Gateway Project Management Webinar

Mark Abotossaway
Blue Origin Engineer and FNL Assistant

ARTEMIS STUDENT CHALLENGES
nasa.gov/stem/artemis.html

NASA Partner

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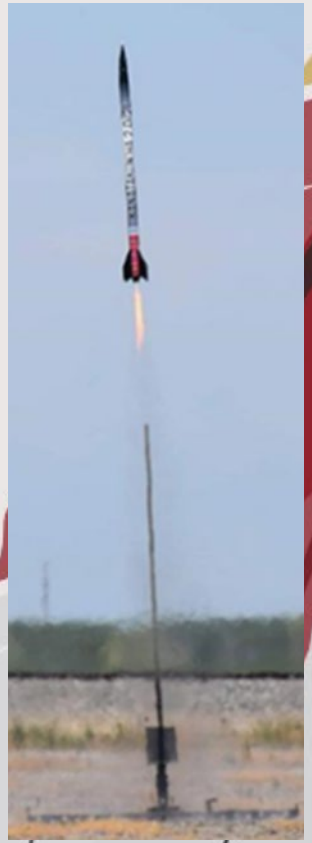
Webinar Overview

- Challenge
  - Challenge Overview
  - Flysheets
  - RockSim
  - Virtual Presentations
- Project Management
  - Scheduling
  - Budgeting
  - Procurement
  - Requirements



Meet the FNL Team

Wisconsin Space Grant Foundation

• Kevin Crosby, Director	kcrosby@carthage.edu
• Christine Bolz, Assistant Director	cbolz@carthage.edu
• Rob Cannon, FNL Project Manager	rcannon@carthage.edu
• Connie Engberg, Project Support Assistant	cengberg@carthage.edu
• Megan Goller, Accounts Assistant	mgoller@carthage.edu

First Nations Launch

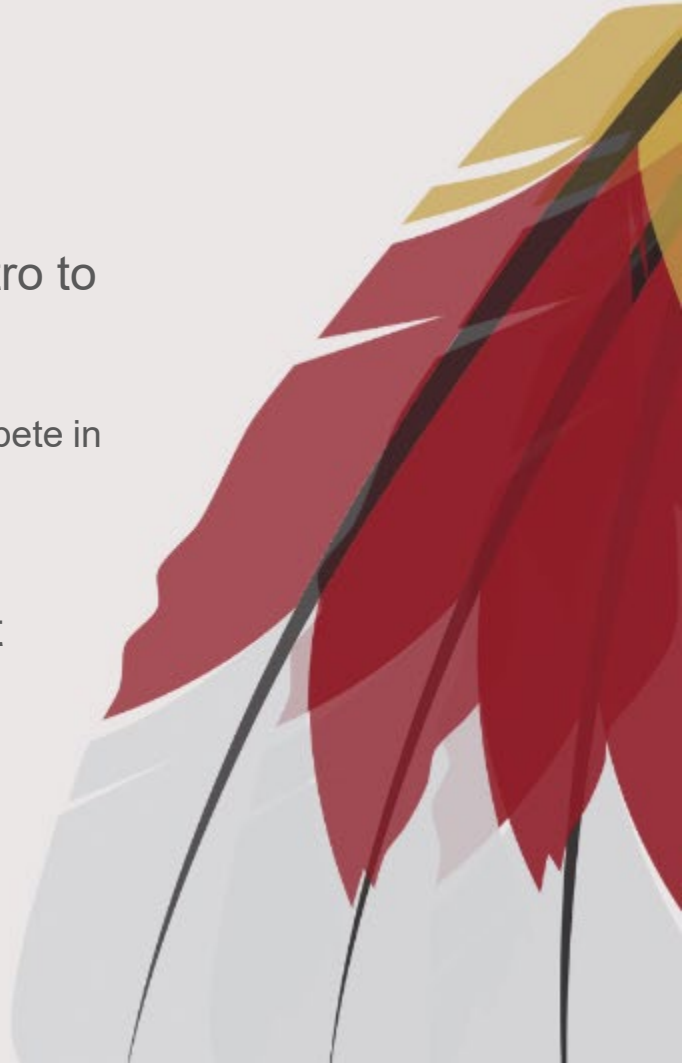
• Frank Nobile, Technical Coordinator, Wisconsin Tripoli	maxq3@aol.com
• Mark Abotossaway, Project Assistant/Advisor Liaison, Blue Origin (Alumni)	mark.a.abotossaway@gmail.com

Tripoli Rocket Association

• Bob Justus, Tripoli Assistant, Illinois Tripoli	bob@mhbofni.com

Challenge Overview

- Gateway Challenge is designed as 1-semester Intro to Rocketry
  - A stepping-stone to the Moon and Mars Challenges
    - Must understand rocketry before you can really compete in engineering challenge
    - Will select and build a dual deploy rocket
- Gateway also introduction to Project Management concepts
  - Used in Moon and Mars Challenges
    - Scheduling
    - Budgeting
    - Procurement
    - Testing / Requirements



Challenge Overview – Kit / Motor Selection

- The Challenge requires you to select 1 of 3 rocketry kits
  - Its not an arbitrary selection (Appendix A5 of Handbook)
- The Challenge also requires you to select 1 of 2 motors
  - For each kit, choice of 2 motors (Appendix A1 of Handbook)
    - Each kit motor combination has different performance
- You will need to use RockSim simulation software
  - Run simulations for all 6 possible combinations
    - Then you can determine which kit you want to start with
    - Appendix D3 of Handbook has RockSim Guidance

Challenge Overview – Kit / Motor Selection

APPENDIX A-5 – First Nations Launch Competition Kits

Gateway Challenge

The Gateway category must select a kit from the following list:

1. Loc Precision YANK Iris – 4" diameter.
    a. https://locprecision.com/collections/rockets-4-00-diameter/products/yiris4
        i. SKU: YIRIS4
    b. When ordering, remember to include the following additional components:
        i. E-bay module
        ii. 38mm motor adapter
    c. RockSim file is available on their website
    d. Motor options:
        i. Aerotech 38mm I280 DMS
        ii. Aerotech 38mm I500T DMS
2. Loc Precision - 4" diameter "EZI 65"
    a. https://locprecision.com/collections/rockets-4-00-diameter/products/ezi-65
        i. SKU: PK-64
    b. When ordering, remember to include the following additional components:
        i. E-bay module
        ii. 38mm motor adapter

Challenge Overview – Kit / Motor Selection

APPENDIX A-1 – First Nations Launch 2024 Motor Choices

For the 2024 First Nations Launch Challenge, the motor selections are constrained to:

Gateway Challenge Motors

Kit	Manufacturer	Size	Type	Motor
YANK Iris	Aerotech	38mm	DMS	I280, I500T
EZI 65	Aerotech	38mm	DMS	I140W, I175WS
Mystic Buzz	Aerotech	38mm	RMS	I366R, I435T

