Final Design Review and Project Proposal

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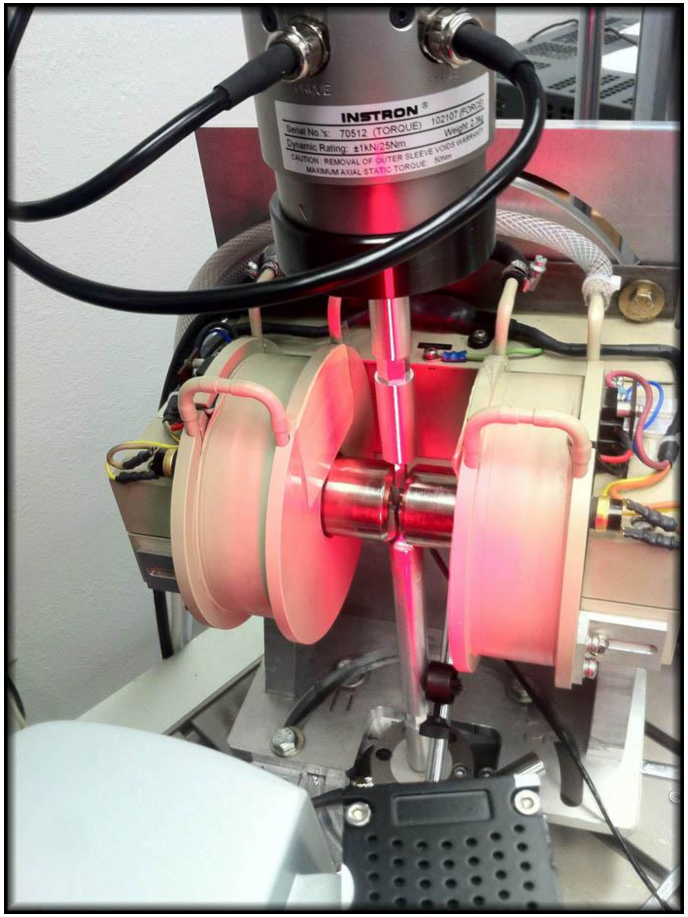
Overview

1. Problem Statement
2. Designs
3. Analysis
4. Selected Design
5. Plans for Next Semester
6. Updated Timeline



Hui

Problem Statement

Need: *The eccentric loading of the test specimens causes fatigue failure.*

Goal: *Design an improved material testing fixture.*

Constraints:

1. Specimen size (3 x 3 x 20) mm
2. Exposed Length (6 mm)
3. Grips cannot bite into specimen
4. Push rods and grips must be non-magnetic
5. Distance between magnets (10mm)
6. Magnetic Field (0.5 - 1.0 T)
7. Axial Alignment (50 µm)

Objectives:

Objectives	Basis for Measurement	Units
Axially Aligned	Distance from Perfect Alginment	µm
Tension Compression Testing	Repeated Testing	# of Tests
Damage Specimen	Cost of Specimen Time to Replace	$$ / Month
Inexpensive	Machining Cost Material Cost	$$

Hui

Quality Function Deployment

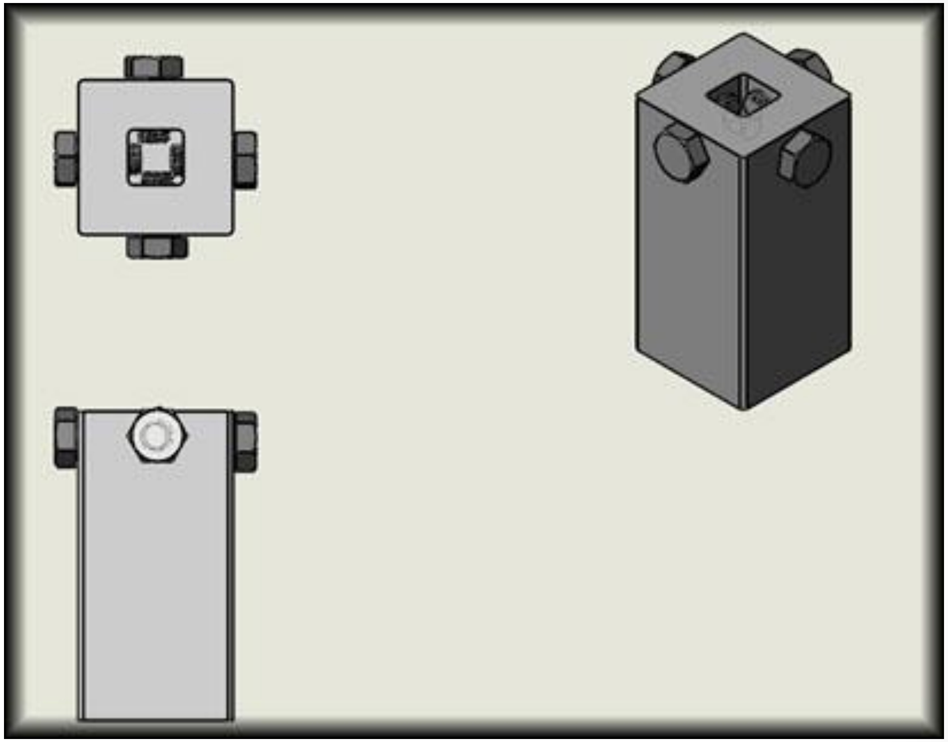
Customer Requirements		Engineering Requirements						
		Strain	Tension	Compression	Exposed Length	Grip Size	Magnetic Field	Cost
Customer Requirements	Does not break	X	X	X				
	Tension Test		X					
	Axial Loading		X	X		X		
	Inexpensive				X			X
	Fits in Testing Device				X	X		
	Magnetic Field				X		X	
	See Specimen				X	X		
	Units	mm/mm	N	N	mm	mm^2	T	$$
	Engineering Targets	1.2	18	60	6	100	1	TBD

