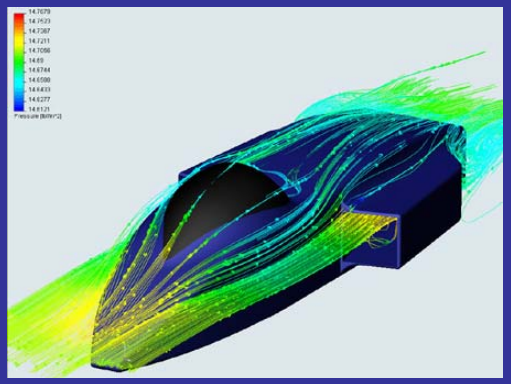
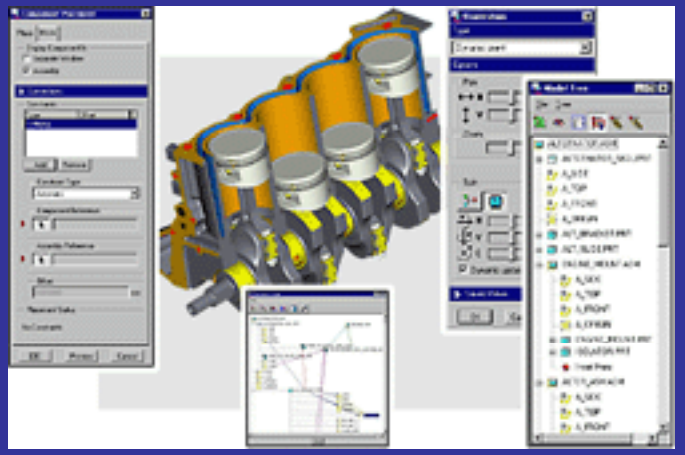
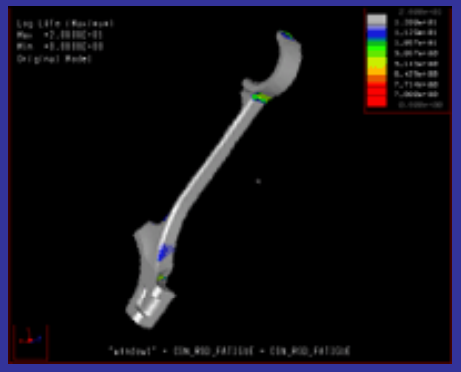
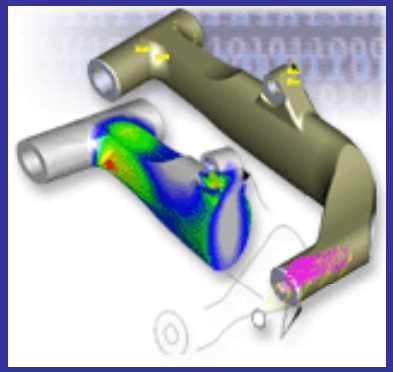
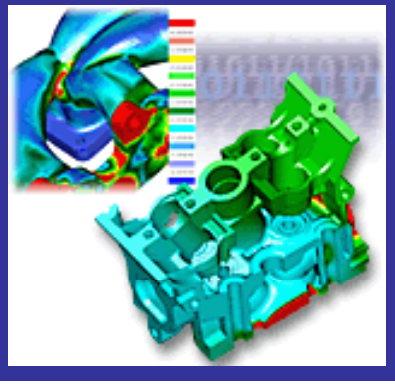
# Final Project and Pro/E Applications

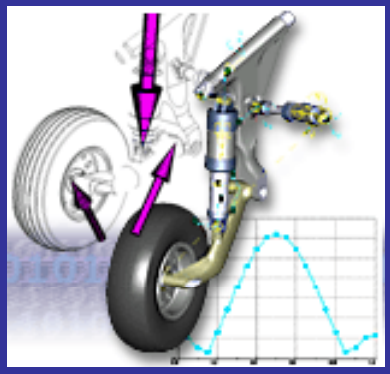


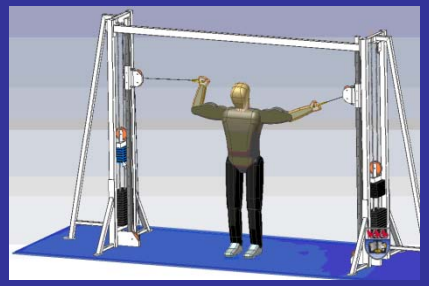


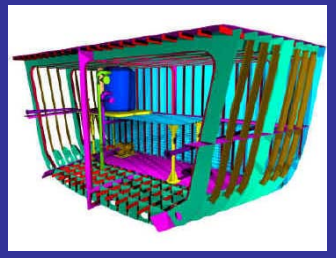


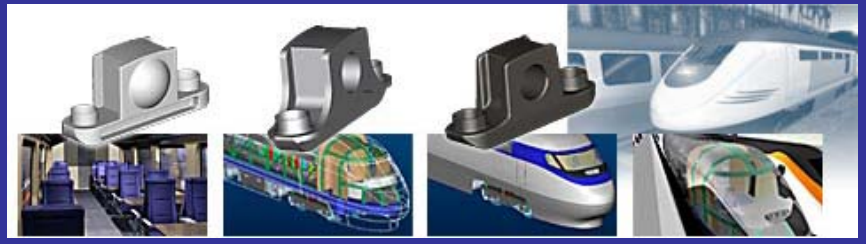












# Final Project - Application of Integrated CAD/CAE/CAM System for Optimal Design, Design Improvement or Soft-prototyping

- Time: March 5 – 31
- Content: Your Choice
- MECH410: Group of 2
- MECH520: Individual

- Project Presentation: March 31, Tue, (1:30 – 4:30 pm)
  ELW238 Computational Design Lab
- Project Report Due: April 3

# Three Project Options

- An Application of Integrated CAD/CAE/CAM System
  (Software: Pro/Engineer, UG NX 6, or SW)
  - creating the optimal (or at least functional) design of a new product with
    - performance analysis (structure, thermo, flow, dynamics, etc.), or
    - animation/simulation (motion, dynamics, manufacturing, etc.), or
  - improving a complex, existing design through analysis and/or simulation, or
  - creating demanding and complex design models.
- Interactive Graphics Programming in CAD
- An Application of Integrated CAD/CAE/CAM System Using Other Packages

**A 3-5 minute slide presentation (4-6 slides) and program demonstration.**

# Format of the Project Report

**Format**

Title of the Project
Names and Student Numbers
Abstract (50 – 100 words)
Table of Contents

1. Introduction (Description of the Project, Problem Definition, Theory or Algorithm)
2. Implementations
3. Technical Challenges
4. Special Features and Highlights
5. Summary (Experience and Suggestions)

References
Appendix

A. Important figures, drawings, calculations, etc.
B. Electronic copy of all related and necessary Pro/E files and other source codes.

**Email the following documents to: mech410@me.uvic.ca**

- A Microsoft PowerPoint Presentation (4-6 slides): LastName1_LastName2 (.ppt)
- Project report in *MS Word* named as: LastName1_LastName2 (.doc)
- The Pro/E model files with the same name as above (different extension name).

**Laboratory Consultants:**

- Mr. Minh Ly (Sen. Sci) Office: ELW B264, Local: 8893, and Email: mly@me.uvic.ca
- Leon Zhou (TA) Office: Email: ylzhou@me.uvic.ca

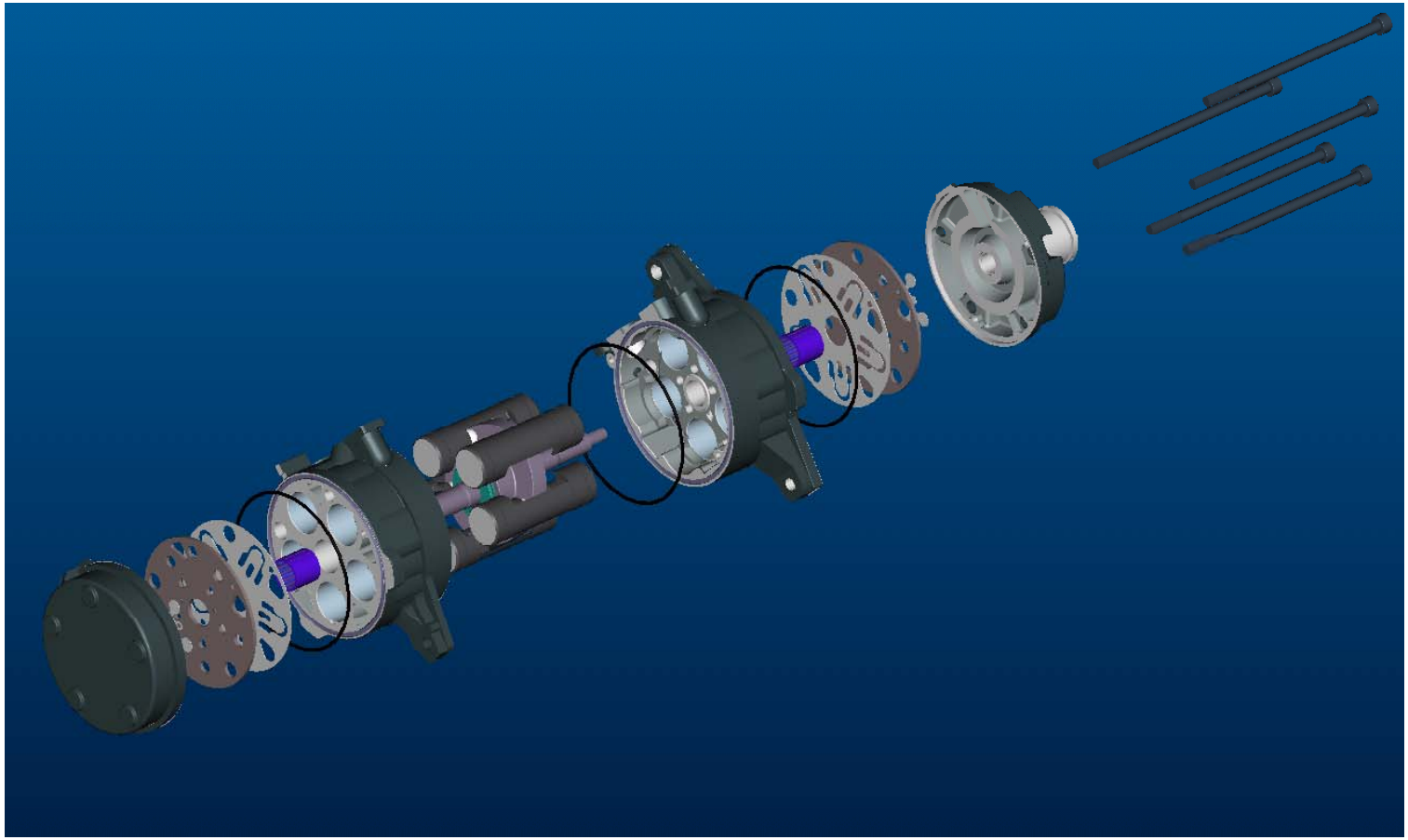
# Scope of the Project

- Design, Analysis, Animation, Planning, Manufacturing and Optimization
- Mechanical Device, Assembly, Product and System
- Being able to show how CAD/CAE/CAM tools are used to obtain better design(s) by introducing:
  - design feedback and improvements
  - design optimization
- Any CAD/CAE/CAM Tool
- Interactive Graphical Programming
- …

# Example Projects

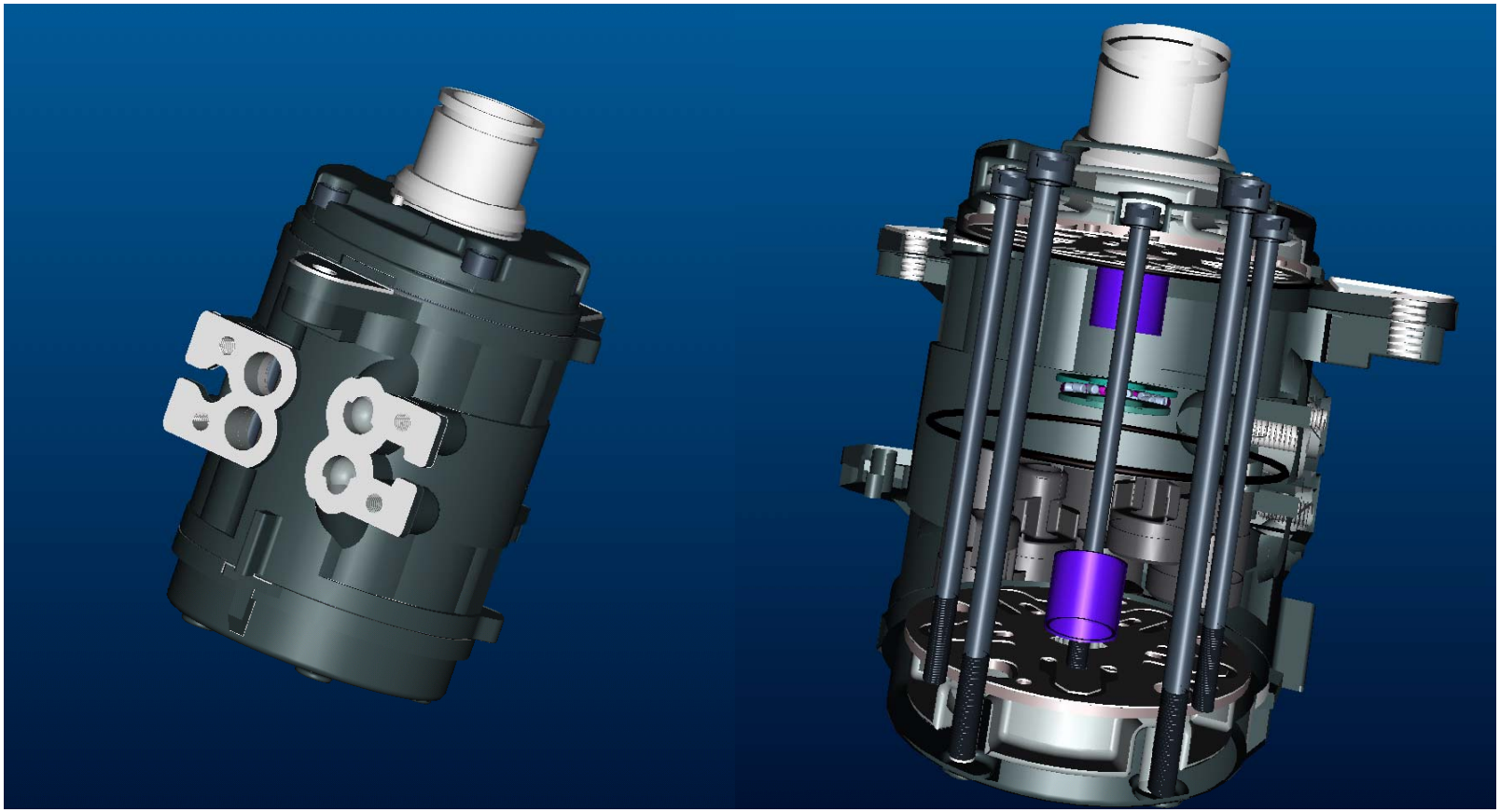
# Air Conditioner Pump for a 1987 Merkur XR-4Ti

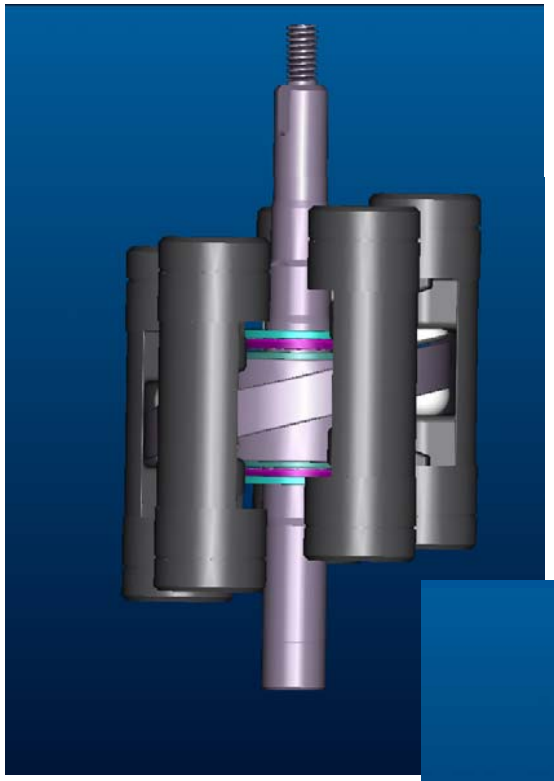
Chris Heynen & Brian Connors

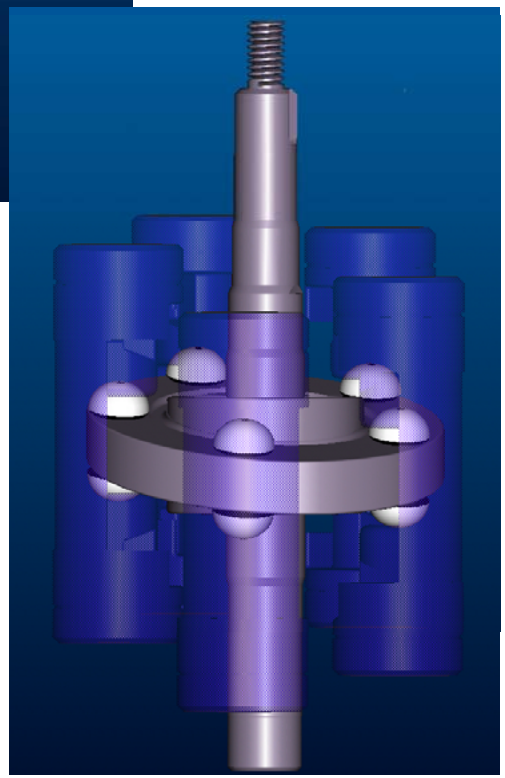


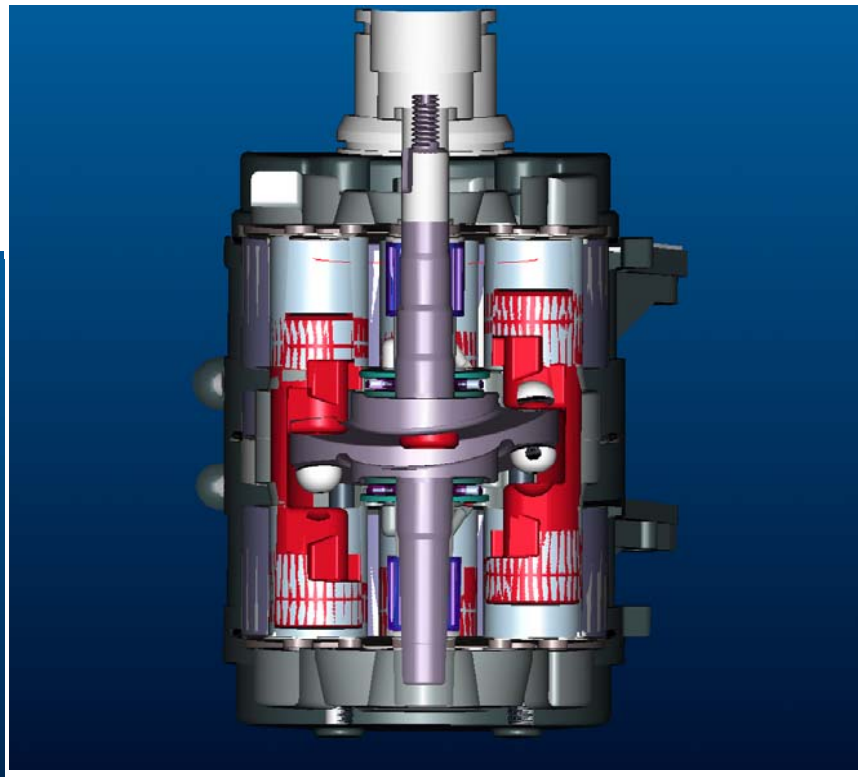
# Air Conditioner Pump for a 1987 Merkur XR-4Ti

Chris Heynen & Brian Connors





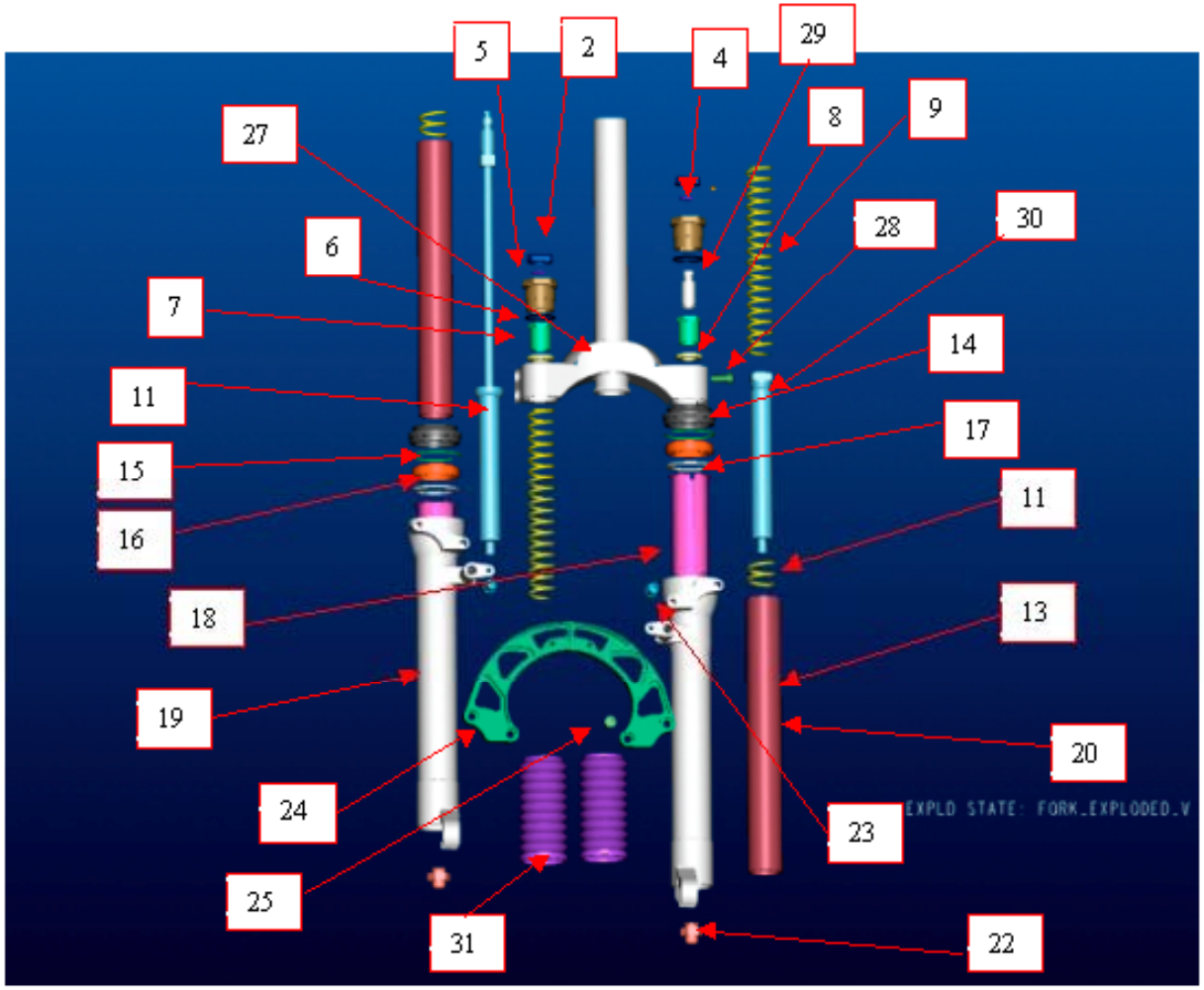




# Modeling the Marzocchi Z.2 Atom Bomb Mountain Bike Shock

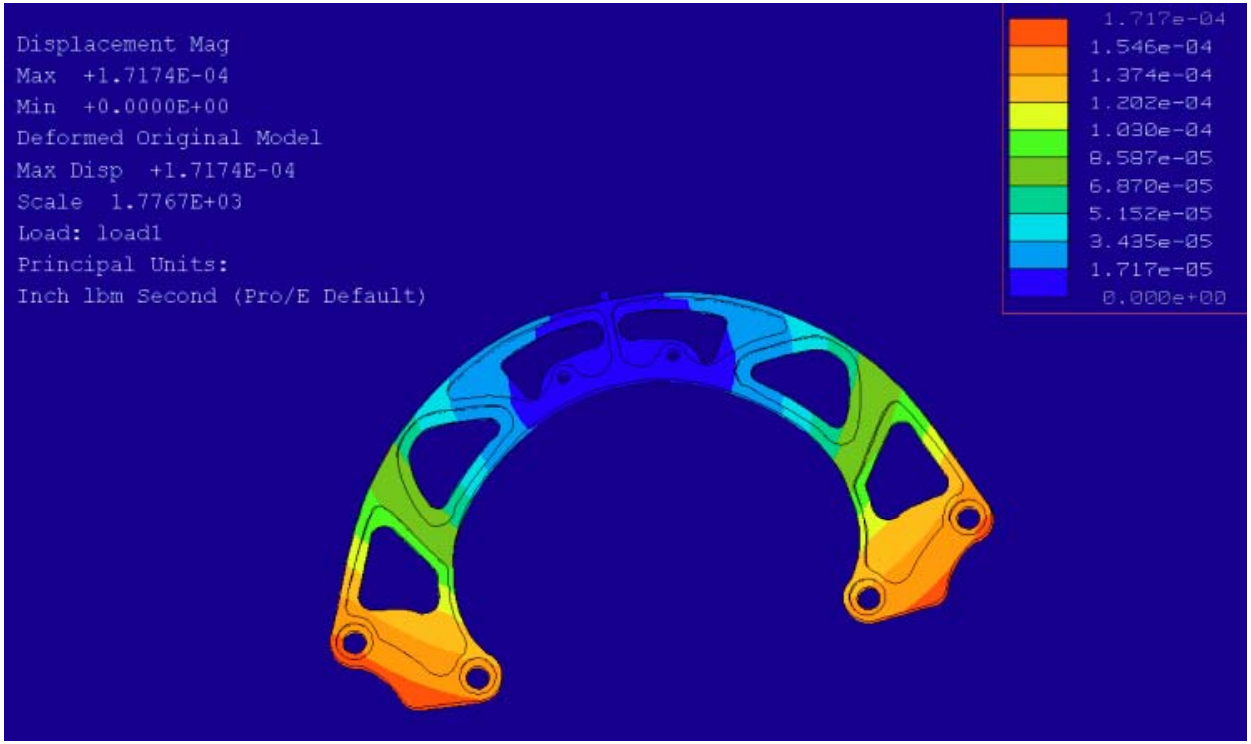
Aaron Lamb & Jon Baggett

- Assembly Modeling
- Stress Analysis on a Key Component



# Modeling the Marzocchi Z.2 Atom Bomb Mountain Bike Shock

Aaron Lamb & Jon Baggett

# Modeling and Analysis of Brodie Diablo Bike Frame

Walter Langer

- Frame Modeling
- Stress Analysis to Identify the Cause of the Failure

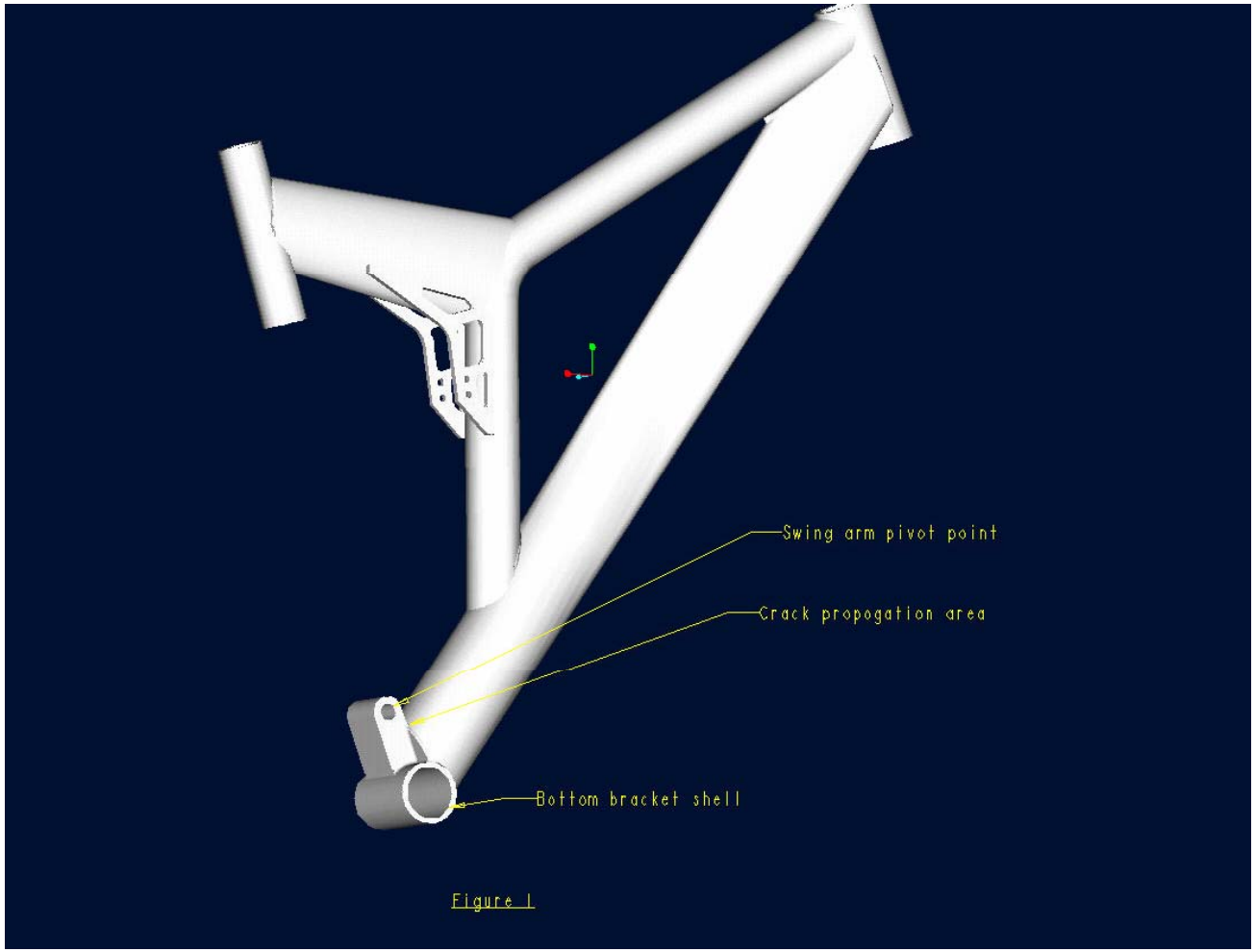
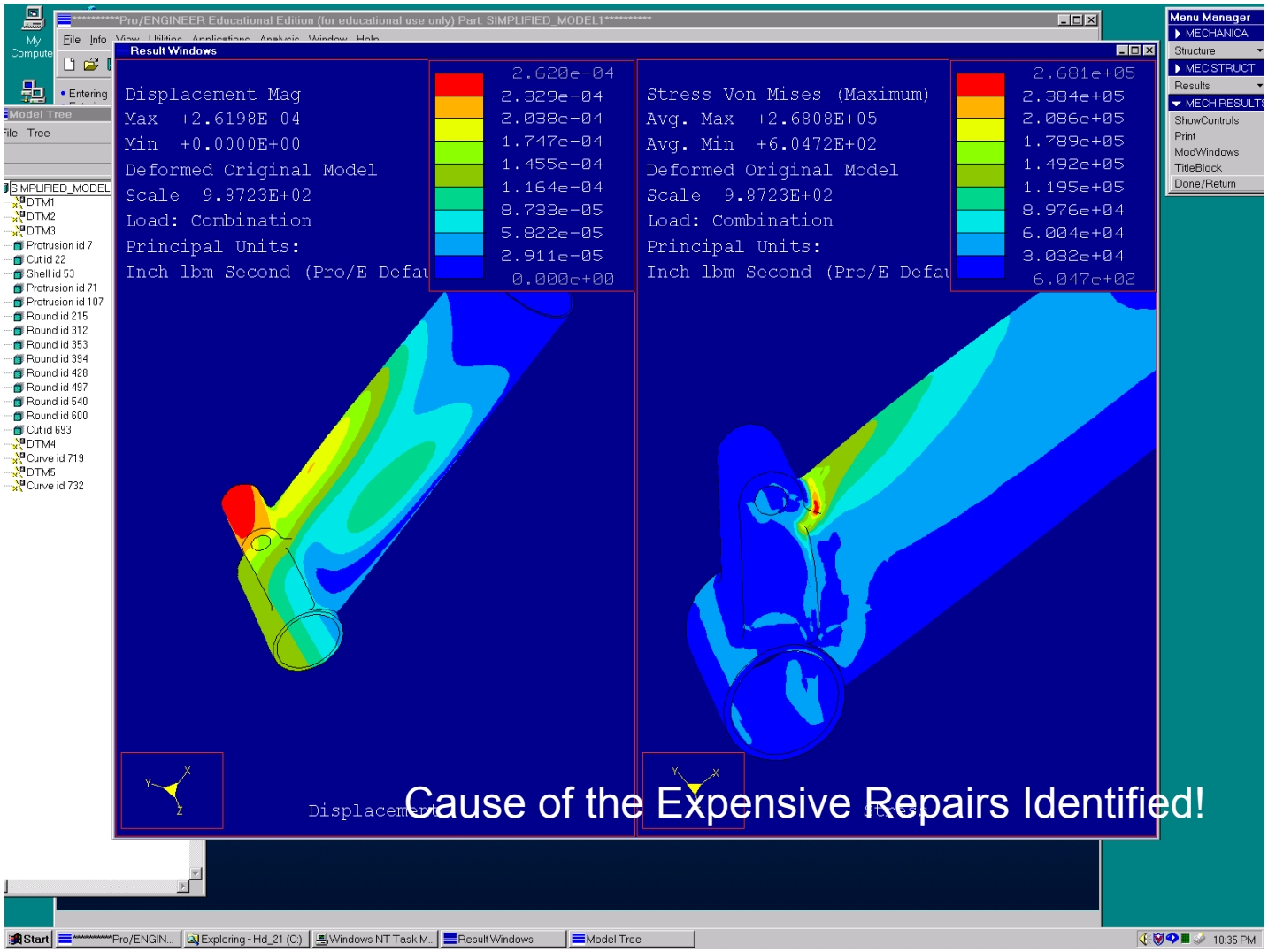



