How to Use

Whenever you do work for Payload/Recovery, write about it here.
Always add your new writing to the **bottom** of the document. Don't add to previous sections, and definitely don't delete anything (but do correct mistakes if you make them).
Include:

- Pictures
- Math (probably scans or Mathematica screenshots)
- Relevant numbers
- Data

Formatting

Put a page break after the previous project (Insert→Page Break).
Write the project/experiment name as a "Heading 1" (Format→Paragraph Styles).
Write the date and your name in bold in the next line.

You can link to other sections (Insert→Link→Headings).
You may comment where applicable (Insert→Comment).
As an example: See the first entry I made here.

Starting to select parts for the actuators

Jan 28 2016 – Colin Poler

Here's a preliminary BOM for the actuators:

Motors	Gearmotor	2
	Motor driver	1
Drum	Aluminum bar	2ft by 0.5in by 3.5in
	OR Aluminum rod	0.5ft by 3.25inOD
Box	Delrin sheet	0.5in by 12in by 12in
	Aluminum sheet	3ft by 0.25in by 6in
	M3 bolts	1 pack
Shaft	Hex shaft	3ft by 0.5"
	OR Keyed shaft	3ft by 0.5"
	Setscrews	1 pack
	Ball bearings	qty2, 0.5in ID
Lines	Fishing line, high test	1 spool
	Surgical tubing	20ft
Thermal	Heatsink	2
	Thermal adhesive	1

Notes from all-hands:

- Mass is critical
    - Use plain bearings instead of ball bearings
    - Free Alcoa aluminum a possibility, but might be too slow
- Keyed shaft is recommended by Todd
    - He has key broaches we can use

Hatch Prototype Testing

Jan 29 2016 - Piper Sigrest

Test #	Observations	Lessons Learned
Sliding Hatch Test 1 (with zip tie cutter)	Zip tie cutter worked really well, but hatch didn't slide open.	Pack parachute less tightly in the hatch.
Flipping Hatch Test 1 (with frangible bolt)	main chute deployed prematurely; frangible bolt did not have time to fire. The hatch deformed and was pulled open by the pilot chute. Then the epoxy holding the kevlar loop quick lined to the main broke.	Use a zip tie cutter, or at least have the retaining device through a complete hole in the hatch, and not just a notch. Epoxy the kevlar loop through a hole in the bulkhead, not just to the bottom of the tube.
Flipping Hatch Test 2 (with zip tie cutter)	Setup and deployment was nominal, but when the zip tie cutter was fired, the hatch did not open because we forgot to remove the masking tape holding it shut.	Masking tape is stronger than you think.
Flipping Hatch Test 3 (with zip tie cutter)	Removed the tape, then a nominal deployment. Test stand broke.	Make test stand sturdier.
Sliding Hatch Test 2	Unsuccessful; bad e-match.	Murphy happens.
Sliding Hatch Test 3	Very bad; pilot chute pulled open the hatch prematurely (cardboard on the hatch failed by the zip tie). Test stand broke again.	Make test stand sturdier. Line the hole in the hatch with washers to keep the cardboard from failing.
Sliding Hatch Test 4	zip tie cutter failed	add more black powder to zip tie cutter.
Sliding Hatch Test 5	Attempted to use a frangible bolt. Bolt did not get kicked out of the hole, so the slider did not deploy.	create a reliable break point in the frangible bolts. Try using a pin on a linear actuator instead.

General Lessons Learned:

- make more solid test stands (to prevent it from spinning in the wind tunnel)
- make joints very well!
- frangible bolts need a way to remove themselves (shrapnel or otherwise)

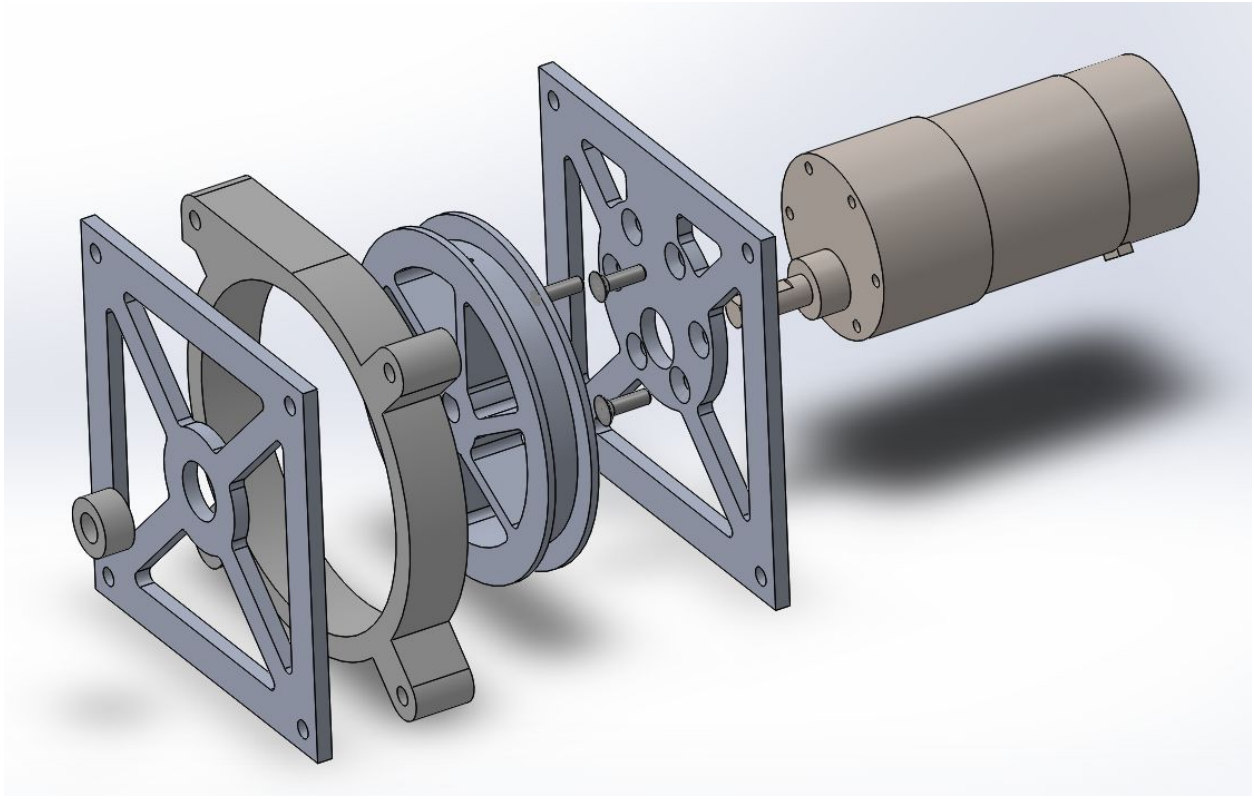
Starting to design actuators

Jan 30 2016 – Colin Poler

I started to design the actuators in CAD.

Goals:

1. Minimize weight
2. Make manufacturing simple and fast



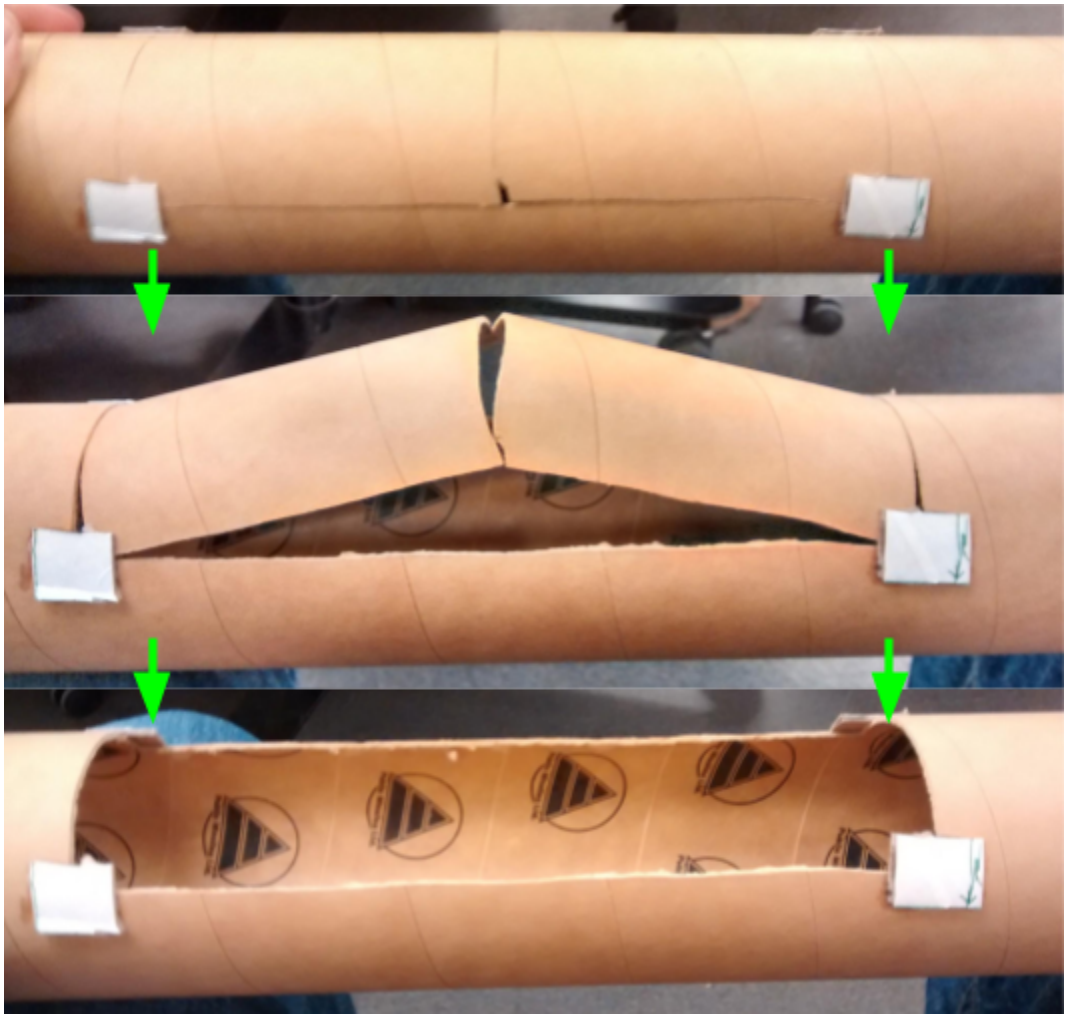
Manufacturing: mostly waterjetting, a little bit of countersinking, tapping, turning.

Weight as of now: 0.8029 (1 motor and 1 drum).

Buckling hatch prototyping

Jan 30 2016 – Colin Poler

Me and Kurtz build a prototype of a buckling hatch. The idea is to support loads during launch (mostly compressive), then buckle when the parachute comes out. See below!

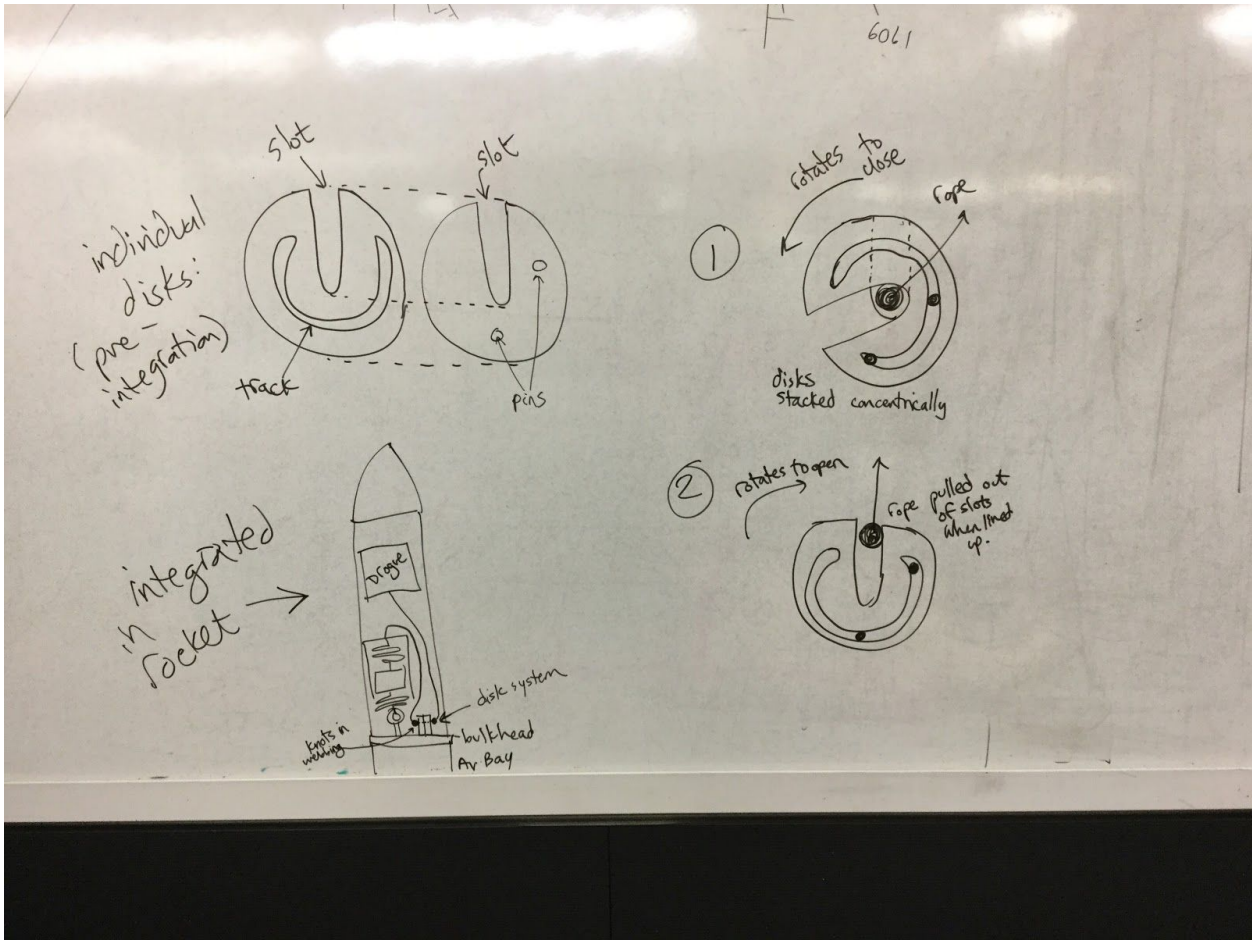


We would probably attach the hatch halves to the deployment bag.

Backup Recovery Actuation Disk Idea

Jan 30, 2016 - Piper

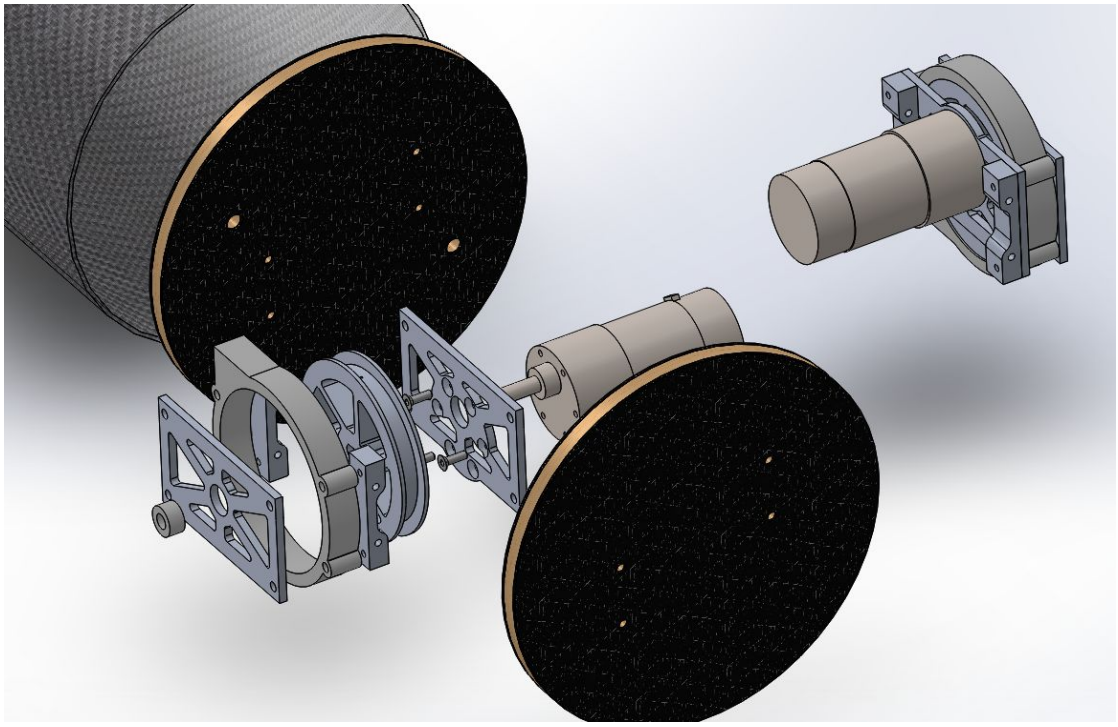
Today we (Andrew, Charlie, Colin, and I) started discussing in depth an alternative, non-pyrotechnic method for setting up and actuating the backup recovery system. This involves two concentric disks with slots in them stacked on one another. The slots, when rotated, trap webbing between them. The disks will be actuated via servo. This would be an alternative to both the tender descender and the frangible zip tie cutter. After initial discussions, it appears to be a good solution because it is fairly light weight, easy to manufacture, easy to integrate, imposes more than tolerable loads on the system (including servo), and is generally pretty elegant. Charlie is going to start building and testing a Mark I prototype of the system. We are also considering using this to actuate the hatch, but we are focusing more on the backup recovery system because the flipping hatch technique is already fairly promising.

