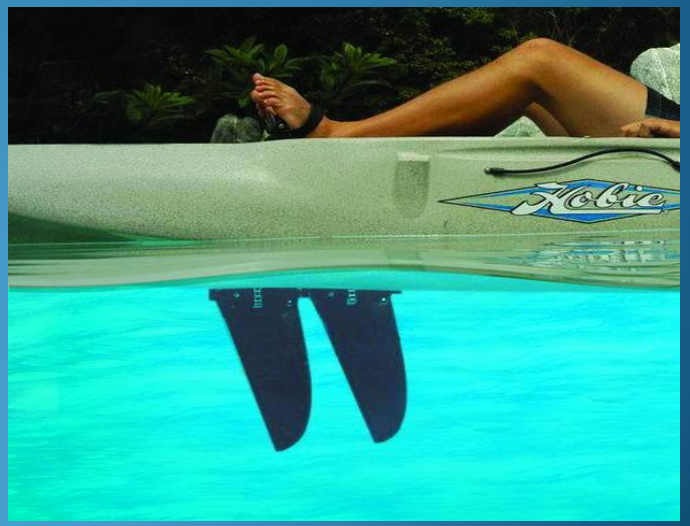
Hobie Cat Kayak

Group Members

Matthew Ricciardi – Group Leader
Brian Back – Technical Liaison
Ryan Wackerly – Purchasing Agent
Zach Walker – Web Page Specialist



Advisors and Clients

- **Faculty Advisor**
  - Dr. Mohamed Samir Hefzy
  - Dr. Mehdi Pourazady
- **Client Advisor**
  - Ms. Jill Caruso
  - Dr. Chris Beins
- **Client**
  - Mr. Steve Grudzien
    CEO Patriot Products
- **Project Sponsor**
  - The Ability Center of Toledo
  - National Science Foundation

What is the Hobie Cat Kayak?

The Hobie Cat Kayak is a non-traditional kayak powered by the Mirage Drive System.

- Foot powered propulsion system.
- More efficient than conventional paddles.
- Modeled from tuna fins and penguin flippers.
  - Foil Design

Matt Ricciardi

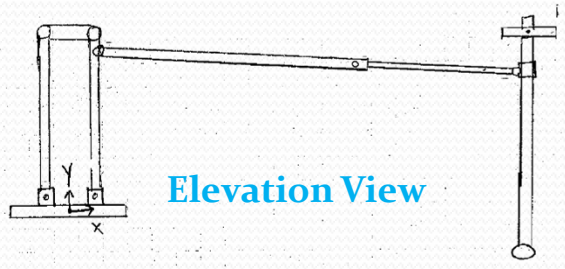
Project Description

- Currently the device is not adaptable to individuals with limited or no use of their legs. Our focus is to transfer the user's arm motion to the Mirage Drive System.
- Our design centers around ease of use, simplicity, and keeping all functionality of the current Hobie Cat Kayak.
- Removal and installation of the device shall be as easy as for the Mirage Drive System.

Methodology

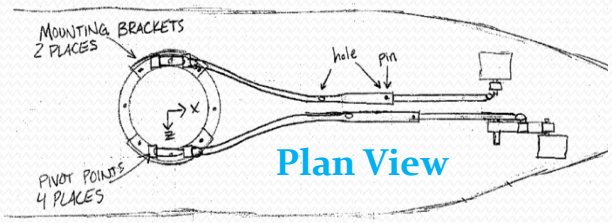
- Design Guidelines
  - Operated by arms while in a sitting position.
  - Device will be located between inner thighs.
  - Corrosion resistant.
  - Light weight.
  - Adjustable grip height and connecting rod length.
- Concepts
  - Two push pull rocker arms
  - Hand crank
  - Direct cables