Figure 1

# Modeling and Analysis of Brodie Diablo Bike Frame

Walter Langer

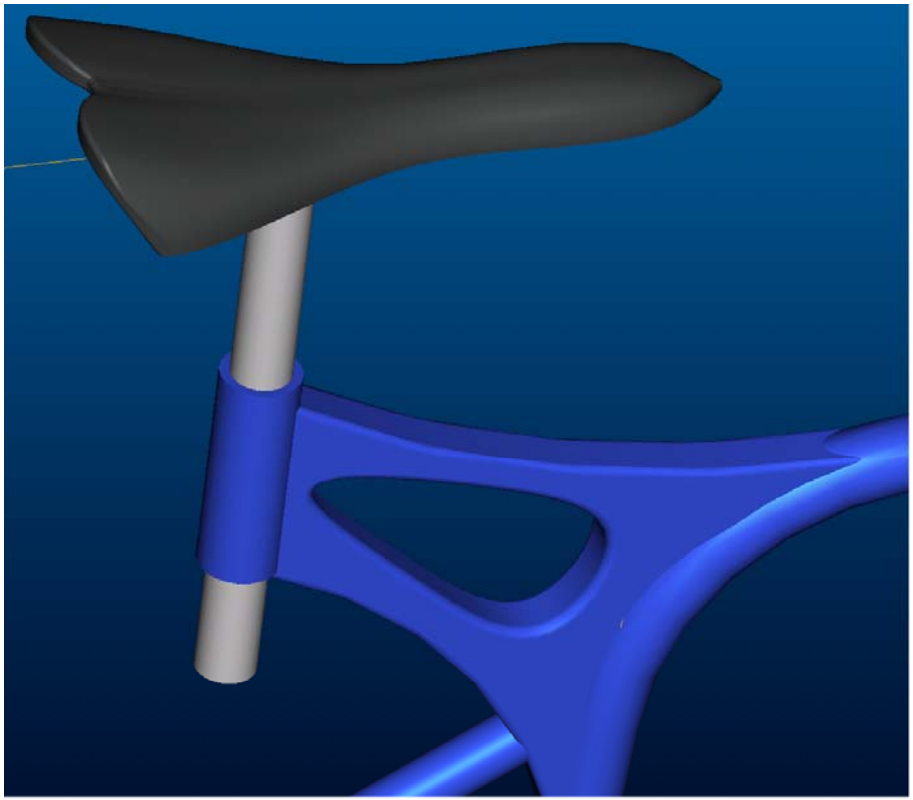


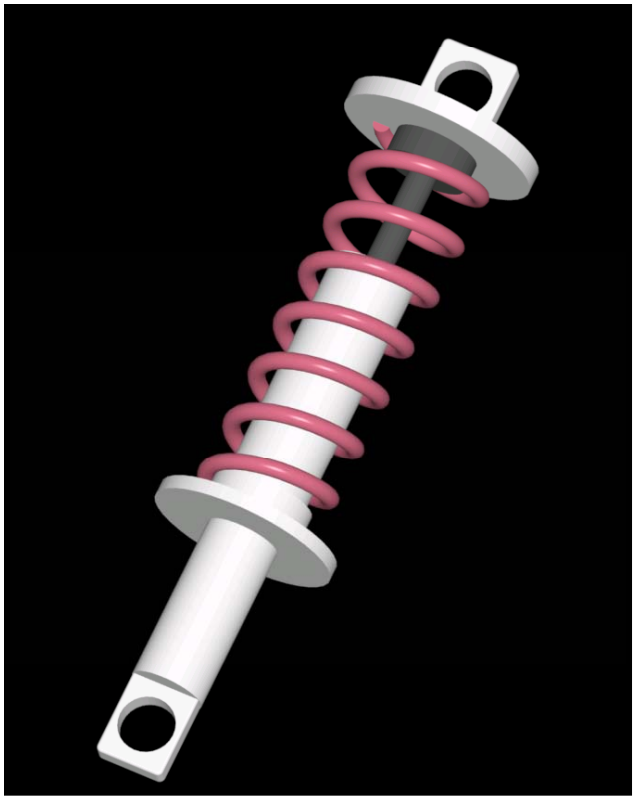
# 3D Mountain Bicycle Model

Lindsey Leu and Jenny Hoang

# 3D Mountain Bicycle Model

Lindsey Leu and Jenny Hoang



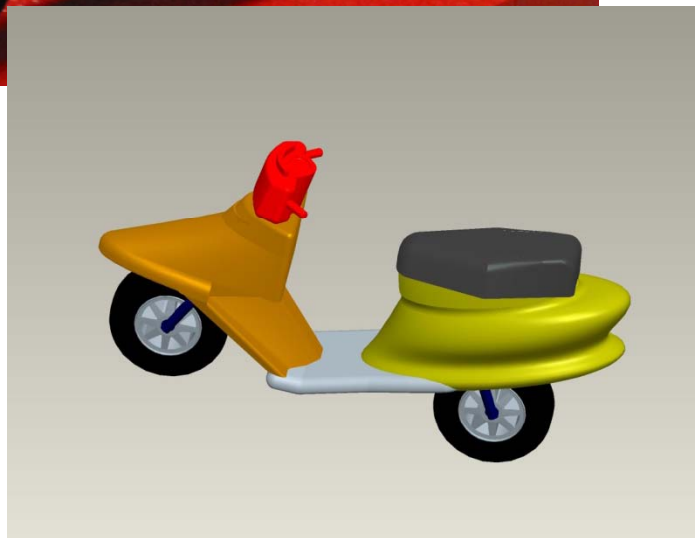


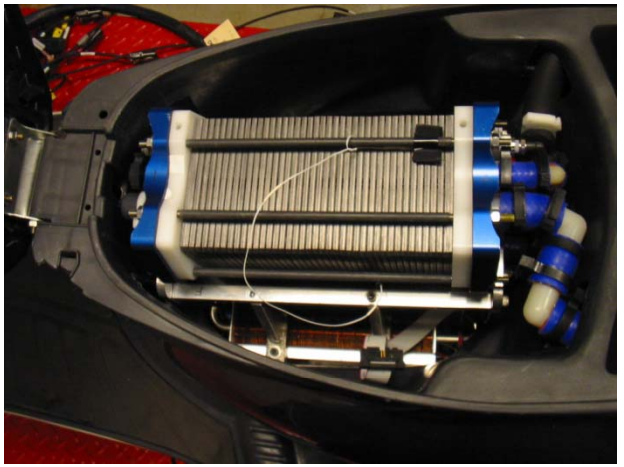
# Fuel Cell E-Bicycle and Scooter Space Analysis

Onur Keskin

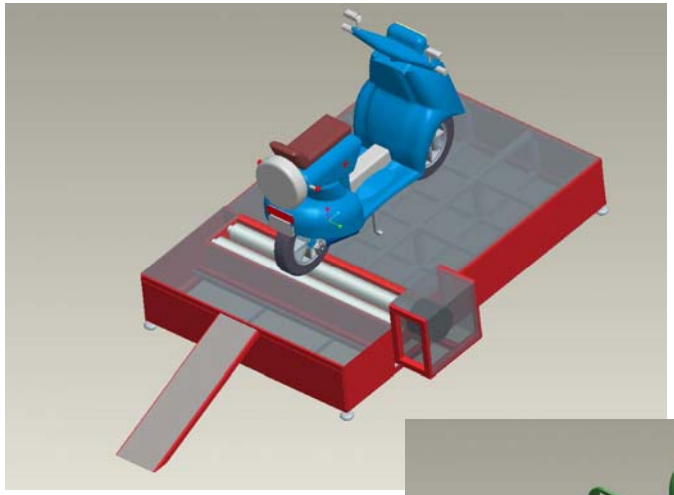
# Fuel Cell E-Bicycle and Scooter Space Analysis

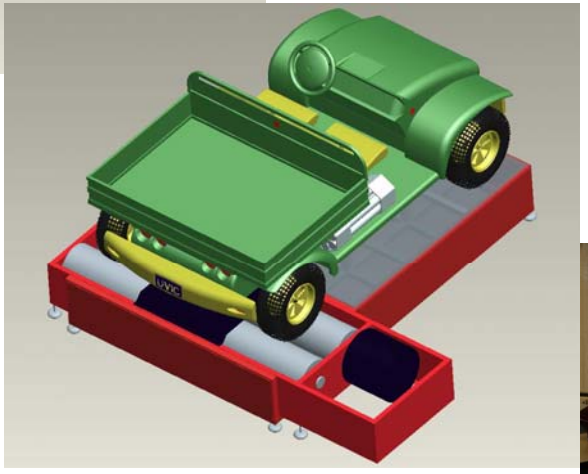
E. Lau & L. Horricks





# Computer Modeling and Design of Fuel Cell Powered Low-Speed Electrical Vehicle Testing Stations






# UVic Fuel Cell Bicycle Configuration

**Richard V. Stackhouse**


- This concept fuel cell powered bicycle shows the fuel cell system attached to a Rocky Mountain Bicycles RM6 full suspension bicycle.
- Due to the front motorized drive, the power system can be quickly and easily fitted to most bicycles, including full suspension.
- Two Wheel Drive Capability

# Adaptable Electric Bicycle Power System


- Proof of power system configuration.
- Large mass better suited at back than front for adequate steering.

# AEBPS Final Specs

| | |
|---|---|
| Prototype Cost | ~$900 CDN ($560 USD) |
| Electrical System | 24 Volt EV Warrior System |
| Motor Controller | Curtis 1505 (20A Continuous, 80A (1 Minute Rating)) |
| Battery Pack | Currie Cycles 24V Sealed Lead Acid 12Ah |
| Motor Power Output | 400 Watts (Max.) 200 Watts (Continuous) |
| Maximum Motor Torque | 37 Nm |
| Maximum Bicycle Speed | 18.5 km/h (Mounted on RM6 with 167 lbm rider) |
| Throttle | Fully Variable Speed (Thumb Operated) |
| Total AEBPS Mass | 14.9 kg (32.9 lbm) |
| Hub Motor Mass | 3.6 kg (8 lbm) |
| Battery Pack Mass | 9.8 kg (21.5 lbm) |
| Electrical System Mass | 0.9 kg (2 lbm) |
| Topeak Beam Rack Mass | 0.6 kg (1.4 lbm) |

Mechanical Engineering
University of Victoria
Victoria, BC, Canada

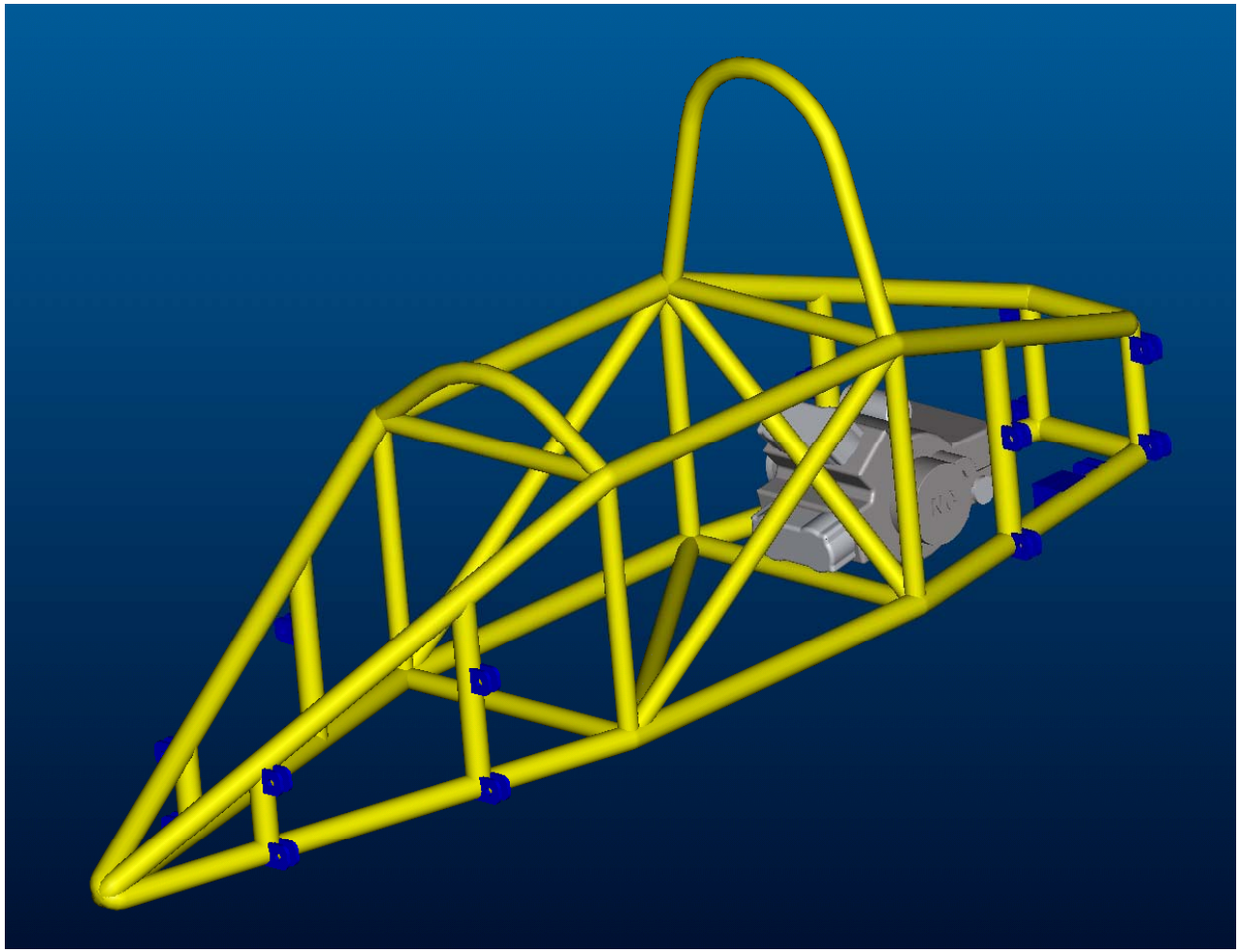

## Formula SAE Competition Car Related

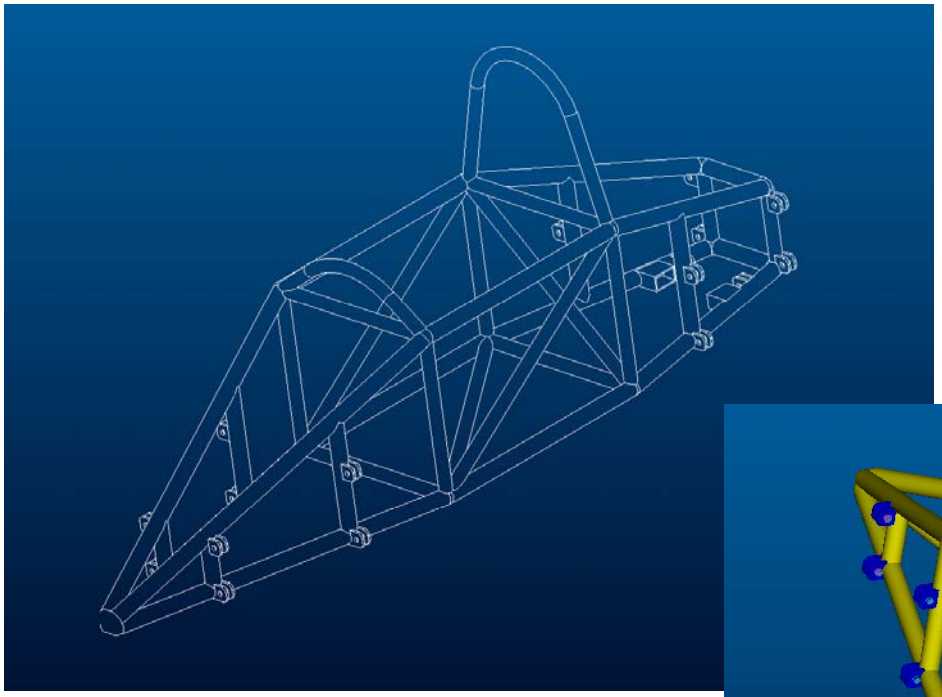

Figure 1: Team UVic race car

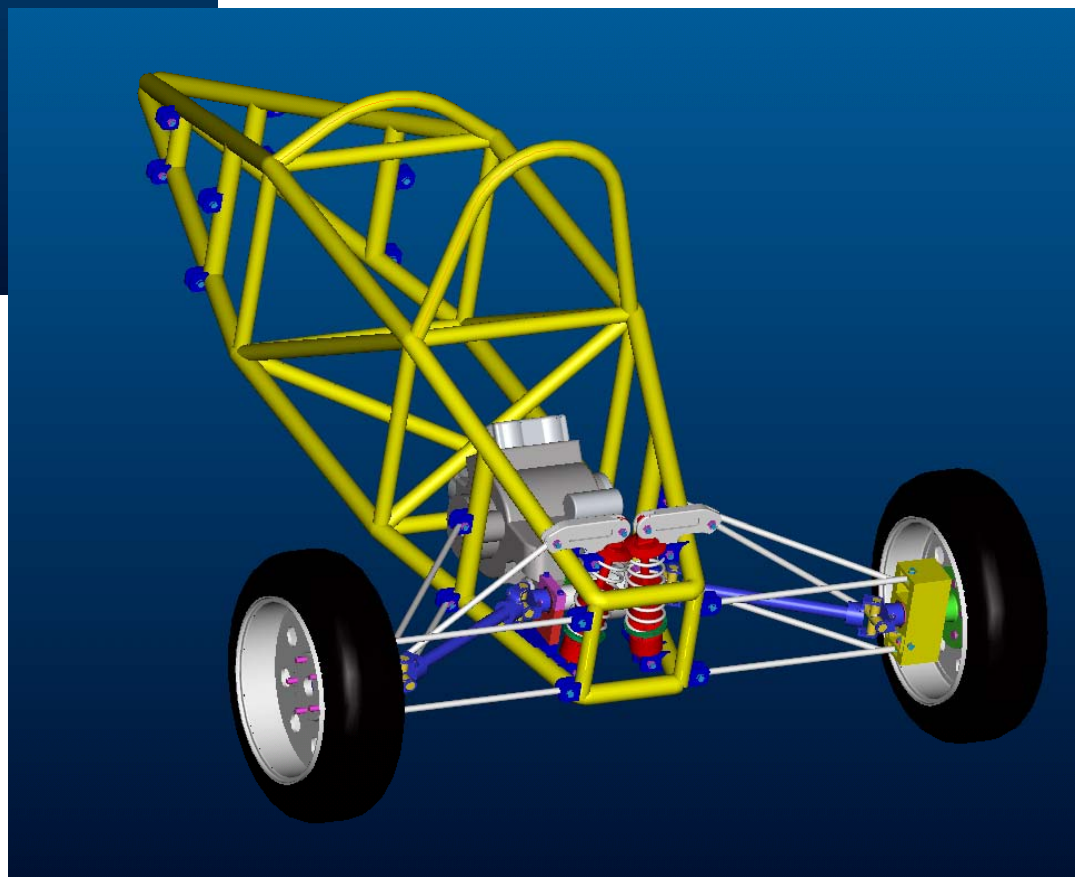
Figure 5: Current 3D model

# SAE Formula Racecar Chassis and Modeling in Pro/ENGINEER

Jarvis Degroot & Greg Montie

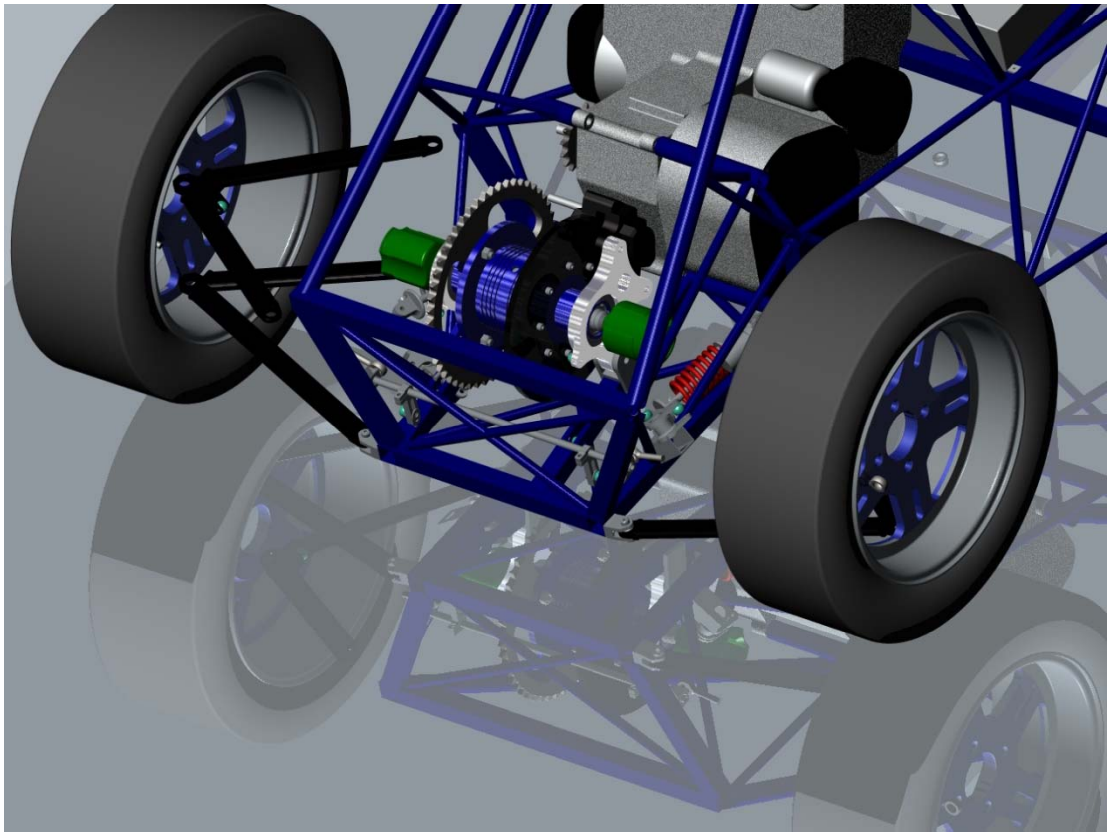


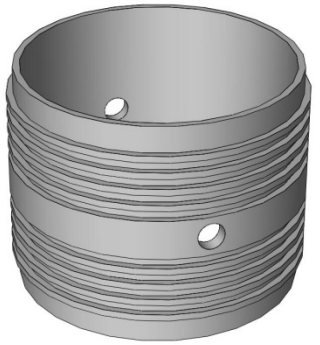


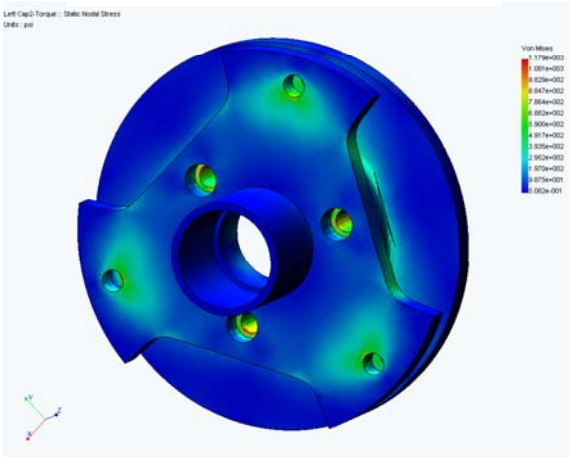


# Formula UVic Drivetrain Design

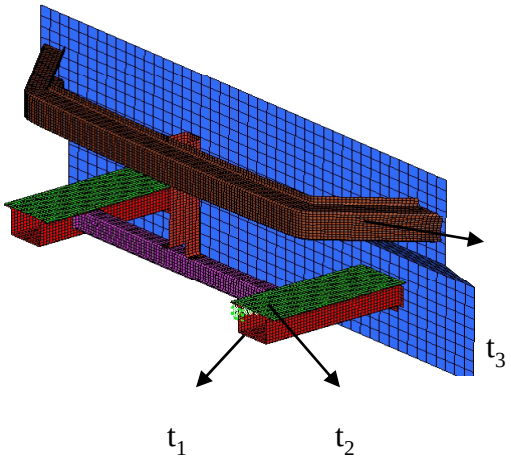
Richard Lewis and Justin Alexander

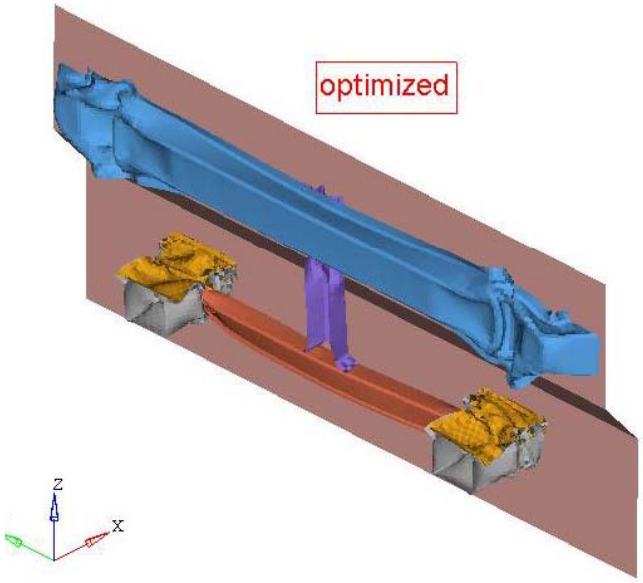


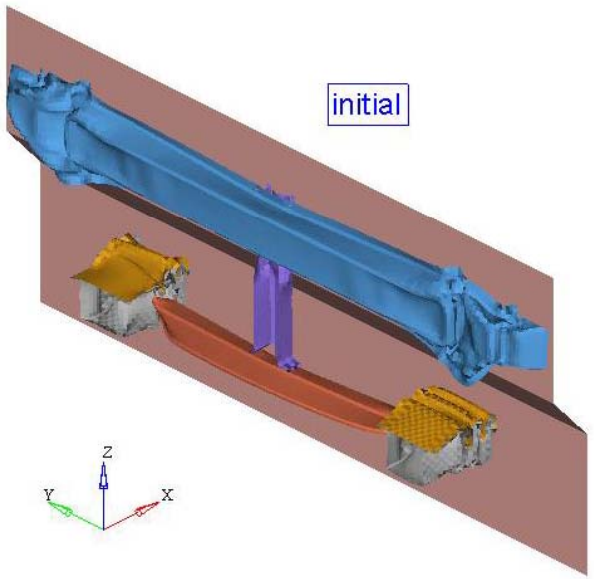




# Vehicle Bumper Crash FEA Simulation and Design Optimization to Control Peak Deceleration and Increase Energy Absorption (J. Gu)



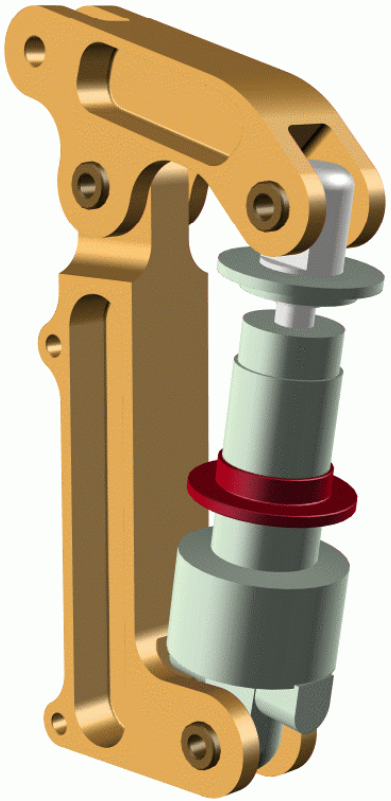



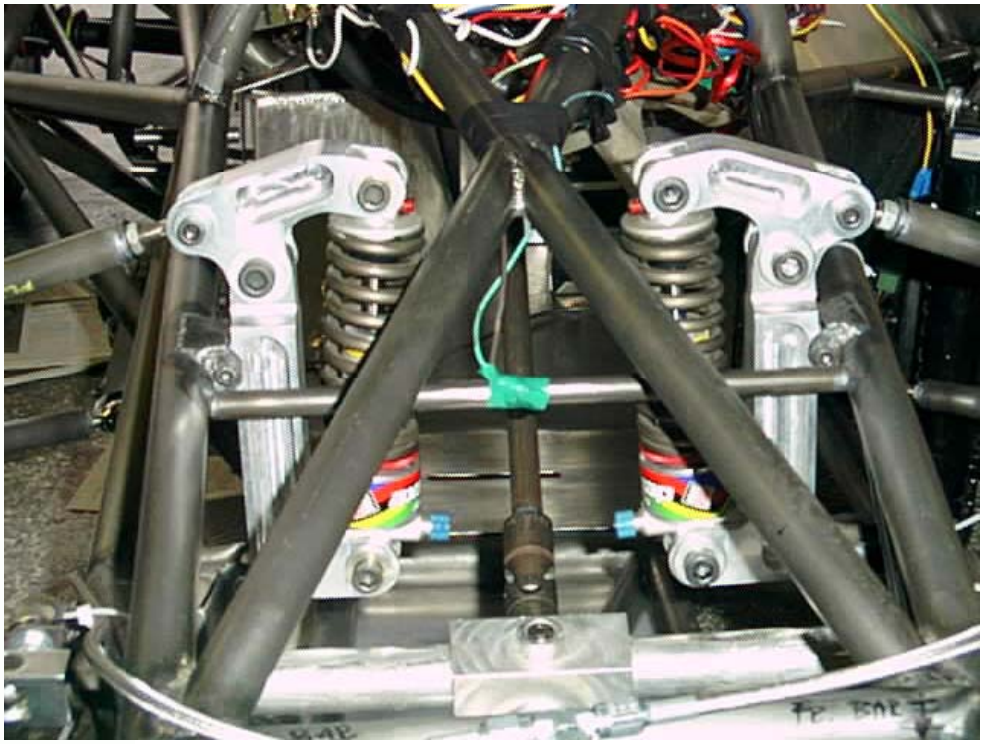



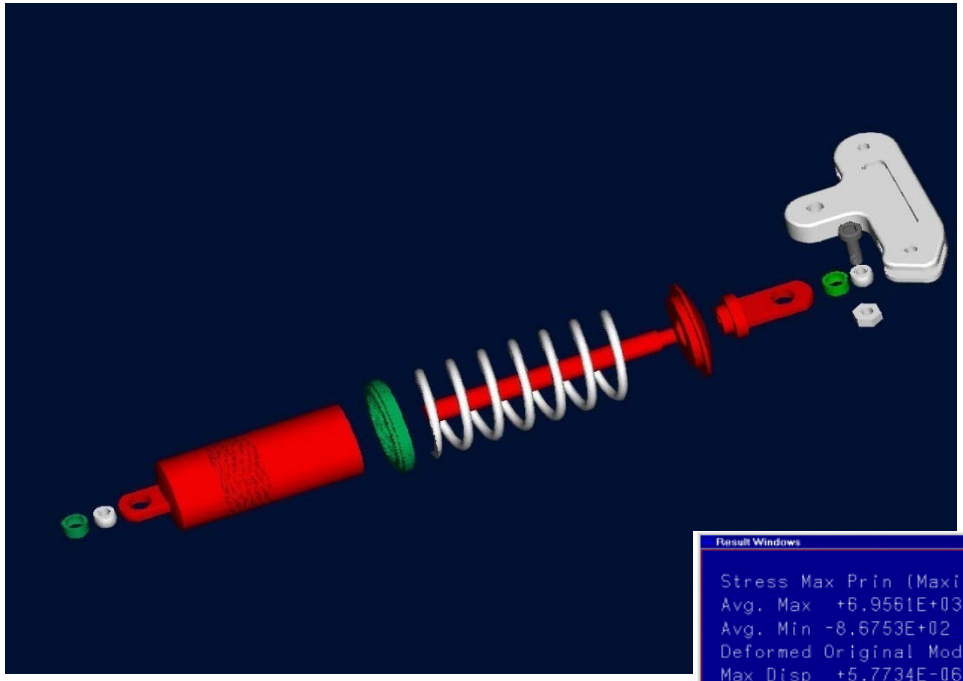
# Modeling the Suspension of a Formula SAE Car

