The Terra Nova Project

Preliminary Design Review

NASA USLI

FSU Panama City Senior Design Rocket Team:

Krieg Conrad, Case Dyer, Austin Zaal, Jonathan Serbest, Matthew Wilson

ROCKET TEAM MEMBERS

KRIEG CONRAD

Team Lead

Oversees project schedule, subsystem integration, finances, hardware acquisition, deliverables, and overall rocket construction.

JONATHAN SERBEST

Safety Officer

Develops and enforces safety procedures, ensures compliance with NASA/NAR/TRA codes, and oversees all hazardous material handling and construction safety.

AUSTIN ZAAL

Recovery Officer

Designs, fabricates, and tests all recovery systems including parachutes, bulkheads, and avionics bay for both subscale and full-scale rockets.

ROCKET TEAM MEMBERS

CASE DYER

Payload System Officer

Leads design, fabrication, and testing of the HAUS payload system, including soil collection mechanisms, capsule integration, and airframe transitions.

MATTHEW WILSON

Electronics Officer

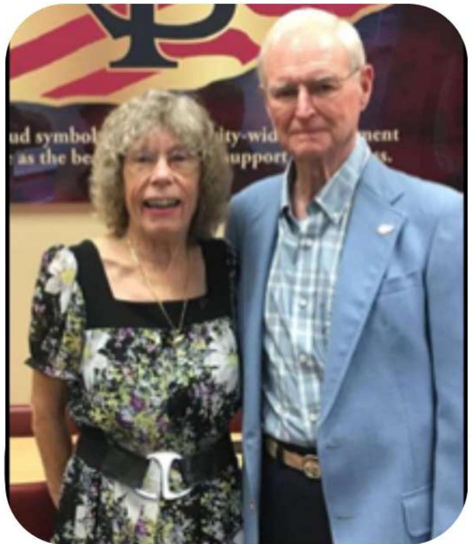
Designs and integrates avionics and payload electrical systems, ensuring redundancy, data integrity, and EMI-free operation.

JAYDEN DUARTE

Publications Officer

Manages outreach, social media, sponsor communication, and STEM engagement documentation for NASA deliverables.

ACKNOWLEDGMENTS



Jim & Sandy Dafoe

Randy Hanna, EdD

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A C K N O W L E D G M E N T S

FSU INSPIRE

ASTRO AMERICA

MARITECH

MISSION OBJECTIVES & FUNCTIONAL DECOMPOSITION

Presented by: Krieg Conrad

MISSION OBJECTIVES

APOGEE

- Rocket must reach 4,000-6,000 ft AGL during powered flight.

RECOVERY

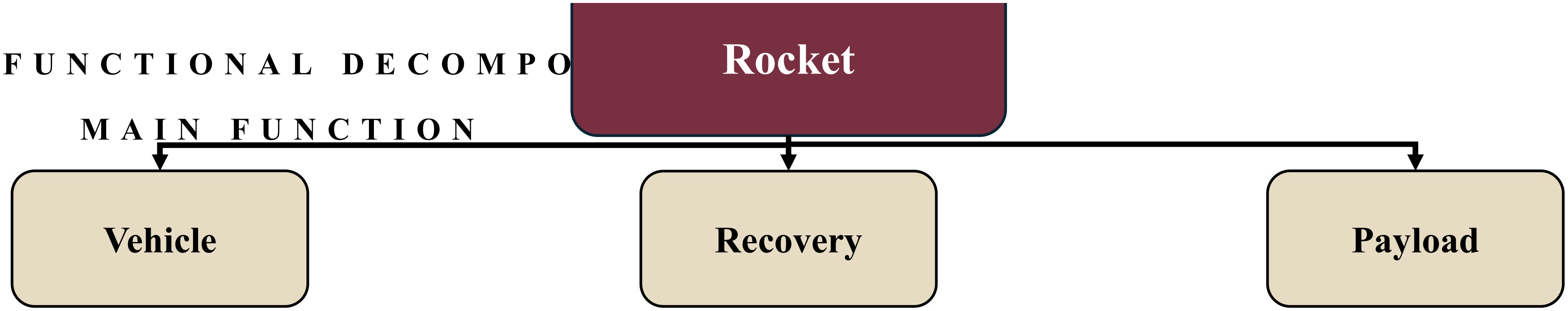
- Time from apogee to ground ≤ 80 seconds
- Impact energy ≤ 65 ft-lb per section at landing
- Must use safe, redundant deployment sequencing

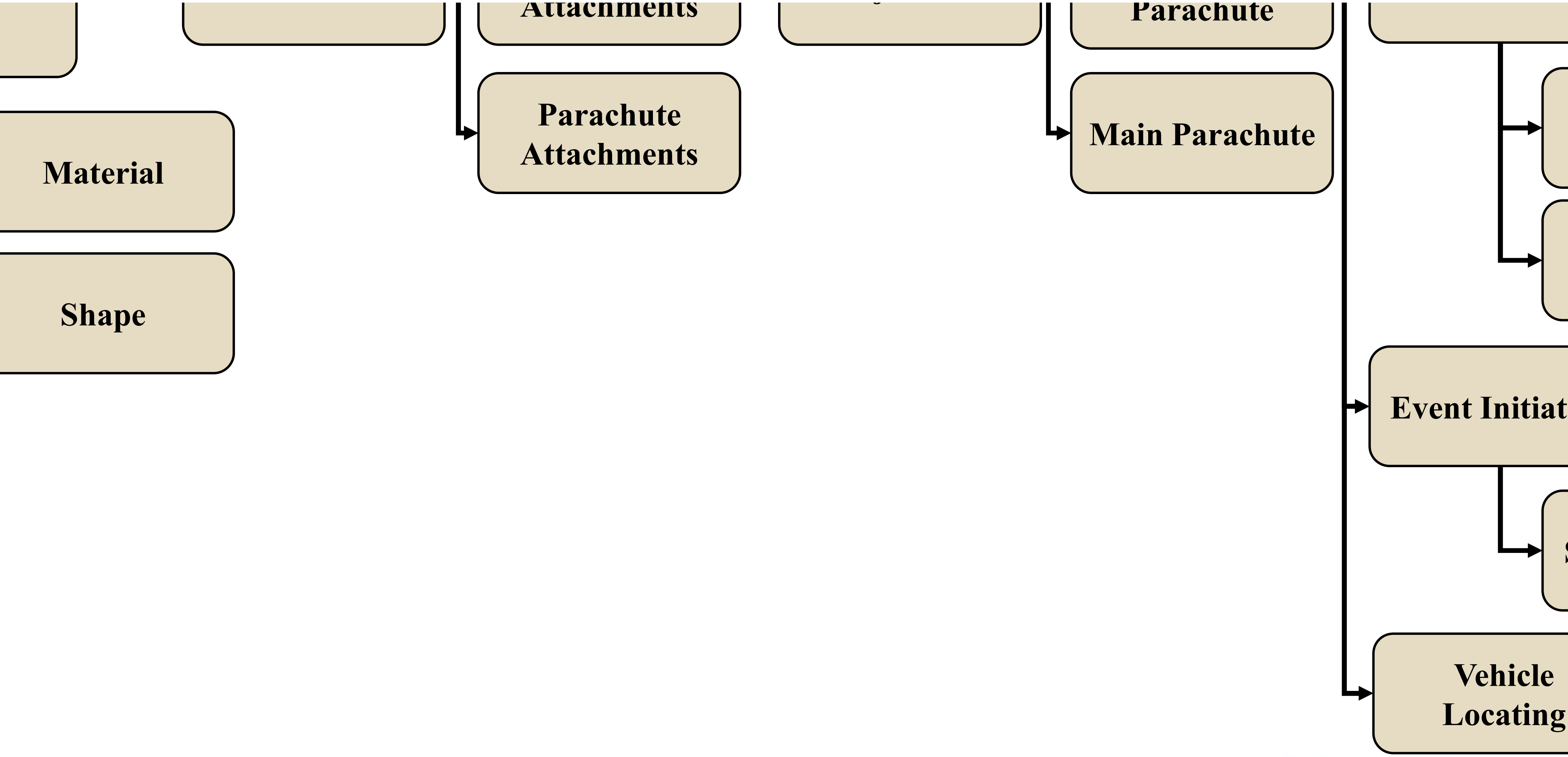
SOIL COLLECTION

- Payload must autonomously deploy after landing or in-air
- Must collect > 60 mL of soil
- Must measure and record pH of the collected sample

