

Making a Nosecone

Joe Shields

But first...

My projects that I won't talk about!



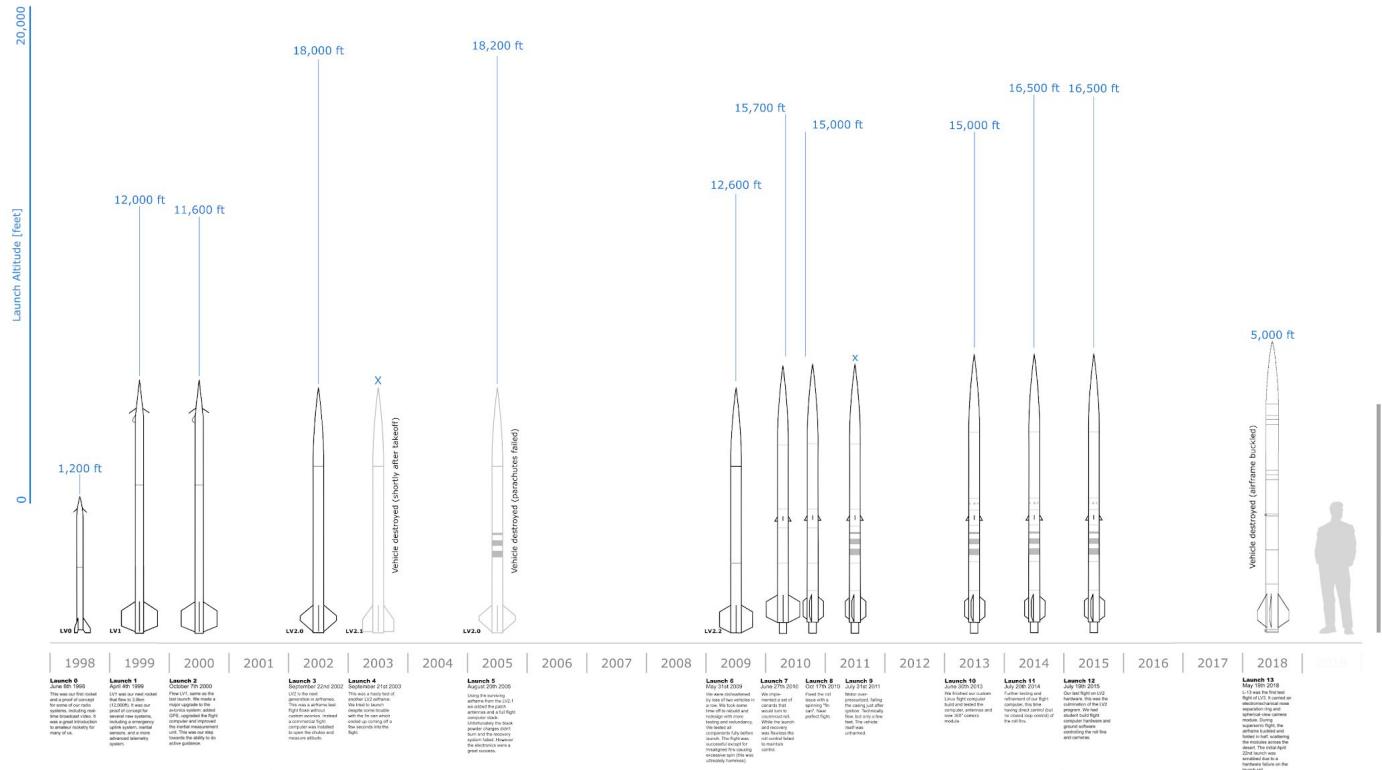
github.com/psas
github.com/oresat

PSAS!

Portland State Aerospace Society

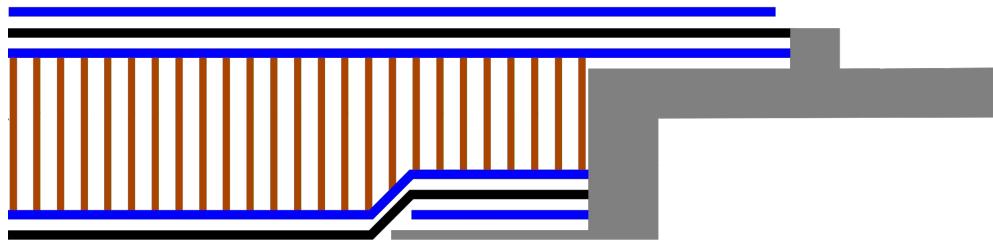


Launch History

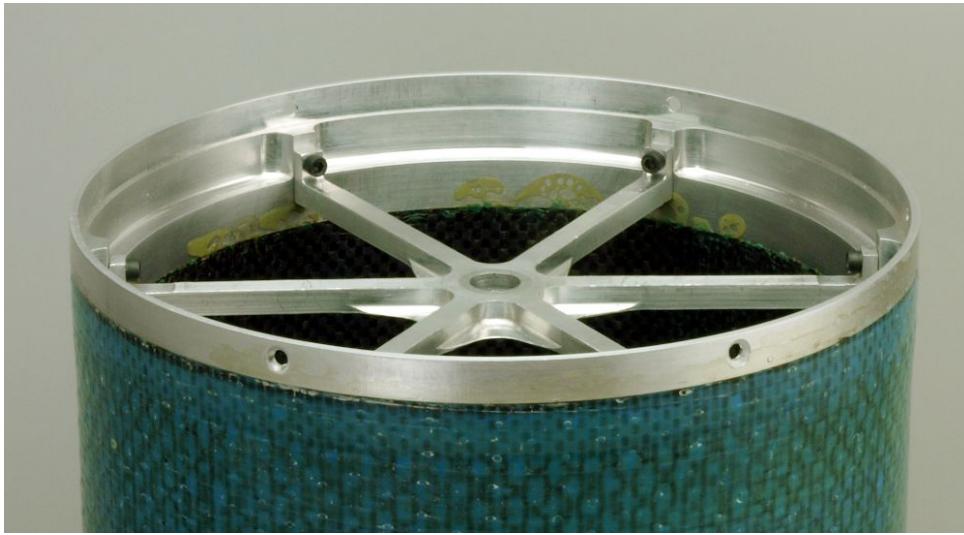


Group History!

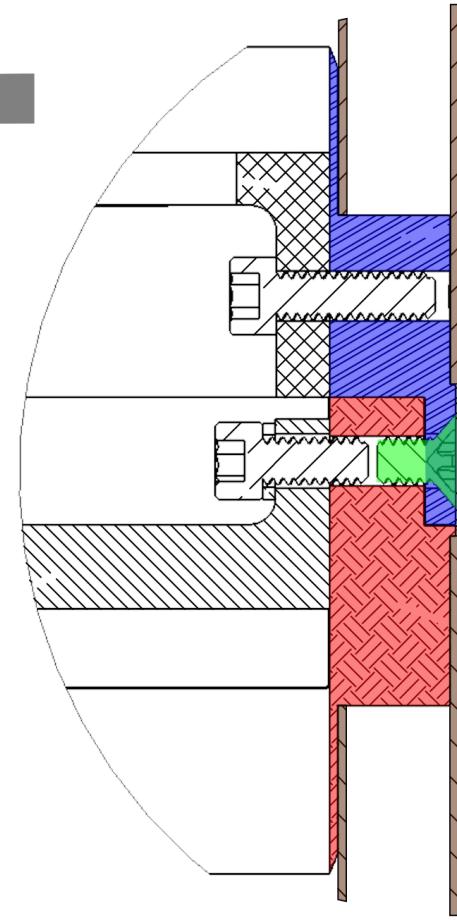
outside

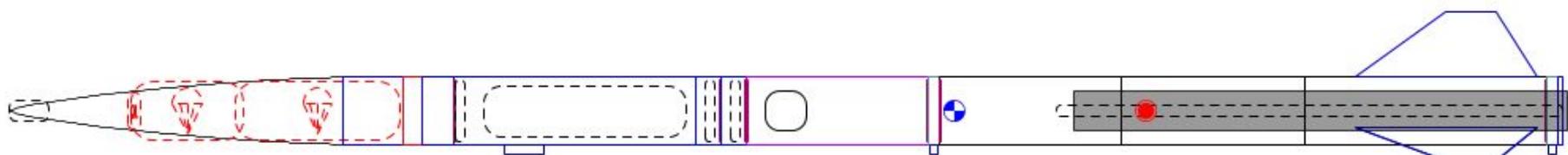


inside



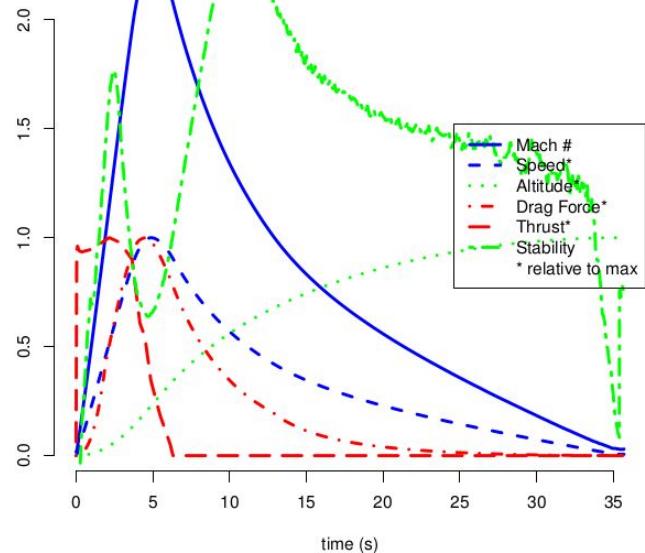
Inherited Designs!

