# 2024 Human Lander Competition (HuLC)
# Q&A Session Summary Document

November 8, 2023
3:00 – 4:30 PM Eastern

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Note: Highlighted questions will be covered during the Q&A Session on November 8th, 2023.

# QUESTIONS RECEIVED IN ADVANCE: TECHNICAL

1. **What lander should we be researching and designing around? Are there general dimensions and specifications to work with? Who is the manufacturer of the Artemis Lunar Lander?**
    a. Please use publicly available information on the Human Landing System (HLS) program from NASA to learn more about the two selected lander providers and general characteristics of those systems.

2. **What is the mass of the lander and what will the mass percentage limitation of our solution be? Is there a maximum allowable weight and volume of a proposed design solution?**
    a. Please use publicly available information on the Human Landing System (HLS) program from NASA to learn more about the two selected lander providers and general characteristics of those systems. There is no NASA-provided specification on mass/volume/power constraints for a proposed design solution, but the general constraints of spacecraft design and historical metrics for payload mass fraction should be used for guidance.

3. **We want to use electromagnetic fields in our project. Are there any concerns with this?**
    a. Please be aware that most lunar soil particles do not have very large magnetic susceptibility. In particular, for highlands soils, about 80% of the mass is anorthositic which is not magnetizable. While it may be true the finer particles may nonetheless be magnetic due to nanophase iron (npFe) on their surfaces due to space weathering, the effect of this npFe may be negligible for larger particles that have a higher mass-to-surface area ratio. So, take this into consideration.

       Also, and perhaps more importantly, consider the distance that is required to turn a super-fast particle via magnetic fields. It might take 100s of meters to get a significant change in the velocity vector, but the fields from a practical magnet delivered to the Moon's surface may only have influence over a couple meters. You can't deflect things traveling that fast over such a short distance. We really don't want to stifle your innovation, but we recommend that before investing too much time in these approaches, teams should do some hand calculations of the forces they can generate and how much this can deflect dust/sand particles traveling 100s to 1000s of meters per second.

4. **Are there payload limitations (e.g., Weight, Size, Shape, Volume)?**
    a. Please use publicly available information on the Human Landing System (HLS) program from NASA to learn more about the two selected lander providers and general characteristics of those systems. There is no NASA-provided specification on payload limitation for a proposed design solution, but the general constraints of spacecraft design and historical metrics for payload mass fraction should be used for guidance.

5. **What fuel will be used on the lander for the landing engine?**
    a. Please use publicly available information from NASA and the Human Landing System (HLS) selected providers for characteristics on design and operations of their landers.

6. **Is there a specific power requirement? What is the maximum power consumption of a proposed design solution?**
    a. There is no specific power requirement. However, "Design Constraints and Guidelines" in the proposal guideline states "minimal barriers to adoption" as a design criterion. Lower power consumption in a viable design solution should be prioritized.

7. **What does the landing sequence for the HLS look like? (e.g., Time frame Positioning, Path)**
    a. Please use publicly available information from NASA and the Human Landing System (HLS) selected providers for characteristics on design and operations of their landers. Trajectories and design details will not be provided but can be approximated through your own flight mechanics simulations.

8. **Is there a current plan in place for having a landing pad of some sort for when HLS initially touches down on the moon during Artemis 3? If not, do you plan to land directly on the lunar surface?**
    a. No. Prepared landing surfaces and structures will not be present for any of the currently scheduled lunar landings, including Artemis 3. The necessary infrastructure and equipment to construct, deploy, and/or assemble such solutions must be delivered to the surface in the same manner that all prior lunar landings have occurred, which is to non-prepared landing sites. Please consult the publicly available NASA technology roadmaps (Space Tech Taxonomy), NASA Space Technology Strategic Framework, and Artemis concepts of operations for information on where such solutions may be possible. Landing pads and prepared landing surfaces do not presently appear on any NASA roadmaps.

9. **Are there any NASA-adopted industry standards we should be aware of?**
    a. NASA has a great deal of standards that are constantly being updated for designing, building, testing, and deploying – too many to list here. We recommend doing an internet search, and using the NASA NTRS system to do some research on the specific area you're interested in.

10. **What is the acceptable NASA factor of safety for a proposed design?**
    a. Please consult publicly available NASA standards for factor of safety.