F U N C T I O N A L D E C O M P O

M A I N F U N C T I O N

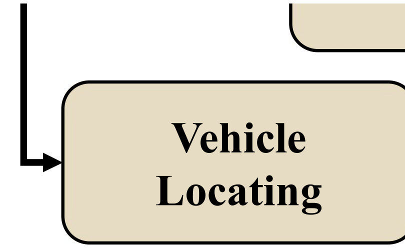



Material
Shape
Parachute Attachments
Main Parachute
Vehicle
Locating

Vehicle Locating

Material

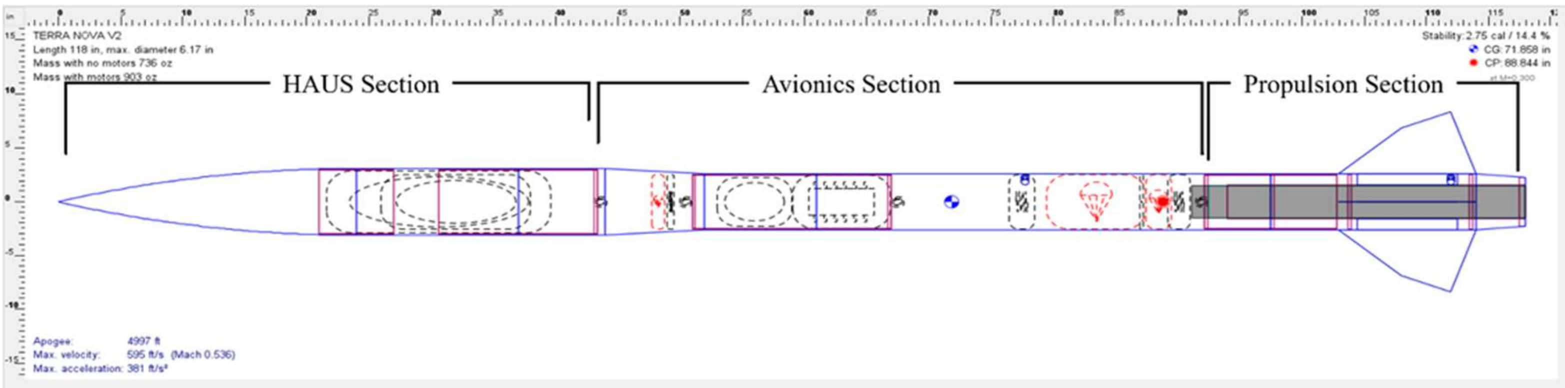
Shape


Vehicle
Locating

VEHICLE OVERVIEW

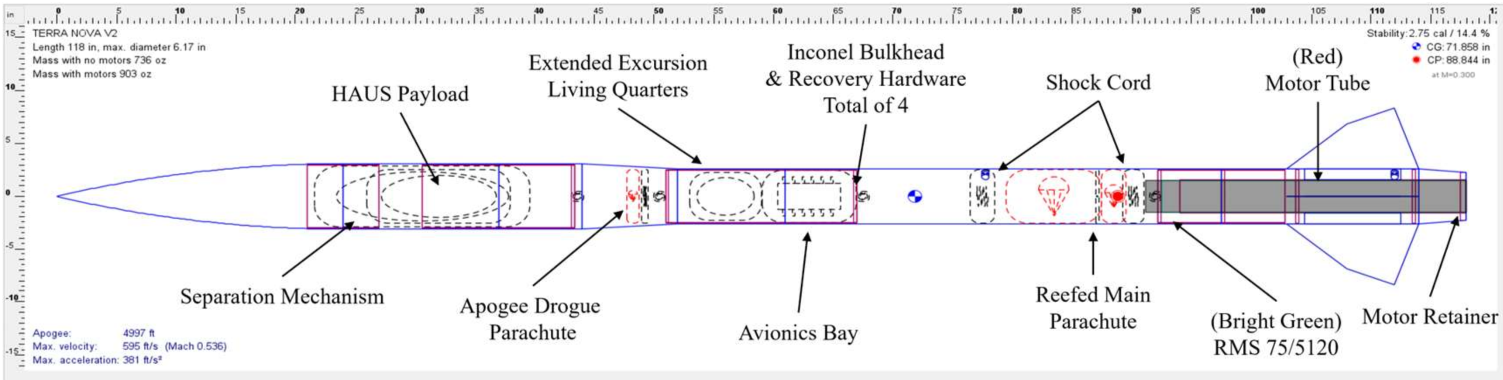
Presented by: Austin Zaal and Case Dyer

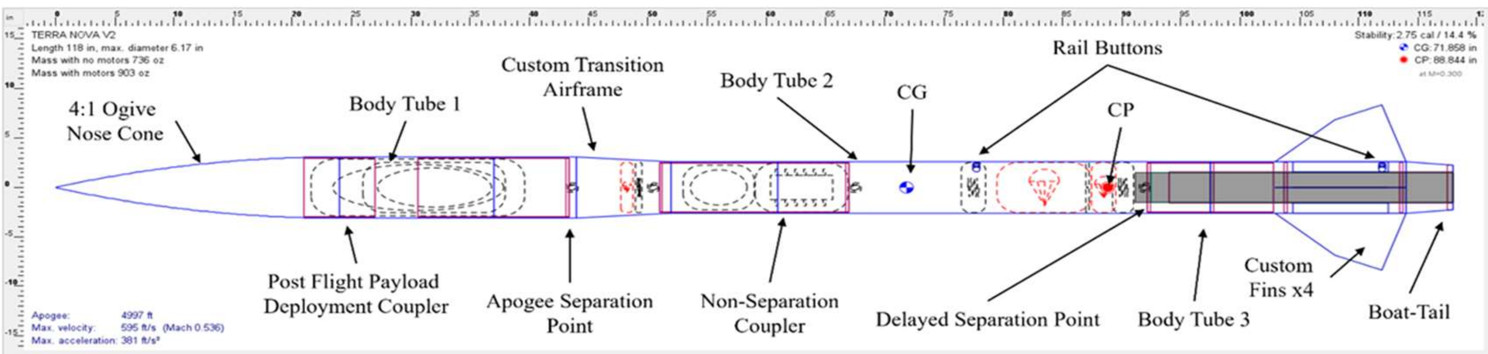
VEHICLE DIMENSIONS



Vehicle Dimensions			
Section	**External Length**	**Weight**	**ID**
HAUS	37”	250 oz	6”
Avionics	60.5”	279 oz	6”-5”
Propulsion	20.5	374 oz (w/motor)	5”
Total	118	903 oz = 56.4 lb	6” and 5”

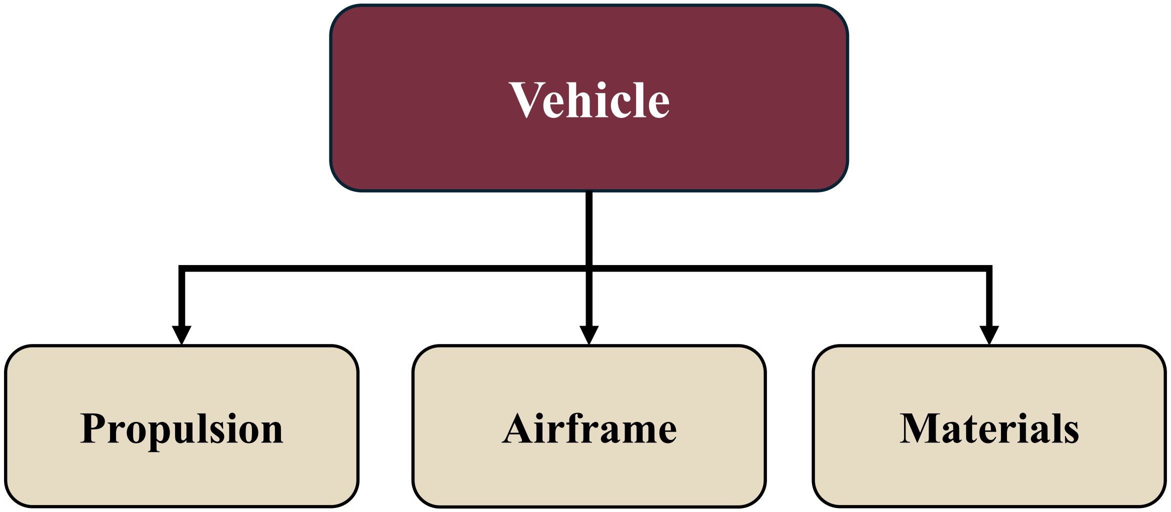
VEHICLE FIGURES





FUNCTIONAL DECOMPOSITION

VEHICLE DESIGN



MORPHOLOGICAL CHART

Subproblem Solution Concepts for Rocket										
Airframe			Propulsion		Materials					
Nose Cone	Fins	Fasteners	Priming System	Ignition Mechanism	Body	Nosecone	No Load Components	Fin	Fastener	Boat-Tail
Ogive	Trapezoid	¼-20 x ½ Bolts	Switch	NASA Electrical Ignition	Fiberglass	Fiberglass	PETG	Fiberglass	Stainless Steel 316	Fiberglass
Von Karman	Tapered Swept	¼-28 x ½ Bolts	Timer	N/A	3D printed material	3D printed material	PLA	3D printed material	2024 Aluminum	Carbon Fiber
Ellipsoid	Freeform		Remote Control	N/A	Carbon Fiber	Carbon Fiber	Fiberglass	Carbon Fiber	6061 Aluminum	Inconel 718
Parabolic	Elliptical		Inserted Component	N/A	Blue Tube	Phenolic	N/A	Phenolic	N/A	Aluminum 6061
Conical	Triangular		Key	N/A	Phenolic	N/A	N/A	N/A	N/A	Steel 1020

NOSE CONE MATERIAL SELECTION

4:1 Ogive Nose Cone			Fiberglass			Carbon Fiber		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.25	USD	191	10	2.5	239	7	1.75
Strength	.3	ksi	80.6	9	2.7	87.0	10	3
Density	.25	$\frac{lb}{in^3}$	.0650	9	2.25	.0578	10	2.5
Handling Safety	.2	Safety Score	6	10	2	6	10	2
Overall Score:					9.45			9.25

BOAT-TAIL MATERIAL SELECTION

Boat-Tail			Fiberglass			Carbon Fiber			Inconel 718			Aluminum 6061			Steel 1020		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.15	USD/Volume	1.10	10	1.5	11.7	4	.6	13.5	3	.45	1.90	9	1.35	9.5	8	1.2
Tensile Strength	.1	ksi	80.6	5.5	.55	87.0	7	.7	139	10	1	51.6	4	.4	81	6	.6
Density	.25	$\frac{lb}{in^3}$	.0650	9	2.25	.0578	10	2.5	.296	3	.75	.0982	8	2	.284	3.5	.875
Manufacturing and Handling Safety	.15	Safety Score	6	6	.9	6	6	.9	3	10	1.5	3	10	1.5	3	10	1.5
Flame Retardant	.2	Flammability Class	B	6	1.2	B	6	1.2	A	10	2	A	10	2	A	10	2
Machinability/ Fabrication	.15	Experience/Available Equipment	3	3	.45	3	3	.45	7	7	1.05	10	10	1.5	8	8	1.2
Overall Score:					6.85			5.17			6.75			8.75			7.38

TRANSITION MATERIAL SELECTION

Reducing Transition			Fiberglass			Carbon Fiber			Creality PETG			Creality PLA			Creality PETG & Fiberglass Composite		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.15	$\frac{USD}{in^3}$	1.10	7	1.05	11.7	2	.3	.387	9.75	1.46	.370	10	1.5	.637	8.5	1.28
Strength	.30	ksi	80.6	9.75	2.93	87.0	10	3.0	7.25	3.5	1.05	7.69	3.75	1.13	80.6	9.75	2.93
Density	.25	$\frac{\text{lb}}{\text{in}^3}$	.0650	6	1.5	.0578	7.5	1.13	.0448	10	2.5	.0452	9	2.25	.0512	8.5	2.13
Handling Safety	.15	Safety Score	6	5	.75	6	5	.75	2	10	1.5	2	10	1.5	6	5	.75
Formability	.15	Experience / Available Equipment	5	5	.75	5	5	.75	10	10	1.5	9.5	9.5	1.35	7	7	1.28
Overall Score:					6.98			5.93			8.01			7.73			8.13

BODY TUBE AND COUPLER MATERIAL SELECTION

Body Tube and Coupler			Fiberglass			Carbon Fiber		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.35	$\frac{USD}{in}$	8.26	10	3.5	18.8	4	1.4
Strength	.30	ksi	80.6	8	2.4	87.0	10	3.0
Density	.25	$\frac{\text{lb}}{\text{in}^3}$	.0650	8.5	2.13	.0578	10	2.5
Handling Safety	.10	Safety Score	6	10	1.0	6	10	1.0
Overall Score:					9.03			7.9

BULKHEAD MATERIAL SELECTION

Bulkheads			Creality PETG			Creality PLA			Inconel 718		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.25	USD/Volume	.387	2	.4	.370	2	.4	N/A	10	2.5
Tensile Strength	.30	ksi	2	3.5	1.05	2	3.75	1.05	139	10	3
Density	.30	$\frac{lb}{in^3}$	.0448	10	3	.0452	9	2.7	.296	2	.6
Handling Safety	.15	Safety Score	2	10	1.5	2	10	1.5	3	8	1.2
Overall Score:					5.95			5.65			7.3

