PRELIMINARY DESIGN REVIEW

Team Structure

- Team Leader:
  - Michael Blackwood
  - NAR #101098L2 Certified
- Safety Officer:
  - Jay Nagy
- Team Mentor:
  - Art Upton
  - NAR #26255L3 Certified
- NAR Section:
  - Jackson Model Rocketry Club
  - Section #620

Team Leadership:

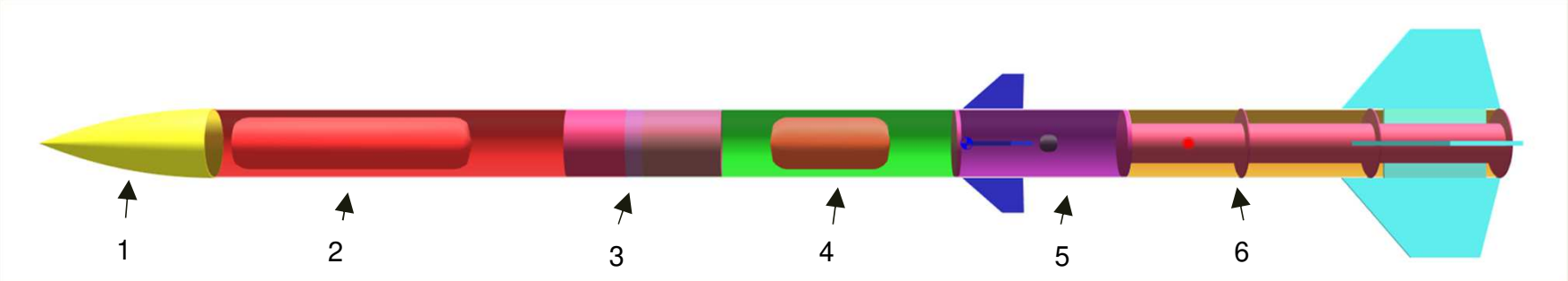
- Michael — Team Lead, Payload System Lead
- Connor — Payload Hardware Lead
- Andrew — Vehicle Body Lead, Treasurer
- Peter — Propulsion Lead
- Jay — Safety Officer
- Patrick — Recovery Lead
- Marwan — Payload Electronics Lead
- William — Education/Outreach Lead