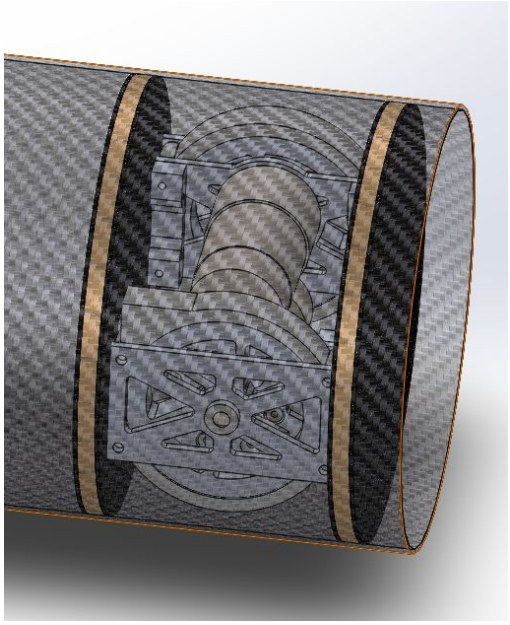


Refining Actuator CAD

Jan 31, 2016 - Colin

I redesigned the actuator to be lighter, and figured out how to mount it to the rocket.
New weight: 0.77lbs each!





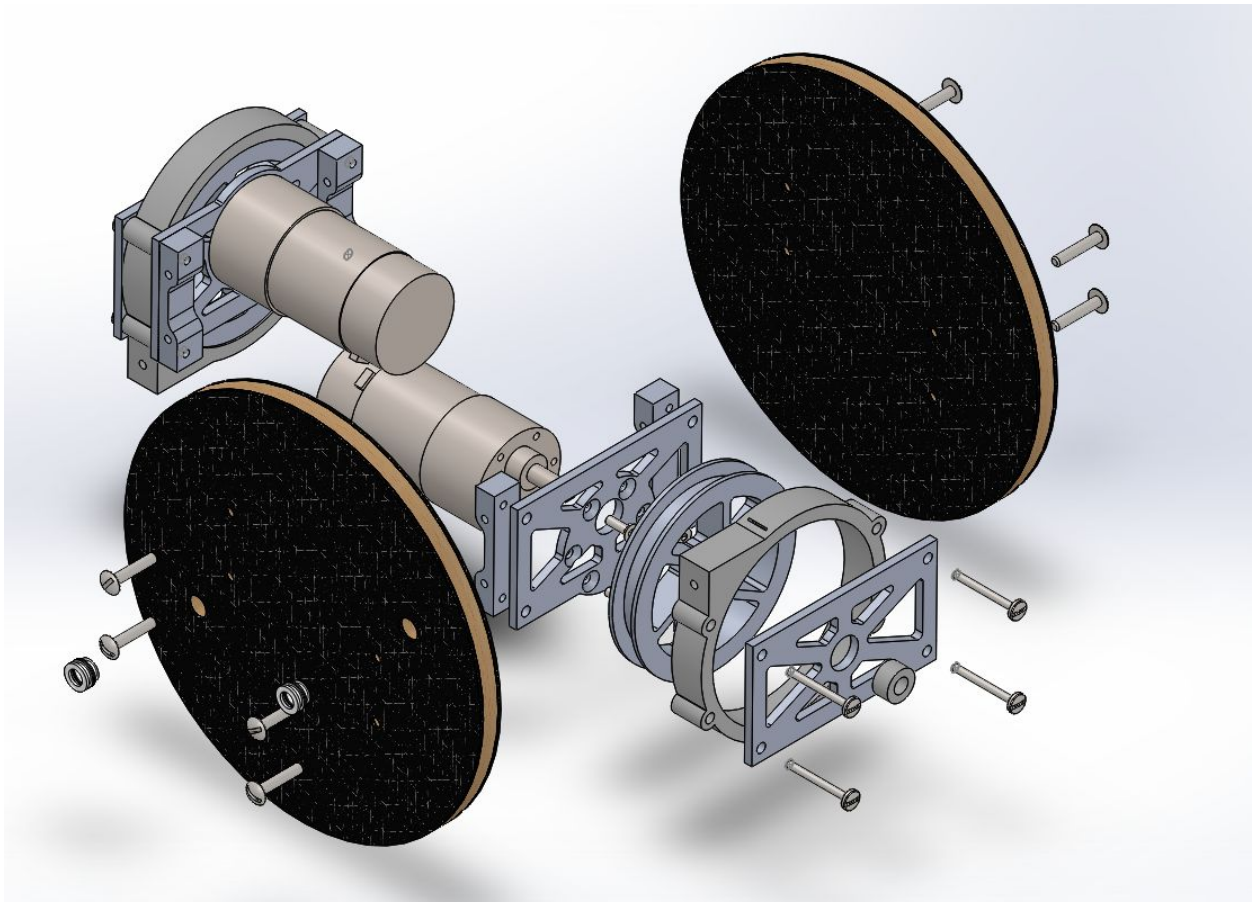
Actuator Design Review

Feb 1, 2016 - Colin

Revised BOM:

Motors	Gearmotor	2
	Motor driver	1
Drum	Aluminum bar	2ft by 7/16in by 3.5in
Box	Delrin sheet	0.5in by 12in by 12in
	Aluminum sheet	3ft by 1/8in by 6in
	M3 bolts	1 pack
	6-32 1in Bolts	1 pack
Lines	Fishing line, high test	1 spool
	Surgical tubing	20ft
Thermal	Heatsink	2
	Thermal adhesive	1
Bulkheads	Fiberglass cloth	
	1/4in balsa wood	
	Epoxy	
	Grommets	1 pack
	6-32 .75in Bolts	1 pack

Weight as of now (whole system): 930.73g



Notes from review

- Change holes to close fit so no sliding
- Flathead motor screws instead of hex
- Brass bearings
- Pressfit tolerances?
- Carbon fiber to fiberglass
- Flat faces on delrin circle

Post-review Actuator changes

Feb 1, 2016 - Colin

Post-review BOM:

Motors	Gearmotor	2
	Motor driver	1
Drum	Aluminum bar	2ft by 7/16in by 3.5in
Box	Delrin sheet	0.5in by 12in by 12in
	Aluminum sheet	3ft by 1/8in by 6in
	M3 bolts	1 pack
	6-32 1in Bolts	1 pack
	Brass bearings	2
Lines	Fishing line, high test	1 spool
	Surgical tubing	20ft
Thermal	Heatsink	2
	Thermal adhesive	1
Bulkheads	Fiberglass cloth	
	1/4in balsa wood	
	Epoxy	
	Grommets	1 pack
	6-32 .75in Bolts	1 pack

Weight as of now (whole system): 930.73g

Throwing out the press-fit needed for assembly

Feb 2, 2016 - Colin

I realized a press-fit drum would be unreliable (chinese motors don't have tight tolerances on the shaft) and hard to install. My bad. So I'm going to use a 4-40 t-slot set screw (sketch below, will CAD ASAP).

