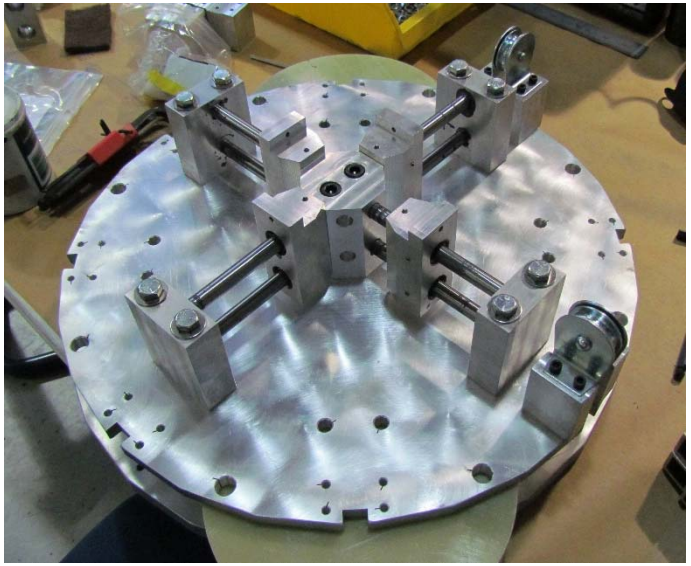
Team 2- Biaxial Tensile Tester



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Graduate Consultant: Parker Harwood
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Agenda

- Background/ Project Scope
- Specimen Geometry
- Material Testing
- Device Modifications
- Assembly
- Grip Testing
- Cable Testing
- Budget and Procurement
- Future Plans

Material Characterization

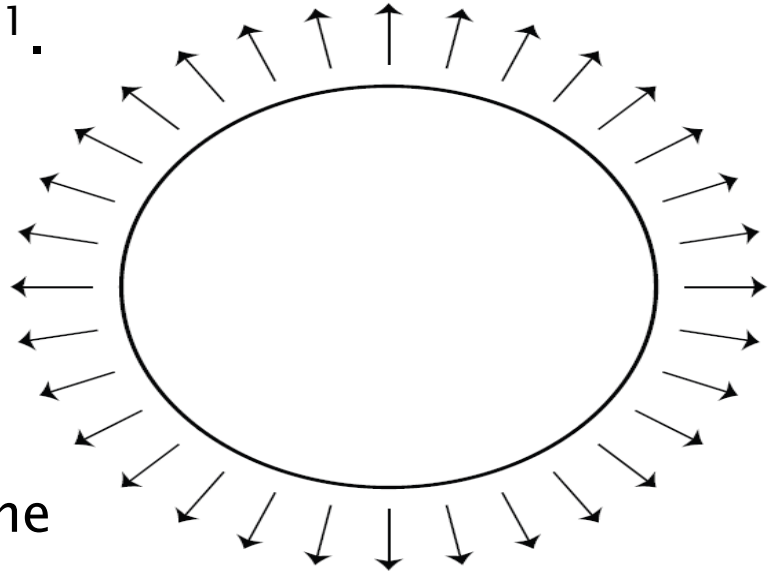
- In order to model materials, accurate predictions of properties are needed
  - **Uniaxial tension**
    - Easy to obtain with standard tensile test
  - **Pure shear**
    - Done with planar tension test
  - **Uniaxial Compression**
    - Inaccurate due to the friction between the load plates and the specimen
    - Causes a mixed state of compression, shear, and tensile strain[1]

Why Equal Biaxial Tension?

- A biaxial tensile strain is equivalent to a uniaxial compressive strain[1].
- Mohr's Circle
  - Becomes a point circle
  - No shear forces are present[3]
- Poisson's Ratio nearly 0.5
  - Means a process of constant volume

