



- Advanced Robot Building and Design Tips

- Jim Walter

Session Summary

- Scoring Tips
- Use the Engineering Design Process
- Discuss robot “subassemblies” and interface parts
- Consider the available material and their best use
- Tools and their uses
- Fabrication tips and examples

Scoring Tips

- Know the rules
- Understand the scoring
- Develop your scoring strategy
- Build your robot based on your scoring strategy
 - Example New London Total Recall
 - Example Archers Space Elevator
- Develop robot maneuvering strategy
- Practice driving

- P.S. This year is complex, make sure you understand what it's

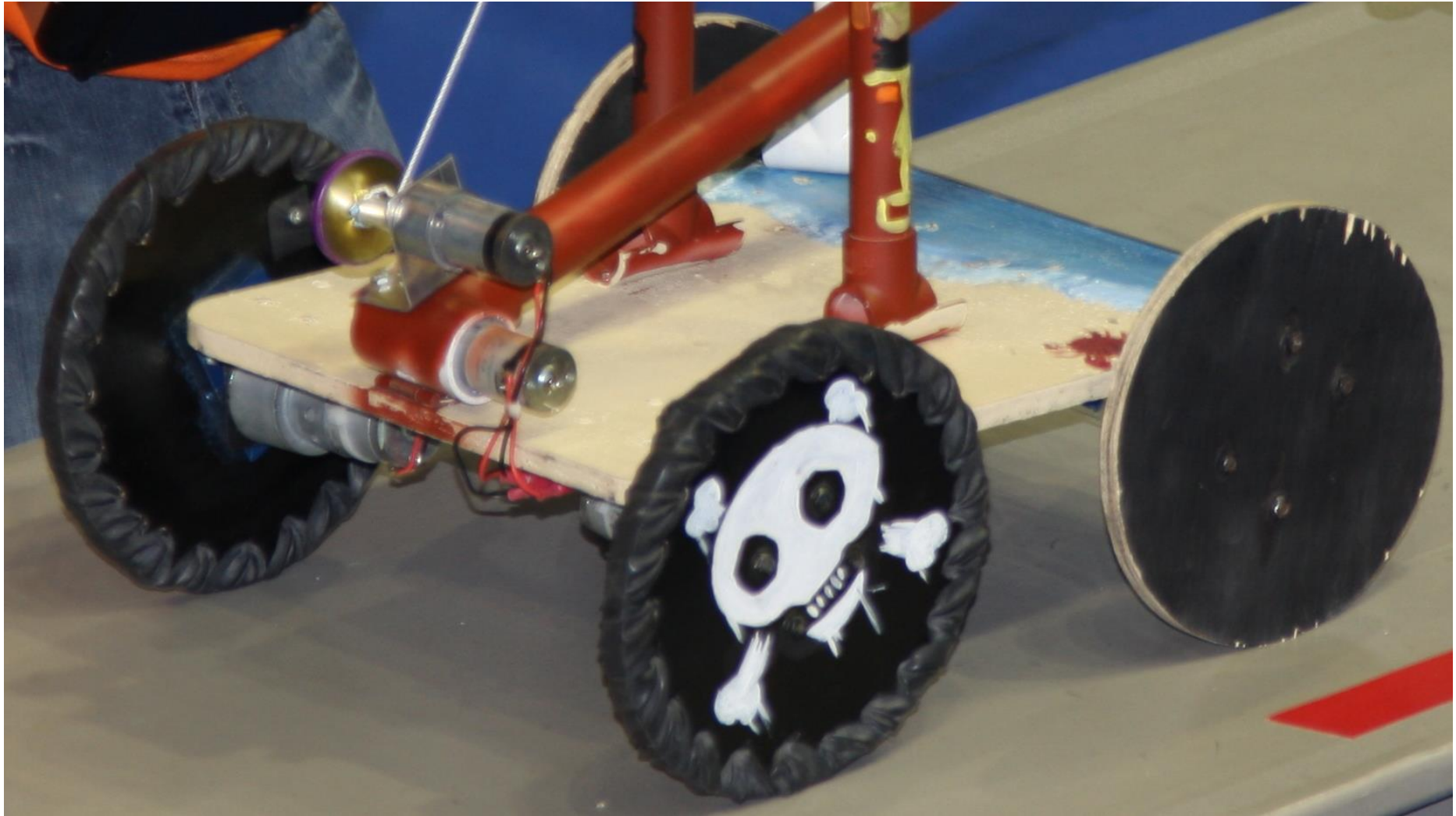
Engineering Design Process Tips

- Know the rules, scoring and develop scoring strategy
- Build part of the game floor and simulate robot movement (mentors)
- Use eDrawings to review Solidworks field and use measurement tool
- EDP brainstorming session identify many alternatives (week #1)
- Determine the different “subassemblies” for your robot
 - Base, tower, arm and claw
- Determine which alternatives work best together
- Determine your interface parts
- Prototype robot parts and/or CAD your robot
- Robot refinement (subEDP) week #4 or #5

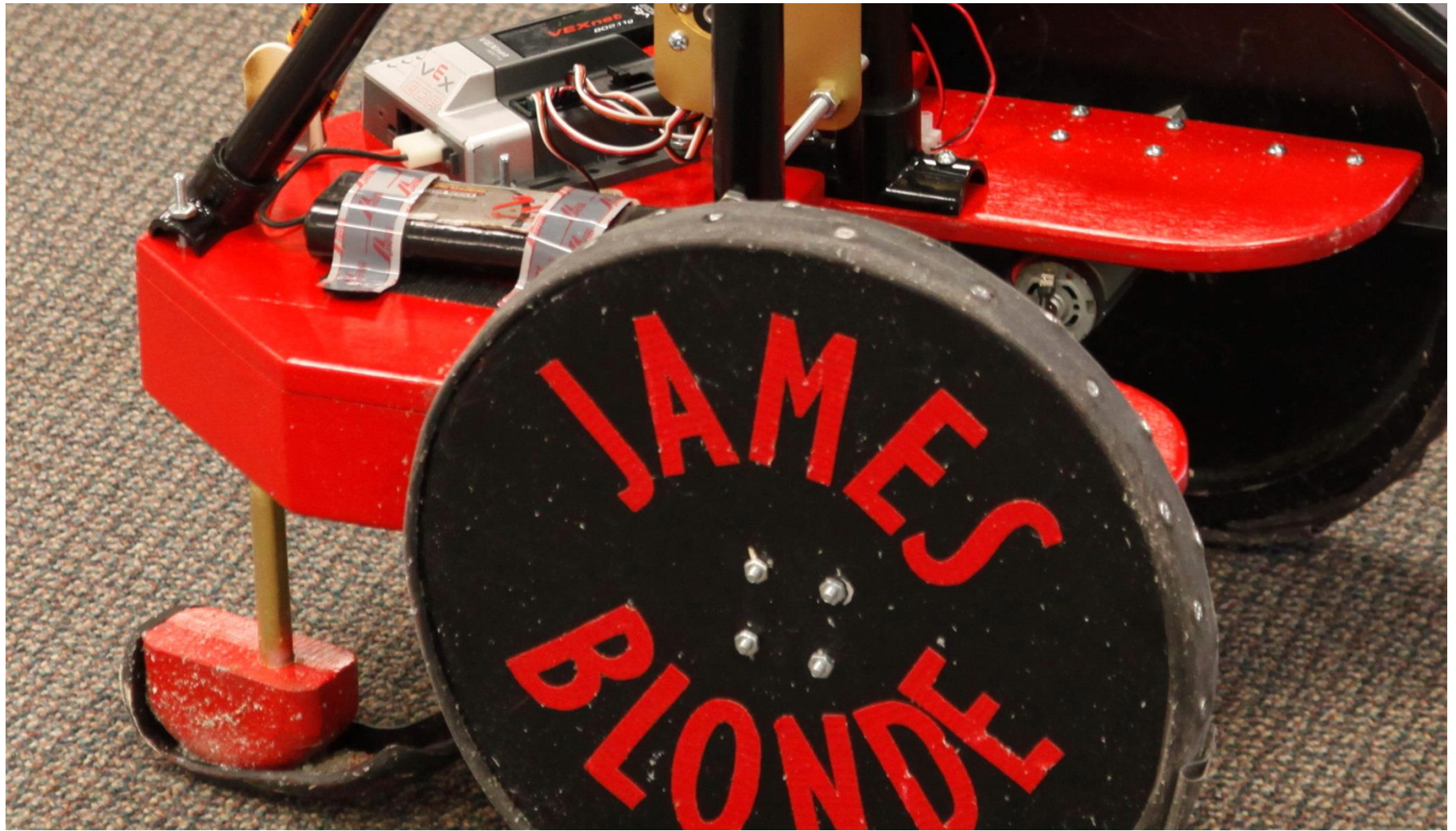
Parts and Subassemblies

- A typical robot has a number of subassemblies
 - Base
 - Tower
 - Arm
 - Grabber/Claw
- You typically need transition parts to connect these subassemblies
 - Base to tower
 - Tower to Arm
 - Arm to Grabber/Claw
- Design and build individual parts to create the subassemblies
 - Levers
 - Gears
 - Tubes
 - Wheels
 - Winch
 - Support or bracing mechanism