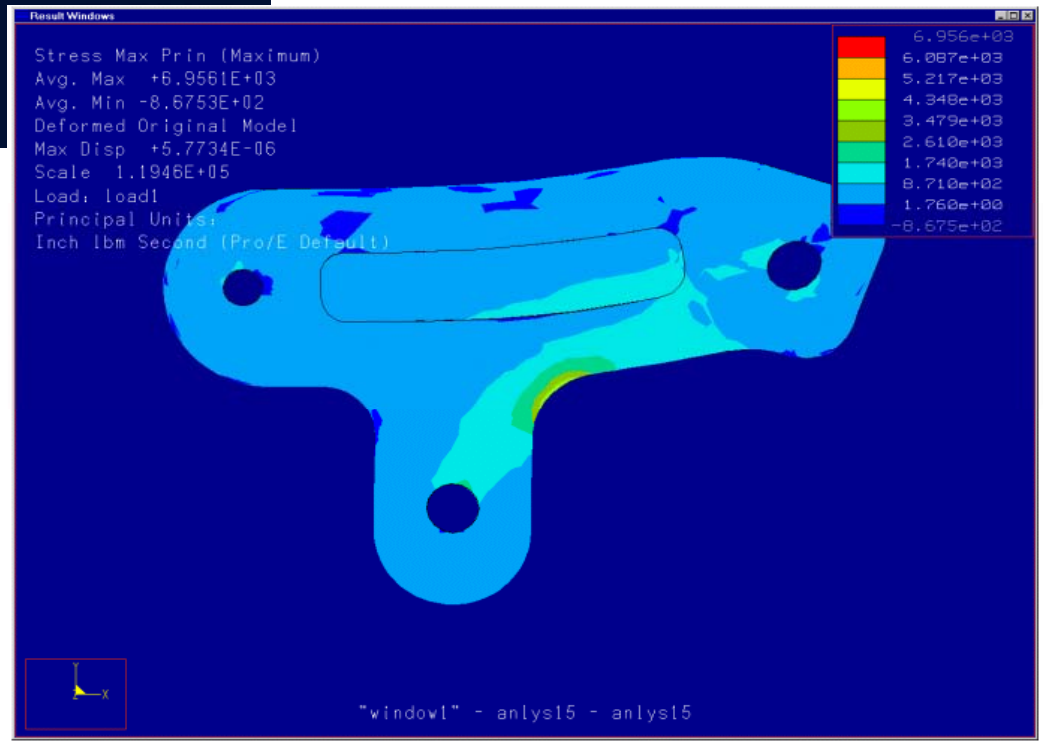

Eldon Cottingham, Carl Thomas and James Cox

# Modeling the Suspension of a Formula SAE Car





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Stress Max Prin (Maximum)
Avg. Max +6.9561E+03
Avg. Min -8.6753E+02
Deformed Original Model
Max Disp +5.7734E-06
Scale 1.1946E+05
Load: load1
Principal Units:
Inch lbm Second (Pro/E Default)
6.956e+03
6.087e+03
5.217e+03
4.348e+03
3.479e+03
2.610e+03
1.740e+03
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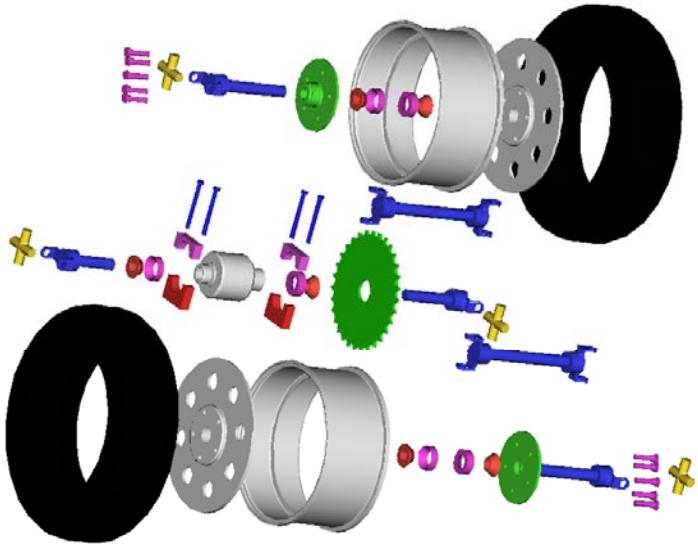
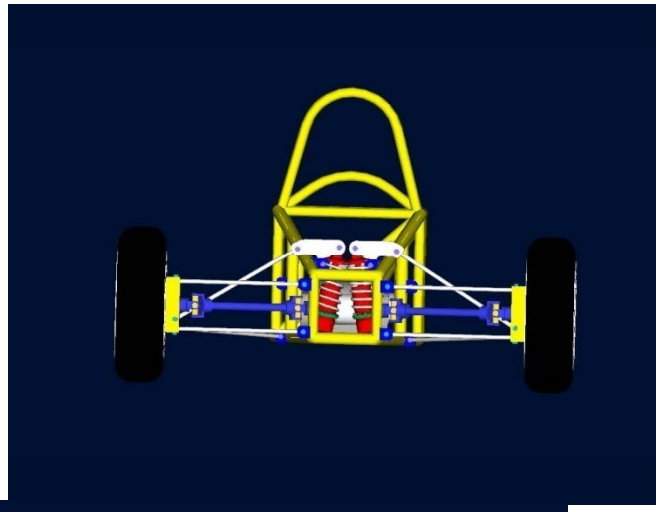
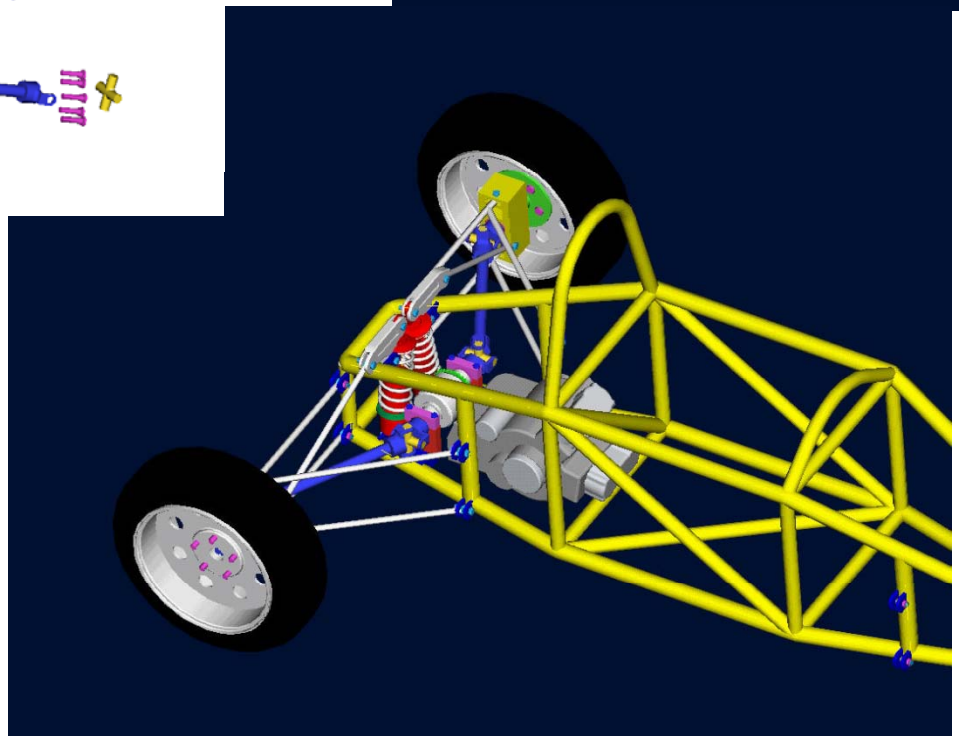


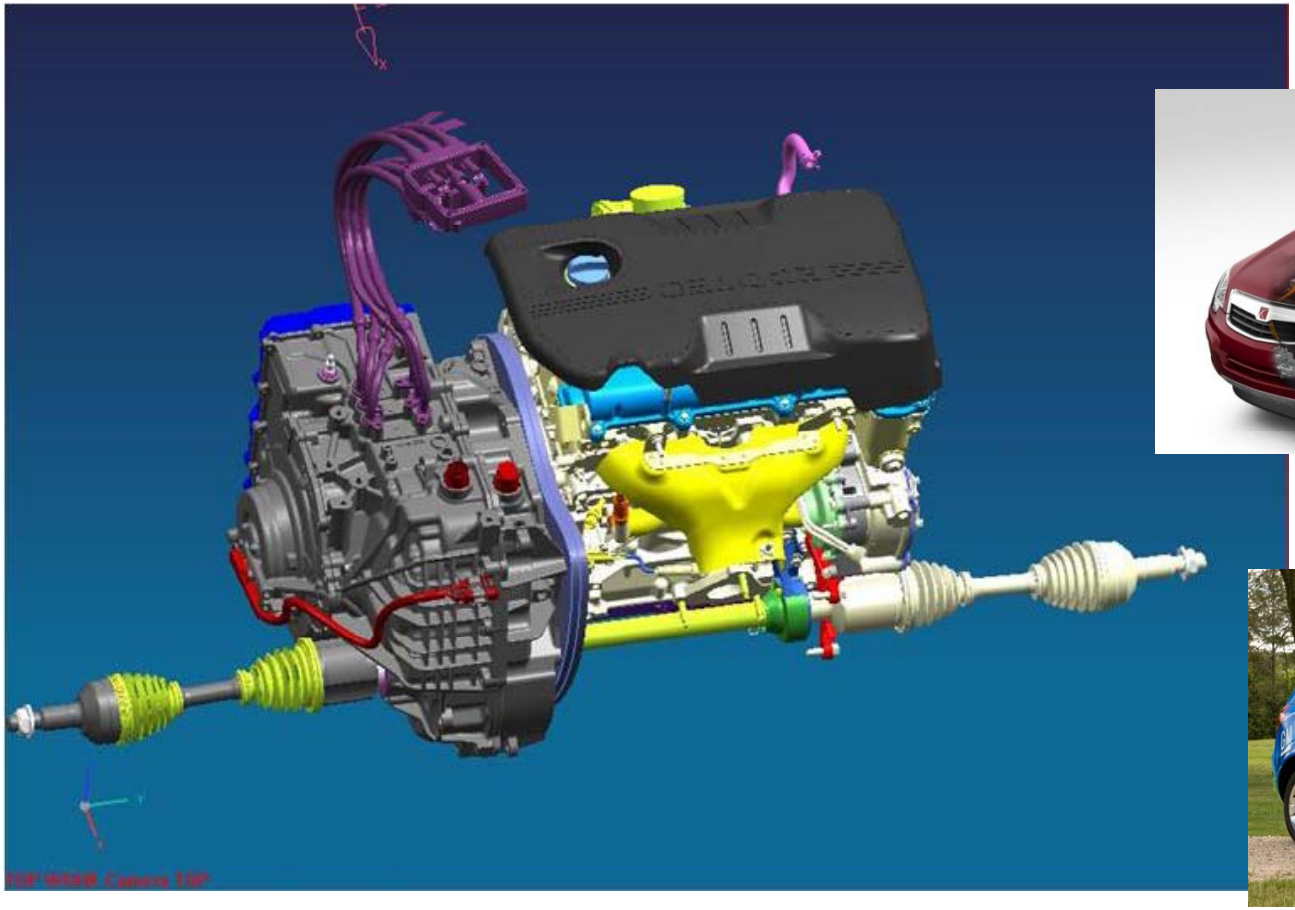


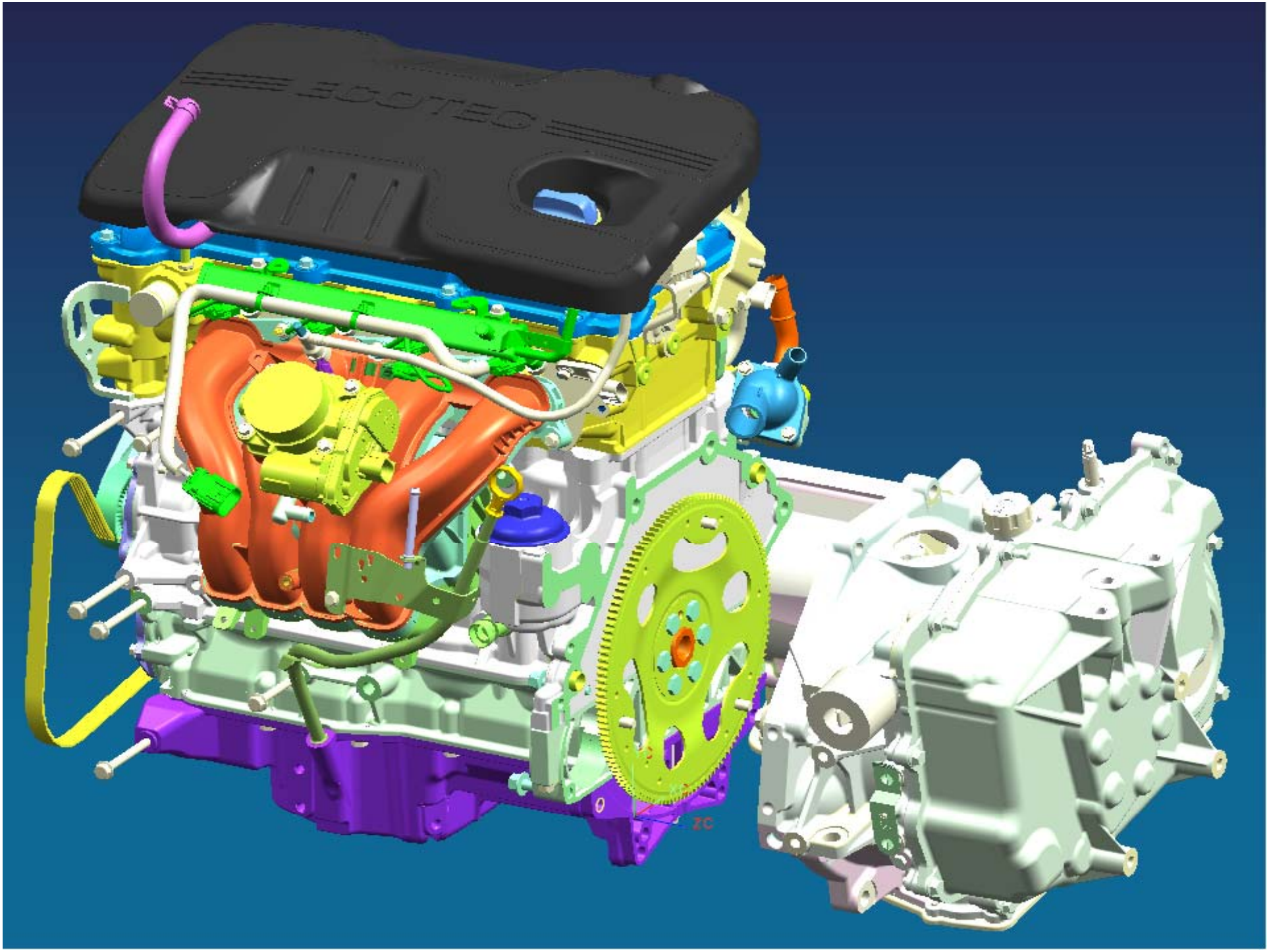


# EcoCAR HEV Design and Analysis Using Unigraphics NX

## Integrating the GM 2-Mode Transmission into the EcoCAR

Design Team: David Robinson, Degnan Hembroff and Michael Versteeg

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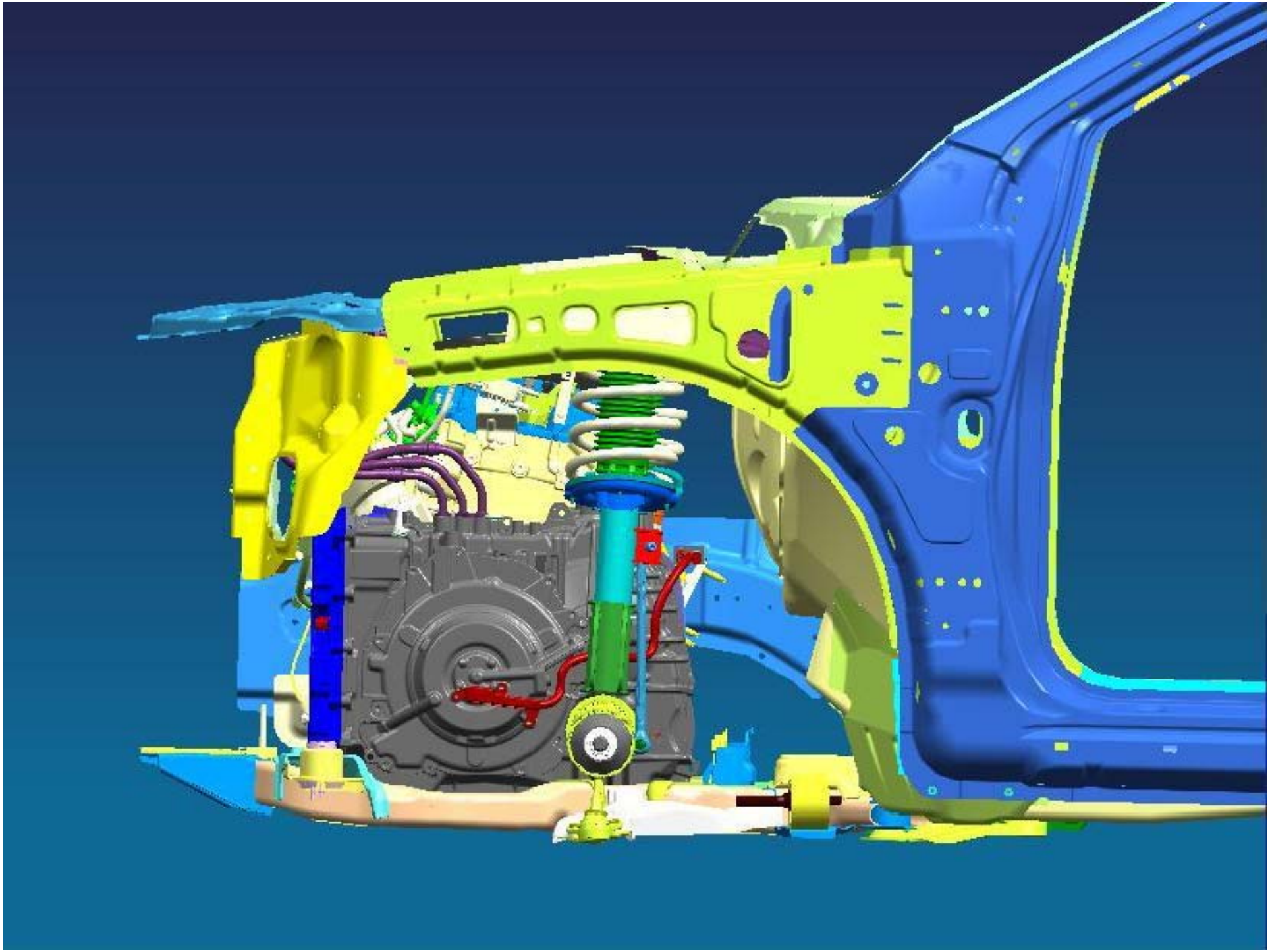
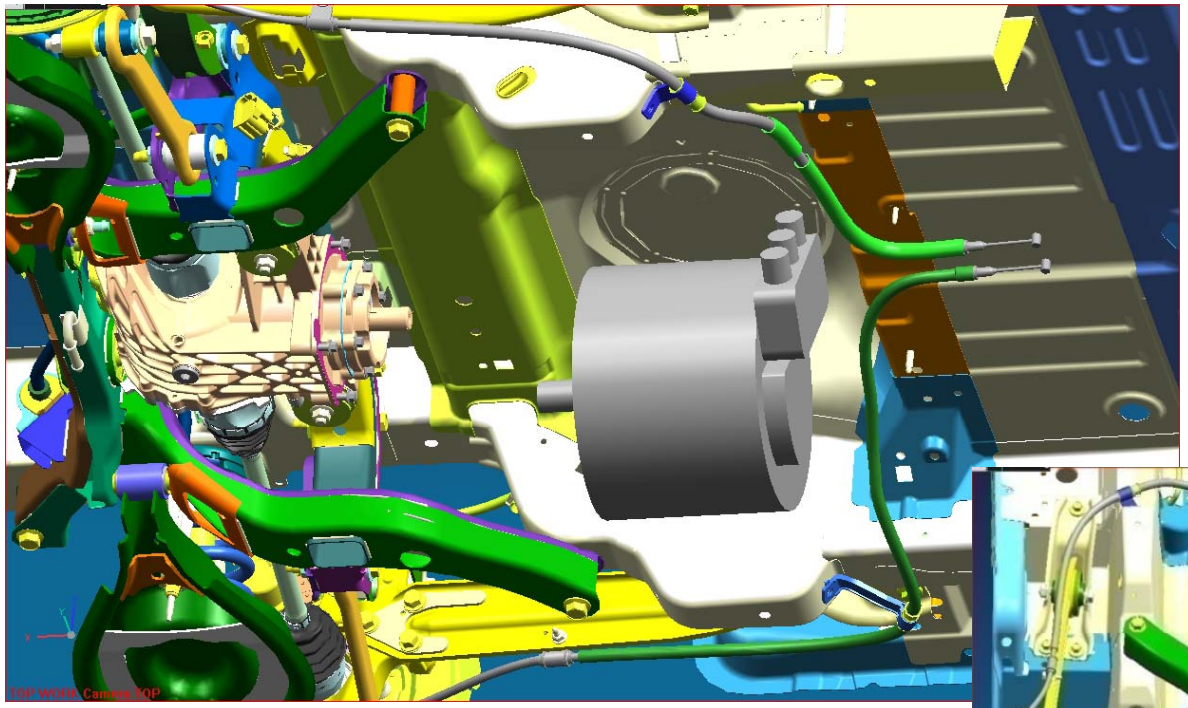
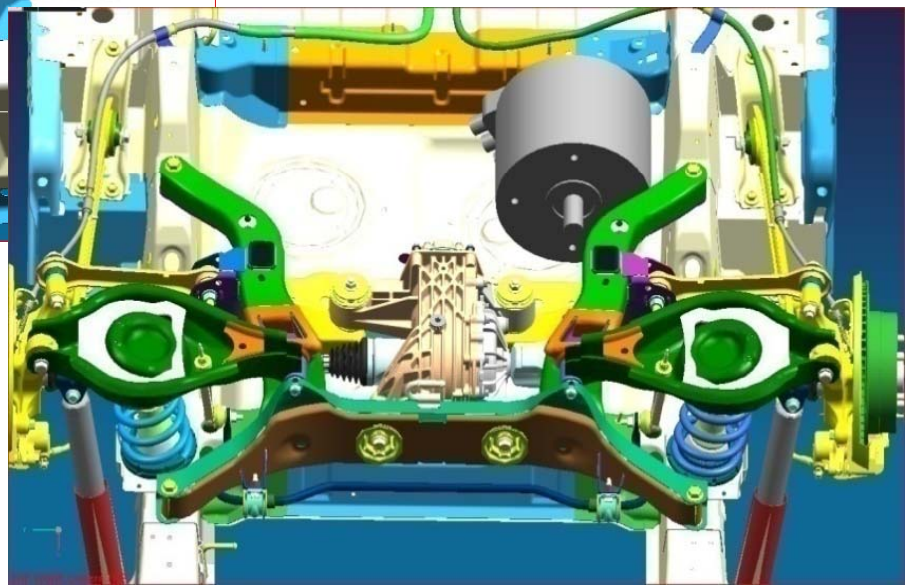


# EcoCAR HEV Design and Analysis

## Electric Rear Wheel Drive Gearbox

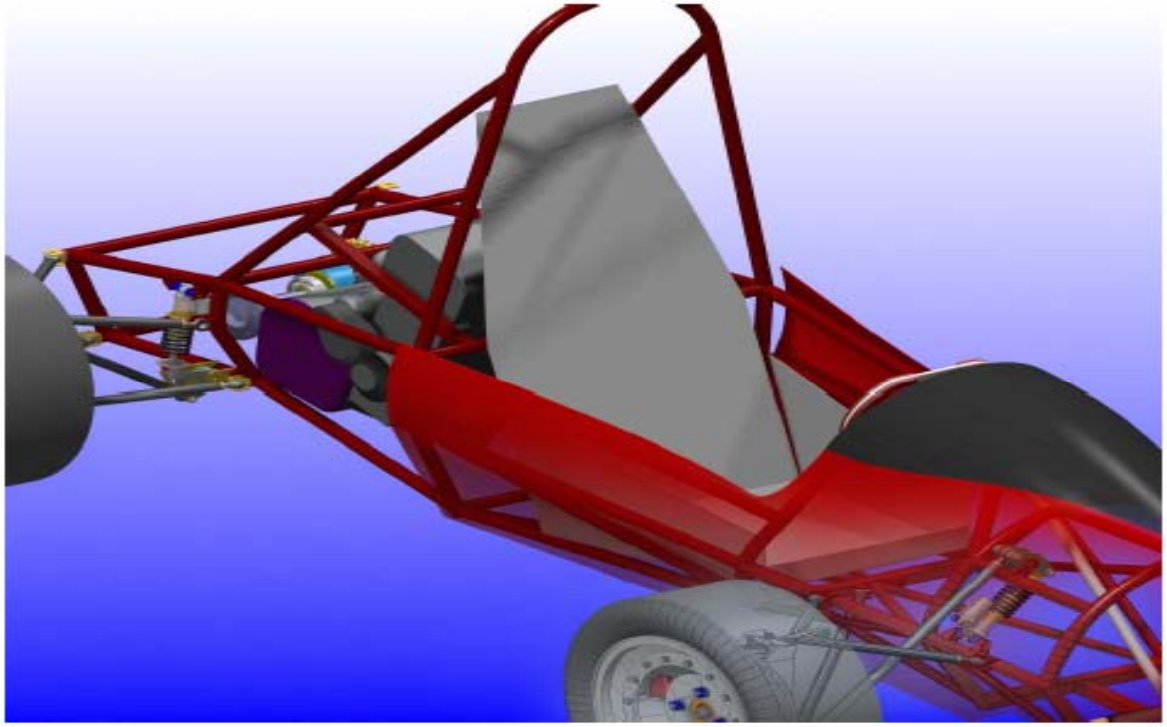
Adam Binley, Jake Soepber, Kyle McWilliam, Bryce Donnelly, Yoshua Ichihashi & Sean Walsh





UVic SAE Team

# Engine Intake Design for the Uvic Formula SAE Race Car



**Mech 410**

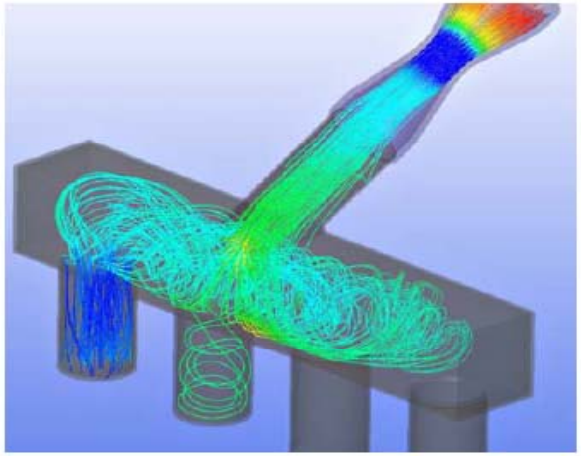
Prepared by:
Aaron Sandstorm
Armando Tura

# SAE Race Car Modeling and Analysis Using SolidWorks, FloWorks and Pro/E

This project was an opportunity to model and analyze the intake system for the Formula SAE race car, and to get familiar with the FloWorks. The analysis confirmed that, on first approximation, the design selected, even if not optimal, should be able to feed the engine in a satisfactory fashion. High performance output is expected from the fuel injected system planned for the next year car.

SolidWorks in conjunction with FloWorks, demonstrated to achieve results intuitively and quickly. A real test of the system will give a response on the reliability of the predictions. SolidWorks models proved to be easily exported into IGES and imported into Pro/E, expanding the possibility of this package.

Modification of Intake Design with Added Venturi Restrictor



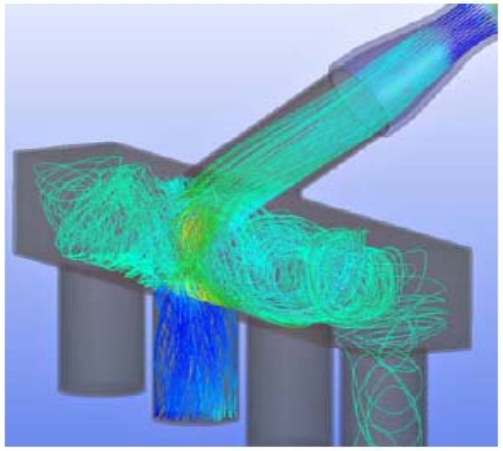
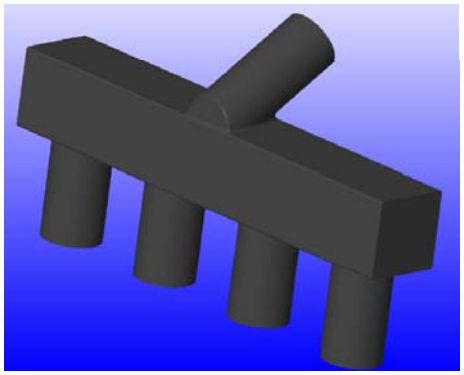
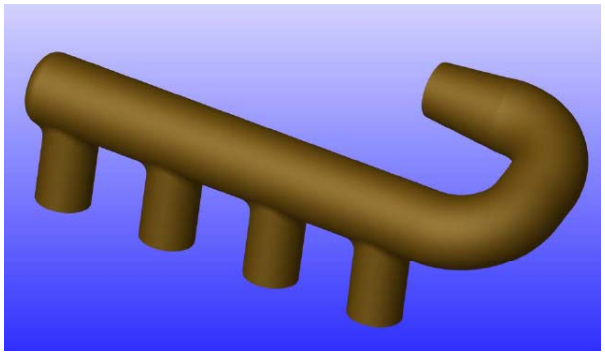


Figure 14: intake current configuration





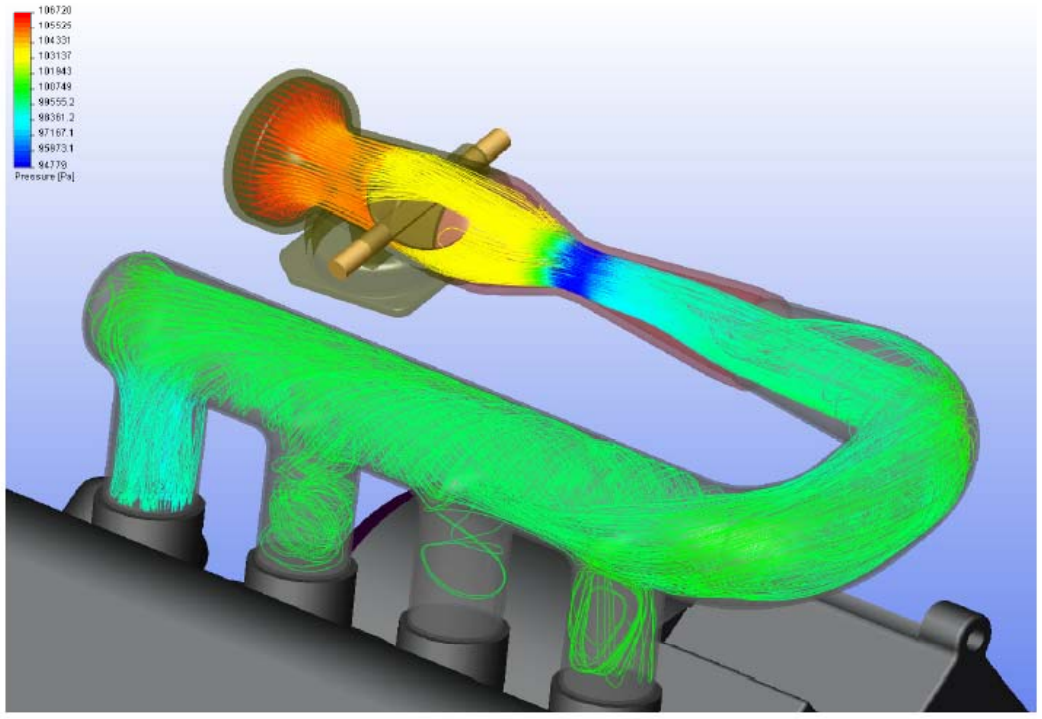



Figure 16: alternative manifold

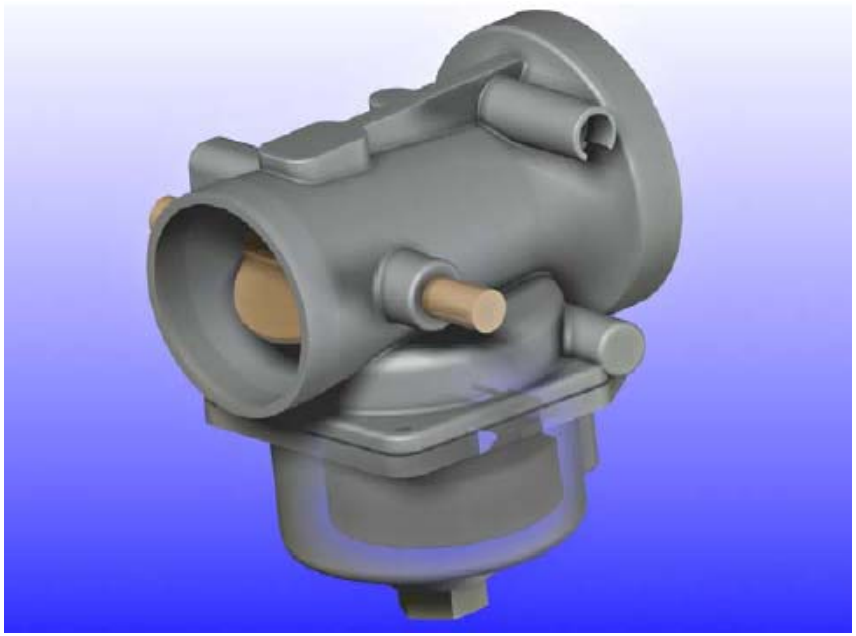
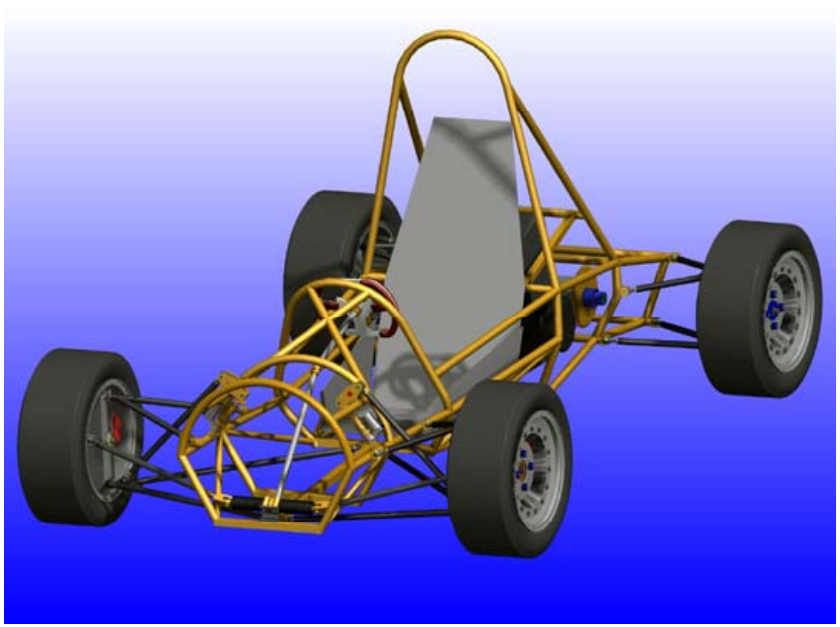
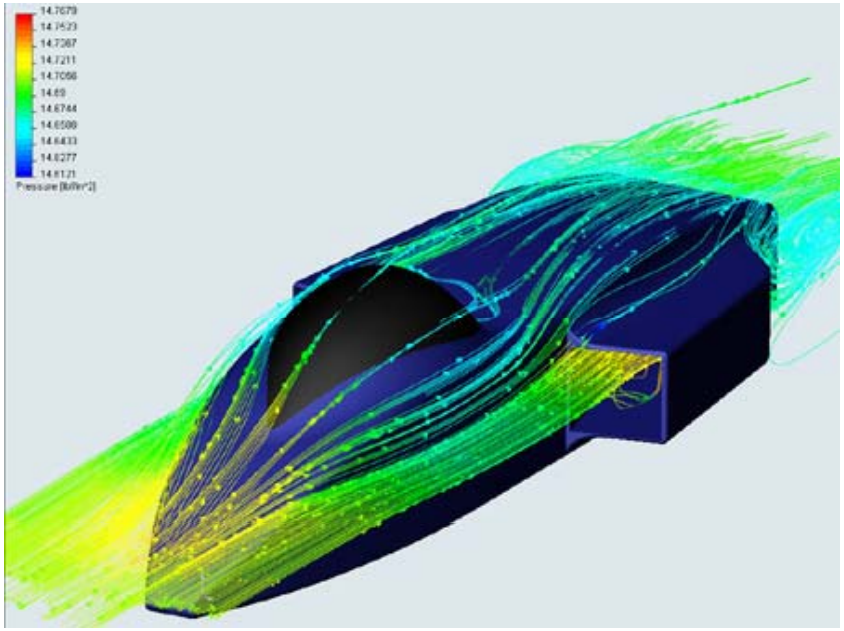
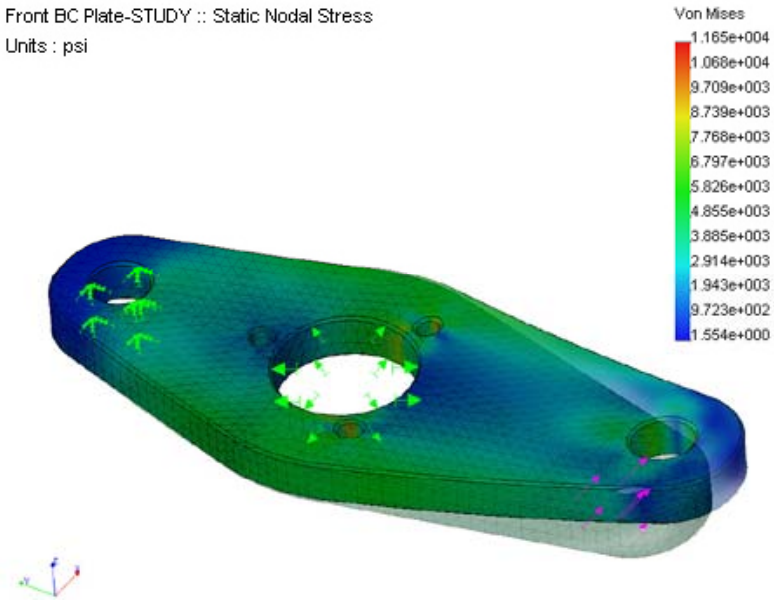