Slide 2

1 This is a very simple section someone can take if they dont know a whole bunch
Andrew Loch, 11/7/2016

1 dibs lol
William Frey, 11/7/2016

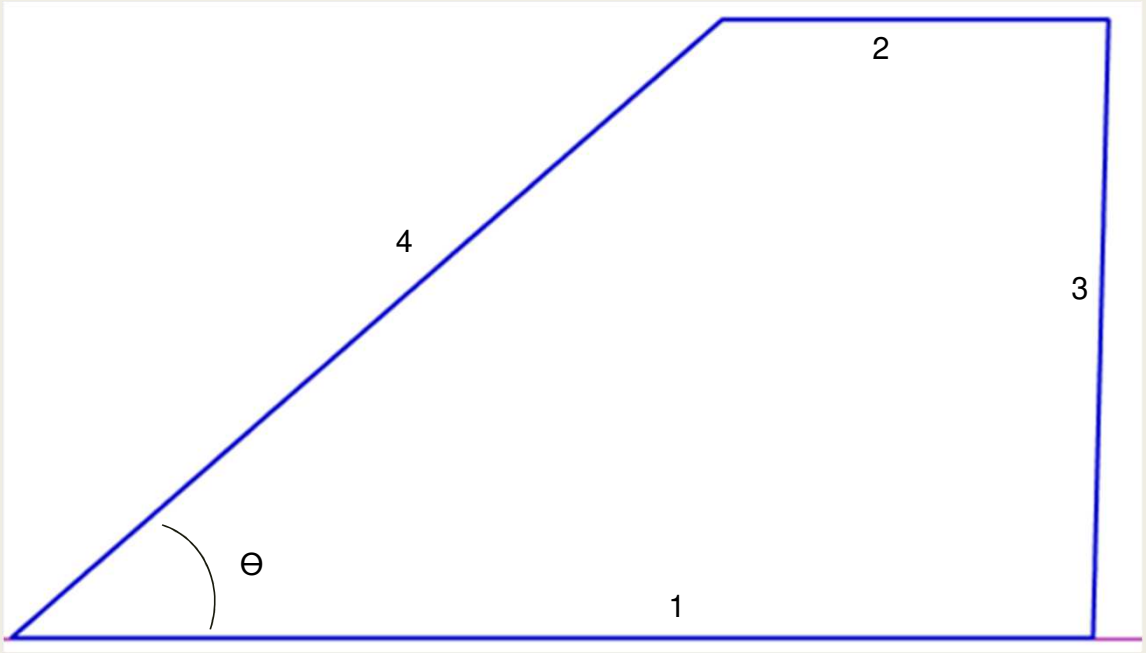
Vehicle Dimensions



	Length (in)	Outer Diameter (in)	Inner Diameter (in)
Nose cone (1)	10.16	4.00	3.84
Main Parachute Bay (2)	24.00	4.00	3.84
Recovery Bay (3)	1.00	4.00	3.84
Drag Chute Bay (4)	18.00	4.00	3.84
Payload Bay (5)	10.00	4.00	3.84
Motor Mount (6)	21.72	4.00	3.84

Nose cone Shape: Ogive

Fin Dimensions (Nard Fins)



	Number of Fins:	4
(1)	Root Chord:	3.50 in
(2)	Tip Chord:	1.25 in
(3)	Height:	2.00 in
(4)	Sweep Length:	2.30 in
	Thickness:	0.25 in
(Θ)	Sweep Angle:	49°

Slide 4

2 I can take this section too but I think it'd be better if someone else did this, not too challenging
Andrew Loch, 11/7/2016

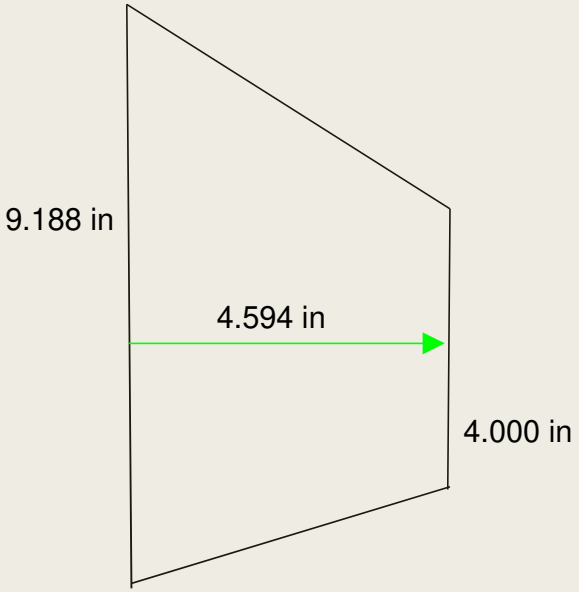
1 I can do this slide
Nathan Riethman, 11/7/2016

Fin Dimensions (Main)

Fin Flutter Calculator					
Inputs		**Units**	**Outputs**		**Units**
Shear Modulus (G)	380000	psi	Wing Area (S)	30.29284	in^2
Root Chord (c_r)	9.188	in	Aspect Ratio(AR)	0.696694	N/A
Tip Chord (c_t)	4	in	Lambda(λ)	0.43535	N/A
Semi Span (b)	4.594	in	Temperature (T)	48.32	°F
Altitude of rocket (h)	3000	ft	Pressure (P)	13.159	lb/in^2
Thickness (t)	0.25	in	Speed of Sound (a)	1105.264	ft/sec

Flutter Velocity (V_f)	2430.23278	ft/sec
	1656.976454	mph
	2.198780966	Mach

$$V_f = a\sqrt{\frac{G}{\frac{1.337AR^3P(\lambda+1)}{2(AR+2)(\frac{t}{c})^3}}}$$



Materials

Part	**Material**
Nose Cone	Plastic
Body Tubing & Motor Mount	Fiberglass
Fins (Nards & Main)	Fiberglass
Motor Retention	Metal (Steel)
Fin Fillets	JB Weld
Glue	2 Ton Epoxy

Fiberglass was chosen due to its high strength to weight ratio. It will provide the best stability for the rocket without becoming too heavy.