Designs

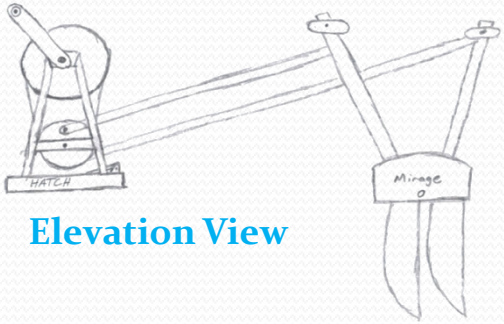


Elevation View

1

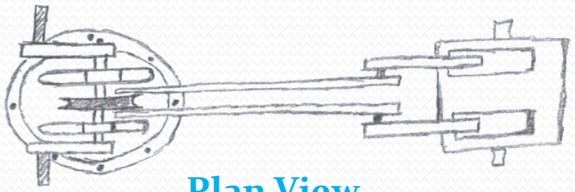


Plan View

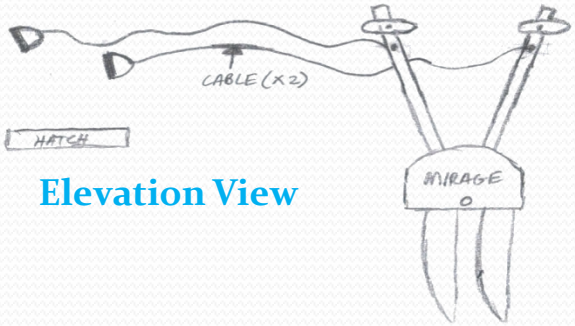


Elevation View

2

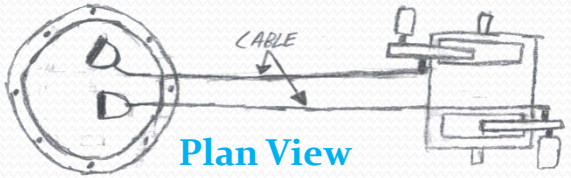


Plan View



Elevation View

3



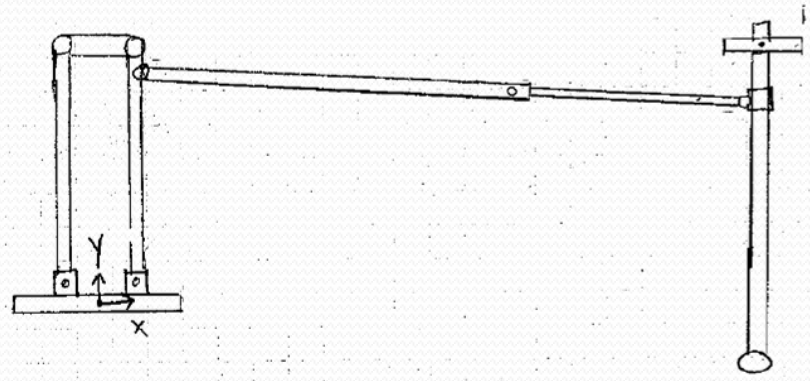
Plan View

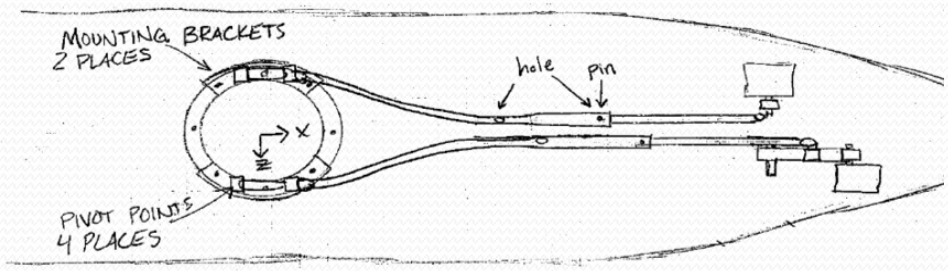
House of Quality

	Importance	Rocker	Crank	Cable
Safety	5	4	4	5
Light Weight	4	4	3	5
Cost	3	4	3	5
Original Function	2	5	3	5
Ease of Use	4	5	3	3
Adaptable	5	5	4	1
Durable	5	4	3	4
Score		123	94	107

Selected Design

- Design 1
  - Allows for upper body to remain square with device, no rotation of spine required
  - Allows for use of hatch.
  - Allows for simultaneous use of rudder while in operation.
  - Lowers center of gravity, mounted closer to kayak hull.

