L'SPACE Mission Concept Academy - Preliminary Design Review (PDR) Rubric - Team 23
Session: Spring 2020

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Color Key: Green - Included in PDR and meets Professional Standards; **Yellow** - Included in PDR but needs additional information to be complete and move to Professional Standards; **No Color** - Not addressed in PDR and needs to be added and explained thoroughly.

PDR Final Goal: All highlights are in the Professional Standards Column and Green

Section	Professional	Intermediate	Novice	Notes
1) Introduction and Summary				
1.1 Team Introduction				
	· Outlines the team members including: their names, college and university names, locations, and list of relevant expertise of team members is listed and described.	· Missing one of the four requirements in this topic.	· Missing two or more of the four requirements in this topic.	
1.2 Mission Overview				
1.2.1 Mission Statement	· Mission statement is clear and summarizes objectives.	· Mission statement is defined but lacks summary of all objectives.	· Mission statement is stated but leaves the reader wondering if team knows full mission requirements and objectives.	HS: Nice way of keeping it concise. My only critique would be to site specific applications of your data for future human use. How can we use water on the moon?
1.2.2 Mission	· Mission	· Mission	· Mission	HS: Lots of good

Requirements	requirements are clearly stated.	requirements are briefly stated.	requirements are missing or severely lacking in detail	thought went into some of these requirements. Good job addressing the main constraints along with some other good system requirements. Planetary protection is important, so I was happy to see you address that!
1.2.3 Mission Success Criteria	· Mission success criteria is clearly stated and defines success and failure.	· Mission success criteria is stated but does not define success and failure modes.	· Mission success criteria is missing entirely.	HS: Great job identifying a quantitative failure mode for your first objective, but I would like to see something similar for your quantity and distribution objectives as well.
1.2.4 Concept of Operations	· A professional graphic detailing mission from launch until completion is provided · A thorough description accompanies the graphic	· A graphic showing mission from launch until completion is provided but could be more professional · There is some discussion of the graphic, but needs more info	· Graphic is either missing or severely lacking in detail · No discussion provided	HS: The graphic looks great, but I would like some detail regarding surface operations with a more specific landing location as well. HS: Description is good, but missing some details I would like to see regarding

				landing mechanisms and surface operations.
1.2.5 Major Milestones Schedule	· Major milestones include important project presentations (SRR, PDR, CDR, TRR, etc). · Includes other milestones like manufacturing of lander, testing, etc. (Phases A-E) · Also included is predicted/ projected dates (month & year) of milestones	· Major milestones are included but missing future project presentations. · Includes some other important milestones but not all. · Predicted dates are not described for milestones.	· Major milestones are included but missing future project presentations. · Does not include other important milestones like manufacturing, testing, etc. · Predicted dates are not described for milestones.	HS: Make sure that when inserting graphics to technical papers, the graphic is of high enough pixel quality that the reviewer can read it clearly if they need to zoom in. HS: Good job identifying key dates. I am curious what your experimental plan is to only sustain a 1 day surface mission length.
1.3 Descent and Lander Summary				
	· Entry, descent, and landing sequence is explained in detail with entry angle, justified estimate for entry speed and height, and entry profile. · A picture is presented with EDL stages of lander. · It is also mentioned whether the	· Entry, descent, and landing is explained but missing entry angle, justified estimate for entry speed/ height, or entry profile. · There is no picture detailing EDL stages. · Team mentions whether the lander is performing a soft landing or	· Entry, descent, and landing is lightly explained. · There are no entry angle data, estimates for speed/height, or entry profile · There is no picture detailing EDL stages. · Team does not mention whether the lander is performing a soft landing or ballistic landing.	HS: For a descent orbit insertion, you must have had some delta-V angle relative to the horizon, and that angle is not explained. Otherwise, all other EDL calculations are good! HS: An image detailing the EDL stages with your speed