Plastic was chosen for the Nose Cone as it would allow a commercially made nose cone to be purchased and to reduce weight.

Steel was chosen for the motor retention for a reliable, heat resistant retention that can be used multiple times.

JB Weld will be used for the fin fillets because of its rigidity when fully cured and its superior bonding strength.

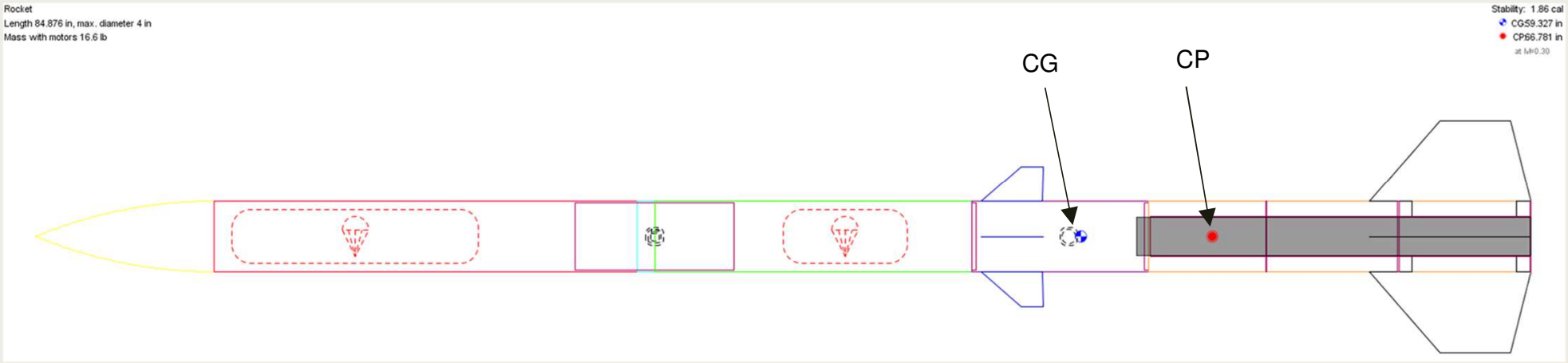
2-Ton Epoxy will be used as it will provide adequate strength bonding without excess weight.

Slide 6

3 Also a pretty easy section, basically just reading the slide adn adding a few extra words in.
Andrew Loch, 11/7/2016

1 I can do this section.
Kevin Bruns, 11/7/2016

Stability Margins (With Motor)