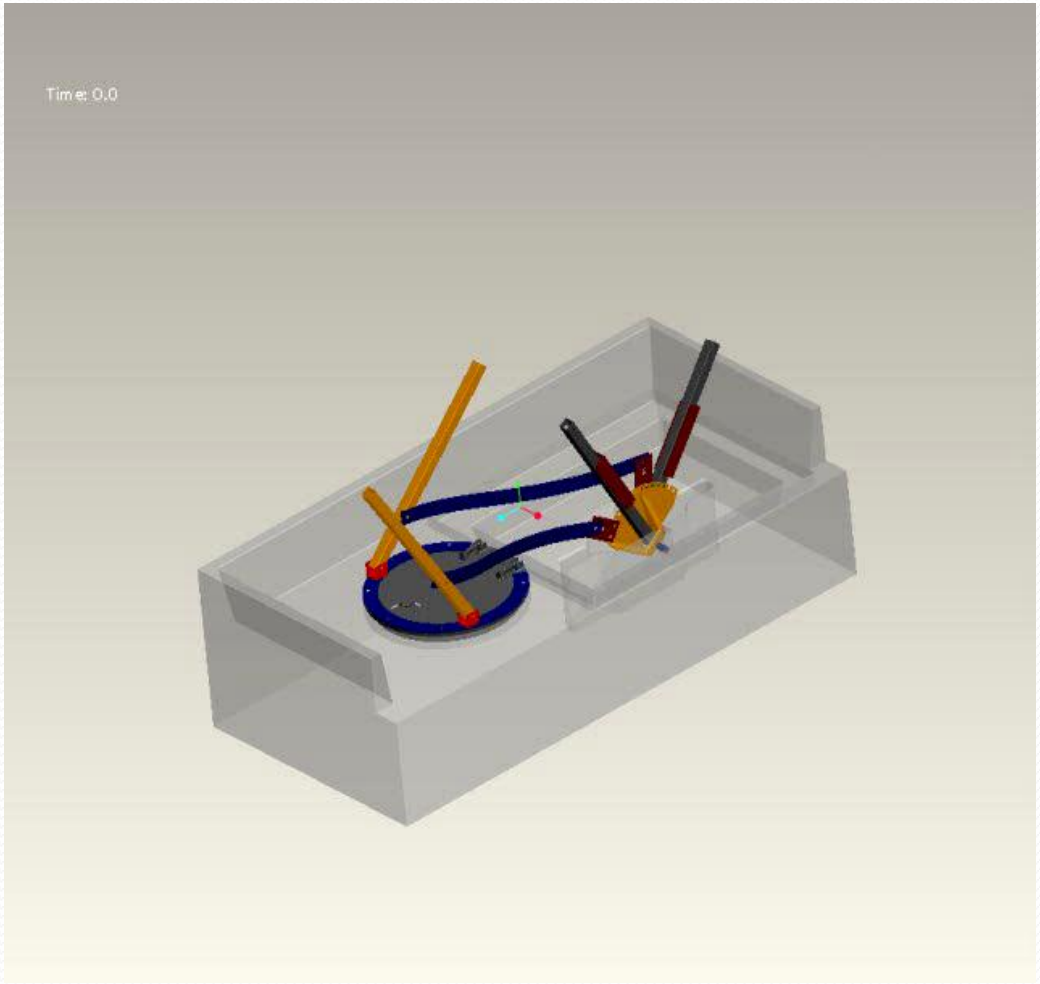




Design Progress

- Telescoping connecting rods.
- Telescoping rocker arms.
- Quick release mounts to Mirage Drive System and kayak hatch.
- Made from aluminum.
  - Mirage Drive supplier uses this currently on their product.
- Interchangeable handles for rocker arms to adapt to different users abilities.

Simulated Prototype



Brian Back

Second House of Quality

	Importance	Aluminum	Stainless Steel	Steel	High Strength Plastic
Safety	5	5	5	5	5
Light Weight	4	4	3	3	5
Cost	3	4	3	5	3
Weldability	3	4	5	5	0
Manufacturer's Use	5	5	0	0	5
Corrosion Resistant	5	4	4	2	5
Strength	5	4	4	5	3
Score		130	101	102	119

General Calculations

Rocker Arm

$F_{in} := 100lbf$

$a := 5in$

$b := 11.5in$

$F_{rod} =$ ▮

$F_{pin} =$ ▮

$\sigma_y := 25000psi$

$\sigma_{total} := \left(3\tau_{max}^{2} + \sigma_{bend}^{2}\right)^{.5}$

ıctor of safety at 10^6 cycles

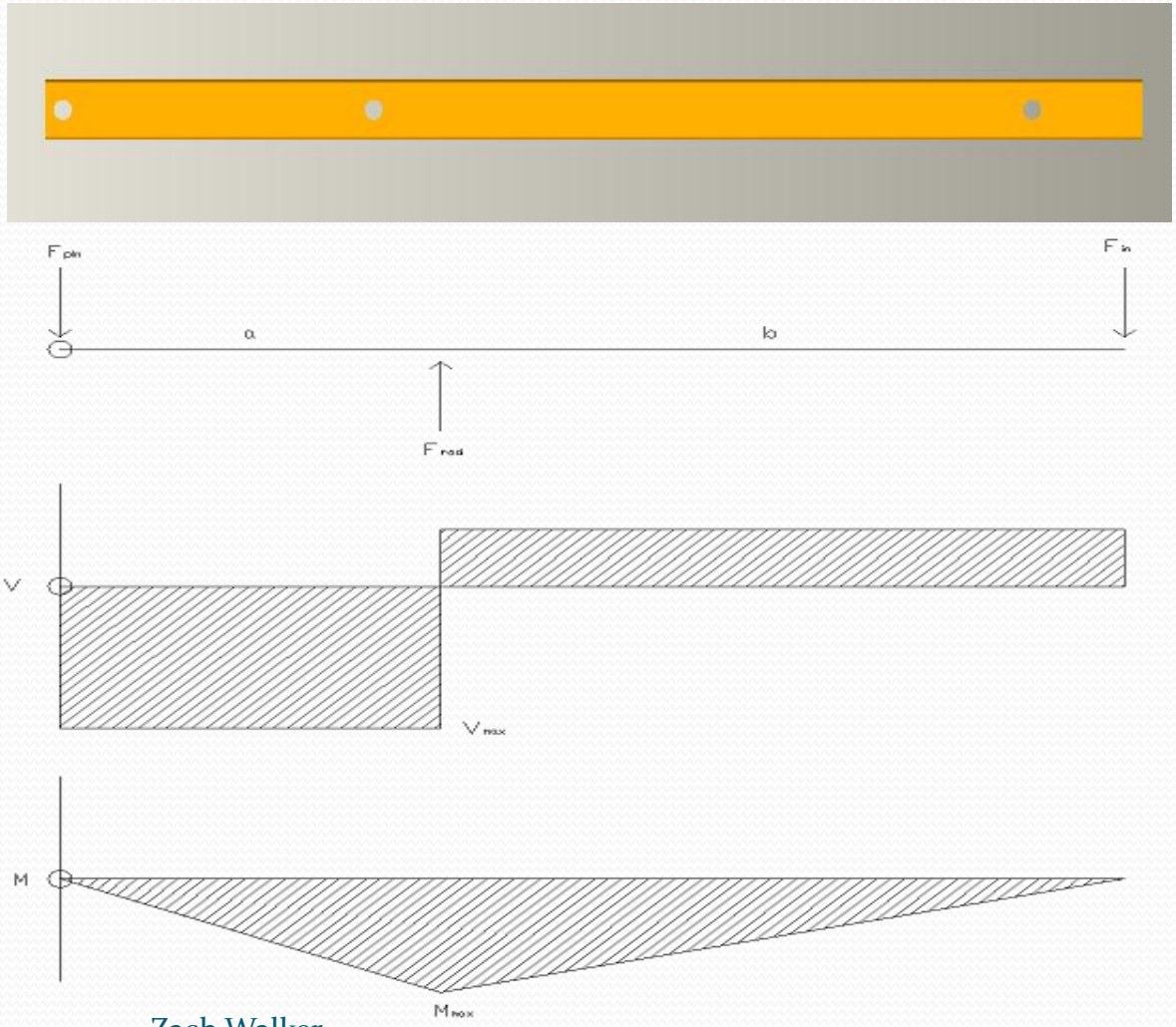
$\sigma_{total} = 2.042 \times 10^{4} psi$