Hui

Generated Tip Design

Screw Tip

- 4 Set Screws
- Rubber Insert
- Allows Tension Tests



Problem

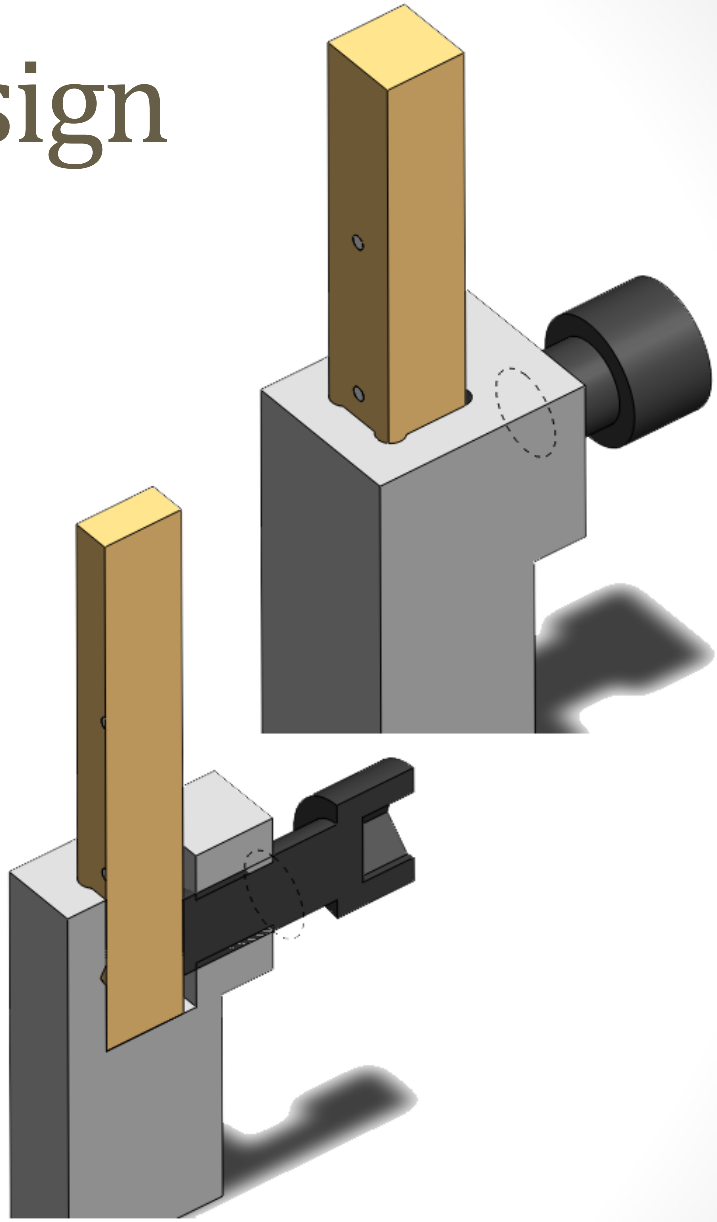
- Axial Alignment

Jeremy

Selected Tip Design

Screw Tip

- 1 Set Screw
- Rubber Insert
- Allows Tension Tests
- Axial Alignment



Jeremy

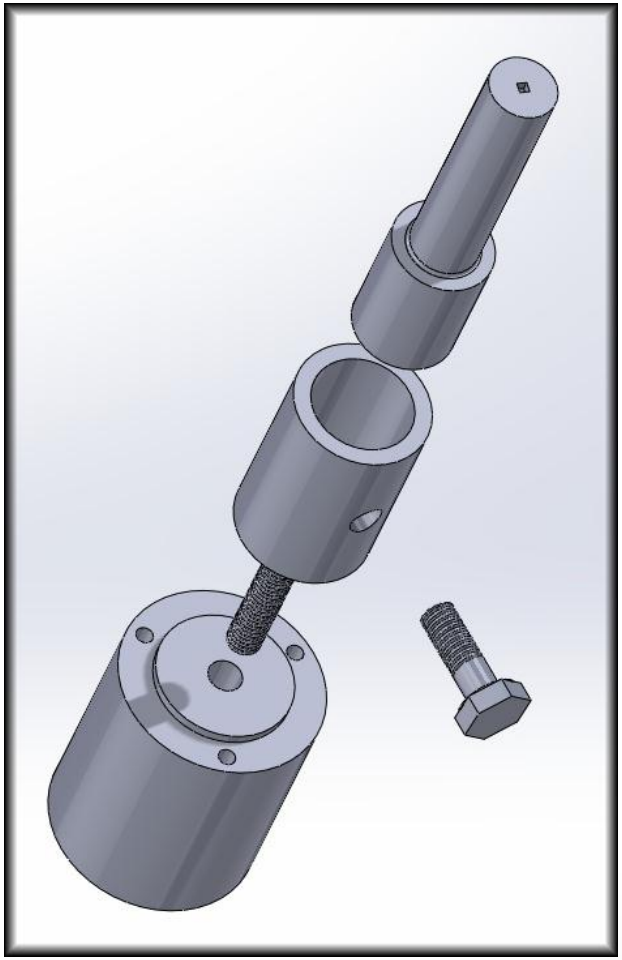