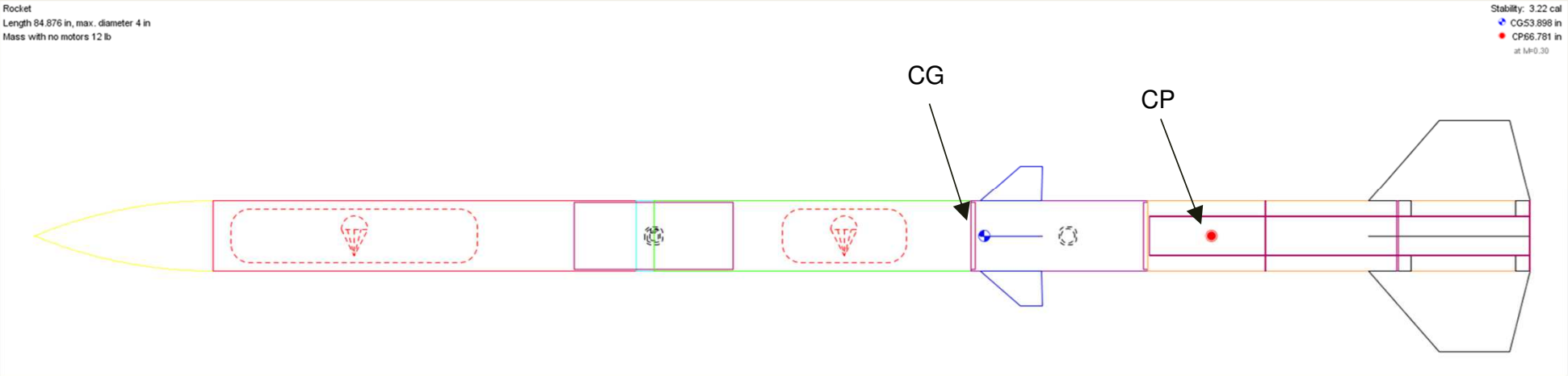
Stability Margin:	1.86 Cal
Center of Gravity:	59.327 in
Center of Pressure:	66.781 in

Motor Used: Aerotech K480W

Slide 7

4 Here we need to explain how we want to improve our stability margin and move our CG higher up while keeping the CP low.
Andrew Loch, 11/7/2016

Stability Margins (Without Motor)



Stability Margin:	3.22 Cal
Center of Gravity:	53.896 in
Center of Pressure:	66.781 in

← No Change

Slide 8

5 Maybe make references to the previous slide and say again how we want to improve the stability margin.
Andrew Loch, 11/7/2016

Preliminary Motor Selections

Primary Motor Selection: Aerotech K480W

- Will Reach and exceed the target height (~400 ft over)
- Built in weight adjustment
  - Easier to add weight than to take away
- Provides “Wiggle room” for adjustment and weather
- Built in buffer against motor underperformance
- 54mm motor mount required

Secondary Motor Selection: Aerotech K700W

- Will Reach and exceed the target height (~300 ft over)
- Built in weight adjustment
  - Easier to add weight than to take away
  - ***To be used if less weight is added than planned***
- Provides “Wiggle room” for adjustment and weather
- Built in buffer against motor underperformance
- 54mm motor mount required

Thrust vs. Weight Ratio & Rail Exit Velocity

K480W Thrust vs. Weight Ratio:
Max. Thrust: 916 N
Max. Weight: 16.6 lb = 7.53kg
Gravity: 9.81m/s

T vs W Ratio = 12.40

$$\frac{T_{max}}{W_{max}} = \frac{916\ N}{(7.53\ kg)(9.81\frac{m}{s})} = \frac{916\ N}{73.865\ N} = 12.40$$

K480W Rail Exit Velocity: 65.6 ft/sec
Rail Length: 72in

K700W Thrust vs. Weight Ratio:
Max. Thrust: 1029 N
Max. Weight: 16.5 lb = 7.48kg
Gravity: 9.81m/s

T vs W Ratio = 14.02

$$\frac{T_{max}}{W_{max}} = \frac{1029N}{(7.48\ kg)(9.81\frac{m}{s})} = \frac{1029\ N}{73.421\ N} = 14.02$$

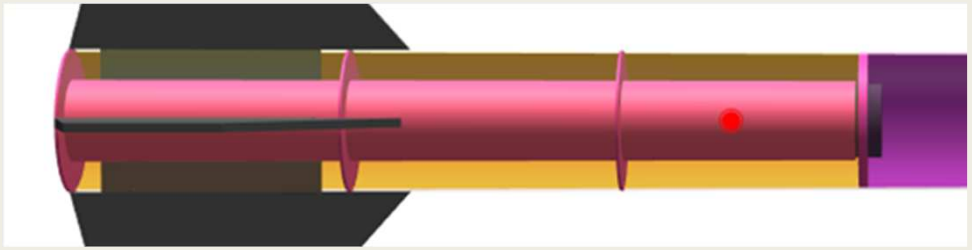
K700W Rail Exit Velocity: 70.8 ft/sec
Rail Length: 72in

