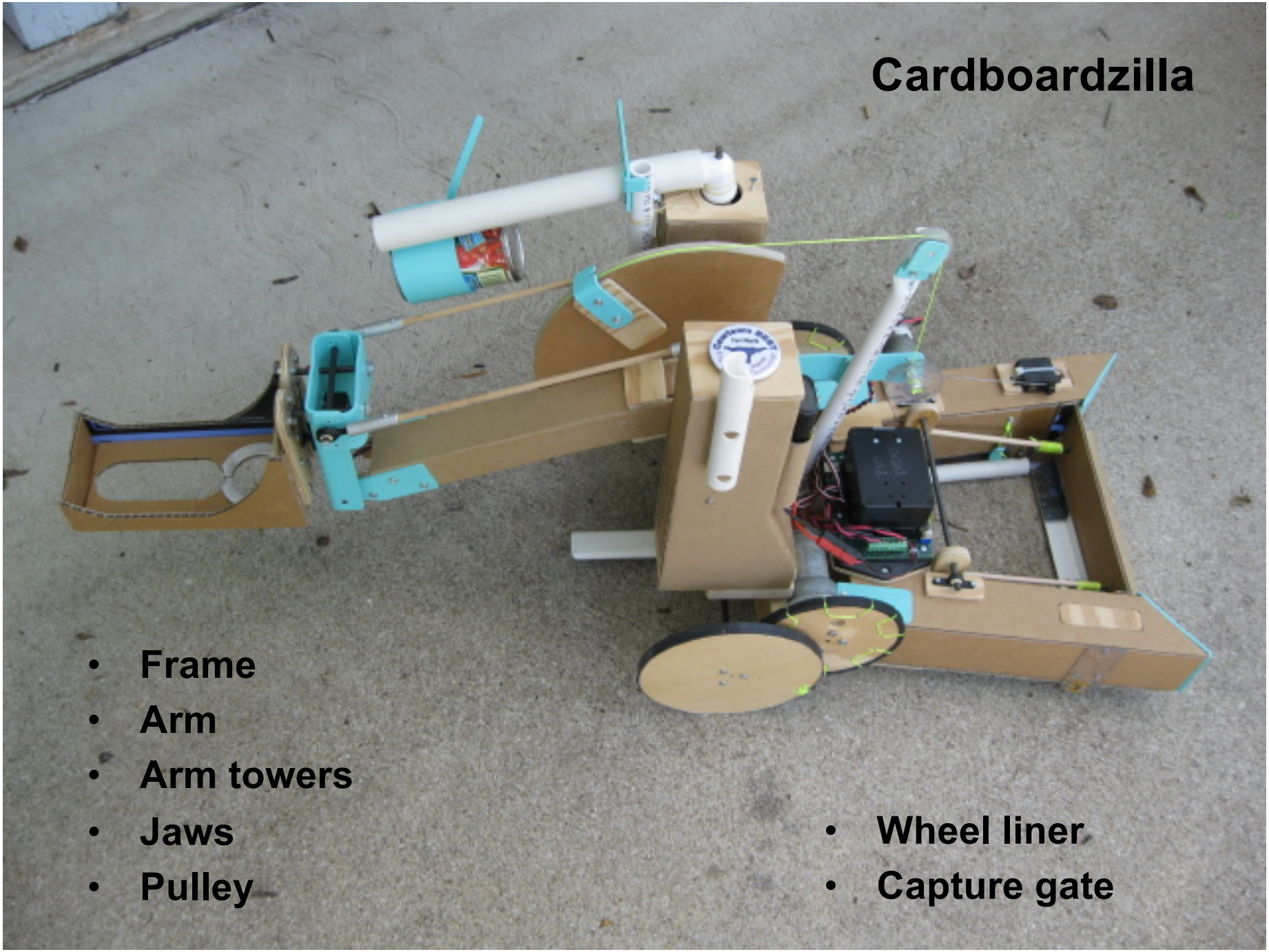
- The anodized aluminum rod surface is very hard, making it difficult to drill through (the drill bit slips off to one side) or cut (hacksaw wanders)
- Nick through the anodized coating with a dremel tool prior to drilling or cutting
- V-Blocks and Center drill work well with no prep work

Fabrication Tips (cardboard)

- Cardboard is very easy to work with and has a fantastic weight to strength ratio
- You can use a lot of it (the rules allow for 2,400 square inches of corrugated cardboard up to ¼ inch thick)
- Cut with a sharp utility knife
- Crushing/creasing along bend lines prior to bending helps a lot
- Can be used for serious structural parts by gluing wood plates at interfaces


crushing/creasing
cardboard.

Bending cardboard.

