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16.810
Vehicle Design Summit Team 1
Ingress/Egress

Design System

Objective :

Multi-Objective problem

- Quantifiable Criteria
  - Cost ($)
  - Visibility (sq. m)
  - Egress Ingress (sec)
- Unquantifiable Criteria
  - Ease of Manufacturability
  - Aesthetics

Design System

Constrains:

Shape of existing Shell (m)

Weight (Kg)

Cost ($)

Design Variables:

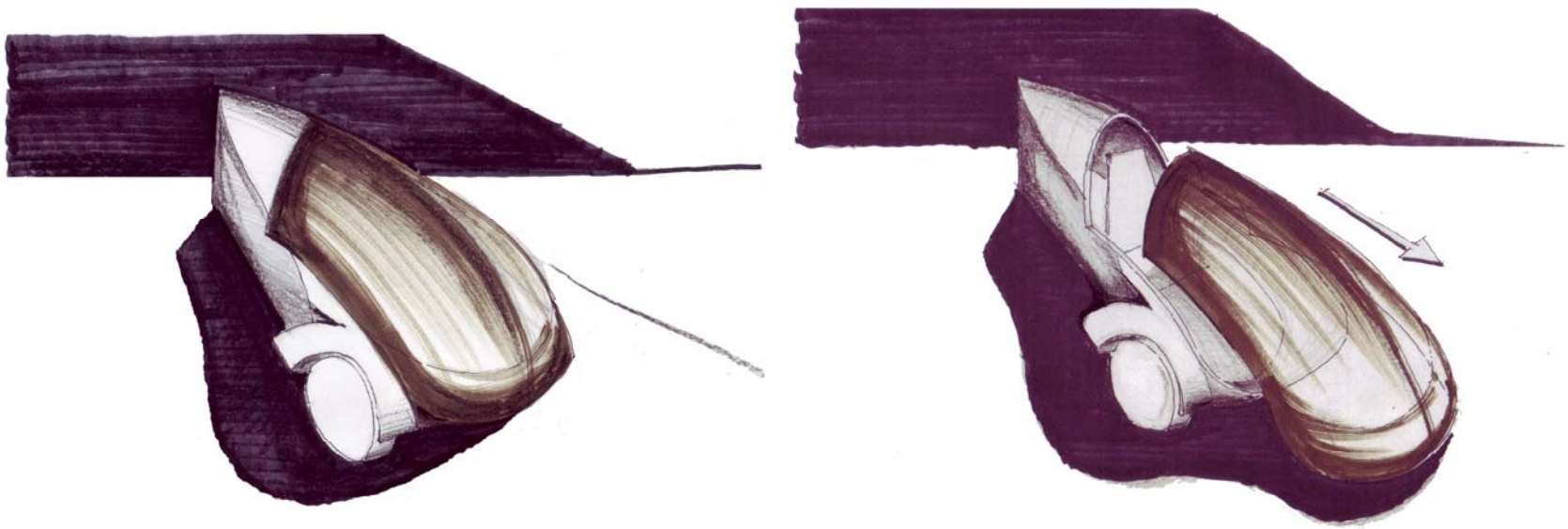
Geometry (Number and positions of Joints)

Material (Transparency/Opaque)

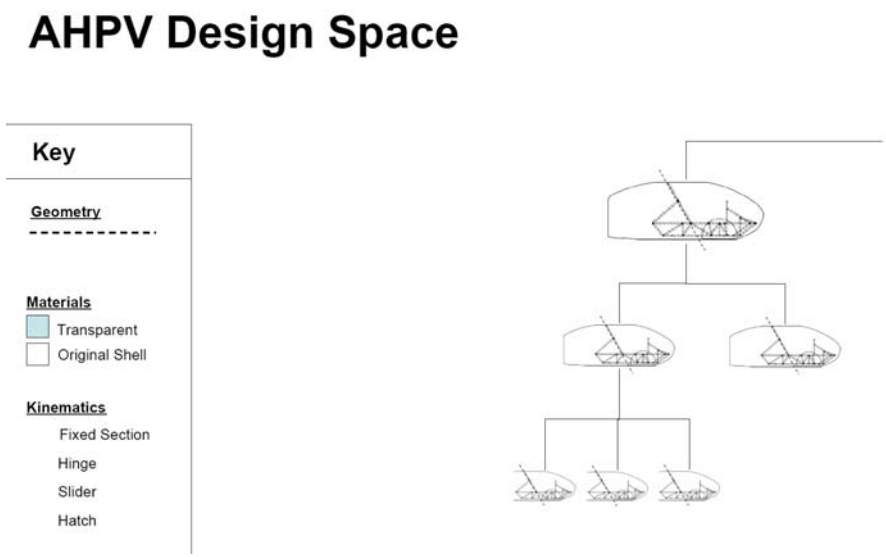
Kinematics (Hinge, Slider..etc)

