Introduction to FEM

Final Project

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11/29/16

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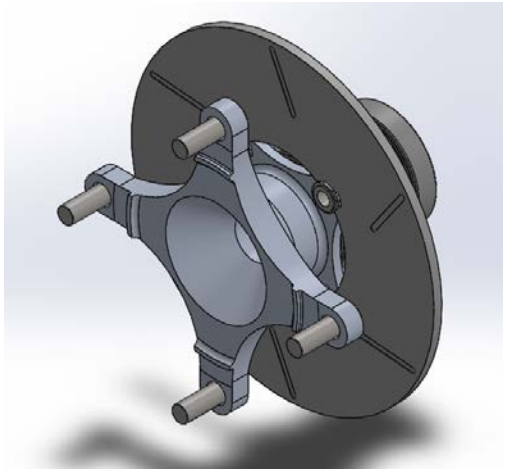
FSAE Front Wheel Hub

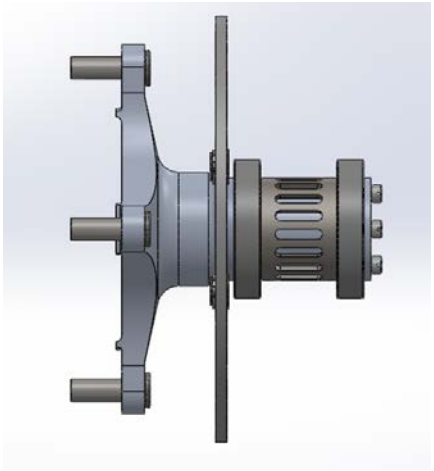
Purpose:

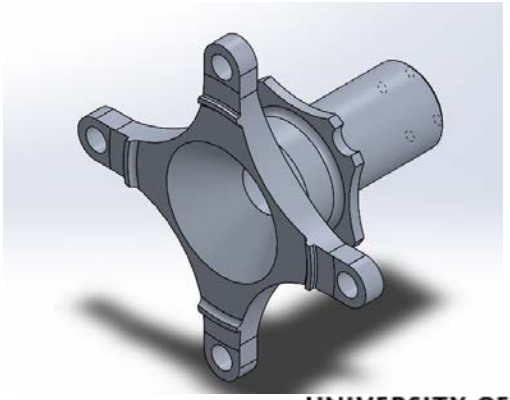
- Attach the chassis of the car to the wheels

Design Overview:

- Serration Bolt holes for Yamaha OEM studs
- Rotor mount to accept floating rotors
- Integration of 2 SKF deep groove ball bearings
- 7075 T6 Aluminum material
- 1.16 lb







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Purpose Statement

1. Perform a static structural analyses using ANSYS Workbench to show that the wheel hub is designed to at least a 2 factor of safety:
   - 1.7G braking de-acceleration