Figure 17: Pro/Engineer model






Front BC Plate-STUDY :: Static Nodal Stress
Units : psi
Von Mises
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1.068e+004
9.709e+003
8.739e+003
7.768e+003
6.797e+003
5.826e+003
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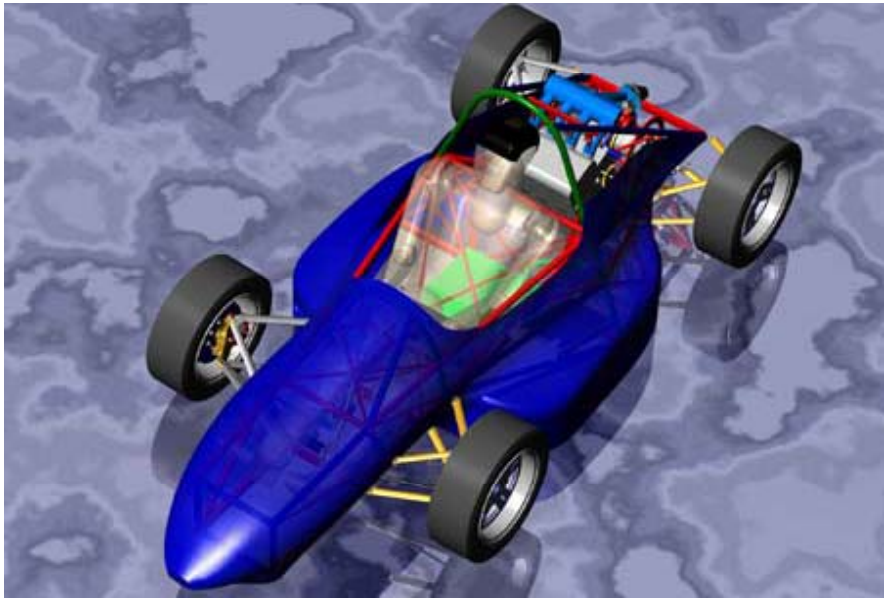
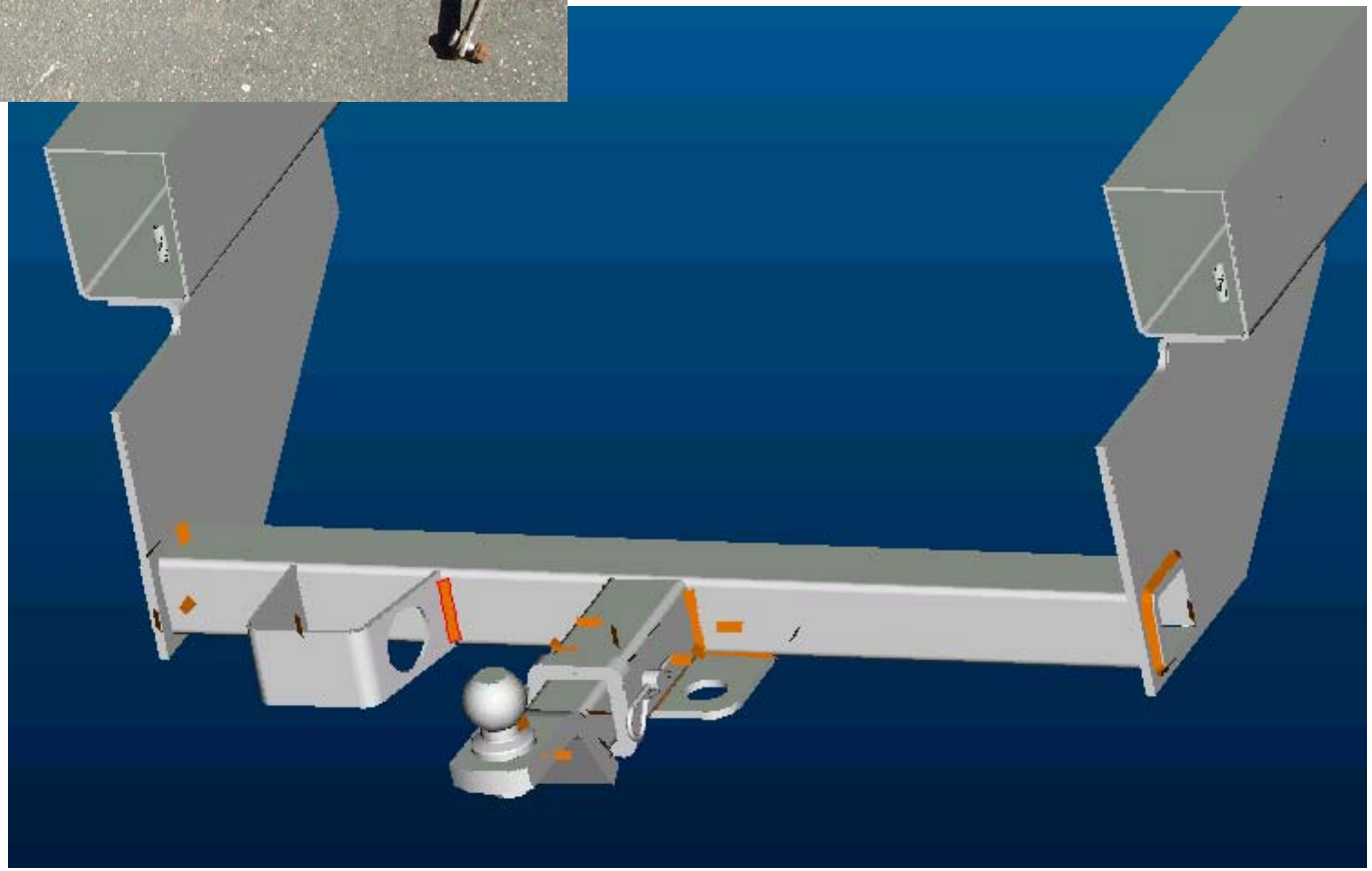


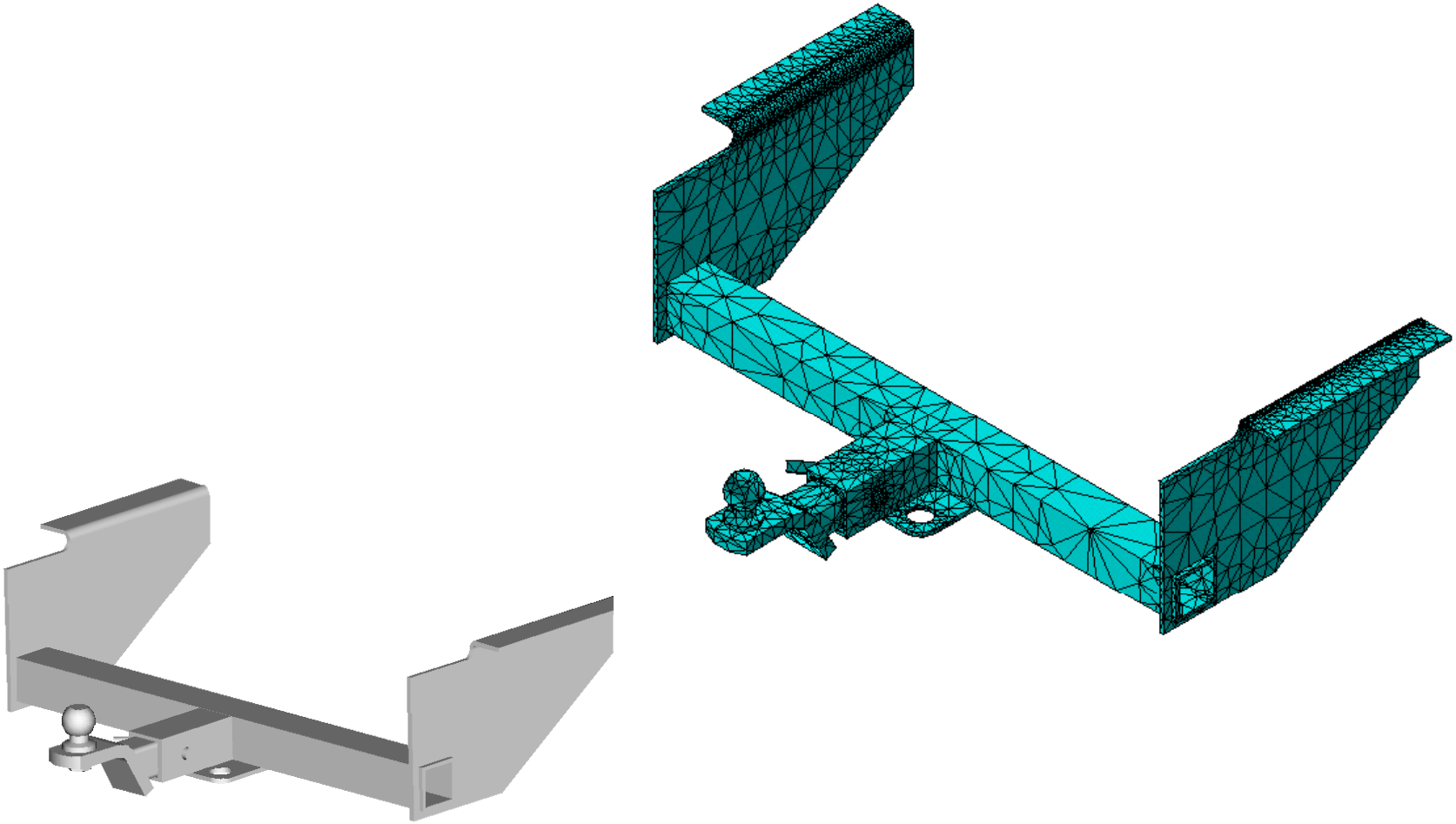
# Modelling and Structural Analysis of a Frame Hitch Using Pro/ENGINEER, Pro/MESH and ANSYS

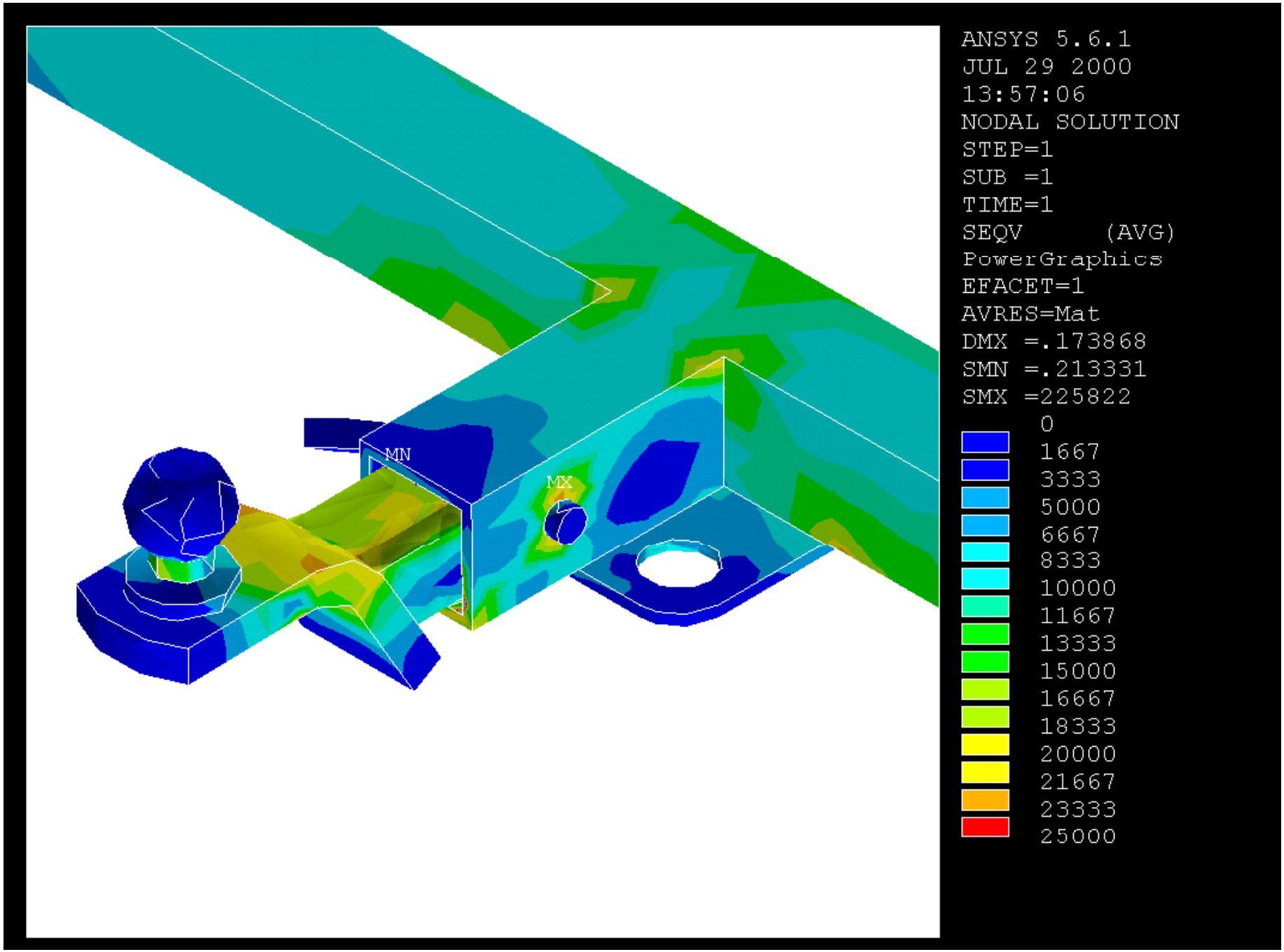
Daryl Brodie and Curran Crawford



# Modelling and Structural Analysis of a Frame Hitch Using Pro/ENGINEER, Pro/MESH and ANSYS

Daryl Brodie and Curran Crawford

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TIME=1
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PowerGraphics
EFACET=1
AVRES=Mat
DMX =.173868
SMN =.213331
SMX =225822
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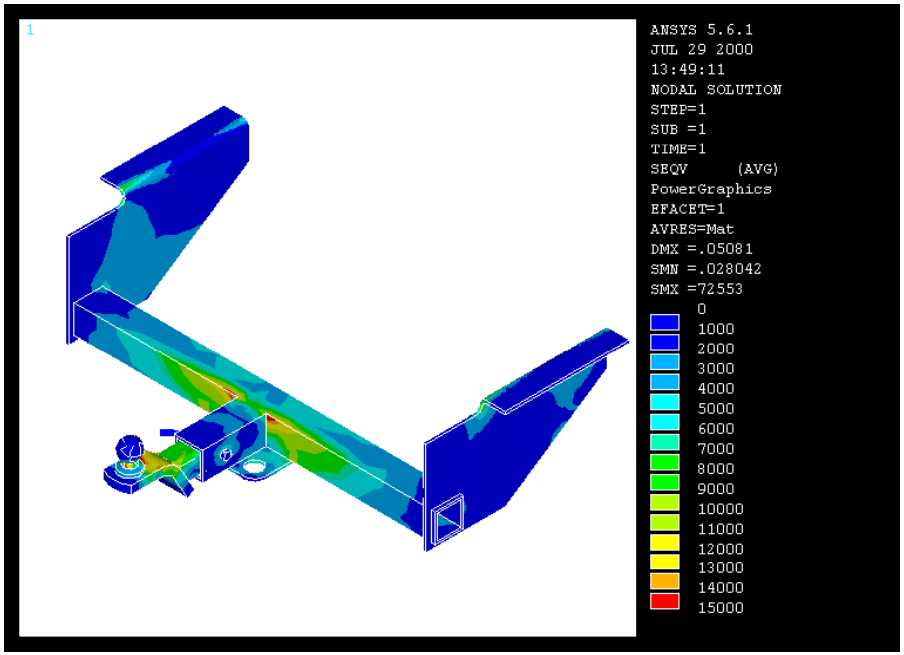
5000
6667
8333
10000
11667
13333
15000
16667
18333
20000
21667
23333
25000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12000
13000
14000
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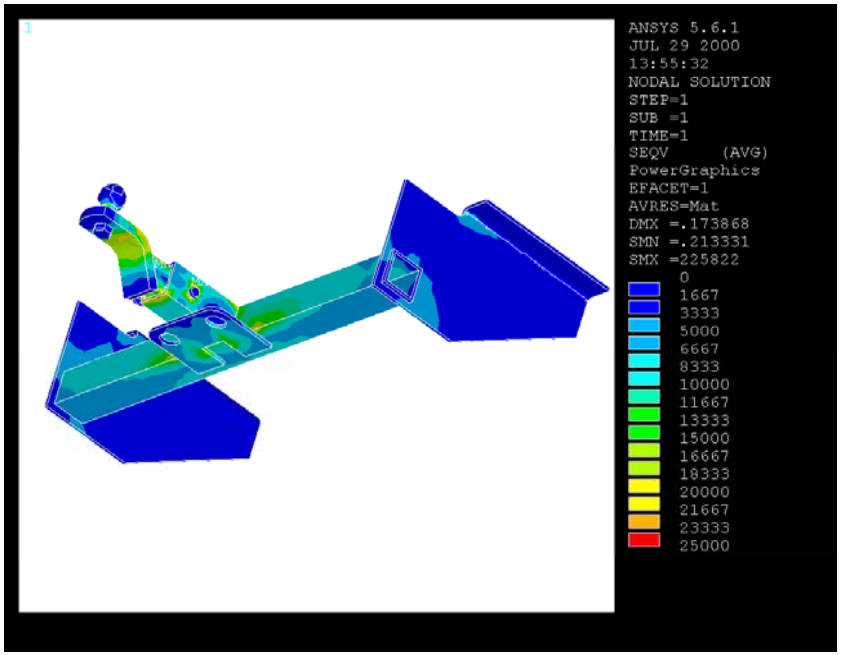
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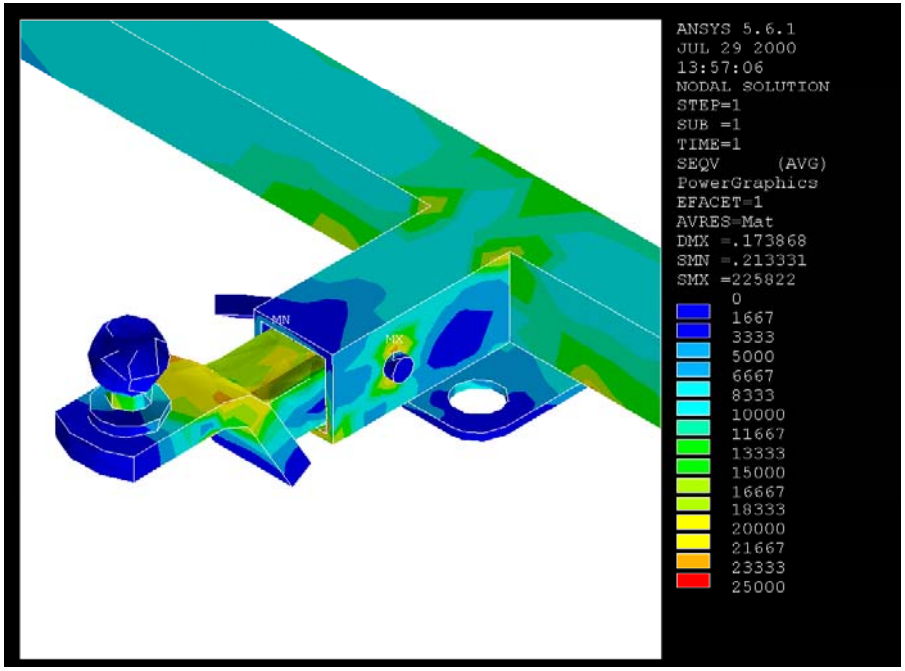
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SMN =.213331
SMX =225822
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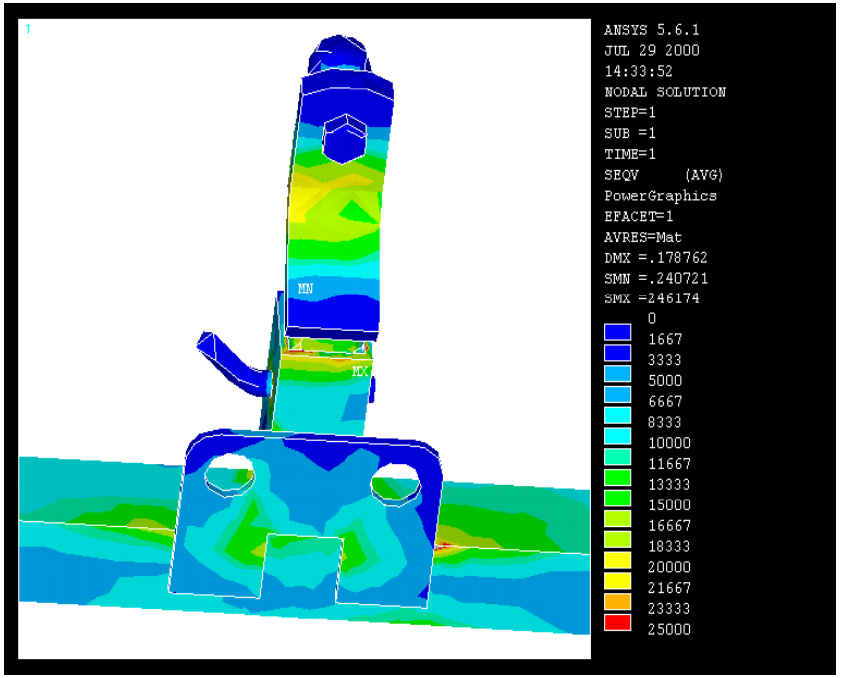
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SMX =246174
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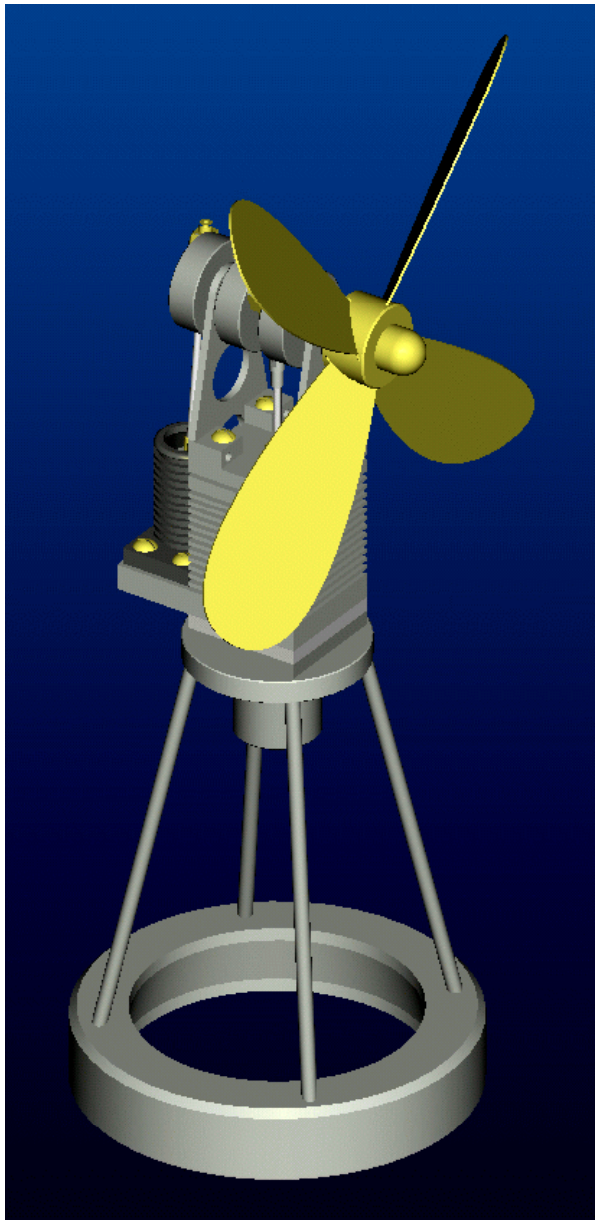
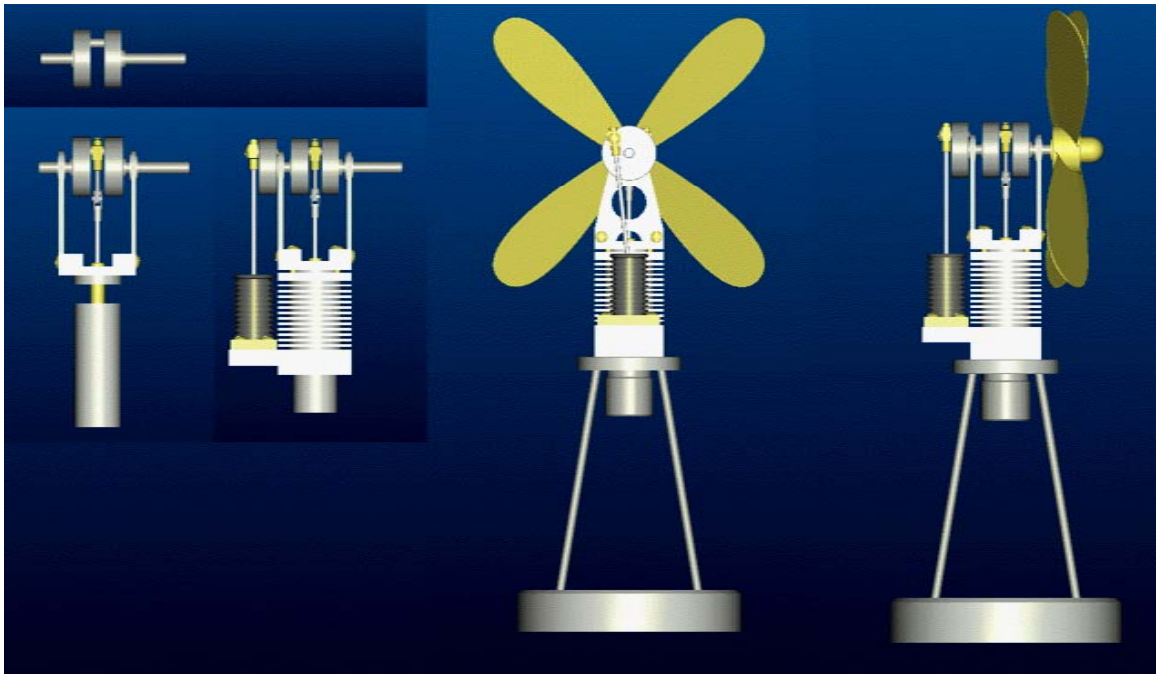