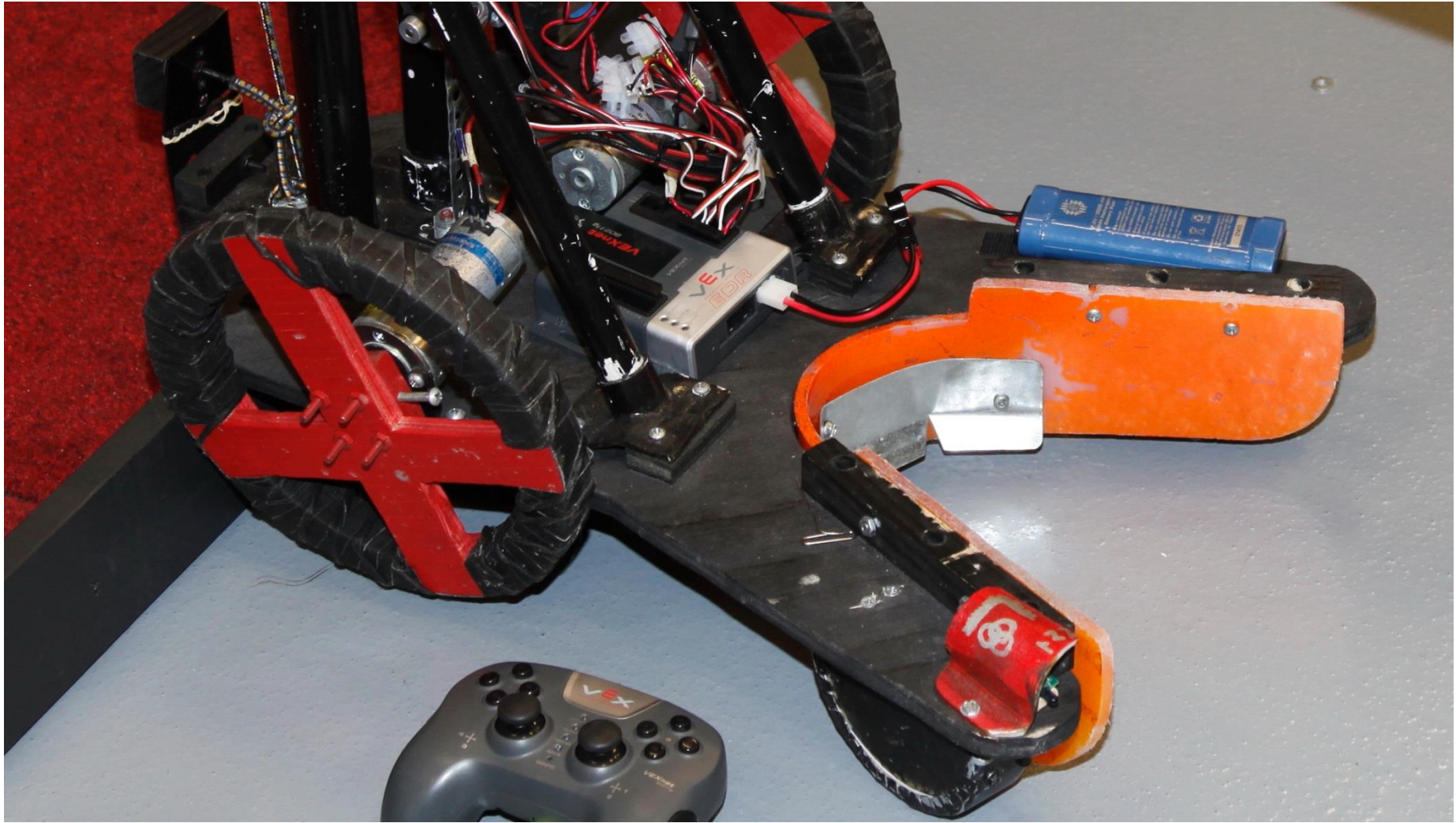
Examples



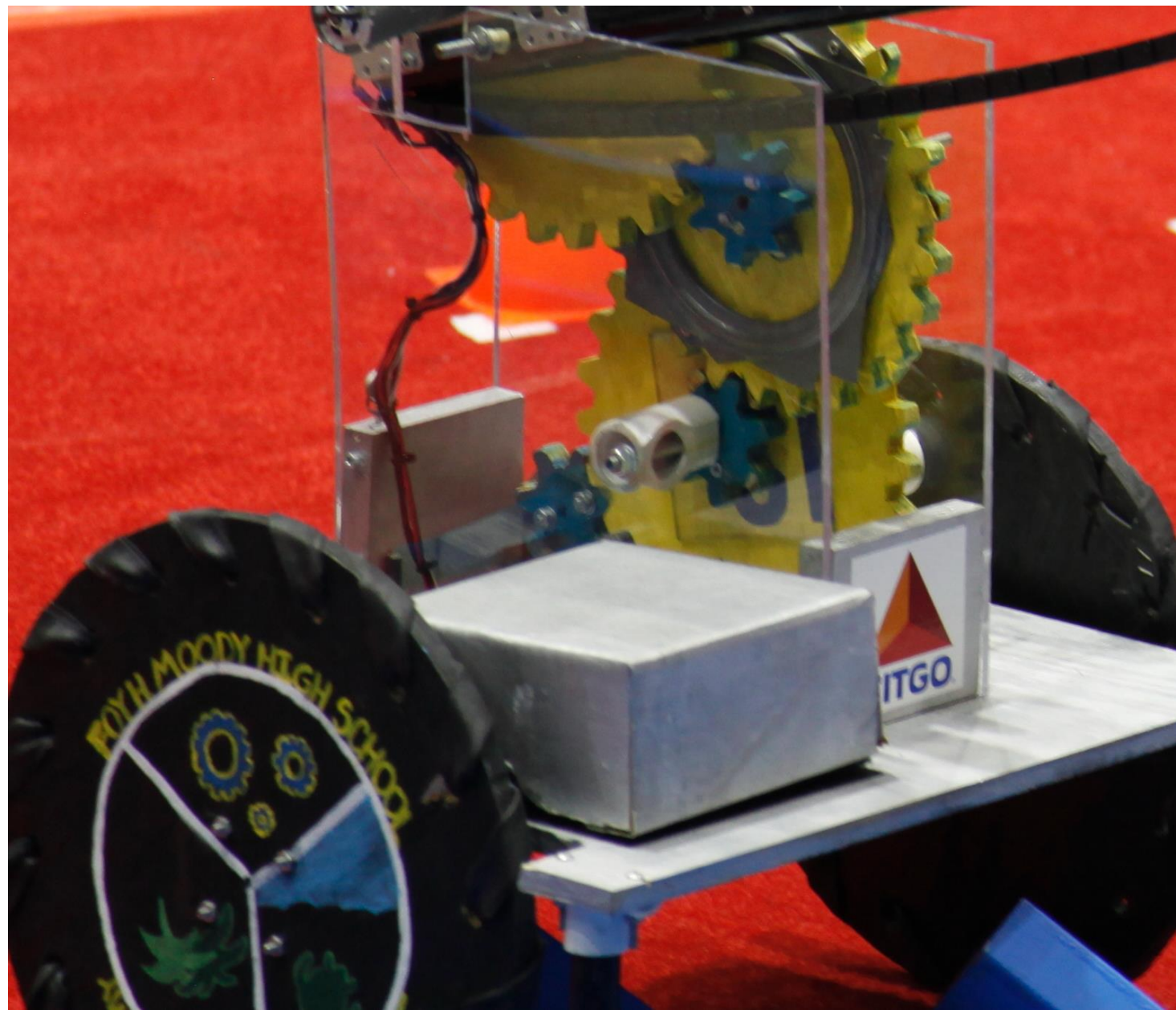
Example Base



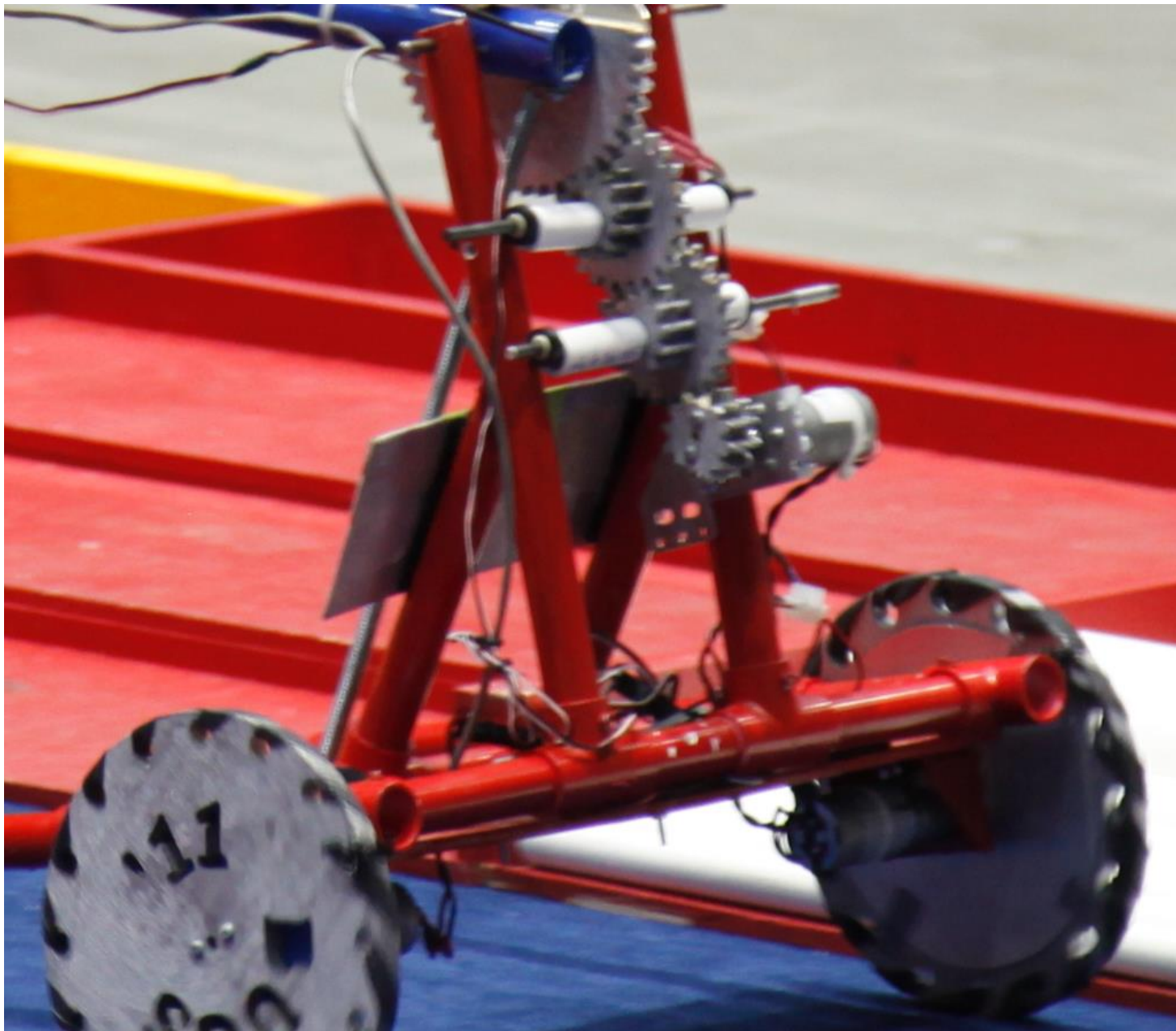
Example Base



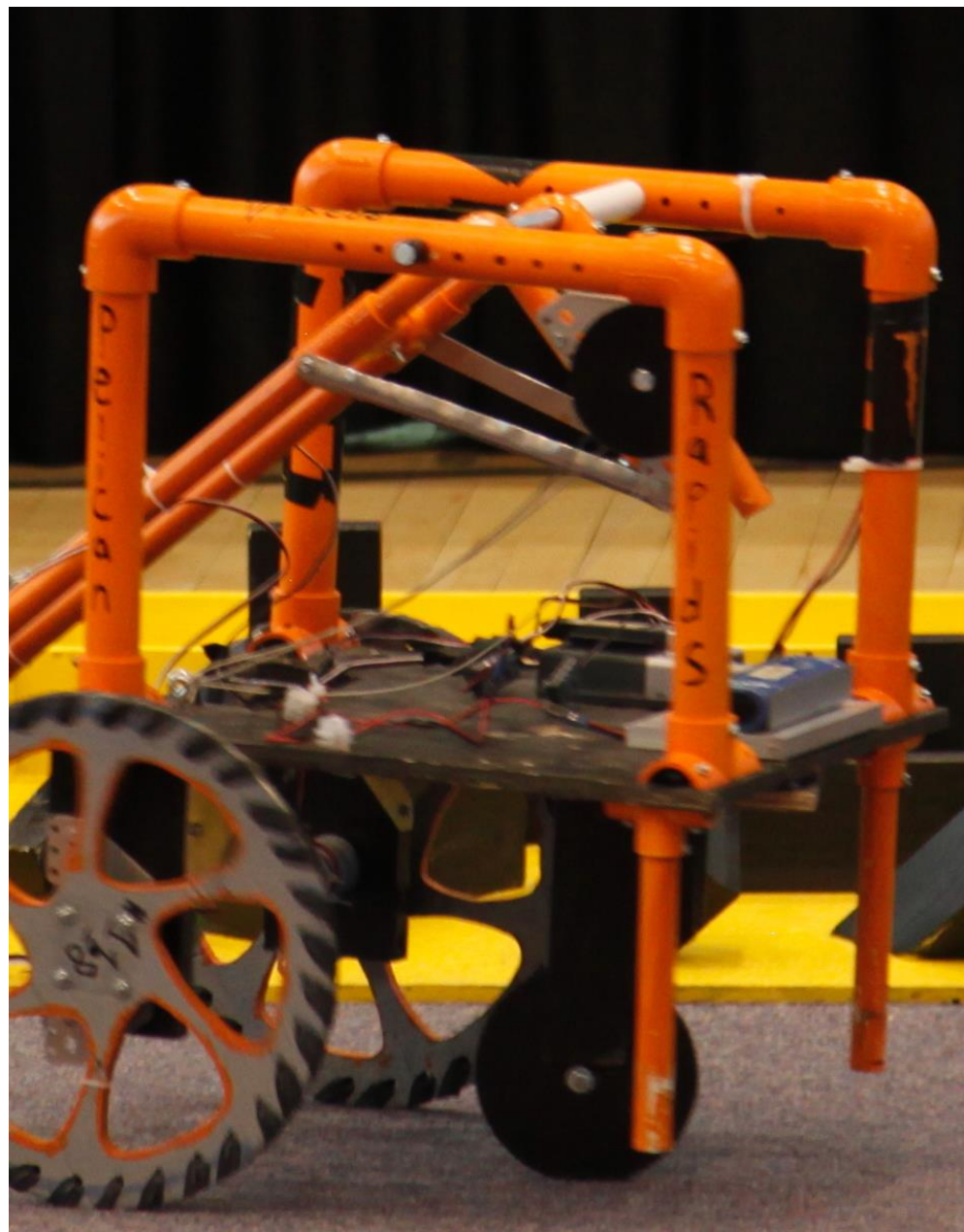
