Maharishi School SLI PDR Presentation

Team “No Way But Up”

Our Team

Karthik - Safety Officer / Vehicle Design

Frank - Student Team Leader / Vehicle Design

Daniel - Payload Design

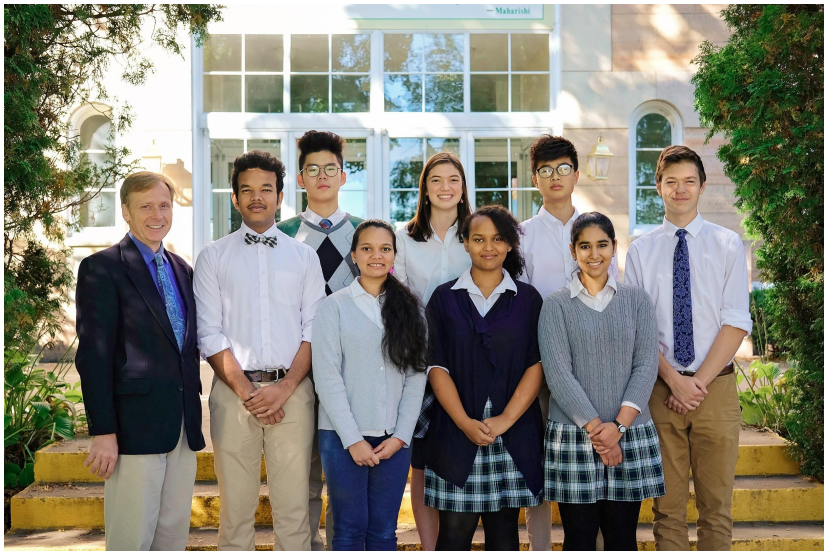
Kai - Payload Design

Lucianna (Lulu) - Educational Outreach

Yenet - Educational Outreach

Deepika - Website Content Manager

Shristi - Project and Budget Manager



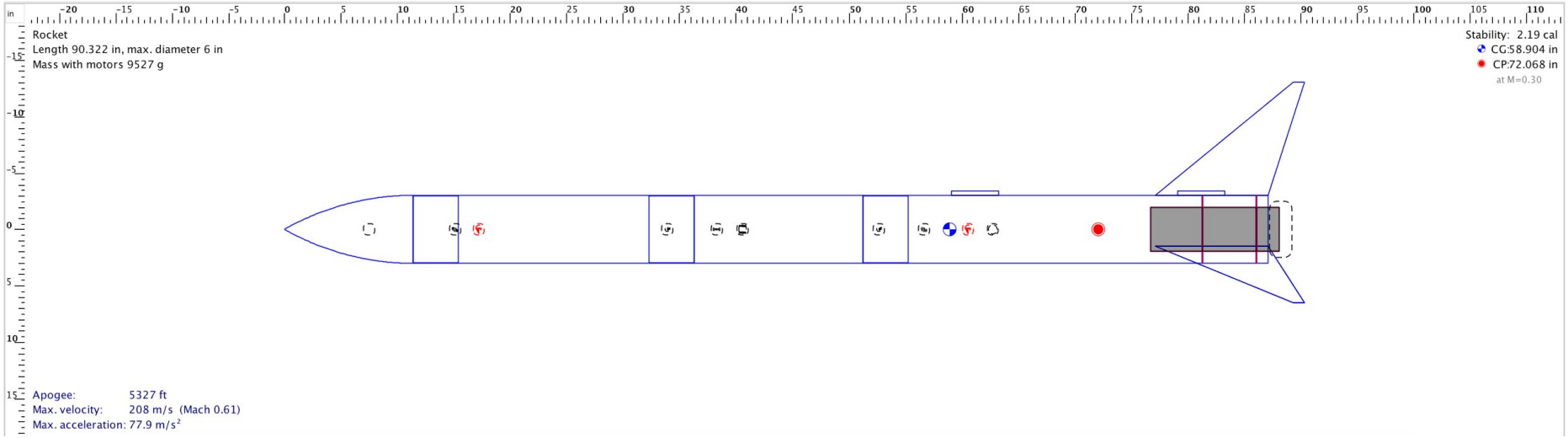
Overview/Agenda

- Vehicle Dimensions, Materials, and Justifications
- Motor Selection and Justification
- Stability
- Thrust-to-Weight-Ratio and Rail Exit Velocity
- Subsystems
  - Recovery
  - GPS
  - Full-Scale
- Payload
- Requirement Compliance Plan
- Safety
- Educational Outreach