Generated Base Design

Base

- Tight Sleeve / Pushrod tolerances
- No Adjustment

Problem

- Inadequate screw tolerance

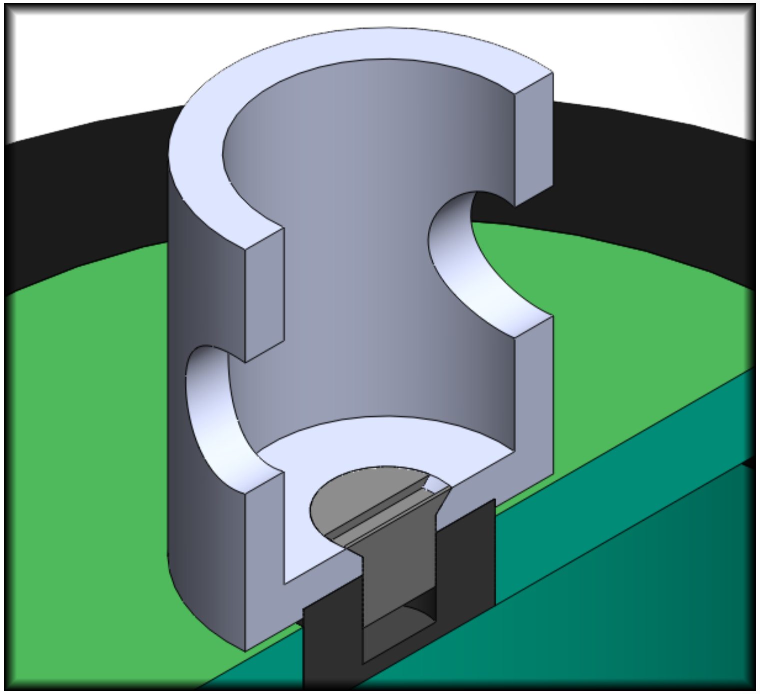


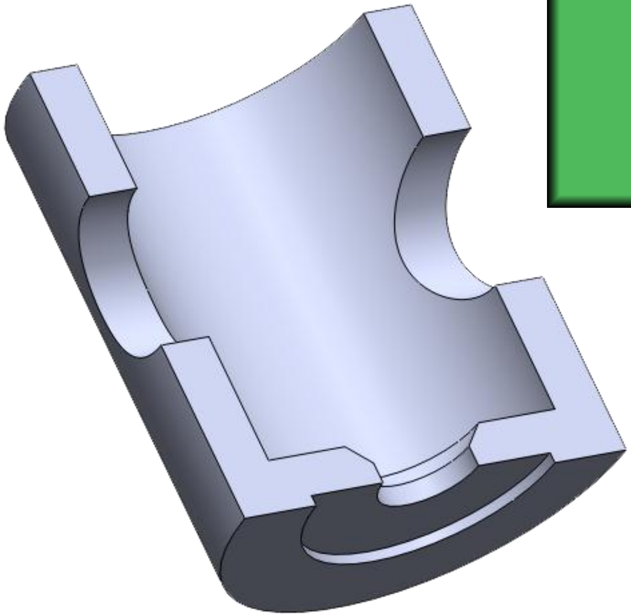
Jeremy

Selected Base Design

Base

- No Alignment Screw
- Uses Existing Alignment
- Tension Tests
- Upper/Lower Fixture