11. **Are there specific regulations (including safety requirements and protocols), both domestic and international, we should be aware of for devices being deployed in space and from the rockets?**
    a. Please consult publicly available NASA standards.

12. **Are there any particular risk assessments or hazard analyses we should conduct for a device that is to be deployed from the Human Lander?**
    a. Risk management and mitigation is crucial to ensure project success. If teams anticipate risks or hazards for their design solutions, consider including identified risks and/or any risk management or mitigation in the proposal. However, performing a full assessment with analysis results is not required.

13. **Will potential Artemis missions utilize radioisotope thermoelectric generators (RTG) in addition to solar panels, especially in darker areas of the lunar surface?**
    a. RTG in addition to solar panels as a power system is not currently part of the planned Artemis missions, but it could potentially be a technology to be tested on the moon for future missions.

14. **How much radiation exposure should a device deployed to the surface of the moon be prepared for?**
    a. The ionizing radiation environment for the lunar surface is defined in Section 3.4.7 of SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE), available from the NASA Technical Reports Server here: SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE) - NASA Technical Reports Server (NTRS)

15. **What are the current ways in which NASA shields electronics from harmful space radiation?**
    a. Space electronics are often built with components that are designed to withstand the high radiation environment, or with redundancy so that "glitches" induced by radiation will be detected and ignored. In many small spacecrafts, there is no need for additional radiation shielding of the electronics. However, these design factors may be supplemented by simple mass shielding to reduce the radiation dose that reaches the components. The shielding can be any material such as aluminum. Research is ongoing to develop better shielding materials that have the same reduction of dose for less mass.

16. **What is the minimum number of cycles needed by a permanent landing structure or design?**
    a. There is no specific requirement, but a system that can be used repeatedly with minimal or no maintenance has advantages over a system that must be repaired or replaced after one use or a

small number of uses. Solutions that require less maintenance and less replacement cost should be prioritized.

17. **Are there any simulations that our team could get a hold of that detail how the surface regolith may respond to the plume of the rocket engines?**
    a. Teams should perform a literature search to understand plume-surface interaction effects. Two places to start are this white paper: [2102.12312] Understanding and Mitigating Plume Effects During Powered Descents on the Moon and Mars (arxiv.org) And this presentation: An Overview of Plume-Surface Interaction Testing and Research - NASA Technical Reports Server (NTRS). A detailed description of plume effects during the Apollo landings is found here: https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2010JE003745.

18. **What is the force exerted on the lunar surface by the thrusters at the base of the Human Lander?**
    a. Teams may use publicly available information about the HLS landers to estimate plume effects such as force exerted on the lunar surface. Generally, the pressure on the ground will equal the weight of the vehicle in lunar gravity, because landing with a constant descent rate requires a thrust that equals the vehicle weight. That pressure will be spread over the surface in a typically Gaussian shape. If there are more than one engine, then when the vehicle is high above the surface the plumes of the engines will merge together so there will be only one gaussian pressure distribution on the surface, but when a multi-engine lander is near the surface then there will be a gaussian distribution beneath each engine individually. Examples of the pressure distribution on the lunar surface for 11-ton and 40-ton lunar landers can be seen in Fig. 4 of this paper: https://www.sciencedirect.com/science/article/abs/pii/S0094576522000716 (click "View Open Manuscript" at the top). Note that the length scale in that figure is identified by the height of the nozzle above the surface. An example of the shear stress from the gas flow over the surface, for the Apollo Lunar Module (about 7-ton mass) at different heights, can be seen in Fig. 4 of this manuscript: http://cfpl.ae.utexas.edu/wp-content/uploads/2012/06/AMorrisRGD2010_Plume.pdf. The temperatures are shown in Fig. 2 of that same paper.

19. **Is there an acceptable depth of cratering below the base of the rocket when landing on the surface?**
    a. The Apollo program had a requirement of landing on a surface that was no more sloped than 11 degrees. As long as the cratering under the vehicle does not create a slope that exceeds some comparable amount, then there should be no risk to vehicle stability. In general, in the Apollo landings the erosion was deeper in a toroid off of the centerline and only a few centimeters deep (at about 1-2 meters radius), and the soil was broadly flat and scoured clean directly under the vehicle. Therefore, it did not create a sloped crater that would be a concern. It is not currently known whether a larger lander might dig a deeper hole directly under the nozzle.