$FS_{srock} := \frac{\sigma_y}{\sigma_{total}}$

$FS_{srock} =$ ▮

$FS_{frock} := \frac{\sigma_n}{\sigma_{total}}$

$FS_{frock} =$ ▮

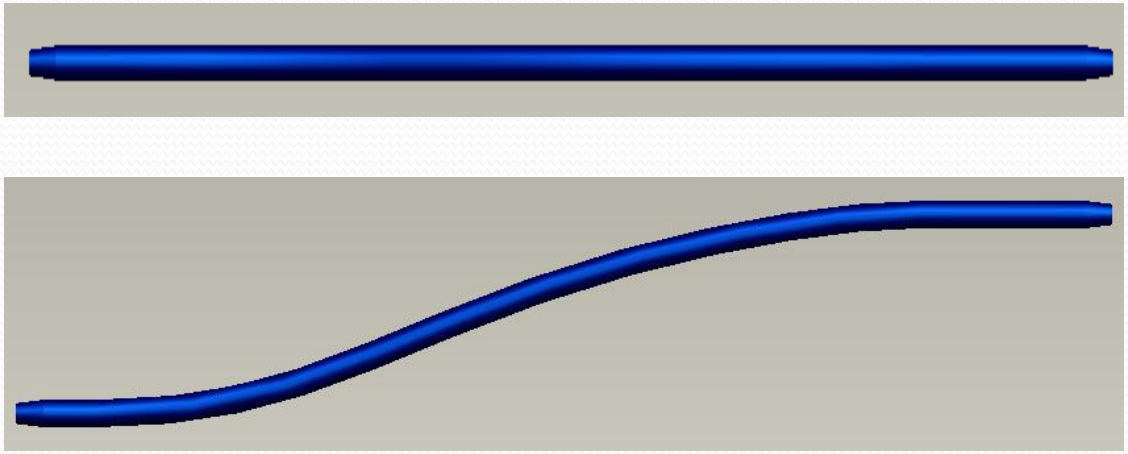


General Calculations

Connecting Rods

$$\sigma_{axial} := \frac{F_{rod}}{A_{rod}} \qquad \sigma_{axial} = \blacksquare$$