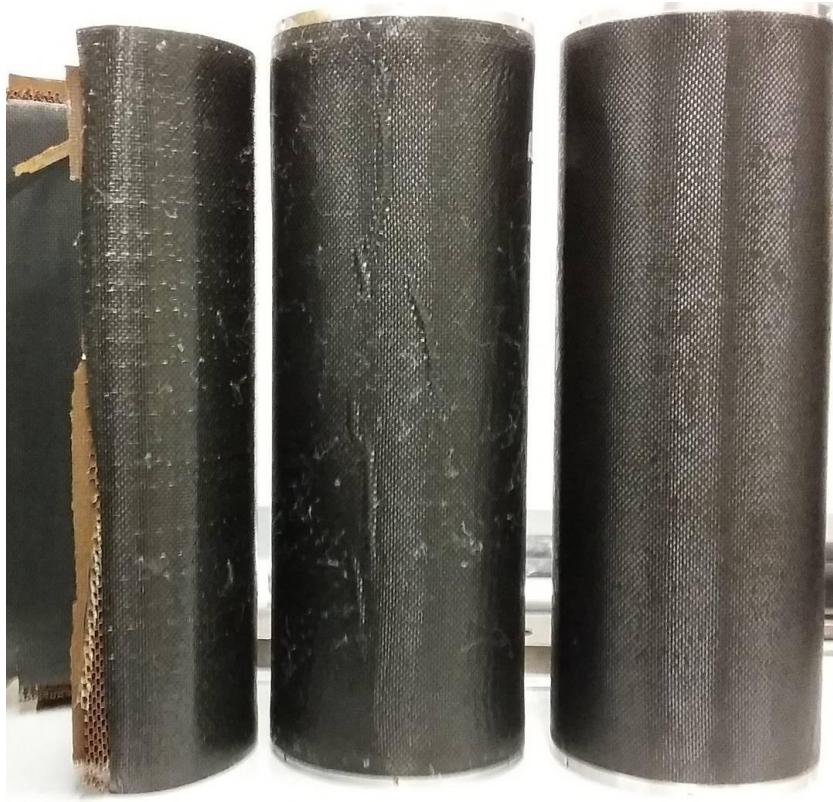
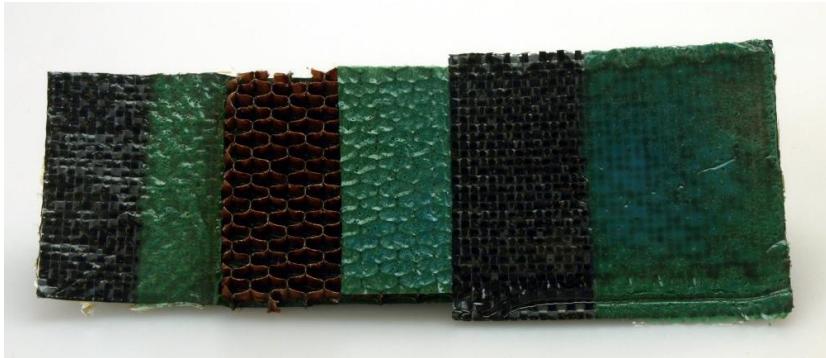




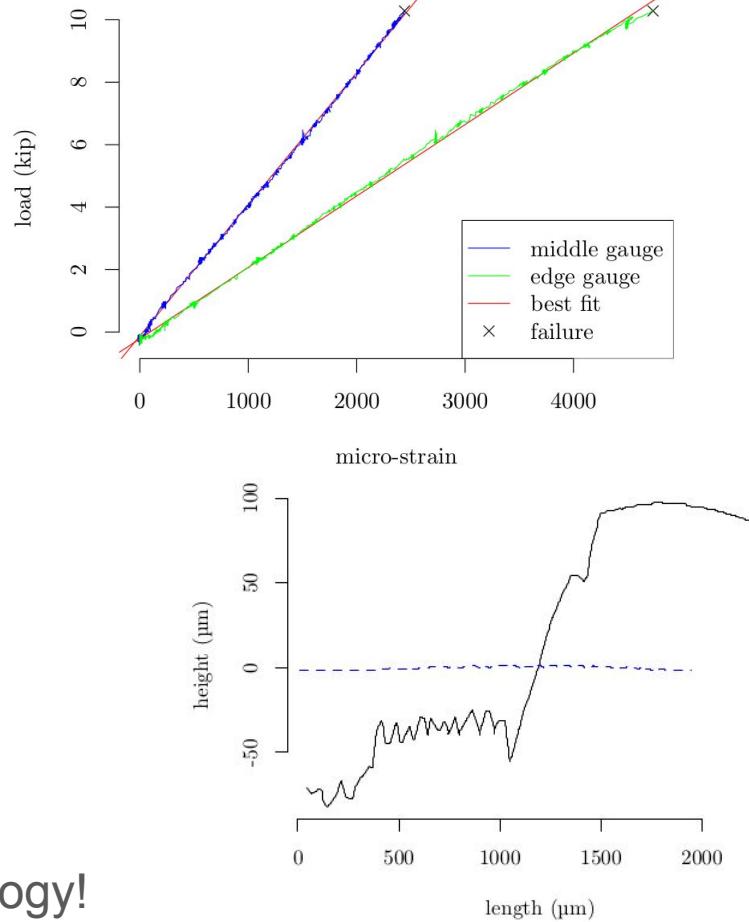
Design and Simulation!

Important Flight Variables
for O_minimal_70degSweptTruncTrap

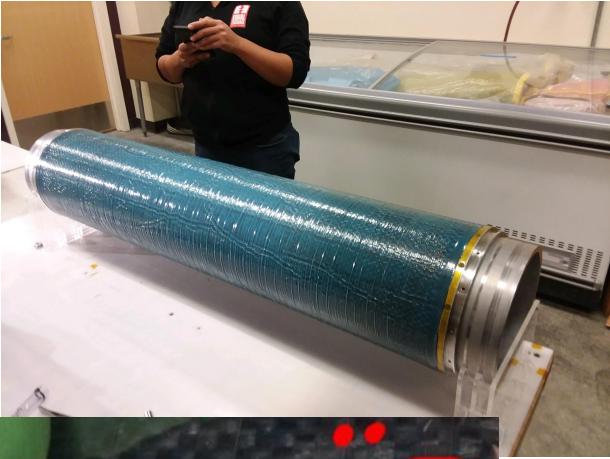




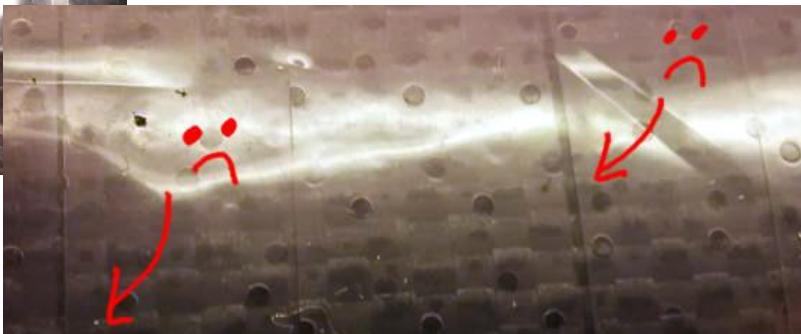
Composite Layer Design!



Testing and Metrology!



Layup Design!



```

* 9d56f8f Joedang (N) 2018-04-25 14:17:08 -0700
  draft of a rail button hard point

* 519010c Joedang (N) 2018-04-25 12:33:52 -0700
  Merge branch 'master' into dev_joe

* 7a864e0 Joedang (N) 2018-04-25 12:23:34 -0700
  Merge branch 'master' of github.com:psas/lv3.0-airframe

* c2f6d50 Joedang (N) 2018-04-24 14:39:36 -0700 (tag: L-13_April)
  refined OR model from scrubbed April L-13 launch

* 8af208f Joedang (N) 2018-04-25 12:32:29 -0700
  Merge branch 'dev_joe' of github.com:psas/lv3.0-airframe into dev_joe

* f3445b8 Joedang (N) 2018-04-21 03:34:29 -0700
  final versions of foam templates

* 9fdd9c2 Joedang (N) 2018-04-21 02:48:05 -0700
  crazy-huge ballast for N1975 motorb

* 6b6bb56 Joedang (N) 2018-04-18 11:16:41 -0700
  Merge branch 'master' into dev_joe

* f8d4128 Joedang (N) 2018-04-09 14:25:54 -0700
  Merge branch 'master' of github.com:psas/lv3.0-airframe

* c504e2f Joedang (N) 2018-04-09 14:25:01 -0700
  alternative motors for L-13

* 6d3cf54 Joedang (N) 2018-04-17 17:14:50 -0700
  finalized templates; prepared laser file

```

① 10 Open ✓ 26 Closed		Author ▾	Labels ▾	Pro
① Deepen the spring pin holes on the ends of the rails	CAD bug	#38	opened on Dec 16, 2018 by Joedang	
① Card notches don't line up with backplane screws	3-Just smoldering CAD bug	#37	opened on Dec 2, 2018 by Joedang	
① Update End Cards with new card design	3-Just smoldering CAD	#36	opened on Oct 7, 2018 by andrewgreenberg	
① Research adhesives and epoxies		#35	opened on Aug 10, 2018 by Joedang	
① First CAD for End Cards and End Caps		#34	opened on Aug 5, 2018 by andrewgreenberg	
① Revise Frame Drawings	CAD bug	#31	opened on Mar 9, 2018 by Joedang	
① Fix solar connector and verify PCB against DXF	CAD	#26	opened on Feb 13, 2018 by andrewgreenberg	
① Rename all the things	enhancement	#25	opened on Feb 12, 2018 by Joedang	0 of 10
① Choose/Design Inhibit Switches	CAD COTS_parts	#11	opened on Jun 3, 2017 by Joedang	
① Part Identification	CAD COTS_parts help wanted question	#3	opened on Mar 29, 2017 by Joedang	

Version Control!