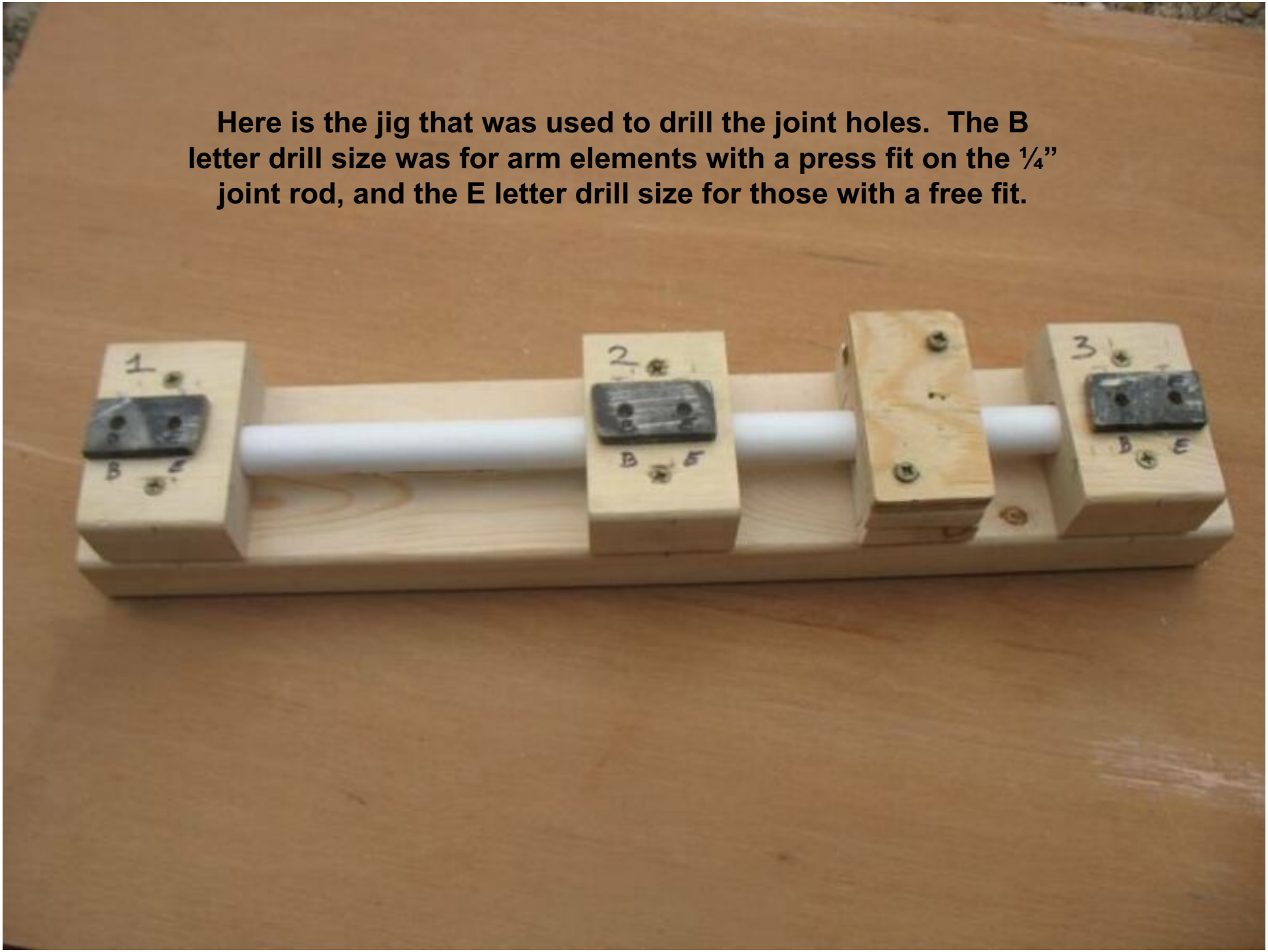

Cardboardzilla
• Frame
• Arm
• Arm towers
• Jaws
• Pulley
• Wheel liner
• Capture gate

Jigs

(Useful for repetitious tasks
Or making multiple parts)