$$FS_{frod} := \frac{S_n}{\sigma_{axial}} \qquad FS_{frod} = \blacksquare$$

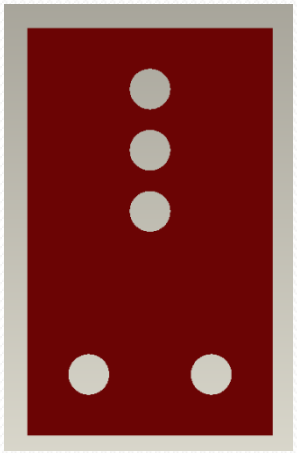


Mirage Adaptor Plate

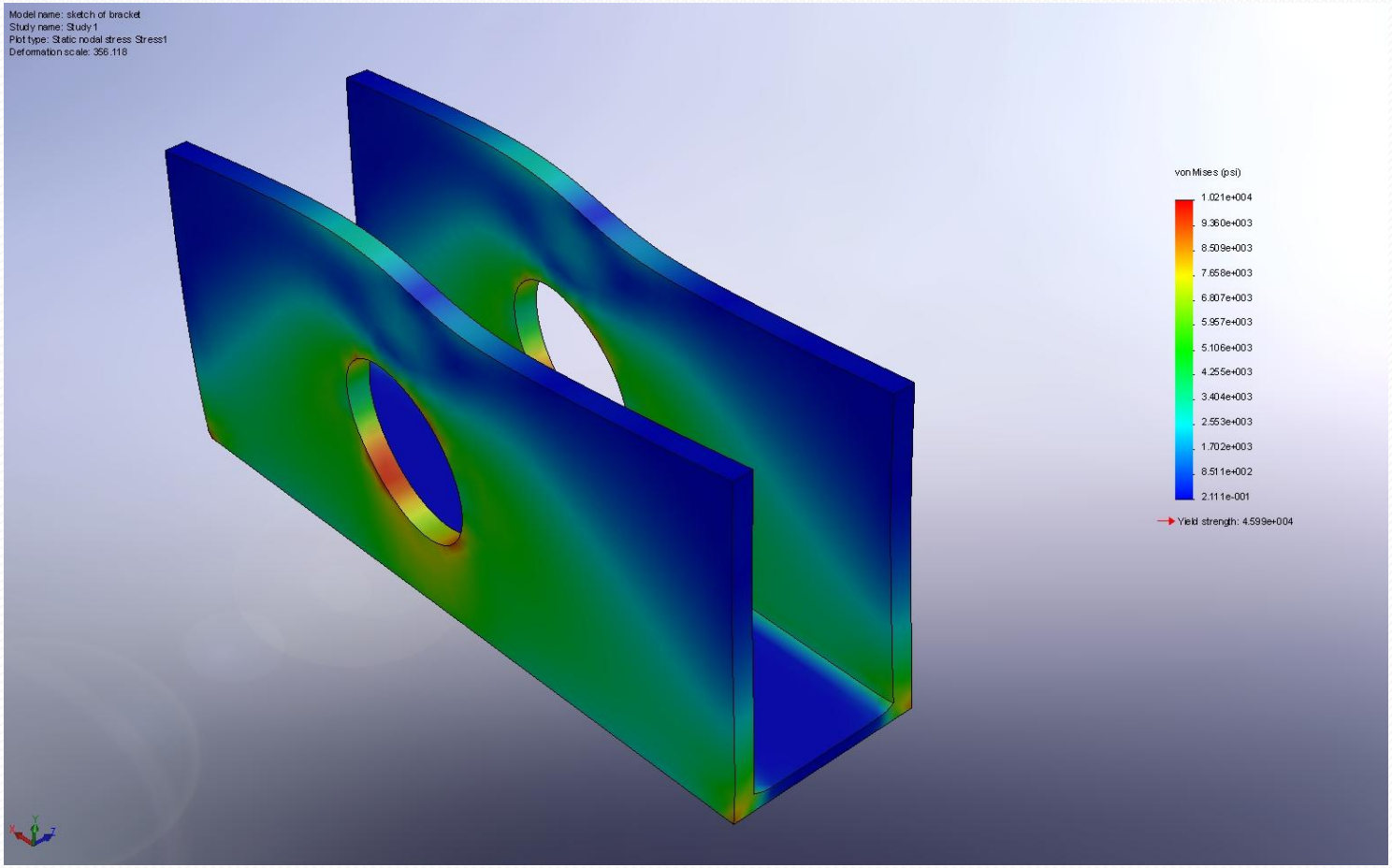
$$\sigma_{bearing} := \frac{F_{rod}}{A_{mpin}} \qquad \sigma_{bearing} = \blacksquare$$