Moon Challenge Motors

Challenge Overview – Kit Selection

- There are numerous kit manufacturers in rocketry
  - For FNL Gateway - we only use kits from 1 manufacturer (LOC Precision)
    - Kit Option 1 - Yank Iris 4”
    - Kit Option 2 - EZI-65
    - Kit Option 3 - Mystic Buzz
  - You will need to also add (in simulation) and purchase (when ordering) an additional component called the Avionics Bay
    - Ensure you get the Electronics Bay 3.90”
  - This component will turn your Kit choice into a Dual Deploy
    - Discussed more in the coming slides

Challenge Overview – Kit Selection

Home / Yank IRIS 4"






LOCPRECISION

YANK IRIS 4”

★★★★★ 4 reviews

YIRIS4

$123.59

Pay in 4 interest-free installments of **$30.89** with shop Pay Learn more

QUANTITY

− 1 +

ADD TO CART

Buy with shop Pay

More payment options

IRIS4 Instructions

IRIS4 Rocksim

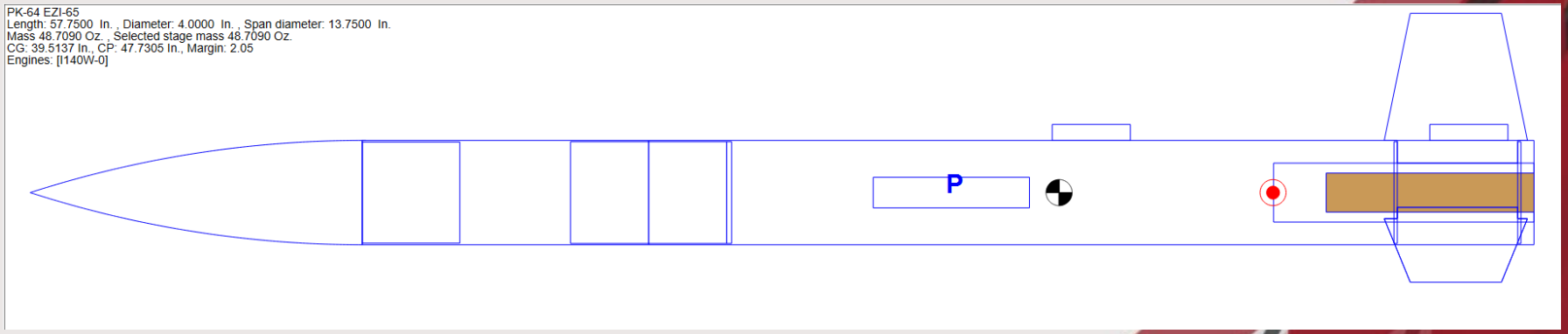
Challenge Overview – Avionics Bay

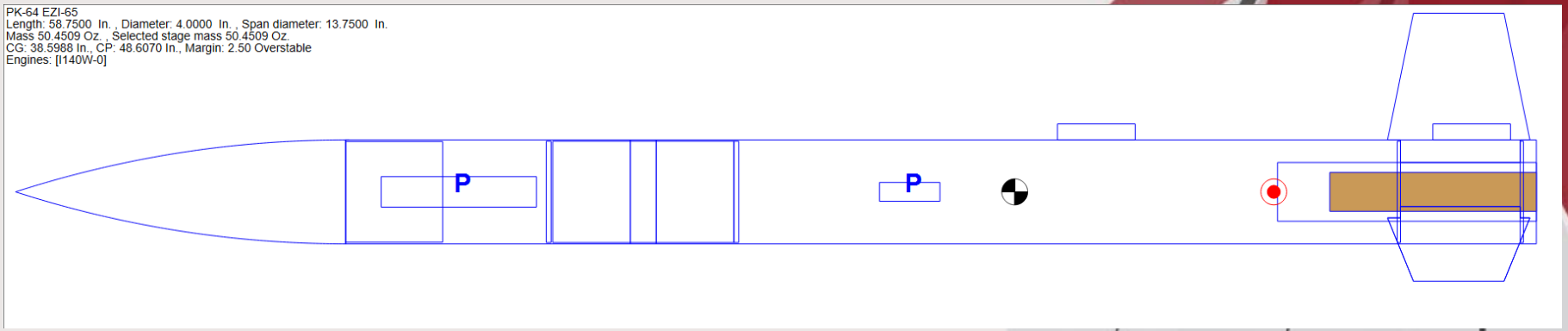
Home / Components / Electronics Bays

Challenge Overview – Single vs Dual

- Single vs Dual Deployment Configuration
  - Basic intro kits are designed with 1 parachute (single deploy)
    - These rockets typically do not fly too high
    - This parachute uses a delay fuse to eject from rocket (no electronics needed)
  - More advanced kits are designed with 2 parachutes (dual deploy)
    - These rockets typically fly higher than single deploys
    - The parachutes use electronics called altimeters to eject the parachutes
    - The drogue parachute prevents too much drift at higher altitude, while the main parachute slows descent at lower altitude for a safe landing
  - Since Moon and Mars always use the dual deploy configuration
    - It is best that Gateway also learn dual deploy configuration

Challenge Overview – Single vs Dual





Challenge Overview – Avionics Bay for Dual

- Many COTS kits you see online are **single** deploy configured
  - But you can convert to dual
    - Simply purchase the additional components
  - You must ‘add’ the dual deploy components yourself
    - Both in simulation, and procurement
  - Gateway teams have made this mistake and not converted to the dual deploy configuration properly
    - Make sure you understand what you need to do to accomplish this!
    - Ask! We can help! Your mentor can help!

Challenge Overview - Milestones

- In any engineering project there are Milestones
  - These are incremental points where the project should meet partial objectives before proceeding to the next Milestone

- Your Milestones are (they align with Moon Mars Milestones):
  - Preliminary Design (Jan 22) — Initial concepts / initial components
  - Critical Design (Feb 26) — Mature design / all components
  - Flight Readiness (Apr 1) — Vehicle is fully fabricated ready for flight
  - Competition Launch (Apr 29) — Competition Flight

Challenge Overview – Data Submission

- At each Milestone, you will submit:
  - Flysheet
    - Summary performance data of simulations (and component selections)
  - RockSim File
    - Simulation of your rocket showing components and performance

- At each Milestone, you will give a Milestone Virtual Presentation
  - You will fill out a Virtual Presentation Template
    - This allows us to give you feedback after the Presentation

Flysheets

- Download Flysheet Template from WSGC Website each Milestone
  - Scoring Rubric | Wisconsin Space Grant Consortium | Carthage College

- Each Milestone requires more information to be filled out in the Flysheet
  - Baby steps at first, to prevent information overload
  - Allows team to learn rocketry incrementally
  - Allows us to see your progress by reviewing your Flysheet

Scoring Rubric

The Moon/Mars Rocket Competitions will be judged by these separate parts:

1. **Design Reports** (75% of total score)
Flysheet At every cycle (Proposal, PDR, etc) every team (every challenge) will fill out a Flysheet and submit a PDF of the Flysheet along with the PDF report.
   a. Competition Proposal (5%)
      i. Flysheet (Proposal Tab)
   b. Preliminary Design Review (PDR) (15%)
      i. PDR Virtual Review w/judges (5%)
      ii. Flysheet (PDR Tab)
   c. Critical Design Review (CDR) (15%)
      i. CDR Virtual Review w/judges (5%)
      ii. Flysheet (CDR Tab)
   d. Flight Readiness Review (FRR) (15%)
      i. Flysheet (FRR Tab)
      ii. Safety Inspection Checklist - Virtual Review (5%)
   e. Post Launch Assessment Review (PLAR) (10%)

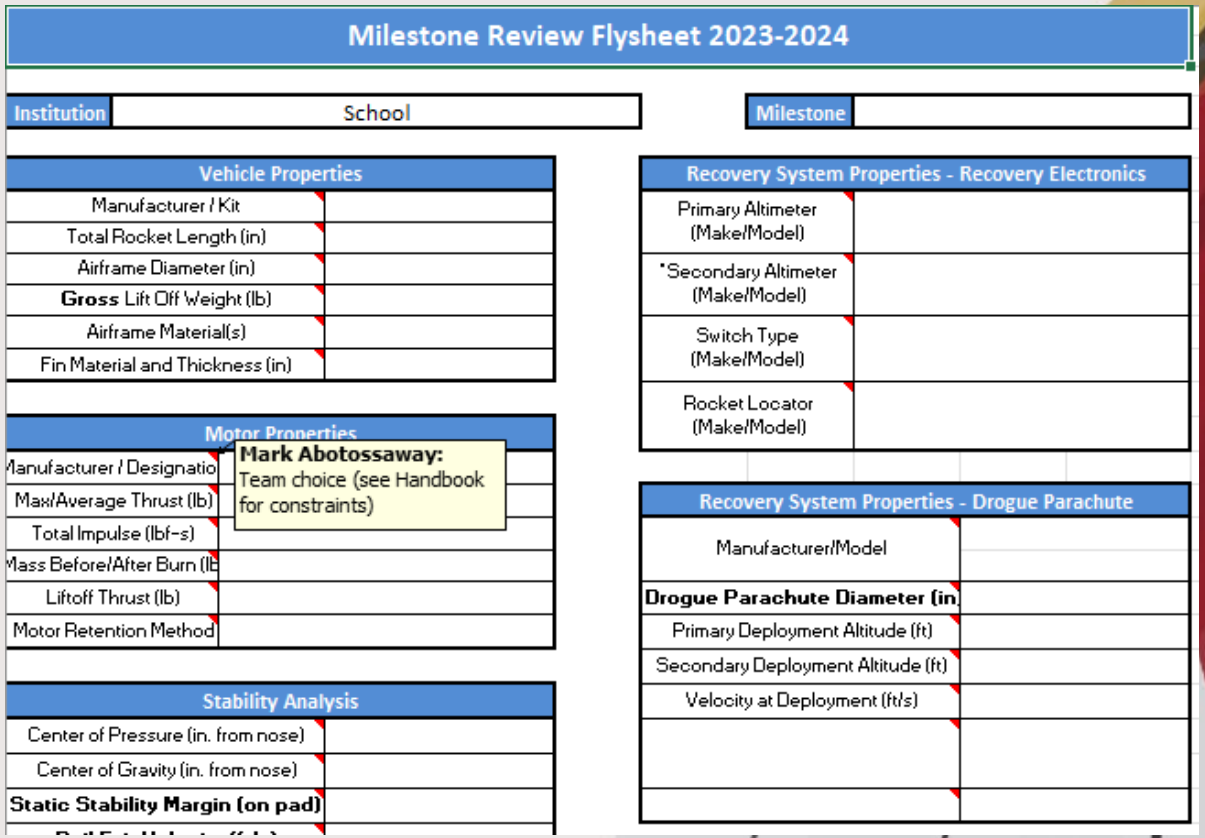
Flysheets

Each parameter (cell that is not blank) must be filled out

There is a comment (by me) in each parameter cell giving a hint how to find the data to fill it out that value

Some of this data is from:
- Team's component selection
- RockSim data
- A website

The **bold** parameters have a required value to them (see Handbook)



Milestone Review Flysheet 2023-2024

Institution	School	Milestone	

Vehicle Properties	
Manufacturer / Kit	
Total Rocket Length (in)	
Airframe Diameter (in)	
Gross Lift Off Weight (lb)	
Airframe Material(s)	
Fin Material and Thickness (in)	

Motor Properties	
Manufacturer / Designatio	
Max/Average Thrust (lb)	
Total Impulse (lbf-s)	
Mass Before/After Burn (lb	
Liftoff Thrust (lb)	
Motor Retention Method	

Mark Abotossaway:
Team choice (see Handbook for constraints)

Stability Analysis	
Center of Pressure (in. from nose)	
Center of Gravity (in. from nose)	
Static Stability Margin (on pad)	

Recovery System Properties - Recovery Electronics	
Primary Altimeter (Make/Model)	
*Secondary Altimeter (Make/Model)	
Switch Type (Make/Model)	
Rocket Locator (Make/Model)	