Step d - drogue line is being pulled out

Assumptions

- no drag force considered for the payload for horizon. and vert. decent until drogue is fully unfurled
- just accounting for the 50' shock chord, therefore not including the lines coming directly from the 'chute
- the drogue pulls out at an angle due to a small amount of drag on the drogue slowing it down horizontally

Variables

- P = speed of plane
- vd = velocity after 50' shock chord is drawn out
- g = acceleration due to gravity
- Lvd = vertical distance gained from step d
- Lhd = horizontal distance gained from step d
- td = time for step d to be complete
- dl = drogue line length the 50' chord as the hypotenuse

$$50 = \sqrt{(x^2) + (y^2)}$$

vertical length gained from step d

$$Lvd = vc * td + 0.5 * g * (td^2)$$

horizontal length gained from step d

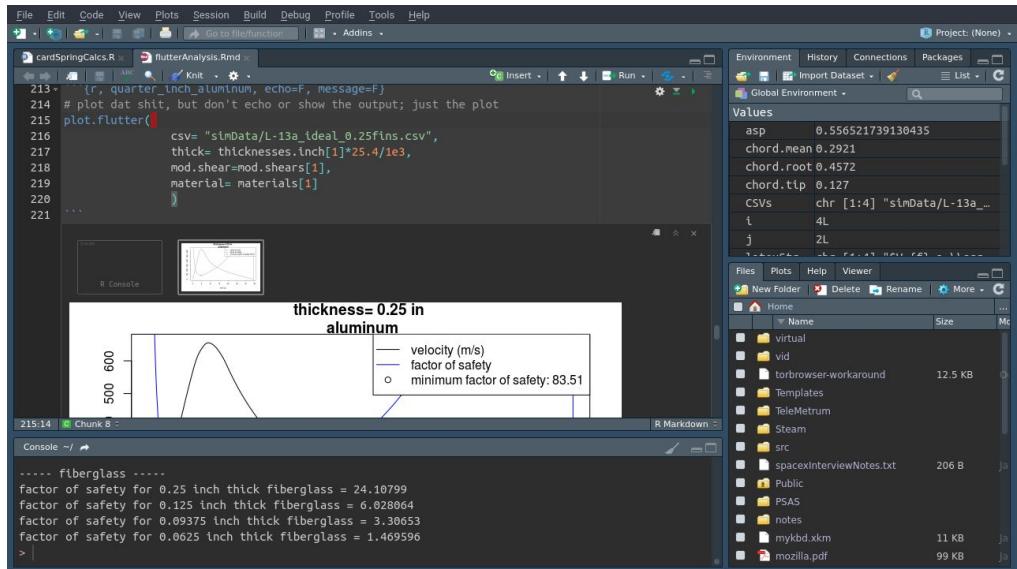
$$Lhd = P * td$$

calculate td by replacing x and y in the above equation

$$dL^2 = (P * td)^2 + (vc * td + g * td^2)^2$$

calculations

```
In [8]: Ps, vds, gs, Lvds, Lhds, tds, vcs = sympy.symbols('Ps vds gs Lvds Lhds tds vcs')
Dparams= {Ps: P, gs: g, vcs: vc}
tdEqn= (Ps*tds)**2 + (vcs*tds + 0.5*g*tds**2)**2 - dl**2
tdSolns= sympy.solve(tdEqn.subs(Dparams))
print('possible solutions:', tdSolns)
for soln in [complex(x) for x in tdSolns]:
    if (soln.imag != 0) or (soln.real <= 0):
        pass
    else:
        print(soln, 'seems fine')
        td= soln.real
```



Jupyter and R Notebooks!

Lab Equipment

Here is the list of equipment and its current status. Sometimes machines break. When they do, we'll be sure to make a note of it here. Click on a machine to jump to its documentation.

Circuit Board Manufacturing



3D Printers



Machining Equipment



Laser Cutters



Websites!



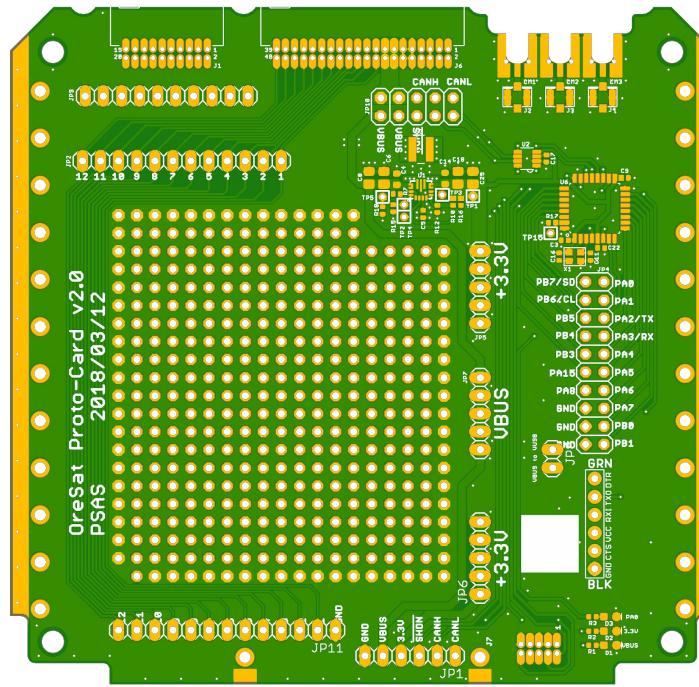
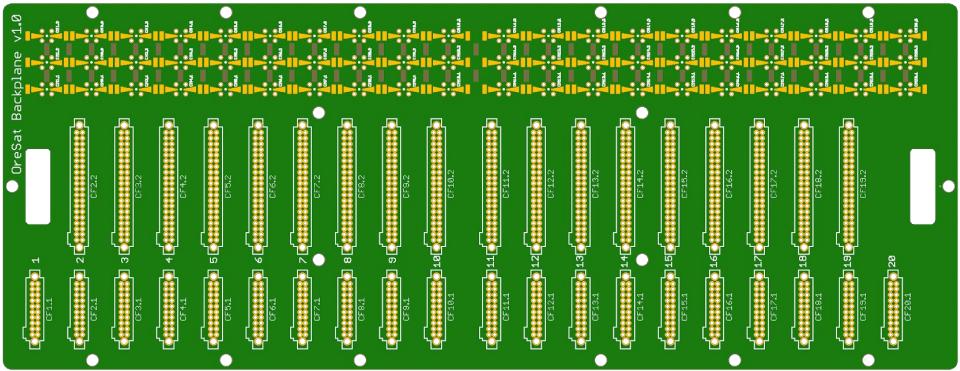
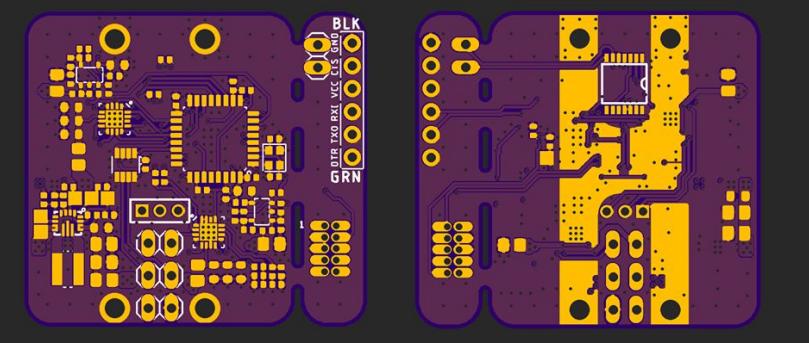
Portland State Aerospace

PSAS is a student aerospace engineering project at Portland State University. We're building ultra-low-cost, open source rockets that feature some of the most sophisticated amateur rocket avionics systems in the world.