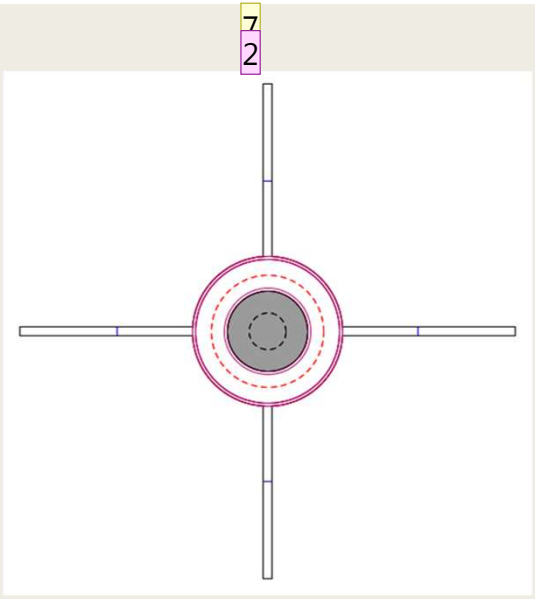
Slide 10

6 Here you want to compare the two motors we are thinking about using and just compare contrast the exit velocities and mention how regardless of the motor, we need a 72 inch rail.

Andrew Loch, 11/7/2016

Motor Mount Overview





- Length: 21.62 in
- OD: 2.283 in
- ID: 2.126 in
- Mounted to bulkhead at the bottom of the electronics bay

Slide 11

7 Say how our mount will be made of fiberglass, is for 54mm motors, and can hold both of our motors we are debating on using.
Andrew Loch, 11/7/2016

2 I can do this slide
Nathan Riethman, 11/7/2016

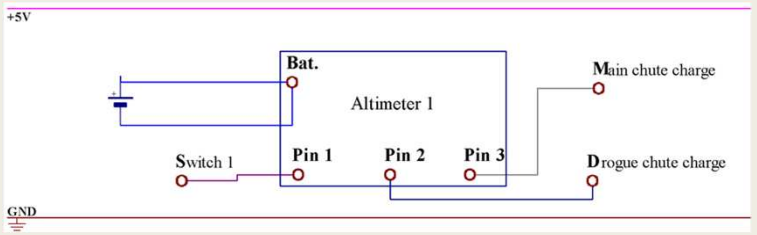
Recovery Overview

Drogue Chute

Recovery Bay
(Altimeter & Ejection Charge Housing)

Main Chute

- Drogue Chute:
  - 12”
  - Deploys at apogee
- Main Chute:
  - 72”
  - Deploys at 700ft
- Altimeter
  - StratologerCF
  - Programmed to trigger blast caps at apogee for drogue and 700 ft for main.
  - Two units
    - Each unit given independent battery
    - Each unit connects to a blast cap for the drogue and main chutes.
- 2 grams of black powder are used for each blast cap.



Recovery Overview (Cont.)

- TeleGPS unit
  - *434.55 MHz Ham Band*
  - *Interfaces with ground station to output altitude, velocity, and GPS location*
- Kinetic Energy at Impact
  - *Velocity: 22.4 ft/s*
  - *Maximum permissible Energy is 75 ft-lbf*
- Nylon Rip Stop Shock Cords
- Nomex Fire Resistant Blankets

	Nose Section	Forward Section	Aft Section
Kinetic Energy of Each Section (Ft-lbs)	19.98	9.12	65.76