Vehicle Dimensions, Materials Justifications

Component	Material	Qty	Weight (grams)	Total Weight (grams)	Length (inches)	Width (inches)	Thickness (inches)
Vehicle							
Nosecone	Fiberglass	1	349	349	11.41	6	0.079
Upper Body Tube	Fiberglass	1	1105	1105	25	6	0.079
Avionic Bay	Fiberglass	1	1106	1106	15	6	0.079
Lower Body Tube	Fiberglass	1	1593	1593	35.9	6	0.079
Fins	Fiberglass	3	502	502	n/a	10	0.118
Motor Retention	Aluminum	1	45	45	1	4.1	n/a
Propulsion							
Aerotech K680R Motor	APCP, plastic	1	3035	3035	11.378	3.858	n/a

Stability

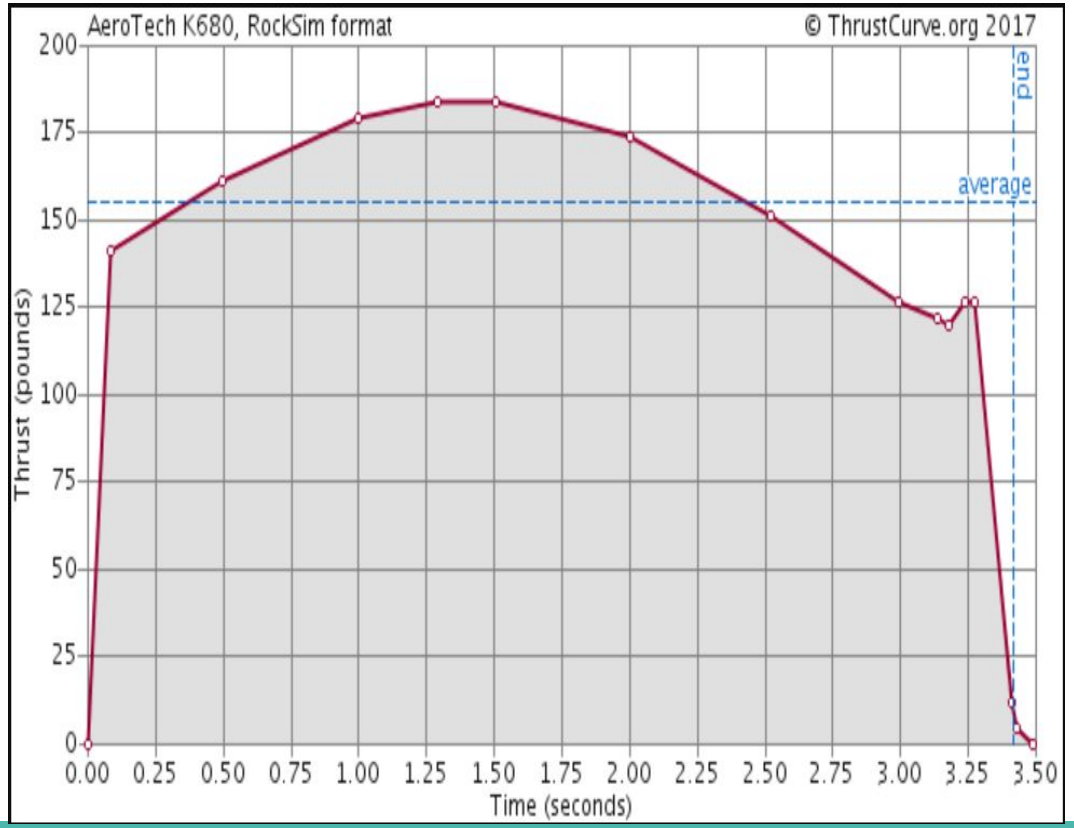

Rocket
Length 90.322 in, max. diameter 6 in
Mass with motors 9527 g
Stability: 2.19 cal
CG:58.904 in
CP:72.068 in
at M=0.30
Apogee: 5327 ft
Max. velocity: 208 m/s (Mach 0.61)
Max. acceleration: 77.9 m/s²

Motor Selection and Justification

- Final weight from our table was 9.527 kilograms, or 21 pounds
- We considered several different motors made by Aerotech
- Aerotech has a reputation for being consistent and reliable.
- Our target altitude was just above 1 mile.
- The simulations, the K680R single-use motor carried our rocket to 5,327 feet – just more of the needed 5,280 feet with a burn time of 3.5 seconds.