2. Perform a modal analysis using ANSYS Workbench:
   - First 10 natural frequencies
   - First 10 mode shapes

3. Perform a thermal analysis to identify thermal stresses incurred during one manufacturing process of the wheel hub

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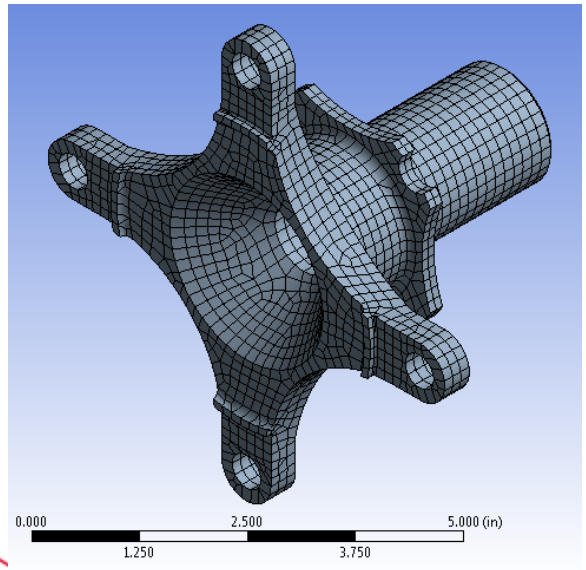
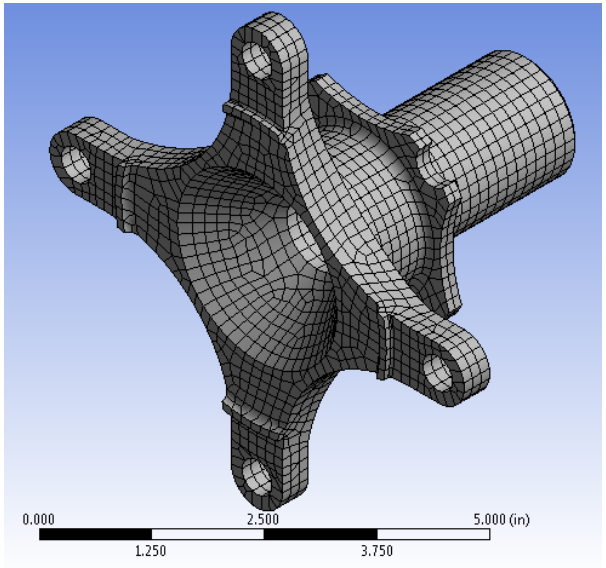
FEM Model

