Design Evolution

**Phase 1**

- Problem Statement
- Sketch
- CAD Model
- CAE
- Rapid Prototyping

**Phase 2**

- Design Optimization (Trimming!)
- CAD Model V2
- CAE V2
- Rapid Prototyping V2

Validation

16.810 Team 5

Critical Design Review
### Comparison of Metrics

<table>
<thead>
<tr>
<th></th>
<th>Displacement 1</th>
<th>Displacement 2</th>
<th>Mass</th>
<th>Natural Freq</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement</td>
<td>0.071 mm</td>
<td>0.011 mm</td>
<td>0.160 lbs</td>
<td>505.7 Hertz</td>
<td>7.8 $ / Part</td>
</tr>
<tr>
<td>CAE 1</td>
<td>0.303 mm</td>
<td>0.0455 mm</td>
<td>0.160 lbs</td>
<td>460 Hertz</td>
<td>$14.83</td>
</tr>
<tr>
<td>Experimental 1</td>
<td>0.7473 mm</td>
<td>0.08625 mm</td>
<td>0.166 lbs</td>
<td>477.45 Hertz</td>
<td>$14.83</td>
</tr>
<tr>
<td>CAE 2</td>
<td>0.1568 mm</td>
<td>0.010998 mm</td>
<td>0.160 lbs</td>
<td>432 Hertz</td>
<td>$10.19</td>
</tr>
<tr>
<td>Experimental 2</td>
<td>0.390 mm</td>
<td>0.043575 mm</td>
<td>0.165 lbs</td>
<td>426.2 Hertz</td>
<td>$10.19</td>
</tr>
</tbody>
</table>

**Table 1:** CAE and Experimental Data

### Load Case

- F1 = 100 lbs
- F2 = 100 lbs
- F3 = 50 lbs
**Final Specifications in Comparison to Requirements**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Constrain</th>
<th>Optimize</th>
<th>Accept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Priorities

- **Design rational**
  - Focused on requirement delta2 to achieve stiff and rigid power train region to give rider a sense of good acceleration
  - Met mass requirement as weight is an important factor in racing bike
  - Cost was largely ignored, as it is an acceptable criteria and optimizing for the other factors naturally improved cost efficiency
Final Conclusions

• Design analysis arrived at performance and weight results within a reasonable window for the 2nd product
  – δ₁ was 221% of the target, while δ₂ was 99.9% of the target deflection
  – Mass was at 100% of the target
• Testing did not align with the CAE to full satisfaction
  – δ₁ was 248.7% of the prediction, while δ₂ was 396.2% of Cosmos Works’ predictions
• While the iterations were successively achieving better results, the final model has nearly approached the limitations of the materials being utilized
  – Only by blending materials and adding new parts to the assembly, can the performance to mass ratio be improved
  – Any advancements of this kind will require a new manufacturing process, which is currently available.
• While further iterations of the design and prototyping process could improve the designs performance, these iterations would not be cost effective