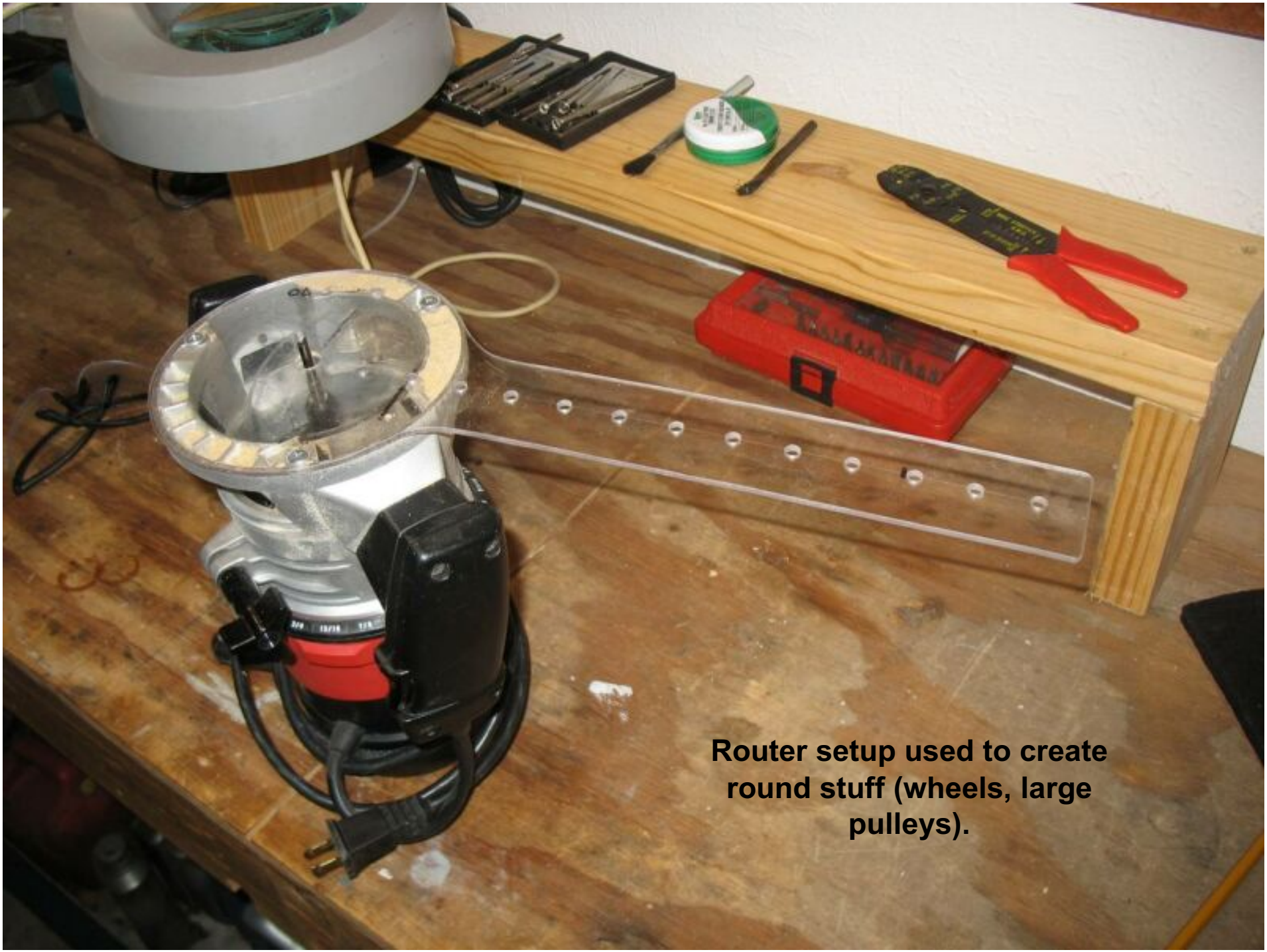

15 elements from a scissor arm. High precision is required
(and lots of lightening holes in this case).

Here is the jig that was used to drill the joint holes. The B letter drill size was for arm elements with a press fit on the ¼" joint rod, and the E letter drill size for those with a free fit.



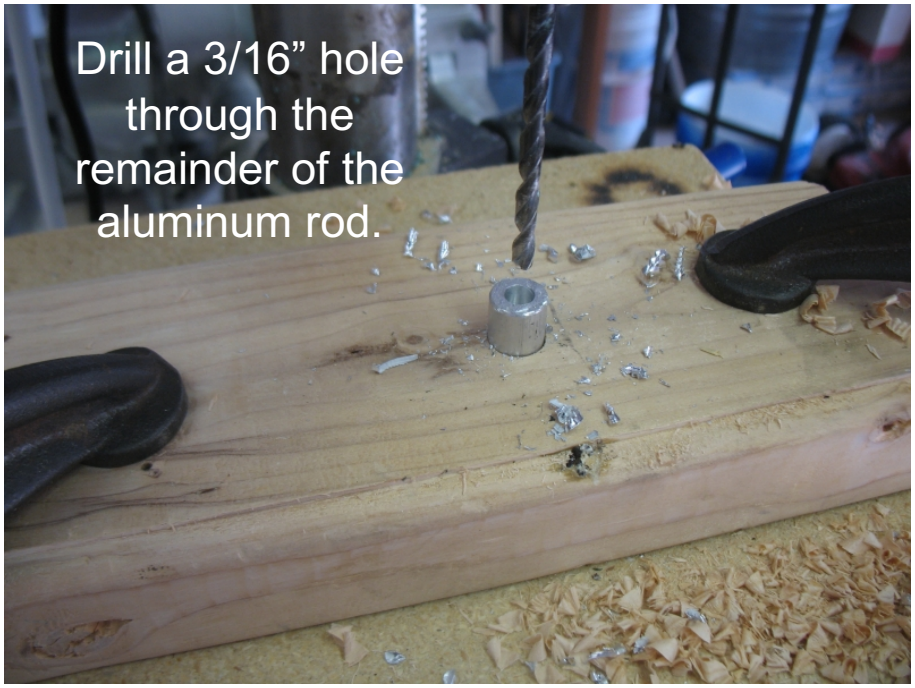
Here is the jig that was used to drill all of the lightening holes in the arm elements.


A jig that was used to form a motor mount. I also recommend a workbench with a replaceable top such that you can secure things to it directly with screws.