	lander is performing a soft landing or ballistic landing. · Payload must also be within the mass budget allotment (10 Kg) · Size of the lander vehicle fits within the 60cm cube constraint. · CAD models are included to illustrate design	ballistic landing. · Payload must also be within the mass budget allotment (10 Kg) · Size of the lander vehicle fits within the 60cm cube constraint. · No/limited CAD models are included in this section	· Payload is not within the mass budget allotment (10 Kg) · Size of the lander vehicle does not fit within the 60cm cube constraint. · No CAD models are included	estimates would be good here. HS: You mention it is landing ballistically in a previous section, but based on the numbers you gave and the maneuvers detailed, you are doing a soft landing not a ballistic landing (you are using powered deceleration beyond the body drag). HS: At this point no details regarding the lander design is given, so I cannot determine whether the size and mass constraint are met.
1.4 Payload Summary				
	· Probe and science payload(s) are thoroughly explained such that the reader understands its significance and importance. · Surface experiment deployment system is achievable and	· Probe and science payload(s) are explained but information regarding the function of the instrument(s), its purpose in the mission, or why it is included is lacking. · Payload summary is	· Probe and science payload(s) are described but description fails to adequately justify the payload choice or explanation of payload function. · Payload is well over the mass budget OR not explained in the	HS: I would like to see a more detailed explanation of the payload components, specifically the science payload, and more explanation regarding why the chosen design will achieve the

	thoroughly explained, with supporting evidence included. · CAD models are included to illustrate design	good, but the lander vehicle is over mass constraint. · Size of the vehicle is within mission constraints. · Surface experiment deployment is practical but needs more thought and explanation, as it does not fully address potential problems. · No/limited CAD models are included in this section	section. · Size of the vehicle is not mentioned within the report and leaves the reader not knowing whether the lander satisfies mission constraints. · Some significant parts might need to be reconsidered. · Surface experiment deployment needs to be reconsidered and/or modified. · No CAD models are included	requirements. HS: No CAD models or design descriptions, so I cannot tell whether the payload fits within the constraints. IA: This is a good breakdown of what's going to be included on the payload, but provides no insight into how the payload will be configured to achieve your science goals
2) Evolution of Project				
2.1 Evolution of Descent and Lander Design				
	· All of the changes made to the Descent and Lander Criteria from the initial concept to final product have been explained. · At least three distinct design iterations are evident	· Some changes were explained. A minimum of three ideas were thought of leading to final Descent and Lander Criteria design. · 2 distinct design iterations are evident	· Little to no team brainstorming was done prior to final Descent and Lander Criteria design.	HS: I would have liked to see some sketches or preliminary CAD designs, but overall you describe your design evolution well.
2.2 Evolution of Payload				
	· All of the changes made	Some changes were explained.	· Little to no team	HS: Design iterations aren't

	to the Payload Criteria from the initial concept to final product have been explained. · At least three distinct design iterations are evident	A minimum of three ideas were thought of leading to final Payload Criteria design. · 2 distinct design iterations are evident	brainstorming was done prior to final Payload Criteria design.	as clear, but it is obvious that much thought went into the final selection.
2.3 Evolution of Mission Experiment Implementation Plan				
	· All of the changes made to the Mission Experiment Implementation Plan from the initial concept to final product have been explained. · At least three distinct design iterations are evident	Some changes were explained. A minimum of three ideas were thought of leading to final Mission Experiment Implementation Plan design. · 2 distinct design iterations are evident	· Little to none team brainstorming was done prior to the final Mission Experiment Implementation Plan design.	HS: Nice!
3) Descent and Lander Design				
3.1. Selection, Design, and Verification				
3.1.1 System Overview	· Each system is explained in detail such that the reader understands the function and purpose of each part. · Important systems are shown through CAD w/ measurements, front, side, and top point of	· Each system is explained but leaves the reader with questions about the function and purpose of parts. · Important systems are shown through CAD but missing measurements or not presented in front, side, and top POVs.	· Each system is explained but leaves the reader questioning what is the purpose of a part OR why a part is necessary. · There are no CAD drawings or any images of systems.	HS: This section left me a bit confused. The details regarding communication architecture and data handling were good, but the EDL info was repetitive and a few new concepts were introduced but explained minimally - the

	views.			“scoop” aspect of the mission and the “hopping” aspect. HS: CAD model is good, but I am curious as to where some of the components from the description are (no thrusters shown, no bottom view to show how payload will contact ground) IA: This section should have been more heavily rooted in your EDL systems. Good model displaying the struts, but where are the thrusters located?
3.1.2 Subsystem Overview	· Subsystems and their importance are explained.	· Subsystems are clearly shown but need more clarification on some parts.	· Subsystems are shown but no clarification on significance/ importance of parts.	HS: Again this section left me a little confused, as the subsystems are introduced, but no specifics on the design are discussed. What batteries are you using? How much energy can the solar panels collect? What specific thermal controls