Design System

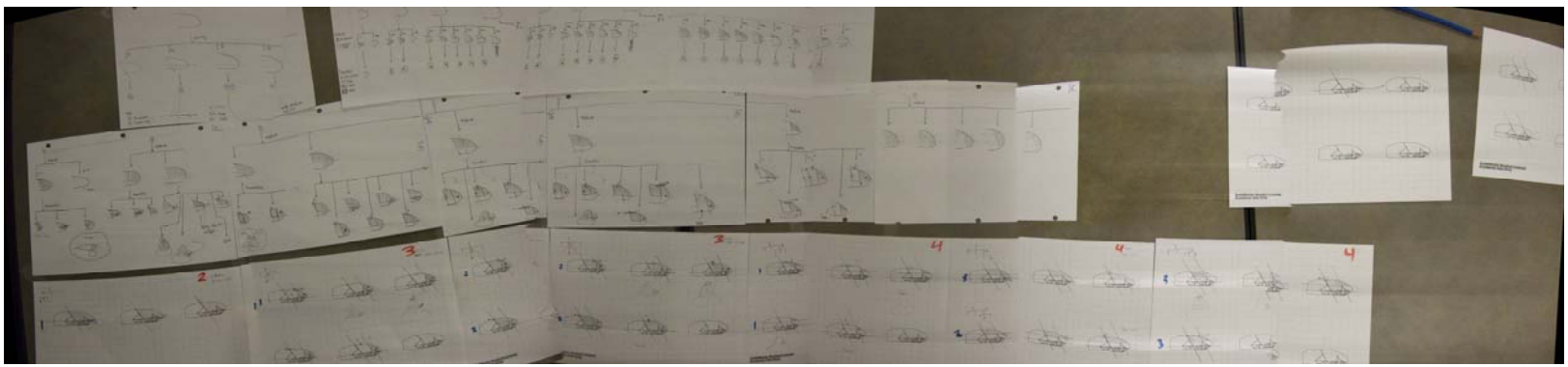
Concept



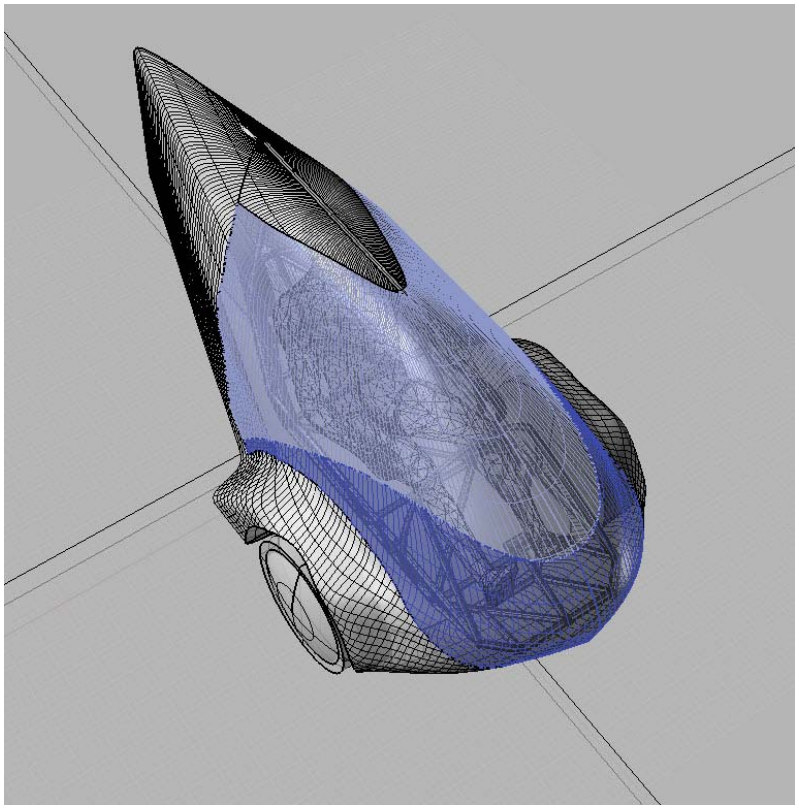
Design System

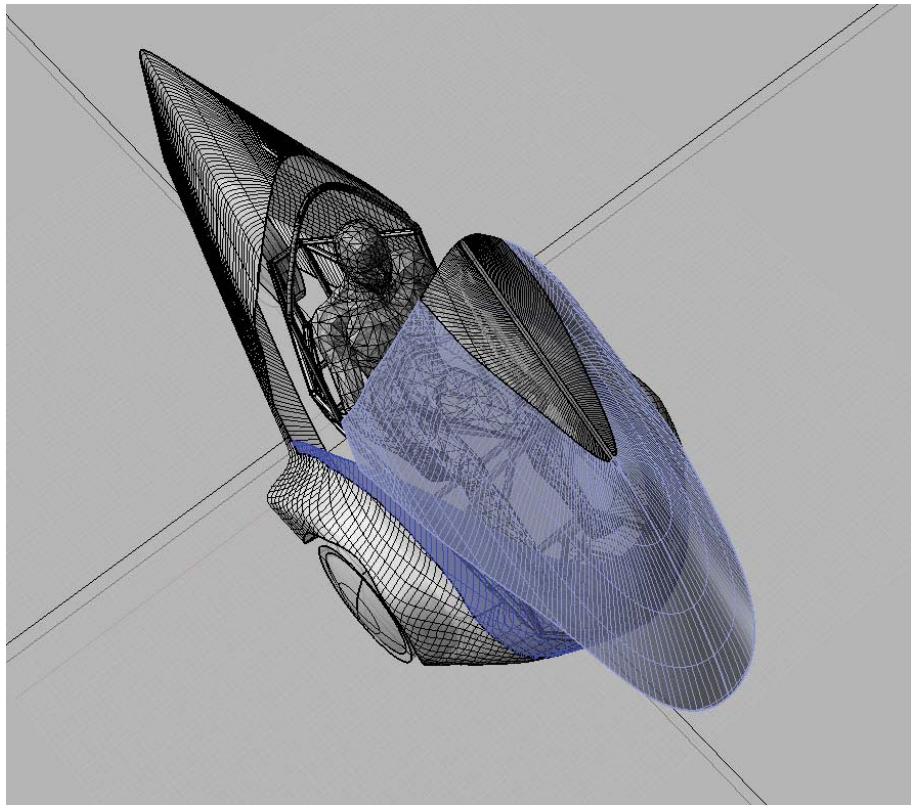