Thrust-to-Weight-Ratio and Rail Exit Velocity

- Motor: Aerotech K680
- Total Weight: 22.5 pounds
- Average Thrust: 152 pounds
- Max Thrust: 187.7 pounds
- Total Impulse: 530 lbs*sec
- Burn Time: 3.5 Seconds
- **Thrust to Weight Ratio: 6.91**
- **Rail Exit Velocity: 68 ft/sec**



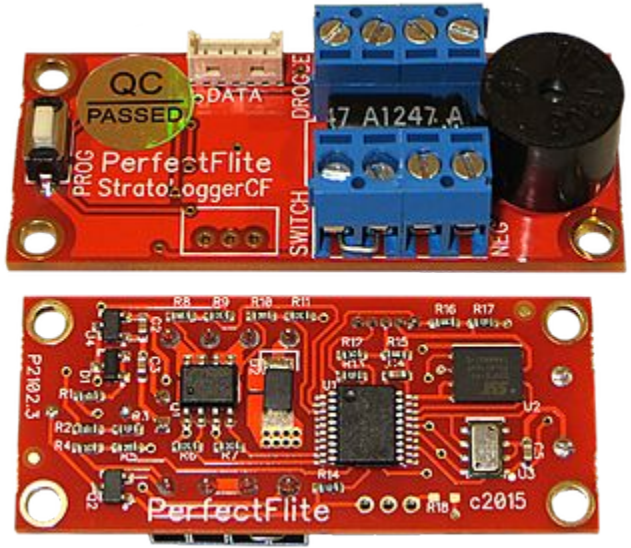
Subsystems

Recovery - Redundant Dual Deployment

GPS - Beeline GPS

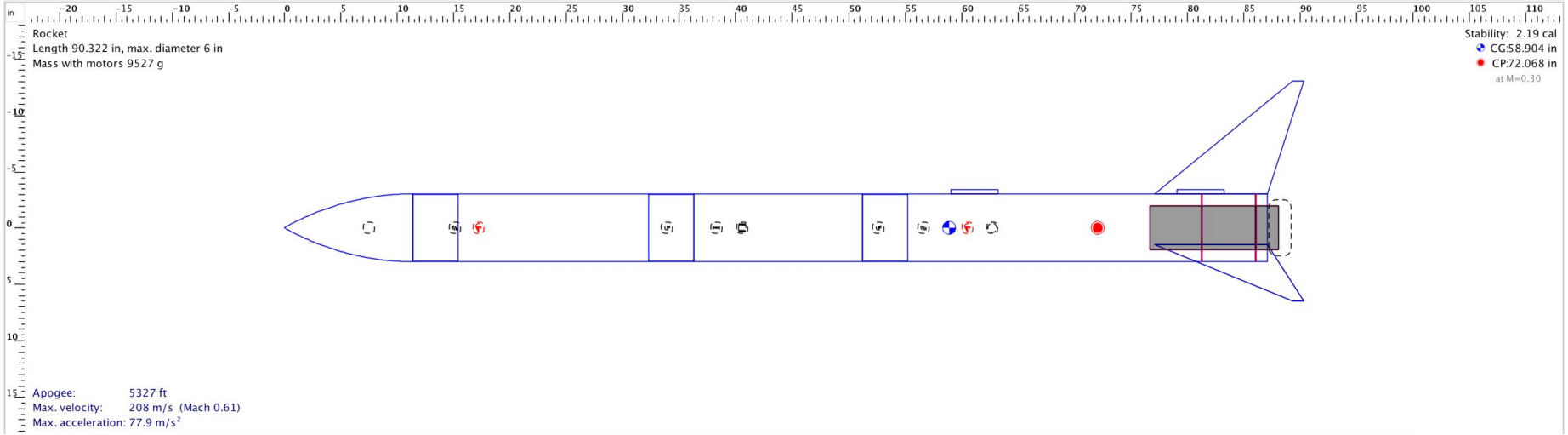
Full Scale - 90 inches (7.5 ft), Aerotech K680