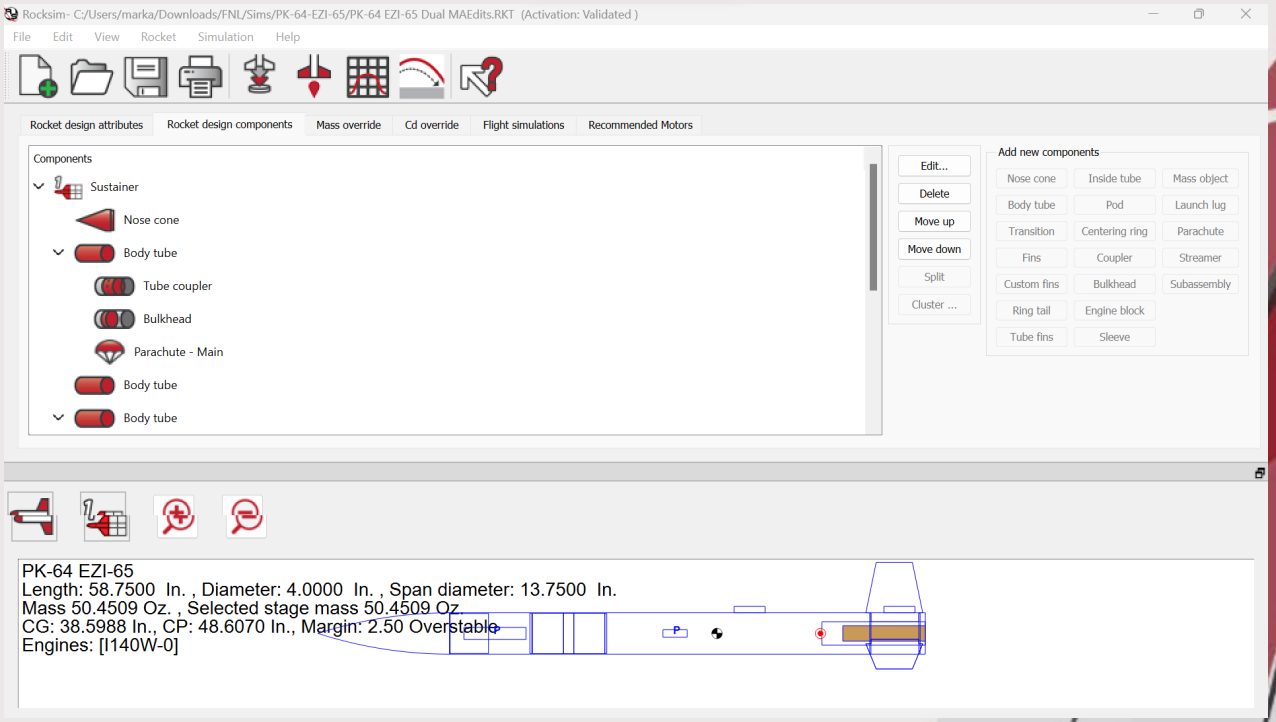
Recovery System Properties - Drogue Parachute	
Manufacturer/Model	
Drogue Parachute Diameter (in	
Primary Deployment Altitude (ft)	
Secondary Deployment Altitude (ft)	
Velocity at Deployment (ft/s)	

RockSim Simulations

- Teams are required to procure and utilize RockSim as their rocket simulation software
  - There is guidance how to procure RockSim in your Acceptance Letter
    - You can install and use a 30-day RockSim trial in the meantime
  - There is guidance how to install and tips in Appendix D-3 Handbook
  - There is technical guidance in our RockSim Webinar Tools and Tips
  - There is technical guidance in our Rocketry Video Series
  - RockSim also has support on their website at Apogee Components

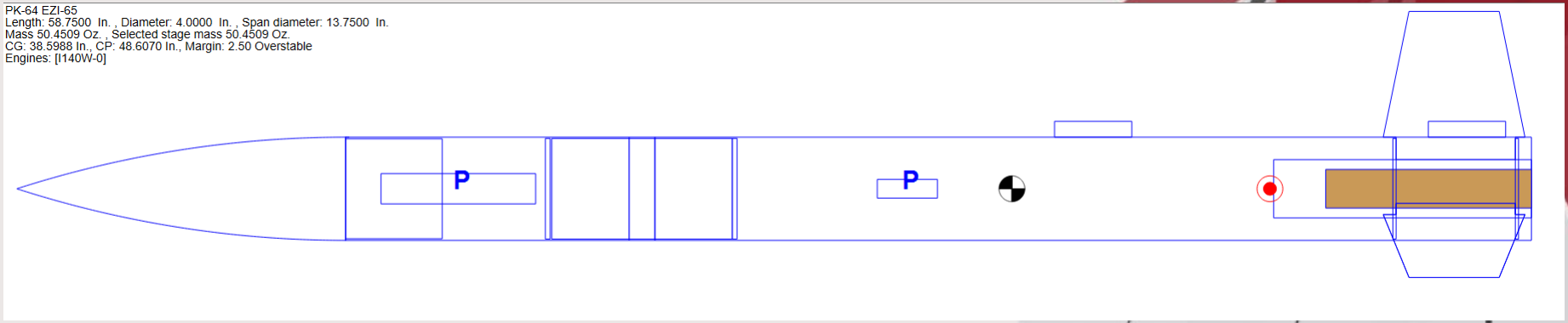
- RockSim allows you to understand the flight performance of your vehicle prior to launch
  - And modify design to achieve a certain performance

RockSim Simulations



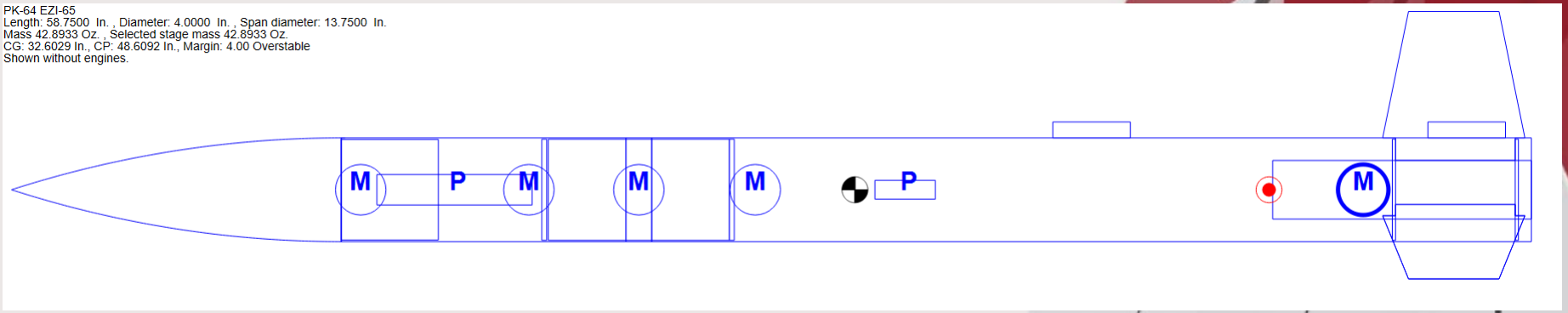
RockSim Simulations

- Your kit / motor selection RockSim model may be ‘empty’ at first
  - You can typically download the RockSim file from vendor
  - That’s ok – you will add components week by week as we go
    - It’s up to you to verify that the simulation represents what you intend to build
    - Do not just assume that the as downloaded file is complete or accurate
      - Its just a starting point



RockSim Simulations

- Your kit / motor selection RockSim model may be ‘empty’ at first
  - Your RockSim simulation will mature over time until all components are determined / added, and the rocket meets performance goals (altitude, rail exit velocity, descent rate, thrust to weight ratio etc)
  - Ensure that the simulation accounts for all the internal components that you will add (the weight is important to performance)



RockSim Simulations







mount adapter. Parachute Recovery.

Excellent Video with On-Board of an L-265.