Design Solution Tree:



Design System





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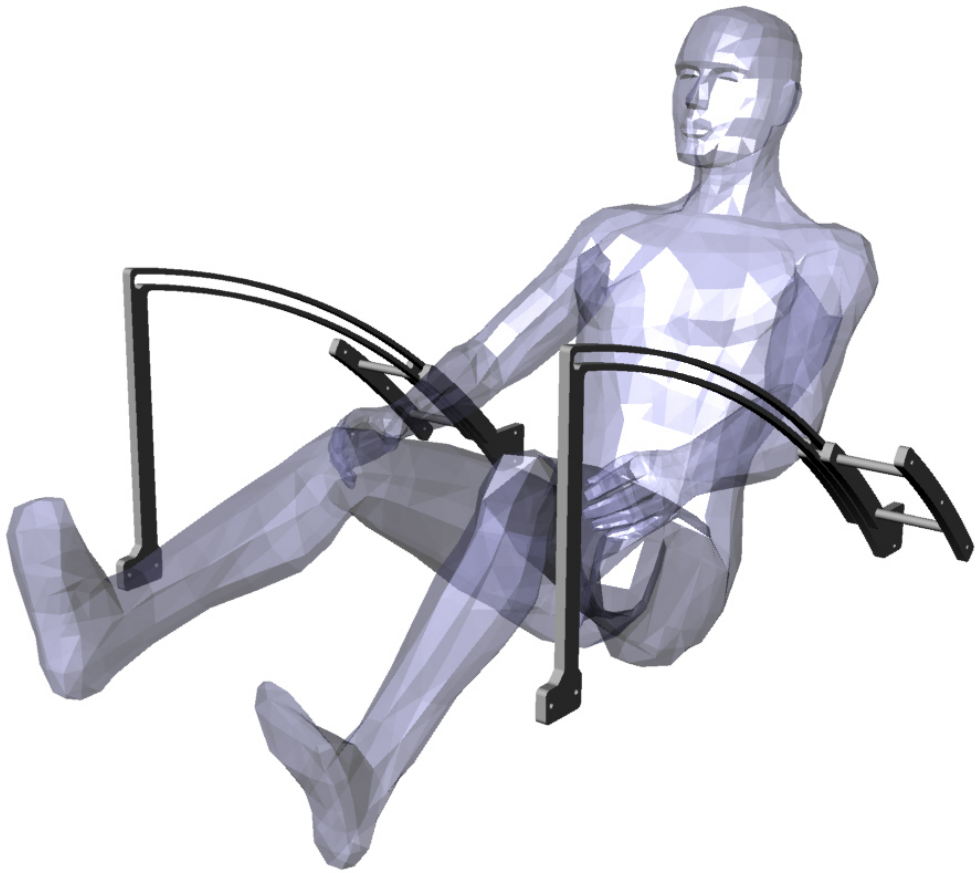