Example Base



Example Tower



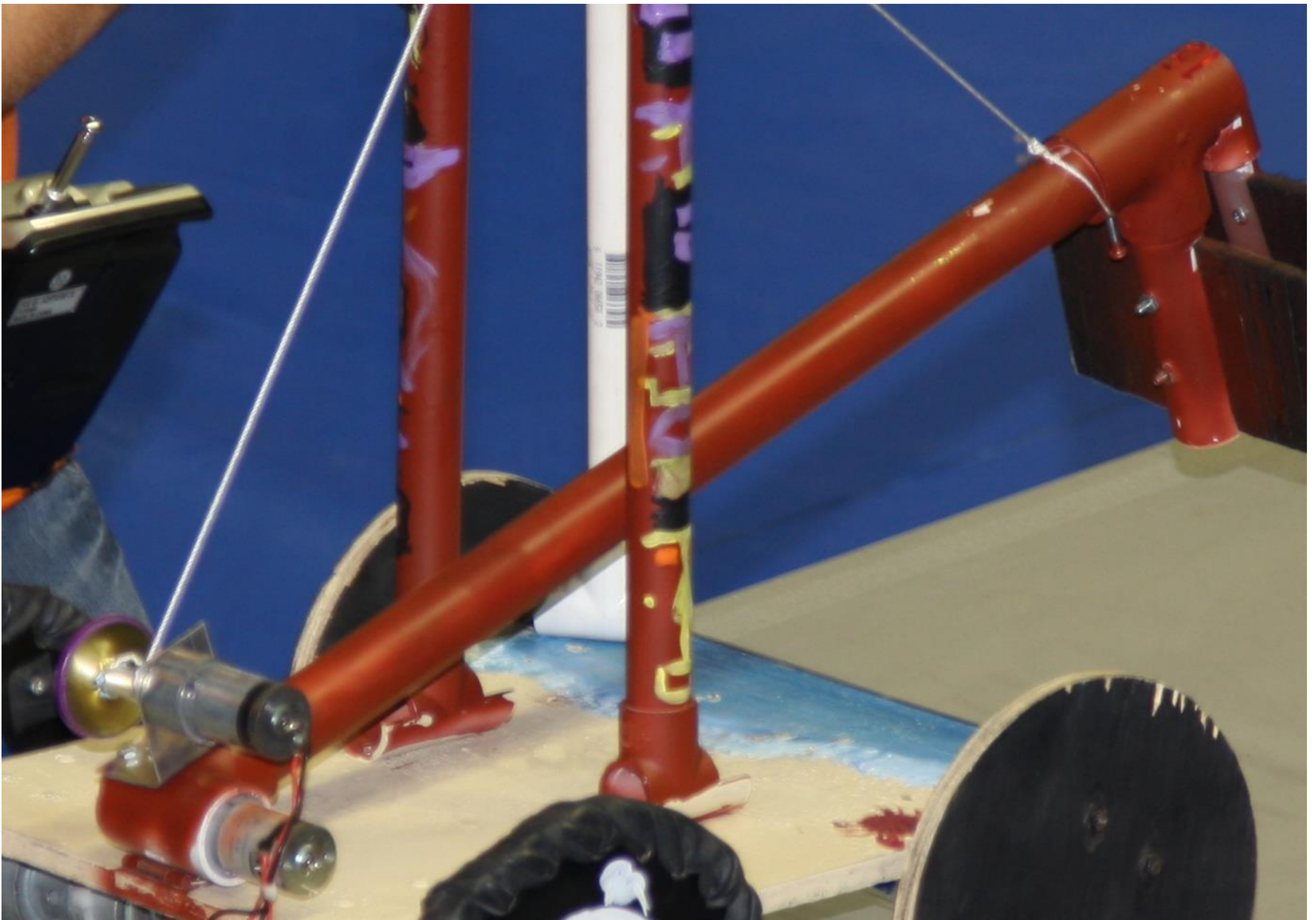
Example Tower



Example Tower



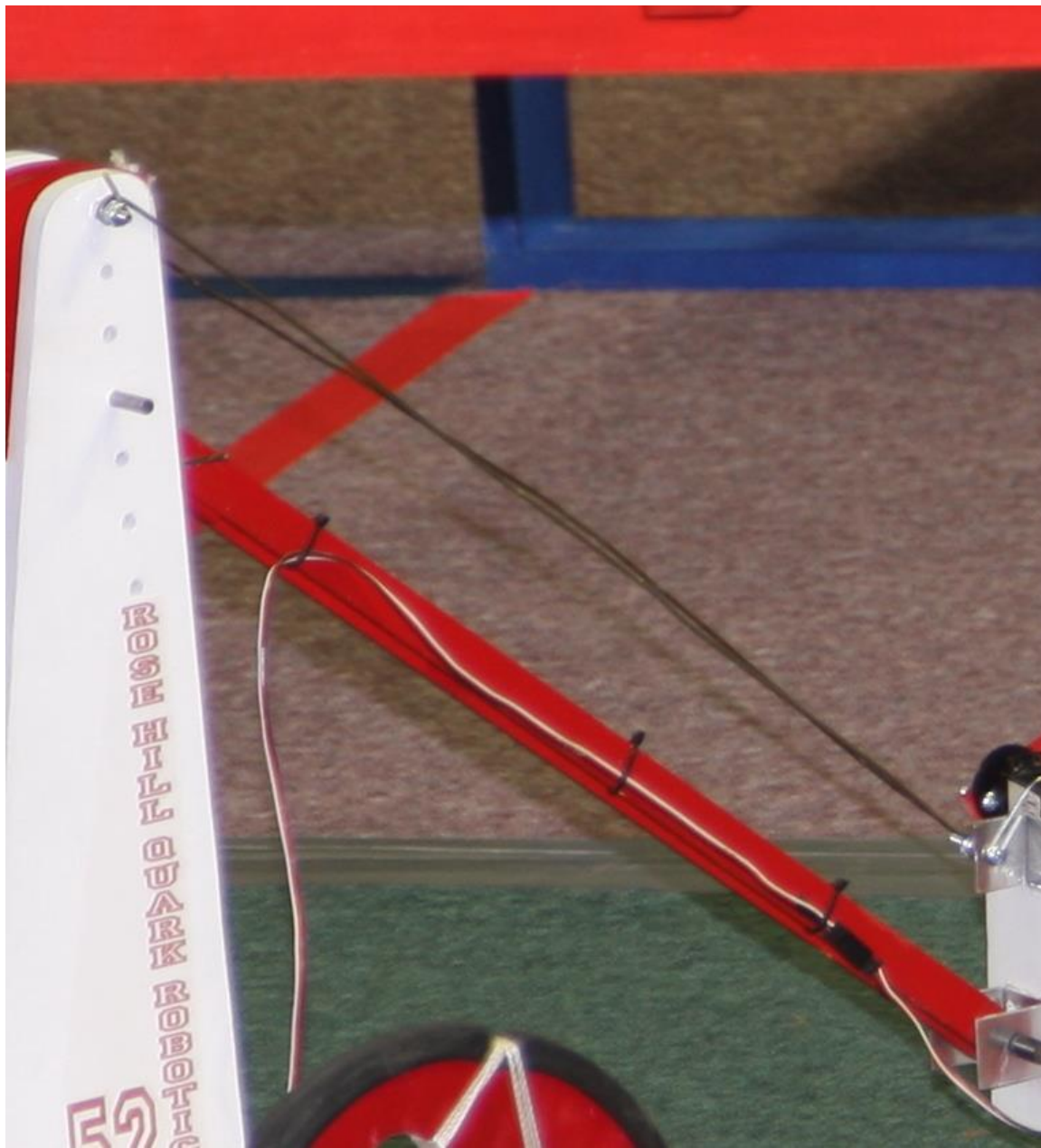
Example Arm



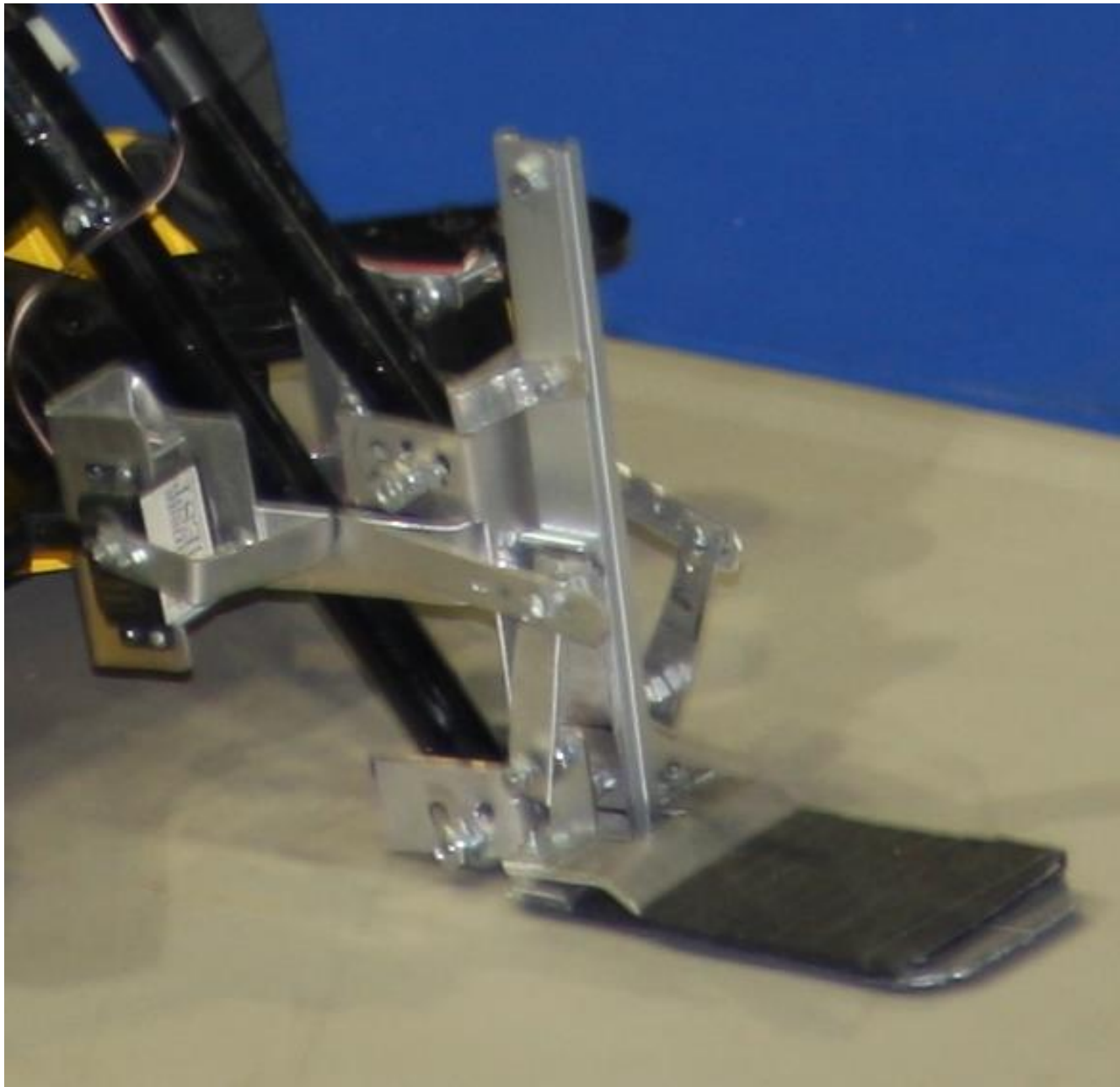