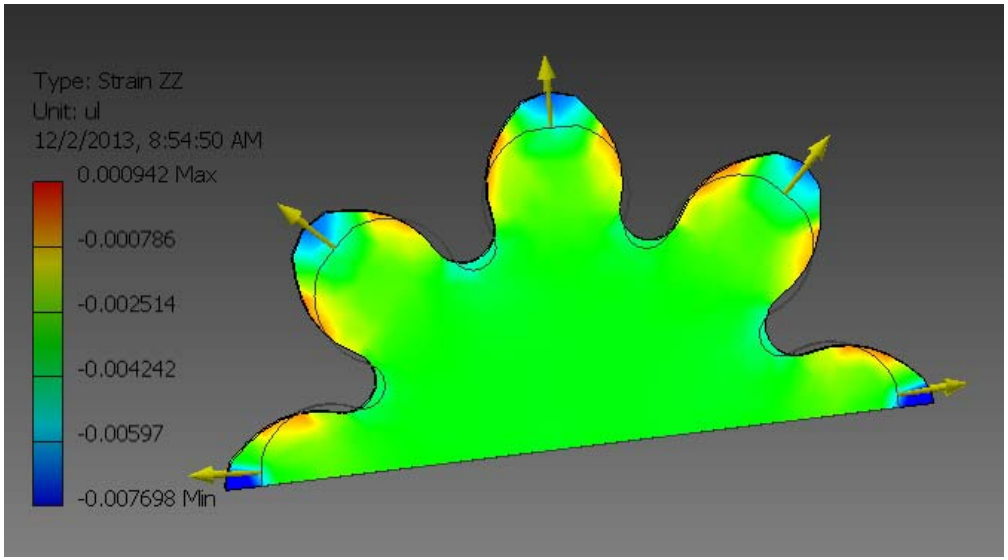
$$\gamma = -\frac{\epsilon_z}{\epsilon_x}$$

- Free of the frictional effects[2]

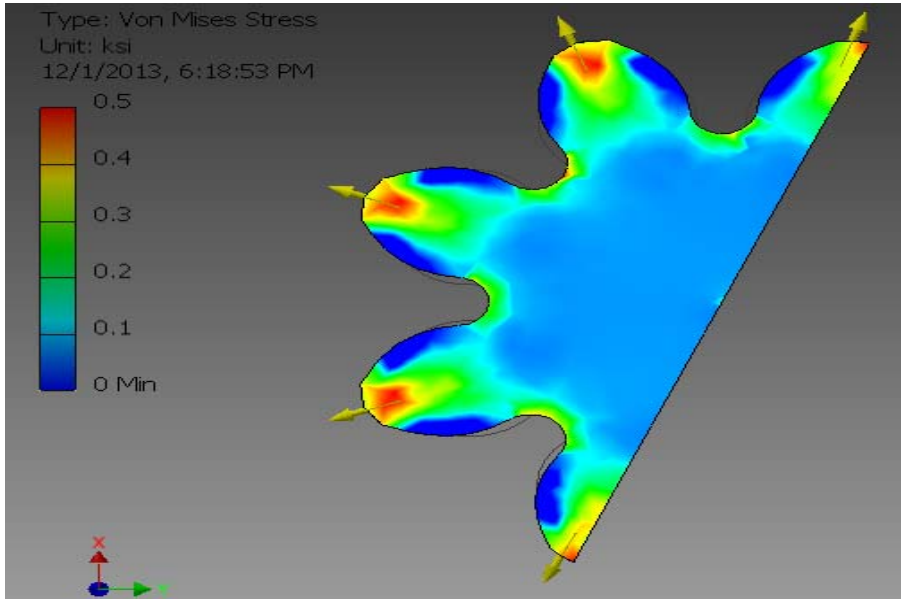


Ideal Equal Biaxial Stress State[1]