Design System | Analysis and Optimization | Fabrication

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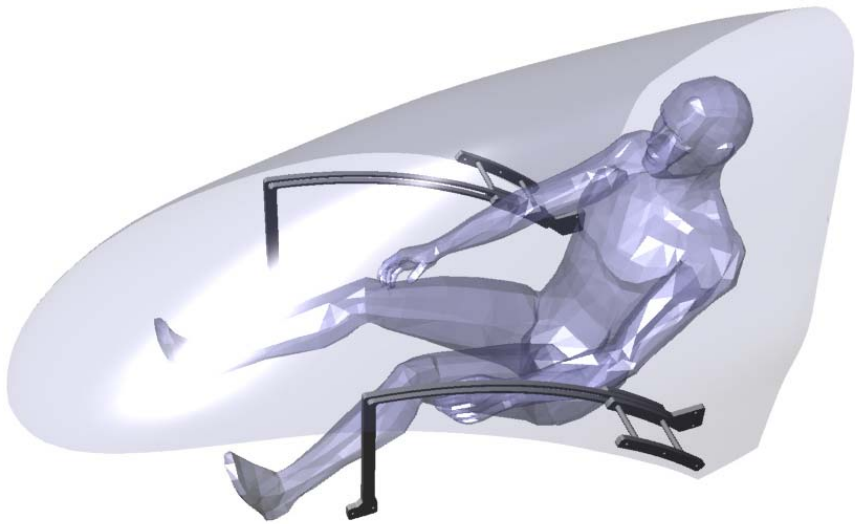

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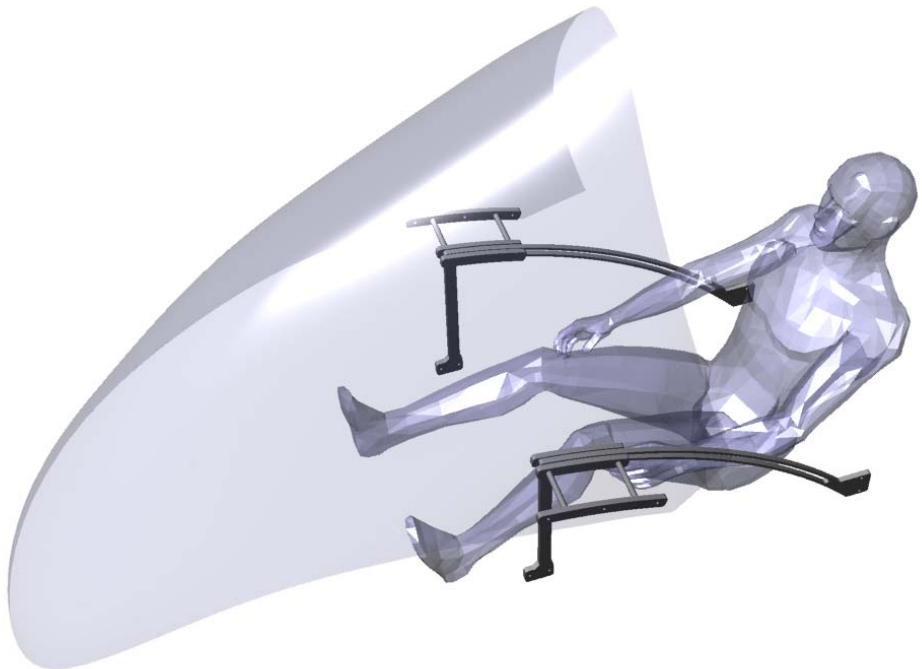
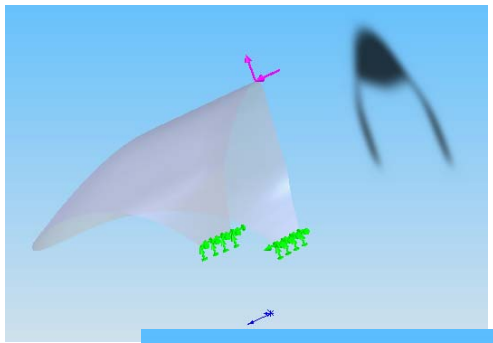
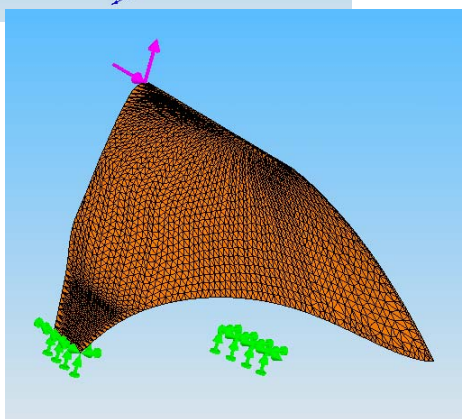