Example Arm



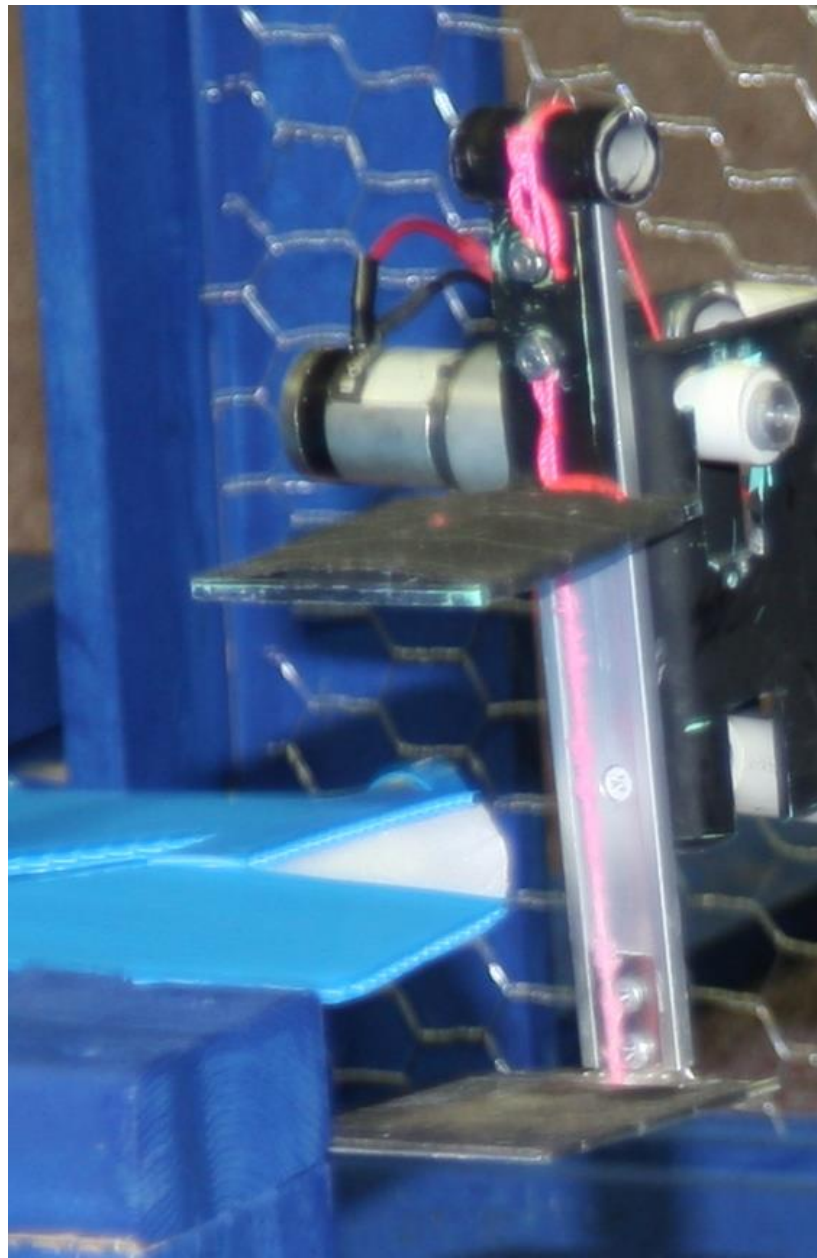
Example Arm



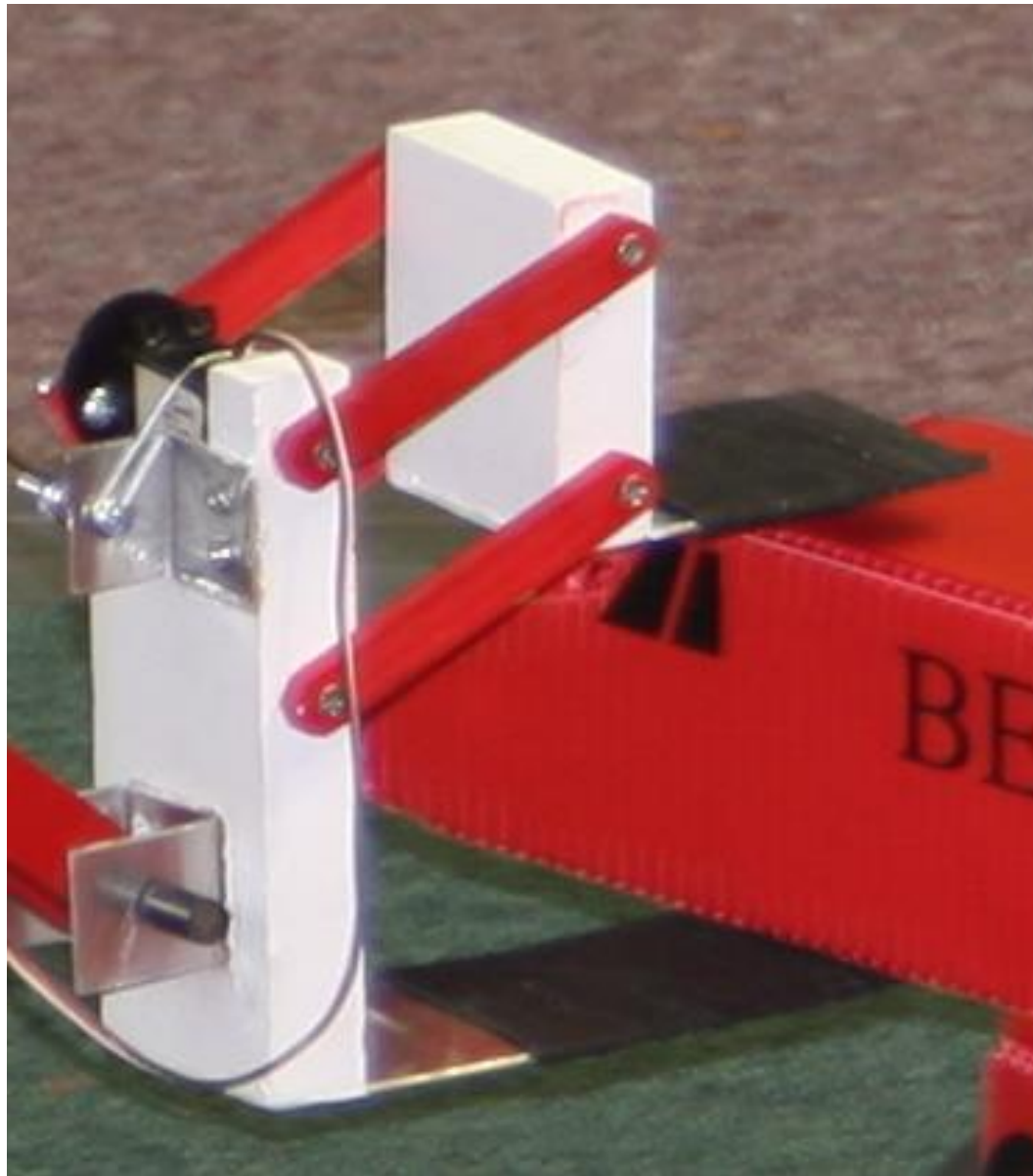
Example Arm



Example Claw



Example Claw



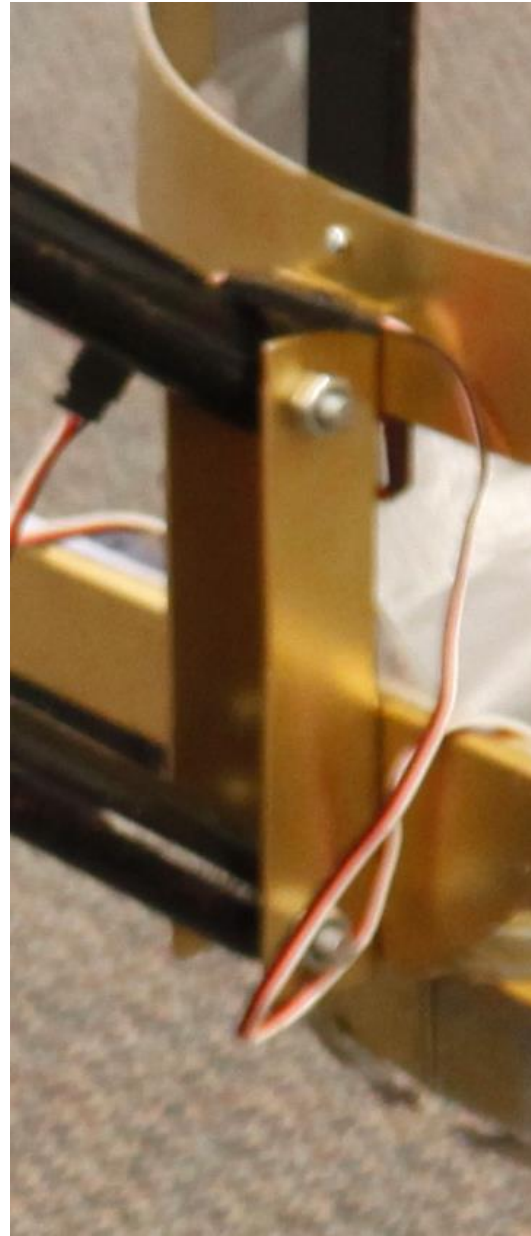