				are you implementing? At this point in the paper, you should be talking design specifics. IA: I am confused about why there is a whole section about spacecraft history and potential equipment. Research should be included to support your design's feasibility, do not include information just for the sake of including it.
3.1.3 Dimensioned CAD Drawing of Entire Assembly	· Fully Dimensioned CAD drawing of the entire assembly is included.	· CAD drawing of the entire assembly is included, but may not be fully dimensioned.	· CAD drawing missing or seriously incomplete	HS: Good CAD, but specifics regarding internal dimensions are missing.
3.1.4 Manufacturing and Testing Plans	· Demonstrated planning of manufacturing and integration · Component testing, functional testing, or static testing is included.	· Demonstrated planning of manufacturing and integration is not complete. · Component testing, functional testing, or static testing is included, but is not complete.	· Planning of manufacturing and integration is missing or is very incomplete. · Component testing, functional testing, or static testing is missing or is very incomplete	HS: The plan is there, but specifically for integration, details are lacking. When you are using all outside contractors, you need to have a clear integration plan (timeline, integration order, etc) since all the

				components were made by different companies and may not be perfectly compatible.
3.1.5 Validation and Verification Plans	· Team created standards and evaluation methods for systems and subsystems to meet requirements and specifications to fulfill the team's objectives.	· Team created standards and evaluation methods for systems and subsystems but needs additional metrics to show the reader that the team will meet requirements and specifications.	· Team created standards and evaluation methods for systems and subsystems but is lacking important mission constraints given OR standards and evaluation methods are missing.	HS: Since this is more a template of a V&V chart rather than containing actual V&V plan information, it is difficult to judge whether the V&V plan for this mission has been well thought out. IA: In the chart you mention that the sponsor will confirm that the lander has passed the tests and is up to par, however that is the entire purpose of this section. Your team should be determining those tests to determine that your design works when you put all the outsourced components together and more importantly that your design will work in space.

3.1.6 FMEA and Risk Mitigation	· Critical thought went into potential risks the lander could encounter. · Risk plot or risk reduction chart is shown. · Each risk is explained along with risk reduction measures that will be placed in to reduce the chance of risk even further. · Both a risk mitigation plot and FMEA are given and include detailed risks and risk mitigation	· Some critical thinking went into potential risks for the lander. · Risk plot or risk reduction chart is shown. · Each risk is explained but little thought went into risk reduction measures. · Either a risk mitigation plot or FMEA are given but lack detailed risks and risk mitigation	· Some critical thinking went into potential risks for the lander. · Risk plot or risk reduction chart is missing. · Each risk is not explained further nor is there an explanation for risk reduction measures.	HS: Some of the risks in this section are not lander risks, but rather personnel hazards and should instead be addressed in section 5. HS: The risks are explained very vaguely, and I would like more detail to understand why some of these are considered risks HS: Mitigations are discussed, but again are relatively vague.
3.1.7 Performance Characteristics and Predictions	· Performance characteristics of system and subsystems are shown that include important data for the reader and that it can operate within environmental conditions.	· Performance characteristics are shown but does not show important data that shows it could operate within environmental conditions.	· Performance characteristics are missing or lacking data that shows it could operate within environmental conditions.	HS: This section is duplicated from section 1.2.3, and therefore not describing the performance characteristics.
3.1.8 Confidence and Maturity of Design	· Confidence and maturity of design is demonstrated.	· Confidence is lacking or maturity of design is not demonstrated.	· Lacking in confidence and maturity	HS: Overall, this section of the PDR did not demonstrate full design development and maturity of design ideas due

				to lack of detail about the design specifics.
3.2 Recovery/ Redundancy System				
	· Recovery and redundancy systems are discussed at length and justified	· Recovery and redundancy systems are mentioned but need more detail	· Recovery and redundancy systems are missing or severely lacking detail	HS: Good job mentioning some key failure points for many spacecraft. Watchdog timers and mitigations for SEUs is very important!
3.3 Payload Integration				
	· Integration plan details integration of the payload(s) onto the lander	· Integration plan lacking in details for the integration of payload(s) onto lander	· Integration plan missing or seriously lacking in details.	HS: Great job mentioning all the specific needs of your payload.
4) Payload Design and Science Experiments				
4.1 Selection, Design, and Verification				
4.1.1 System Overview	· Review of the design at a system level provided, going through each system's functional requirements (includes sketches of options, selection rationale, selected concepts and characteristics). · N^2 Chart is detailed and professional	· Review of the design at a system level provided, but some details going through each system's functional requirements (includes sketches of options, selection rationale, selected concepts and characteristics) are lacking. · N^2 Chart is	· Review of the design at a system level not provided or seriously lacking in detail. · N^2 Chart is missing or severely lacking in detail	HS: Description should be about the design at this point, as the objectives are already understood. HS: No N^2 chart given.