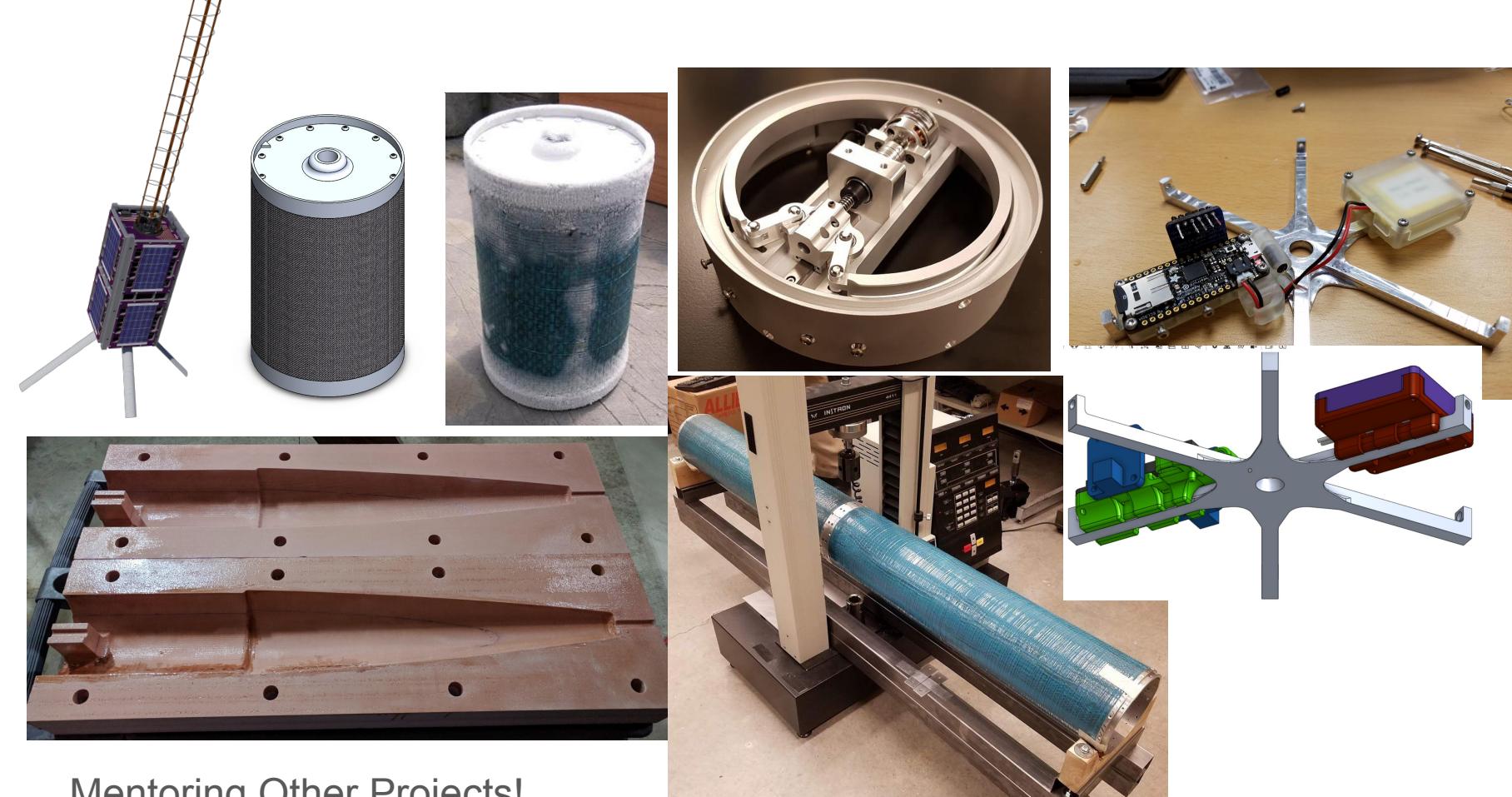
Our long term goal at Portland State Aerospace Society is to put a tiny satellite into orbit. This is very ambitious—there are so many technical, financial, and legal challenges that we may never never get there! However, this goal clarifies our intent and allows us to ask, "Where do we start?"

The answer is that we focus on small, ongoing projects which move us toward our long-term goal. We build everything ourselves from the ground up and our work necessarily touches all aspects of aerospace engineering. Our rockets are in the amateur classification: smaller than commercial but larger than model rockets. We haven't built the biggest or highest-altitude amateur rocket, but we hope we're building one of the most sophisticated.

Meetings take place almost every **Tuesday at 7pm at PSU in room FAB 86-01**. Come join us anytime! See our Schedule section for detailed information on the where and when we meet.



Working With Sparkies!



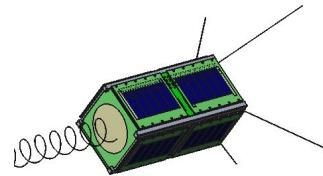
Mentoring Other Projects!



When you get blamed for
the offensive memes



Fostering Group Culture!



lonely edwards



squiggleSMARTS



...we got some:



slack daddies



turbo farts

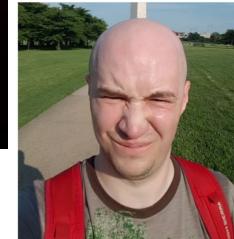


pointy bois



confusion

You versus the guy she
tells you not to worry about



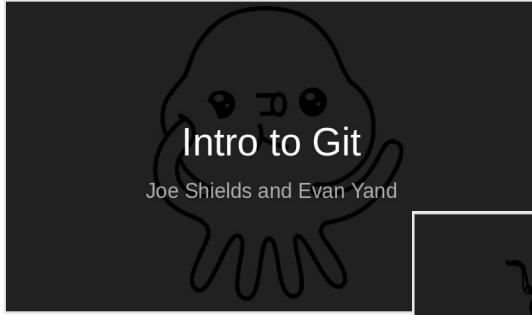


Image credit: flickr.com/photos/deborah_s_perspective/12632517853



An Intro to \LaTeX
PSAS

What is \LaTeX ?
The Basics
Useful Environments
Packages
Floats
Biblio graphies
Miscellaneous
Resources

An Intro to \LaTeX

Portland State Aerospace Society
Joe Shields

May 31, 2018



Teaching Workshops!

Design and Manufacture of an Open-Hardware University Rocket Airframe using Carbon Fiber

Joe Shields* Leslie Elwood*

The amateur and university rocket communities are rapidly reaching higher altitudes with more sophisticated rockets. However, most groups are still using heavy airframes made of metal or fiberglass. Commercial off-the-shelf airframes are either too expensive for low-budget university groups or too small to use as a platform for high altitude experiments. A capstone team of mechanical engineering seniors at Portland State University has developed a low-weight, modular carbon fiber airframe as an open-hardware technology for university rocketry. This project continues the work of a previous capstone team, who developed a carbon fiber layup process with promising results. This will enable low-budget groups like the Portland State Aerospace Society to explore high altitude science and compete in the university space race.

Nomenclature

CF	Carbon Fiber
CFD	Computational Fluid Dynamics
CTE	Coefficient of Thermal Expansion
GPS	Global Positioning System
LV2	Launch Vehicle 2
LV3	Launch Vehicle 3
PSAS	Portland State Aerospace Society
PSU	Portland State University

I. Introduction

PSAS is an interdisciplinary group of engineering students, alumnus of PSU, and aerospace enthusiasts with the vision to explore the atmosphere and beyond. The first rocket, named LV1, was built in 2014, and since then, named LV2, has served for over 12 years, representing 10 of the group's 13 hours less, and housed experiments including custom patch antennas and long range WiFi technology, GPS navigation and a cold gas reaction control system (figure 1). The LV2 platform is mostly constructed of aluminum with a fiberglass shell, with many of the parts fabricated in home garages. This makes for a robust but heavy design. Additionally, this airframe is built with a 4.5 inch inner diameter which PSAS's experiments have outgrown.

The new airframe, named LV3, aims to address these issues and create a test platform for the technologies PSAS will use for their eventual shot at a 100 km launch. The LV3 platform uses a 6 inch inner diameter, made of a layer of CF and then aluminum coupling rings, a CF nose cone, and a CF fin section. All of the airframe components connect via standardized rings, to accommodate future experimental modules and flight configurations. The cylindrical LV3 airframe modules outperform the old design with an 80% reduction in weight.

*Portland State University, 1930 SW 4th Ave, Portland, OR 97201

1 of 8
American Institute of Aeronautics and Astronautics



Failure Analysis of a Composite Amateur Rocket Airframe



PNW AIAA Technical Symposium 2018

Risto Rushford Joseph Shields

Carbon Fiber Layup Procedure

Joe Shields Leslie Elwood Alex Farias

January 19, 2019

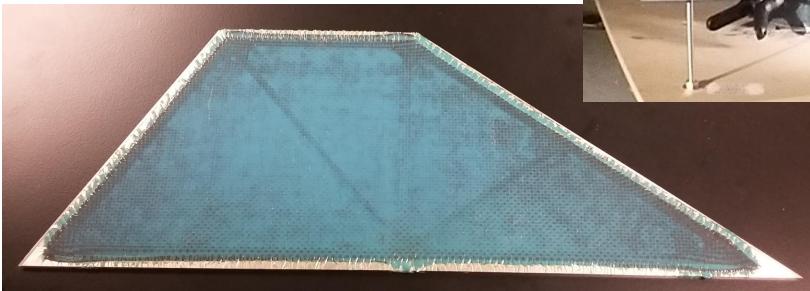
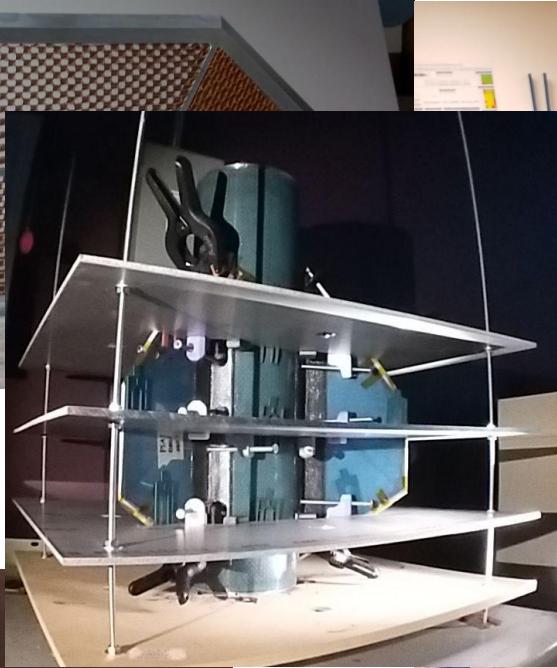
Contents

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2.2	Coupling ring preparation	3
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3.1	Layers	5
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I. Introduction

This is the procedure to make a cylindrical module. If you find any steps which are unclear, erroneous, unnecessary, or need improvement, please add an issue for it on this repo.