Example Claw



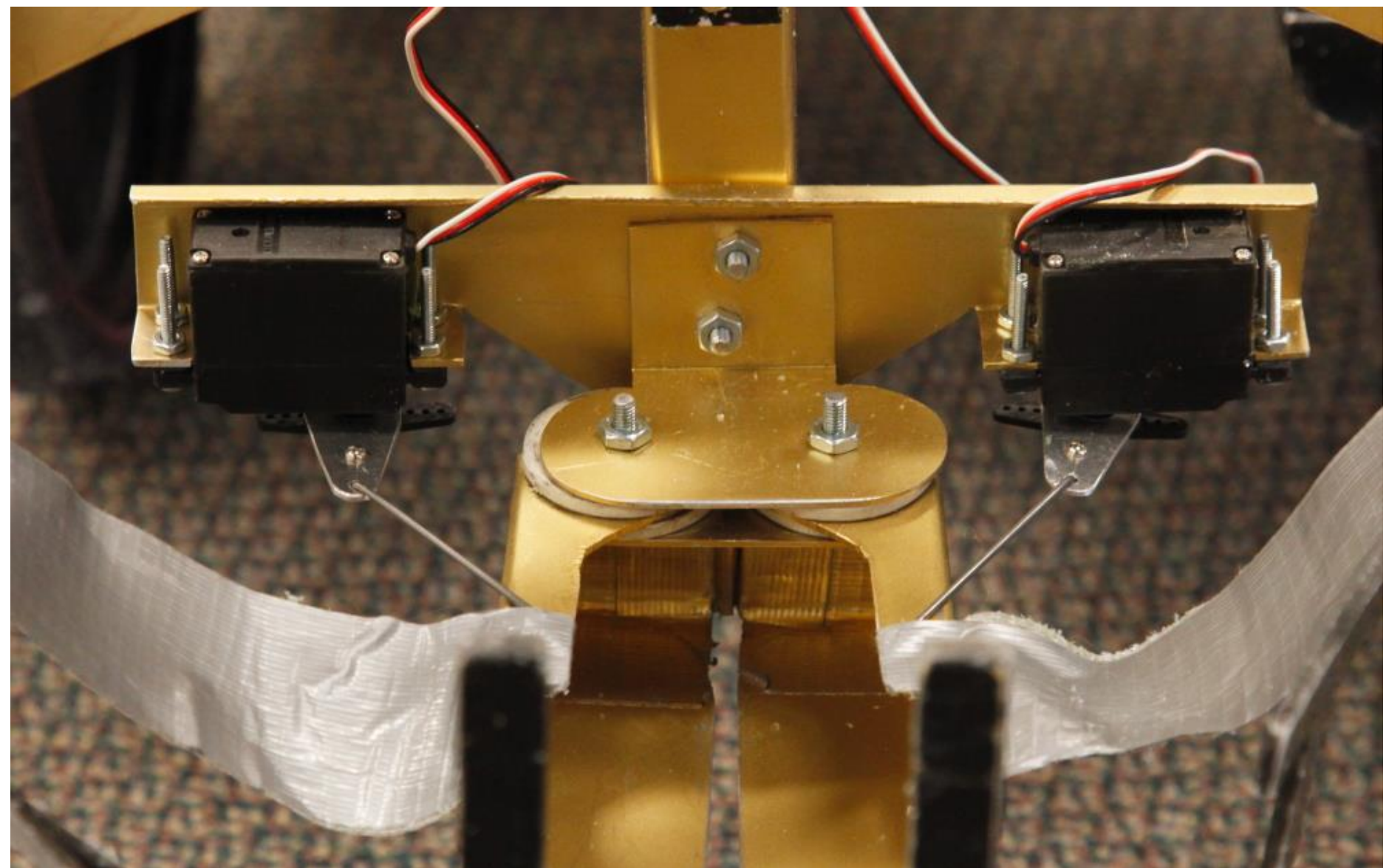
Example Claw



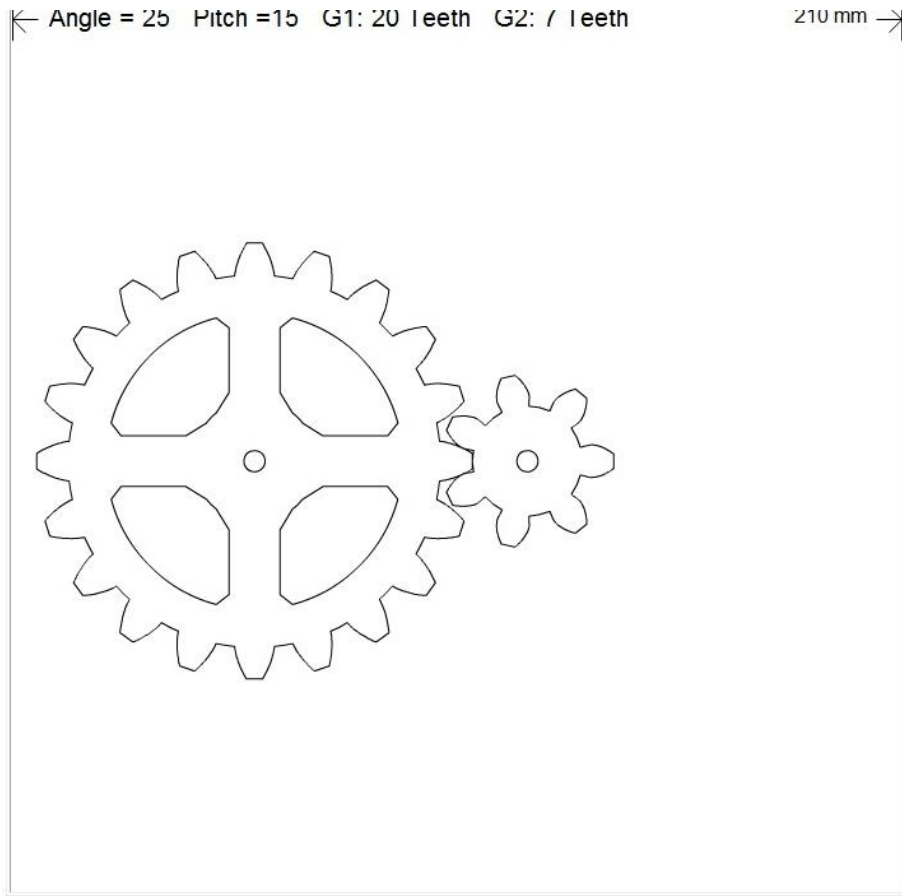
Example Transition



Example Transition



Example Transition and Servo Mount



Tooth spacing (mm):

15

Contact angle(deg):

25

Shaft hole dia. (mm):

5

Gear 1 teeth:

20

Gear 2 teeth:

7 Two gears

Show rotated (% of a tooth):

0

Printed page width (mm):

210

Spokes:

4 Show spokes

Print gears

Show pitch diameter

Show line of contact

Show center

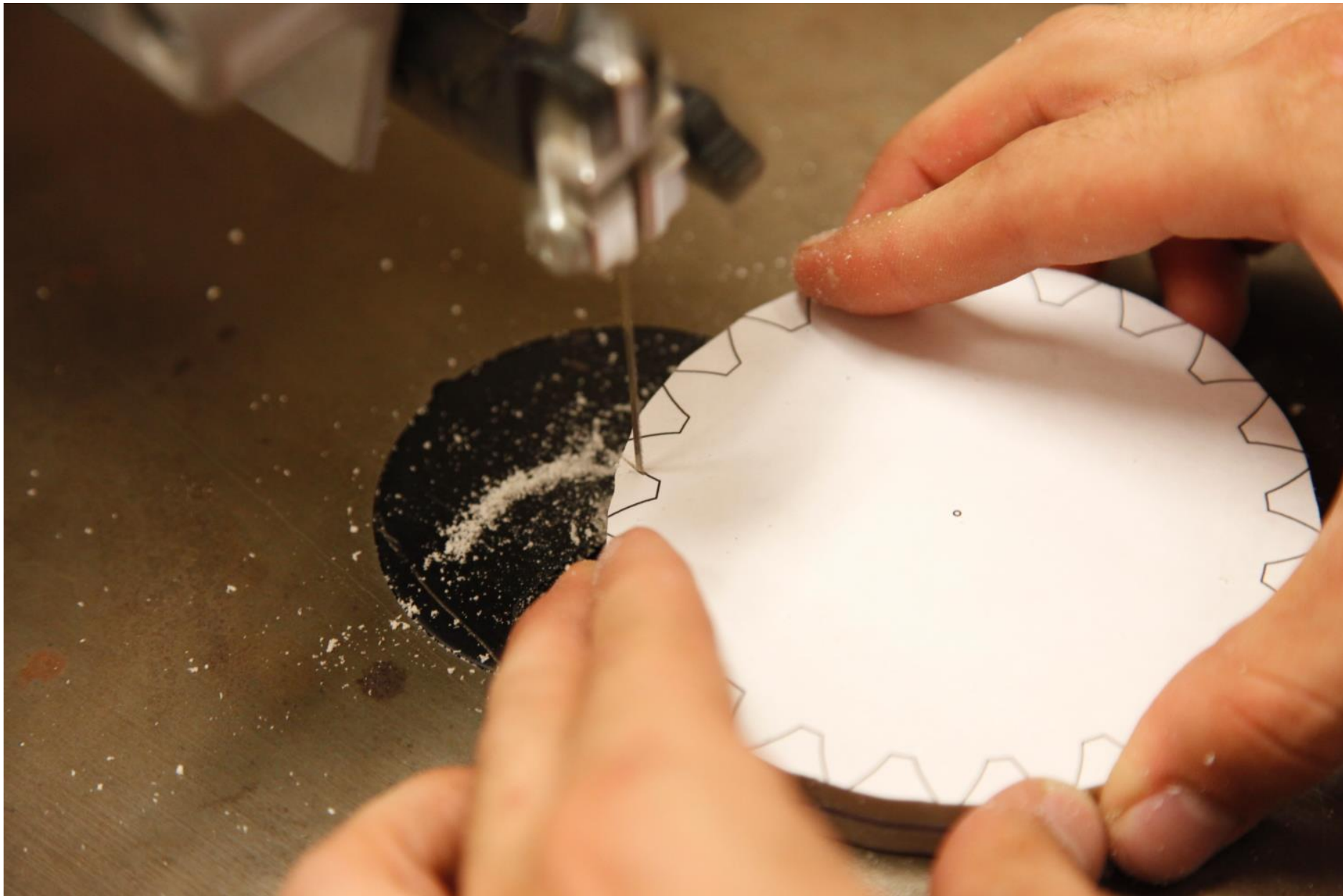
Show cm grid

Animate

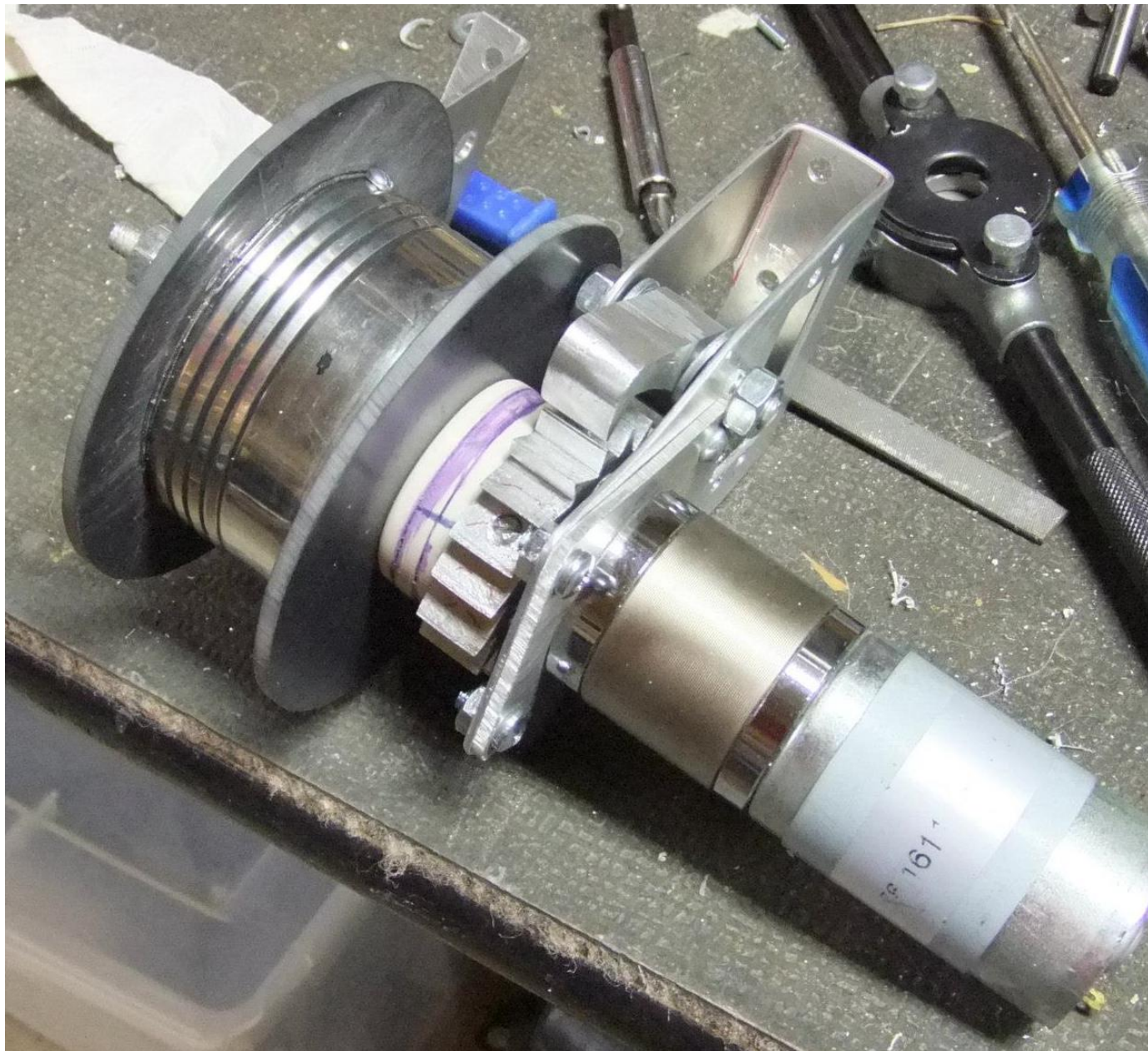
Dividing plate mode

[Explain fields \(Help\)](#)

Example Gear Template



Example Gear Using Scroll Saw



Example Gear and Subassembly

Tips for Materials

- Organize your material and know what you have to work with
- What are their characteristics?
 - Screws vs Bolts
 - Glue vs Tape
 - Stiff vs Flexible
 - Light vs Heavy
 - Moldable vs bendable
 - Stretch vs non-stretch
- Display materials during EDP brainstorming sessions
- HOW CAN MATERIALS BE CHANGED INTO PARTS?
 - Through Design and Tools

Recommended Tools

Bare Minimum

- Basic hand tools (screw drivers, wrenches, pliers)
- Drill bits
- Drill/driver
- Hacksaw
- Saber saw
- Soldering iron
- Wire stripper
- Clamps
- Square
- Tape measure
- Work table
- Wood/metal Files

Basic

- Drill press
- Heat gun
- Dremel tool
- Hole saws
- Vise
- Scale with 25 lb capacity
- Tap and die set
specifically,
#10-32 tap
1/4 - 20 die

Deluxe

- Scroll saw
- Z-bender
- Toaster Oven
- Metal brake
- Sander
disk/drum/belt
- Micrometer
- Band saw

I prefer “non-finger cutting” tools!

Major Tools

- Scroll Saw
- Drill Press
- Belt Sander
- Toaster Oven
- Metal Brake

Scroll Saw

- It can cut all material except steel and tin
 - Great for Wood, Aluminum sheets, PVC and even Aluminum bar
- Makes excellent gears and detailed cuts
- Interior cuts, just drill hole insert blade and cut away
- Remember to always file or sand sharp edges of cut material
- Use blades that are for hardwood!

Drill Press

- Perpendicular holes
- Rotary sander
- Forstner bits are best for wood but expensive
- Hint: When drilling a tight hole, first drill size too small then final

Belt Sander

- Makes surfaces and edges smooth
- Squares cut ends of PVC
- Use circular sander for sanding to final lines
- Can even be used on aluminum

Toaster Oven

- Best Kept Secret!!
- Used to heat up PVC so it is moldable (no melting)
- No more than 250 to 300 degrees for a couple of minutes
- Use leather gloves and clamps
- When molding PVC use jigs whenever possible

Metal Brake

- Ask a business to donate time on their Brake
- Used on all sheet material, aluminum and tin
- Good for bracing bends as well as part bends
- Don't pinch you fingers!

Fabrication Examples



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.

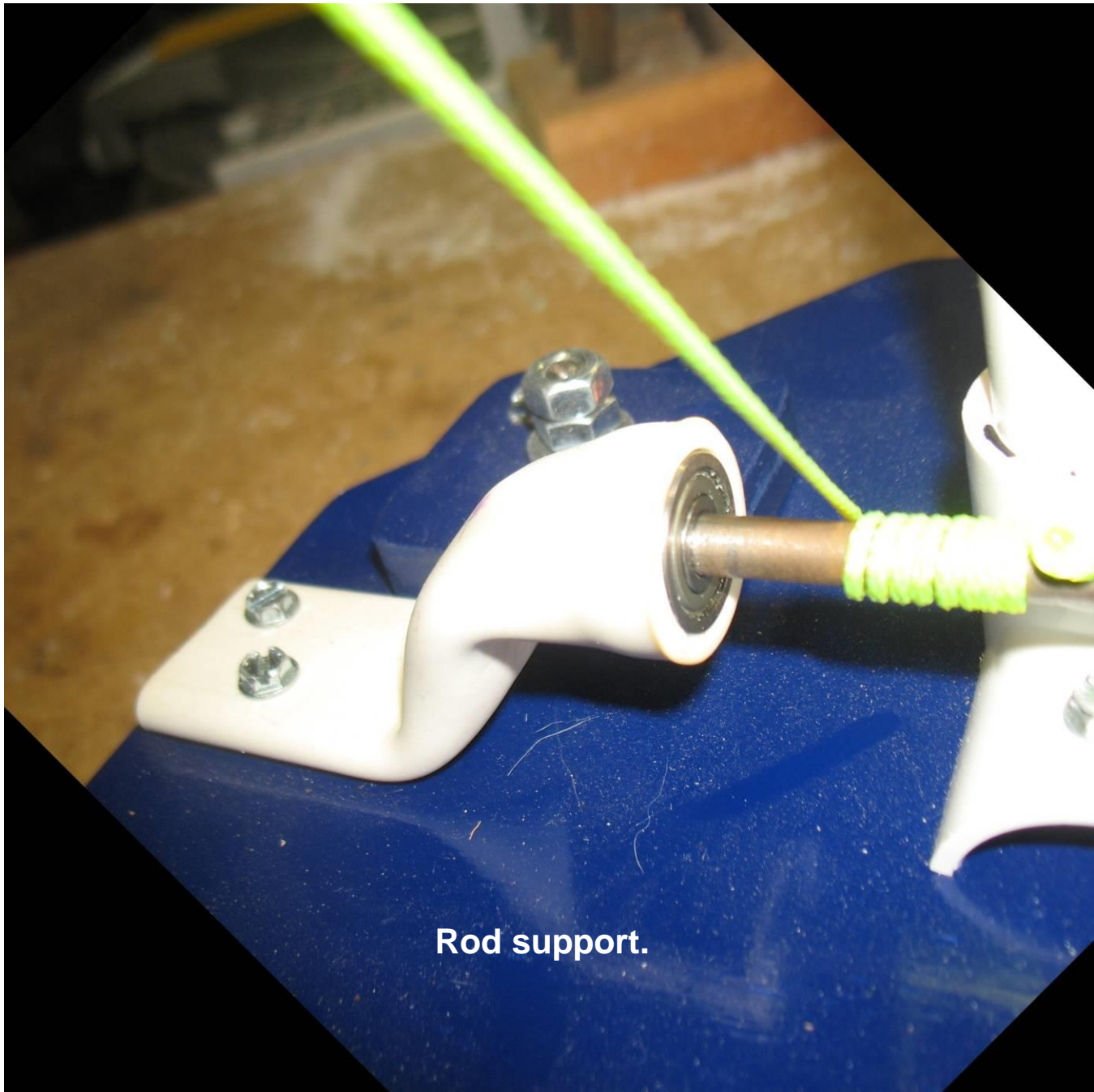


Bending PVC.