PK-64_EZI-65-Instructions

RockSim

DESCRIPTION

Complexity: Entry-Intermediate
Diameter: 4"
Height: 57.75
Weight: 3.2lbs
Motor Mount: 54mm with MR-1 Retention
Parachute Size: 36" Ripstop Nylon
Shock Cord Type: NW-15 15' 3/8" Nylon with sewn loops
Shock Cord Mount: SCM-3 Eyebolt
Fin Thickness: 1/8"
Ring Thickness: 1/4"
Instructions: Yes

From LOC Precision website - https://locprecision.com/products/ezi-65

Virtual Presentation

- At PDR and CDR you will give a Virtual Presentation of your status
  - You will use the same template that Moon Mars use
  - Some of the slide content may not be applicable to Gateway
    - Leave it blank – skip it

- This Virtual Presentation can also be considered practice
  - You will give a final presentation of your teams work at Launch Weekend

- Native Engineering Professionals (along with Mark & Frank) will be your audience and give feedback at your presentations

Virtual Presentations

- Download Virtual Template from WSGC Website each Milestone
  - Scoring Rubric | Wisconsin Space Grant Consortium | Carthage College

- Each Milestone requires more information to be filled out in the Presentation
  - Baby steps at first, to prevent information overload
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      i. Flysheet (FRR Tab)
      ii. Safety Inspection Checklist - Virtual Review (5%)
   e. Post Launch Assessment Review (PLAR) (10%)

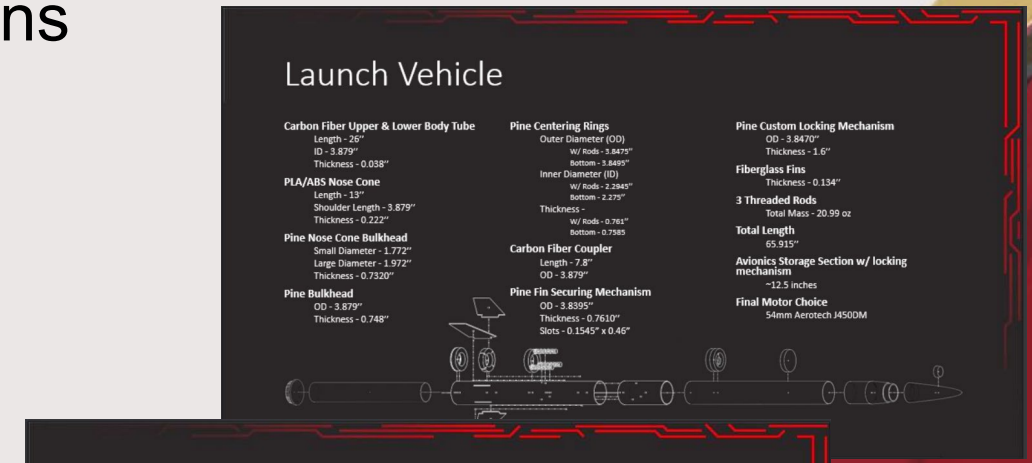
Virtual Presentations

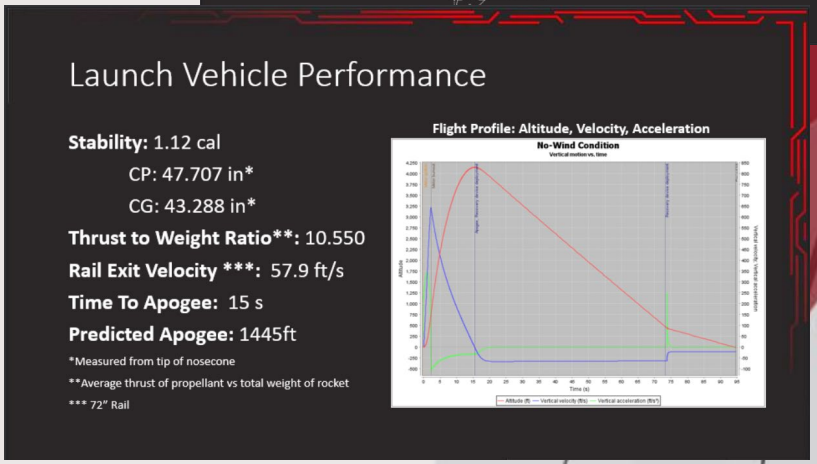
The template has about 10 slides – your present for 15 min

Simply fill out the content that the template slide asks for

Much of the presentation information comes from your RockSim data and your component selections

You will talk about:
- Kit / Motor you selected
- Recovery components
- Avionics components
- Test Program
- Schedule / Budget





Project Management

- Project Management plays a big part in the success (or failure) of any Project
  - Project Management is
    - Scheduling
    - Budgeting
    - Procurement
    - Training
    - Simulations
    - Test Plan
    - Requirements Verification

Project Management - Scheduling

- We will simply provide you with a basic schedule outline to follow
  - Your Milestones drive the schedule (what needs to be accomplished)

		Deadlines / Milestones	Webinar Support / Training
1-Jan	Week 1		
8-Jan	Week 2		
15-Jan	Week 3		Webinar - Project Management
22-Jan	Week 4	PDR Flysheet/RockSim Due	Webinar - Avionics
29-Jan	Week 5	PDR Presentations	
5-Feb	Week 6		Webinar - Recovery
12-Feb	Week 7		Webinar - Build & Assembly
19-Feb	Week 8		
26-Feb	Week 9	CDR Flysheet/RockSim Due	
4-Mar	Week 10	CDR Presentations	
11-Mar	Week 11		
18-Mar	Week 12		
25-Mar	Week 13		Webinar - Launch Operations
1-Apr	Week 14	FRR Flysheet/RockSim Due	
8-Apr	Week 15	FRR Virtual Inspection	
15-Apr	Week 16		
22-Apr	Week 17		
29-Apr	Week 18	Launch Weekend	

Project Management - Scheduling

- Student Role
  - Training, Simulations, Component Selections, Procurement, Assembly

		Milestone	Student Goals	Student Goals	Student Goals	Student Goals	Student Goals
1-Jan	Week 1						
8-Jan	Week 2		Training	Simulations	Component Selections		
15-Jan	Week 3		Training	Simulations	Component Selections		
22-Jan	Week 4	PDR	Training	Simulations	Component Selections		
29-Jan	Week 5		Training	Simulations	Component Selections		
5-Feb	Week 6		Training	Simulations	Component Selections		
12-Feb	Week 7		Training	Simulations	Component Selections		
19-Feb	Week 8		Training	Simulations	Component Selections	Procurement	
26-Feb	Week 9	CDR	Training	Simulations	Component Selections	Procurement	
4-Mar	Week 10			Simulations	Component Selections	Procurement	
11-Mar	Week 11			Simulations		Procurement	
18-Mar	Week 12			Simulations		Procurement	Assembly / Fabrication
25-Mar	Week 13			Simulations		Procurement	Assembly / Fabrication
1-Apr	Week 14	FRR		Simulations		Procurement	Assembly / Fabrication
8-Apr	Week 15			Simulations			Assembly / Fabrication
15-Apr	Week 16			Simulations			Assembly / Fabrication
22-Apr	Week 17						Assembly / Fabrication
29-Apr	Week 18	Launch					