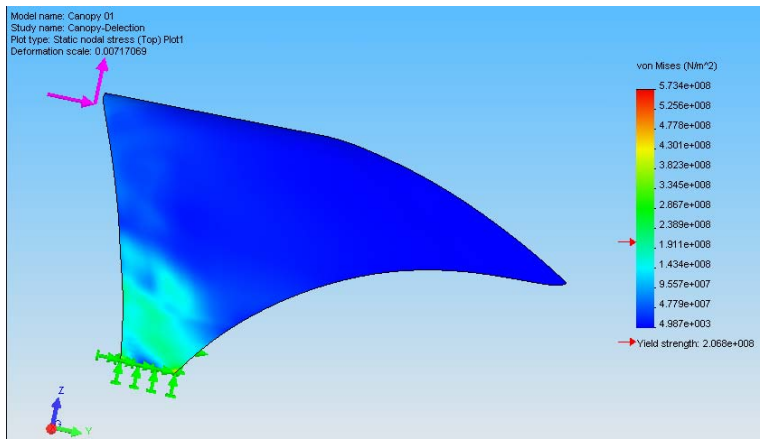
Analysis and Optimization

Test 1 – ‘Hard Opening’

- Highest dynamic load when someone opens canopy and pins hit end of rails
- Force of 2g * mass of canopy ~ 11 pounds
- Restraints of fixed edges roughly equivalent to final design
- Stress concentrated around joint
- Displacements acceptable



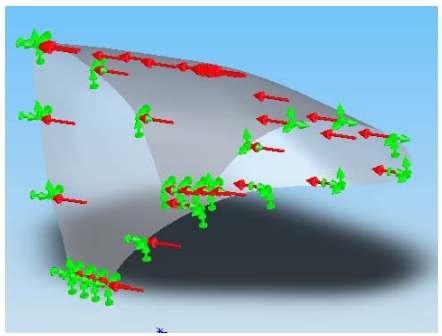


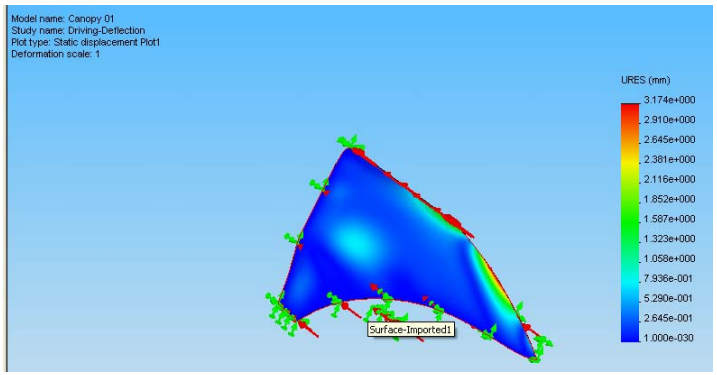


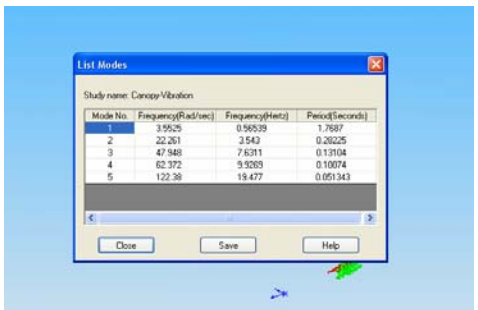
Analysis and Optimization

Test 2 – ‘Driving Pressure Force’