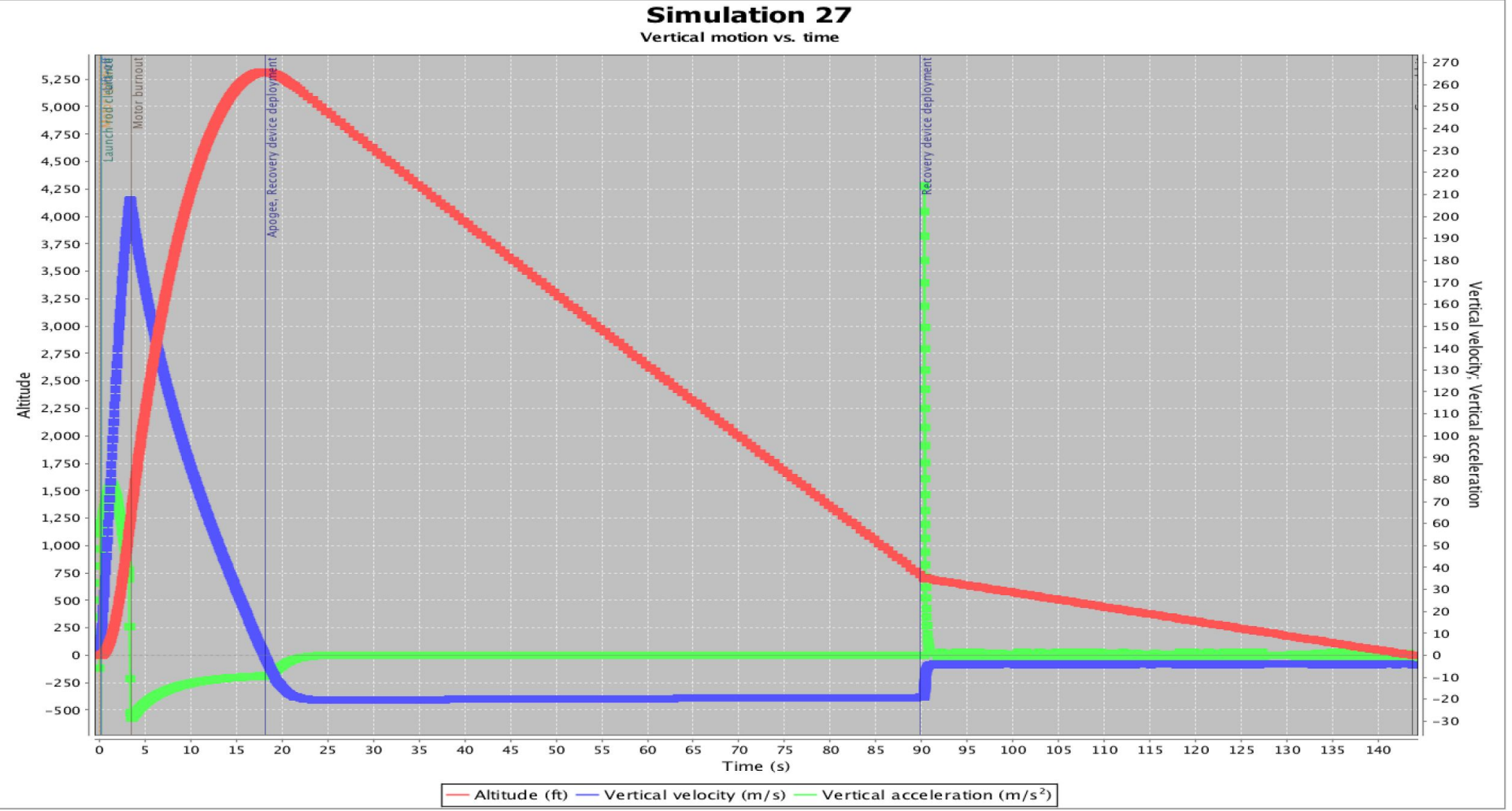
StratoLoggerCF - Perfectflite



Trackimo 3G GPS Tracker

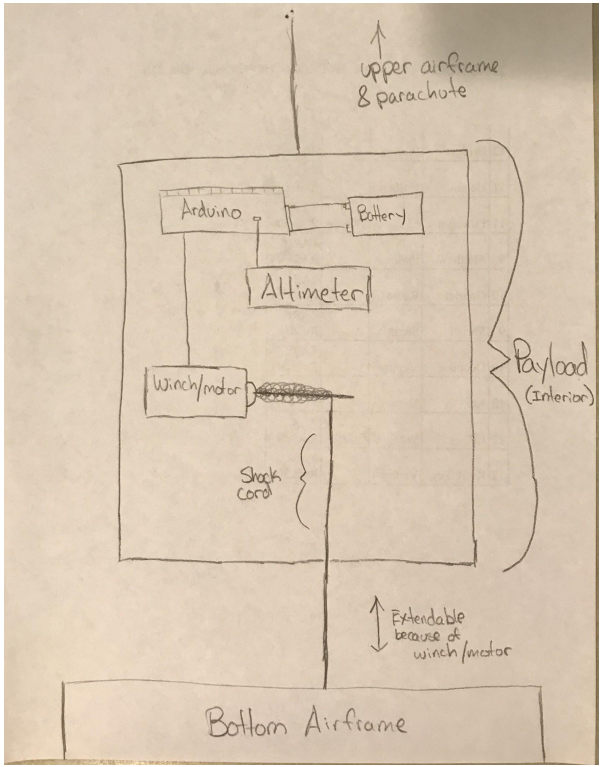
Full Scale Rocket



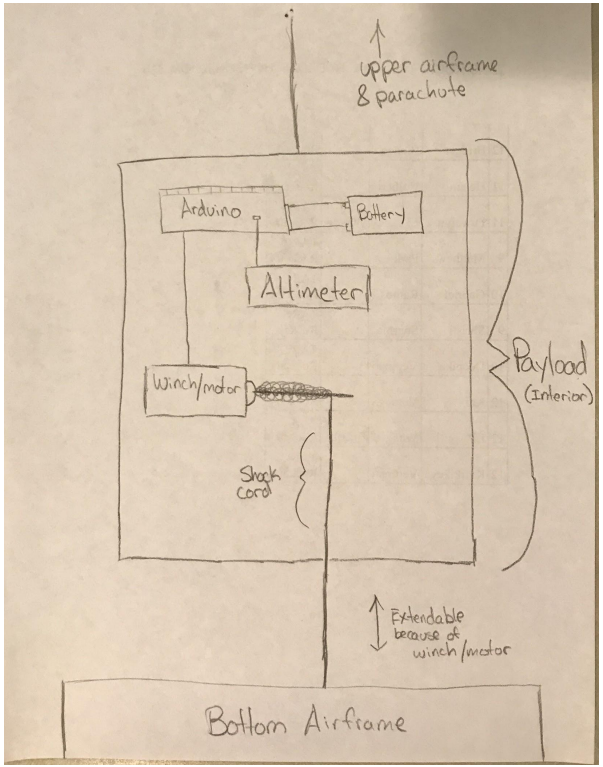

Simulation 27
Vertical motion vs. time
Launch rod cleared
Motor burnout
Apogee, Recovery device deployment
Recovery device deployment
Altitude
Vertical velocity; Vertical acceleration
Time (s)
Altitude (ft)
Vertical velocity (m/s)
Vertical acceleration (m/s²)