$$FS_{smpin} := \frac{S_y}{\sigma_{bearing}} \qquad FS_{smpin} = \blacksquare$$

$$FS_{fmpin} := \frac{S_n}{\sigma_{bearing}} \qquad FS_{fmpin} = \blacksquare$$

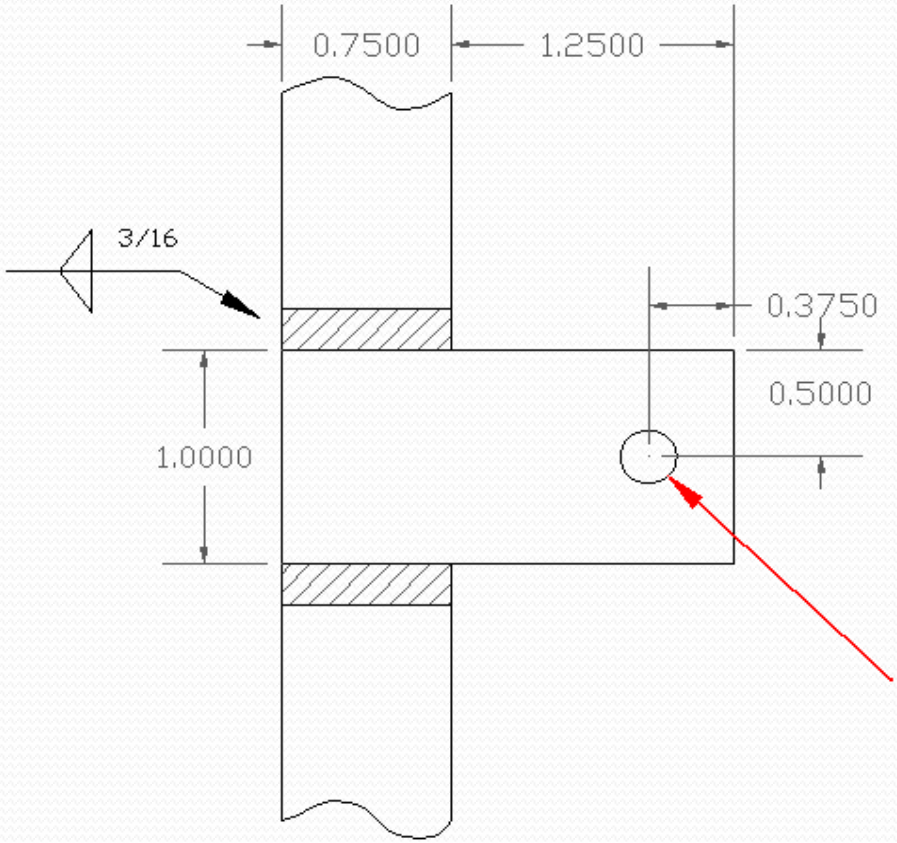


FEA on Rocker Arm Pivot



Zach Walker

General Calculations



$Sy_{alum} := 25000 \cdot psi$ $Ssy_{alum} = 14425 psi$

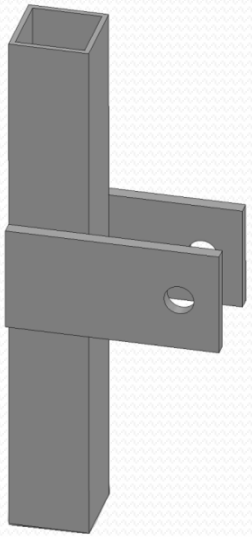
$t_{plate} := .1875 \cdot in$ $t_{weld} := .1875 \cdot in$

$A_{throat} := 2\left[\frac{3}{4} \cdot in \cdot \left| .707 t_{weld} \right|\right]$ $V := .5 F_{rod} \cdot \cos(\theta)$

$\tau' := \frac{V}{A_{throat}} = 762.179 \cdot psi$ $\tau'' := \frac{M \cdot r}{J} = 2005.733 psi$

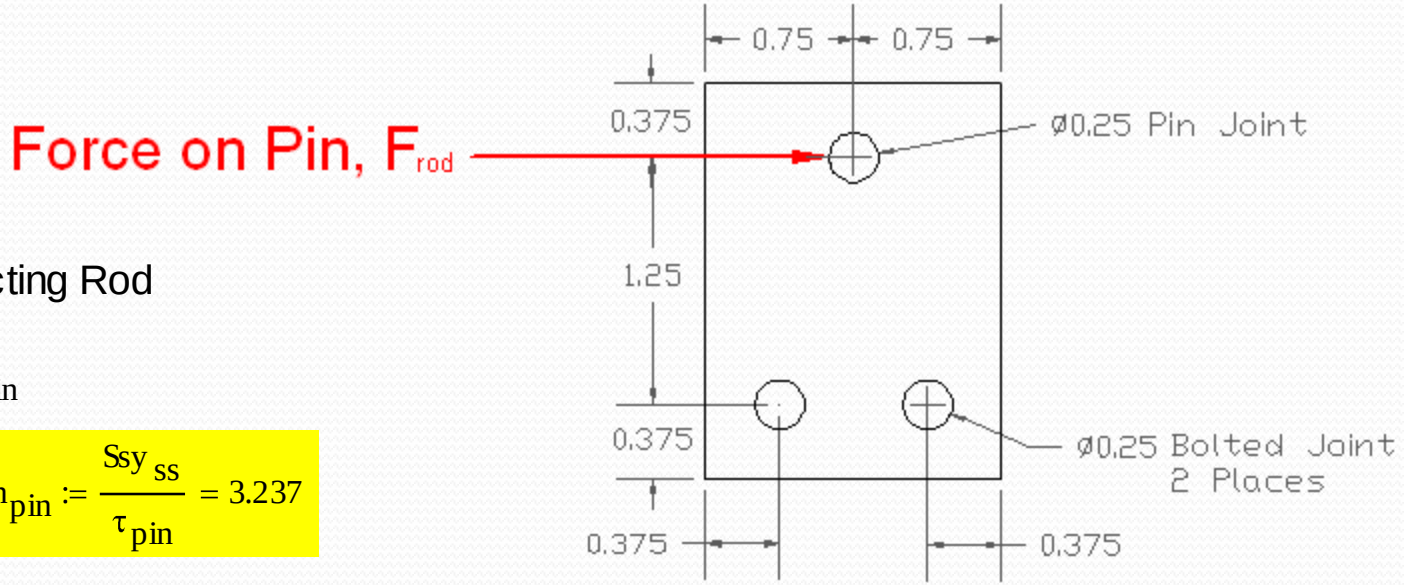
$\tau := \sqrt{\tau''_x{}^2 + \left| \tau''_y + \tau' \right|^2} = 2537.391 \cdot psi$

$n_{weld} := \frac{Ssy_{alum}}{\tau} = 5.685$



Ryan Wackerly

General Calculations



Pin Joint between Connecting Rod and Bracket

$F_{rod} := 350 \cdot lbf \qquad D_{pin} := \frac{1}{4} \cdot in$

$\tau_{pin} := \frac{F_{rod}}{A_{pin}} = 7130.14 \cdot psi \qquad n_{pin} := \frac{Ssy_{ss}}{\tau_{pin}} = 3.237$