FIN MATERIAL SELECTION

Custom Fins			Fiberglass			Carbon Fiber			Creality PETG			Creality PLA		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.15	$\frac{USD}{in^3}$	1.10	7	1.05	11.7	2	.3	.387	9.75	1.46	.370	10	1.5
Strength	.40	ksi	80.6	9.75	3.9	87.0	10	4	7.25	3.5	1.4	7.69	3.5	1.4
Density	.20	$\frac{\text{lb}}{\text{in}^3}$	.0650	6	1.2	.0578	7	1.4	.0448	10	2	.0452	9	1.8
Handling Safety	.15	Safety Score	6	5	.75	6	5	.75	2	10	1.5	2	10	1.5
Formability	.10	Experience / Available Equipment	7.5	7.5	.75	7.5	7.5	.75	10	10	1.0	9	9	.9
Overall Score:					7.65			7.2			7.36			7.1

CENTERING RING MATERIAL SELECTION

Centering Rings			Fiberglass			Carbon Fiber			Creality PETG			Creality PLA		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.25	$\frac{USD}{in^3}$	1.10	7	1.75	11.7	2	.5	.387	9.75	2.44	.370	10	2.5
Strength	.20	ksi	80.6	9.75	1.95	87.0	10	2	7.25	3.5	.7	7.69	3.5	.7
Density	.30	$\frac{\text{lb}}{\text{in}^3}$	.0650	6	1.8	.0578	7	2.1	.0448	10	3	.0452	9	2.7
Handling Safety	.15	Safety Score	6	5	.75	6	5	.75	2	10	1.5	2	10	1.5
Formability	.10	Experience / Available Equipment	7.5	7.5	.75	7.5	7.5	.75	10	10	1.0	9	9	1.0
Overall Score:					7.0			6.1			8.64			8.4

MOTOR TUBE MATERIAL SELECTION

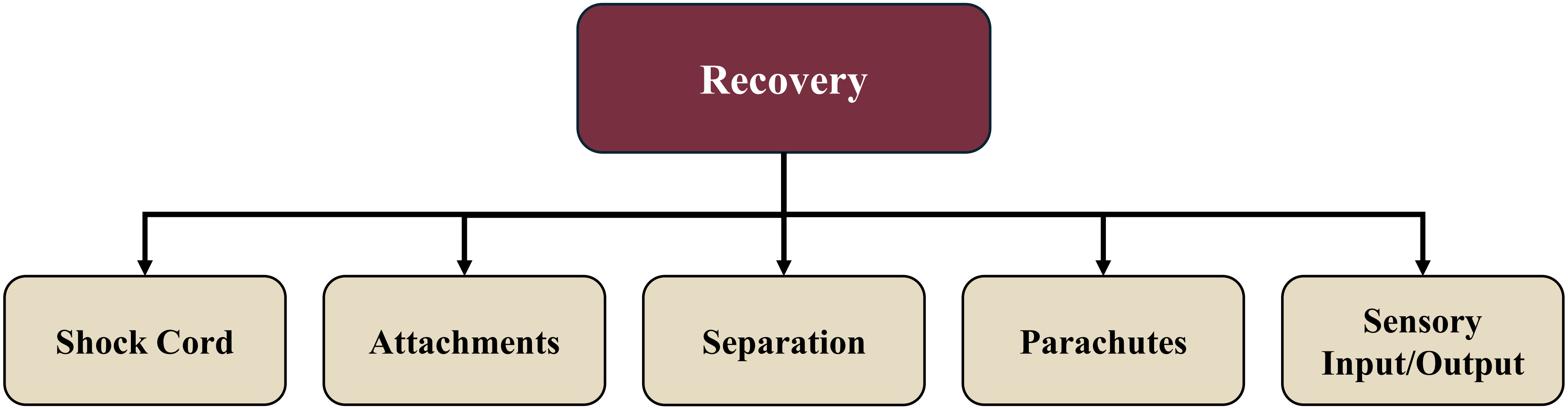
Motor Tube			Fiberglass			Cardboard			Phenolic		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.35	$\frac{USD}{in^3}$	2.10	4	1.4	.682	10	3.5	.716	9	2.25
Strength	.20	ksi	25.4	10	2.0	4.21	4	.8	13.5	7.5	1.5
Density	.30	$\frac{\text{lb}}{\text{in}^3}$	.0650	6	1.8	.0450	10	3	.0450	10	3
Handling Safety	.15	Safety Score	6	6	.9	2	10	1.5	2	10	1.5
Overall Score:					6.1			8.8			8.25

R E C O V E R Y S Y S T E M

Presented by: Austin Zaal and Matthew Wilson

FUNCTIONAL DECOMPOSITION

RECOVERY SYSTEM



MORPHOLOGICAL CHART

Recovery Systems					
Shock Cord				Attachments	
Cord Material	**Design Concept**	**Drogue Length (Multiplier of Rocket Diameter)**	**Main Length (Multiplier of Rocket Diameter)**	**Cord Attachment Type**	**Cord Attachment Material**
Kevlar (0.25” Diameter)	Base-Elastic Hybrid	20	20	3/8” Eye Bolt	Stainless Steel 316
Paramax (0.25” Diameter)	Base Material Only	30	30	3/8” U Bolt	2024 Aluminum
N/A	N/A	40	40	N/A	6061 Aluminum

MORPHOLOGICAL CHART

Recovery Systems						
Separation				Sensory Input/Output		Parachute
Method	**Drogue Separation Event**	**Main Separation Event**	**Main 2^{nd} Sequenced Event**	**Event Initiation**	**Main Sequencing Device**	**Main Sequencing**
Black Powder Charge	Apogee	2000 ft	1500 ft	Altimeter/Flight Computer	Tender Descender (Pilot-Main)	Pilot-Main
CO2 Ejection	N/A	1500 ft	1000 ft	Timer	Reef-line cutter (Reefed Main)	Reefed Main
N/A	N/A	1000 ft	750 ft	N/A	N/A	N/A

RECOVERY SYSTEM SELECTION

Recovery Selections					
Shock Cord			Separation		
Problem	**Selection**	**Justification**	**Problem**	**Selection**	**Justification**
Cord Material	Paramax Cord	• High TS (1200lb) • Low Weight • Elasticity	Method	CO_2 Ejection	• Minimal Pyrotechnics Needed • Safe for Recovery Hardware
Drogue Length	30x Rocket Diameter (15 ft)	• Drogue Altitude Below Main • Sufficient Length	Drogue Separation	Apogee	• Specified Requirement by NASA
Main Length	40x Rocket Diameter (20 ft)	• Main Altitude Above Drogue • Sufficient Length	Main Separation	1500 ft	• Meets Energetic Altitude Requirement • Sufficient Height for Sequencing
Design Concept	Base Cord Only	• Cord & Body can Withstand Recovery Loads • Easer to Fabricate	Main Sequence Event	750 ft	• No Energetics Needed • Achieves Flight Time and Impact Energy Goals

RECOVERY SYSTEM SELECTION

Recovery Selections					
Shock Cord			Separation		
Problem	**Selection**	**Justification**	**Problem**	**Selection**	**Justification**
Cord Material	Paramax Cord	• High TS (1200lb) • Low Weight • Elasticity	Method	CO2 Ejection	• Minimal Pyrotechnics Needed • Safe for Recovery Hardware
Shock Cord Length	4x Rocket Length (40 ft)	• Drogue Altitude Below Main • Sufficient Length	Drogue Separation	Apogee +1s	• Specified Requirement by NASA
Design Concept	Base Cord Only	• Cord & Body can Withstand Recovery Loads • Easer to Fabricate	Main Events	1000 ft / 650 ft	• Meets Energetic Altitude Requirement • Sufficient Height for Sequencing • Main Separation / Reef Event
			CO2 Sizing	25g / 38g / 45g	• 25g for Drogue Separation / 38g for redundancy • 38g for Main Separation / 45g for redundancy

RECOVERY SYSTEM SELECTION

Recovery Selections

Parachute			Attachments			Sensory Input/Output		
Problem	**Selection**	**Justification**	**Problem**	**Selection**	**Justification**	**Problem**	**Selection**	**Justification**
Main Sequencing	Reefed Main	• Accomplishes Time to Ground and Impact Energy Goals • Simpler than Pilot-Main Design	Cord Attachment Device	Eye Bolt	• Single Load Concentration • Distributes Load Across Bulkhead	Event Control	Telemetrum / EZ Mini flight computers	• Separation 1 at Apogee • Separation 2 at 1000 ft • Reef Cut at 650 ft
Drogue Size	15”	• Accomplishes Time to Ground and Impact Energy Goals	Cord Attachment Material	Stainless Steel 316	• Commercially Available Parts • Sufficient Strength	Event Initiation	E-Matches to Contained BP Charge	• CO2 Canisters & Reef Cutters initiated via Energetic Event
Reefed Main Size	36”	• Accomplishes Time to Ground and Impact Energy Goals				Arming Device	Screw Switch	• Simple to install • Easy to access from outsize airframe
Full Main Size	120”	• Accomplishes Time to Ground and Impact Energy Goals				Power Device	9V Lithium Battery	• Sufficient Power Capability for All Devices

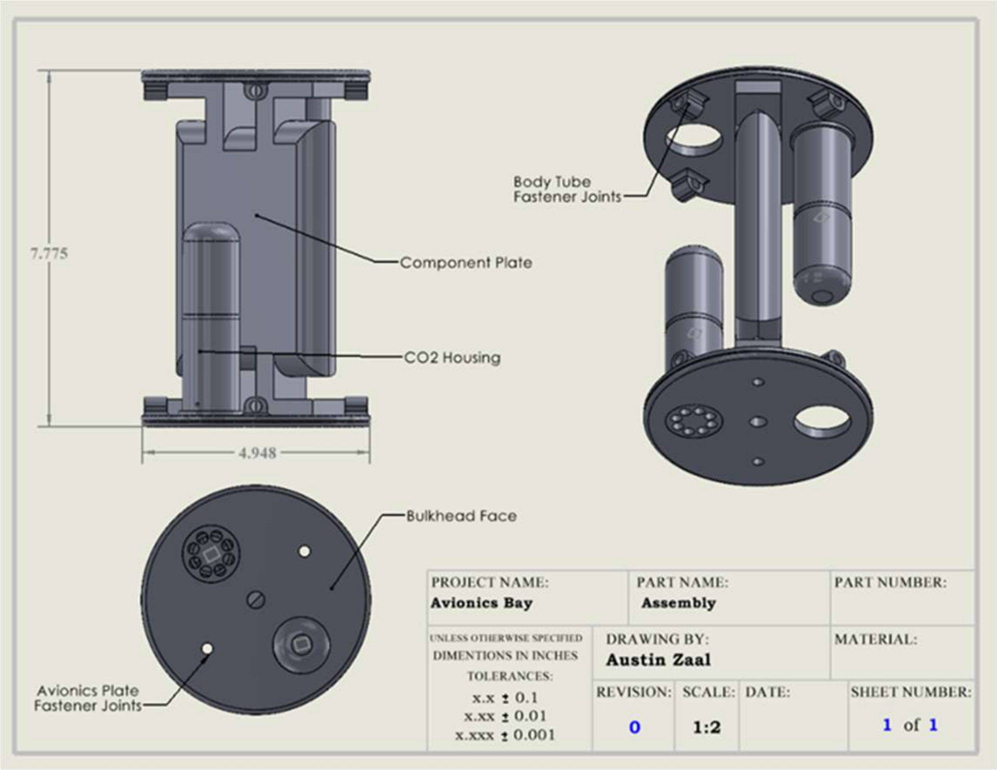
A V I O N I C S B A Y

Flight Computer – Telemetrum & Eggtimer Proton Flight Computers

Power Supply – Energizer Ultimate Lithium 9V (L522)