20. **What are the expected thermal ranges a device external to the lander will experience during the descent and ascent phases of the Human Lander?**
    a. For a multi-engine lander, the bottom of the spacecraft between the engines will be subjected to very high temperatures when the engines are thrusting very close to the lunar surface, perhaps as high as 2700 Kelvin for a brief time. Any equipment located there would require insulation to survive. For any other location on the spacecraft, you may assume that the plume will not cause any heating. The temperatures during coast to the Moon and while in lunar orbit before landing may be as low as –120 degC and as high as +100 degC. While on the lunar surface, the temperatures may be in the range of -30 degC to +100 degC depending on whether it is on the side of the lander in direct sunlight or shadow.

21. **What vacuum and microgravity considerations should be taken into account when deploying mechanisms onto the Lunar Surface?**
    a. Good question! Teams considering suction should be aware that you can't suck harder than lunar vacuum, so sucking doesn't work on the Moon. If you are trying to suck supersonic gas from inside

a plume (where it is not vacuum) then it is still doubtful a system practical for lunar delivery could move gas quickly enough to do that. The gas flow will be highly inertial so small pressure differences at orifices along the vehicle's skin would have essentially no effect. Teams might consider consulting with a professor at their school who does flow modeling before investing too much time in a suction concept.

Gravity considerations depend on mission phase. While a spacecraft is in transit to the Moon or on orbit, it will generally experience a microgravity environment. During active thrusting, loads will vary based on the spacecraft and configuration. Once landed on the surface, the spacecraft will experience lunar gravity, which is about 1/6 Earth's gravity. Gravity has a significant effect on plume-surface interaction behaviors. As for mechanisms, loads or structural analyses should use lunar gravity as an input. Mechanisms interacting with regolith should also account for this reduced gravity environment.

22. **Are there any limitations on materials or components due to off-gassing or other concerns for a device that is to be deployed from the Human Lander?**
    a. This should not be a serious concern. There is more concern with off-gassing for items inside the breathing-space of the crew.

23. **What are the requirements for physical and data interfaces with the rocket and any other onboard systems?**
    a. Interfacing with the rocket is beyond the scope of this challenge.

24. **What are the ways in which the lander can receive data given to it by our device?**
    a. Teams may assume either wired connections or radio interface to transfer data into the lander. The radio receiving the data onboard the lander would be designed to work with all the payloads on the mission.

25. **Are there any protocols or standards for data encryption and security for communication between the Human Lander and a device deployed onto the lunar surface?**
    a. Data encryption and security is beyond the scope of this challenge.

26. **What are the bandwidth and data rate capabilities for communication between a device onto the lunar surface from the Human Lander and Earth?**
    a. Teams are encouraged to consult publicly available NASA standards and previous missions for this information.

27. **Should our design be limited to implementation on HLS, or should we consider other applications such as CLPS missions?**
    a. Designs can be considered for HLS and/or CLPS applications.

28. **Is NASA interested in PSI only during landing and takeoff? Does it anticipate additional lunar transport facilities that carry valuable resources from near-by lunar surface to these 13-candidate landing zones?**
    a. PSI is the focused topic for this competition. Additional lunar transports that does not experience PSI is beyond the scope of this challenge.

29. **What is the typical size of a lunar landing zone that needs PSI mitigation? The proposal gave a 15kmx15km regions, but what's the typical size of actual landing zone that accommodates lander and its downward thrust.**
    a. Teams are encouraged to research previous missions and analogs, and reference the 15km x 15km region as you develop your proposal.

30. **In the Proposal Evaluation Criteria section, what do you mean by "solution to PSI with system-level impacts?" Does the "system" refer to lunar assets already present in those regions, or does it refer to various components of PSI mitigation strategy we propose?**
    a. "System" refers to the lunar assets and/or the whole lander. Consider presenting the impact of the design solution to how it may affect other subsystems in the vehicle or overall lander performance.

31. **Are there any "acceptable" deployment mechanisms for a device from the Human Lander?**
    a. There are no deployment mechanism restrictions.

32. **What are the operational constraints during deployment of a device from the Human Lander (e.g., communication blackouts, power limitations)?**
    a. Teams are encouraged to research past lunar missions for operational constraints to consider.