New parts:

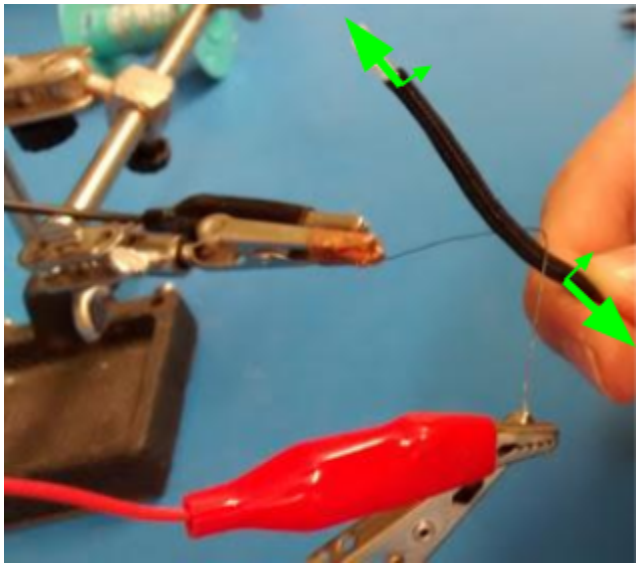
Drum	Aluminum sheet	7/16in by 8in by 8in
	4-40 square nuts	1 pack
Box	Aluminum sheet	1ft by 1/8in by 4in
Bulkheads	1/4in balsa wood	

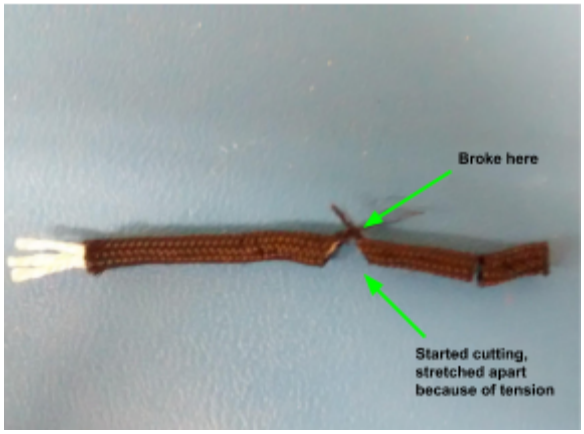
Testing hot-wire cutting a rope

Feb 2, 2016 - Colin

I tested cutting a rope with a hot wire.

- Wire and rope held perpendicular, both under tension and pressed against each other
    - The tension was roughly 50N and cross-pressing force roughly 5N





The ropes tended to break in a distinct triangle pattern.
The current required was about 2.3 amps (3.4 volts) for about 10 seconds before it broke.

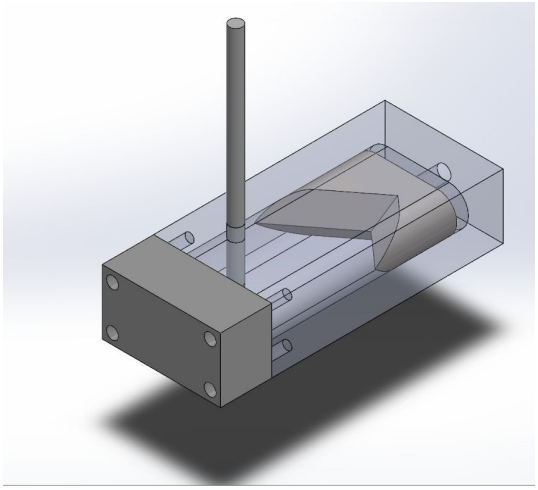
I tried it 10 times, and it worked 9 times. During the failure, the wire melted to itself. But I may not have applied enough tension.
Overall, probably not the best way to cut, unless the ropes are very thin.

--new entry to format.
Hatch Meeting
Feb 2,2016 - Piper

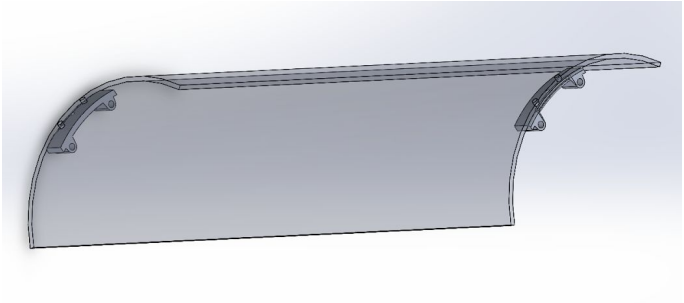
Last n

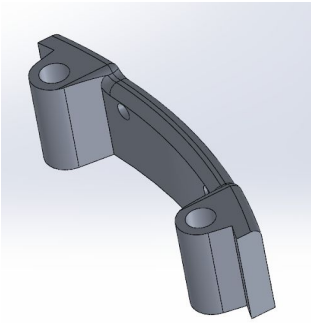
Rope Hatch Design Work

Feb 3, 2016 - Andrew



need to figure out manufacturing, not sure we will be able to make the slot that the knife slides along. Also need to do research on how tight the tolerance needs to be between the knife, pretty much concerned about the gas escaping around the knife. need to figure out a way to quantify that shit as well as determine what the cutting force is going to be. Thinking it might be fun to just test that shit.
The large piece on the end of the chamber opposite to the knife is HDPE and is there to try and catch the blade after it has cut the knife.

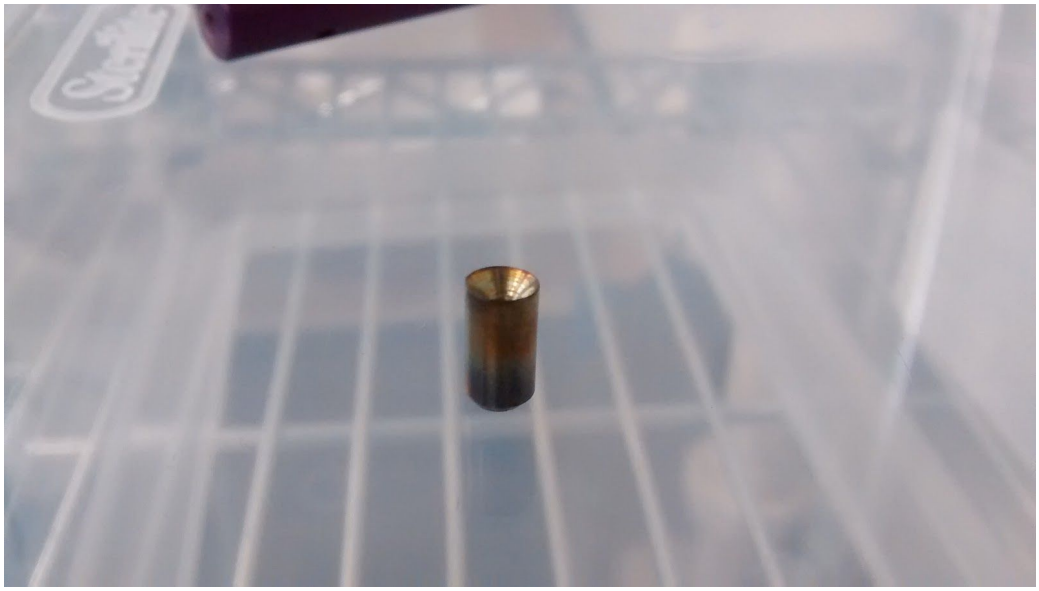




Beginning to machine cutter and drums

Feb 5, 2016 - Colin

We machined a blade into the zip tie cutter, then hardened it using the blowtorch and a bucket of water:



We machined a jig for making the drums for actuators:

Everything is in a clear box on the recovery shelves.