Final Specimen Geometry



The strain profile in the ZZ plane after load is applied



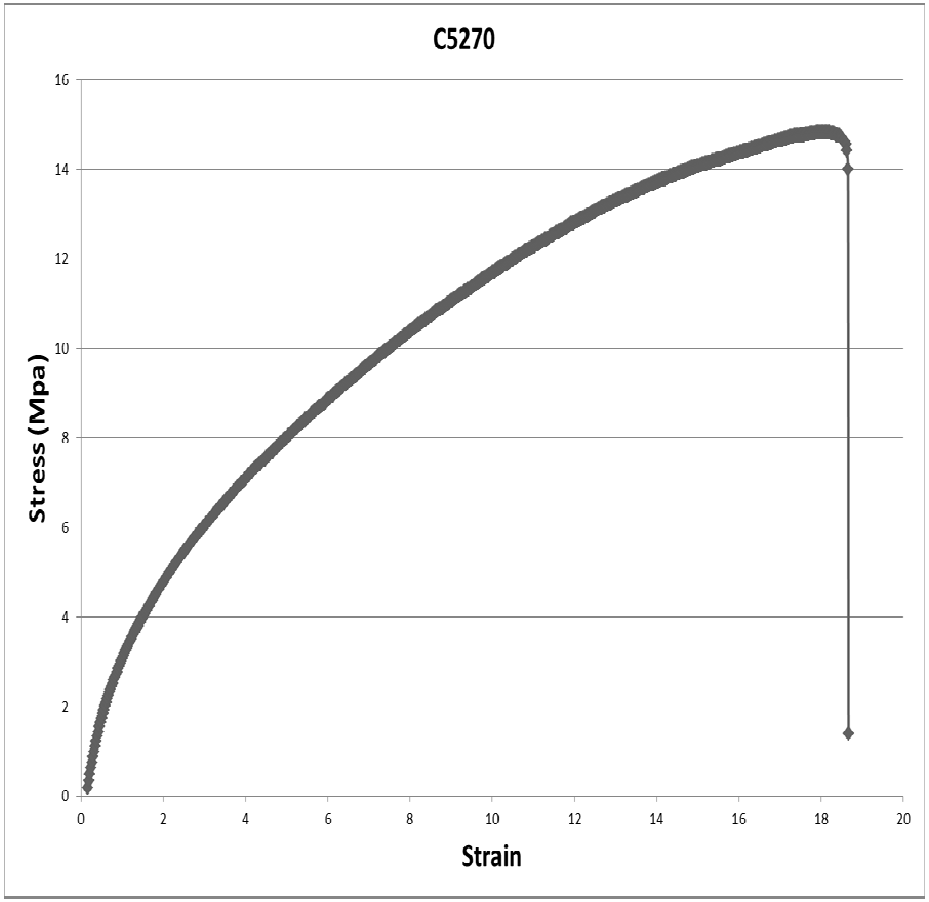
The resulting Von Mises Stresses as force was applied radially

How to Get Specimen Geometry

- A company, Apple Die, was contacted and gave us a quote on the manufacturing of a rule die
- This route was decided upon because it reduced the wait on manufacturing, and it was only a two day turnaround
- Total cost was ~$200

Material Testing

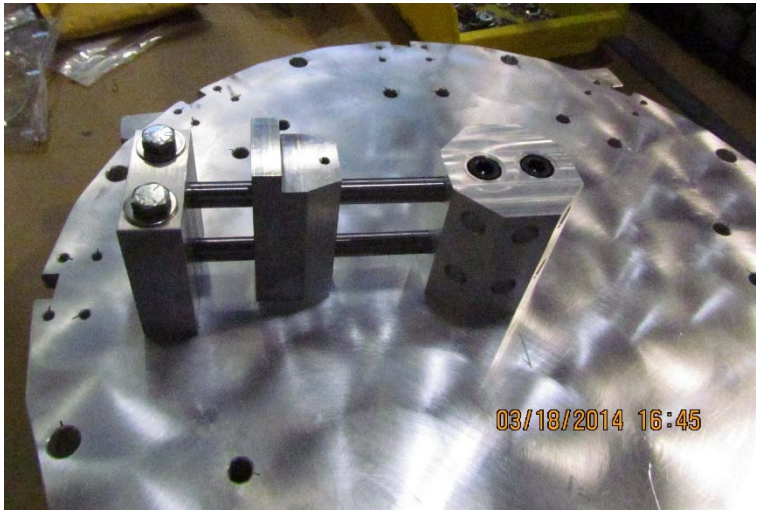
- The stiffest material, Gasket C5270, was tested in the traditional dog bone shape
- Maximum stress was found to be 14.8 MPa
- The max stress was used with a conservative cross-section of our sample geometry
- This gave an estimation of the maximum load to be used on our device of 1.054 kN