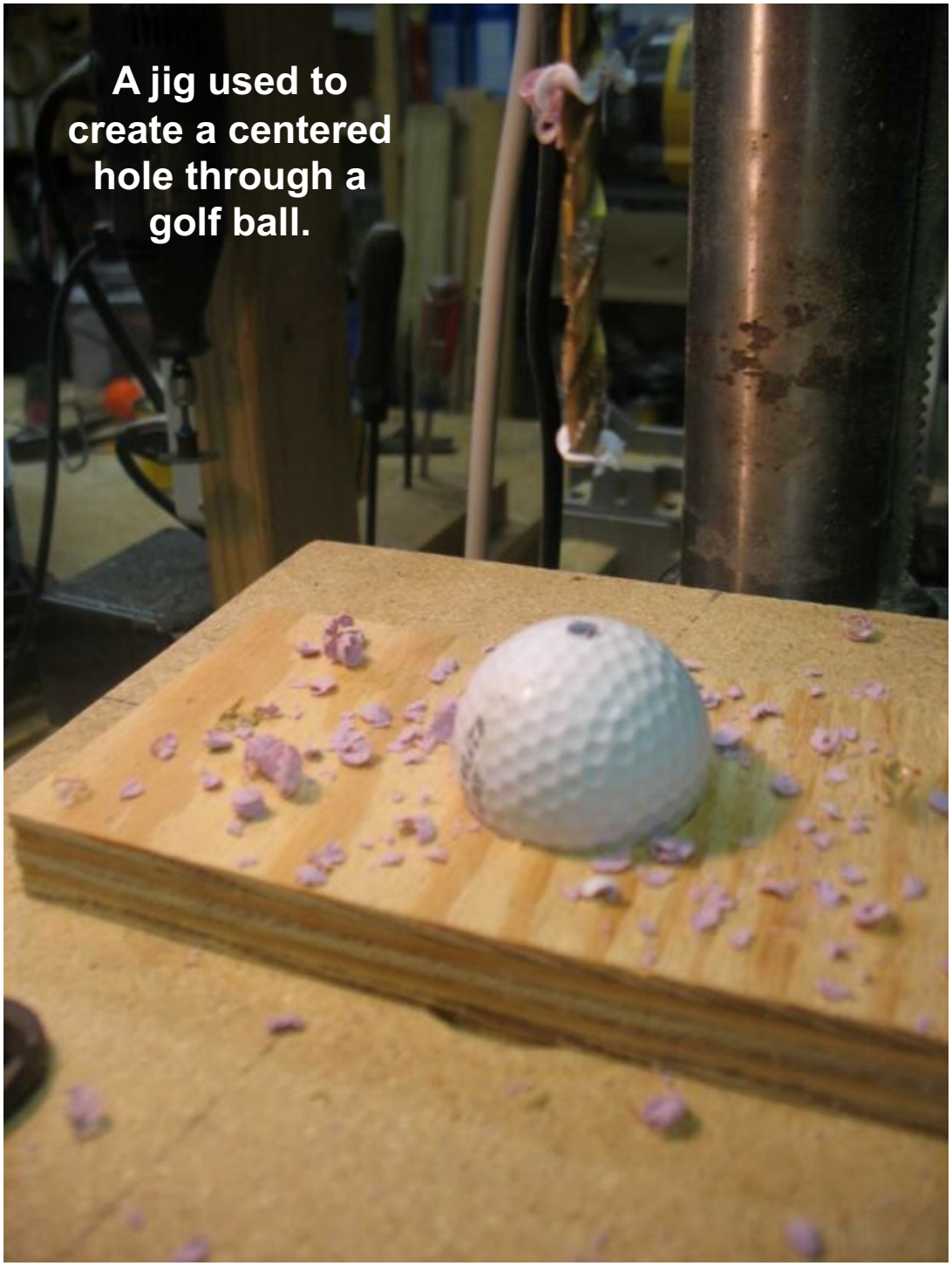
Router setup used to create round stuff (wheels, large pulleys).

Steps for creating a coupling to join the small motor to a 1/4” rod. The drill press setup is unchanged through these step. Only the drill bit is changed out. This is to ensure axis alignment.



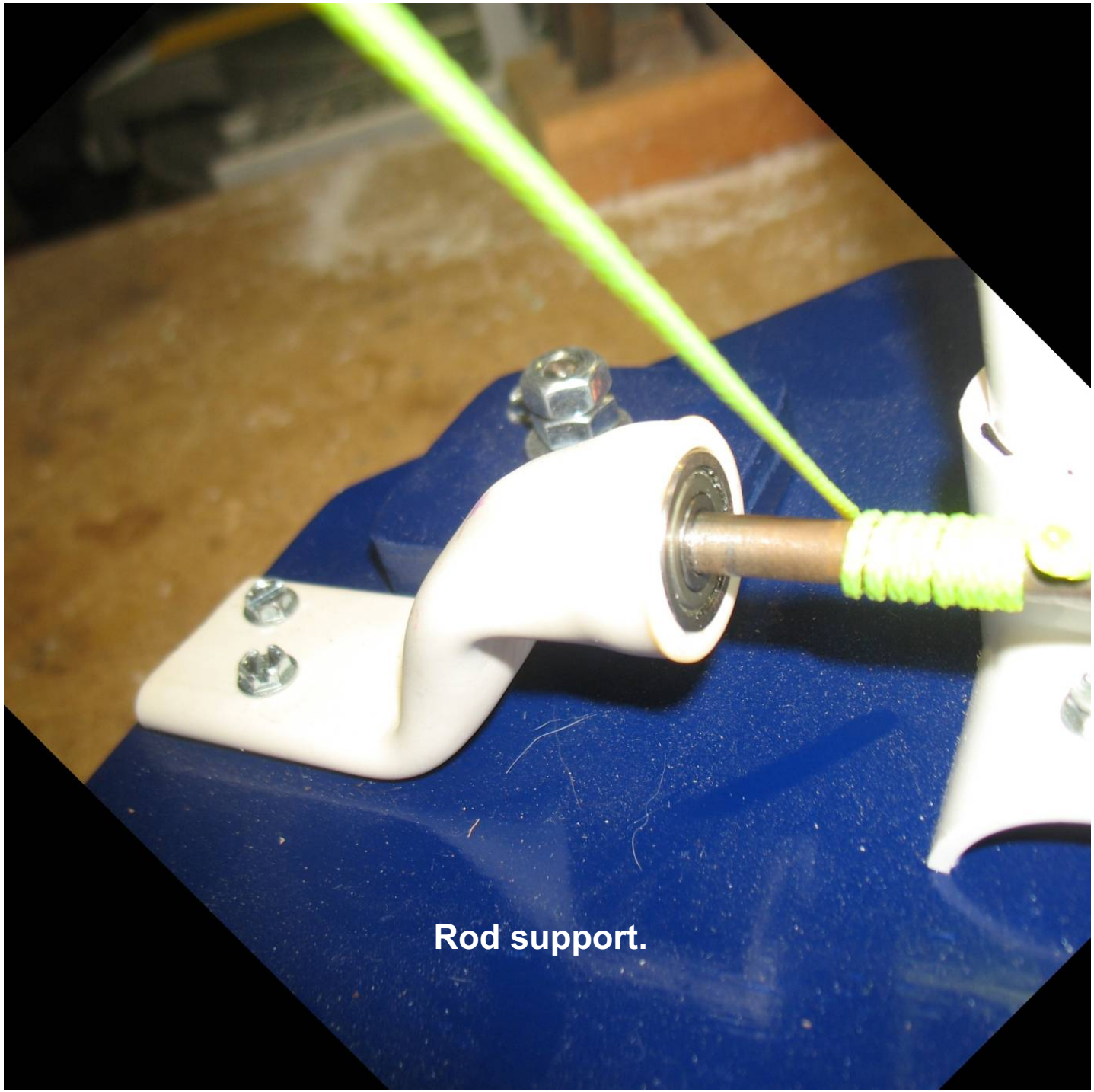
Other tips: Water can be used (in the hole) to get the wood to swell up and give a tighter fit on the aluminum rod.