# Mini-Stirling Engine Fan

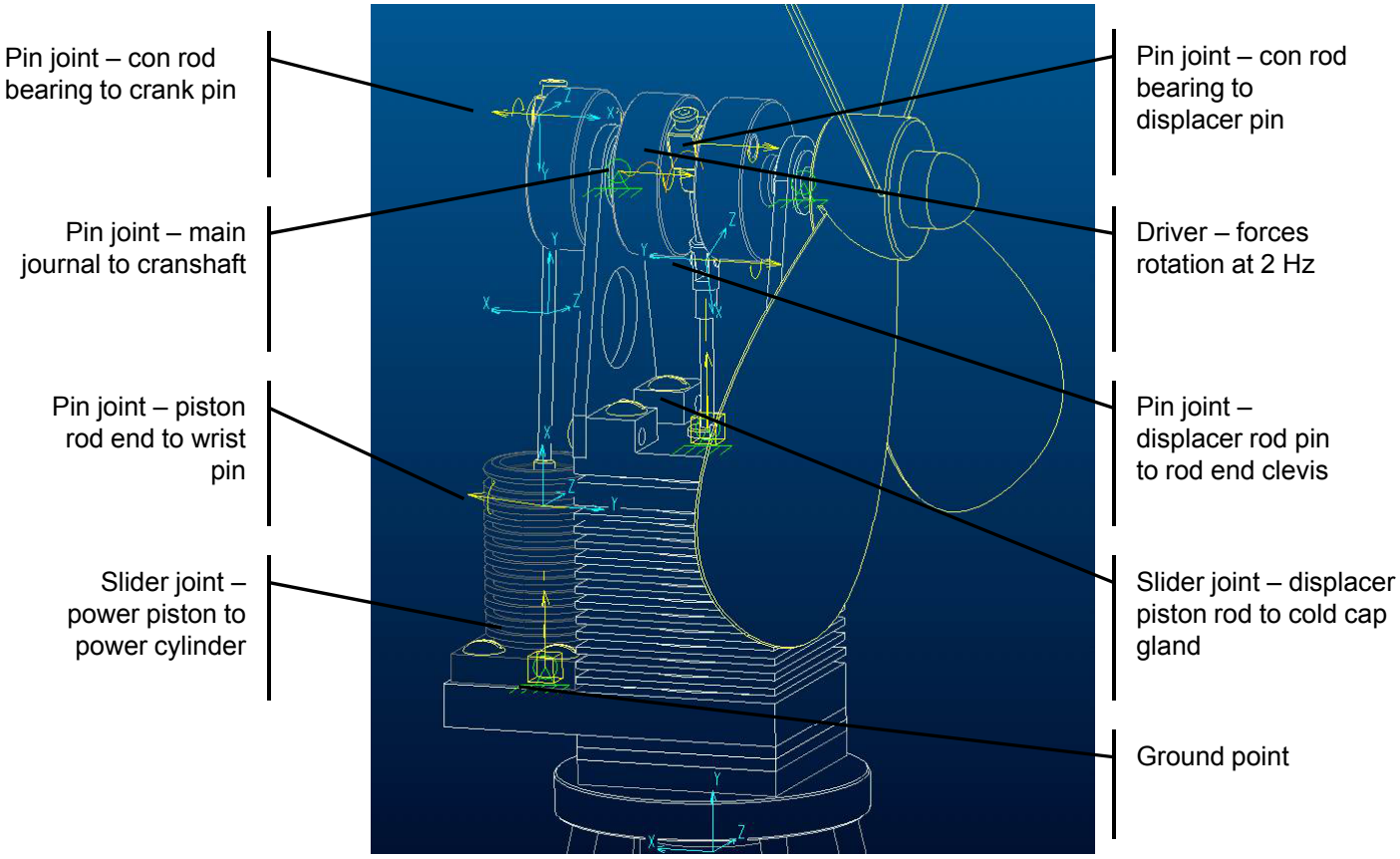
Dean Lowe

- Design Modeling
- Production Drawings
- Motion Animation



# Mini-Stirling Engine Fan

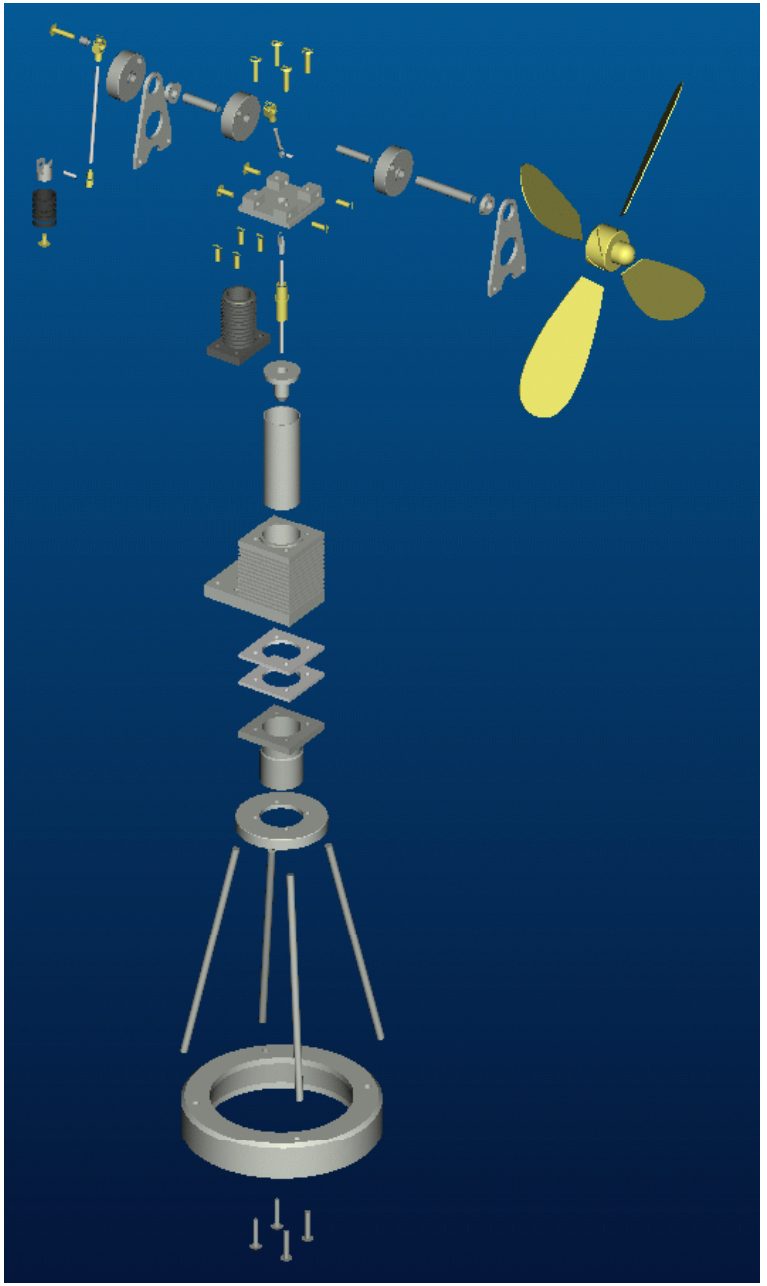
Dean Lowe




**Joints and drivers on the Stirling engine fan**

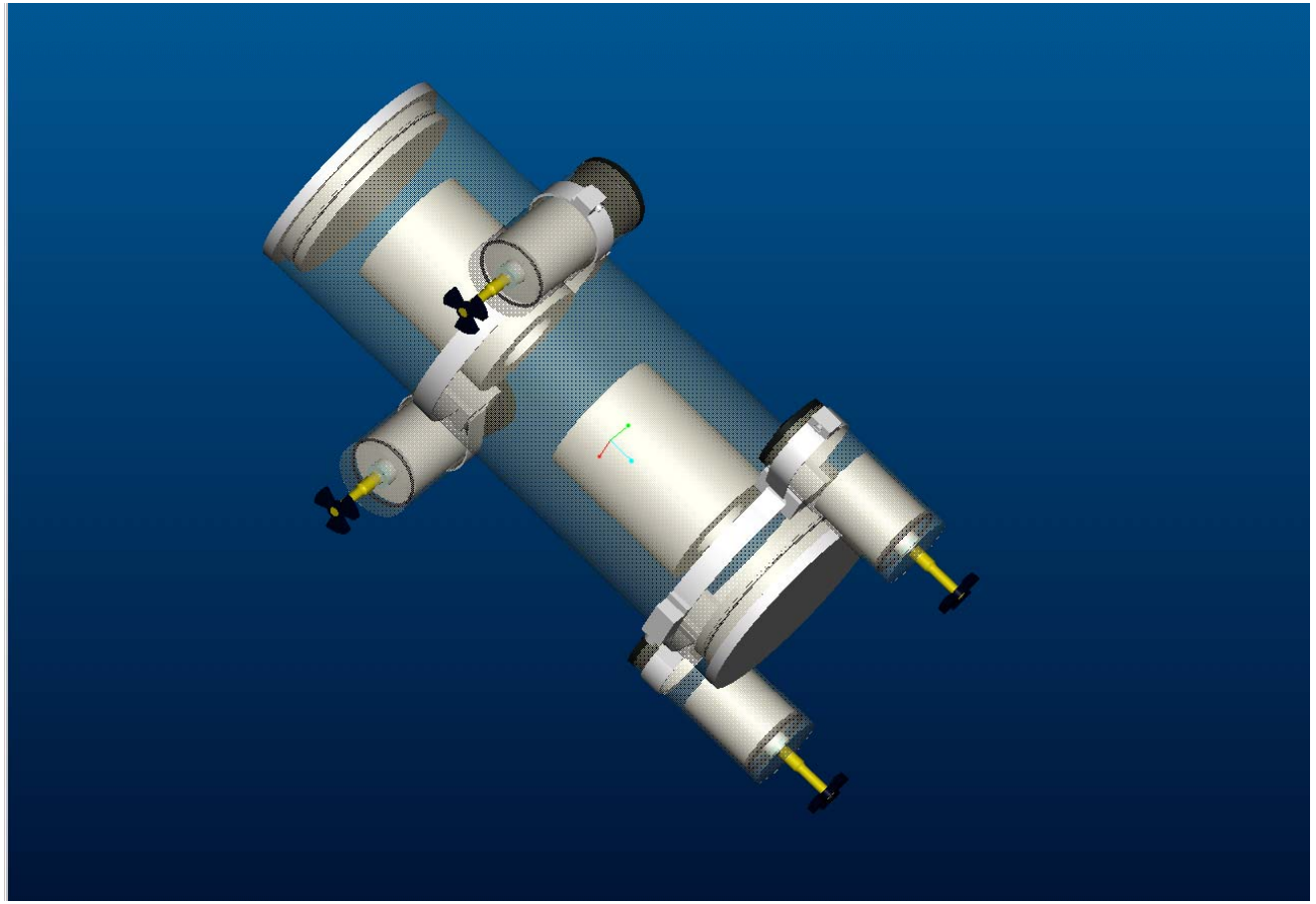
# Mini-Stirling Engine Fan

Dean Lowe



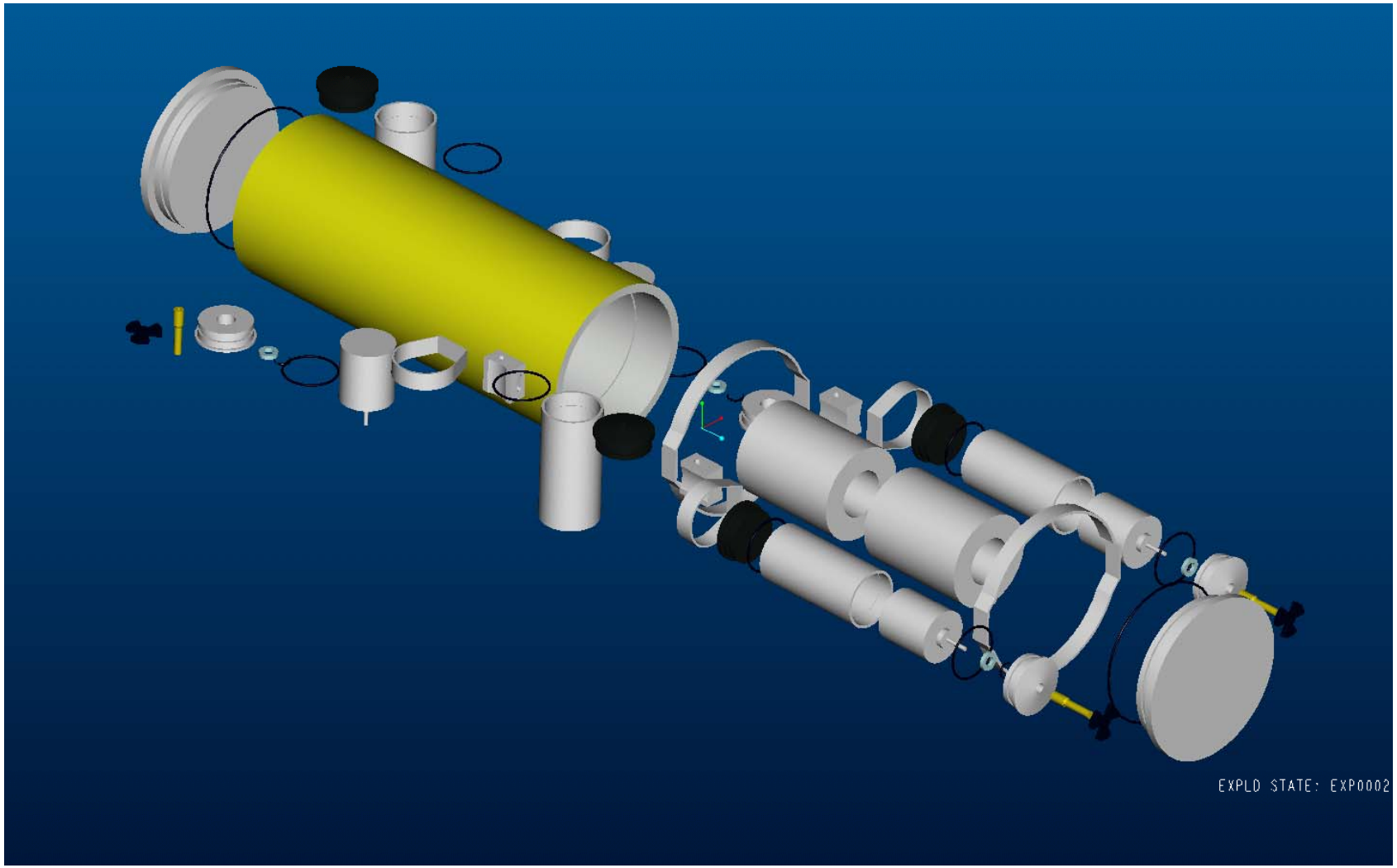
# Parametric Modeling of an ROV

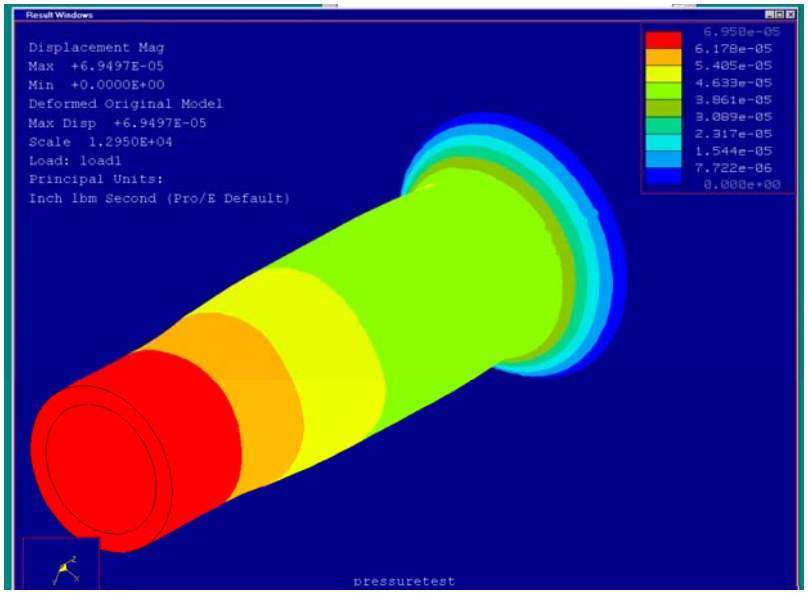
Chris Lyons,and Alex Wigzell



# Parametric Modeling of an ROV

Chris Lyons,and Alex Wigzell

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Min +0.0000E+00
Deformed Original Model
Max Disp +6.9497E-05
Scale 1.2950E+04
Load: load1
Principal Units:
Inch lbm Second (Pro/E Default)
6.950e-05
6.178e-05
5.405e-05
4.633e-05
3.861e-05
3.089e-05
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7.722e-06
0.000e+00
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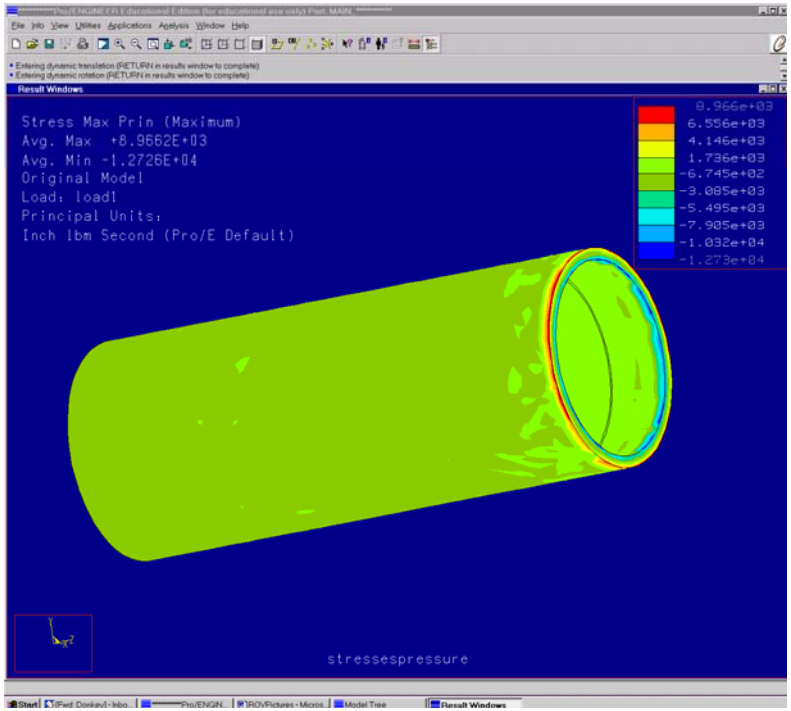
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Avg. Max +8.9662E+03
Avg. Min -1.2726E+04
Original Model
Load: load1
Principal Units:
Inch lbm Second (Pro/E Default)
8.966e+03
6.556e+03
4.146e+03
1.736e+03
-6.745e+02
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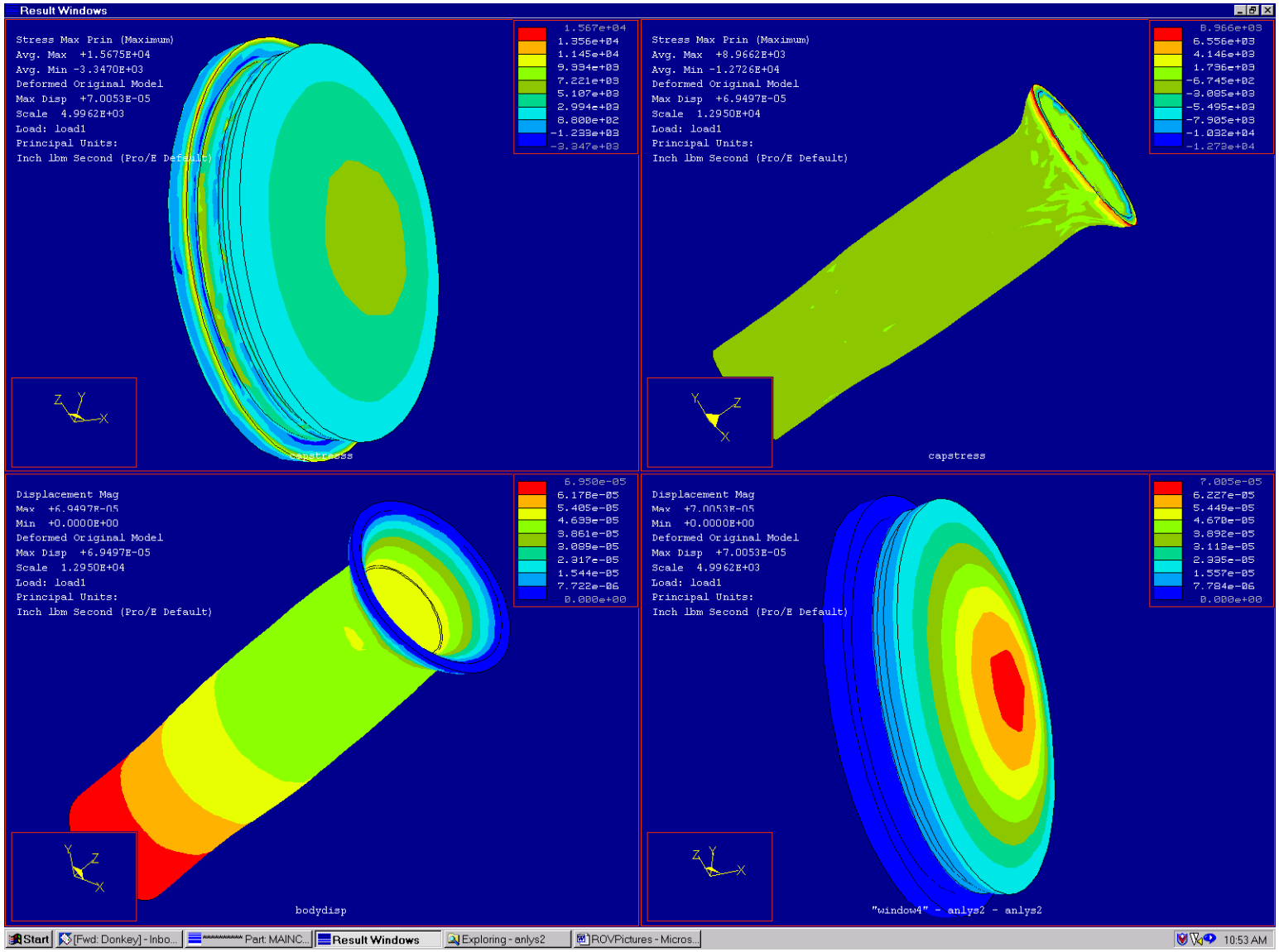
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Avg. Min -3.3470E+03
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Scale 4.9962E+03
Load: load1
Principal Units:
Inch lbm Second (Pro/E Default)
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1.356e+04
1.145e+04
9.334e+03
7.221e+03
5.107e+03
2.994e+03
8.800e+02
-1.233e+03
-3.347e+03
capstress
Stress Max Prin (Maximum)
Avg. Max +8.9662E+03
Avg. Min -1.2726E+04
Deformed Original Model
Max Disp +6.9497E-05
Scale 1.2950E+04
Load: load1
Principal Units:
Inch lbm Second (Pro/E Default)
8.966e+03
6.556e+03
4.146e+03
1.736e+03
-6.745e+02
-3.085e+03
-5.495e+03
-7.905e+03
-1.032e+04
-1.272e+04
capstress
Displacement Mag
Max +6.9497E-05
Min +0.0000E+00
Deformed Original Model
Max Disp +6.9497E-05
Scale 1.2950E+04
Load: load1
Principal Units:
Inch lbm Second (Pro/E Default)
6.950e-05
6.178e-05
5.405e-05
4.633e-05
3.861e-05
3.089e-05
2.317e-05
1.544e-05
7.722e-06
0.000e+00
bodydisp
Displacement Mag
Max +7.0053E-05
Min +0.0000E+00
Deformed Original Model
Max Disp +7.0053E-05
Scale 4.9962E+03
Load: load1
Principal Units:
Inch lbm Second (Pro/E Default)
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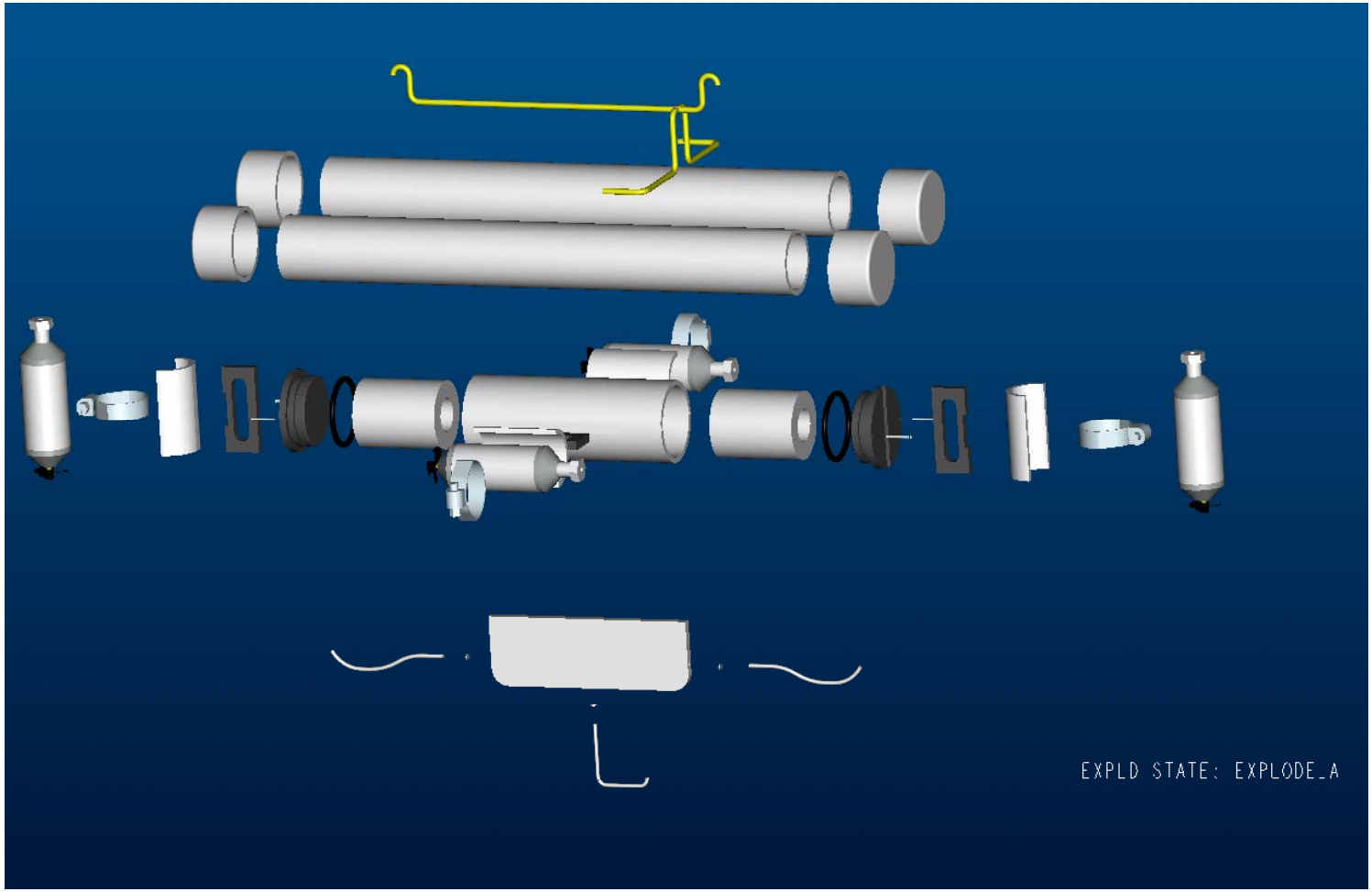
5.449e-05
4.670e-05
3.892e-05
3.113e-05
2.335e-05
1.557e-05
7.784e-06
0.000e+00
"window4" - anlys2 - anlys2
Start
[Fwd: Donkey] - Inbo...
Part: MAINC...
Result Windows
Exploring - anlys2
ROVPictures - Micros...
10:53 AM

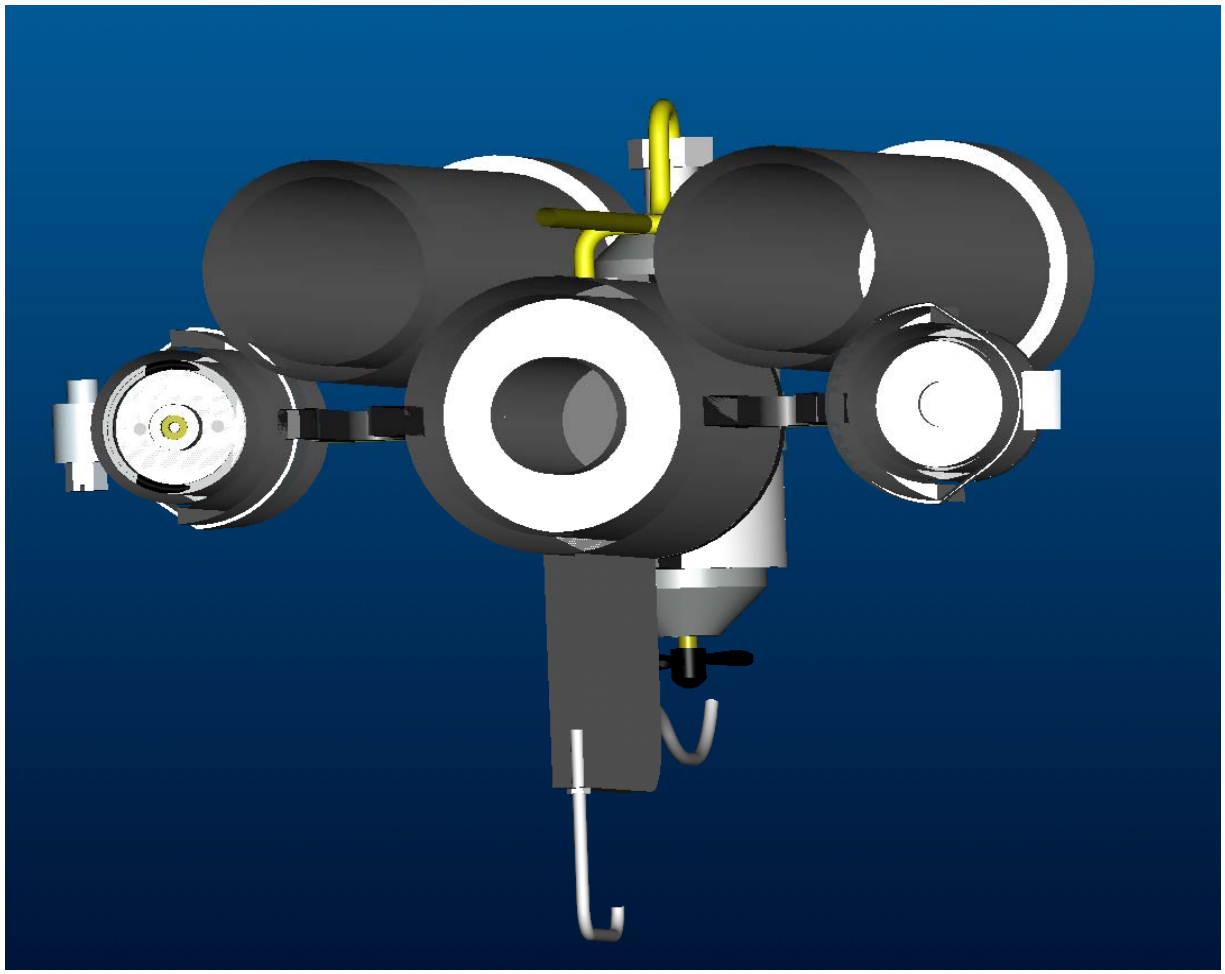
# Computer Modeling of a Remotely Operated Underwater Vehicle

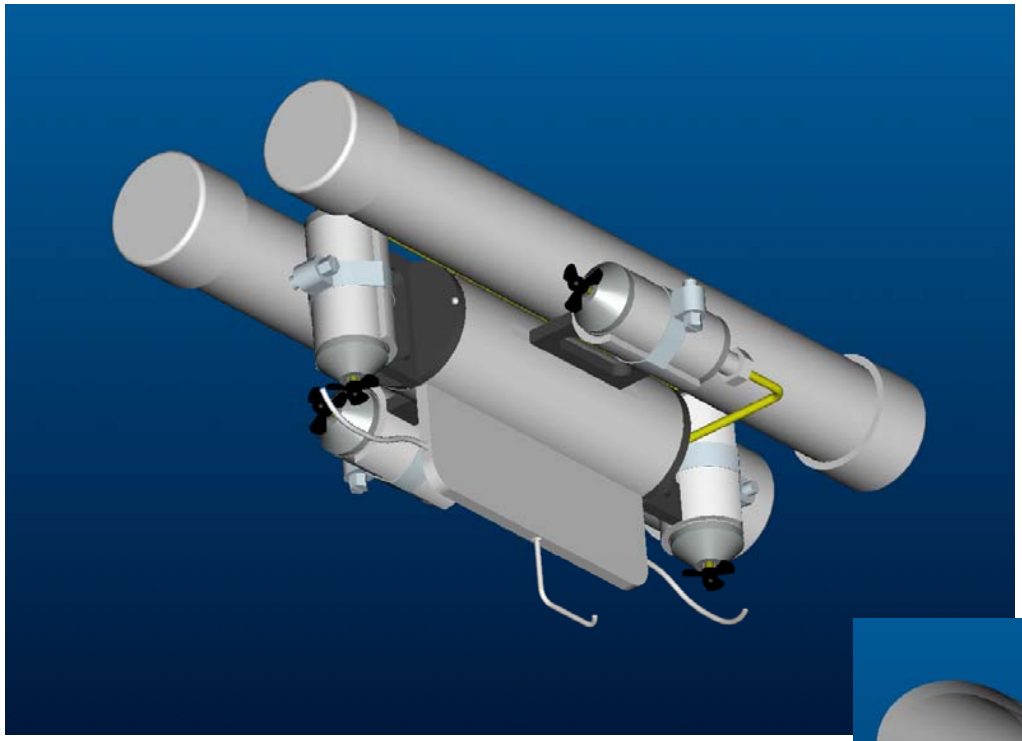
Chris Dicken and Mark Tsui

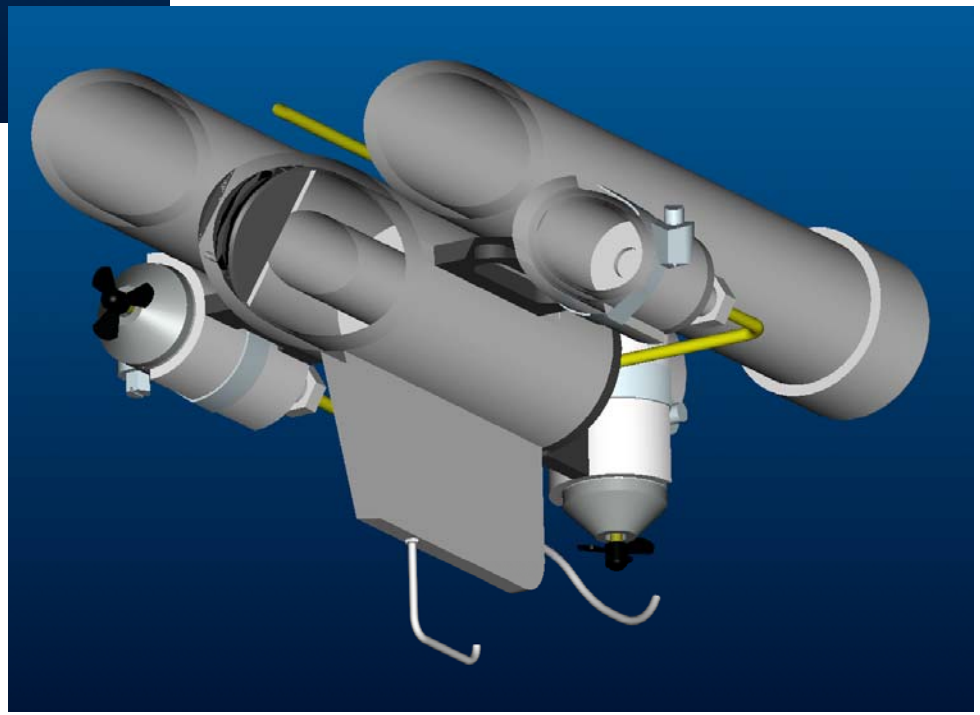


# Computer Modeling of a Remotely Operated Underwater Vehicle

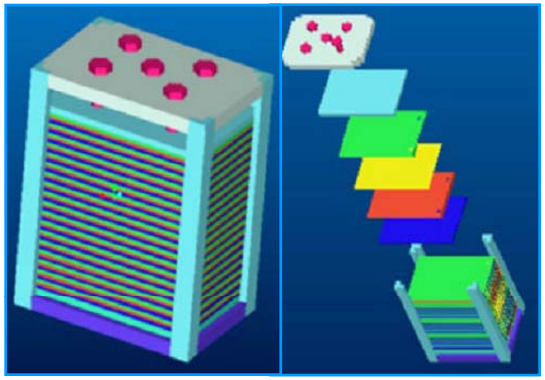
Chris Dicken and Mark Tsui

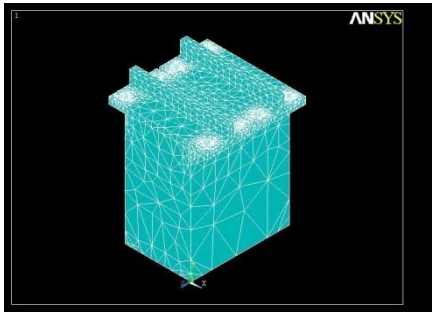


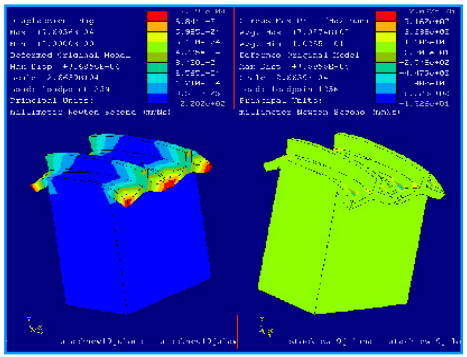


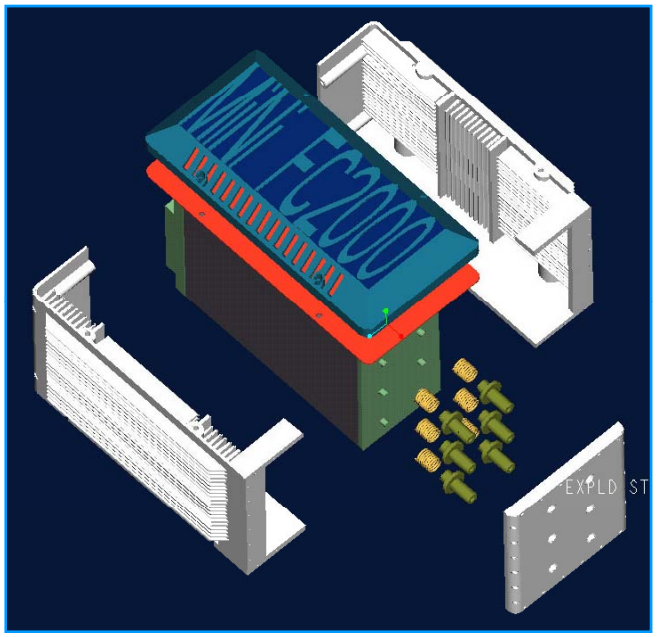


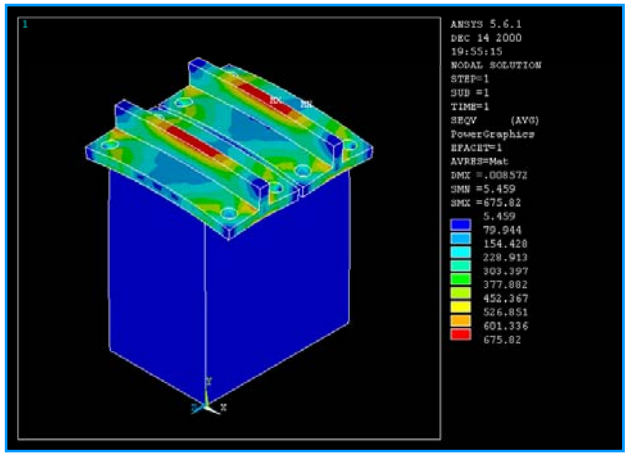
# Concept Fuel Cell Stack Modeling and Analysis