		given but missing some details		
4.1.2 Subsystem Overview	· Payload subsystems (if applicable) that are required to accomplish the payload objectives are clearly described.	· Payload subsystems (if applicable) that are required to accomplish the payload objectives are described, but the details are lacking	· Payload subsystems (if applicable) that are required to accomplish the payload objectives are not described, or details are seriously lacking	HS: Good job detailing operational specifics for each of the payload components. I would like some more detail regarding how they are interfaced with the lander (CAD models), but overall nice work. IA: Be sure to keep things professional, phrases like “we admit this is a crack-head idea” wouldn’t belong in a formal PDR
4.1.3 Precision of Instrumentation, Repeatability of Measurement, and Recovery System	· Precision of instrumentation and repeatability of the measurements is considered. Recovery system is also discussed	· Precision of instrumentation or repeatability of the measurements is considered. Recovery system is also discussed briefly	· Precision and repeatability are not at all considered. No mention of the recovery system	HS: Very vague description, especially for recovery plan. What do you plan to do if one of your components is experiencing a failure?
4.1.4 Validation and Verification Plan	· Team created standards and evaluation methods for systems and subsystems to	· Team created standards and evaluation methods for systems and subsystems but	· Team created standards and evaluation methods for systems and subsystems but	HS: No specific metrics to determine how to verify the system was built to meet

	meet requirements and specifications to fulfill the team's objectives.	needs additional metrics to show the reader that the team will meet requirements and specifications.	is lacking important mission constraints given OR standards and evaluation methods are missing.	requirements and validate the system was built to function under proper environments.
4.1.5 FMEA and Risk Mitigation	· Critical thought went into potential risks the lander could encounter. · Risk plot or risk reduction chart is shown. · Each risk is explained along with risk reduction measures that will be placed in to reduce the chance of risk even further. · Both a risk mitigation plot and FMEA are given and include detailed risks and risk mitigation	· Some critical thinking went into potential risks for lander. · Risk plot or risk reduction chart is shown. · Each risk is explained but little thought went into risk reduction measures. · Either a risk mitigation plot or FMEA are given but lack detailed risks and risk mitigation	· Some critical thinking went into potential risks for lander. · Risk plot or risk reduction chars is missing. · Each risk is not explained further nor is there an explanation for risk reduction measures. · Risk mitigation plot and FMEA are missing or severely lacking detail	HS: Duplicated from section 3.1.6, no additional information given regarding specific payload risks.
4.1.6 Performance Characteristics	· Performance characteristics for the system (and subsystems if applicable) are listed.	· Performance characteristics for the system (and subsystems if applicable) are not all listed or missing some details.	· Performance characteristics for the system are missing entirely or lacking in detail.	HS: This section should be discussing how you think the payload will perform in the harsh environment. What proves that this instrument will work on the moon?

4.2 Science Value				
4.2.1 Science Payload Objectives	· Science payload objectives are thoroughly described and outlines what it is supposed to achieve.	· Science payload objectives are described to a reasonable extent.	· Science payload objectives are either minimally discussed or not mentioned.	HS: Objective is relatively clear, but again some new concepts that were introduced previously, but never explained, are brought up again which is a bit confusing.
4.2.2 Creativity/ Originality and Uniqueness/ Significance	· Creativity and originality · Uniqueness or significance. Answers what kind of unique science this mission will provide	· Lacking creativity or originality · Lacking in uniqueness or significance	· Neither creative nor original · Neither unique nor significant	HS: Good job stating what kind of useful science you will provide.
4.2.3 Payload Success Criteria	· Payload success criteria explains the significance of payload deliverables and furthers our understanding of the planetary body.	· Payload success criteria are present, but the level of payload deliverable is not too significant that it will further our understanding of the planetary body.	· Payload success criteria are vague and show no payload deliverables to further our understanding of the planetary body or are missing.	HS: Overall, payload success criteria aren't very firm. You waiver in some of your main points when you should make them very clear. Are you hopping on the crater or not? Also, again this hopping method is not ever discussed in the design so it's a bit confusing.
4.2.4 Describe Experimental Logic, approach, and method of	· Team describes how their scientific payload will	· Team describes how their scientific payload will	· Team describes how their scientific payload will	HS: JMARS is referenced from section 4.2.2. HS: Overall, the