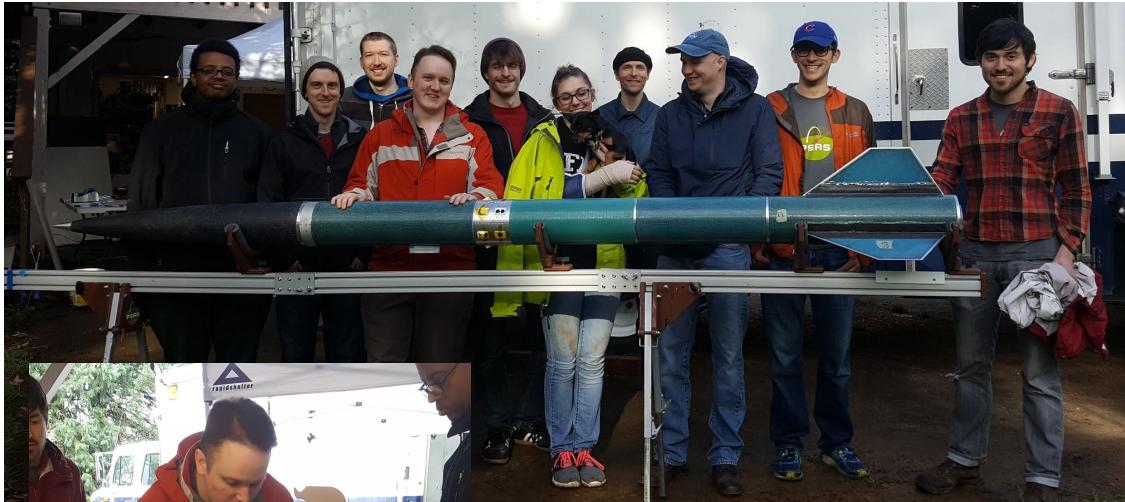
This procedure takes about 5 hours, if you have 3 people working on it, not counting the 5 hour cure cycle. If you're following this procedure for the first time, it's probably going to be closer to 7 or 8 hours. If you *really* know what you're doing, one person can do it, but it's not nice to make one person work for 10 hours straight. If you're trying modifications to this procedure, it's a good idea to do so on a smaller mandrel with no coupling rings, since that takes off a lot of the time.



Fins!



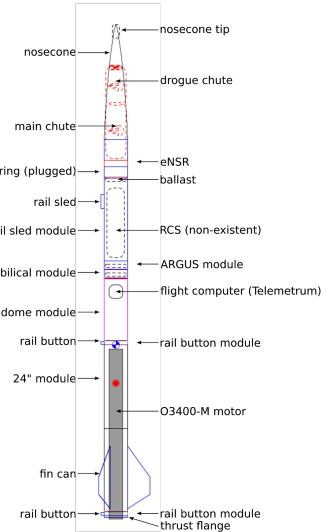
Integration and Testing!





Launch Coordination!

L-13.1 Configuration of LV3

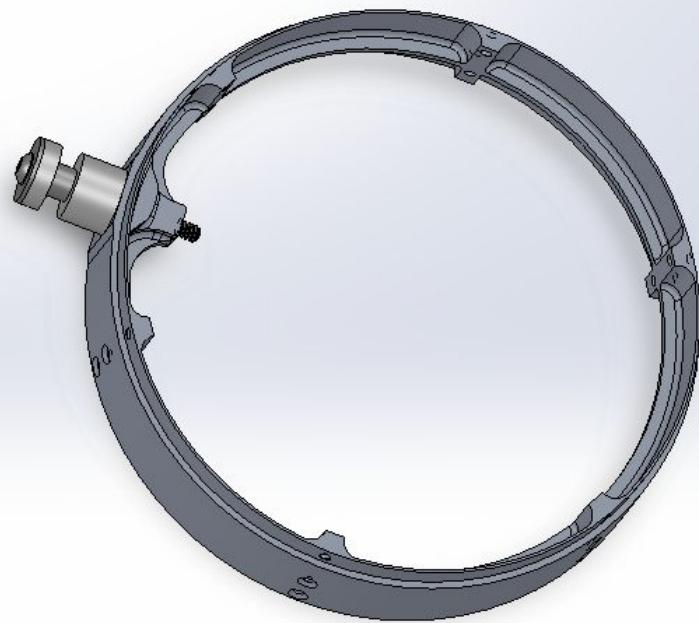
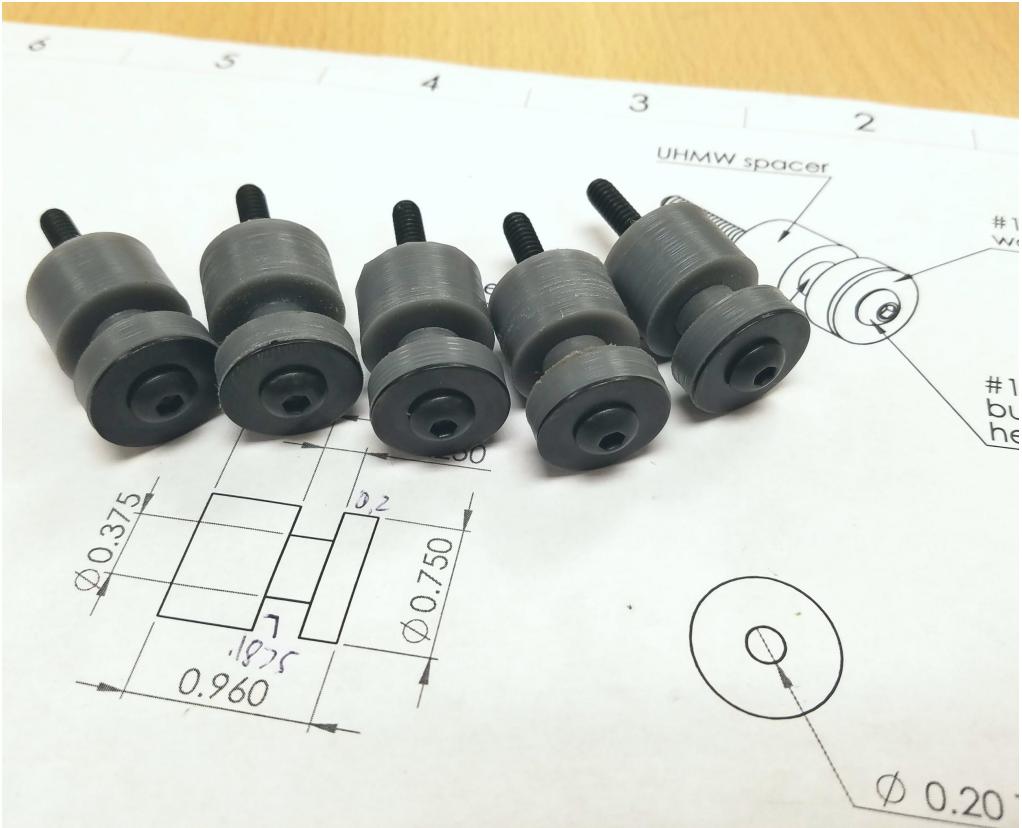




360 Degree Cameras



Part Failures and Summit Fever!



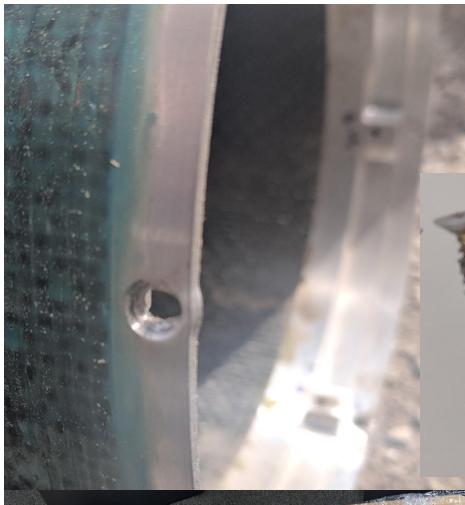
Redesigning Failed Systems!