Parachute Load and Speed Estimator

Feb 7, 2016 - Piper

I made a MATLAB script to estimate the loads and speeds of parachutes when they deploy. Found on the Dropbox here:
https://www.dropbox.com/work/Rocket%20Team/IREC%202015-2016/Recovery

Channel Count for Avionics

Feb 7, 2016 - Piper, Colin, Andrew K, Andrew A, Martina, Ricardo, Jake

Channels needed to deploy things:

Parafoil System:
Mortar - x2 pyro (for redundancy)
3 options for parafoils: (chose one of the following)
- Break Away Hatch - x1 pyro
- Flipping Hatch - x1 pyro
- Servo Hatch - x2 (1 pyro, 1 servo)

Cutting Away the Parafoil:
x1 pyro

Backup System:
deploy nose cone/drogue - x2 pyro (for redundancy)
deploy main - x1 (pyro or servo)

Total:
7 pyro channels, up to 2 servo channels

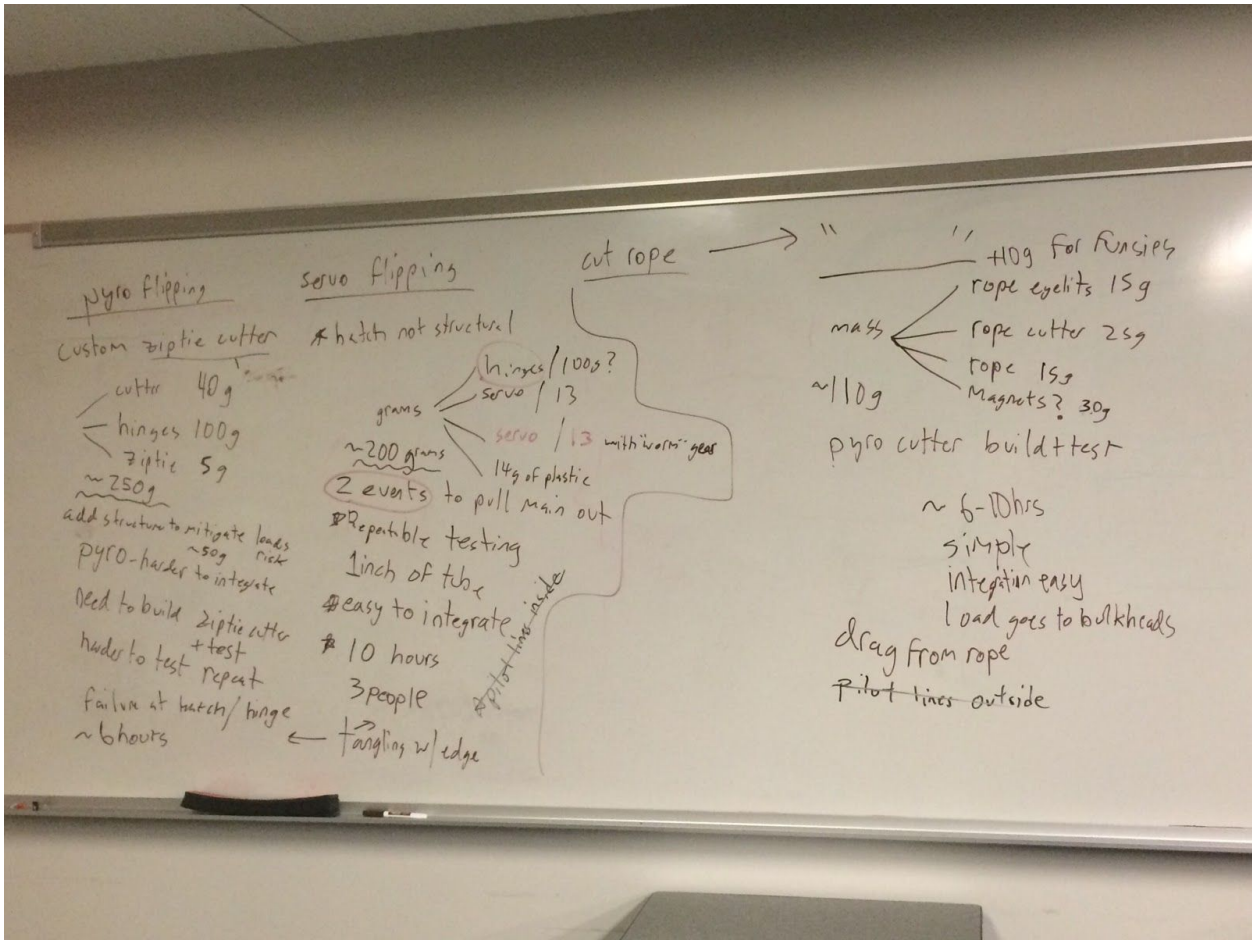
Hatch Decision

Feb 11, 2016- Piper, Andrew Kurtz, Colin, Andrew Adams, Eric, and Co.

At the last team leads meeting, we decided between the pyro flipping hatch, servo flipping hatch, and rope cutter hatch to pursue the rope cutter hatch. This was largely for the following reasons:

- Light weight
- Simple design/few “moving” parts
- Easy integration
- Easy manufacturability
- The hatch is retained with the deployment bag, but goes away from the hatch to reduce the risk of snagging on the parafoil
- We already have a working prototype/design of the rope cutter to test

A summary of pros and cons can be seen in this picture:



Notes on Manufacturing the Mortar and Hatch

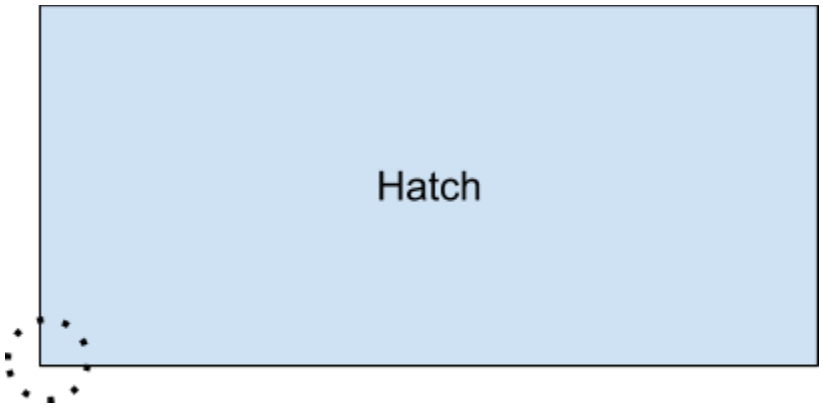
Feb 16, 2016 - Piper S. and Andrew A.

This past week, we've been working on manufacturing the hatch and mortar for the first drop test. A quick procedure write-up:

1) Cut the ends of the 3" mortar tube at 45 deg angle using the (soon-to-be-existing) jig.
2) trace out on the body tube where the couplers will go (about 5" from each end)
3) trace out where the mortar will go (give it about 12" of space, at the top of the hatch tube, closer to the nose cone). Trace one end of the cut mortar tube to get the size and shape about right.
4) trace out where the hatch will go. Should be directly beneath the mortar (give an inch or so of margin space). 18" long, and ⅓ the circumference of the tube.
5) Cut out the hatch with the Fein Multimaster. Pretty straight forward.
6) Cut out the hole for the mortar in the main body tube. To cut out the hole for the mortar in the tube, I recommend using the Dremmel. lightly score the top surface of the tube, to just cut through the fiber glass layer. This lets you make really nice smooth curves. Then, cut through the rest of the phenolic with a hand held razor. It takes a bit of effort but gives you a nice curve.
7) Sand things with the dremmel. make them pretty. If you can, make the ends of the mortar tube more concave so that they fit more flush with the main body tube.

NOTE: We need to find a nice way to round out the corners of the hatch. According to some structural analysis by a friend of Will's, that's the first failure point. I think we can try doing this using the partial-scoring method with the Dremmel. Rounding the corners will also help mitigate the risk of the parafoil snagging when it deploys.

NOTE: Kurtz literally just suggested drilling a hole in each sharp corner with a hand held drill bit. Like this:



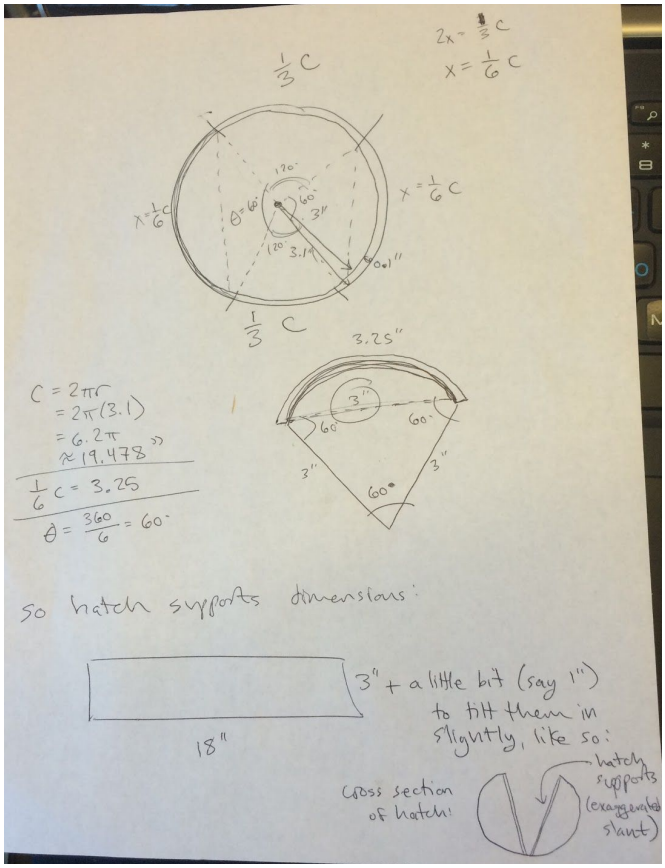
To be completed:
8) machine the little aluminum pieces that go on each end of the hatch
9) machine the rope cutter (one for the hatch section and one for the backup recovery section
10) cut the rope to the appropriate length.
11) integrate everything.