Ejection System – TR Eagle CO_2 Ejection Device

Material Makeup – 3D Printed Material (PLA/PETG)



E J E C T I O N   S Y S T E M

Two Stage Main Deployment

- Tinder Rocketry's Eagle CO_2 Ejection System
- 38 g CO_2 canisters
- 2 each side, 1 for redundancy
- E-Matches to contained charge

Drogue Release

- Sep Body tube 1 & 2
- Event initiated at apogee

Main Release

- Sep Body tube 2 & 3
- Event initiated at 1500 ft

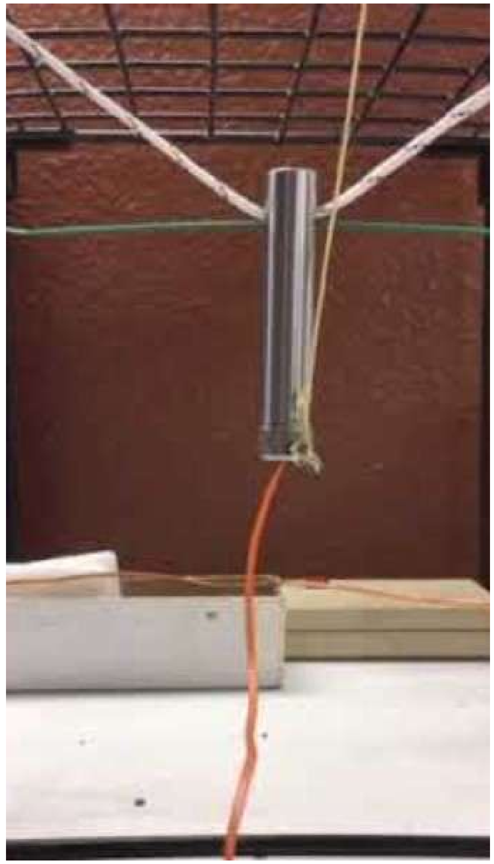

TR Peregrine

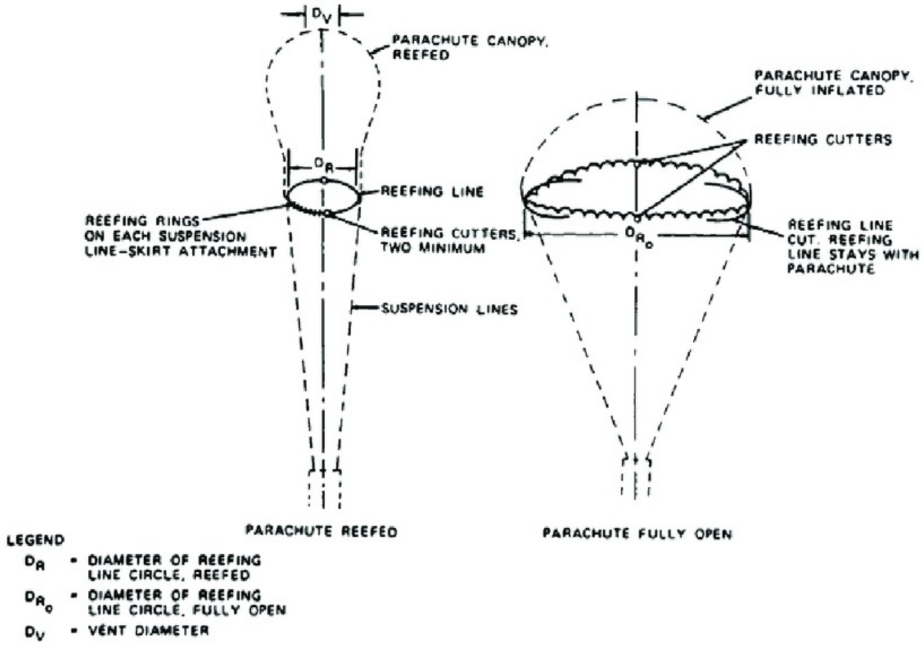

TR Eagle

Two Stage Main Deployment

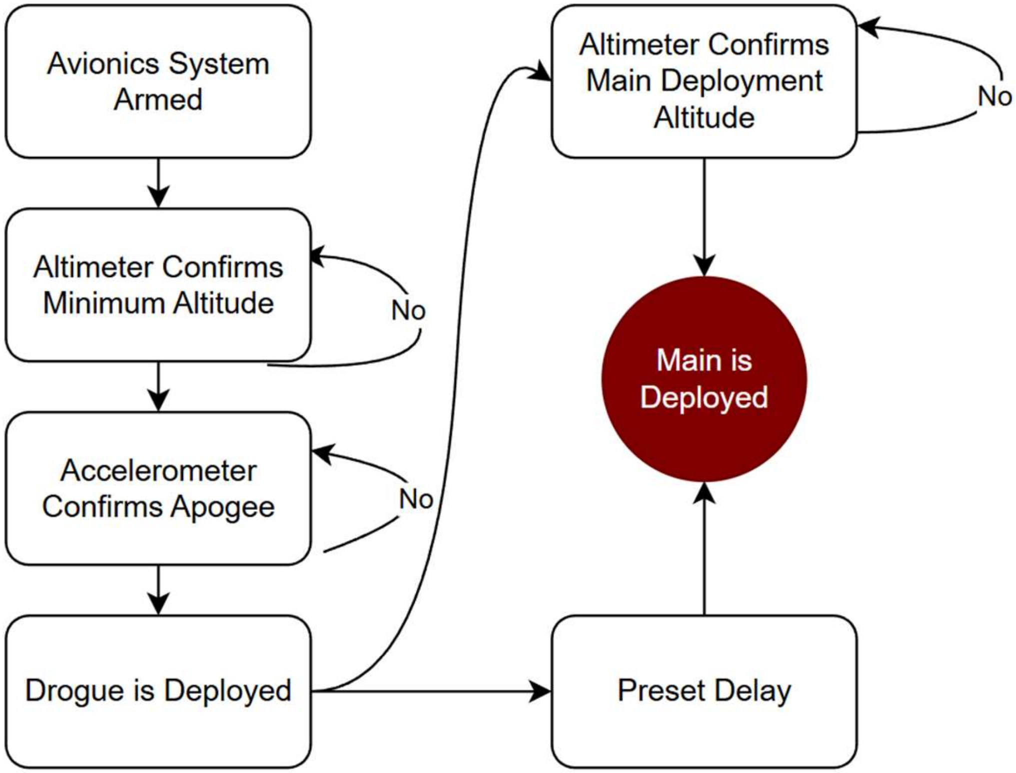
120” Parachute
- Deployed at 1500 ft
- Reefed to 30”
- Reef Cut at 750 feet

Initiation
- Isolated flight computer/power supply
- E-Matches to contained charge