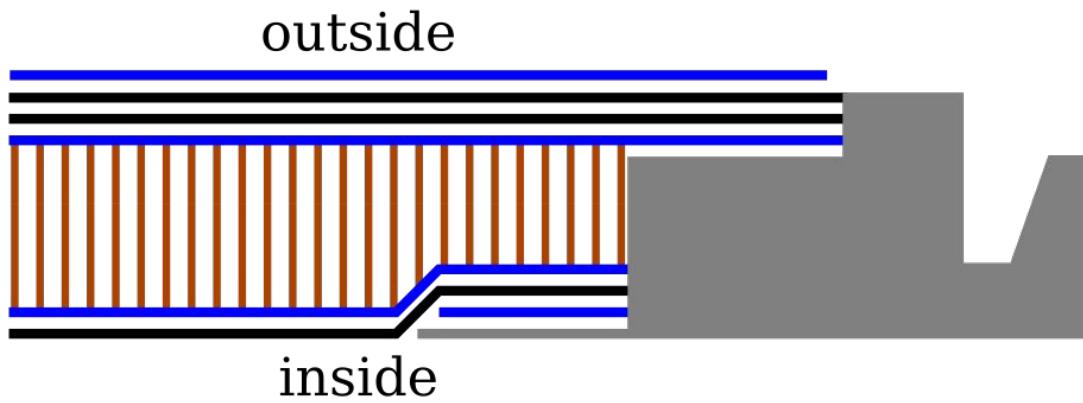
Rapid Unscheduled Disassembly!



Post-crash Recovery



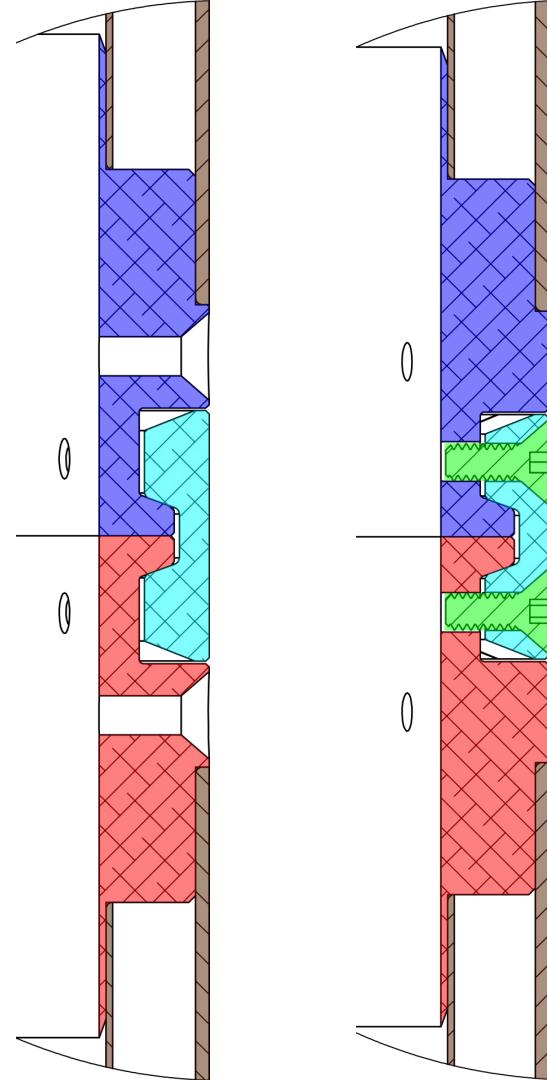
Root Cause Analysis

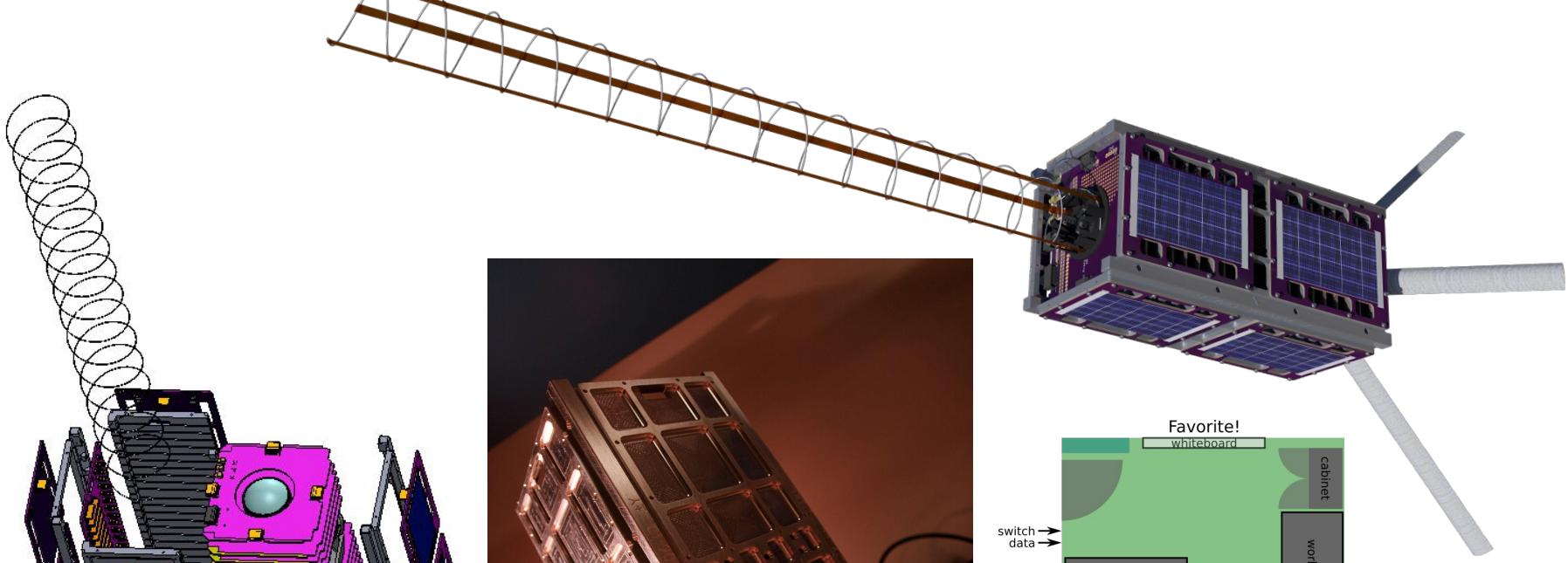


inside

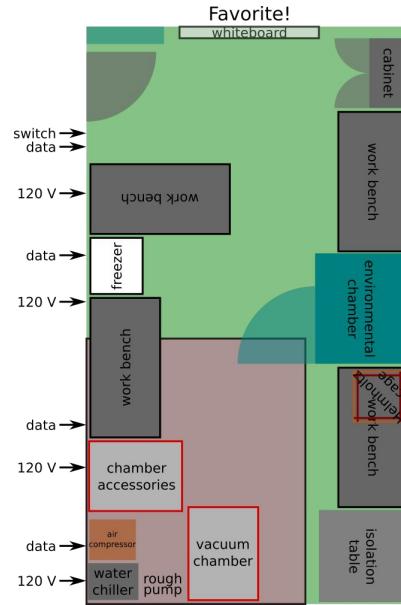


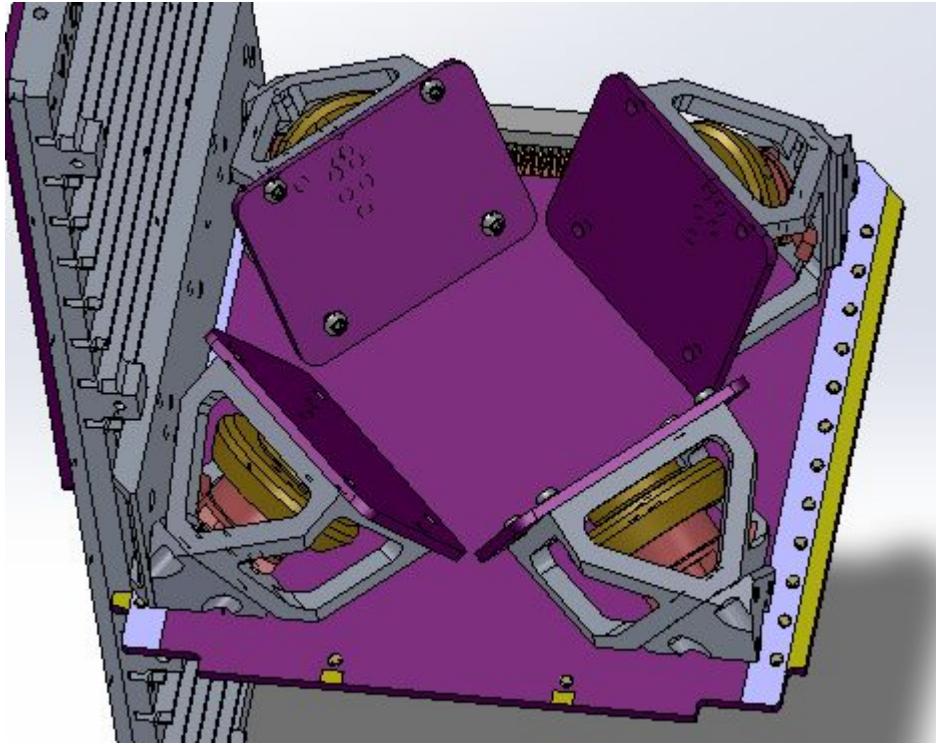
New Coupling Rings!