- Pressure on canopy while driving 60mph ~550N/m2
- Restraints of fixed edges based on magnetic strips
- Natural modes at low freq – first mode at 0.5Hz
- Canopy displacement ~3mm max at 60mph







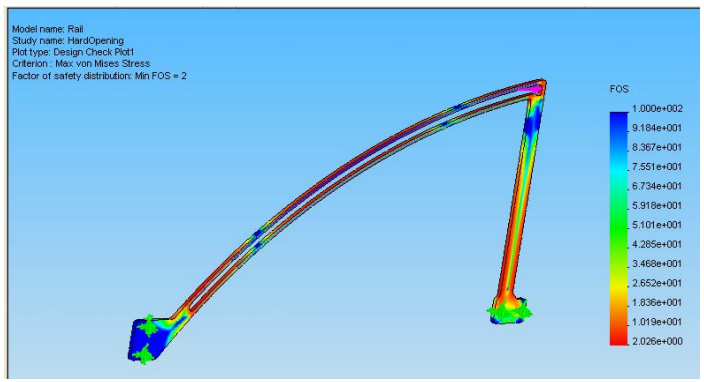
Analysis and Optimization

Test 3 – ‘Rail Optimization’

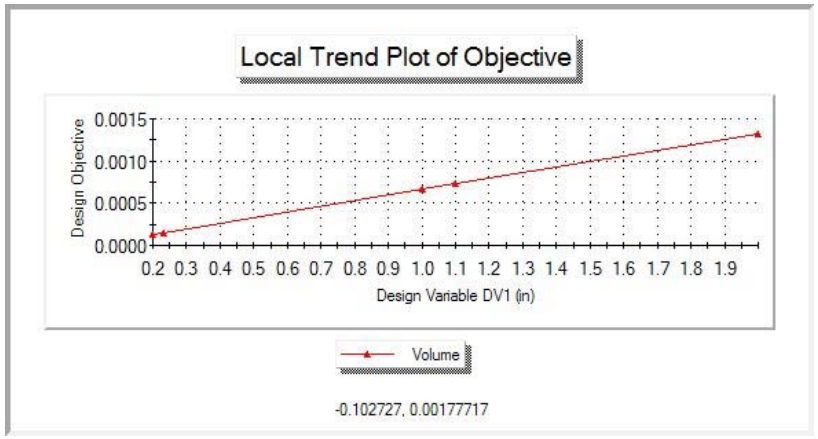
- Varied thickness of rail to find optimum size to avoid yield at min mass
- Force of 40N side load – someone leaning on canopy

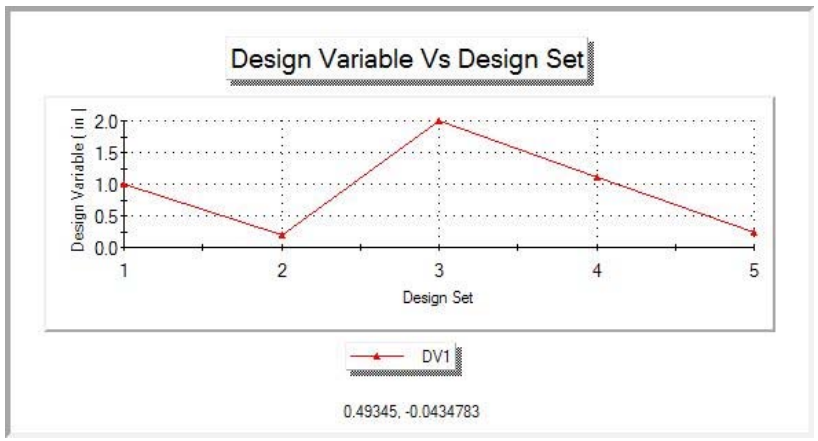
Thickness (inches)	FoS
1	8.9
0.5	2.7
0.25	2.0

- We tried to use a thicker sandwich material – delaminated
- Now using 0.25 inch aluminium, slightly different rail design