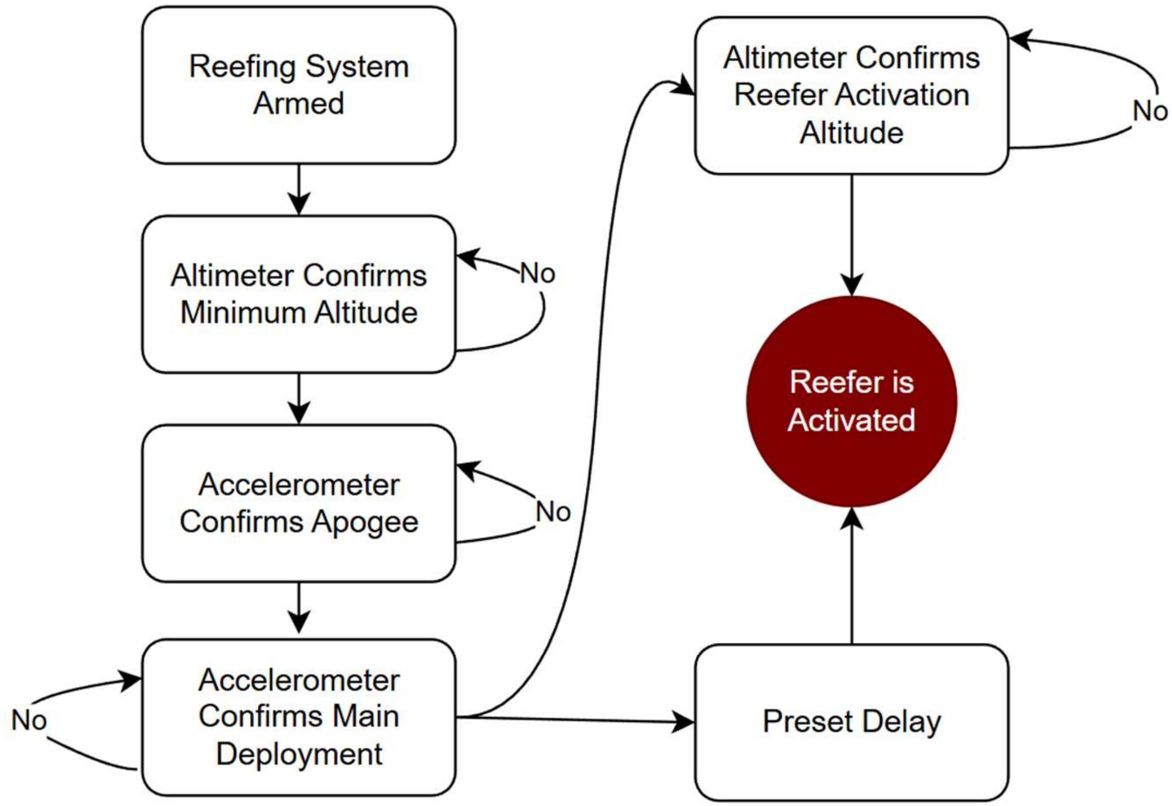




AVIONICS BAY STATE DIAGRAM



REEFING & CUTTING SYSTEM STATE DIAGRAM



LAUNCH VEHICLE PREDICTED PERFORMANCE

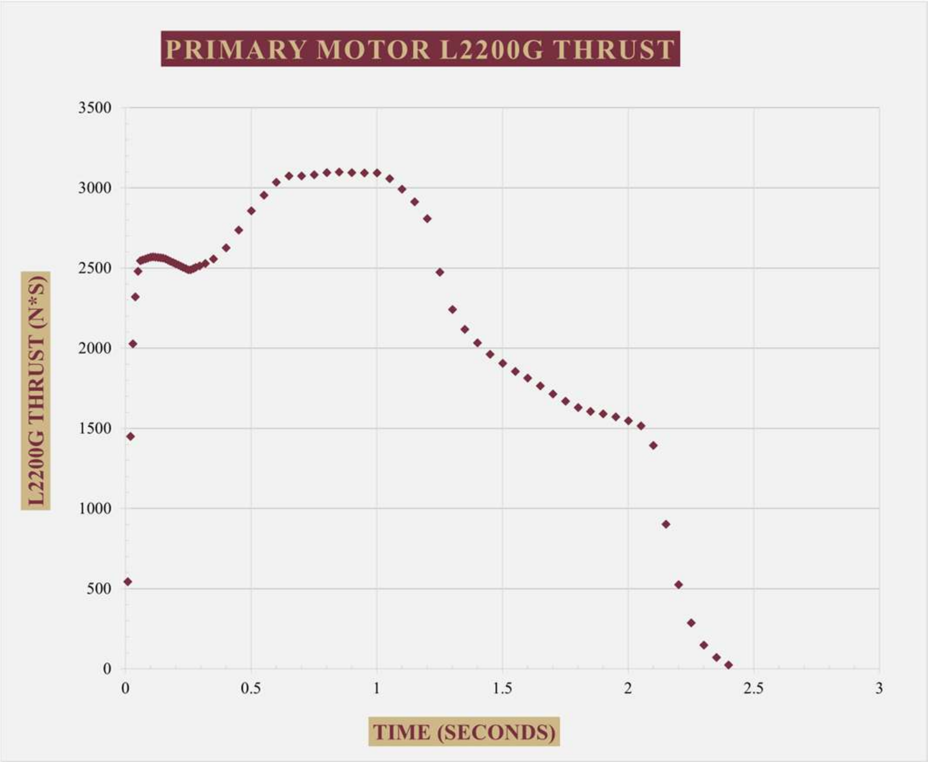
Presented by: Austin Zaal

ROCKET PERFORMANCE PREDICATIONS

Motor Selection	
Primary Motor	Secondary Motor
L2200G-0	**L1420R-P**
Justification	
• Average Apogee of 5015 ft • Total Impulse: 5104 Ns	• Average Apogee of 4033 ft • Total Impulse • 4616 Ns

L2200G-0:

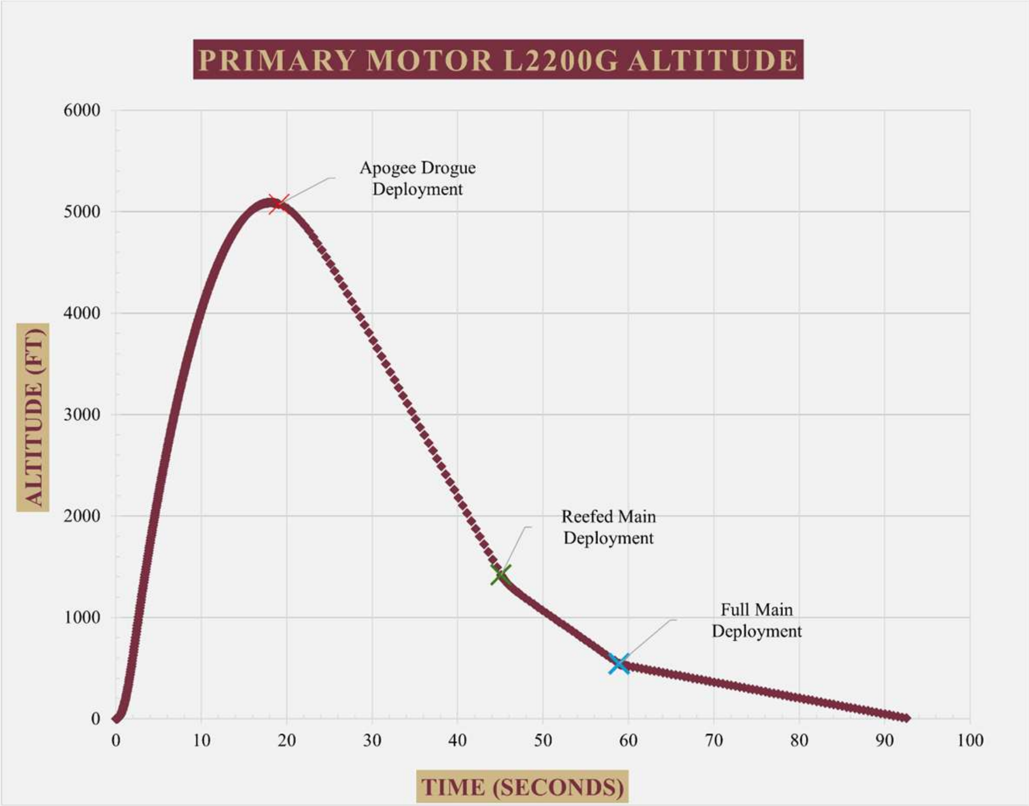
- Thrust to weight ratio: 8.94:1.0
- Maximum Thrust: 3099 N
- Average thrust: 2243 N
- Velocity off Rod: 77.7 ft/s



ROCKET PERFORMANCE PREDICATIONS

Altitude
Primary Motor
L2200G-0
Justification

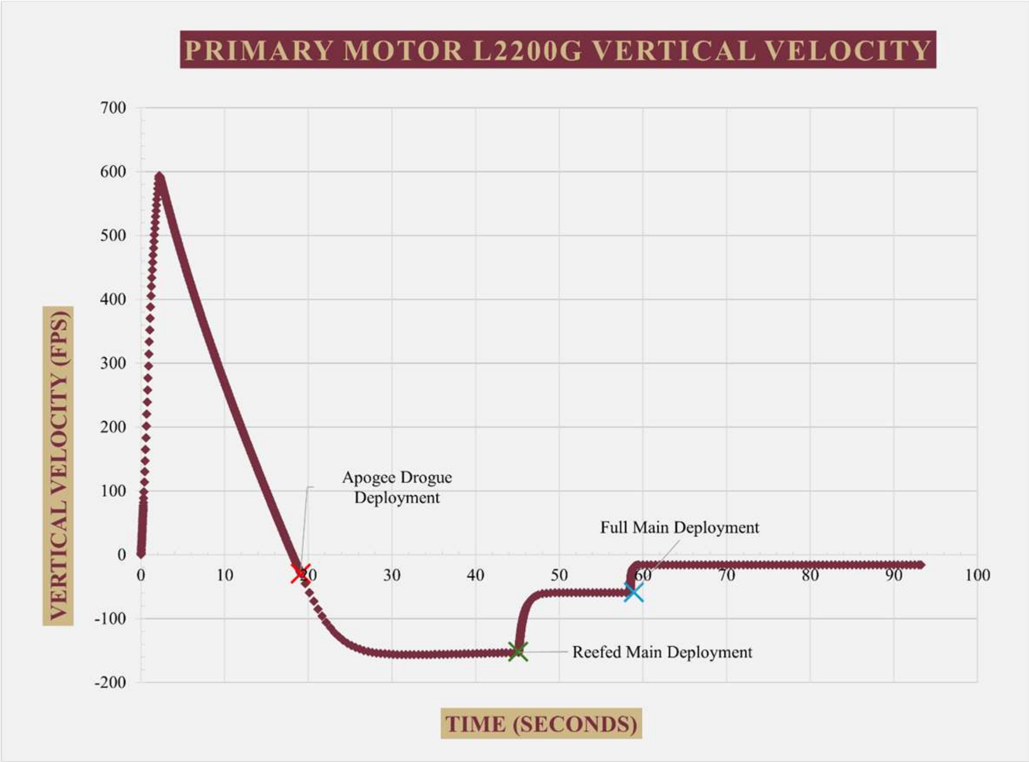
- Average Apogee of 5015 ft



ROCKET PERFORMANCE PREDICATIONS

Velocity
Primary Motor
L2200G-0
Justification

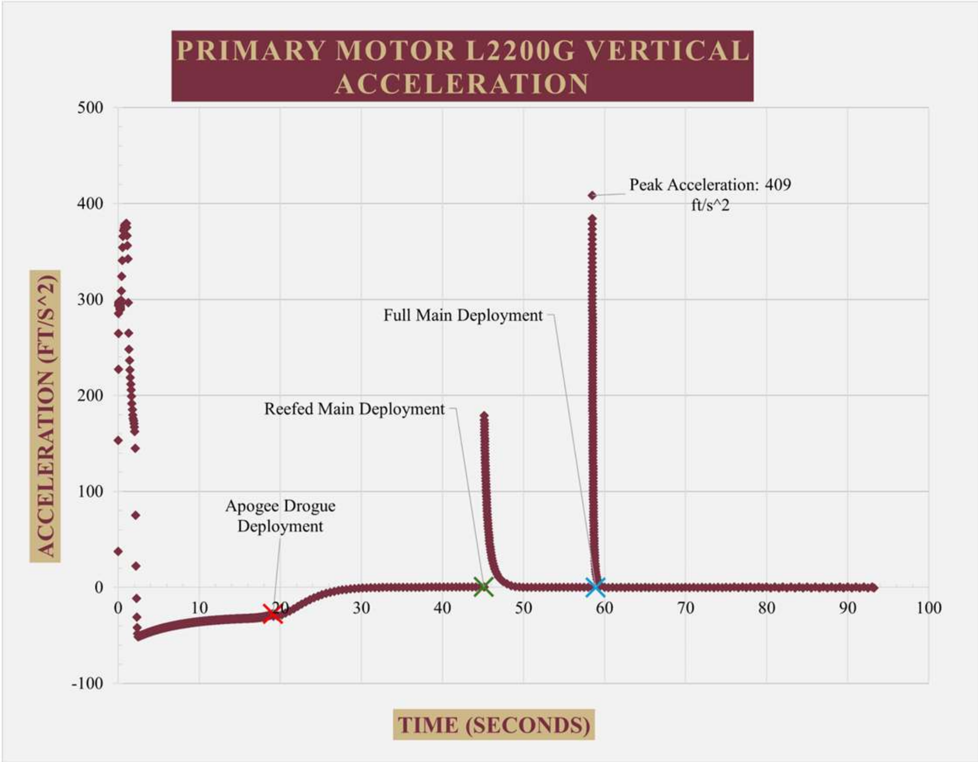
- Off the rail: 77.7 fps
- Peak Velocity: 596 fps
- At deployment of Reefed Main: 154 fps
- At deployment full Main deployment: 59.1 fps
- Ground Hit: 15.7 fps



ROCKET PERFORMANCE PREDICATIONS

Acceleration
Primary Motor
L2200G-0
Justification

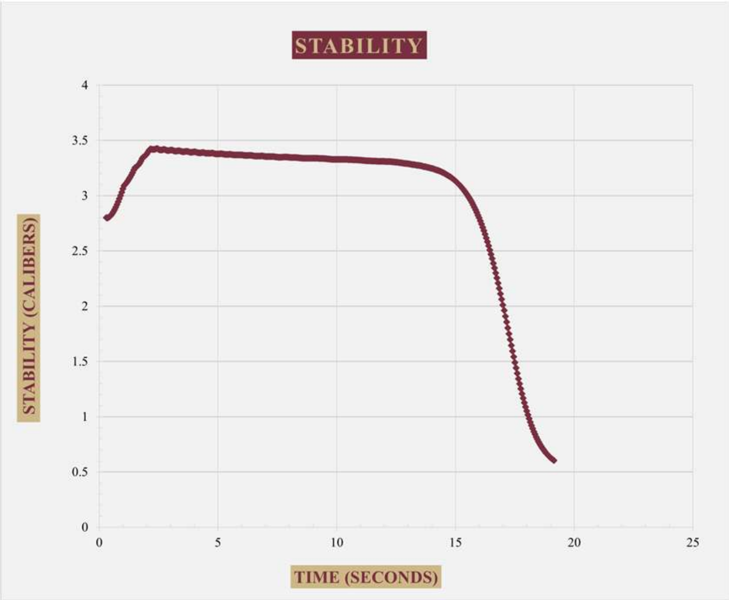
- Peak Motor Thrust Acceleration: 381 ft/s^2 or 11.8 G's
- Peak Acceleration: 408 ft/s^2 or 12.7 G's
- At deployment reefed Main deployment: 180 ft/s^2 or 5.6 G's