investigation	answer their science deliverables by their method of design, subcomponents, and approach to collecting data. · JMARS tool is utilized and explained to the reader. · A picture is provided within report showing landing site and any other important JMARS filters to show the reader the importance/ significance of landing site.	answer their science deliverables but their method might seem problematic or confusing for the reader. · JMARS tool is utilized but there is no explanation for the reader about what it is and why it is being used. · A picture is provided within report showing landing site and any other important JMARS filters BUT fails to explain to the reader the importance/ significance of landing site.	answer their science deliverables but their method of approach is unrealistic or unachievable. · JMARS tool is not utilized OR there is no evidence of JMARS tool within report. · No picture is provided within report showing landing site or any importance/ significance of landing site.	experimental method is confusing because the "hopping" between sites is not supported by the design. Also, you mention the general landing site, but don't mention your exact experimental plan. You only have 1 day according to your schedule - how are you spending it? IA: In some sections you mention "hopping" to another location as only a possibility, yet in this section you mention moving locations with ease. How will this be implentemend into your design? Can your instruments withstand the impact of hopping around? IA: You mention that WAFFLE will utilize "a number of other methods of investigation" in

				addition to the NSS, explain those methods in detail.
4.2.5 Describe Testing and Measurements, including variables and controls	· Team describes in detail how science payload can be tested on Earth and suitable to operate in the planetary body's conditions. · Team also provides and explains what the variables and controls are during testing.	· Team describes how science payload can be Earth tested but their approach or testing could be problematic. · Team provides what the variables and controls are during testing but don't explain why variables were decided.	· Team describes how science payload can be Earth tested but their approach or method of testing is unachievable. · There is no variables or controls provided by team.	HS: You talk more about the on-site testing on the Moon, but it is clear that you thought through the testing process and included the appropriate variables.
4.2.6 Show expected data & analyze (error/ accuracy, data analysis)	· Educated predictions of scientific payload in the planetary body's conditions can be calculated and an accuracy/ error analysis is made. For any instruments, check if there are any spec sheets provided. · Example data is shown and analyzed	· Predictions of scientific payload in the planetary body's conditions can be calculated and an accuracy/ error analysis is made. For any instruments, check if there are any spec sheets provided. · Example data is shown but missing analysis	· Predictions of Scientific payload in the planetary body's conditions were not calculated and an accuracy/ error analysis was not made. · Example data is missing	HS: Data is given, but application to specific landing site lacking. HS: Example data is not explained to the reader to understand what the data means in relation to the specific mission.
5) Safety and Environment				
5.1 Personnel Safety				
5.1.1 Safety	· Safety officer	· Safety officer	· Safety officer	

Officer	for team identified (must be present in-person at Earth testing site, or Team Safety Officer must designate an on-site person).	for team not identified (or no on-site person designated).	for team not identified.	
5.1.2 List of Personnel Hazards	· Provided a list of personnel hazards. Include data demonstrating that safety hazards have been researched (such as Material Safety Data Sheets, operator's manuals, NAR regulations)	· Provided a list of personnel hazards, but some elements missing. Include data demonstrating that safety hazards have been researched (such as Material Safety Data Sheets, operator's manuals, NAR regulations)	· Hazards list not provided or seriously lacking in information.	HS: Good hazards given, but lacking explanation as to why these hazards arise in the context of this mission.
5.1.3 Hazard Mitigation	· Team discusses plans to mitigate hazards listed in section 5.1.2 at length and shows full understanding of hazards and how to prepare for them	· Team briefly discusses plans to mitigate hazards listed in section 5.1.2 and shows some understanding of hazards and how to prepare for them	· No discussion of personnel hazard mitigation or discussion severely lacking in detail	HS: I would have liked to see a little more detail in these mitigation mechanisms. What does "work with precaution" mean? What PPE will they wear?
5.2 Lander and Payload Safety				
5.2.1 Environmental Hazards	· Discussion included of any environmental concerns – including optimal	· Discussion included of any environmental concerns provided, but	· Discussion of any environmental concerns not provided, or	HS: Great job. As far as the temperature goes, are you going to try to