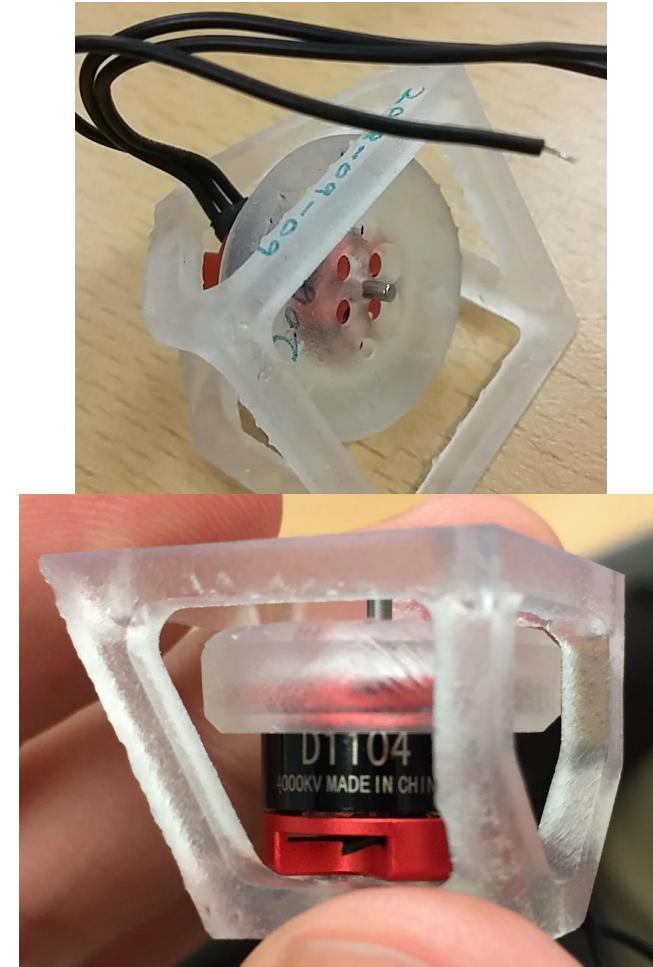


Cubesats!





Reaction Wheels!



But let's just talk about the
Launch Vehicle No. 3 (LV3) Nosecone Project

Background

Background

- Sounding rocket
 - Test platform
 - Replacing similar-sized rocket
- For amateur group
- Main contributor to drag



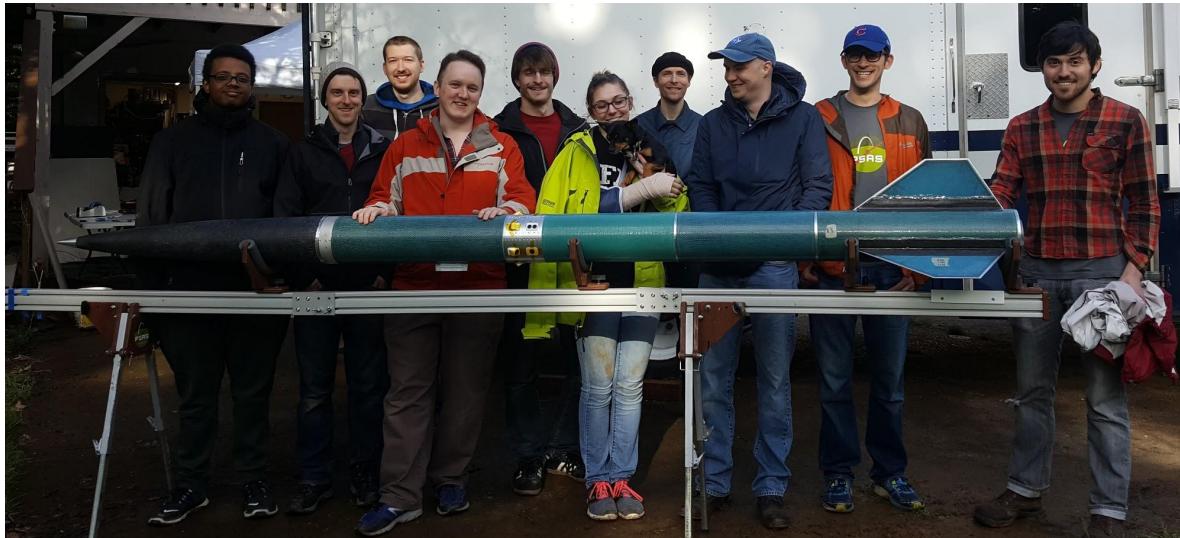
Requirements

- Recoverable
- Reusable
- Reuse CF technology
- Reduce weight and drag

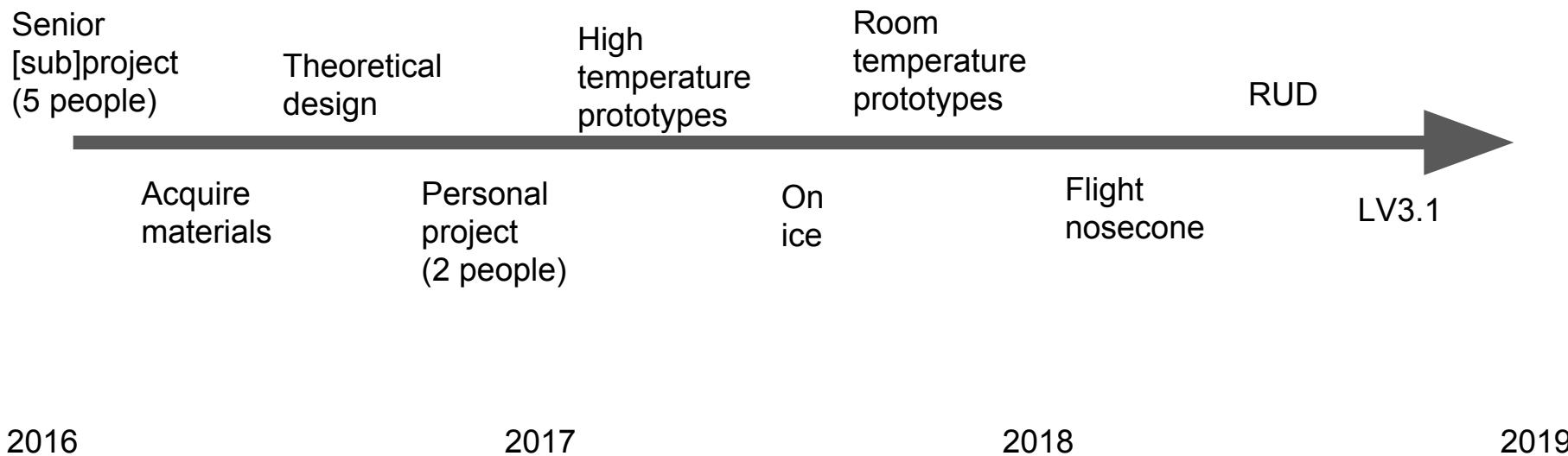


Roles

- Top-level design
- Manufacturing design and debugging
- Teaching
- Cat herding
- Politics
- 2 teams → 2 people