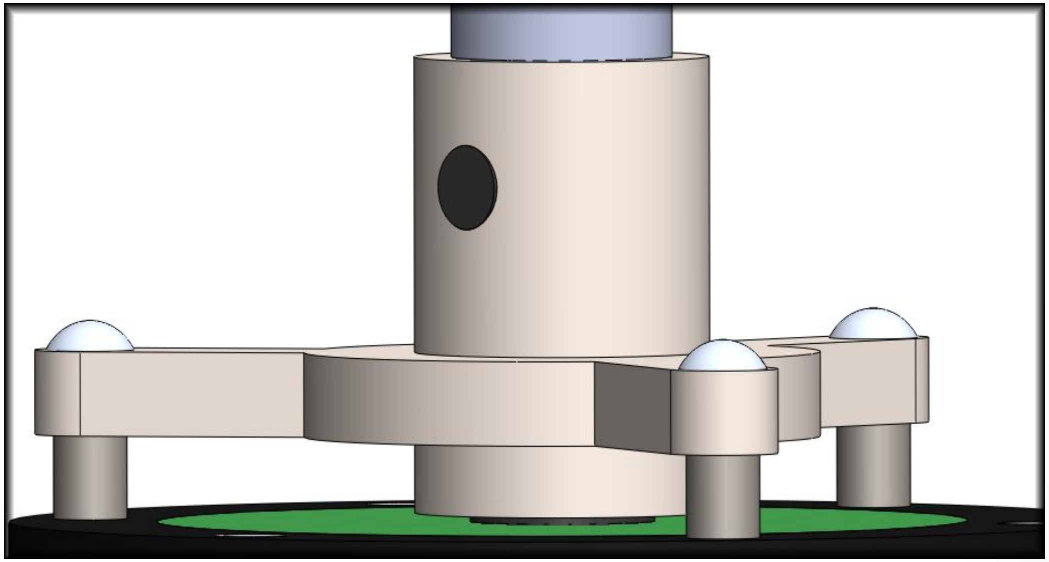


Jeremy

Generated Base Design

Base

- 3 Securing Screws
- Securing Pin
- No Adjustment



Problem

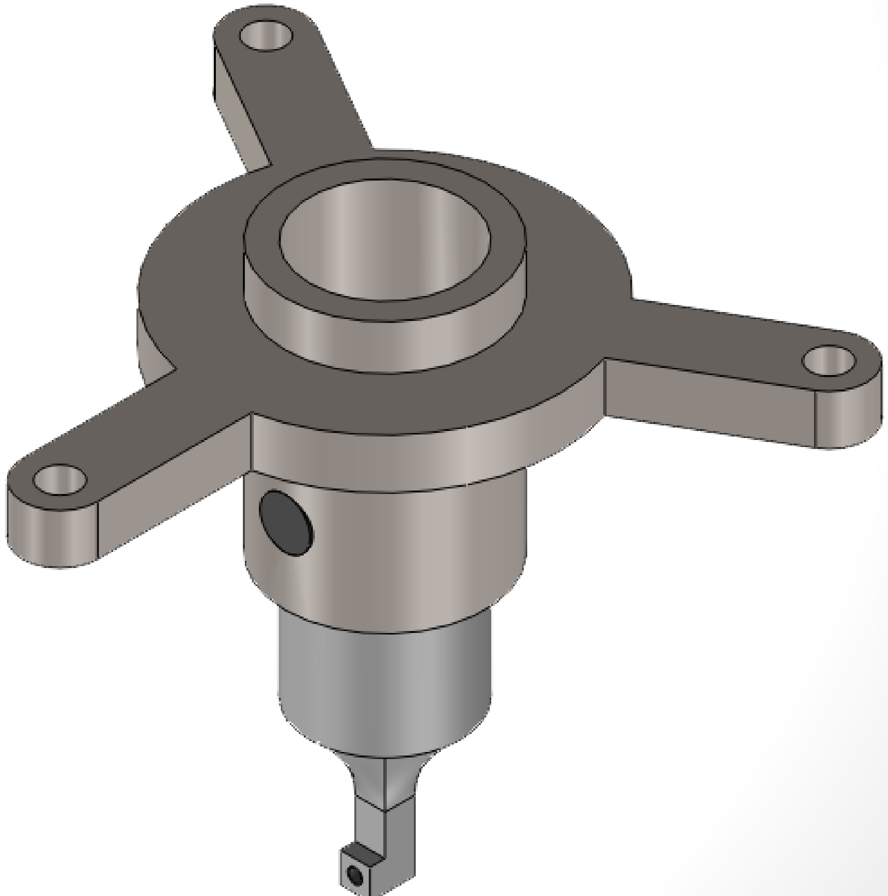
- No Force Analysis Possible

Qian

Modified Base Design

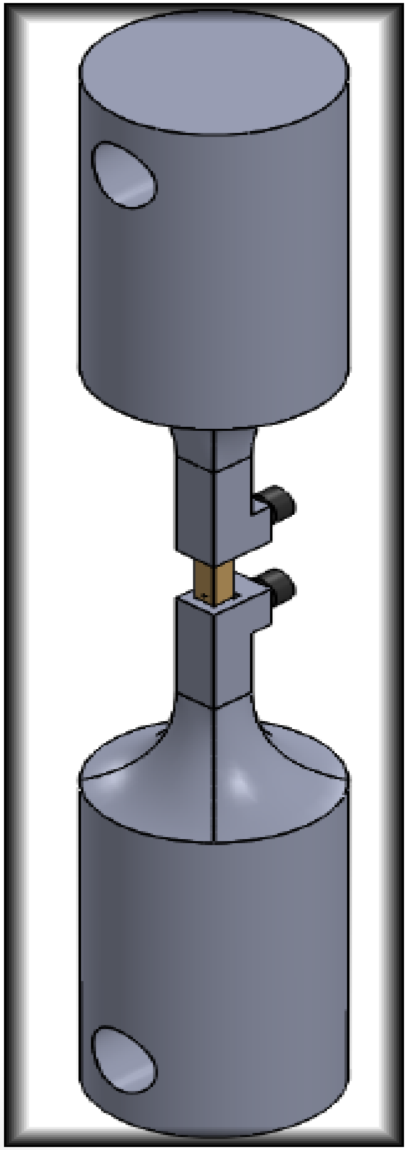
Alternate Upper Fixture

- No Force Analyzer
- Securing Pin
- Allows Tension Tests