Progress and General Updates

Feb 20, 2016 - Piper

Today we made good progress on recovery. A mount for the mortar is currently being 3D printed, and a seal for the mortar will also soon be printed. Andrew is working on a calculator for ejection charge sizing. We cut supports for the hatch out of thin plywood. See calculations for the dimensions below. We also decided to try the Tender Descender for the backup recovery system. I sketched out some alternative ideas, but I think (from consulting with Andrew and Zach) that the Tender Descender is worth a shot, because it's designed for exactly this scenario and we will actually be able to access it to integrate it this year. If, during CRIMP, we see that it is not an effective solution, we can switch to an alternative method. But for now, the Tender Descender is nice because it's a proven system, basically all ready to go.

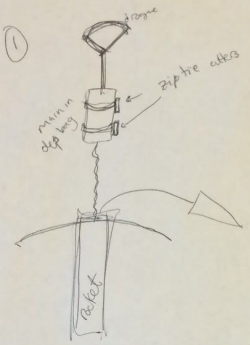
Hatch Dimension Calculations:



Alternative Backup Recovery System Ideas:

Back Up Recovery

- Main chute retention mechanisms:

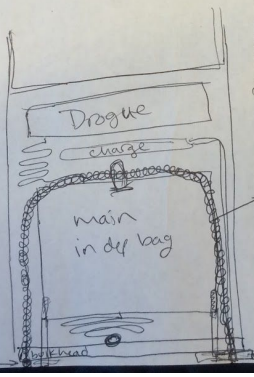


pros: - COTS - (simple) easy operation
- easy to integrate
cons: - have to run wires up to parachute

Tender Descender

- pros: we know how to do it
  - COTS
- cons: tough to integrate

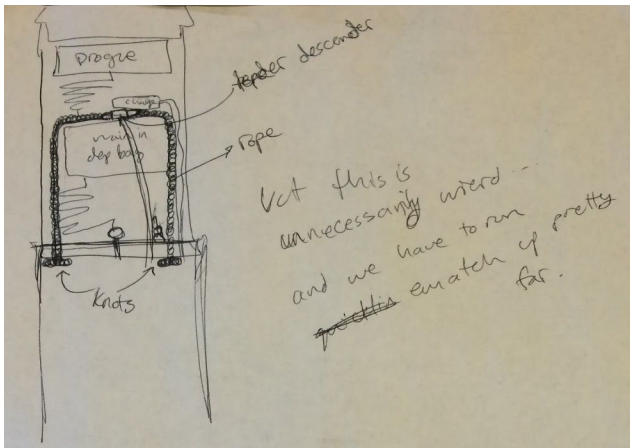
[redacted] → Rope cutter variation



Rope runs through bulkhead, tied on one end, rope cutter on the other. Physically retains main. Run rope through loop on top of dep bag to keep it from slipping off.

- pros: ~~easier to integrate~~ don't have to run wires very far.
- cons: shock runs through the rope + bulkhead
- kind of tough to integrate

(alternatively, we could sew loops onto the dep bag, run the loops through the bulkhead, then a rope through the loops)



Not this is unnecessarily wierd and we have to run ~~pretty~~ much as pretty far.

let's just try Tender descender, it's proven, will be simple(r) to integrate (cuz we can actually get to it this year.

Actuators Rev 1 Manufacturing

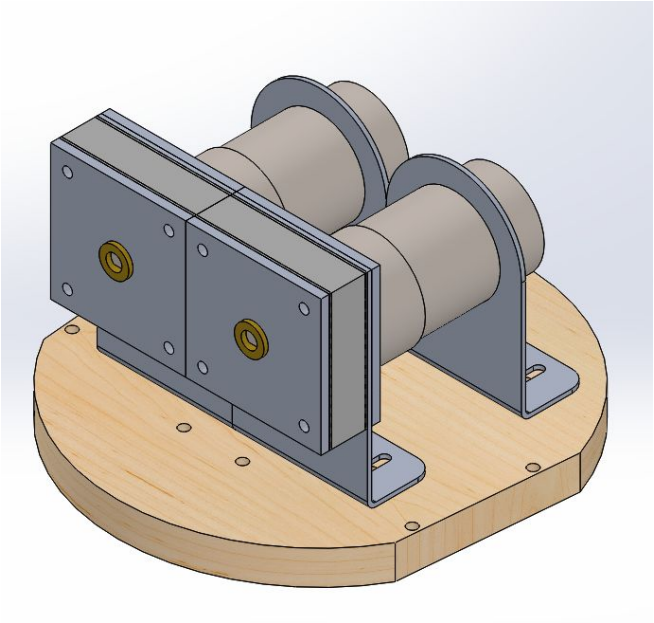
Early March, 2016 - Colin

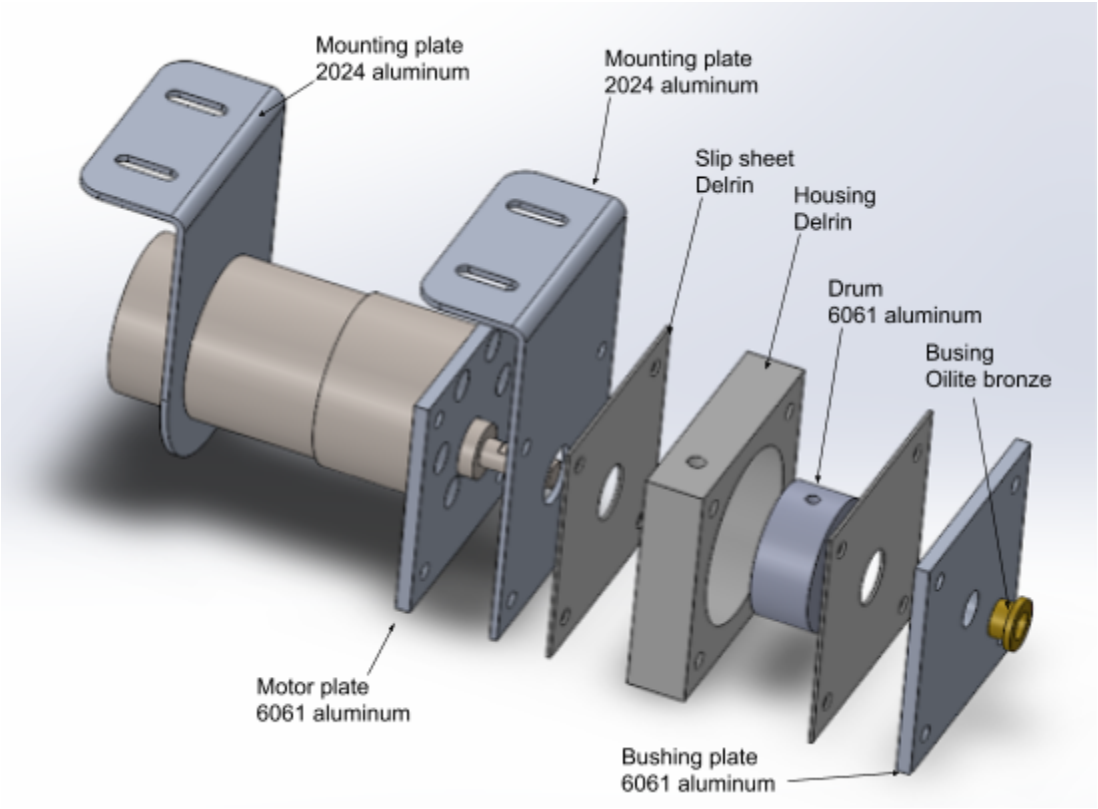
- Machining the delrin housings was very annoying. The delrin would deform under the clamp, and would then slip during cutting. I had to use the Hobby Shop's sander to fix the interior.
- Machining the drum was also very annoying. We had to use a cutoff tool to cut the groove, which Todd didn't like. And then centering the hole at the top was also hard (also, I messed it up).
- The bushings were metric, which made them very difficult to hold in the lathe. They need to be imperial next time.
- Everything else was relatively straightforward to machine.
- Assembling it was annoying at points, but not too bad.
- Inserting them into the rocket was difficult, because they're so big. I'm going to make the next revision much smaller.