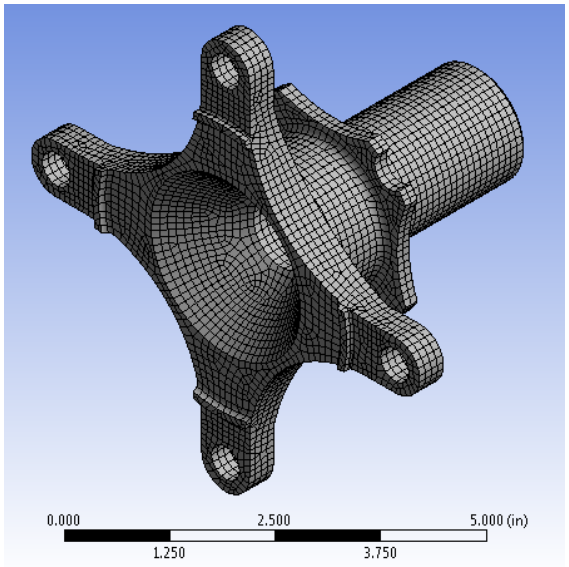
.2” Element Size



.15” Element Size



.10” Element Size



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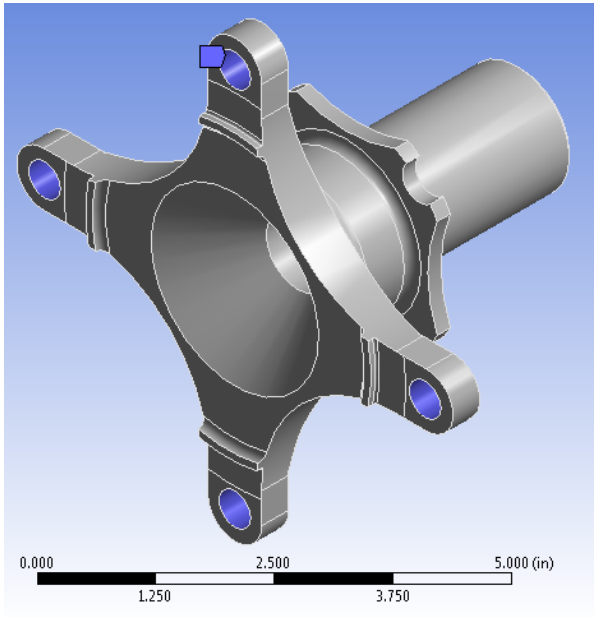
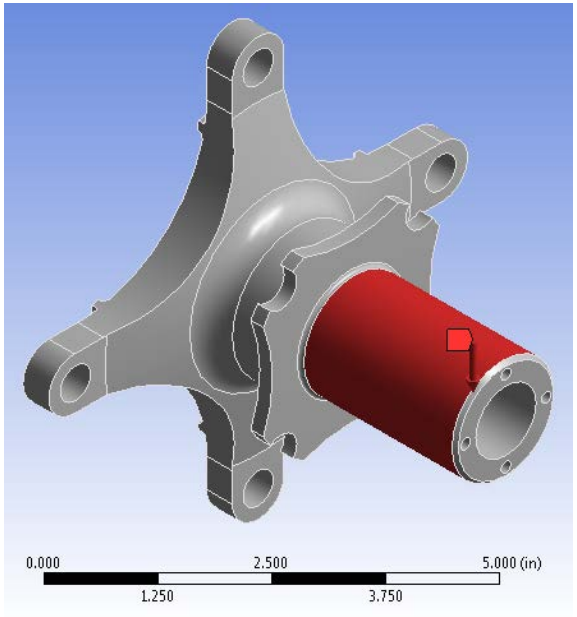
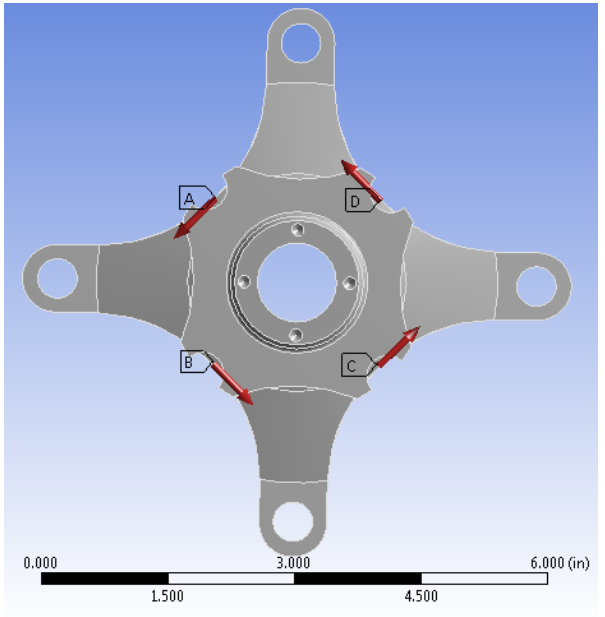
Static Structural: Loading Conditions



- Fixed support at wheel stud holes



- 225 lb_f bearing load at bearing surface



- 550 lb_f remote force at each rotor button interface

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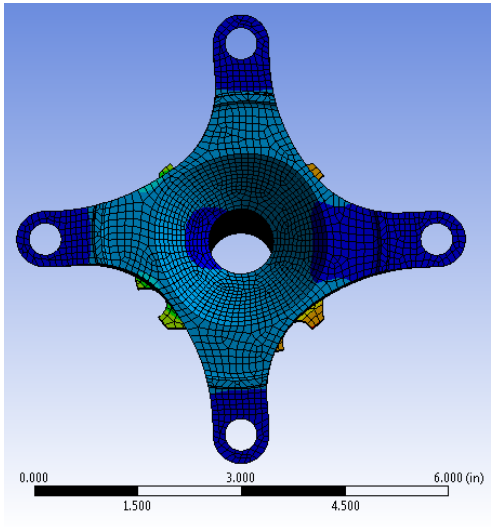
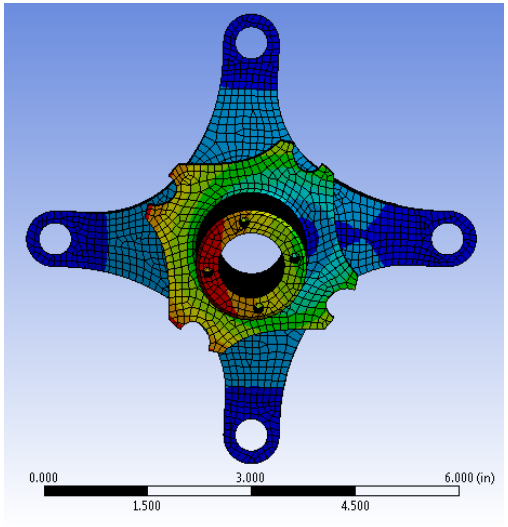
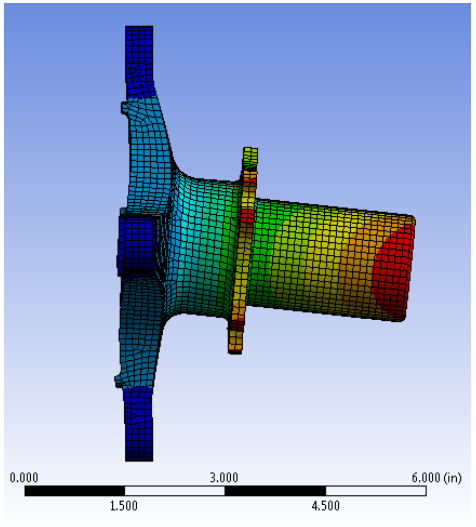
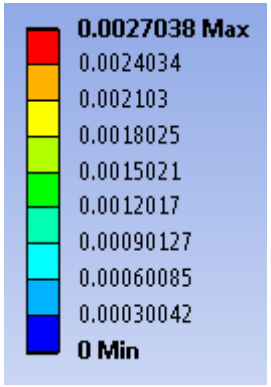
Deformation Results