ROCKET PERFORMANCE PREDICATIONS

Stability and Drift
Primary Motor
L2200G-0
Justifications

Calculated Drift Estimation	
Wind Velocity (fps)	Total Drift (ft)
0	0
5	380
10	760
15	1140
20	1520
25	1900
30	2280



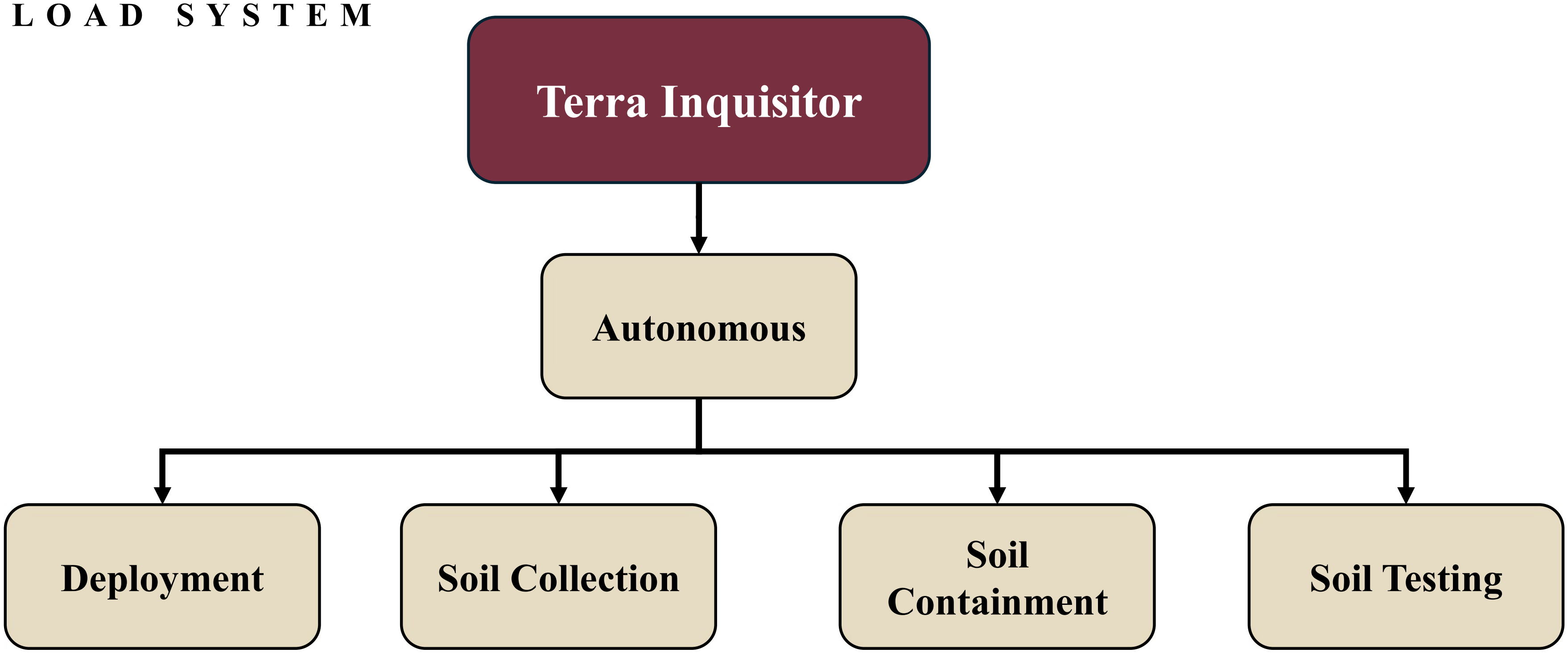
- Static Stability on Launch Rail: 2.75 calibers
- Stability at Rail Exit: 2.8 calibers
- Maximum Stability: 3.43 calibers

TERRA INQUISITOR SYSTEM

Presented by: Case Dyer and Mathew Wilson

FUNCTIONAL DECOMPOSITION

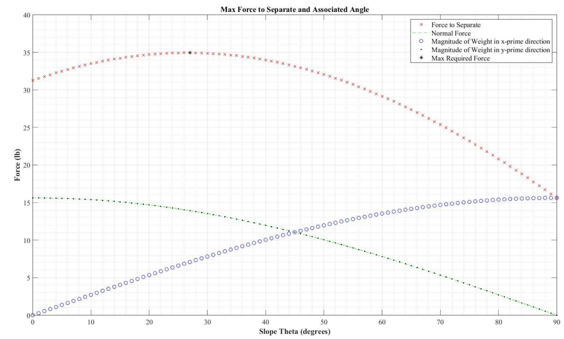
PAYLOAD SYSTEM



Mechanism Type
- Non-pyrotechnic
- Power Screw

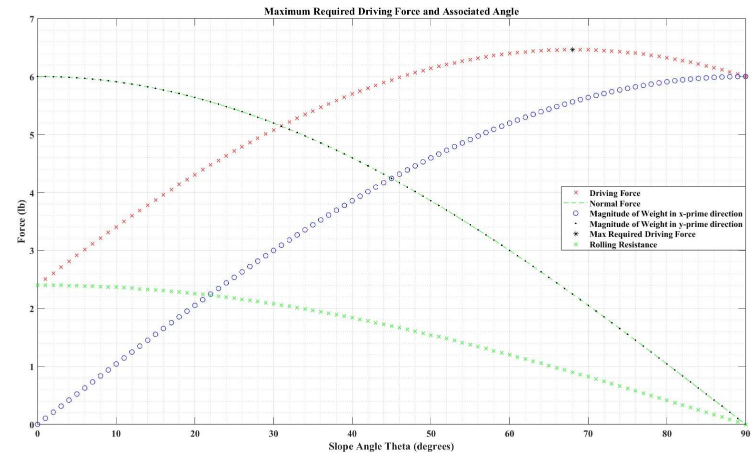
Requirements:
- Minimum Output Force: 35 lb
- Minimum Input Torque: 39 in-oz

Payload retention:
- Secured to separation mechanism
- Separation Mechanism fastened
- to HAUS section airframe
- and couplers



Mechanical Separation			Geared Rack Mech			Power Screw Mech		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.25	USD/ft	9.24	5.5	1.375	4.88	10	2.5
Tensile Strength	.10	ksi	78.3	10	1	63.8	8	.8
Weight	.30	lb/ft	.175	7	2.1	.131	10	3
Handling Safety	.10	Safety Score	3	10	1	3	10	1
Implementation	.25	Experience	7	7	1.75	10	109	2.5
Component # on McMaster Carr			6295K233			98935A205		
Overall Score:					7.225			9.8

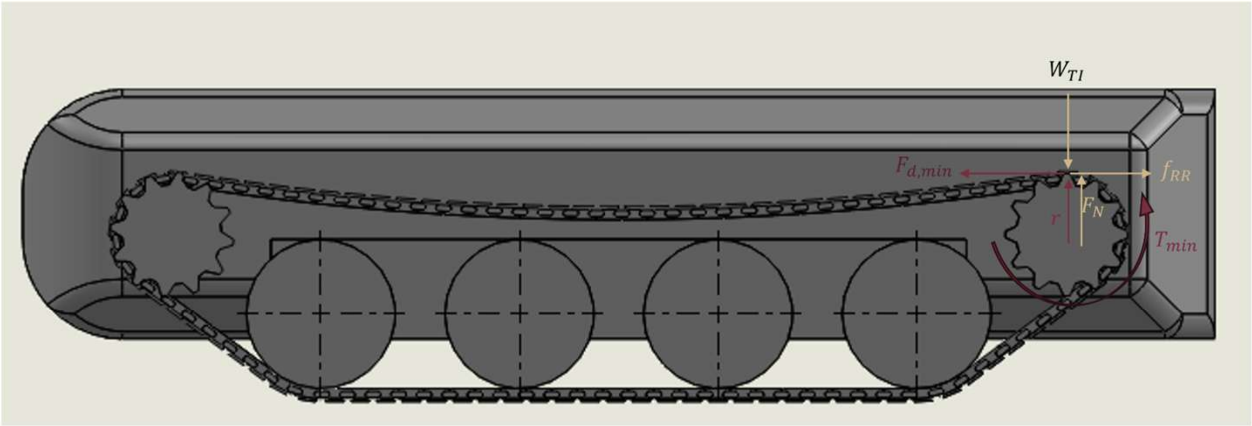
P A Y L O A D   P R O P U L S I O N   S E L E C T I O N



Traction Method
- Tacks

Tracks provide:
- Superior Traction
- Easier integration of Steering

Motor Requirements
- Minimum Output Force: 6.5 lb
- Minimum Torque Output: 52 in-oz



PAYLOAD CHASSIS AND MATERIAL SELECTION

Chassis			Fiberglass			Carbon Fiber		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.20	$\frac{USD}{in^3}$	1.10	7	1.4	11.7	2	.4
Strength	.15	ksi	80.6	9.75	1.63	87.0	10	1.5
Density	.25	$\frac{\text{lb}}{\text{in}^3}$	.0650	6	1.5	.0578	7	1.75
Handling Safety	.15	Safety Score	6	5	.75	6	5	.75
Formability	.25	Experience / Available Equipment	5	5	1.5	5	5	1.5
Overall Score:					6.78			5.9

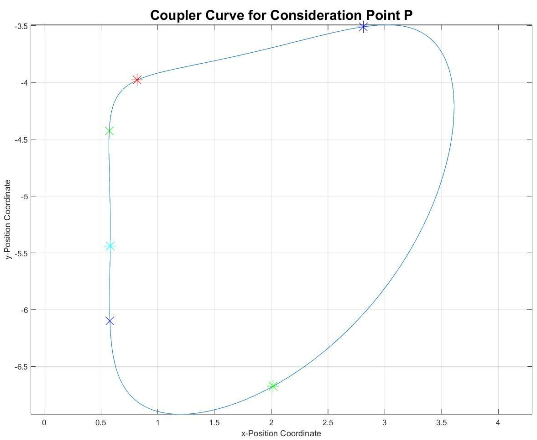
Chassis			Creality PETG			Creality PLA		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	.20	$\frac{USD}{in^3}$	.387	9.75	1.95	.370	10	2
Strength	.15	ksi	7.25	4	.6	7.69	4	.6
Density	.25	$\frac{\text{lb}}{\text{in}^3}$	.0448	10	2.5	.0452	9	2.25
Handling Safety	.15	Safety Score	2	10	1.5	2	10	1.5
Formability	.25	Experience / Available Equipment	10	10	2.5	9	9	2.25
Overall Score:					9.05			8.6