- Non Adjustable



Qian

Material Analysis



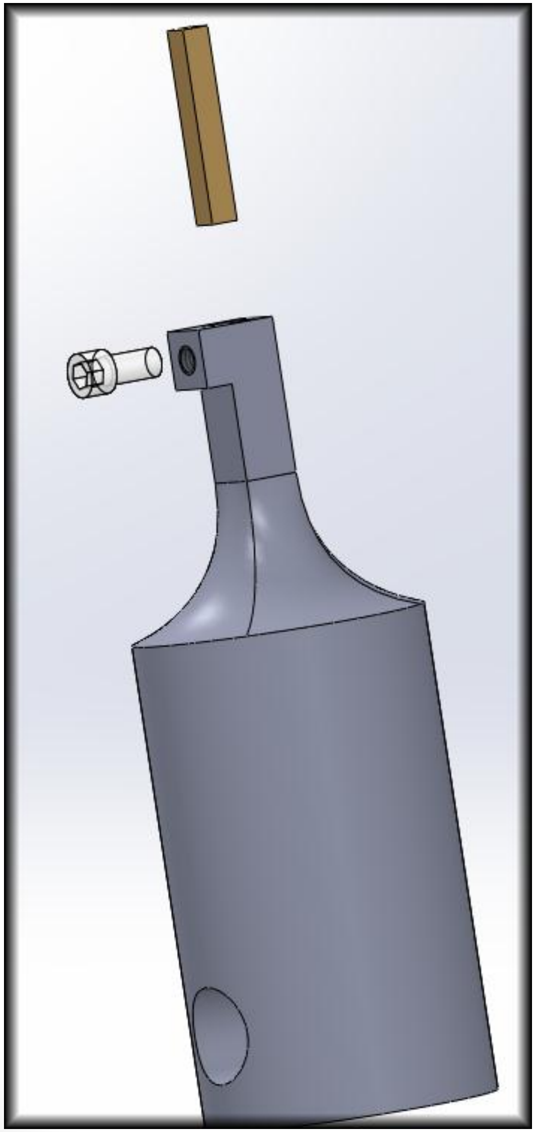
Aluminum 6061 – T6

- A precipitation hardening aluminum alloy.
- It has good mechanical properties.
- It is one of the most common alloys of aluminum for general purpose use

- **6061 - T1**
- **6061 - T3**
- **6061 - T4**
- **6061 - T5**

Qian

Material Analysis – Cont.