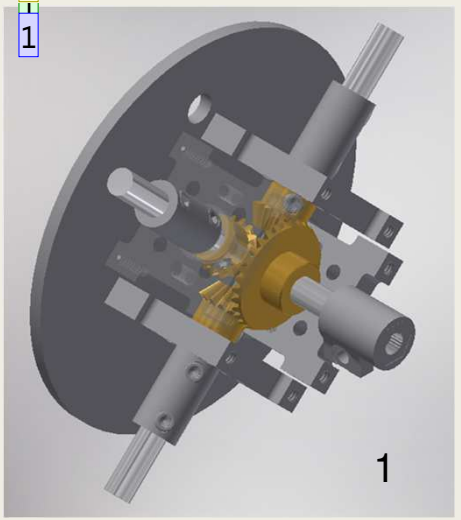
Slide 13

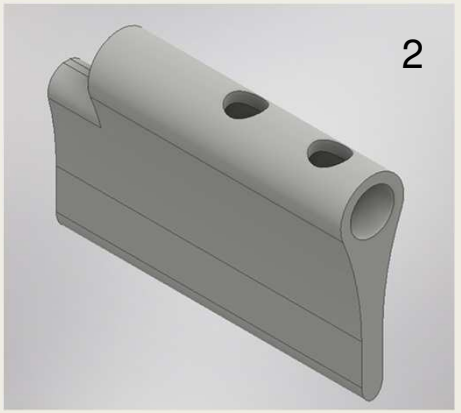
8 Mention how we are using the same GPS as last year so we are familiar with it, and our kinetic energy values are a-okay.
Andrew Loch, 11/7/2016

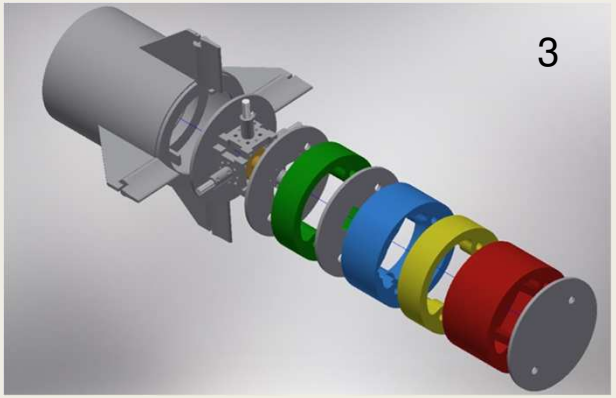
Payload Overview

The payload will consist of an active surface controlling the roll of the rocket during flight.

- Single Servo controlling a differential (Figure 1)
  - All four (4) control surfaces will move in sync
- Control surfaces will be connected via a rod system which will secure using flush screws (Figure 2)
- Breakdown of Payload System Colors (Figure 3)
  - Green
    - Spacer to guide threader rods and provide support between servo and differential bulkheads.
  - Blue
    - Top support of PCB
  - Yellow
    - Bottom support of PCB
  - Red
    - Holds battery components
- Electronics
  - Reads and stores sensor data
  - Directs control loop







Slide 14

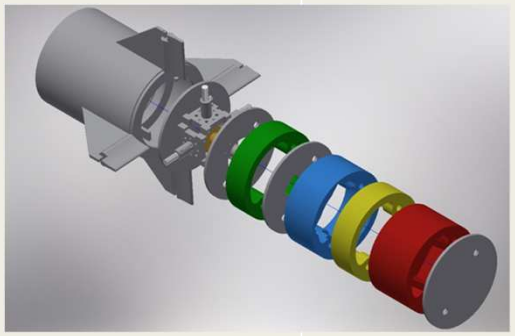
1 I can take this I am currently planning on doing the sections I am officially lead on but could add this as well. Depends on how it distributes, would rather not have 4 slides in a row.
Marwan Mohamed, 11/7/2016