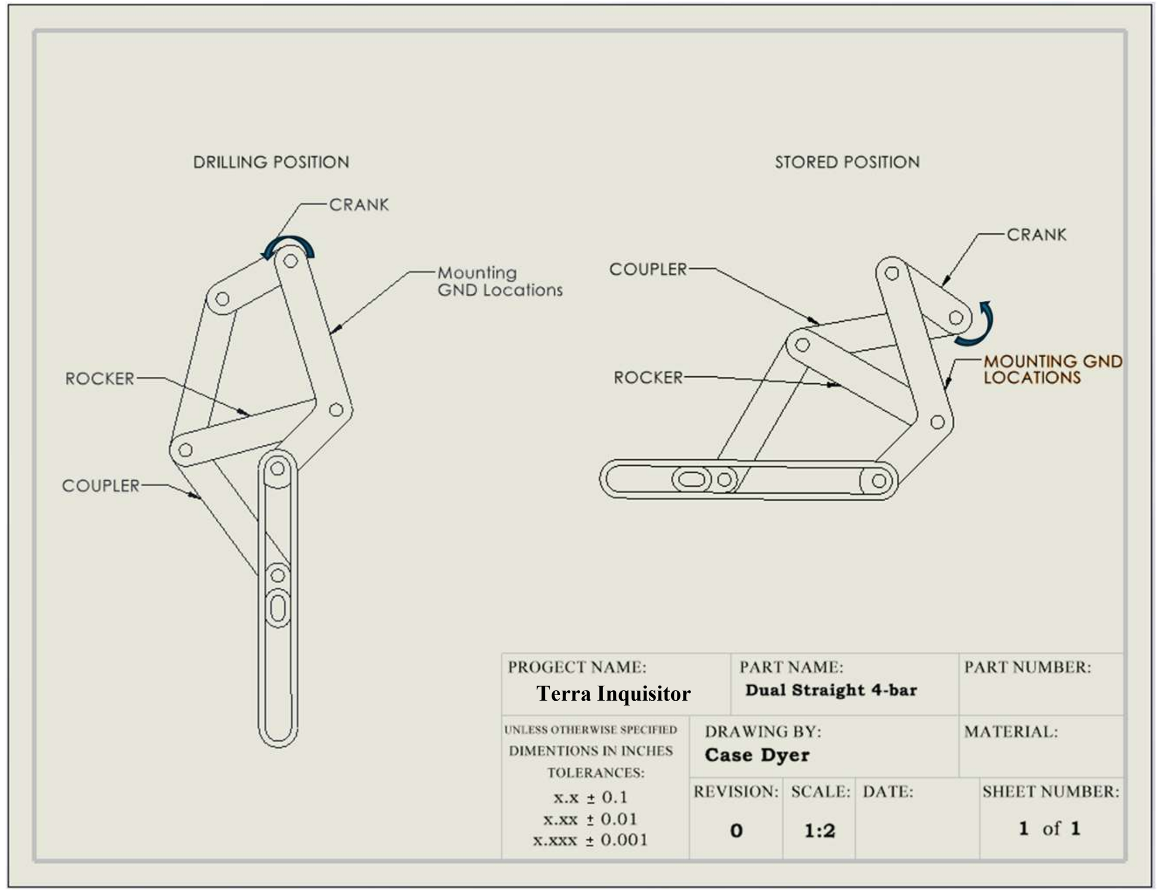
P A Y L O A D S O I L S A M P L E C O L L E C T I O N M E C H A N I S M

Drilling Mechanism:

Linkage based on:

- Symmetric four-bar linkage synthesis
- Coupler Curves
- Mechanical Advantage

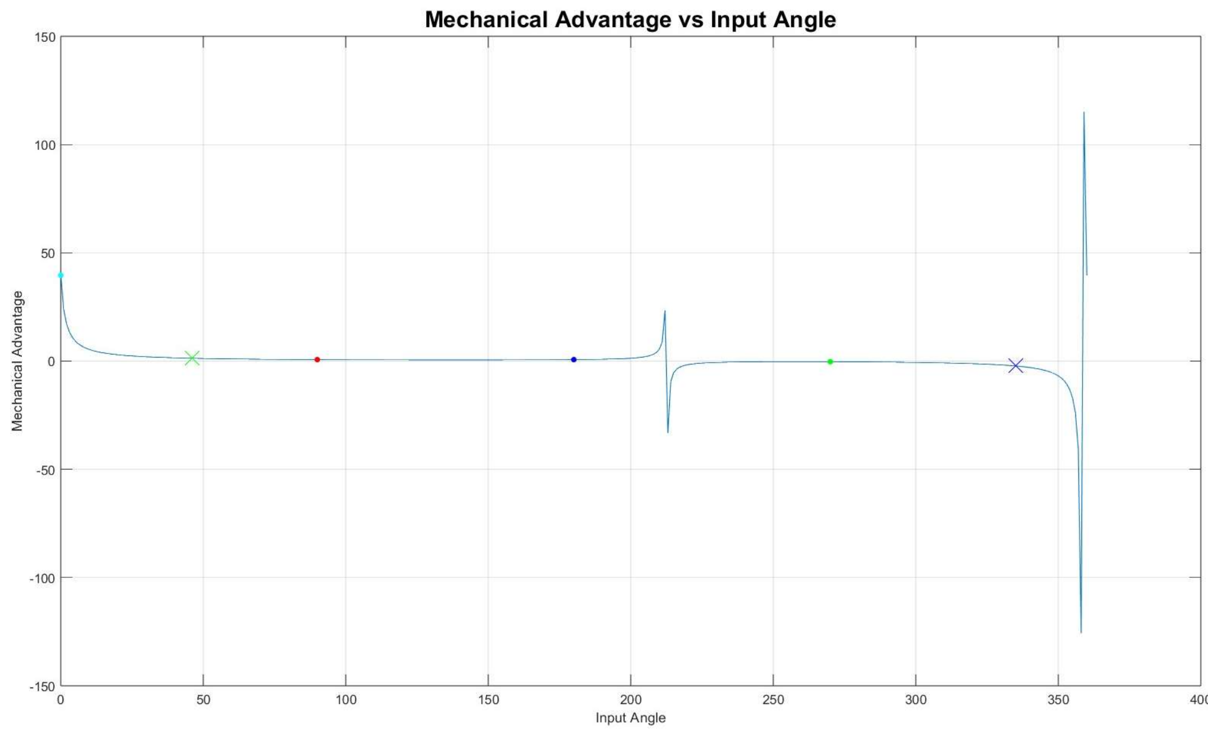




PAYLOAD SOIL SAMPLE COLLECTION MECHANISM

Mechanical Advantage:
- Average: MA = 9.67
- Peak: MA = 126
- Minimum: MA = 1.31

Range of Motion:
- 1.5” Vertical Range
- For crank input angles of 46° to 335° CW



PAYLOAD SOIL SAMPLE TESTING

Sensor Type
- Passive Sensor

Required Electronics
- Signal Conditioning Module
- ADC
- MCU

Error Mitigation
- Temperature Correction
- Solution Mixing

pH Probe			Probe 1			Probe 2		
Criteria	Weight	Parameter	Magnitude	Rating	Score	Magnitude	Rating	Score
Cost	0.25	USD	$169.99	3	0.75	29.99	10	2.5
Durability	0.25	scale (1-10)	8	10	2.5	4	5	1.25
Size (Length)	0.3	milimeters	127.7	10	3	177.7	6	1.8
Accuracy	0.15	pH	0.002	10	1.5	0.1	7	1.05
Overall Score:					7.75			6.6

Probe 1: Atlas Scientific Spear Tip/Soil pH Sensor
Probe 2: Gravity Lab Grade Analog pH Sensor

SAFETY COMPLIANCE

Presented by: Jonathan Serbest

FAMU-FSU College of Engineering

HAZARD ANALYSIS METHODOLOGY

Hazard Severity Criteria					
Description	**Value**	**Personnel Health**	**Equipment Health**	**Launch Vehicle**	**Mission Health**
Negligible	1	No injury	Insignificant damage	Insignificant damage/ minor reconstruction	Mission success not impacted
Moderate	2	Minor injury	Moderate damage	Moderate reconstruction	Possible mission success
Critical	3	Severe injury	Major damage	Major reconstruction required	Partial mission success
Disastrous	4	Life-threatening injuries	Complete destruction	Complete loss	Mission failure

Probability Levels		
Definition	Value	Probability of Occurrence
Unlikely	1	<1%
Uncommon	2	1% to 15%
Occasional	3	15% to 50%
Probable	4	50% to 80%
Likely	5	Above 80%

PERSONAL HAZARD ANALYSIS

Risk and Hazard Assessment Matrix

		Severity			
		Negligible (1)	Moderate (2)	Critical (3)	Disastrous (4)
Probability	Unlikely (1)	1	2	3	4
	Uncommon (2)	2	4	6	8
	Occasional (3)	3	6	9	12
	Probable (4)	4	8	12	16
	Likely (5)	5	10	15	20

Consolidated Hazard Assessment

Table 34

Definition	Value
Minimal	1-6
Tolerable	7-10
Immediate Attention	11-15
Failure	16-20

Facility Hazards

Table 35

Facilities	P'	S'	Value	Causes	Mitigations
Senior Design Lab	3	2	6	The room serves storage: • Variety of hand and power tools • Chemicals • Variety of raw material. • 3D printers • Soldering irons.	• Keep room organized and clean • Label and safely store chemicals. • Provide PPE for all cases (gloves, safety glasses, face mask or respirator). • Maintain good ventilation for soldering and 3D printing.
Machine Shop	2	3	6	Houses: • Heavy machinery • Hand and power tools • Variety of raw material.	• Mandatory PPE in the case of machine operation including safety glasses, hearing protection, closed-toe shoes. • Knowledge of emergency stop locations. • Operator instructions near each machine. • Regular maintenance and inspections of equipment. • Limit occupancy in the event of machine operation.
Digital Design Studio	1	1	1	Serves as a center for: • 3D printing • Laminating • Printing	• Proper ventilation for 3D printers. • Keep materials (paper, resin, etc.) away from heat sources. • Maintain workspace.
Electrical Engineering Laboratory	1	2	2	Houses: • Wavelength generators • Hand and power tools • Electronics & soldering tools	• Provide PPE for all cases (gloves, safety glasses, face mask or respirator). • Proper ventilation for soldering. • Review lab safety procedures according to the Electrical Engineering Department. • Knowledge of emergency stop locations. • Fire extinguishers for electrical fires (Class C).
Materials Lab	1	3	3	Houses: • Material property testing machines • A variety of material samples • Power/Hand tools	• Provide PPE for all cases (gloves, safety glasses, face mask or respirator). • Maintain clear zones around testing machines. • Properly label and store samples. • Knowledge of emergency stop locations for [illegible]al testing machine[illegible] • [illegible]ccording to