Nylon Type 66

- One of the most commonly used polymers.
- Easy and cheap to get.
- Less Yield Strength than aluminum alloy

Other Considerations

- Brass
- Aluminum
- Rubber Insert

Qian

Compression Analysis

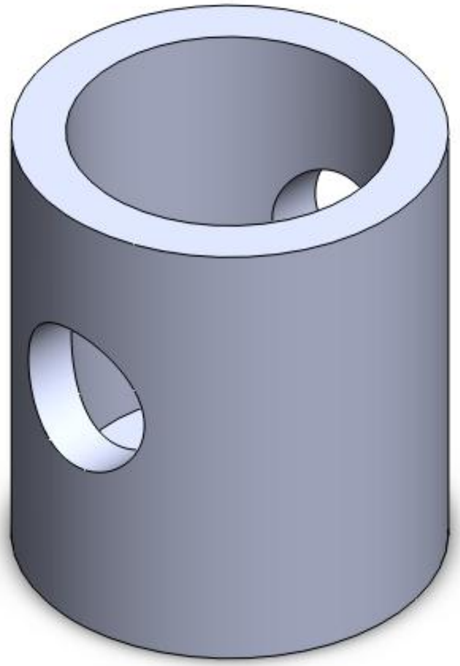
Smallest Area

Length	3	mm
Width	3	mm
Area	9	mm^2
	0.000009	m^2

Force (N)	Stress (N/m^2)
10	1.111E+06
20	2.222E+06
30	3.333E+06
40	4.444E+06
50	5.556E+06
60	6.667E+06
70	7.778E+06
80	8.889E+06
90	1.000E+07
100	1.111E+07

Randy

Bearing Analysis



	Pin 10mm	Pin 15mm	Pin 20mm	Pin 25mm
Outer Diameter (mm)	**Stress (MPa)**	**Stress (MPa)**	**Stress (MPa)**	**Stress (MPa)**
31.0	16.00	10.67	8.00	6.40
32.0	8.00	5.33	4.00	3.20
33.0	5.33	3.56	2.67	2.13
34.0	4.00	2.67	2.00	1.60
35.0	3.20	2.13	1.60	1.28
36.0	2.67	1.78	1.33	1.07
37.0	2.29	1.52	1.14	0.91
38.0	2.00	1.33	1.00	0.80
39.0	1.78	1.19	0.89	0.71
40.0	1.60	1.07	0.80	0.64