Make sure the 1/4” drill does not wander with the initial contact with the aluminum rod (the hole will be drilled at an angle if it does).

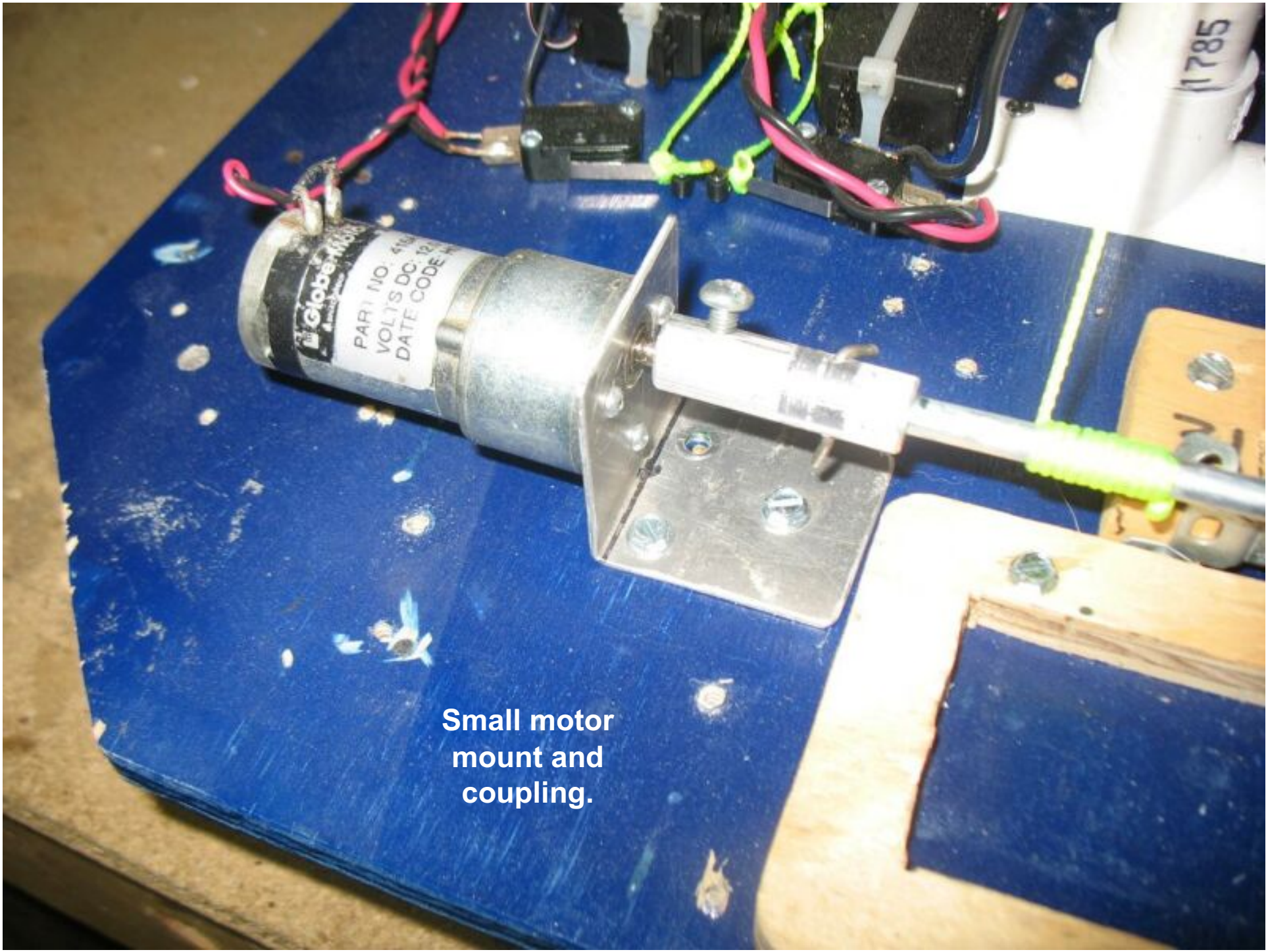

A jig used to create a centered hole through a golf ball.

V-Block (for supporting round stock).