Actuators Rev 2 Design

Late March, 2016 - Colin

I designed new actuators!





To make manufacturing easier:

- Imperial bushings (we need to drill out the center to 6mm)
- Flat drum (increases usable area for line, and easier to make)
- Smaller package
    - Uses a faster motor and smaller drum
- Adjustable spacing from bulkhead
- Smaller and simpler delrin housing (easier to make)

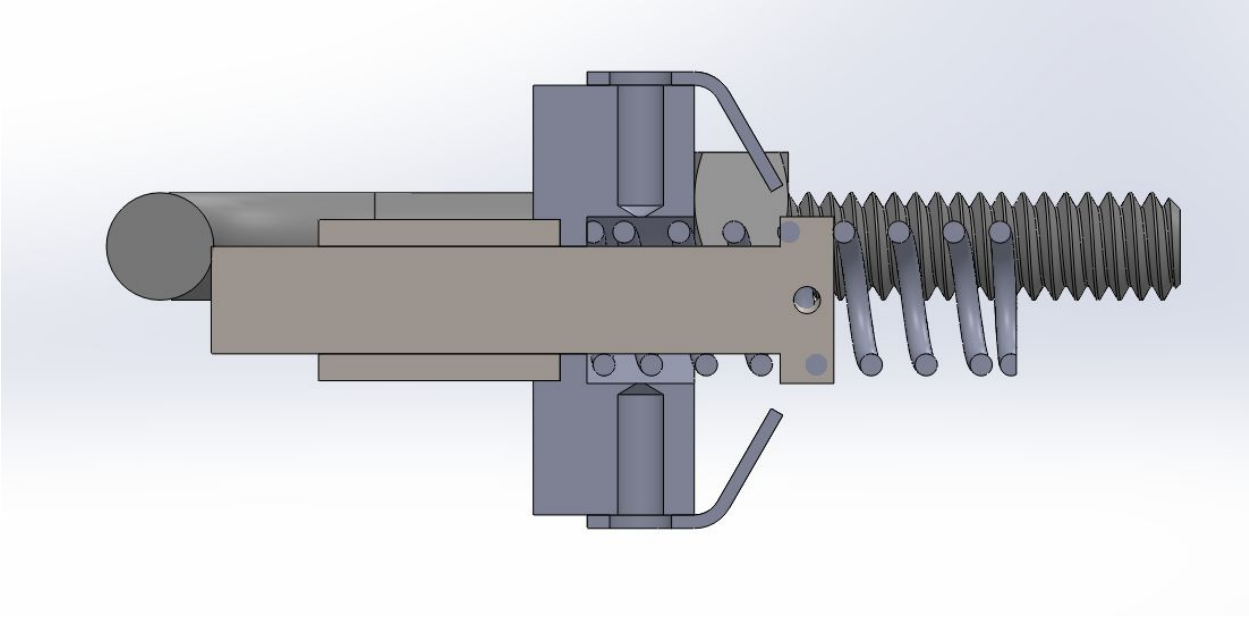
Actuators Rev 2 Manufacture

Early April, 2016 - Colin

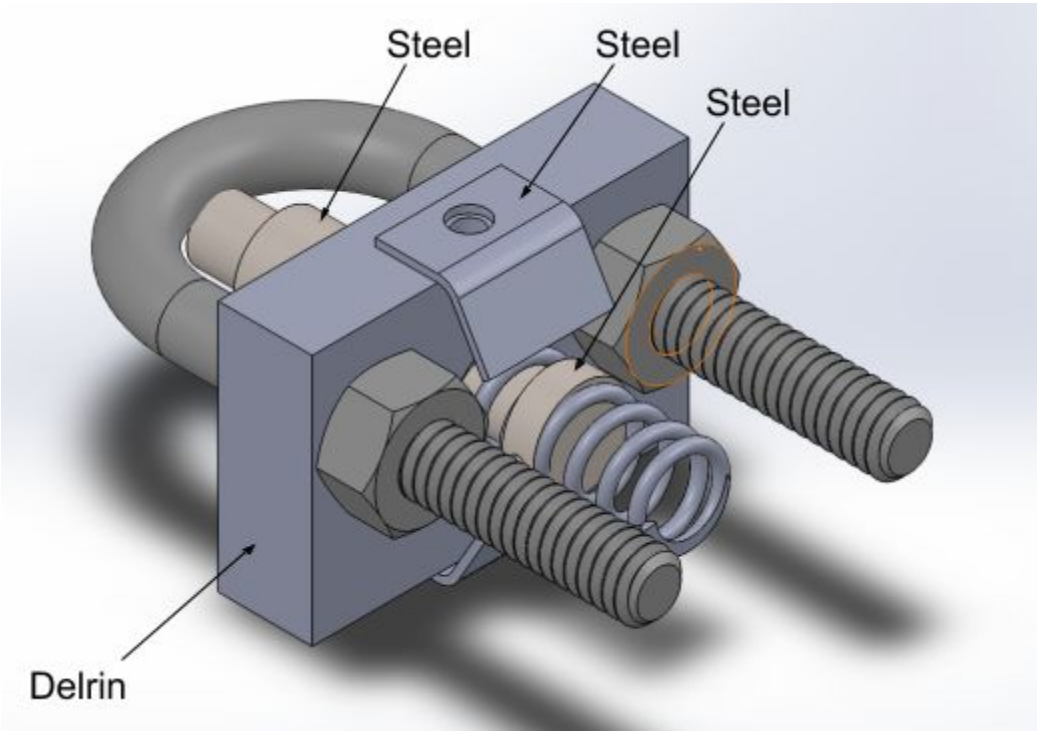
- I made a custom fixture for the delrin blocks. This made them super easy to make, and super nice.
- Bending the plates broke one of them. Never flange a plate that needs to be bent, lubricate the parts and just don't bend things with Todd's brake press. It's terrible.
- Glue in the nuts before inserting them in the rocket, because they're hard to reach.
- Threadlock the bolts that hold the housing together, because if they're too tight they stall the motor, and if they're not tightened, they come loose.