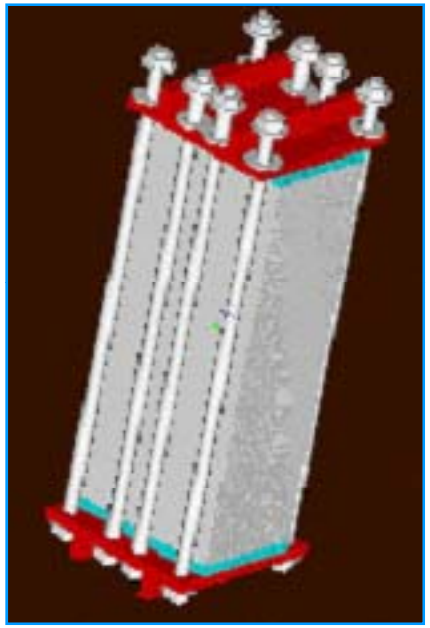


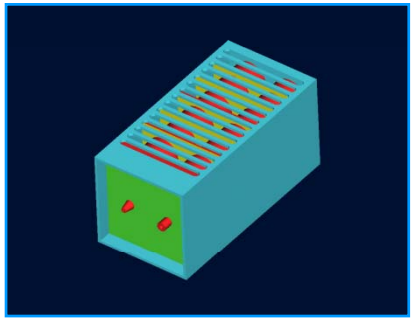




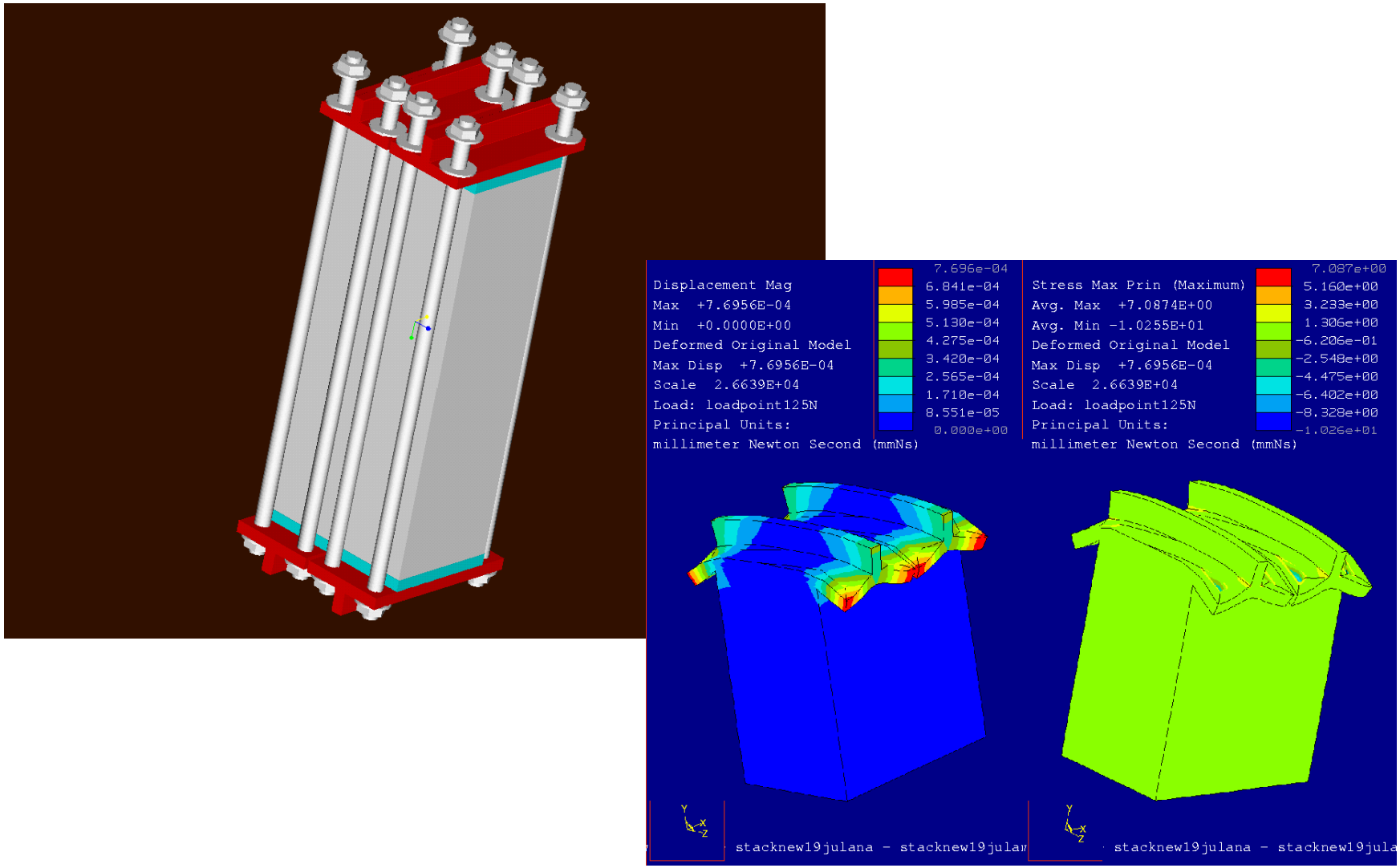



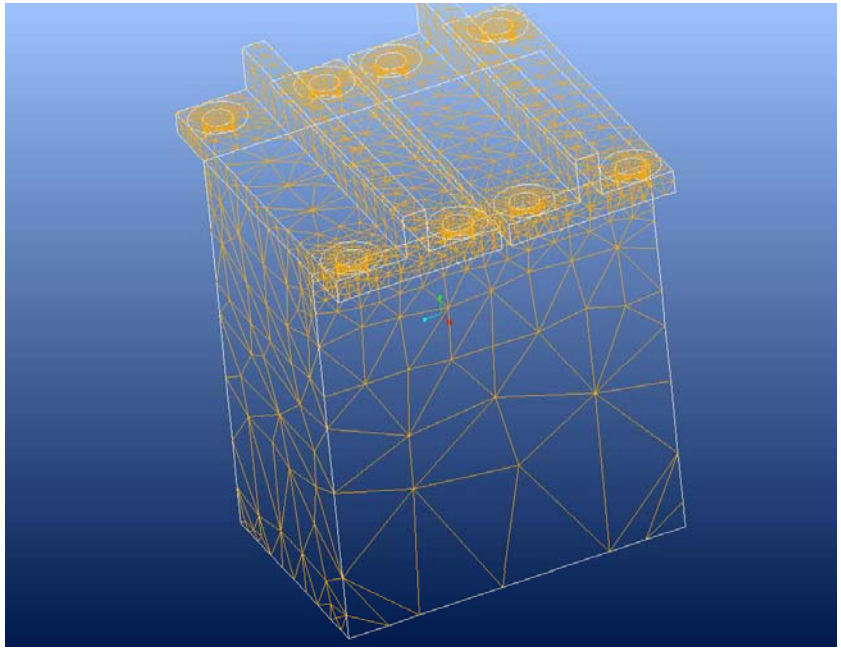


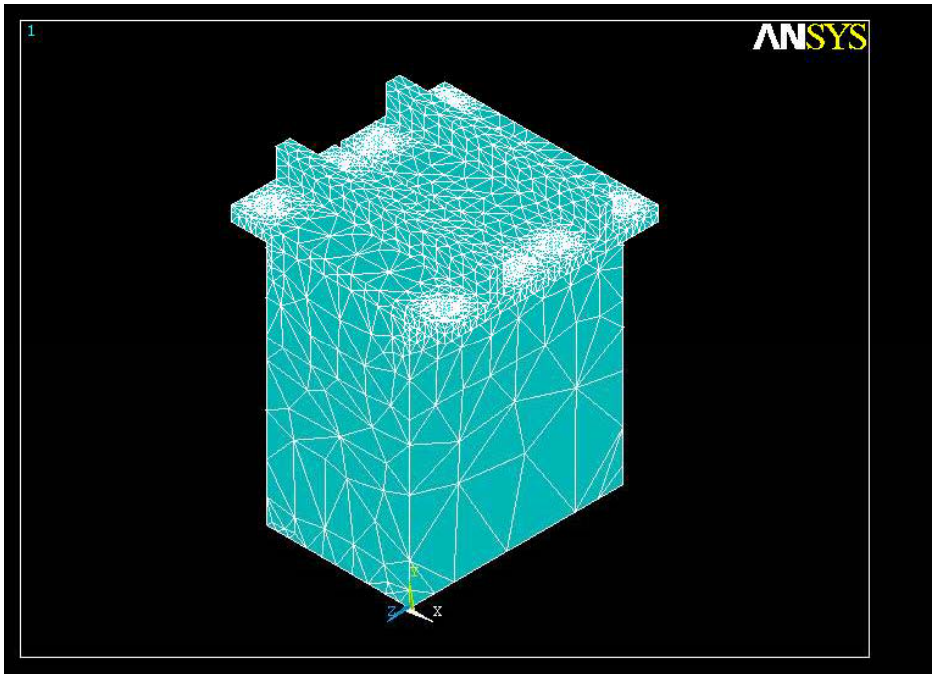
# Fuel Cell Stack Modeling and Analysis

M.M. Rao

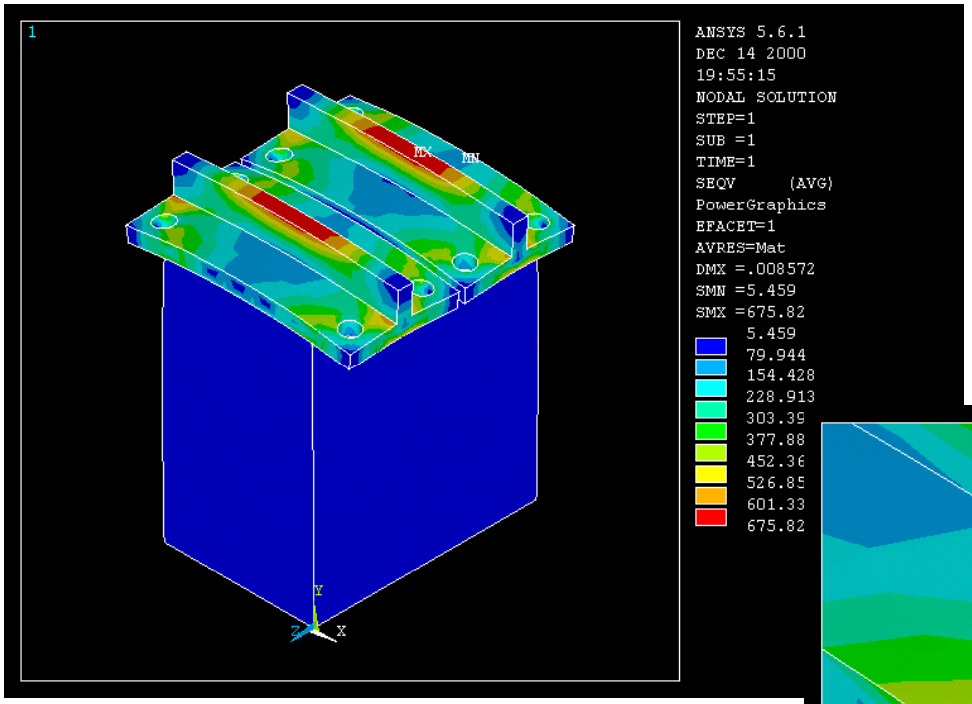


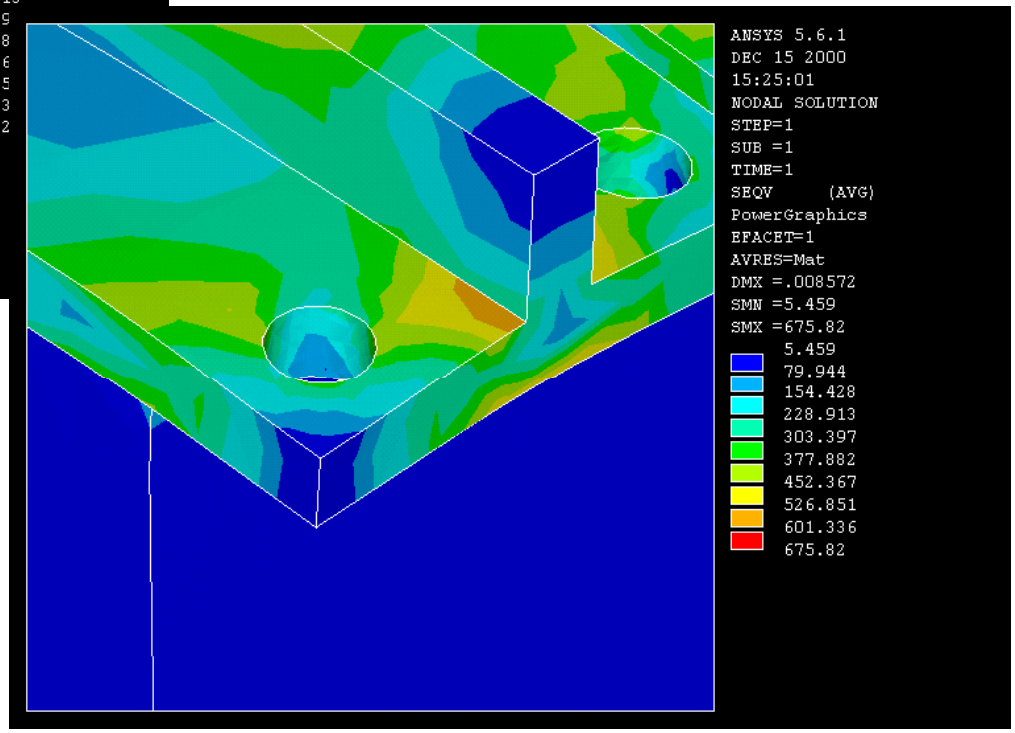
# FEA Mesh Generation of Fuel Cell Stack





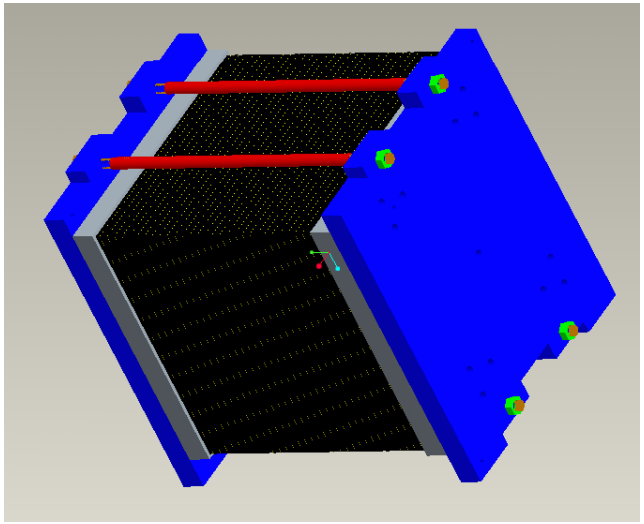
# FEA Fuel Cell Stack Stress and Compression Analysis

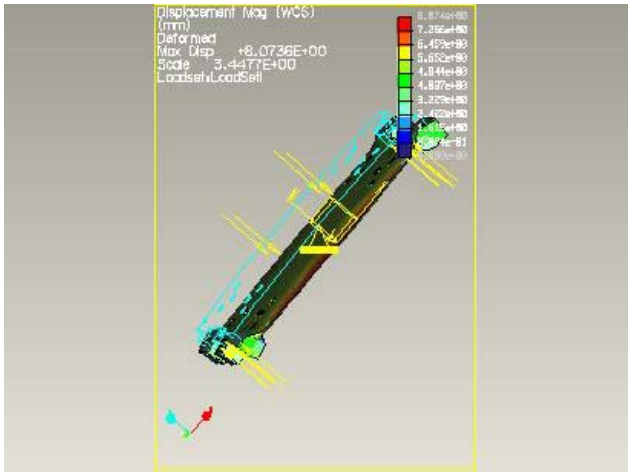


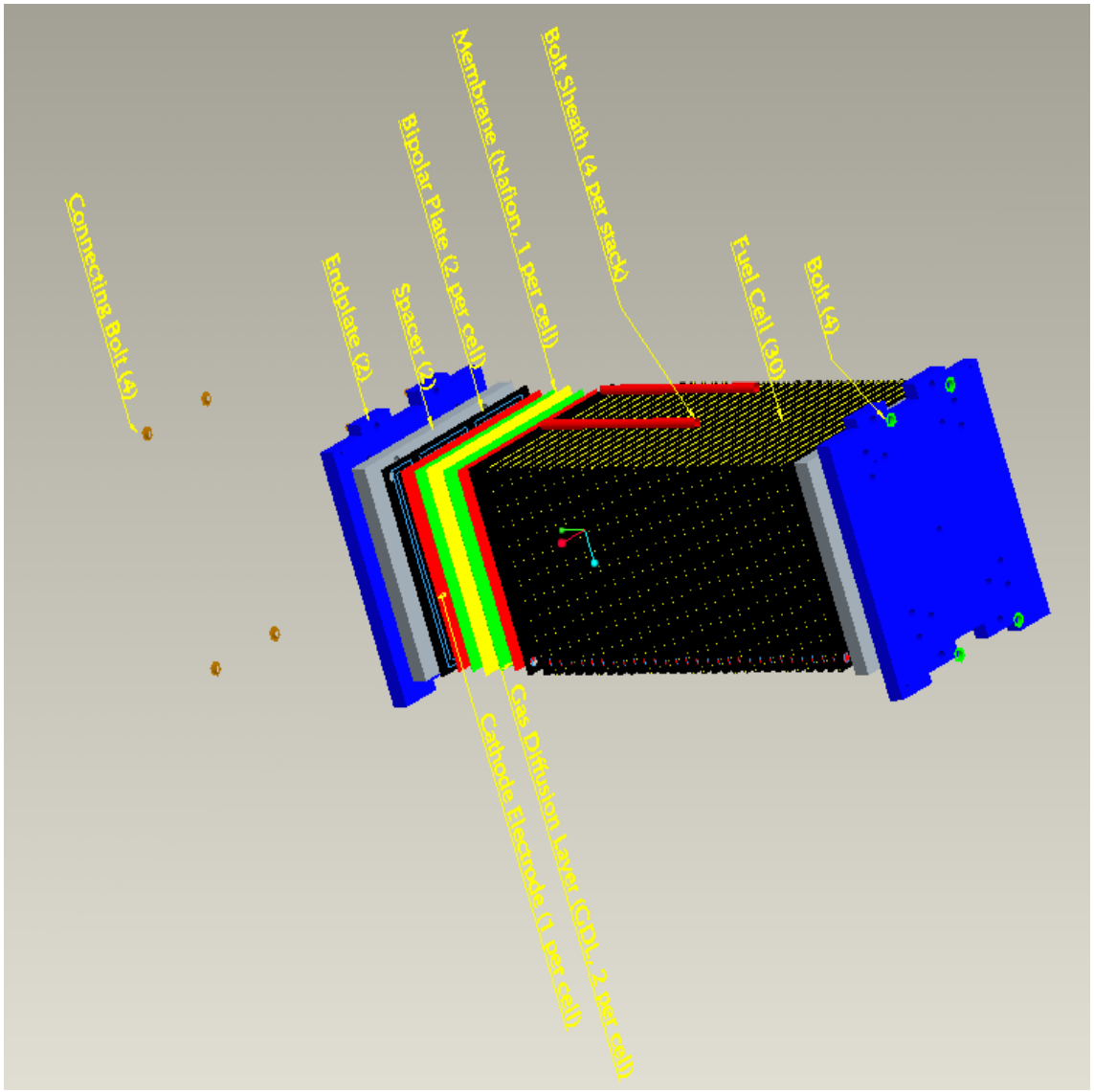



# Modeling and Optimization of Fuel Cell Stack Endplate

**Jeff Wishart**

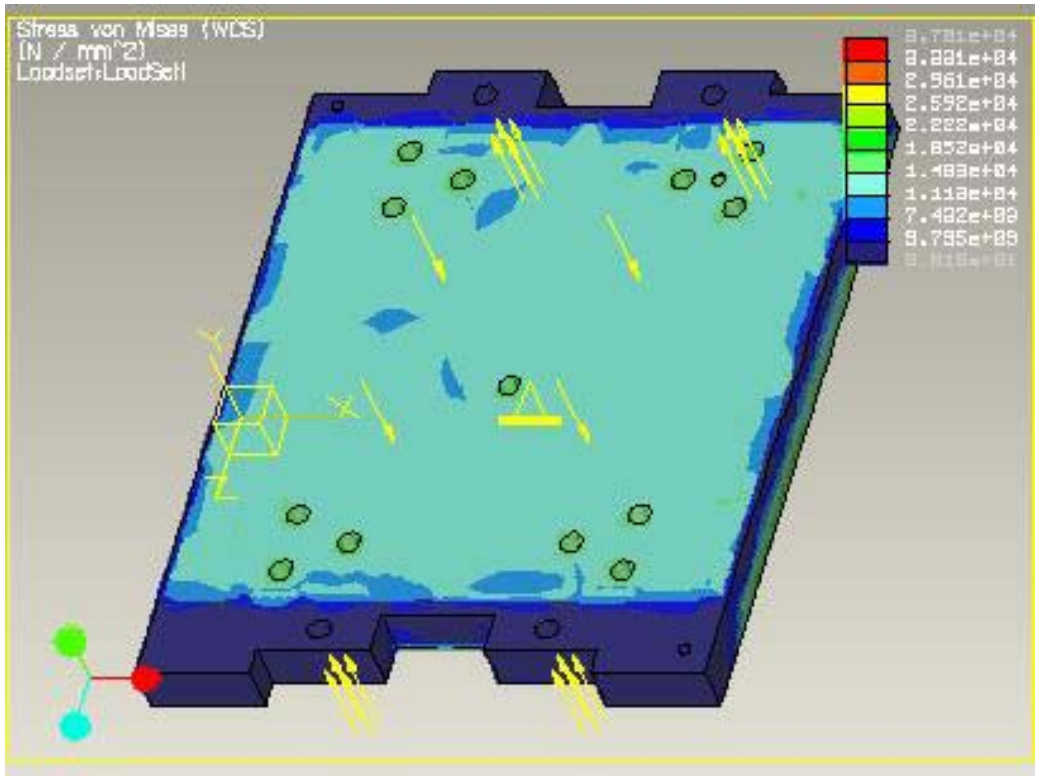


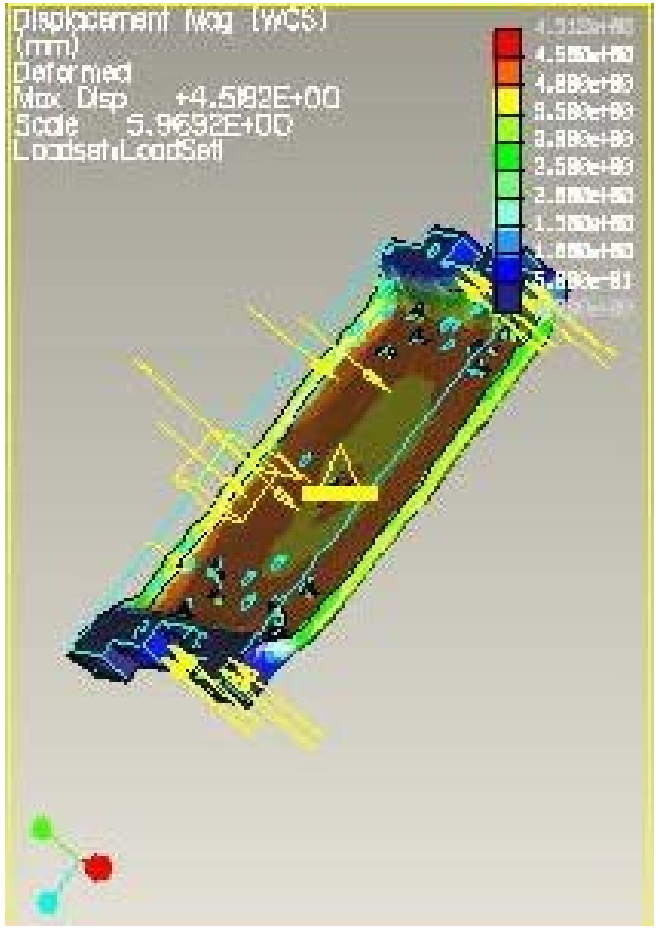


# Structural Analysis

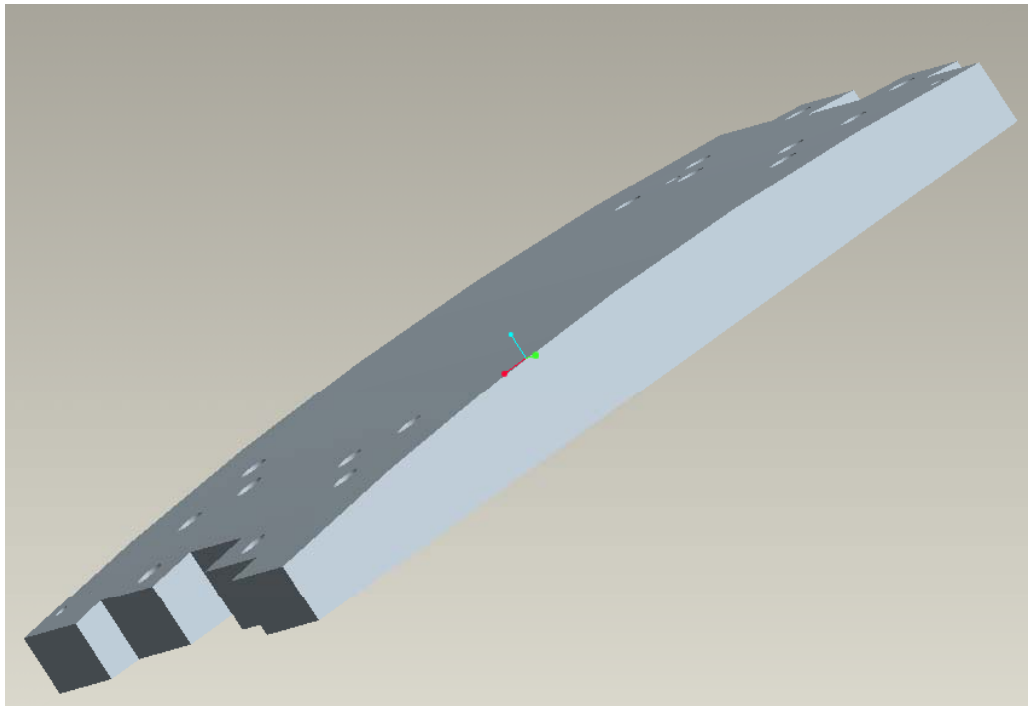
- Pressure load on place of Endplate from spacer and from four bolts/nuts: 0.5MPa and 0.125MPa, respectively
- Actual load causes 4μm of displacement: too small for Pro/E to handle
- Artificial Pressure loads of 20000 and 5000 MPa used
- Maximum Displacement: 4.518mm
- Maximum Von Mises Stress: 37GPa



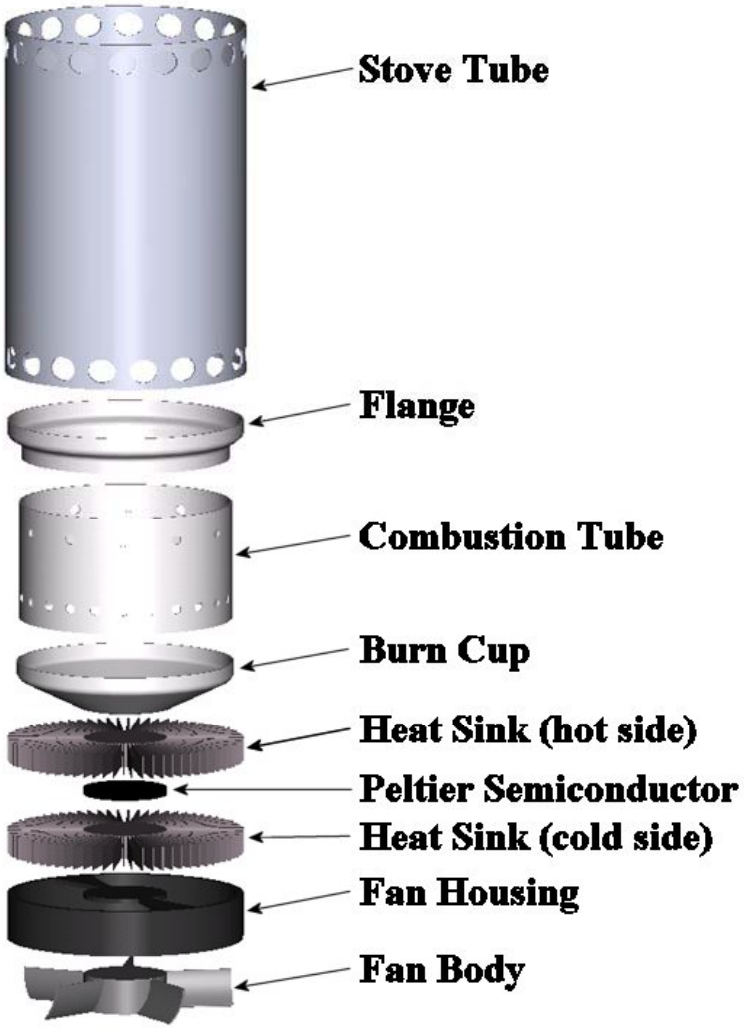
# Bowed Endplate Design

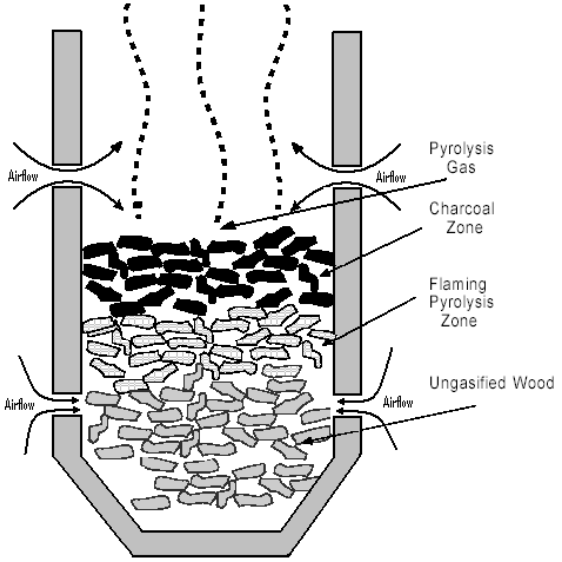
- Radius of curve (bow) calculated such that the maximum distance from curved surface to original dimension equal to maximum displacement value (4.518mm), and then varied decreasingly to zero
- Maximum Displacement: 8.07mm
- Maximum Von Mises Stress: 90GPa

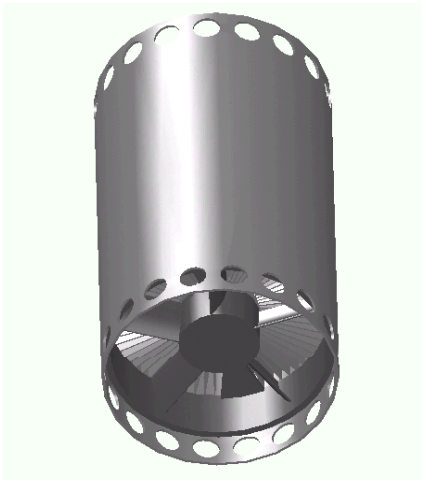


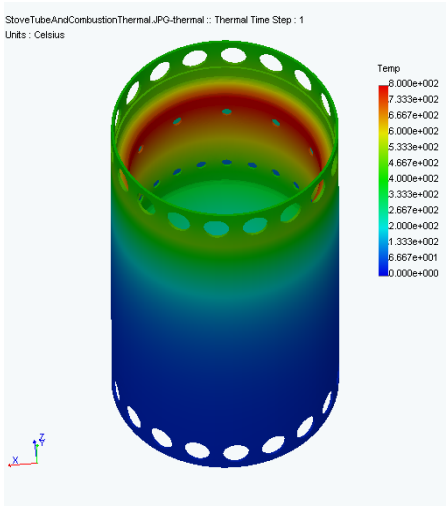
# Modelling a Lightweight Solid Fuel Backpacking Stove