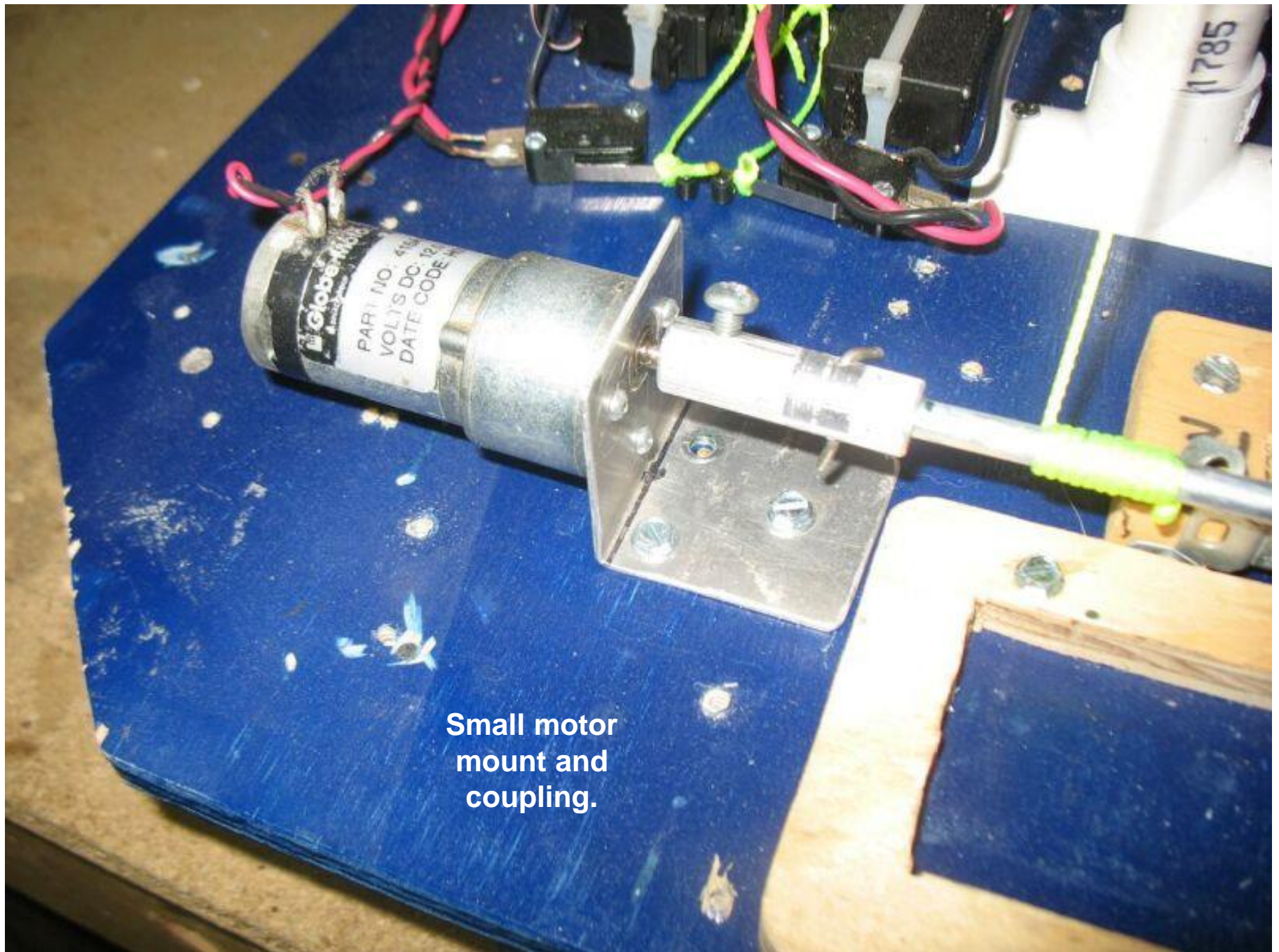


**A Z-bender tool
(available at RC model
shops).**

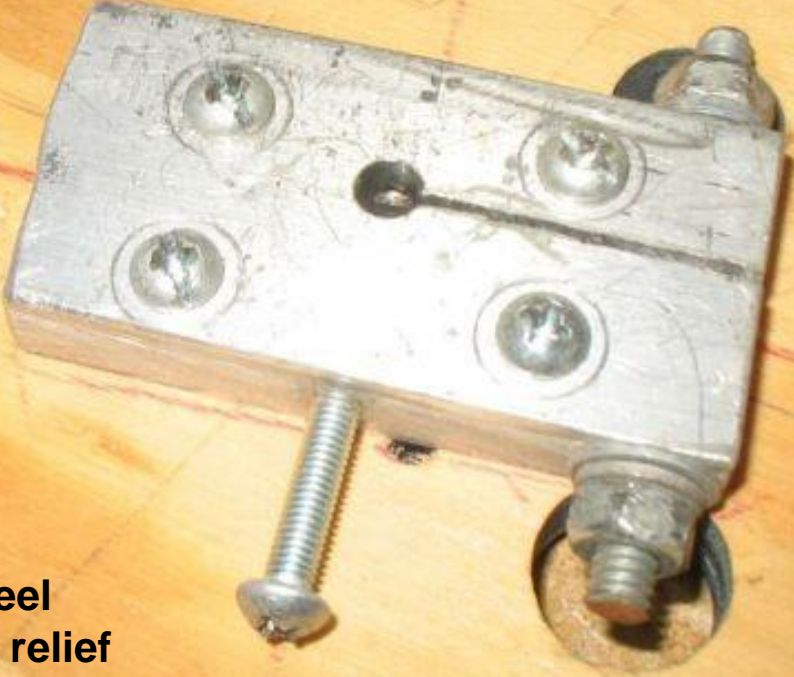




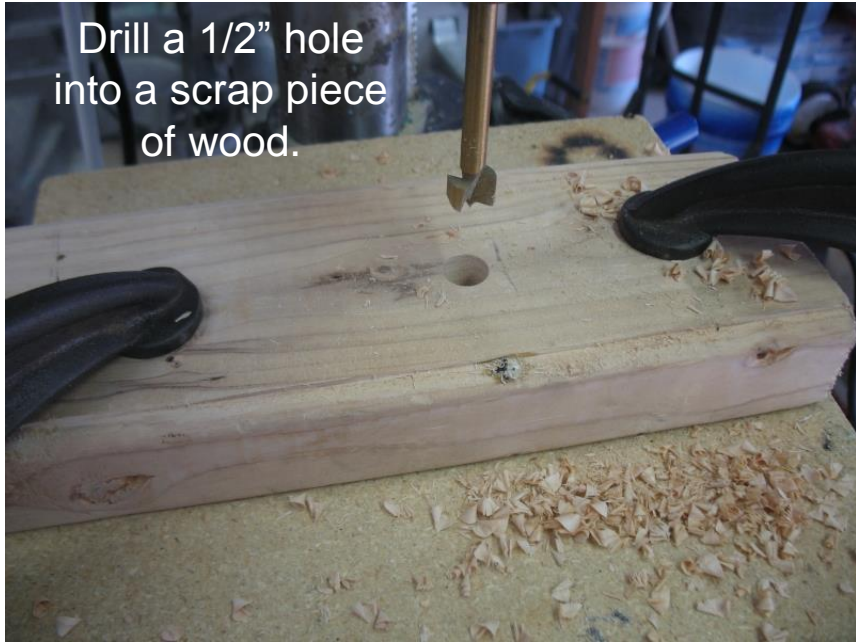
Rod support.




Small motor
mount and
coupling.

A metal wheel mount assembly is shown on a wooden surface. The assembly consists of a rectangular metal block with four screws on its top surface. A long threaded rod extends from the bottom left, and a shorter threaded rod with a nut is attached to the bottom right. The metal block has a central hole and two smaller holes on its top surface. The wooden surface has red lines drawn on it, and pink string is visible at the top corners.

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

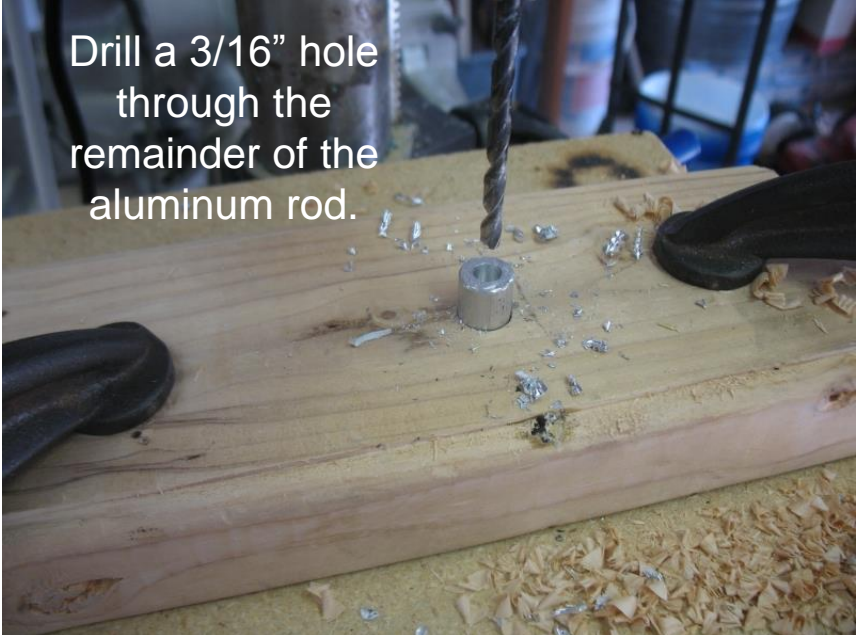


Drill a 1/2" hole into a scrap piece of wood.



Drill a 1/4" hole half way through the aluminum rod.

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.



Drill a 3/16" hole through the remainder of the aluminum rod.

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).

Fabrication Tips (PVC pipes)

- 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

Fabrication Tips

- Use the 1/2" plywood if base board is used, holds wood screws better
- Cut down screws for attaching to the motor front plate
- Leave excess material when possible (and trim later)
- Make jigs
- Make templates (in CAD) for the motor front plate hole pattern, attach to part (spray adhesive works good) to be drilled
- 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
- 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)

Other Stuff

- Review “2010 Tools, Tips and Materials”
 - Main BRI Web Site, Participants, File Manager, Training, Technical Training
- Remember to keep up with the Q & A
- At every stage, design and construct to the very best quality
- www.bestinc.org

- Jim Walter
- jwalter@702communications.com
- Bison BEST Team Mentor