Element Size (inches)	Max Deformation (inches)
.2	.0027
.15	.0027
.1	.0027

- ✓ Convergence
- ✓ Minimal deformation

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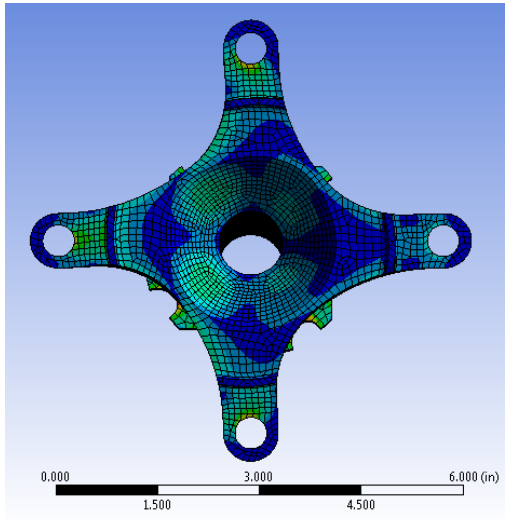
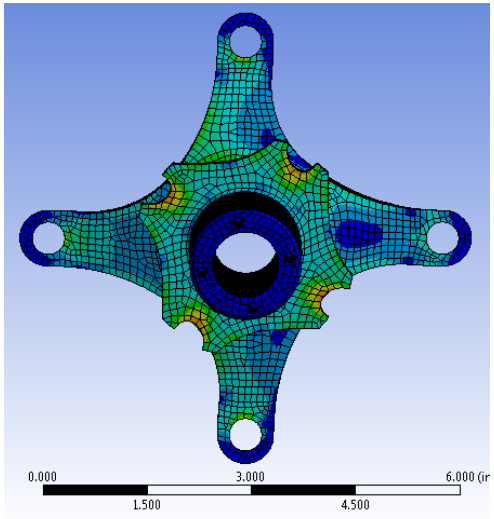
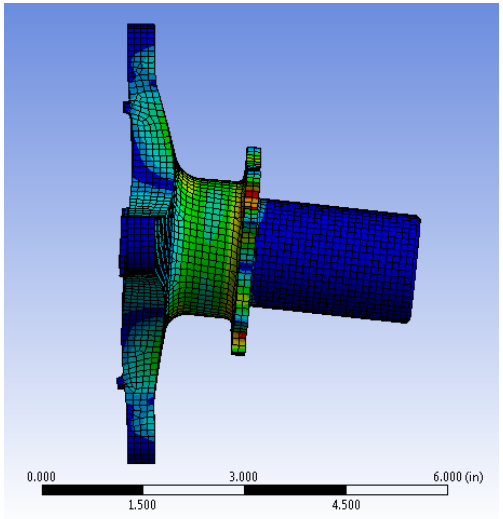
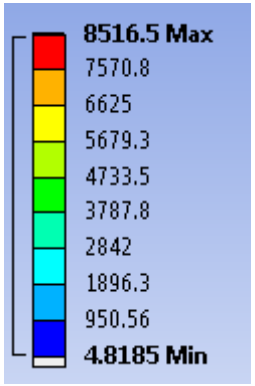
Von Mises Stress Results