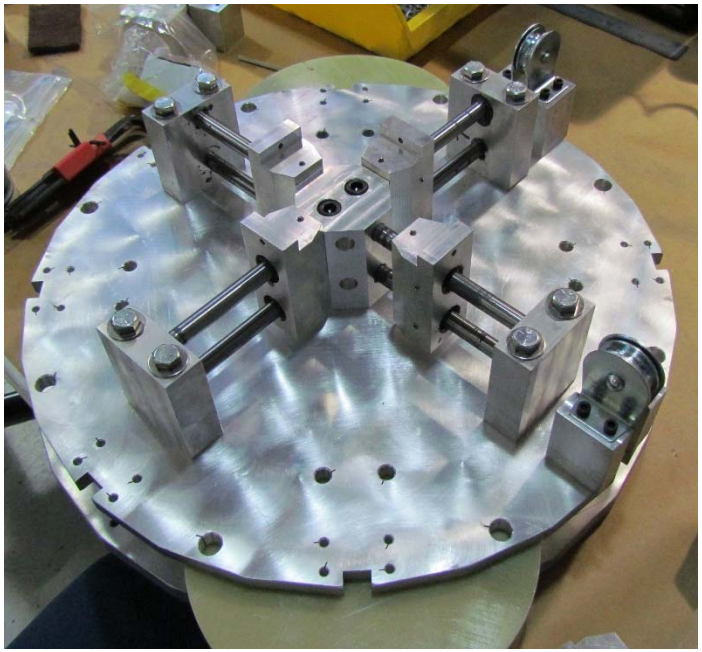


Device Modifications

- Cut down diameter of all plates by 5 inches
  - Reduces weight by ~50 lb
- All other components remained the same except the carriers
  - Location is only part modified due to reduced baseplate
- Carriers had to be modified to fit cable that was decided upon

Assembly



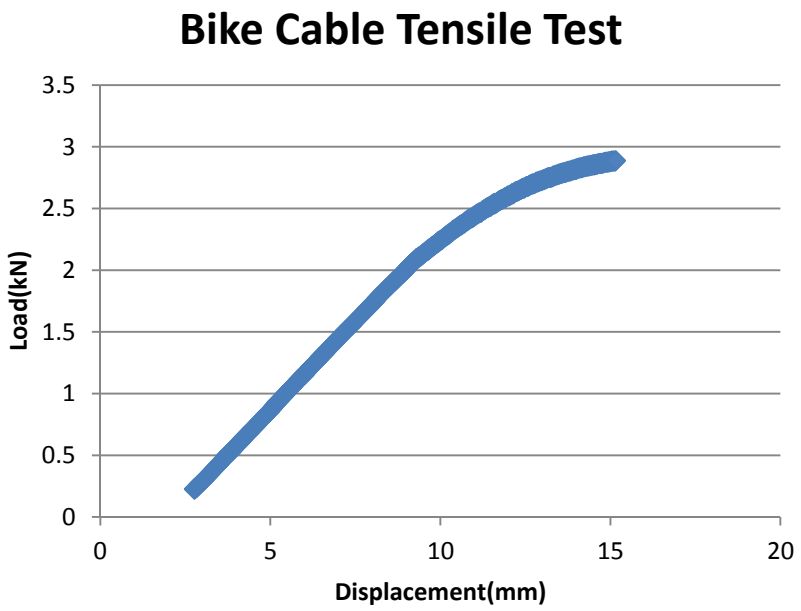


Grip Testing

- Mock-up constructed for single axis
  - Mock grips constructed for use in MTS machine
  - 1:1 Single axis sample of stiffest material made
- Tested for capability of grasping without slip
  - Slip did not occur
  - 1:1 Sample broke at reduced gauge section
  - Sample broke at 125lbf