Randy

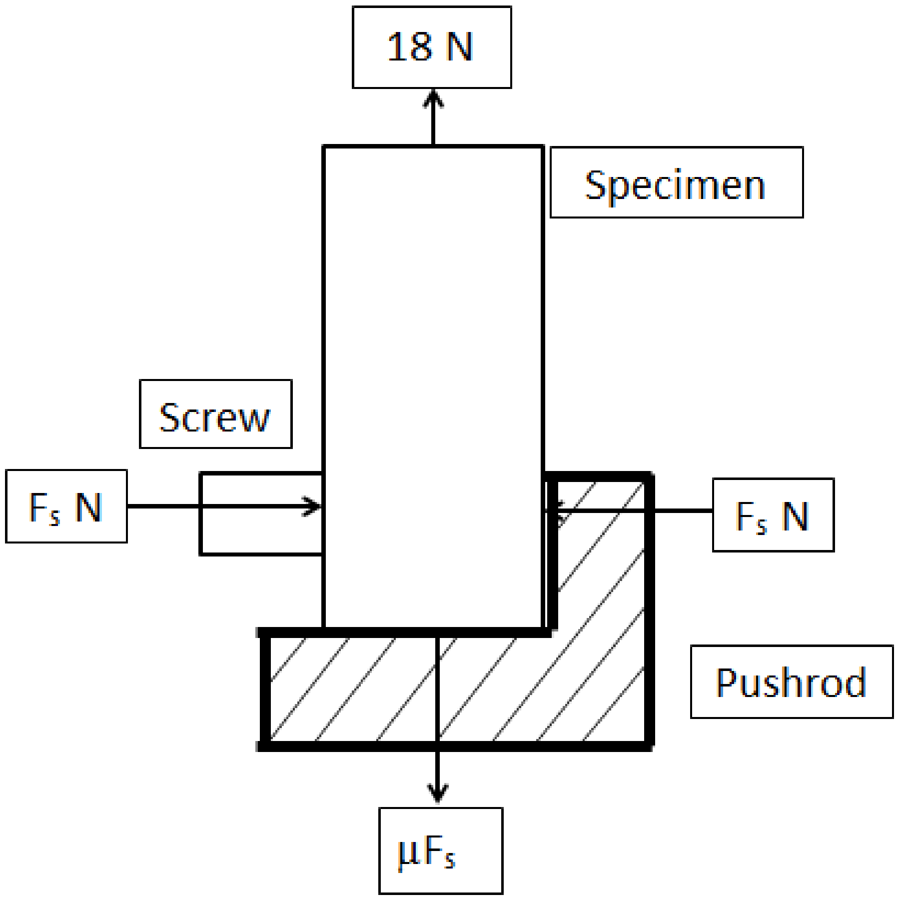
Screw Analysis

Sum of the forces:

$$\sum F_y = 18N - \mu F_s = 0$$

$$F_s = \frac{18}{\mu} N$$

F_s [N]	Friction
120.0	0.2
36.0	0.5
21.2	0.9
15.0	1.2



Randy

Screw Analysis – Cont.

Screw: M3 x 0.5 x 6 mm

Major Diam. D [mm]	Minor Diam. dr [mm]	Thread Engagement Length Le [mm]	Pitch Diam. dp [mm]	Pitch p [mm]	External Shear Area [mm^2]	Internal Shear Area [mm^2]
3.000	2.385	3.500	2.567	0.500	**18.623**	**32.986**

	Nylon Type 66			Brass		
	Yield Str. [MPa]	Force [N]	Coeff. Friction	Yield Str. [MPa]	Force [N]	Coeff. Friction
	45	120	0.15	130	51.43	0.35
External Thread Force to Fail [N]	838.1			2421.0		
Internal Thread Shear to Fail [N]	8081.6			8081.6		

Randy

Cost Analysis

Type	Material	Cost
Main	Aluminum Alloy	0.6-0.9 $/lb
Screw	Nylon	0.005-0.006 $/piece

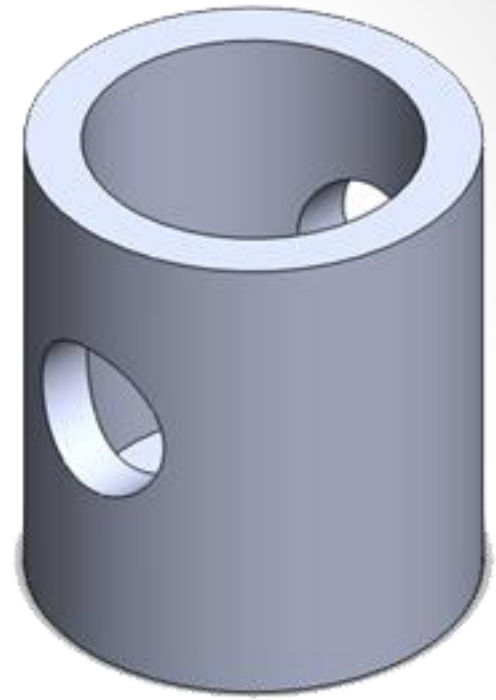
Other Considerations

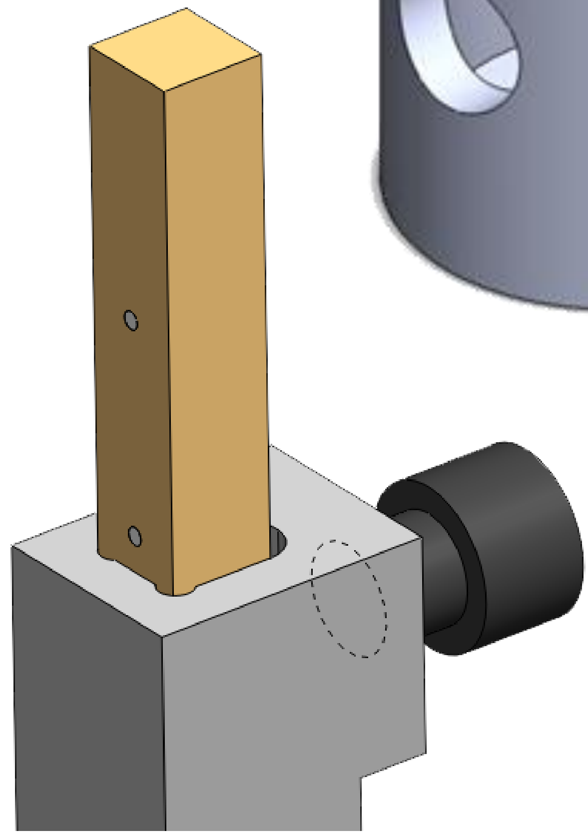
- Copper
- Lead
- Magnesium

Randy

The Next Steps

1. Continue with Proposed Designs
2. Regular Customer Input
3. Manufacturing
4. Build Prototype
5. Test Prototype
6. Analysis and Refinement
7. Produce Final Product