Grade 1 Bolts Connecting Bracket to Mirage Drive

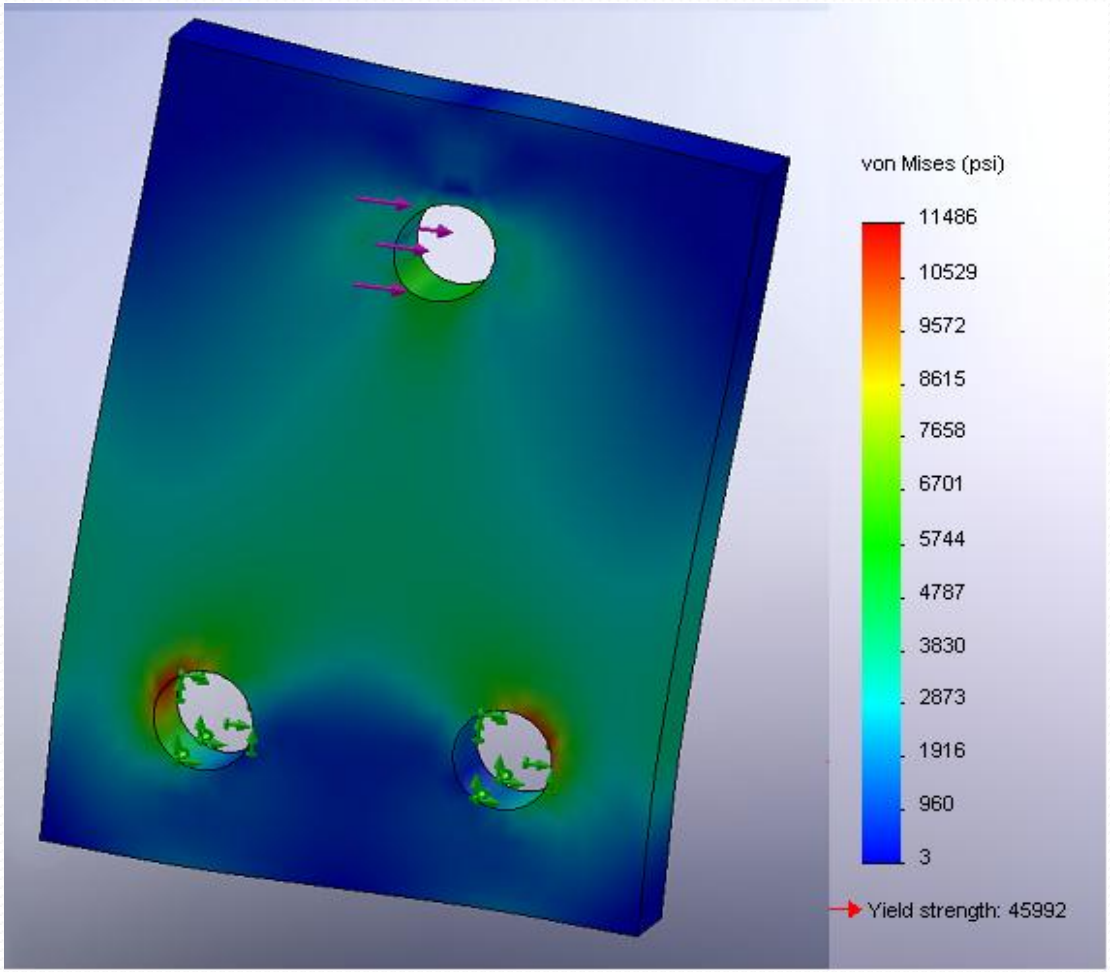
$D_{bolt} := \frac{1}{4} \cdot in \qquad F' := \frac{F_{rod}}{2} \qquad F'' := \frac{F_{rod} \cdot 1.5 \cdot in}{.375 \cdot in} \cdot \frac{1}{2}$

$F_{eq} := \sqrt{F'^2 + F''^2} \qquad \tau_{bolt} := \frac{F_{eq}}{A_{bolt}} = 14699.163 psi$