Examples



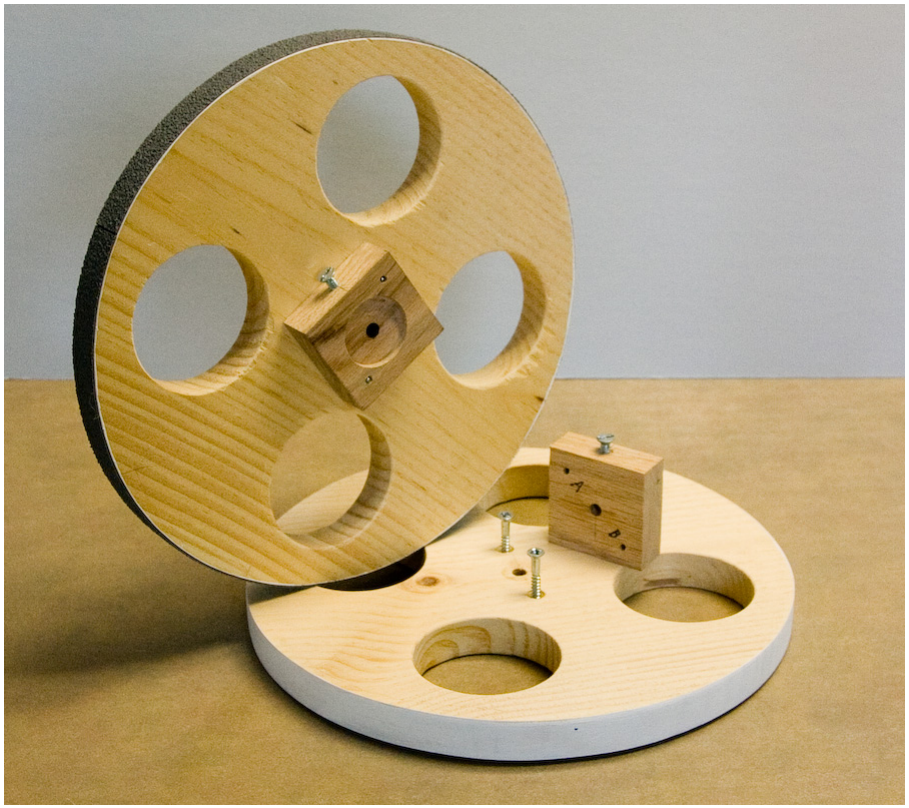
Rod support.

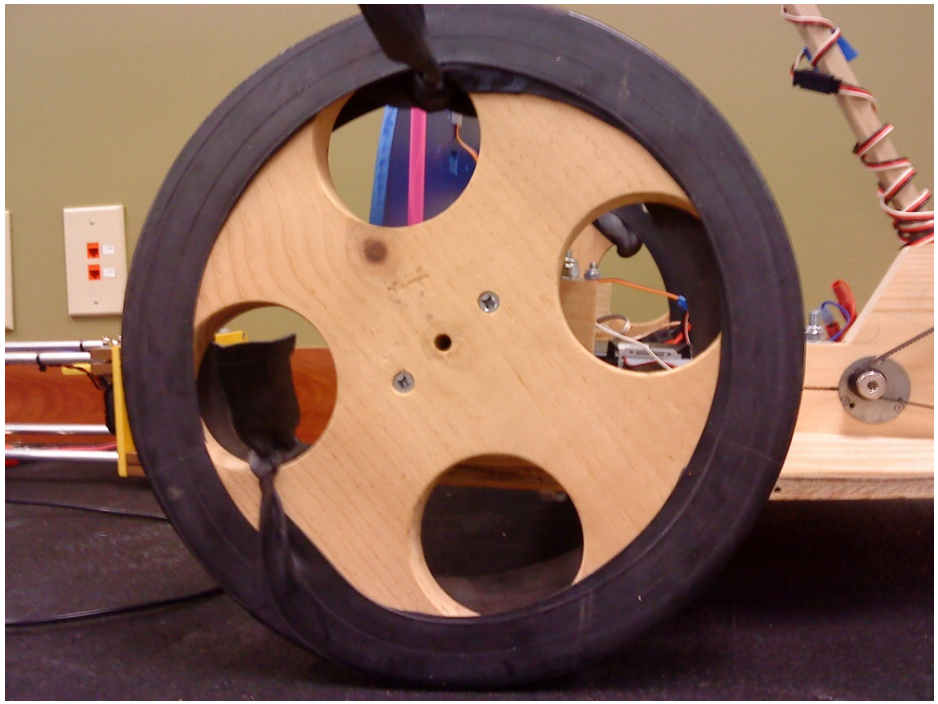


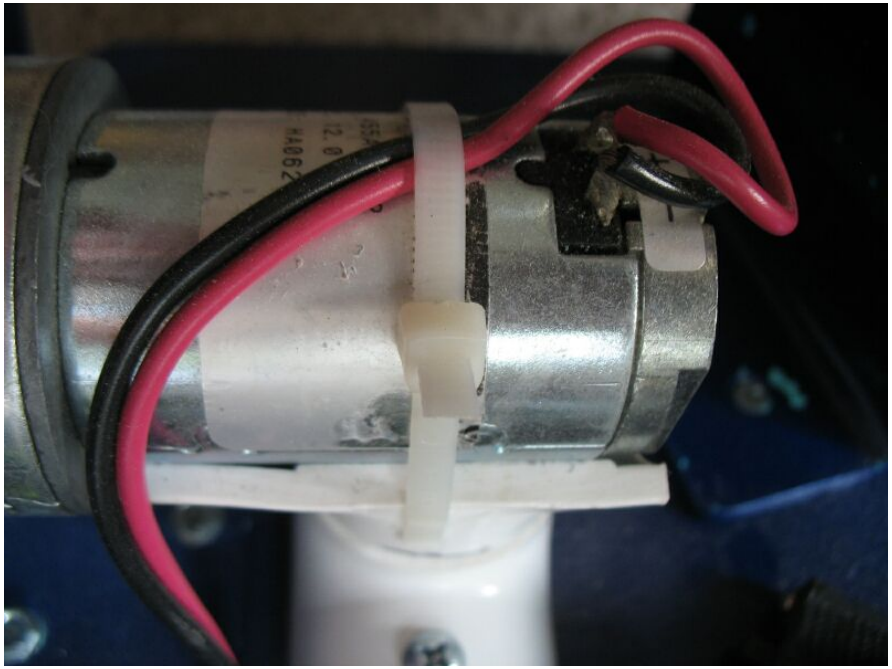
Small motor mount and coupling.