Nichrome Pin Design

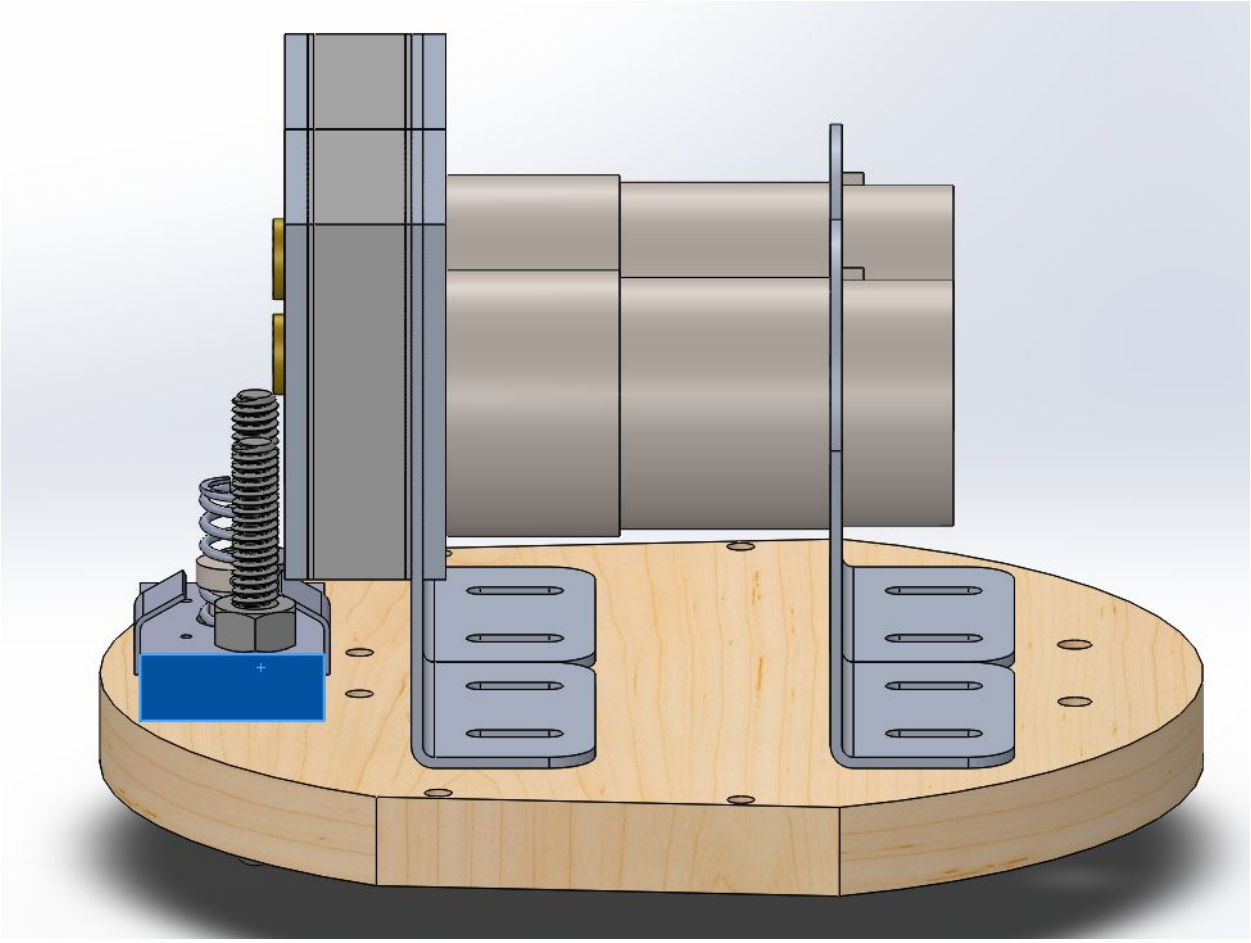
May 1, 2016 - Colin

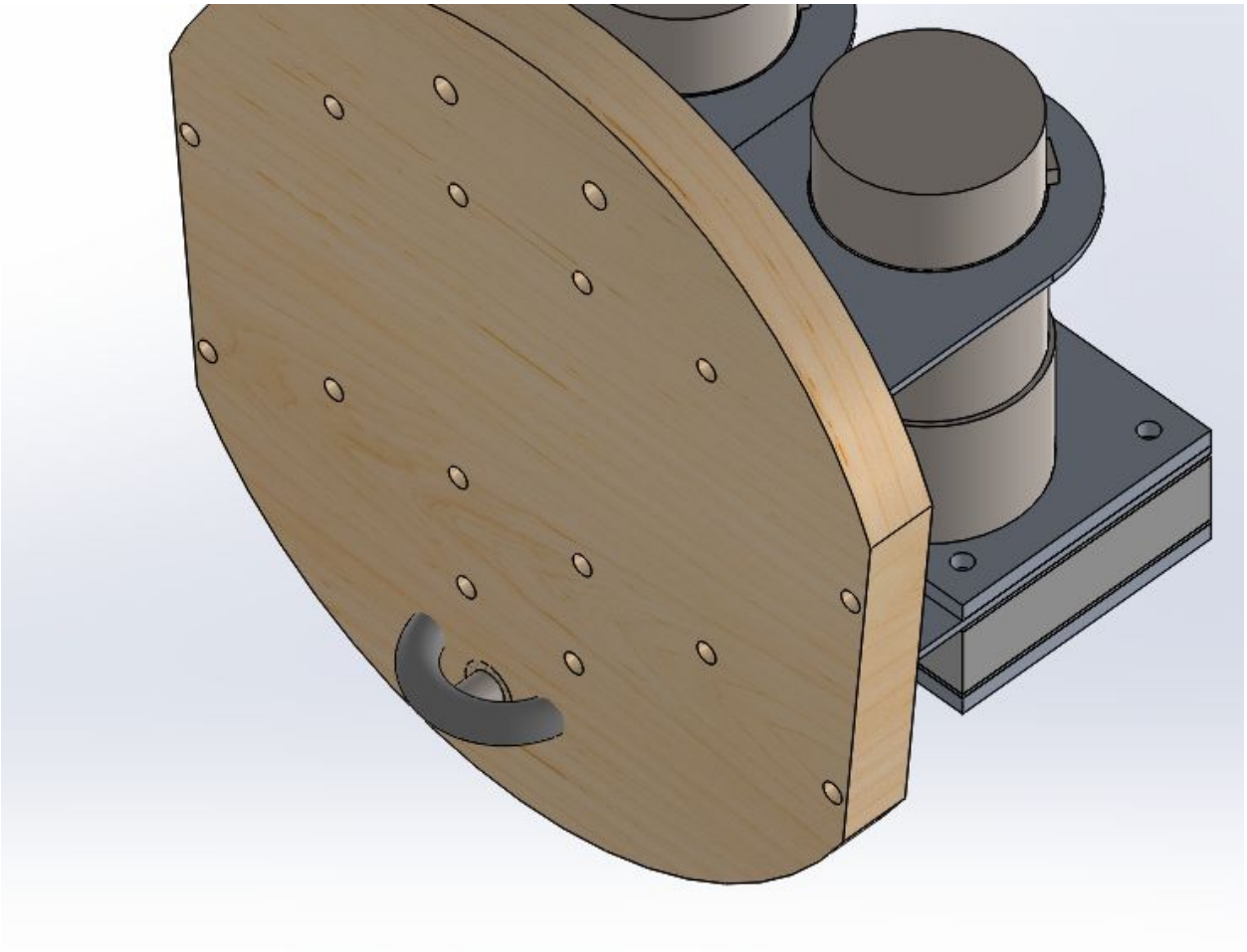


This is my first design for the nichrome pin release mechanism:



The spring exerts 26lbs of force. The minimum gauge of wire that will support this is 22AWG nichrome wire. So, for safety, use 18AWG wire.
Grease needs to be applied to the pin for every use.
The pin and sleeve are to be manufactured from steel rod.
A thread is tied through the pin as a retention device, so it doesn't go elsewhere.
The leads from the capacitor are soldered onto the bent pieces.
The U bolt needs to be epoxied into the bulkhead, and requires some manual fitting (not just straight drilled holes, unfortunately)
The design just barely fits next to the actuators. Unfortunately, the actuators will need to be removed in order to reload the pin release mechanism.
Find the CAD files here.





Nichrome Pin Testing

May 10, 2016 - Colin

I had to make some change to the design. The barrel now has a 0.5” OD, and I only drilled the spring hole down to 3/16”. Also, the inner hole was drilled out to 17/64. I lubricated the pin with Todd’s blue grease.

Anyway, I started with 22AWG nichrome wire. I put Kapton on the steel pin, then clamped the wire on one end, used a vice to compress the spring, then clamped the other end. Then I plugged it into the power supply, and it gave 10A with 2V. The wire didn’t break though.

Then I tried 36AWG nichrome wire. This broke before I even clamped it on both ends, so I deemed it too fragile.

Then I borrowed Dave’s 26AWG nichrome wire. This quickly broke under 10A, which led to the pin rather violently being ejected.

Then I borrowed Dave’s 26AWG steel wire. This also broke, maybe a little slower, under 10A, which led to the pin being violently ejected again. I tested it one more time to watch the voltage, but I couldn’t see anything when it broke so quickly. So I measured the resistance, and it was about 1R.

Charlie has posted the videos here:
https://www.dropbox.com/sh/6zu1792qyg3uf1q/AABDkK4EUYYiZXQCJDWJP-BCa?dl=0

Nichrome Pin Redesign

May 11, 2016 - Colin

I made some changes to the nichrome pin release mechanism.

- The original tabs were stainless steel, which can't be soldered to. Instead, we'll use brass.
- A pin retention method needed to be built, so this will use fishing line (which is weaker but has a higher fracture energy than metal)
- I got rid of the U-bolt in favor of a machined wall, made of delrin.
- I made almost all of it insertable from the hatch side, so make integration easier.
- The spring pushes directly on the steel barrel, which makes me feel better

Problems:

- Need square hole in bulkhead
- Fun times machining ;-) but it's delrin, so it'll be fine, probs.