Scott Borstad



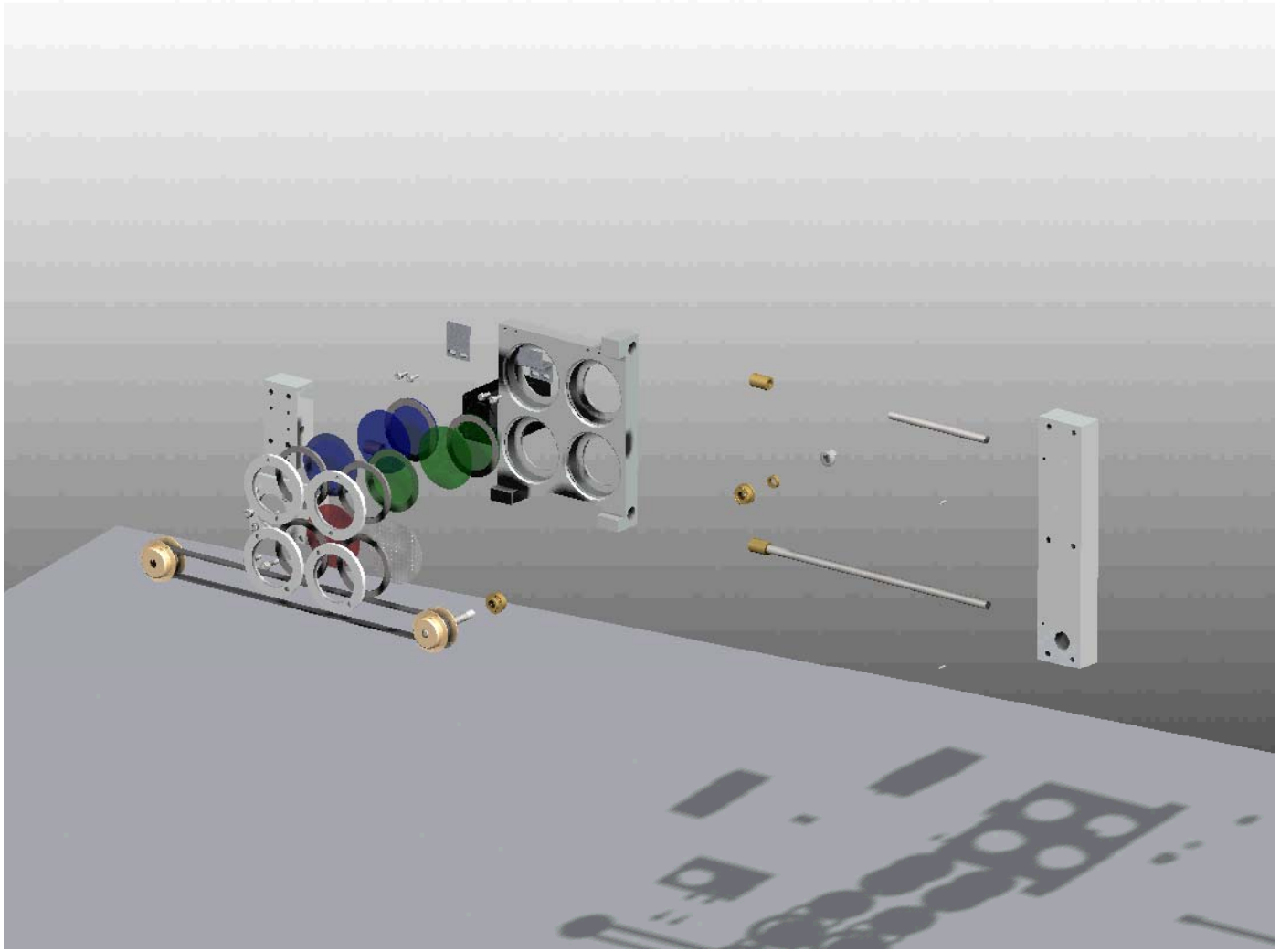





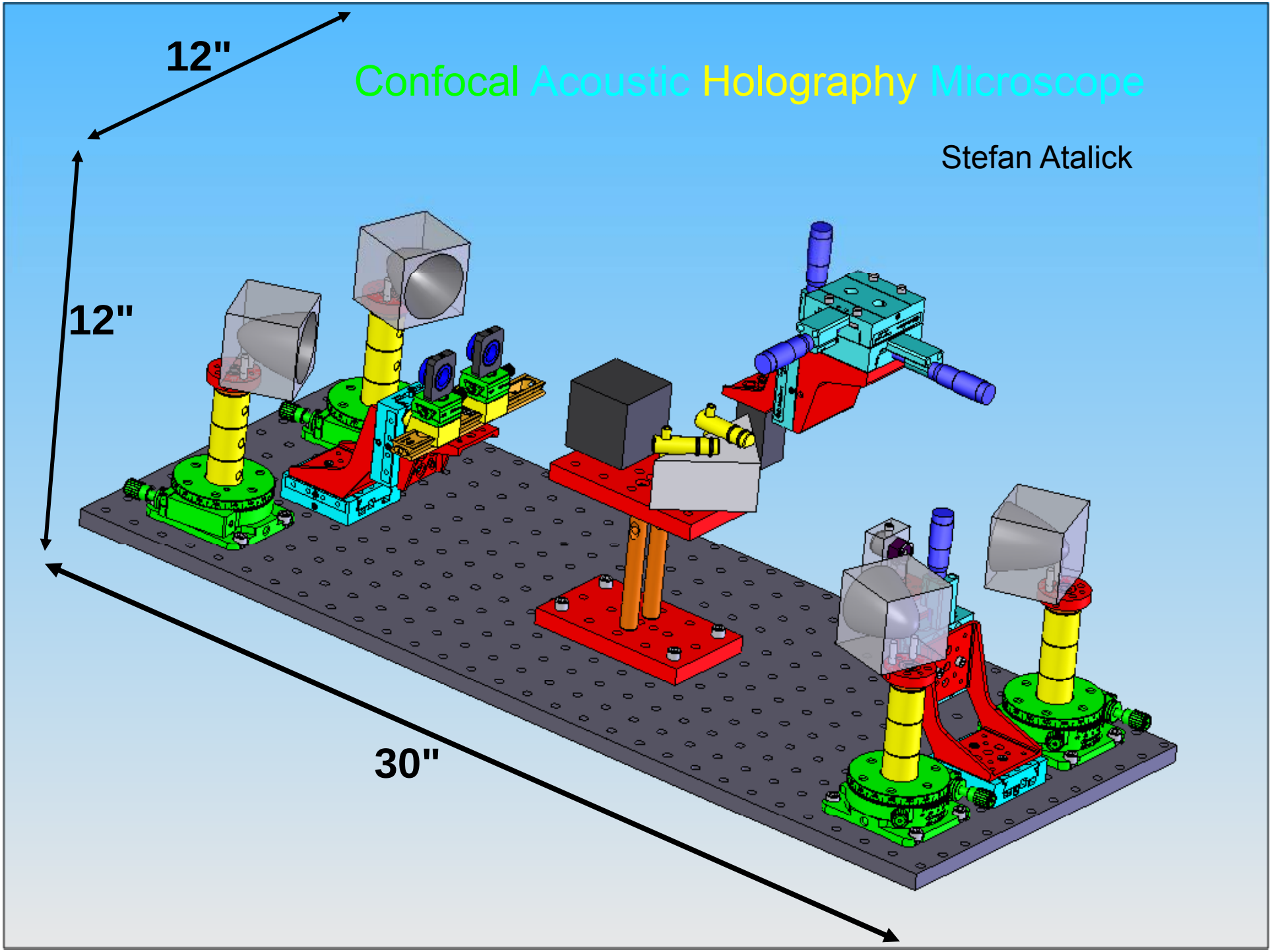
# Color Filter Slide Assembly Animation

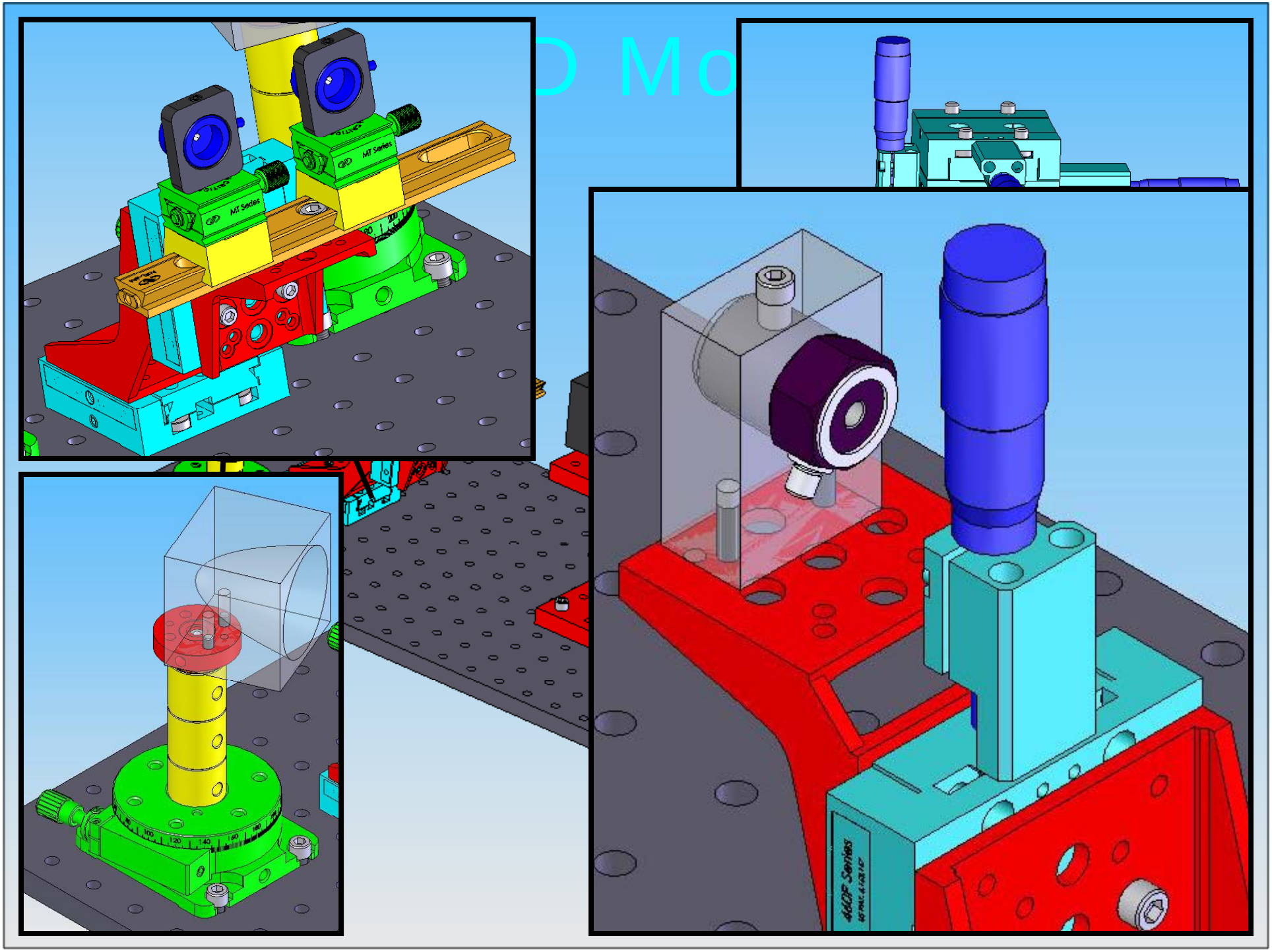
Alexis Hill and Ben Townsend (SolidWorks)



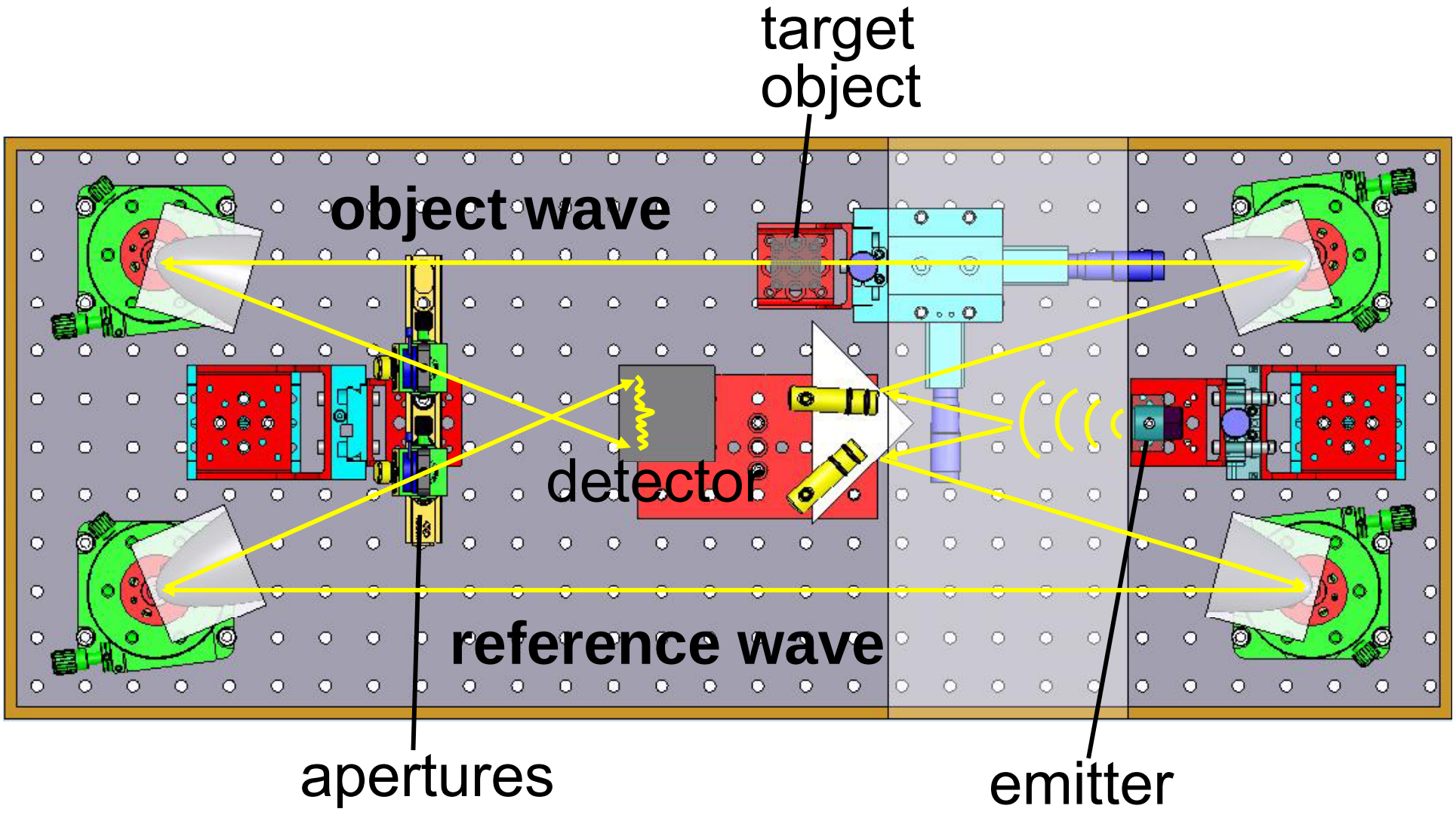
# Confocal Acoustic Holography Microscope

Stefan Atalick



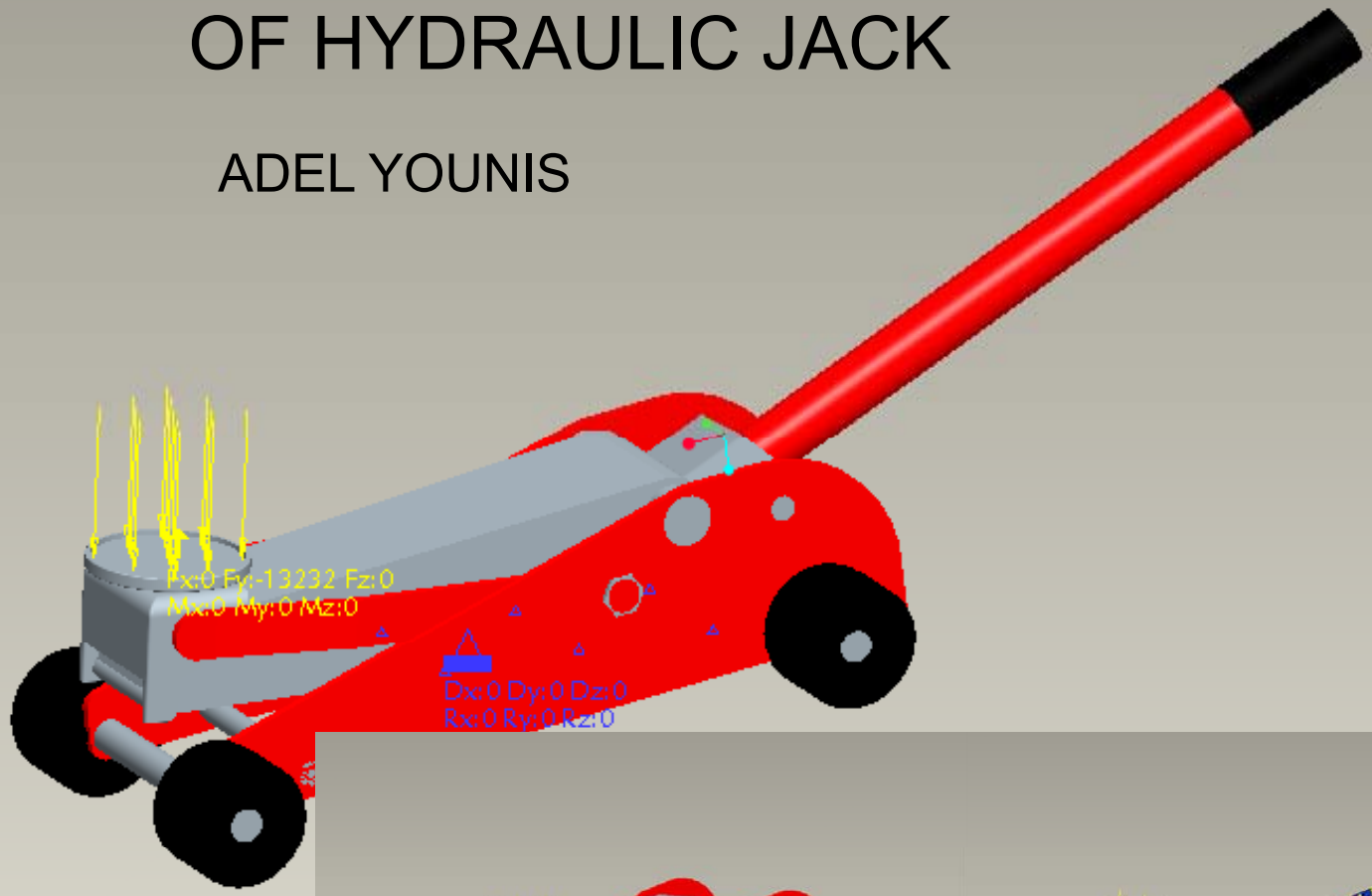

MT Series
MT Series
460F Series

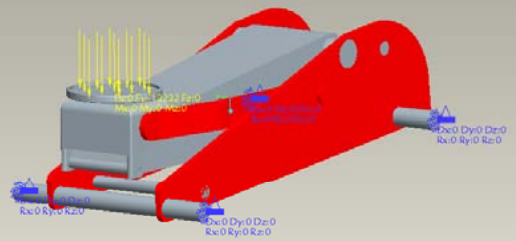
# CAD Model

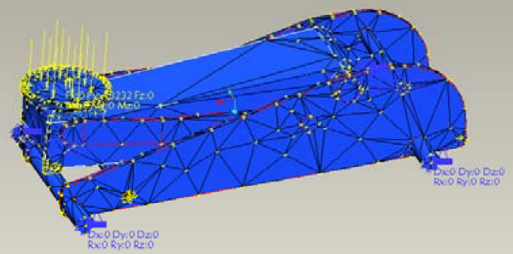

target
object
object wave
detector
reference wave
apertures
emitter

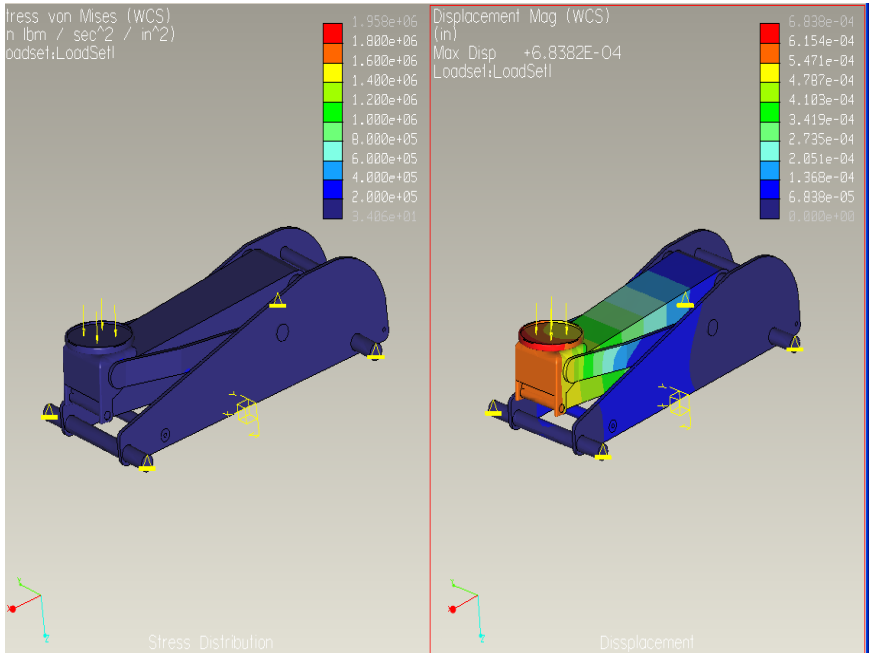
# 3-D MODELING AND DESIGN OPTIMIZATION OF HYDRAULIC JACK

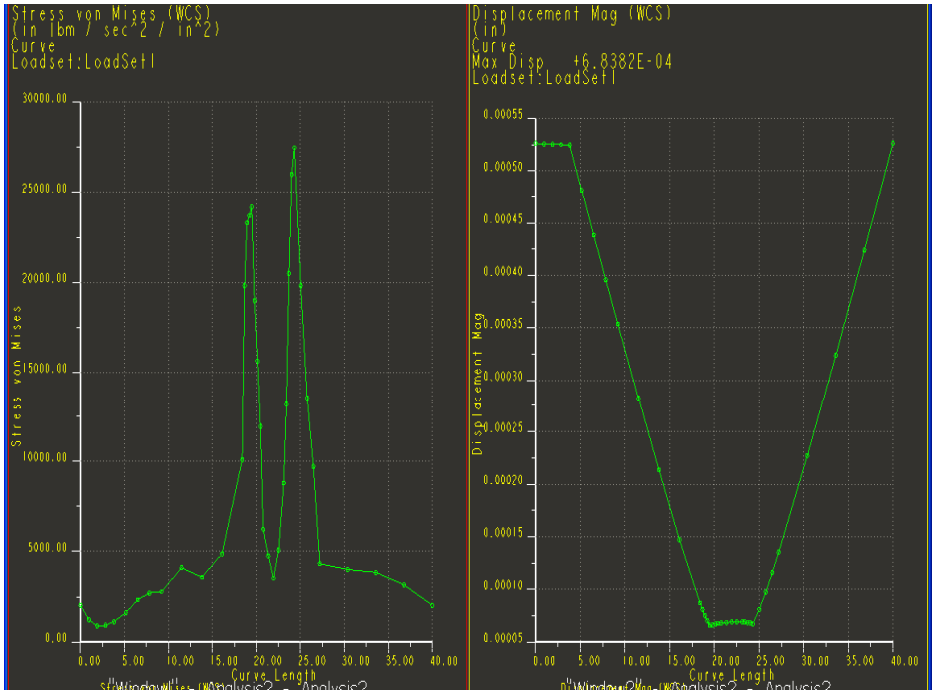
ADEL YOUNIS







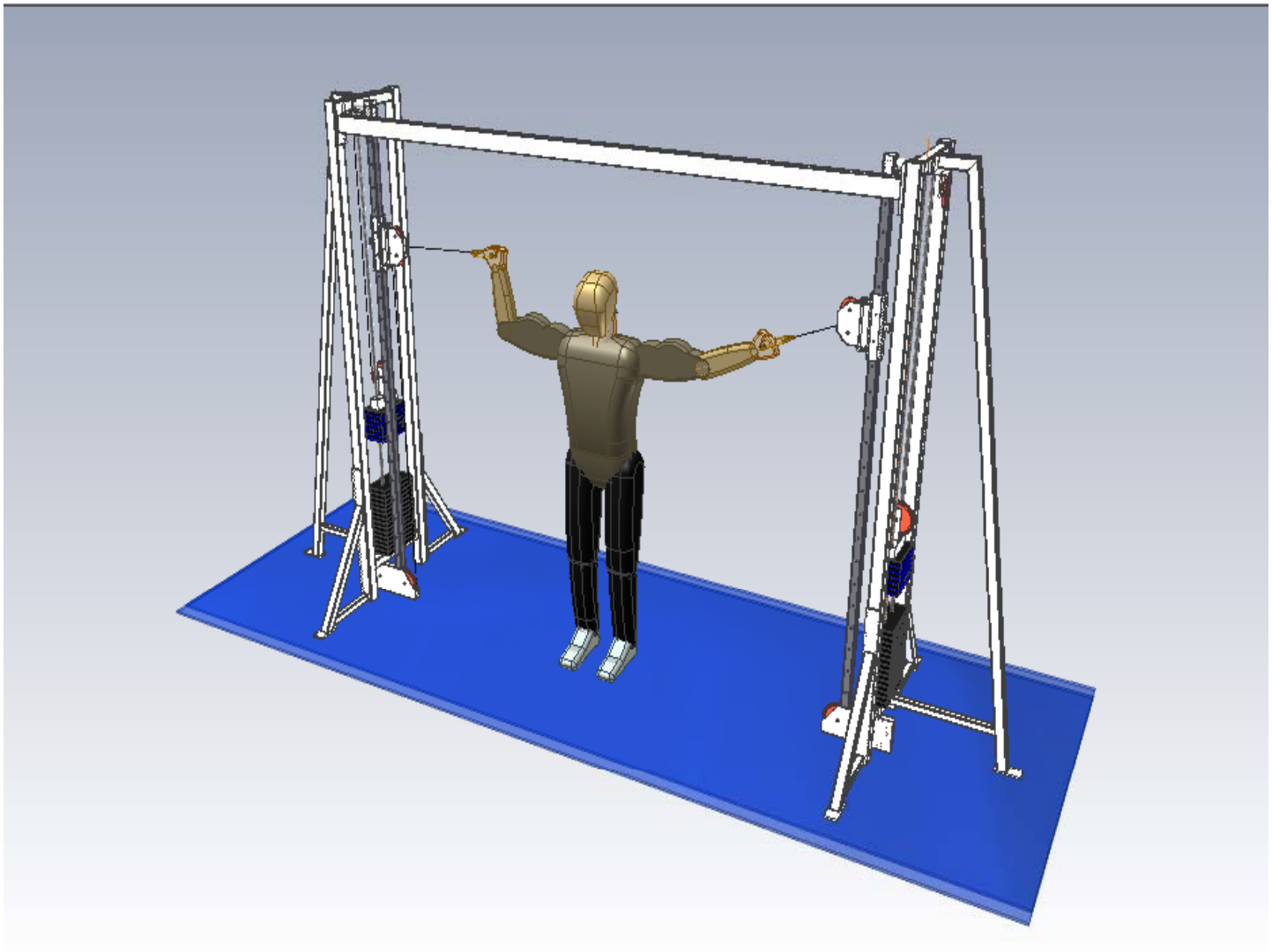

- The model showed low maximum stresses (σ= 1.958e+06 lbm/sec^2/in^2) under the design load.
- The design optimization result by selecting the pin diameter d=1.5” of the lifting arm also proved to be the Best Design:

$d_{72}$( Pin diameter)=1.5”

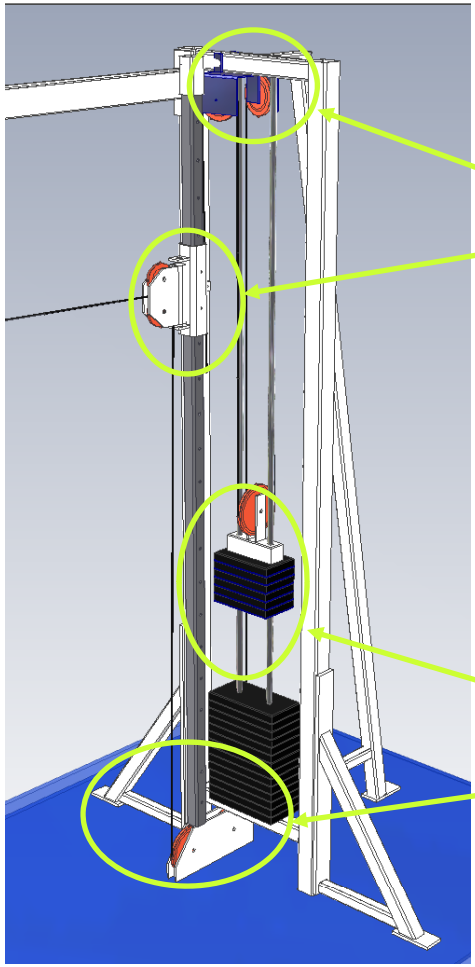
Goal: 1.1809e+02

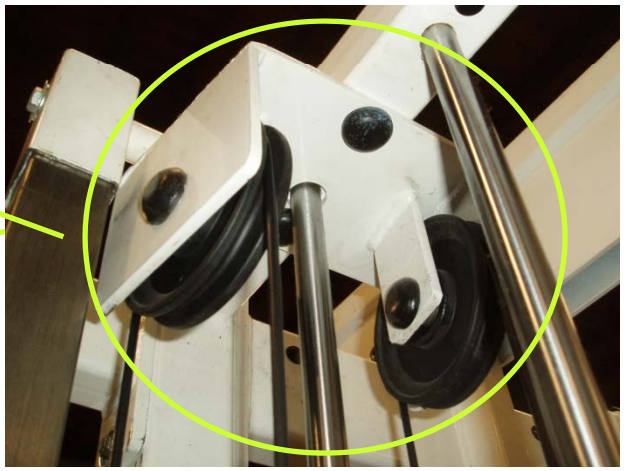
# Universal Cable Weight Machine

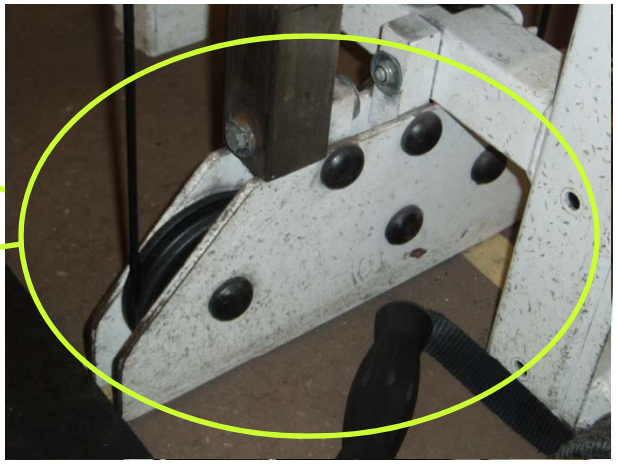
Hamid Abdollahi and Richard Chan

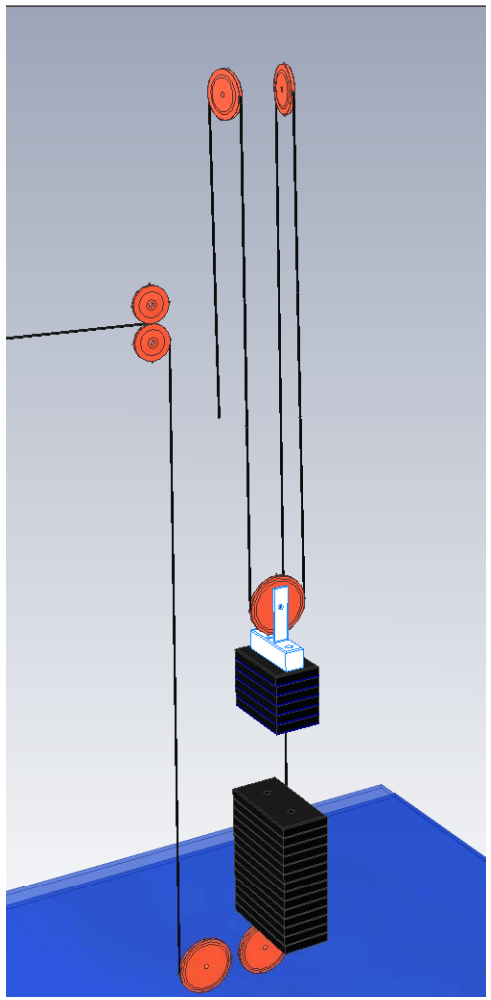


# Model



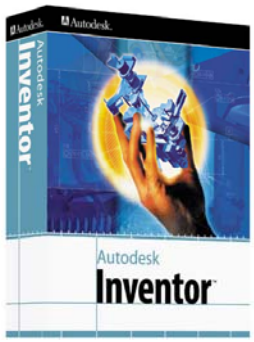






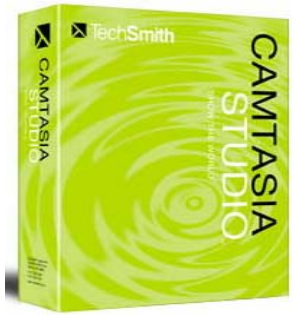
# Process

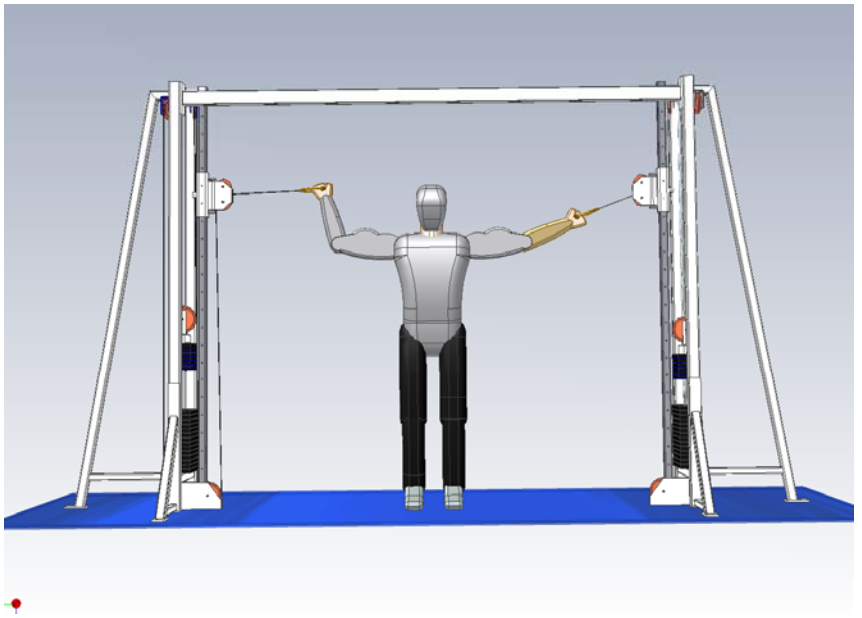
**Modeling and Assembly using Inventor 5.0**