Analysis and Optimization





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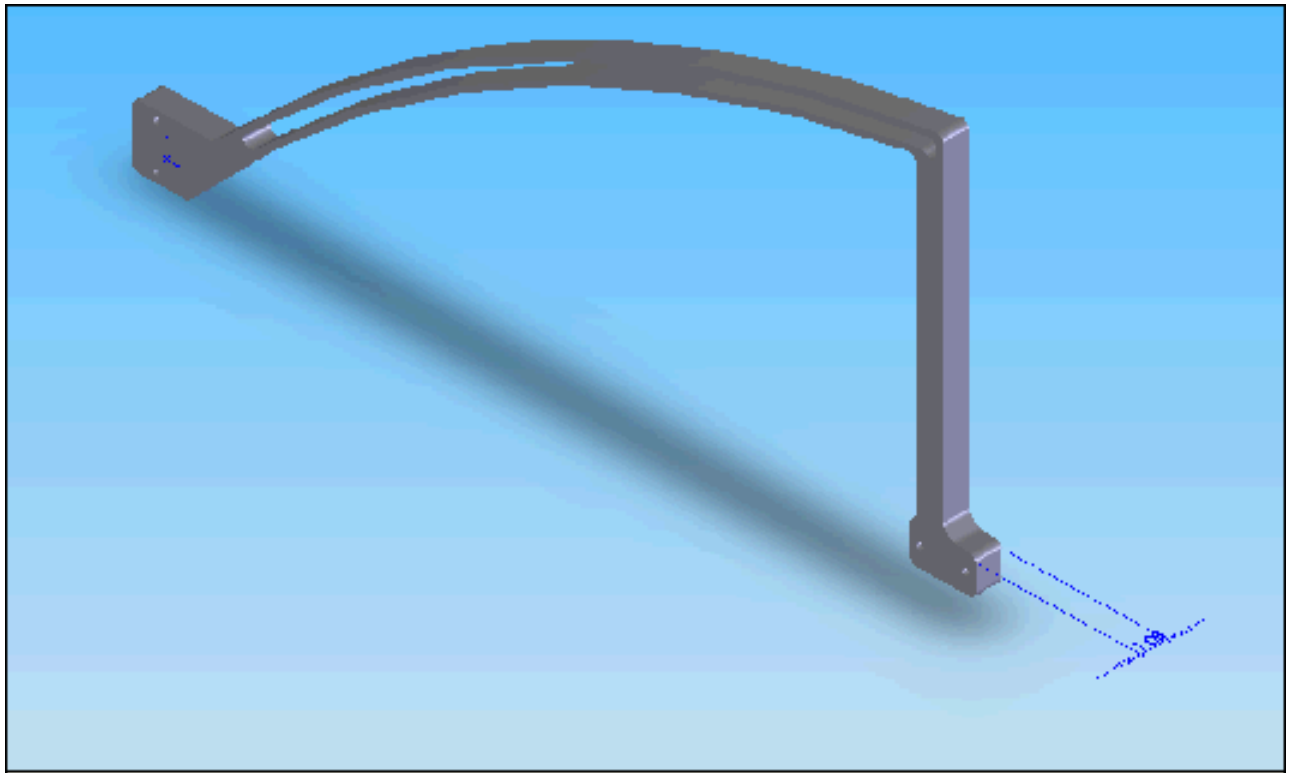