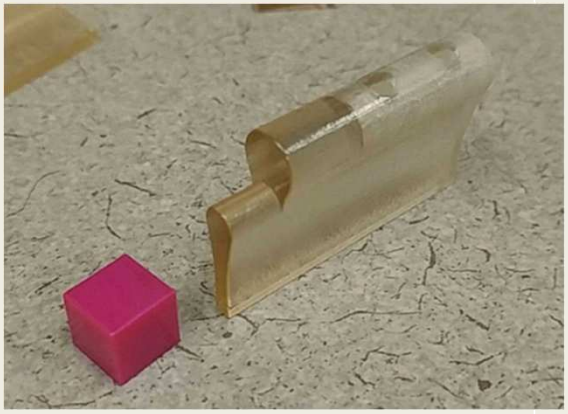
9 Just someone who knows exactly what they are talking about need to take this, go very in depth here.
Andrew Loch, 11/7/2016

1 If you want, I can take this. If you can just tell me what parts to emphasize.
Nathan McFarland, 11/7/2016

Payload Hardware

- 4 Way Pinion Differential
  - *Connects servo to control surfaces*
  - *2:1 Gear Ratio*
  - *Bevelled gears*
- Single HV 40 Kg-cm Servo Motor
  - *Found using Calculations in Matlab*
    - Equations obtained from OpenRocket Technical Documentation
    - Shows Torque over a range of deflection angles
  - *Exceeds factor of safety of 2*
  - *Metal gears*
- 2X Threaded Rod Runs Through Payload
  - *Keeps payload bay in compressions*
  - *Compresses 3D printed components*
- PCB, Battery, Servo Contained in 3D Printed Parts
- Control Fins 3D Printed
- Support Fins use Standard Rocket Fin Construction
  - *Carbon fiber internal fillets*
  - *Fumed silica external fillets*



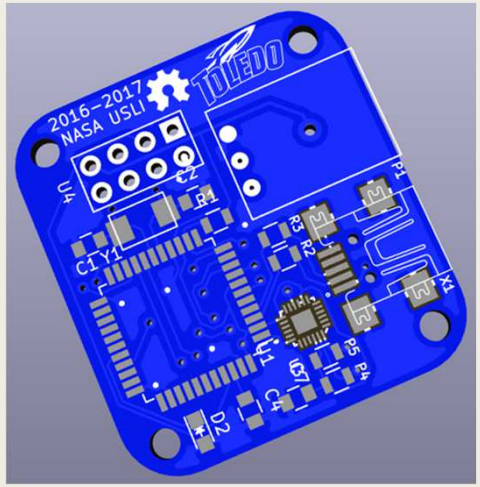


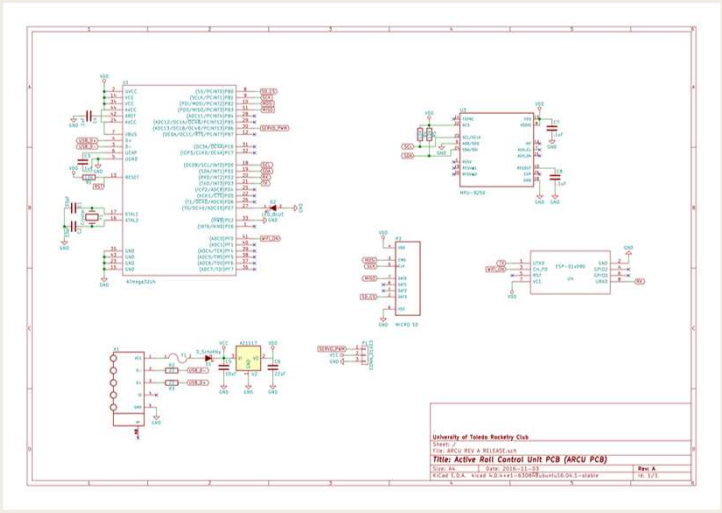
Slide 15

10 Similar as last slide, just go very in depth.
Andrew Loch, 11/7/2016

Payload Electronics

- ATmega32u4 Running Sparkfun Bootloader
  - *Compatibility with Arduino IDE*
  - *Can create and test program on standard Arduino devices*
- MPU-9250 IMU, Accelerometer, Gyroscope, Magnetometer
  - *9 degrees of freedom*
  - *Will be used to monitor roll state of rocket*
- Micro SD Data Logging in SPI Mode
  - *External storage to record roll of rocket*
  - *Quick and simple to pass to computer*
- HV (8.4-7.4V Direct) 40kg-cm Servo Motor
- 7.4V 2S 1500mAh Lipo Battery (Servo)
- ~1.5 Hour Logic Battery (9V) Life
  - *Will last through the entire launch including pad time*
  - *Exclusively for Microcontroller and sensor suite*