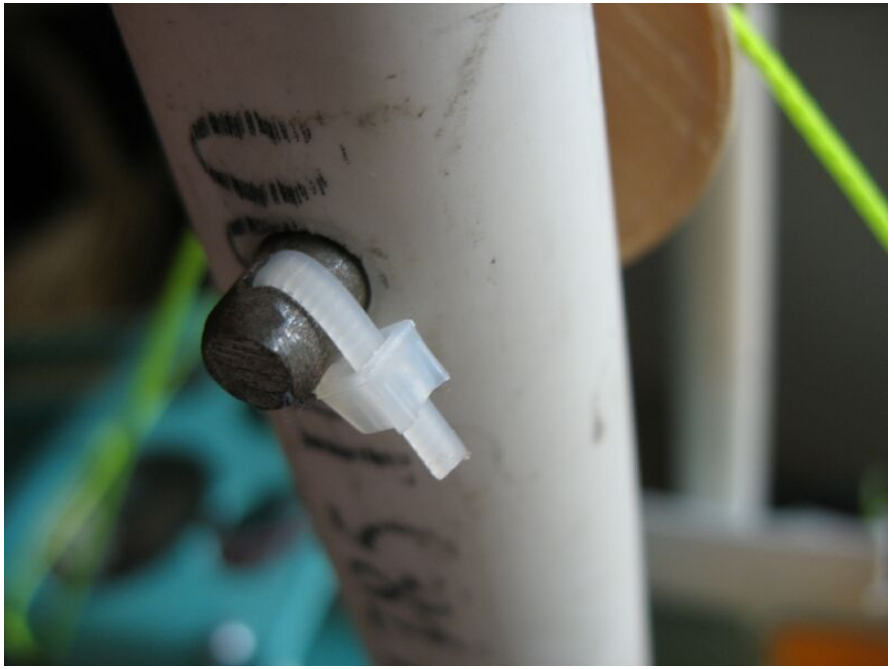
Wheel & Hub

A larger wheel means more speed/less power.
A smaller wheel means more power/less speed.
Track/tank tread is also an option.