Optimization 01.avi

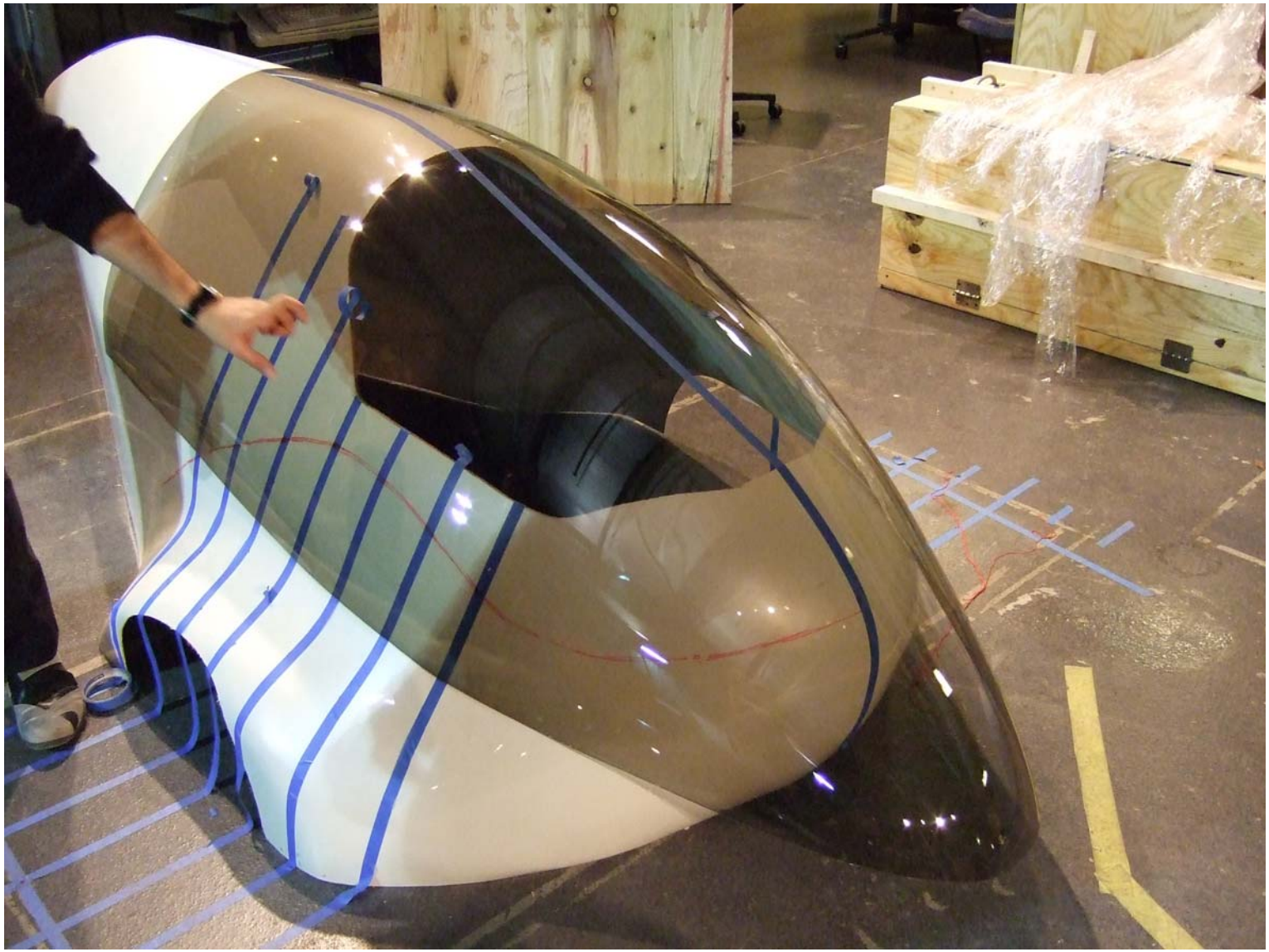
Fabrication

Canopy – Ordered from professional manufacturer in Florida
Handles – Aluminium tube welded onto waterjetted guide rails
Rails – Aluminium, waterjet, attached by U-Clamp
Attachment – Adhesive backed magnetic strip

Fabrication

Fabrication

Fabrication



Fabrication

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Fabrication

What's Next…?

- Handles welded to rails
- Attach rail to chassis
- Sand shell and canopy
- Reinforcing canopy
- Attaching canopy to reinforcement
- Attaching reinforced canopy to handles
- Test mechanism, fix problems!
- Stick on magnetic strips so canopy stays shut
- Drive AHPV to Solidworks World
- Sleep…

Cost Estimation

16.810 Cost Estimation Sheet
Team V1

Section			Rate	Qty	Cost
I. Design and Engineering					
	Labor Rate for Each Designer		$75	10	$750
	Labor Rate for Each CAD/CAM Workstation		$40	5	$200
II. Materials Cost					
	Aluminium Sheet	1/16" thick	$40	1	$40
		1/4" thick	$80	1	$80
	Aluminium Tube		$20	1	$20
	Miscellaneous Components		$60	1	$60
III. Canopy					
	Canopy		$350	1	$350
	Shipping		$200	1	$200
IV. Waterjet Manufacturing					
	Labor Rate		$55	3	$165
	Machine Use		$75	3	$225
V. Other Manufacturing					
	Shell and Canopy Cutting - Labor		$40	4	$160
	Miscellaneous Labor		$30	8	$240
VI. Assembly and Testing					
	Assembly Labor		$30	3	$90
				TOTAL	$2,580

Lessons Learned

- Set realistic goals
- Better use of FEA for optimization – our rail could have been designed to be lighter
- Start manufacturing early, maybe finish on time
- Have the right tools
- Make the right decisions at the right time

To be continued…