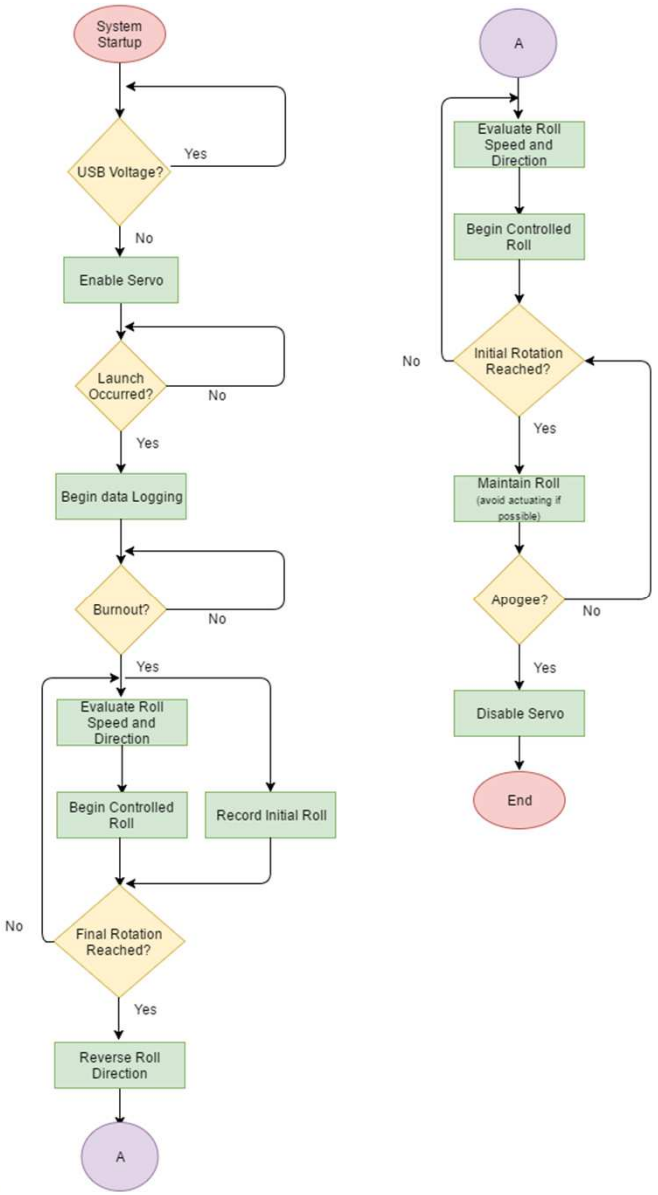
Slide 16

11 Someone else knows knows wayyyy more about this than I do.
Andrew Loch, 11/7/2016

2 See Comments section
Marwan Mohamed, 11/7/2016

Payload Control

- Microcontroller
  - *Reads data from MPU9250*
  - *Uses PID loop to determine Servo position to output*
  - *Saves data to SD card.*
- Servo Control
  - *Servo will only run when sufficient power is applied*
  - *Before burnout servo holds 0° position*
  - *Servo will move a maximum of 10° during control*
  - *Disabled after apogee*



Requirement Compliance Plan

- Follow the NAR official guidelines for proper flight preparation, launch, and recovery.
- Follow the guidelines set forth by the team Safety officer.
- Verify that all required operations fall within safe operating limits (as determined by safety officer and build conventions)

Slide 18

3 I can do this slide as well (this would be my 3rd)

Nathan Riethman, 11/7/2016

Questions?

TOLEDO

ROCKETRY CLUB