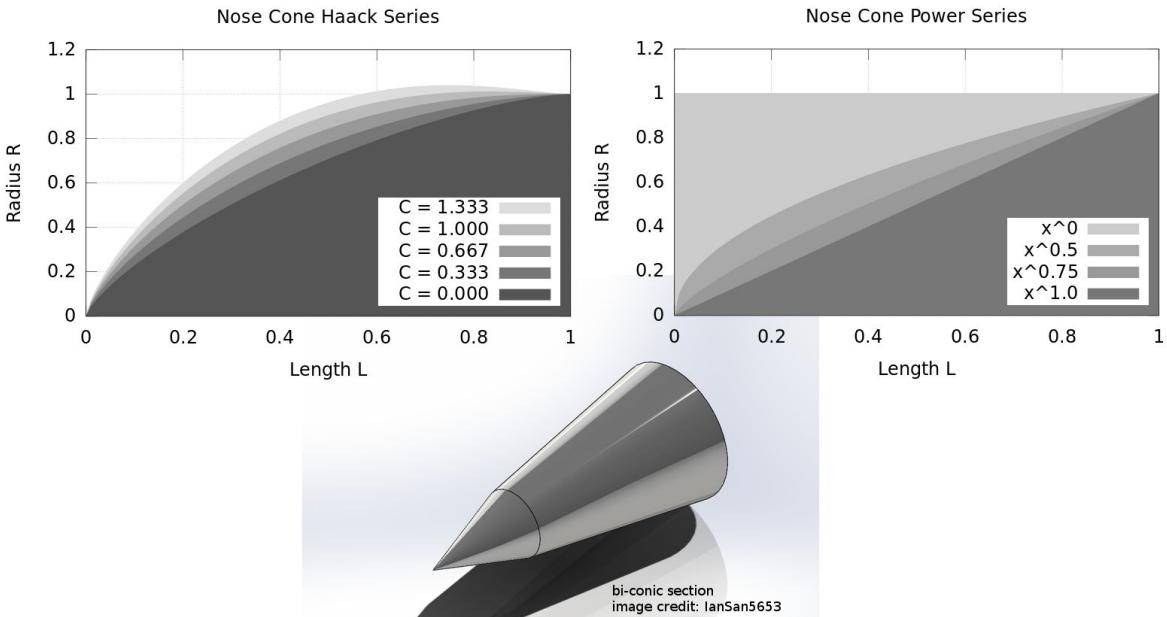
Timeline



Challenges

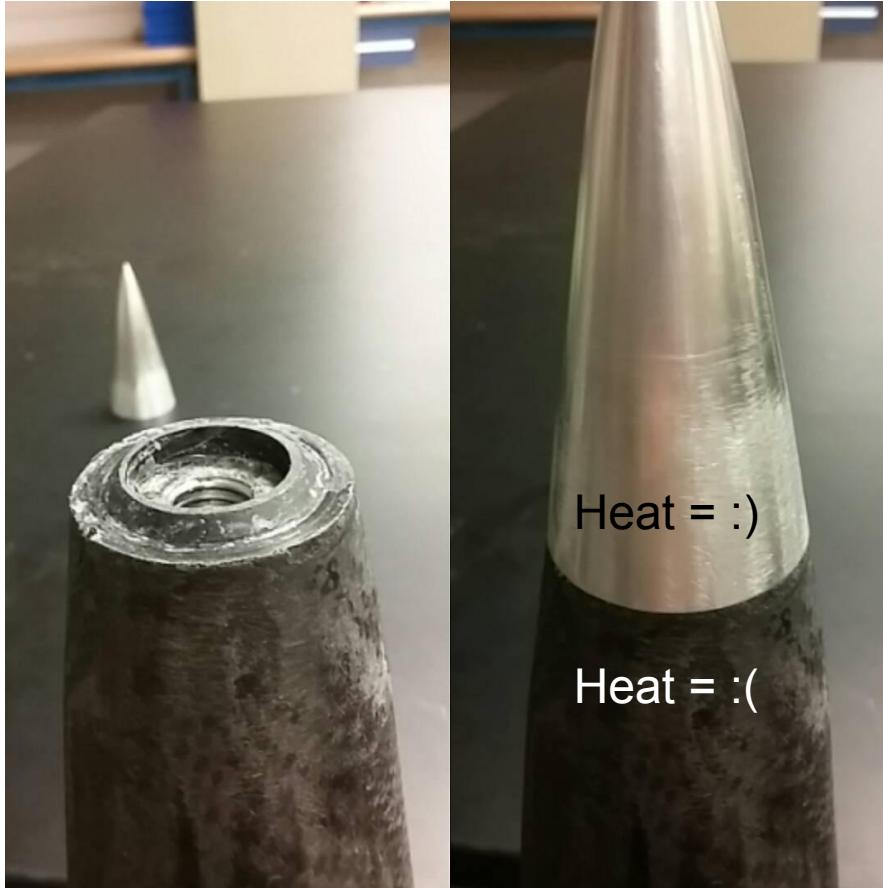
Challenges

- ● Choose a shape
- Aerodynamic heating
- Material choice
 - Cost
 - Temperature
 - Ease of manufacture
- Manufacturing strategy



Challenges

- Choose a shape
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Challenges

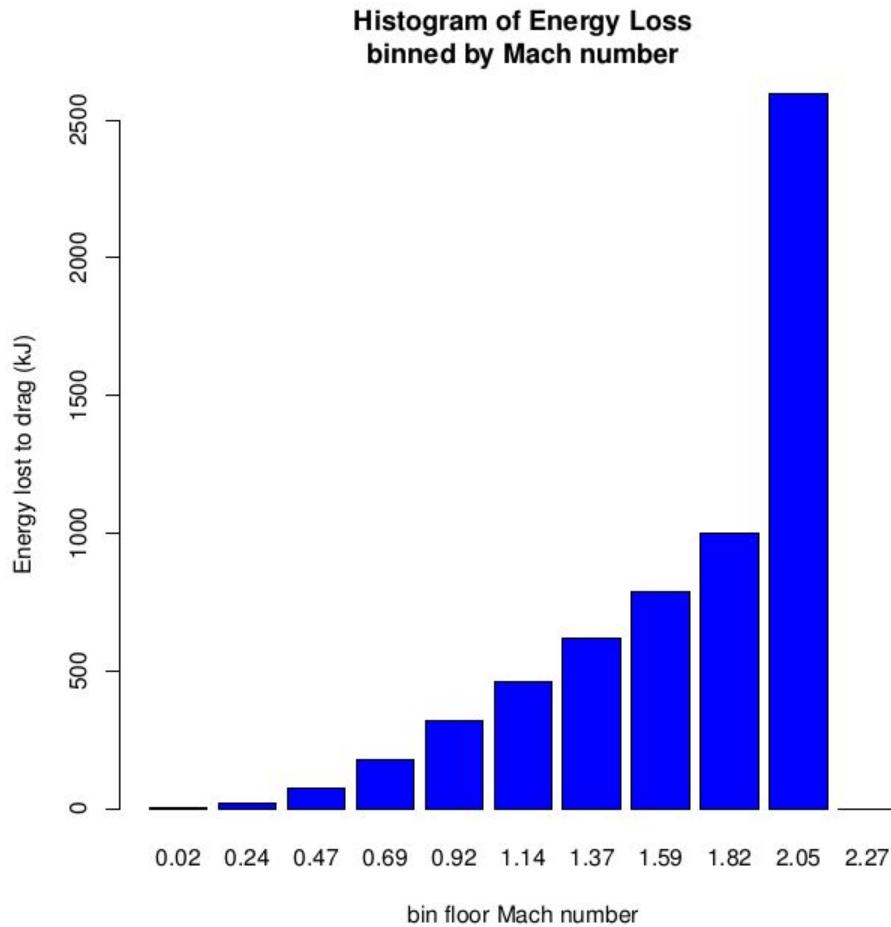
- Choose a shape
- Aerodynamic heating
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Solutions

Solutions

- Find metrics for shape
- Thermal analysis
 - Coarse→fine
- Small-scale material tests
- Break up manufacturing



Solutions

- Find metrics for shape
- Thermal analysis
 - Coarse→fine
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Solutions

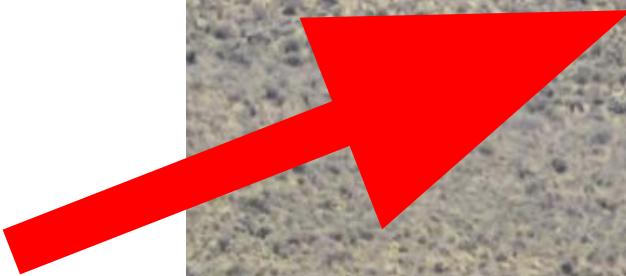
- Find metrics for shape
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Solutions

- Find metrics for shape
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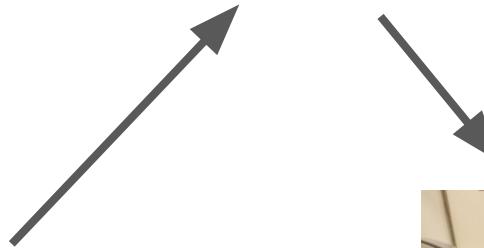


Lessons

Lessons

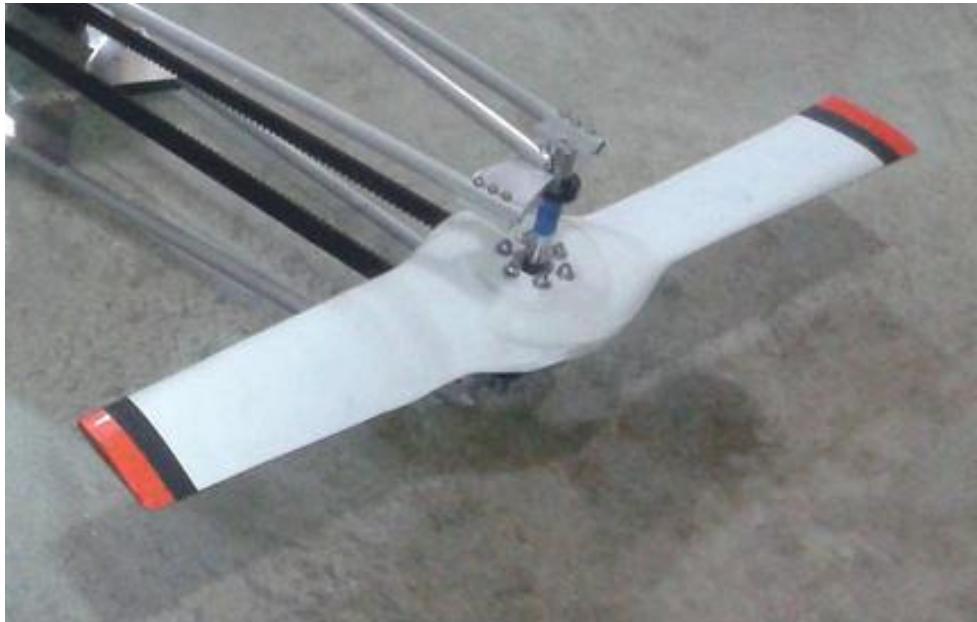
- If you get stuck, try reevaluating your decisions.
- Seek out advice and alternatives.
- Problems get easier when you decouple them.

~~High temp~~



Lessons

- If you get stuck, try reevaluating your decisions.
- Seek out advice and alternatives.
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Lessons

- If you get stuck, try reevaluating your decisions.
- Seek out advice and alternatives.
- Problems get easier when you decouple them.



Present Status

- Advisory role
- New team
- New experiments
- Spring/summer launch



Bonus Lessons!

Bonus Lessons

- Trust but verify.
- It's okay to blow the whistle.
- Beware of sacrificing reliability for performance.
- Confirm understanding when conveying information.
- Identify related and unrelated problems.
- Making your own job easier can make someone else's harder.
- Revisit old ideas.
- Go out on a limb.

RUD: <https://youtu.be/6IZ3c6rnkdM>

Rail: <https://youtu.be/fc4IA9D3WhM>

Tape: <https://youtu.be/Rn9xHs1TgXq>