PERSONAL HAZARD ANALYSIS

Construction Hazard Table

Table 37

Hazard	e.g.	P'	S'	Value	Cause	Effects	Mitigation
Compressed Air Systems	Air compressor and accessories.	1	4	4	- Faulty hose and fittings - Over-pressurization - Negligent use of tool according to provided owner's manual	- Hearing damage - Flying debris and shrapnel causing possible cuts, lacerations, and possible death.	- Make sure that equipment is well maintained and clean before using. This includes procedures like inspecting hoses and fittings. - Use ear protect when using compressor at all times. - Do not use equipment improperly. Ex. Pointing spray nozzle at others or yourself.
Construction Hand Tools	Pliers, screwdrivers, hammers, clamps, wrenches.	4	2	8	Unclean or oily hands while working, Sharp edges, blunt forces.	- Cuts - Bruises - Skin pinching - Puncture wounds	- Maintain and clean all tools after use. - Gloves are required when working with all tools. Depending on the tool, use of ear and eye protection shall be enforced in junction. - Store and procure tools safely when using.
Cutting Tools (Hand & Powered)	Knives, box cutters, scissors, hacksaws, chop saws, table saws.	3	3	9	- Unclean or oily hands while working - Negligent handling - Open wires - Dull blades - Leaving powered tools unattended	- Severe lacerations - Eye injury from debris -Electrocution - Puncture wounds	- Heavy duty gloves should be used - All wires shall be inspected before and after use. - Storage of tools safely away from heavy occupied zones and safe to hold in their stored state.
Electronics & Soldering	Soldering irons, wire cutters/	3	2	6	- Leaving hot or powered tools unattended	- Burns - Blistering - Skin	- Area shall be properly ventilated

Environmental Hazards

Table 38

Hazards	P'	S'	Value	Causes	Mitigations	Verification
Potential Effects and Hazards to Environment						
Material Waste	5	1	5	• PLA filament waste due to supports and shaping. • Packaging (cardboard, Styrofoam, bubble wrap) • Excess epoxy.	• Recycle as much material as possible. • Use as much as needed	• A designated recycling bin will be located in the major area of waste production such as the Senior Design Lab.
Chemical Aerosol	3	2	6	Chemical reaction producing a aerosol by-product.	• Were proper PPE when using any chemical • Ventilated room or open air is required.	• Proper PPE for according to manufacturer specification
Energetic by-product (post launch)	5	1	5	Ash, smoke, dust, and soot.	• Do not approach rocket launch pad or rocket until by-products have clearly dissipated.	• Post-Launch check log shall be implemented to verify completion of debris removal.
Field Debris	5	1	5	Broken fins, launch preparation disposables, snack trash and water bottles.	• Continue to clean throughout the day. • Bring plenty of trash bags and dispose of the trash properly with any recyclable trash be handled accordingly.	• Post-Launch check log shall be implemented to verify completion of debris removal.
Batteries	5	2	10	Improper disposal of batteries or any device using lead-acid or AGM technology.	• Dispose of batteries per the manufacture specification.	• Log of all batteries being disposed of and when.
Potential Environmental Effects and Hazards on the Rocket						
Dense pockets of air and cross wind	3	3	9	Early deployment due to avionics bay air density verification.	• The avionics bay will be equipped with multiple pitot tubes for ample air circulation and barometric pressure accuracy	• Pre-flight check for any pitot tubes obstructions. • Flight computer and avionics will be calibrated to launch site elevation. • Pre-Launch check log shall be implemented to verify completion of calibration and obstruction check.
Typical						• Pre check for any obstructions.

VERIFICATION OF MITIGATION

Verification – A process of proving that a requirement was made and reforms effectively and as specified.

Types of Verification –

1. Inspection
2. Test
3. Demonstration
4. Analysis
5. Record/Documentation Review

Questions to be asking:

- What is the data proving?
- Are the mitigation procedures or techniques working?
- How can we improve our mitigations?

Project Document Identification					
Doc. Name	Doc. ID	Rev.	Date of Revision	Owner	Auditor/Approver
Room Sign-in/out	SAFE-SIO-ALL-MNTH-R0	R0	N/A	Krieg Conrad	Jonathan Serbest
Pre-launch Rocket Preparation Check List	OPS-CKL-PREL-PER-R0	R0	N/A	Krieg Conrad	Jonathan Serbest
Launch Day Material, Component, and Equipment Check List	OPS-CKL-PREL-PER-R0	R0	N/A	Krieg Conrad	Jonathan Serbest
Post-Launch Check List	OPS-CKL-PSTL-PER-R0	R0	N/A	Krieg Conrad	Jonathan Serbest
Attendance Log	SAFE-ATND-ALL-MNTH-R0	R0	N/A	Krieg Conrad	Jonathan Serbest
Chemical Accounting	SAFE-CNTS-ALL-MNTH-R0	R0	N/A	Jonathan Serbest	Krieg Conrad
Equipment Quality and Cleanliness Control	OPS-CKL-ALL-MNTH-R0	R0	N/A	Jonathan Serbest	Team
Material Property Testing	TEST-TEST-DEV-AN-R0	R0	N/A	Case Dyer, Matthew Wilson	Krieg Conrad, Jonathan Serbest
Payload Component Testing and System Competition	PAY-TEST-DEV-PER-R0	R0	N/A	Case Dyer, Matthew Wilson	Krieg Conrad
Recovery Component Testing and System Competition	REC-TEST-DEV-PER-R0	R0	N/A	Austin Zaal, Matthew Wilson	Krieg Conrad

Example of Verification by Inspection & Record/Documentation Review

T I M E L I N E & O U T R E A C H

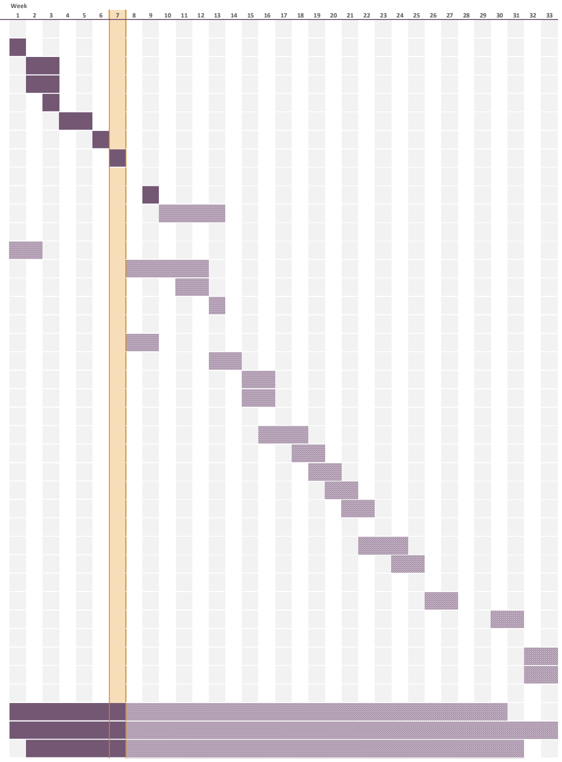
Presented by: Krieg Conrad

SCHEDULE OVERVIEW

The Terra Nova Project - Gantt Chart

Week Highlight: 7 | Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

Category	ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
PDR Development						
	Draft PDR Outline & Assign Content Owners:	1	1	1	1	100%
	Write Subsystem Sections:	2	2	2	2	100%
	Draft Hazard Analysis & FMEA:	2	2	2	2	100%
	Mission Performance Sims	3	1	3	1	100%
	Format & Peer Review PDR:	4	2	4	2	100%
	PDR Mock Presentation	6	1	6	1	100%
	Submit PDR Deliverables:	7	1	7	1	100%
Material Testing						
	Prepare Inconel Specimens:	9	1	9	1	50%
	Conduct Material Tests:	10	4	10	4	0%
Subscale Build & Test						
	Subscale Design Finalization:	1	2	1	2	0%
	Subscale Fabrication:	8	5	8	5	0%
	Subscale Launch:	12	0	12	0	0%
	Analyze Subscale Flight Data:	13	1	13	1	0%
CDR Development						
	Draft:	8	2	8	2	0%
	Integrate Subscale Lessons:	13	2	13	2	0%
	Finalize CDR Report & Slides:	15	2	15	2	0%
	Submit CDR Deliverables:	16	0	16	0	0%
Full-Scale Build & Test						
	Begin Full-Scale Fabrication:	16	3	16	3	0%
	Ground Ejection Tests:	18	2	18	2	0%
	Payload Vibration Tests:	19	2	19	2	0%
	Final Integration & Assembly:	20	2	20	2	0%
	Full-Scale Launch (VDF):	22	0	22	0	0%
FRR Development						
	Draft FRR Report & Slides:	22	3	22	3	0%
	Submit FRR Deliverables:	25	0	25	0	0%
Launch Week						
	Prepare Logistics & Travel:	26	2	26	2	0%
	Competition Launch:	31	0	31	0	0%
Post Launch						
	Draft PLAR & Lessons Learned:	32	2	32	2	0%
	Submit PLAR:	33	0	33	0	0%
Ongoing Activities						
	STEM Outreach Visits:	1	30	1	30	25%
	Sponsor & Budget Mgmt:	1	33	1	33	22%
	Safety & Risk Updates:	2	30	2	30	22%



Decision Gate #2	**Evaluate subscale flight data vs. simulation (±10 % apogee tolerance) to authorize full-scale fabrication.**			
Week 14 (Holiday)	Dec 22 – 28	Add "Changes Since PDR"; polish subsystem sections.	Finalize payload technical design.	Maintain sponsor contact; light outreach.
Week 15	Dec 29 – Jan 4 2026	Integrate subsystem text; proofread & format.	Send bulkhead & boat-tail designs; confirm heat-treat & finishing specs.	Year-end budget & outreach update.
Week 16 CDR Due	Jan 5 – 11	**Submit CDR (Jan 7);** internal debrief; outline FRR structure.	Airframe: motor mount/fin can assembly; payload flight-version fabrication.	Post-CDR sponsor updates; outreach planning.
Week 17	Jan 12 – 18	Draft FRR skeleton; subsystem integration descriptions; payload verification plan.	Finish fin can; recovery wiring; payload bench test.	Logistics prep for test launches.
Week 18	Jan 19 – 25	Draft "Changes Since CDR"; update CAD with as-built; document ground-test procedures.	Airframe couplers & payload bay; **1st ejection test;** avionics ICT.	Confirm spring outreach calendar.
Week 19	Jan 26 – Feb 1	Integrate subsystem updates into FRR draft; redundancy plan; payload data methodology. **Risk Review & Mitigation Update.**	Payload vibration testing; **2nd ejection test**; airframe finish work.	Sponsor engagement; plan Huntsville travel.

O U T R E A C H & E D U C A T I O N

- Schools in Bay & Walton County – Reaching out to schools to talk about Stem with students
- University Events – Discovery Days & Tech Days held by FSU PC
- Further Outreach – Blue Angels STEM Event (Pensacola, November 2025)

ANY QUESTIONS?