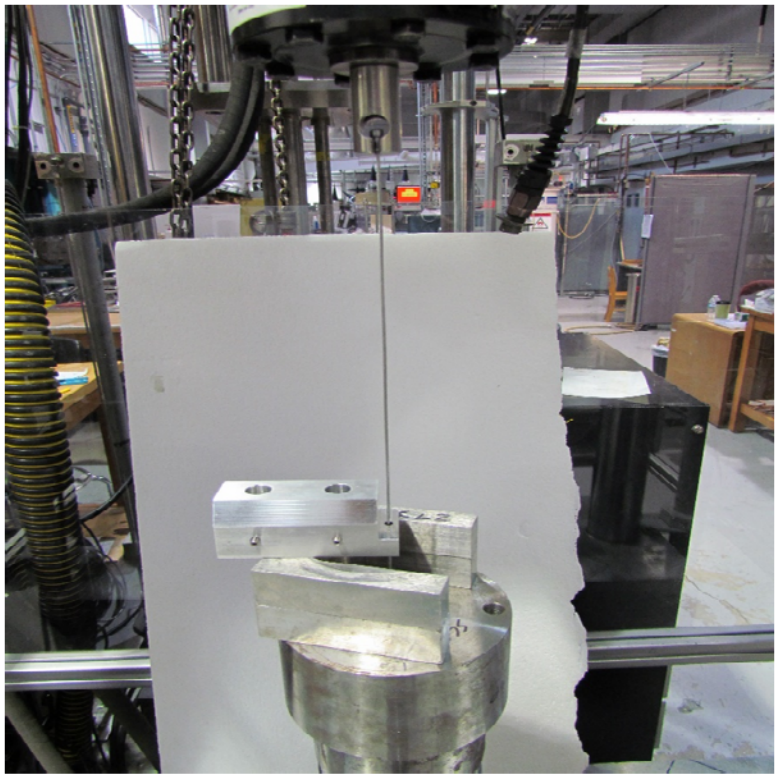
Cable Testing

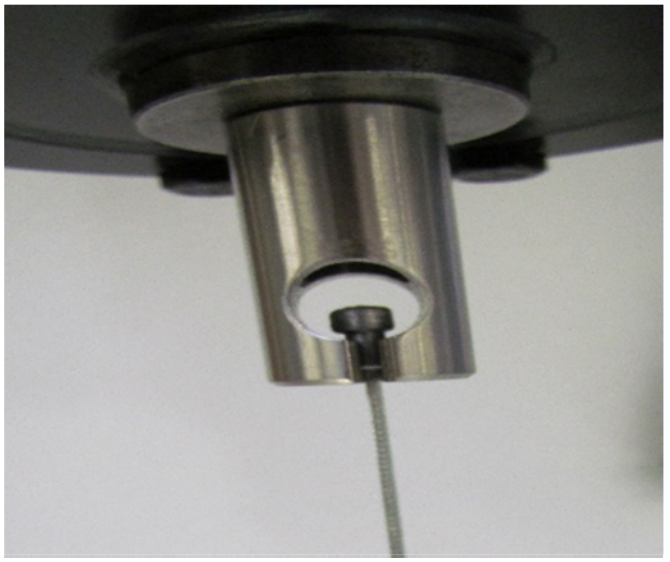
- Dyneema rope
  - Pre-load of 1lb.
  - 350 mm sample stretched an average of 5mm in load range.
  - Inconsistent stretch
- Steel cabling
  - Pre-load of 5lb.
  - 780 mm sample stretched 3.5mm in load range
    - Expected stretch of 1.6mm



Cable Testing

- Tested actual cables to be used
  - Proof test of attachment
  - Possible over-tightening
  - 4 passed
  - 2 failed
- Performance of the passing cables was excellent
  - All remained in the elastic region
  - Max. Stretch: 2.20mm`