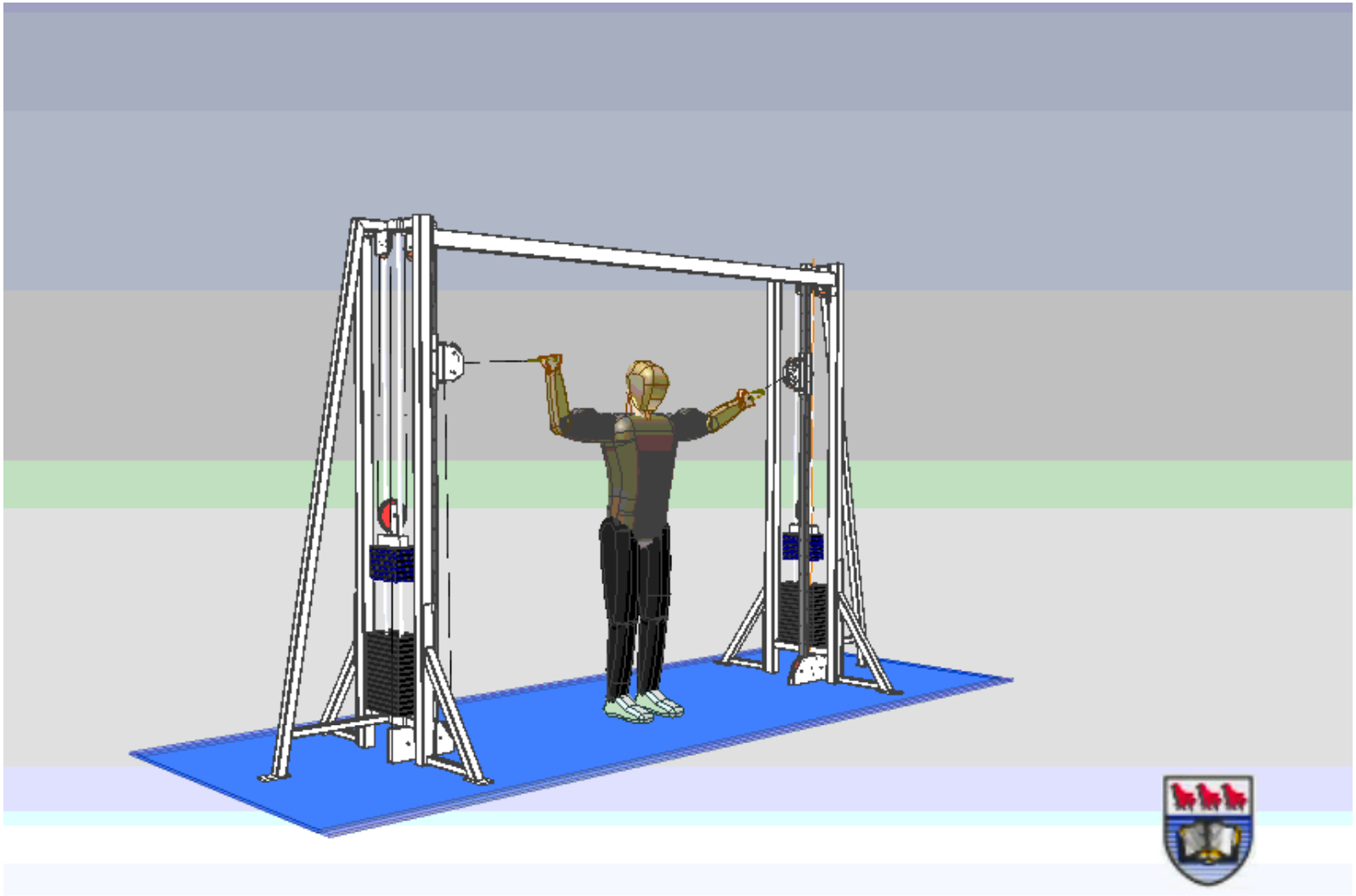



**ANSYS IGES reader converts IGES information into Parasolid data**

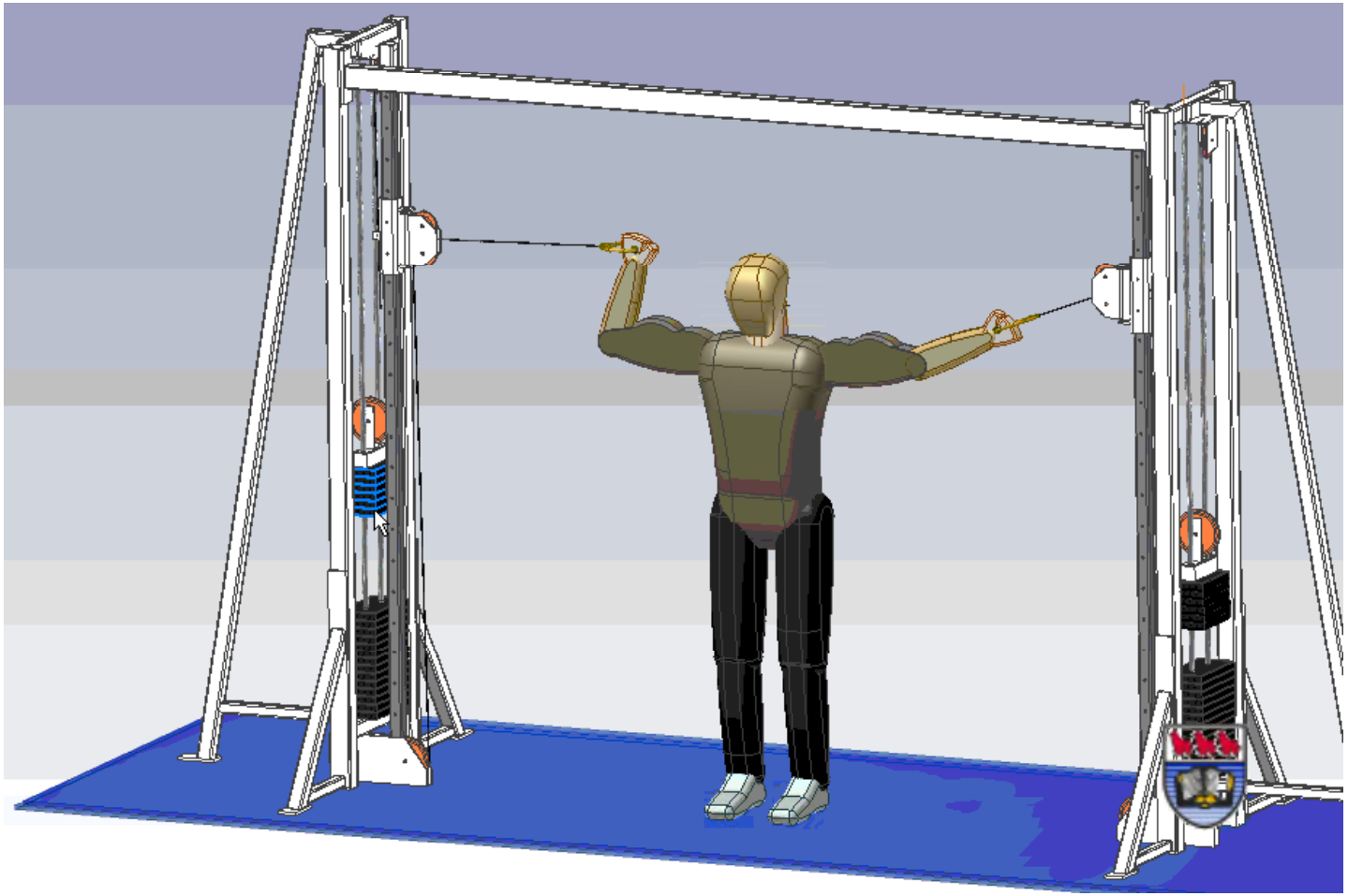
**CAMTASIA: Complete solution for recording, editing and publishing screen videos**





# Animation Simulation



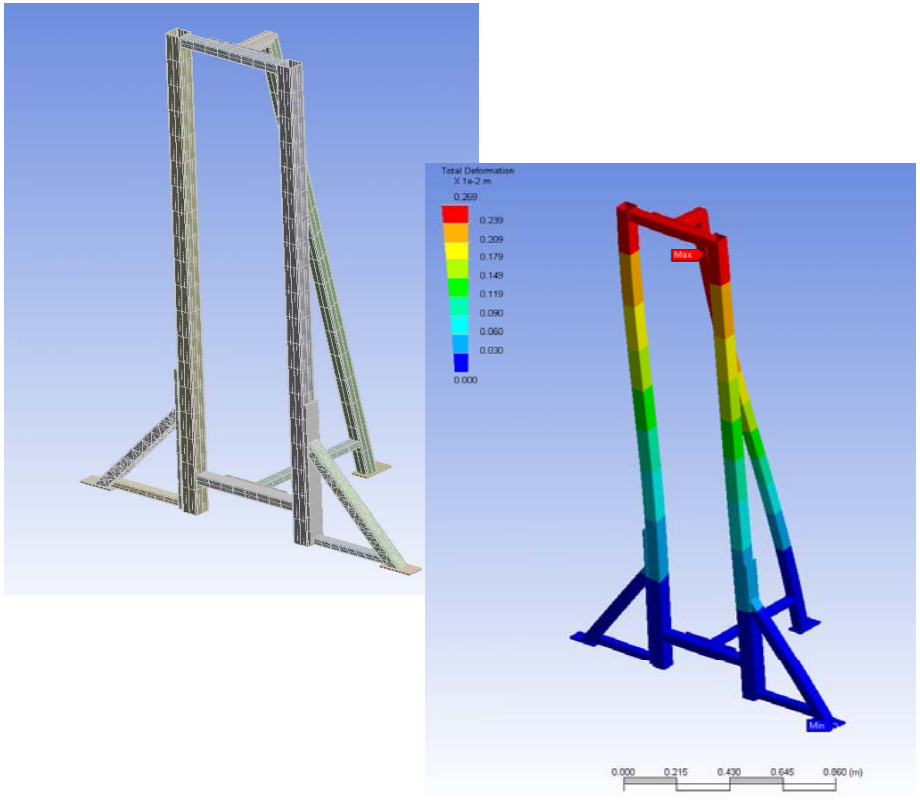
# ANSYS

ANSYS Workbench is a desktop simulation tool

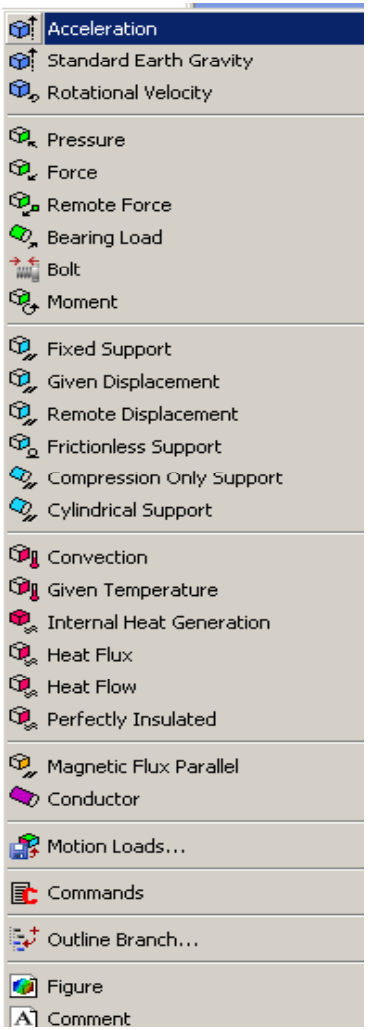
- Improved version from Classical Ansys
- Multiphysics functionality
- Powerful Meshing processor
- Integrated CFD solver

Steps:

- Geometry creation
- Meshing
- Defining BCs
- Solving
- Post processing

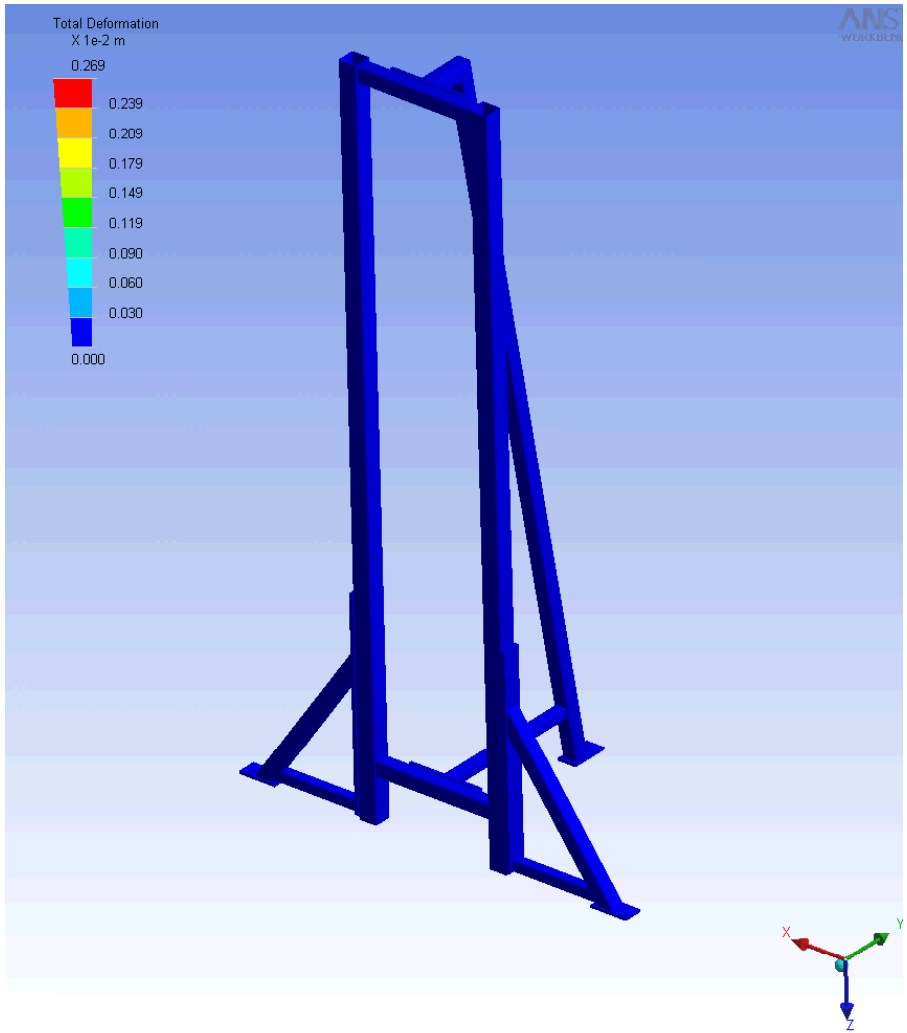


**Boundary Condition**

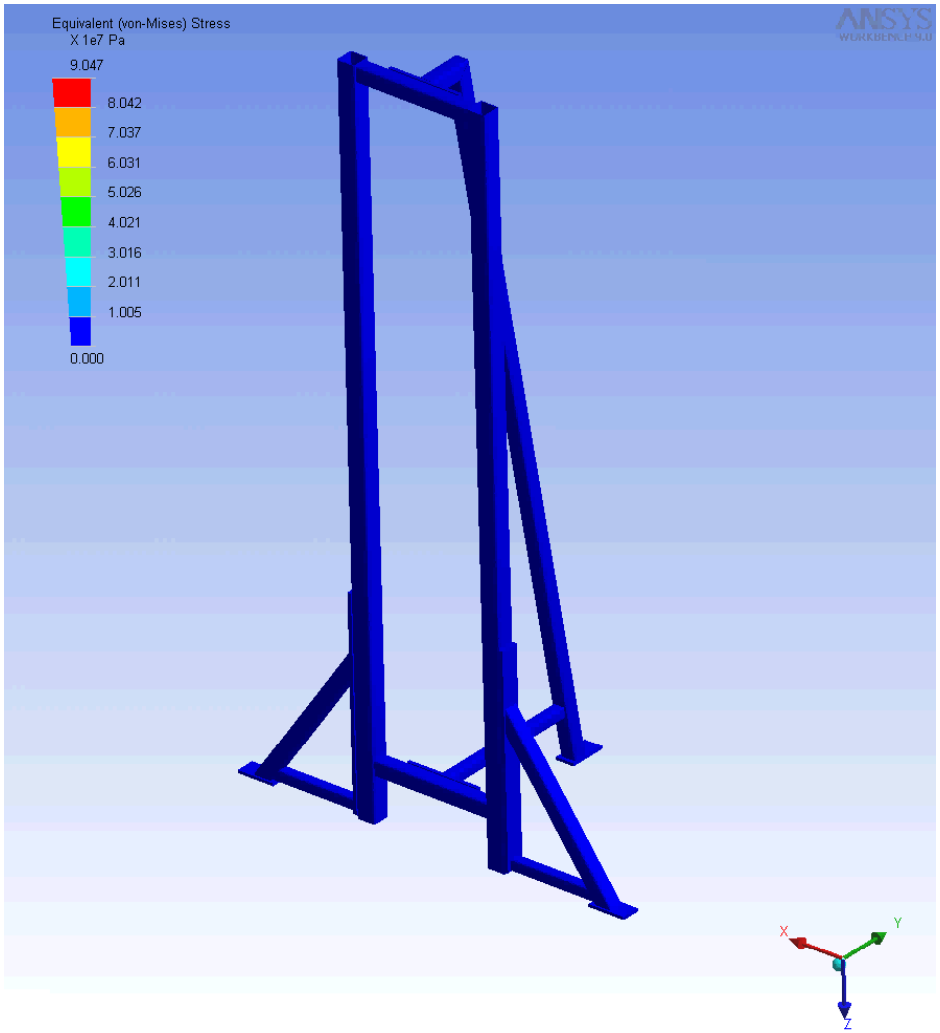


# Ansys Results

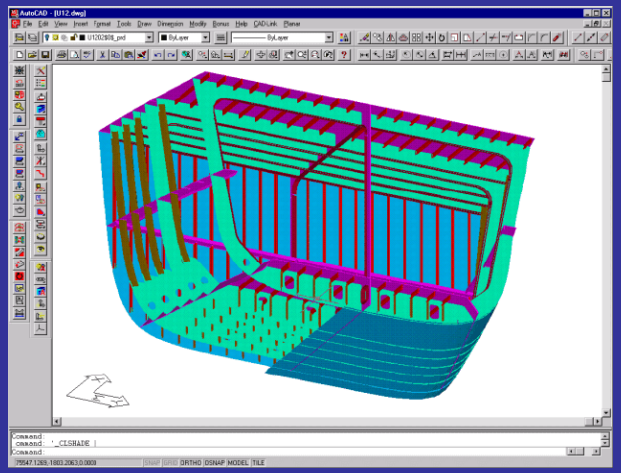
## Deformation

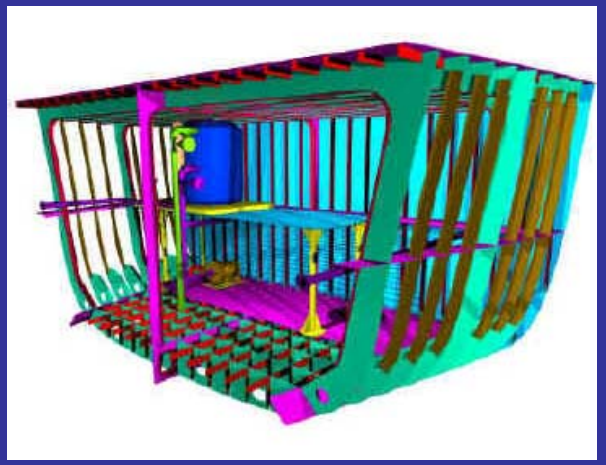


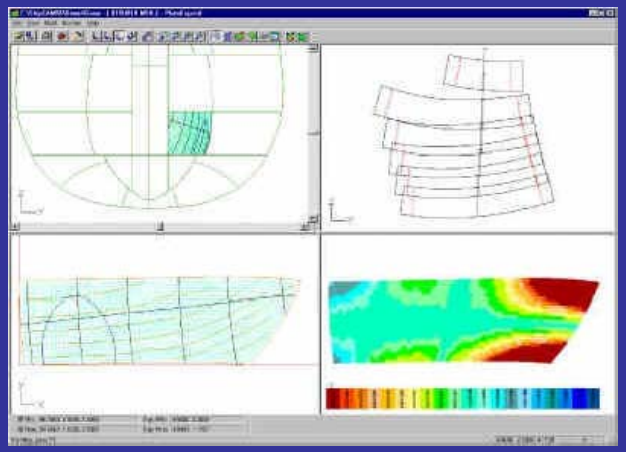

## Stress

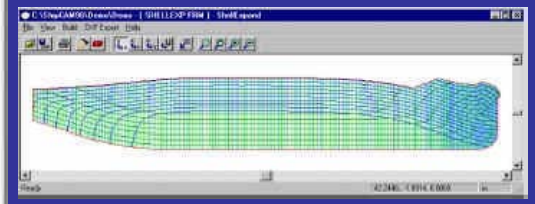


# CAD Applications through Interactive Graphical Programming in AutoCAD









# Interactive Graphics Programming in CAD

***General Requirement***

One option of the final project is to develop an AutoCAD ADS Interactive Graphical Program. You can pick up a subject of your own choice, develop the 3D interactive graphics program within AutoCAD using ADS, and present the results to the class.

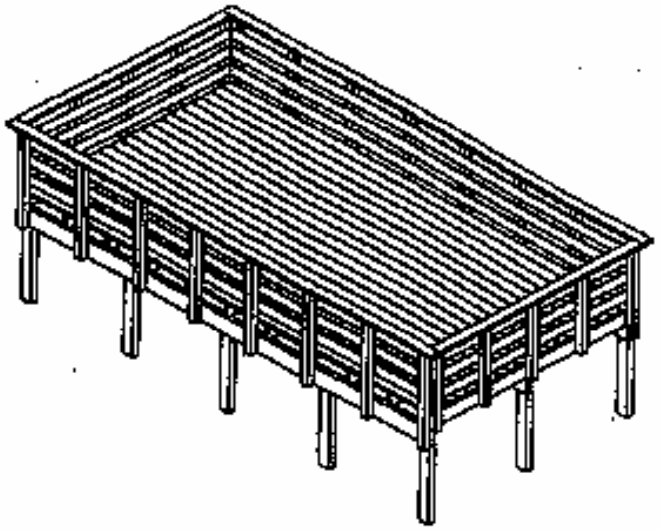
AutoLISP and ARX might be used as alternative programming environments with the permission from the instructor. The project can be of any types within the general scope of engineering applications. However, interactive graphical programming must be an evident part of the project.

***Example Projects***

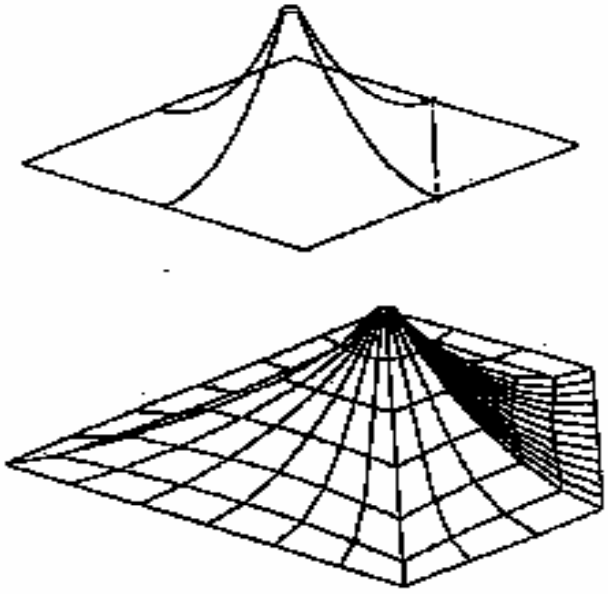
The following is a list of some of the *MECH4101520* projects done by previous students. The graphical outputs of some projects are attached.

# Design Automation

- An Interactive Deck Design and Visualization Program Using AutoCAD and API (3D ADS)
- An Interactive Program for Tent Cutting Pattern Generation Using GKS
- Automated Bolt Design in AutoCAD, Bolt-CAD
- An Interactive Program for Designing A Tension Structure in AutoCAD
- A General Logo Making Program Using AutoCAD and ADS
- An Interactive Logo Design Program in Borland C
- Interactive Camshaft Design and Simulation
- Gear Pair Design and Simulation Using ADS and API
- A Program for Automated Geometric Tolerance Specification and Dimension Chain Database Formation in AutoCAD Environment

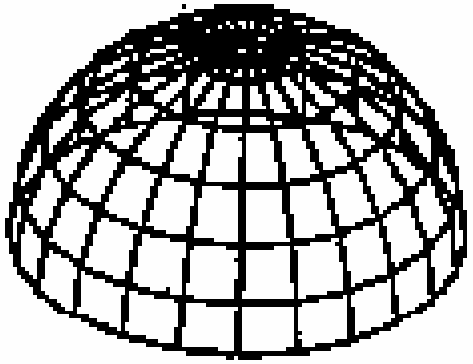


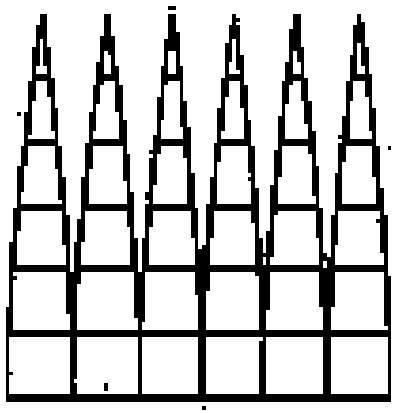
Interactive Deck Design

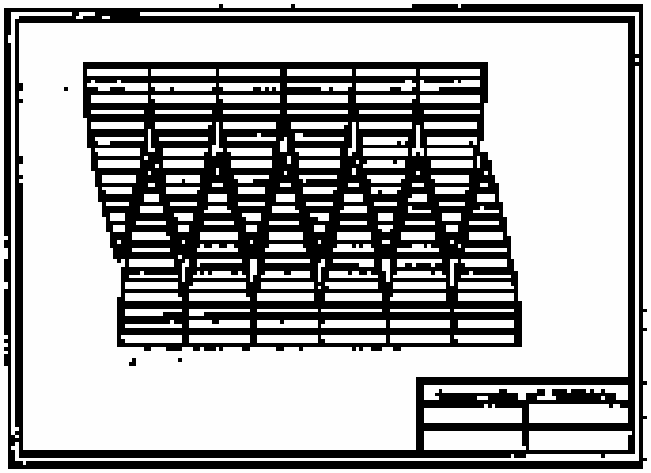


Tension Structure Design

# Tent Cutting Pattern Generation

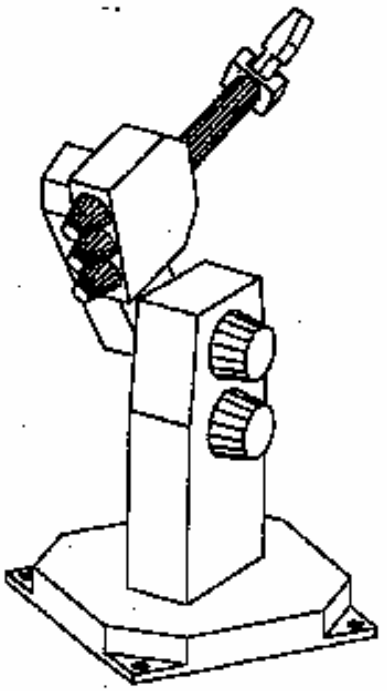




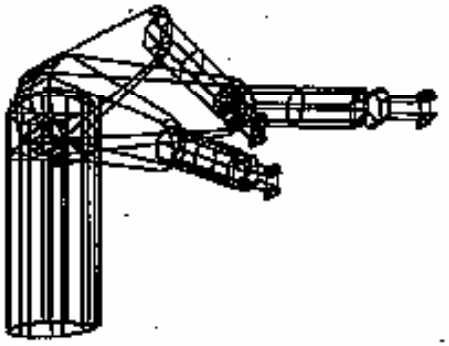


# Computer Animation

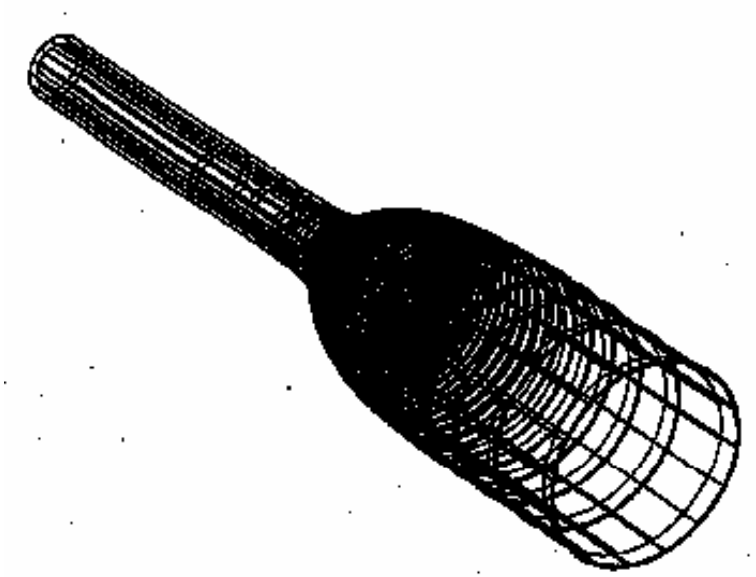
- An Interactive Robot Solid Modeling and Animation Program Using AutoCAD
- Interactive Robot Animation Using PHIGS
- Robot Simulation Using GKS
- Animation of a Four Cylinder Engine
- Visualization of Satellite Orbit
- Interactive Vehicle Control and Simulation
- Animation of Axisymmetric Potential Flow about a Rankine Half-Body of Revolution Fluid How Modeling of a Rankine Half Body and a Doublet



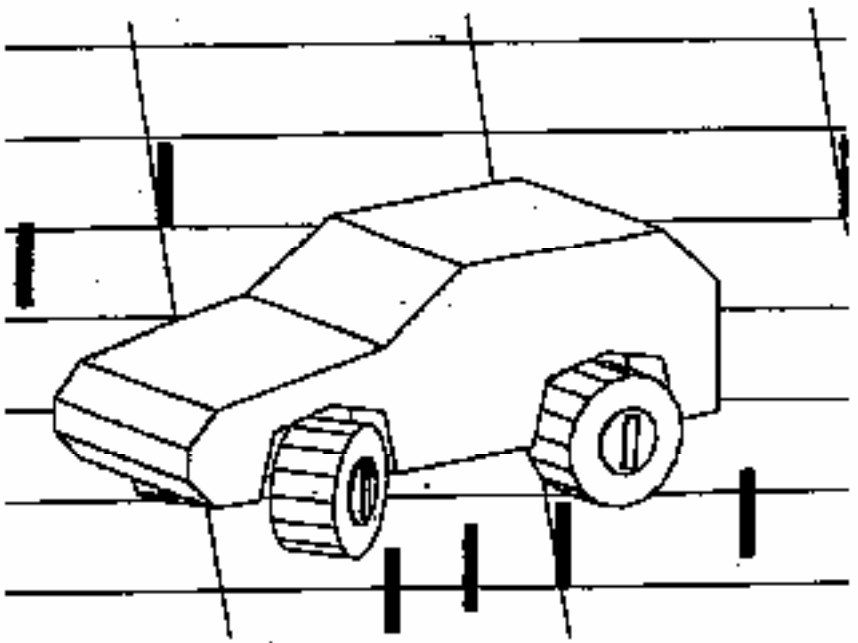
Robot Animation I



Robot Animation II



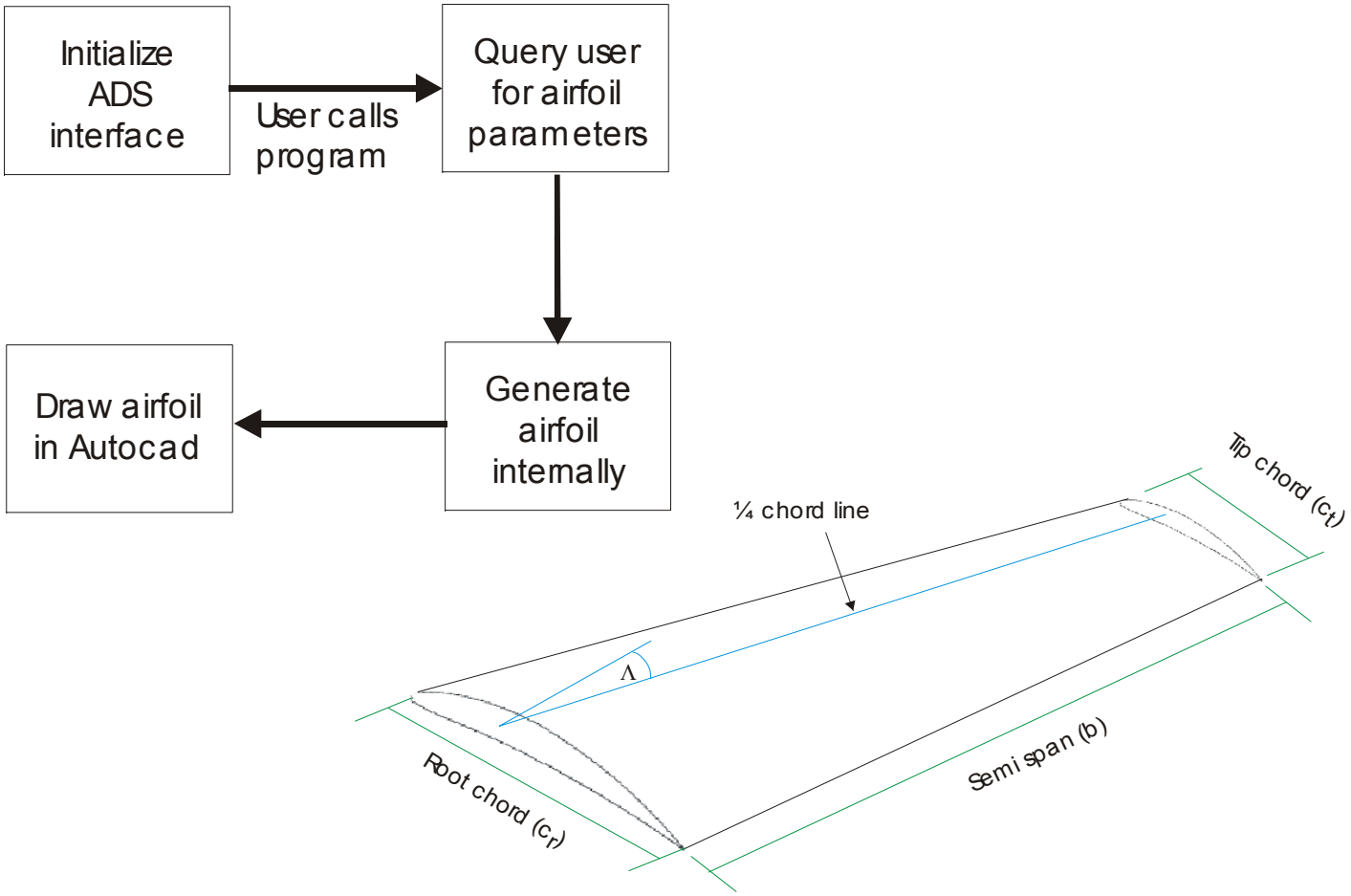
Flow Visualization



Interactive Vehicle Control and Simulation

# Airfoil Generation Using AutoCAD™ ADS Programming

Gonçalo Pedro



# Airfoil Generation Using AutoCAD™

Gonçalo Pedro