Element Size (inches)	Max Von Mises Stress (psi)	Percent Change (%)
.2	8413	-
.15	8413	0
.1	8516.5	1.23

- ✓ Convergence
- ✓ Factor of safety from yielding is ~8.57

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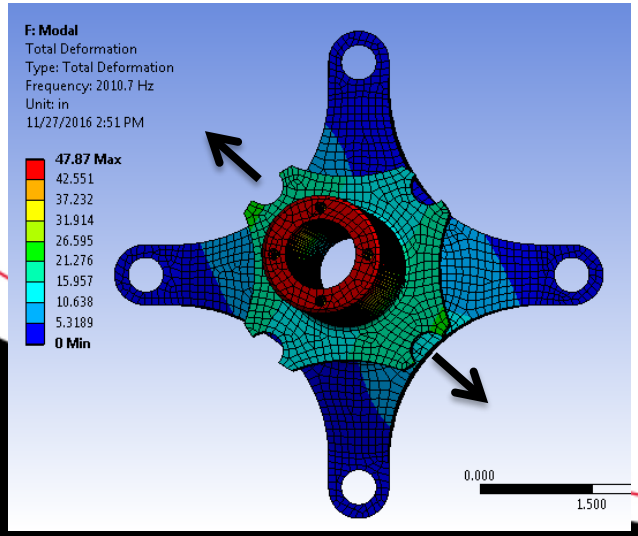
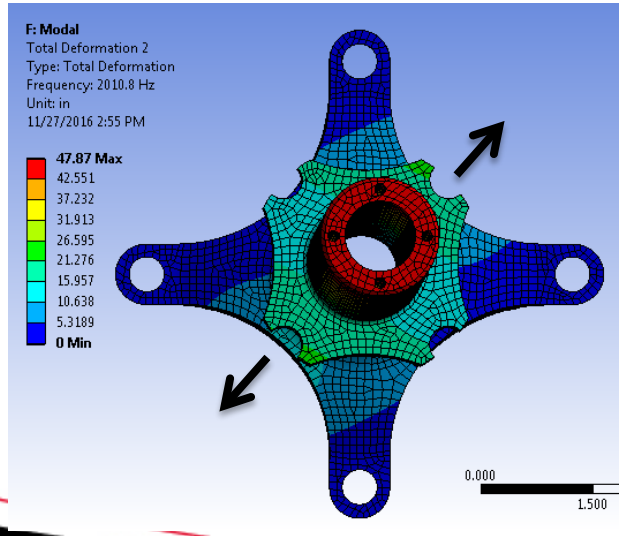
Modal Analysis Results

Mode	1	2	3	4	5	6	7	8	9	10
Frequency (Hz)	2010.7	2010.8	2825.6	8032.4	8173.8	8174.0	11072	11072	11816	13351