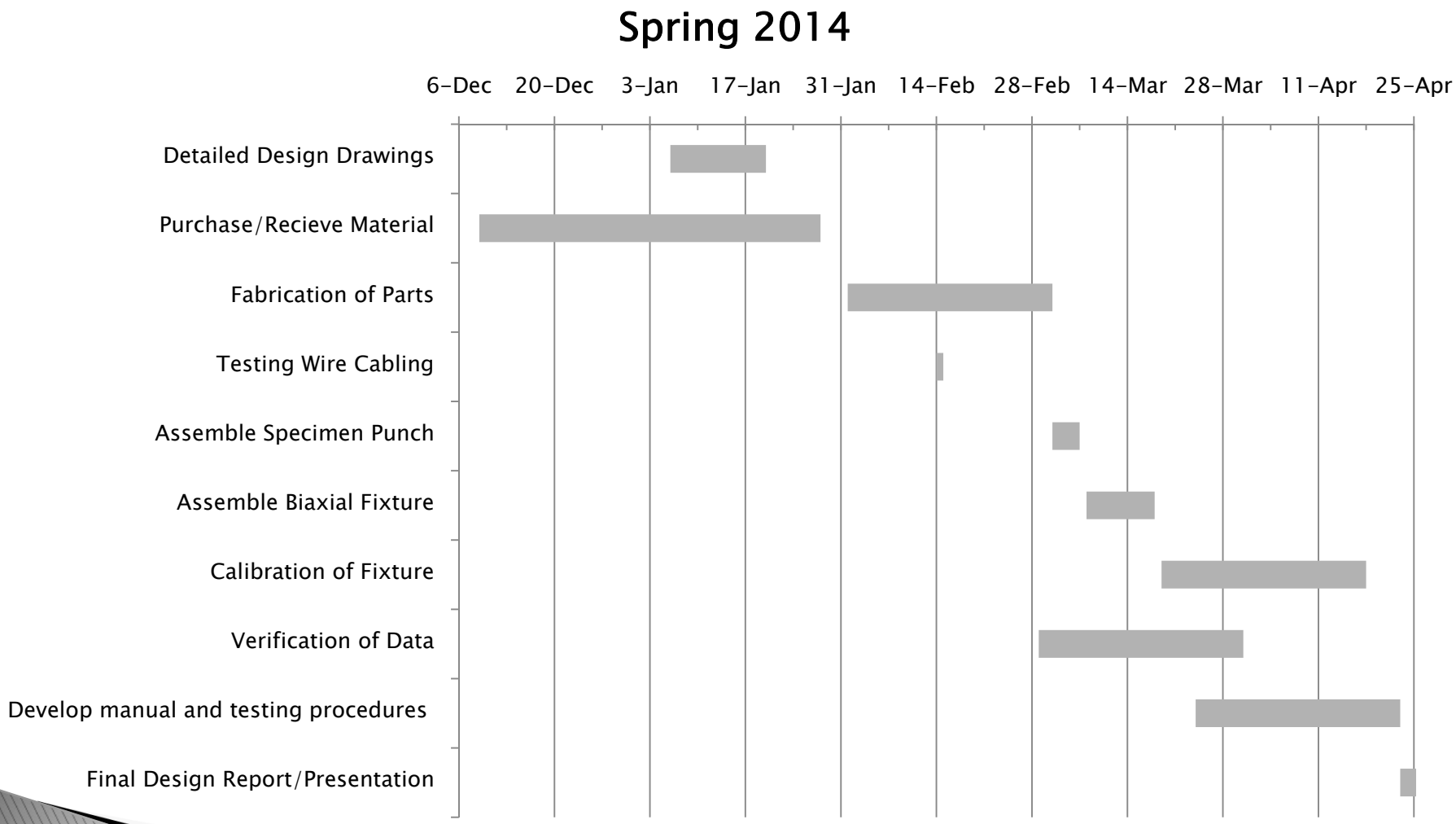
Budget

- Procured
  - Everything! Except more bearings…
- Remaining Items
  - 6 bearings remaining due to shipping error.
    - Should arrive any day
  - 2 foot Acetyl rod
    - Next week
- Remaining Budget
  - $601.28

Future Plans

- Test remaining gasket materials in uniaxial tension
- Test bearing function
  - Explore other options
- Begin proof testing
- Calibrate device to operate successfully
- Make changes if necessary
- Create procedure for use and safety handbook

Gantt Chart


Spring 2014
6-Dec
20-Dec
3-Jan
17-Jan
31-Jan
14-Feb
28-Feb
14-Mar
28-Mar
11-Apr
25-Apr
Detailed Design Drawings
Purchase/Recieve Material
Fabrication of Parts
Testing Wire Cabling
Assemble Specimen Punch
Assemble Biaxial Fixture
Calibration of Fixture
Verification of Data
Develop manual and testing procedures
Final Design Report/Presentation

References

1. http://www.axelproducts.com/downloads/CompressionOrBiax.pdf
2. Callister, W.D. (2007). *Material Science and Engineering, An Introduction;* 7th ED. York, PA: John Wiley & Sons, Inc.
3. Day, J. and Miller, K. (July 2000), Equibiaxial Stretching of Elastomeric Sheets, An Analytical Verification of Experimental Technique. *Equibiaxial Stretching, Rev 2. 1-8.*

Questions?
Comments?
Suggestions?