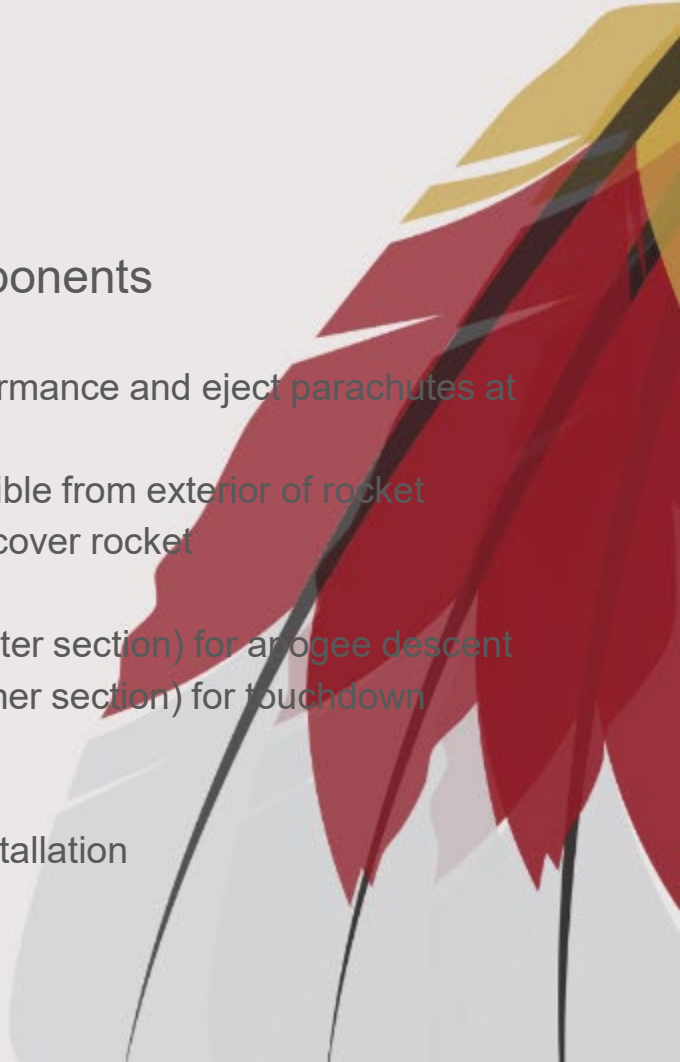
Project Management - Scheduling

- Advisor Support Role
  - Recruiting, Procurement, Resources, Travel, Meetings, Documentation

		Milestone	Advisor Objective	Advisor Objective	Advisor Objective	Advisor Objective	Advisor Objective
1-Jan	Week 1		Recruiting Students	Procure RockSim			
8-Jan	Week 2		Recruiting Students	Procure RockSim			
15-Jan	Week 3		Recruiting Students	Procure RockSim	Team Meetings		
22-Jan	Week 4	PDR	Recruiting Students	Procure RockSim	Team Meetings	Gather Resources	
29-Jan	Week 5		Recruiting Students		Team Meetings	Gather Resources	
5-Feb	Week 6		Recruiting Students		Team Meetings	Gather Resources	
12-Feb	Week 7		Recruiting Students		Team Meetings	Gather Resources	
19-Feb	Week 8		Recruiting Students		Team Meetings	Gather Resources	Assist Procurement
26-Feb	Week 9	CDR			Team Meetings	Gather Resources	Assist Procurement
4-Mar	Week 10				Team Meetings	Gather Resources	Assist Procurement
11-Mar	Week 11				Team Meetings	Gather Resources	Assist Procurement
18-Mar	Week 12				Team Meetings	Gather Resources	Assist Procurement
25-Mar	Week 13				Team Meetings	Gather Resources	Assist Procurement
1-Apr	Week 14	FRR			Team Meetings	Gather Resources	Assist Procurement
8-Apr	Week 15				Team Meetings	Gather Resources	Assist Travel
15-Apr	Week 16				Team Meetings	Gather Resources	Assist Travel
22-Apr	Week 17				Team Meetings	Gather Resources	Assist Travel
29-Apr	Week 18	Launch					Assist Travel

Component Selection

- Team will need to research and select these components
  - Will sit inside Avionics Bay (sled)
    - Altimeters – electronic trigger to measure flight performance and eject parachutes at proper altitudes
    - Switches – altimeters need switches that are accessible from exterior of rocket
    - GPS Tracking – electronic tracking device to help recover rocket
  - Will sit in Rocket Body
    - Drogue Parachute – small parachute sits in aft (booster section) for apogee descent
    - Main Parachute – large parachute sits in fwd (sustainer section) for touchdown
    - Shock cords, parachute protectors, quicklinks
  - Motor Retention
    - Component that keeps motor secure in tube after installation