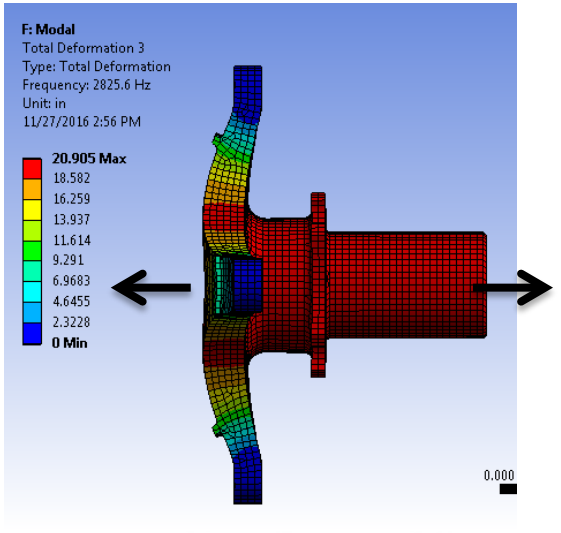
1st Mode



2nd Mode



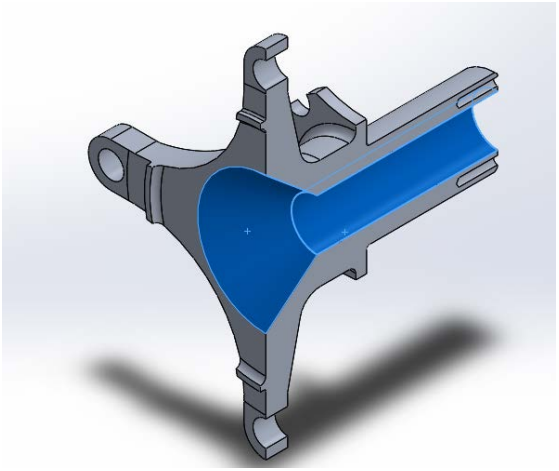
3rd Mode



Thermal Analysis Results

Manufacturing Process:

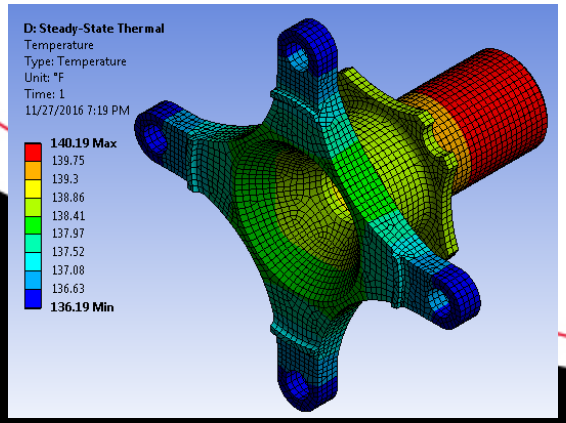
- Reaming and turning process to hallow out the wheel hub



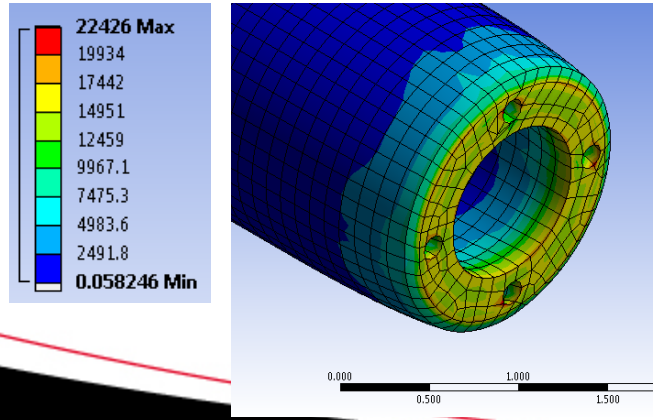
Assumptions:

- Heat flux: .0008 BTU/s*in^2
- Air film coefficient: 3.397E-6 BTU/s*in^2*F
- Fixed support on rear face

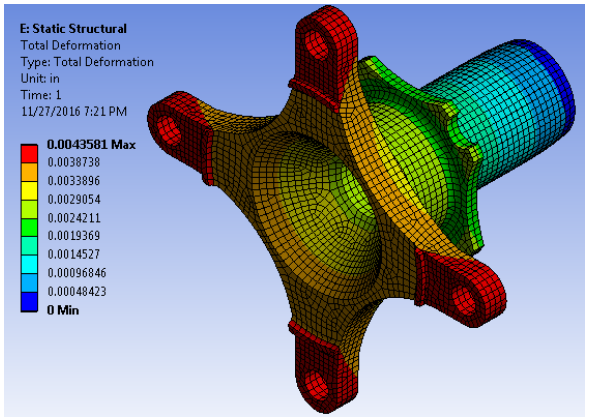
Temperature



Stress Results



Deformation



Conclusion

Deformation & Stress

- Current design is robust for the Formula SAE application
  - ✓ Minimal deformation at 1.7G brake de-acceleration : .0027” max deformation
  - ✓ Strength at 1.7G brake de-acceleration : 8.57 FOS
  - ✓ Over design is acceptable

Modal & Thermal

- The first 10 vibratory modes and natural frequencies were found
- Thermal stresses due to one manufacturing process were found
  - ✓ Results showed that thermal stresses incurred during manufacturing can be significant : analysis showed stress of 22.426 ksi

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