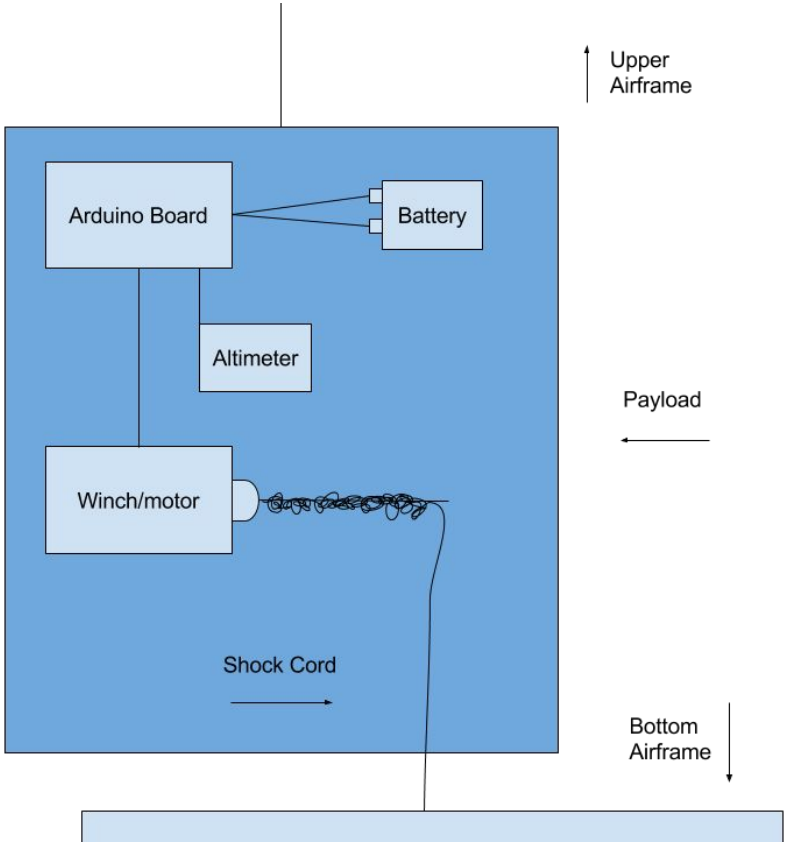
Payload

Payload will consist of a “Sky Crane” design that serves the purpose of lowering/raising the bottom airframe to meet a specific landing time requirement which we have decided to be 135-138 seconds.



Payload


upper airframe & parachute
Arduino
Battery
Altimeter
Winch/motor
Payload (Interior)
Shock cord
Extendable because of winch/motor
Bottom Airframe


Upper Airframe
Arduino Board
Battery
Altimeter
Payload
Winch/motor
Shock Cord
Bottom Airframe

Project Verification Requirements

- General
- Vehicle
- Recovery
- Payload
- Safety

Safety

Safety Officer: Karthik Vempati

- Team Safety Mission: To pursue our goals for this project in a safe and sound manner we have addressed all of the safety issues (to our best knowledge), ranked them on their severity based on our matrix and listed mitigation procedures.
- Safety concerns have been listed, ranked in terms of risk and addressed through mitigation procedures in our PDR Document.
- Below are the areas in which safety issues are identified and addressed.
    - Functionality of the Rocket and its various aspects
    - Personal Health and Safety Hazards
    - Environmental Hazards
    - Launch Operations

Risk Severity Table

Description	Value	Personnel Safety & Effect on Health	Facility and Equipment	Environmental Hazards	Effect on the Mission
Catastrophic	4	Loss of a life or permanent disabling injury	Loss of facility, systems or associated hardware	Major irreversible severe environmental damage	Complete failure of a mission related system
Critical	3	Severe injury of occupational related illness	Major damage to facilities, systems,or equipment.	Major reversible environmental damage	Partial failure of a non-mission related system
Marginal	2	Minor injury or occupational - related illness	Minor damage to facilities, systems,or equipment	Minor mitigatable environmental damage	Complete failure of a non-mission related system
Negligible	1	First aid injury or occupational related illness	Minimal damage to facility, systems,or equipment	Minimal environmental damage	Partial failure of a non-mission related system

Risk Probability/Frequency Table

Description	Qualitative Definition	Quantitative Definition
Frequent- 1	High likelihood to occur immediately or expected to be experienced continuously	Probability is > 0.1
Probable- 2	Likely to occur through expected to occur frequently within time	.1≥Probability > 0.01
Occasional- 3	Expected to occur several times or occasionally within time	0.01≥Probability > 0.001
Remote- 4	Unlikely to occur, but can be reasonably expected to occur at some point within time	0.001 ≥ Probability > 0.000001
Improbable- 5	Very unlikely to occur and an occurrence is not expected to be experienced within time	0.000001 ≥ Probability

Risk Assessment Matrix

Probability	4 -Catastrophic	3 - Critical	2 - Marginal	1 - Negligible
Frequent - 5	High Risk	High Risk	High Risk	Low Risk
Probable - 4	High Risk	High Risk	Moderate Risk	Low Risk
Occasional - 3	High Risk	Moderate Risk	Moderate Risk	Minimal Risk
Remote - 2	Moderate Risk	Moderate Risk	Low Risk	Minimal Risk
Improbable -1	Low Risk	Low Risk	Low Risk	Minimal Risk

Educational Outreach

- Doing Experiments with middle school students
  - Hoop Gliders
  - Rocket Kits
- Emailed the Science Center of Iowa

Image from: http://science4fun.info

1st Subscale Launch

- Date: Nov. 19
- Reason: Our 7,500 ft waiver ended on the 19th, because the site has shut down for the winter months
- Location: Indianola, Iowa
- Testing: Dual Deployment, Mid-power construction
- Success:
  - Went to target altitude of 2,301ft
  - Apogee charge fired and drogue chute deployed successfully
  - Rocket was safely recovered within 2,500 feet
- Issues:
  - Main chute deployed at apogee - caused by no shear pins in nose cone
  - Arming switch had to be manually activated because it was inaccessible from exterior
  - Main chute deployment charge did not fire - reason unknown