Project Management - Budgeting

- We will simply provide you with a basic budget outline to follow

General Budget Example

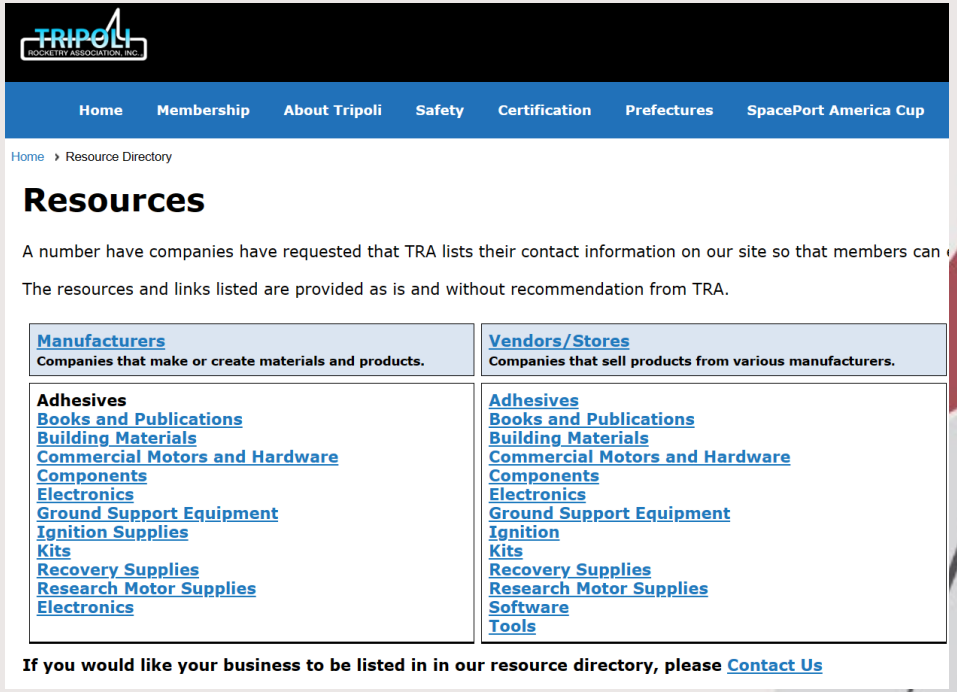
Category	Item	Manufacturer	Vendor	Qty	Unit Cost	Total Cost	Example
Rocket							
	Rocket Kit	LOC Precision	LOC Precision	2	$123.29	$ 246.58	ezi-65-mini-0175 – LOC Precision / Public Missiles Ltd.
	Avionics Bay	LOC Precision	LOC Precision	2	$ 37.70	$ 75.40	Model Rocket Electronics Bays w/Switch Band - LOC Precision – LOC Pre
	Altimeter 1	Missileworks		1	$ 79.95	$ 79.95	RRC3 (missileworks.com)
	Switch 1	Missileworks		1	$ 25.00	$ 25.00	Power Switches (missileworks.com)
	Altimeter 2	Featherweight		1	$175.00	$ 175.00	Blue Raven - Featherweight Altimeters
	Switch 2	Featherweight		1	$ 25.00	$ 25.00	Av-Bay Components - Featherweight Altimeters
	GPS	Featherweight		2	$265.00	$ 530.00	Featherweight GPS Tracker (upd) (featherweightaltimeters.com)
	Parachute - Drogue	Rocketman		1	$ 50.00	$ 50.00	The Rocketman's Online Rocket Parachute Store (the-rocketman.com)
	Parachute Protector - Drogue	Rocketman		1	$ 25.00	$ 25.00	The Rocketman's Online Rocket Parachute Store (the-rocketman.com)
	Shock Cord - Drogue	Rocketman		1	$ 25.00	$ 25.00	The Rocketman's Online Rocket Parachute Store (the-rocketman.com)
	Parachute - Main	Sky Angle		1	$100.00	$ 100.00	b2 Rocketry Web Site
	Parachute Protector - Main	Sky Angle		1	$ 25.00	$ 25.00	b2 Rocketry Web Site
	Shock Cord - Main	Sky Angle		1	$ 25.00	$ 25.00	b2 Rocketry Web Site
	Miscellaneous Electronics	Wiring, Battery		1	$100.00	$ 100.00	
	Miscellaneous Recovery	Swivels, Quicklinks		1	$100.00	$ 100.00	
Build / Fabrication							
	Build Supplies	Epoxy, Tooling				$ 200.00	
	Protective Equipment	Gloves, Goggles				$ 200.00	
Travel							
	Travel					$2,000.00	
						$4,006.93	TOTAL PROJECT COST

Project Management - Procurement

- Vendors and Manufacturers (and components) to start

Procurement References				
	Manufacturer	LOC Precision	WI	High Power Model Rocketry Supplies | Advanced Model Rocket Kits – LOC Precision / Public Missiles Ltd.
	Manufacturer	Wildman Rocketry	IL	Rocket Motors, Kits, and Supplies from Wildman Rocketry – wildmanrocketry.com
	Manufacturer	Madcow Rocketry	CA	Madcow Rocketry
	Vendor	Chris Rocketry	GA	Chris' Rocket Supplies, LLC (csrocketry.com)
	Vendor	Apogee Components	CO	Model Rockets & How-To Rocketry Information (apogeerockets.com)
	Vendor	Performance Hobbies	VA	Performance Hobbies Homepage
	Vendor	Giant Leap	OR	Giant Leap Rocketry: High Power Rocketry supplier of parts and kits – GiantLeapRocketry
	Vendor	OffWeGo Rocketry	MN	Off We Go Rocketry
	Vendor	Bay Area Rocketry	CA	Home - Bay Area Rocketry
	Electronics	Featherweight	CA	Featherweight Altimeters - Home
	Electronics	Missileworks	CO	Home (missileworks.com)
	Electronics	AltusMetrum	CO	Altus Metrum
	Electronics	Eggtimer	CA	eggtimer rocketry electronic altimeter gps tracker kit
	Recovery	Sky Angle	GA	b2 Rocketry Web Site
	Recovery	Fruity Chutes	CA	Parachute Manufacturers for Drones, UAV, Rockets, Research | Fruity Chutes
	Recovery	Rocketman	MN	The Rocketman's Online Rocket Parachute Store (the-rocketman.com)
	Motors	Motor Data		Rocket Motor Data • ThrustCurve
	Motor Hardware	Aeropack		Aero Pack – Aeropack
*reference	Motors	Aerotech Motors		AeroTech/Quest Division, RCS Rocket Motor Components, Inc (aerotechstore.com)
*reference	Motors	Cesaroni Motors		Cesaroni Technology Incorporated
Other Information				
	Tripoli Rocketry Association			Rocketry Vendors and Resources - Tripoli Rocketry Association
	National Association of Rocketry			National Association of Rocketry - NAR
	RockSim Simulations			RockSim Download & Registration : Apogee Rockets, Model Rocketry Excitement Starts Here

Project Management - Procurement



TRIPOLI ROCKETRY ASSOCIATION, INC.

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Resources

A number have companies have requested that TRA lists their contact information on our site so that members can

The resources and links listed are provided as is and without recommendation from TRA.

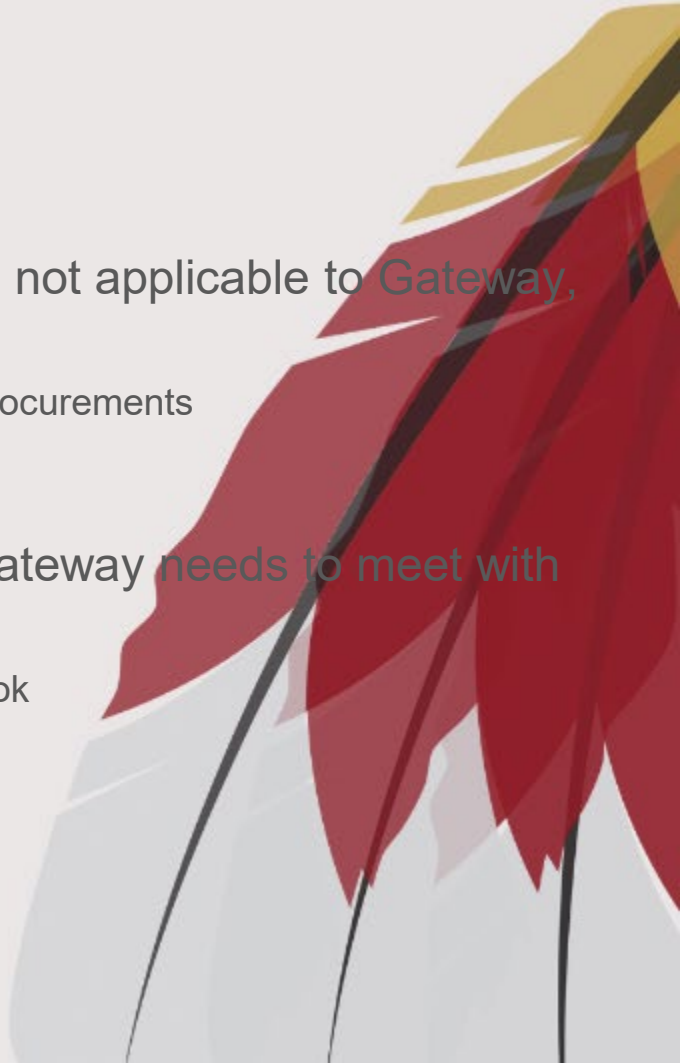
Manufacturers **Companies that make or create materials and products.**	Vendors/Stores **Companies that sell products from various manufacturers.**
Adhesives Books and Publications Building Materials Commercial Motors and Hardware Components Electronics Ground Support Equipment Ignition Supplies Kits Recovery Supplies Research Motor Supplies Electronics	Adhesives Books and Publications Building Materials Commercial Motors and Hardware Components Electronics Ground Support Equipment Ignition Kits Recovery Supplies Research Motor Supplies Software Tools