	testing environment conditions (e.g., weather conditions, landing surface, etc.). (ON the planetary body)	lacking in particulars.	seriously lacking in particulars.	land during the lunar day in the hotter season to help with temperatures?
5.2.2 Hazard Mitigation	· Team discusses plans to mitigate hazards listed in section 5.2.1 at length and shows full understanding of hazards and how to prepare for them	· Team briefly discusses plans to mitigate hazards listed in section 5.2.1 and shows some understanding of hazards and how to prepare for them	· No discussion of environmental hazard mitigation or discussion severely lacking in detail	HS: Some good thought, but I would like to hear more about the temperature mitigation, as the Shackleton crater is permanently shaded and VERY cold.
6) Activity Plan				
6.1 Budget				
	· Detailed Budget Plan. Includes the 30% general margin and margins for manufacturing and F&A. Teams should budget template and include salaries, and travel costs to launch.	· Budget plan missing some details.	· Budget plan missing or seriously lacking in details.	HS: I would like to see a budget narrative describing some specific breakdown for these costs (materials, equipment, etc). Great job getting the margin right! HS: Why does your budget extend out 5 years when your mission timeline is only 2 years (1/2020 to 10/2021)?

6.2 Schedule				
	· Detailed schedule going out past launch. Should include margin/"buffer" to account for unexpected delays.	· Schedule goes out past launch. Does not include much margin/"buffer" to account for unexpected delays. Could be additional details added	· Schedule missing and/or not detailed going out past launch. No margin/"buffer" to account for unexpected delays.	HS: Overall lacking detail regarding intermediate tasks. What work is done within the phases beyond the design reviews? Also, these dates somewhat conflict with the previous dates given, which adds confusion.
6.3 Outreach Summary				
	· Mission Education and Public Outreach Summary included.	· Mission Education or Public Outreach Summary included, lacking in detail	· Mission Education and Public Outreach Summary missing are severely in detail.	HS: Good plan to use a combination of traditional and current outreach methods!
6.4 Project Management Approach				
	· Project Management Approach thoroughly described	· Project Management Approach discussed but lacks detail	· Project Management Approach missing or severely lacking in detail	HS: I would have liked to see the org chart you discuss, but otherwise good work!
7) Conclusion				
	· Includes detailed summary of PDR, and outlines next steps for the project up until the CDR	· Includes summary of PDR, and briefly outlines next steps for the project up until the CDR	· No/poor summary of PDR, and no mention of next steps for the project	HS: Could use some more confident discussion of mission, and also a plan of action going forward for

				development.

Additional Notes:

No 1st person pronouns
Hannah Stickel (HS):

> You all should be extremely proud of the ideas and concepts of this mission! I think you came up with an extremely interesting idea that fits within the constraints of what you were given. Using a static lander with the possibility of “hopping” around the crater gives a high payoff to NASA for a variety of data sources. Overall, your mission objectives are grounded in NASA’s exploratory interests for the Moon and your idea for a small lander clearly supports that objective.
>
> Your biggest weakness throughout the PDR is clarifying your design ideas. You briefly touch on some of the subsystems, but never really discuss them in depth enough for a reviewer like myself to understand the specifics of your design. You also have a few key risks that aren’t really addressed in the design, specifically thermal risk. Landing at the bottom of Shackleton crater is an interesting idea considering the possibility of ice, but the region is permanently shaded due to the inclination of the sun to the surface and the depth of the crater. Being permanently shaded means extreme low temperatures. This specific risk is not addressed in the design, and I think this is a crucial consideration when determining the feasibility of the mission.
>
> Again, you all turned in a really nice PDR and should be proud of your work. I encourage you to read through my feedback and if you have any questions, please feel free to contact me at hksticke@asu.edu.

Team 23,

Congratulations on completing your PDR! You should be proud of your hard work and dedication, you have created a solid document.

My overarching concern with the PDR was a lack of continuity and cohesion between sections. There a few design ideas that were briefly mentioned and not further elaborated on, or following sections contradicted their existence. Some of these designs included the thrusters (where were they located, how did they fit), the hopping mechanism, and the low-orbiting solar panel and laser. Additionally be sure to keep your document consistent and professional; this applies to formatting citations, excluding personal pronouns, and labeling figures.

Overall, you came up with unique and exciting ideas, with further research and details this has the makings of a fantastic PDR!

-IA