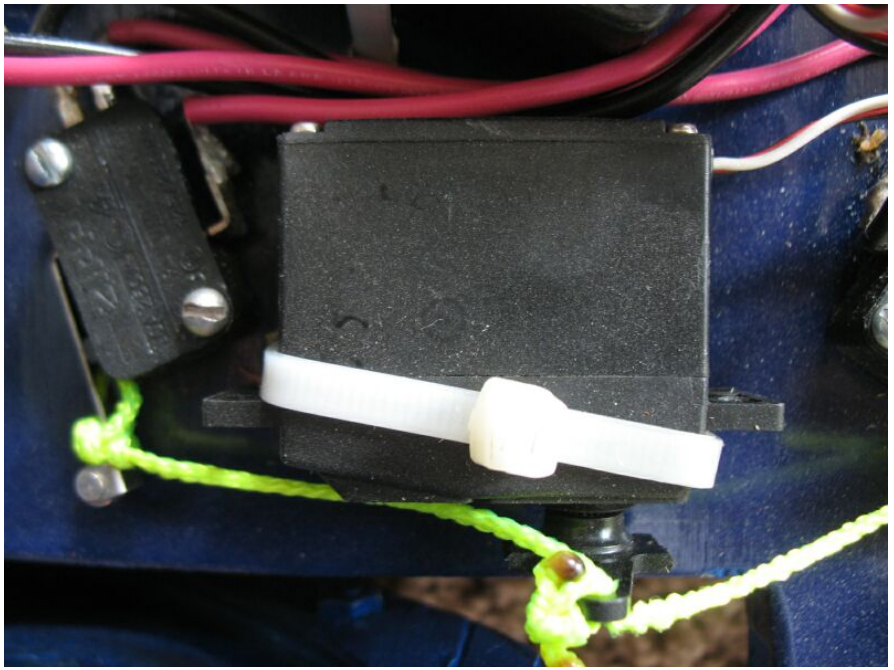




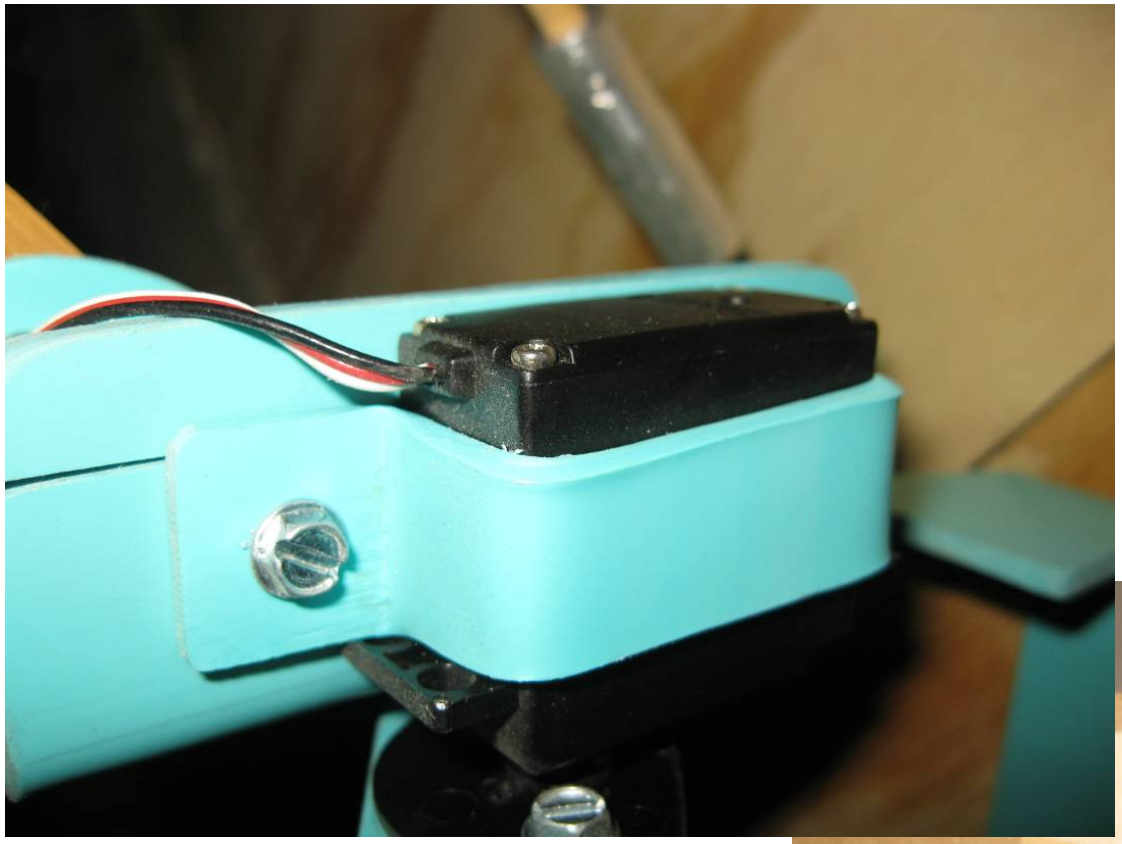


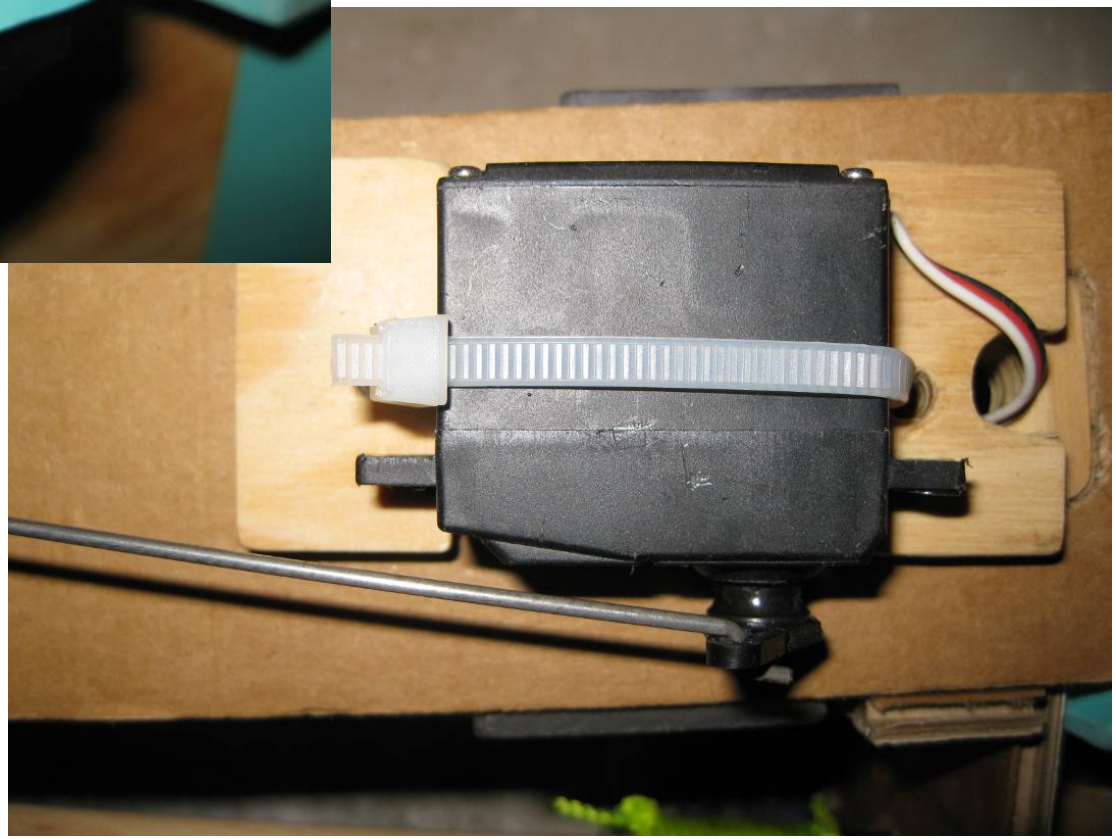


Stuff to do with zip ties.



Servo mounting examples.





Cereal box cardboard is great for mixing and spreading epoxy

Set Screw Flats

- If you grind a flat on the shaft where you will use a set screw in a coupling, it will lessen the likelihood of the shaft breaking free.

Q&A