$n_{bolt} := \frac{Ssy_{gr1}}{\tau_{bolt}} = 1.413$

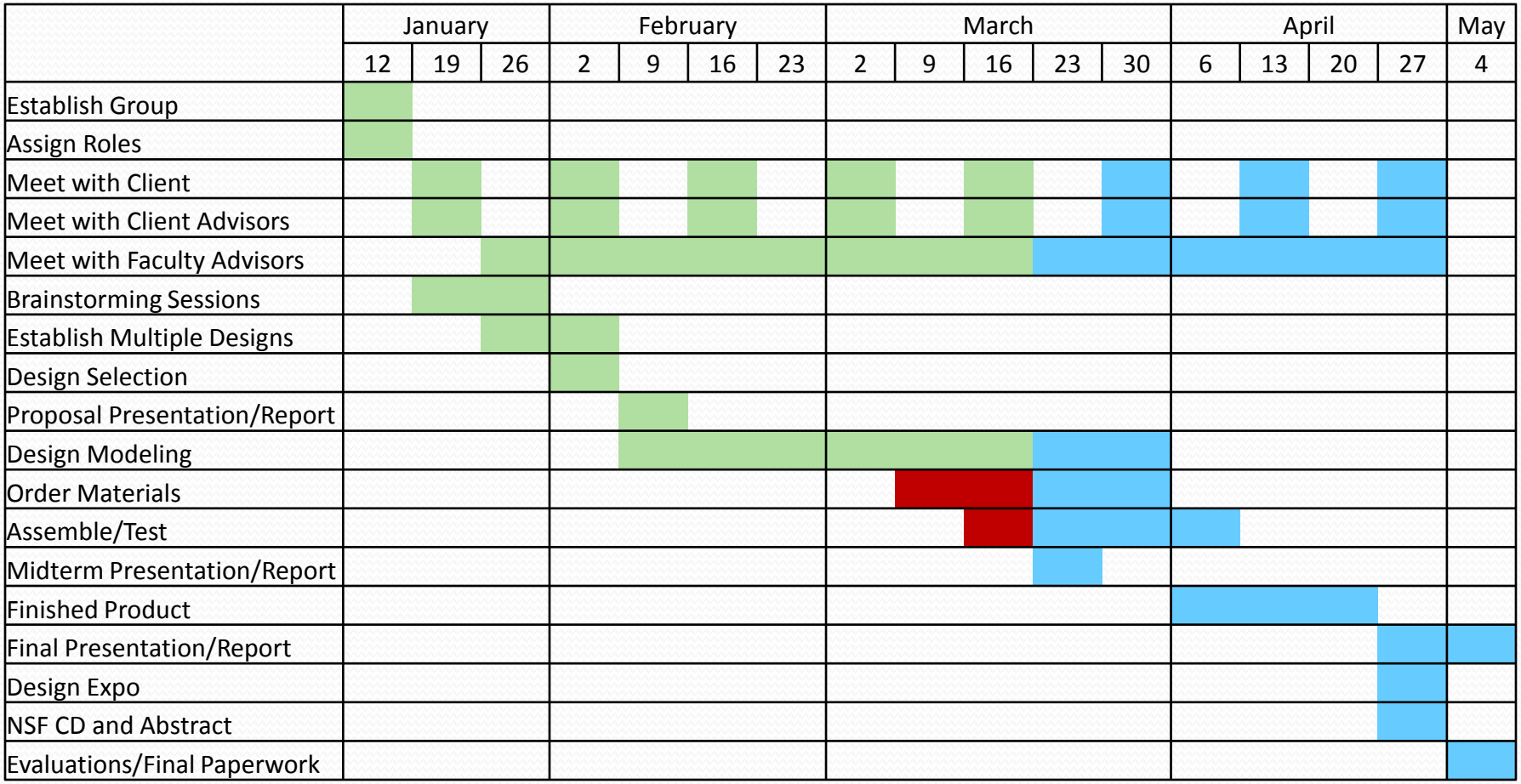
Ryan Wackerly

FEA on Mirage Adapter Plate



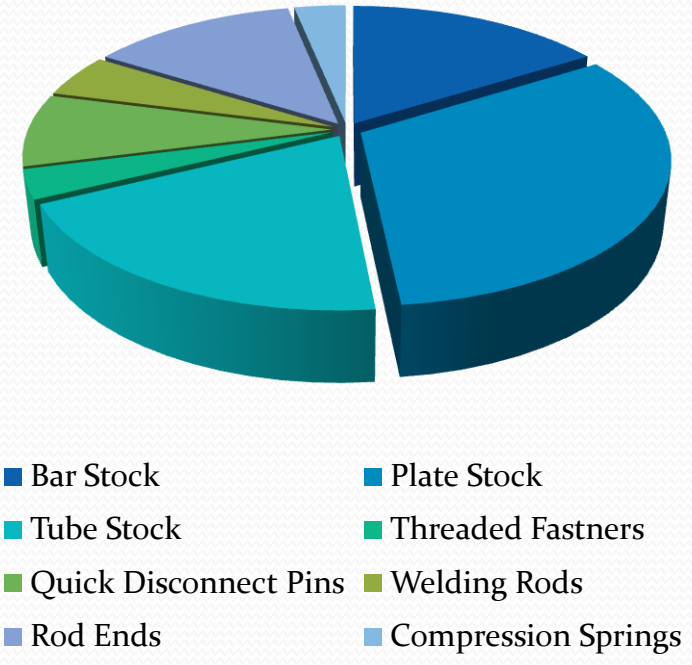
Ryan Wackerly

Work Plan & Project Deliverables



Budget

Aluminum Bar Stock	$50
Aluminum Plate	$100
Aluminum Tube	$60
Threaded Fasteners	$10
Quick Disconnect Pin	$25
ER 5356 Aluminum Welding Rods	$15
Rod Ends	$80
Compression Springs	$10
Shipping	$85
Machining Costs	$65/hr
Current Total Deliverables	$500



Future Plans

- Testing prototype on kayak in lake/pool and using spring scale to verify input force required.
- Model and FEA final design.
- Build display stand for final presentation.
- Recalculate stresses and loading for final design.

Questions

Thank you very much