If you would like your business to be listed in in our resource directory, please Contact Us

Project Management - Other

- The other items listed as Project Management are not applicable to Gateway, but will be if you are in Moon / Mars Challenge
  - So, its good you get a grasp on scheduling / budgeting / procurements
  - Testing should begin if time allows

- There are basic performance requirements that Gateway needs to meet with their rocket
  - These performance requirements are listed in the Handbook
  - We verify these performance requirements are met in your
    - Flysheet
    - RockSim



Project Management - Requirements

- Challenge Requirements
  - Rocket restricted to those on the list
  - Motor restricted to those on the list
  - Altitude target
    - Is a range of 2200 – 2800 feet
    - AGL is Above Ground Level
      - Your simulation apogee goal
      - Your altimeters will measure in flight

Gateway Challenge – The following specific challenge requirements must be satisfied:

1. Detailed Parameters
   a. The team shall select one of the rockets listed in **Appendix A-5**
   b. Motor selection for the team is based on the rocket selected
   c. The rocket shall reach an altitude of 2200' – 2800' AGL
   d. The team / rocket should satisfy all other requirements as outlined in this Handbook
   e. The team shall submit a Flysheet at PDR, CDR and FRR (written reports are not required for this challenge)
   f. The team shall submit a RockSim flight simulation at PDR, CDR, and FRR
2. Competition Performance – Shall be judged on the following criteria
   a. Quality and timely completion of program milestones (see **Program Milestones** section)
   b. Success of competition flight
   c. Recorded altitude of competition flight

Project Management - Requirements

- General Requirements
  - Minimum 1 altimeter
    - 2 suggested
  - Minimum static margin of 1
  - Minimum rail exit velocity of 52 ft/s
  - Minimum thrust-to-weight ratio of 5:1
    - This is your motor thrust divided by your gross rocket weight

General Vehicle Requirements

1. The launch vehicle will use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), and/or Tripoli Rocketry Association (TRA). Motors are provided by WSGC. Motors are limited to those listed in **Appendix A-1**.
   a. Final motor choices will be declared by the CDR milestone.
   b. Any motor change after CDR must be approved by the Tripoli Wisconsin Range Safety Officer (RSO) and will only be approved if the change is for the sole purpose of increasing the safety margin.
   c. A penalty against the team's overall score will be incurred when a motor change is made after the CDR milestone, regardless of the reason.
2. The vehicle will carry, at a minimum, one commercially available, barometric altimeter for recording the official altitude used in determining the Altitude Award winner (see '**Appendix A-4**' for awards criteria) and is to be used for electronic deployment of ejection charges.
3. Each altimeter (if redundant) will have a dedicated power supply, on an independent circuit.
4. Each altimeter (if redundant) will be armed by a dedicated mechanical arming switch, on an independent circuit, that is:
   a. Accessible from the exterior of the rocket airframe when the rocket is in the launch configuration on the launch pad.
   b. Capable of being locked in the ON position for launch (i.e., cannot be disarmed due to flight forces).
5. The launch vehicle will have a minimum static stability margin of 1.0 at the point of rail exit (to be determined by simulations). Rail exit is defined at the point where the forward rail button loses contact with the rail.
6. The launch vehicle will accelerate to a minimum velocity of 52 feet per second (fps) at rail exit (to be determined by simulations). This parameter is also known as 'rail exit velocity' or 'velocity at launch guide departure.'
7. The launch vehicle and motor will have a thrust-to-weight ratio greater than 5:1.

Project Management - Requirements

- Recovery Requirements
  - Drogue parachute should be selected such that the rocket descends at 45 – 65 ft/s from apogee
  - Main parachute should be selected such that the rocket descends at 15 – 20 ft/s at touchdown

Recovery System Requirements

1. The launch vehicle will utilize a standard dual deployment recovery scheme, where a drogue parachute is deployed at apogee and a main parachute is deployed at a lower altitude. Tumble or streamer recovery from apogee to main parachute deployment is also permissible, provided kinetic energy during drogue-stage descent is reasonable, as deemed by the RSO.
   a. The main parachute shall be deployed no lower than 300 feet.
   b. The apogee event may contain a delay of no more than 2 seconds past apogee.
   c. Single deployment parachute release devices (tender descender, jolly logic parachute release etc.) are not allowed.
2. The recovery system electrical circuits shall be completely independent of any payload/challenge electrical circuits.
3. All recovery electronics will be powered by commercially available batteries.
4. Descent rate after apogee (under drogue parachute) shall range between 45 – 65 feet per second.
5. Descent rate upon touchdown (under main parachute) shall range between 15 – 20 feet per second.
6. Electronics (COTS altimeters) must be used as your primary ejection events, at both apogee and main deployment.
   a. Suggest utilization of two altimeters for ejection event redundancy, but not required.
7. The motor ejection charge is the required backup (redundant) deployment at apogee.
   a. Motor ejection cannot be used as your primary (or only) ejection event.
   b. Note this requires that the drogue parachute sits in the booster section.
   c. The estimated time to apogee should be known (from simulations) to adjust the ejection charge delay fuse during motor prep.
8. An electronic tracking device (i.e., GPS) will be installed in the launch vehicle and will transmit the position of the tethered vehicle or any independent section to a ground receiver.
   a. Any rocket section or payload/challenge component, which lands untethered to the launch vehicle, will contain an active electronic tracking device.
   b. The electronic tracking device(s) will be fully functional during the official flight on launch day.

Resources

- If you need help, please ask!
- Your Advisor
- Your Rocketry Mentor
- WSGC FNL Tech Team
  - Frank Nobile
  - Mark Abotossaway
- WSGC FNL Admin Team
  - Rob Cannon
  - Connie Engberg

Questions?