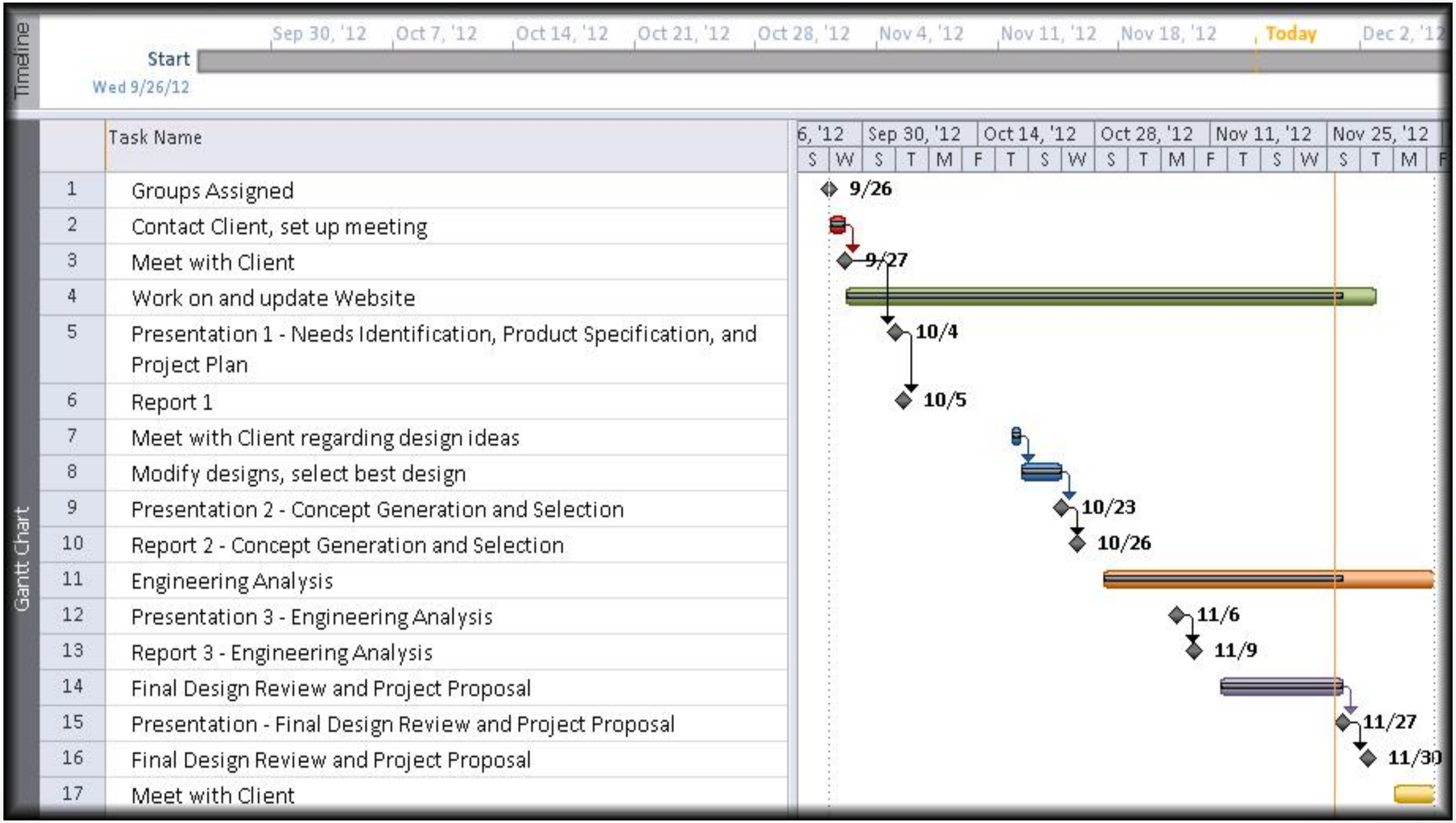
Matt

Conclusion

1. Problem Statement
2. Designs
3. Analysis
4. Future Plans

Matt

Updated Timeline



Matt

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Dr. Constantin Ciocanel