33. **Are there restrictions on the type or amount of onboard power sources a device deployed onto the lunar surface can use?**
    a. There are no restrictions on the type or amount of onboard power sources a device deployed into the lunar surface can use. Please keep the design constraint of "minimal barriers to NASA adoption" in mind.

34. **Can proposed design solutions be implemented to the exterior of the lunar lander? If so, how much space can we use on the outside of the lander?**
    a. Yes, please include in the proposal how much space is needed and how it would work.

35. **Where might a device be attached on the Human Lander so that it could be deployed during the Lander's descent phase? (e.g., What are the specifications of these points of attachment?)**
    a. Please use publicly available information on the Human Landing System (HLS) program from NASA to learn more about the two selected lander providers and general characteristics of those systems. Device attachment locations should be carefully considered how it will interfere with the lander operation and other subsystems.

36. **Will solutions need to be stored within a cargo hold inside the lander for later use or deployment?**
    a. Solutions are not required to be stored within a cargo hold insider the lander for later use or deployment. If your solution can be redeployed for other systems and/or launches, that would be important information to include in your proposal.

37. **Can proposed design solutions be deployed to the lunar surface from the lander prior to descent and landing?**
    a. Yes, please include in your proposal how that would work.

38. **Can a system be implemented manually by an EVA crew for subsequent flights?**
    a. Yes. Please keep in mind the system implementation should pose minimal risk to the crew, and that looping in the crew adds complexity to the execution process. The first flight to land crew will also face PSI mitigation needs.

39. **Is there already a designated landing spot of the 13 listed for the first few Artemis missions?**
    a. No. Please tell us which landing site you are designing for.

40. **Is it necessary that a proposed solution work on the first landing?**
    a. That would be ideal. In general, rigorous testings to proof the technology are required prior to its execution for the first landing.

41. **While PSI is most immediate problem of landing, the erosion of landing site is a general long-term problem with repeated HuLC ops. Does the solution need to address both the PSI during landing, take-off scenarios only or should it address erosion as well?**
    a. Erosion of regolith is also an immediate consequence plume-surface interactions.

42. **What are the specific restrictions on the requirement of a non-toxic solution? Can toxic materials be used that are out of reach and would not be harmful to astronauts?**
    a. Toxic material can be used if out of reach and contained such that it would not be harmful to astronauts and/or lander. Safety concerns regarding toxic materials potentially escaping containment should be considered.

43. **Is there a specific constraint on what the budget of the actual project would be?**
    a. No, but budgets should be realistic.

44. **What is a recommended vendor to purchase test regolith?**
    a. NASA does not recommend commercial simulant providers. Resources such as the Lunar Surface Innovation Consortium's Lunar Simulant Working Group may help teams learn more about lunar simulant characteristics.

45. **Is it possible to interact and test a solution made ourselves with a company's resources (facilities and maybe rockets)?**
    a. If you have existing industry connections to do testing, we'd love to see the results. However, this is not required or necessary.

46. **How can we effectively measure locations and amounts of lunar dust?**
    a. Teams are encouraged to do research and come up with their assumptions.

47. **How does lunar dust react to liquids, above the lunar surface, and on the lunar surface?**
    a. Because the lunar surface is in vacuum, water will flash-evaporate into vapor immediately. Liquid water cannot exist on the lunar surface. Some liquids other than water may evaporate more slowly, so it may be possible to spray a non-water liquid on the soil that will evaporate and/or harden after application. Whether the liquid will soak into the soil or not prior to hardening would depend on its viscosity and the permeability of the soil. Lunar soil is not very permeable due to the very fine dust. Some liquids will not soak into the soil for this reason. If teams wish to pursue a solution that involves applying liquids onto the lunar surface, they may wish to study these characteristics further, perhaps by performing experiments.

48. **How high does a moon lander have to be to stir up dust? Are there any valuable resources (demos, publications, etc.) we can reference regarding the lander-dust interaction process? How far up did the Apollo LM start blowing soil? Could we turn off engines early and free-fall?**
    a. The height the LM starts blowing soil will be determined by its thrust, which scales with vehicle mass. A larger lander would start blowing dust from higher altitudes. The Apollo LM started blowing soil around 31-33 meters, or about 100 feet. Of course, it got worse as it descended, so shutting off engines early at any height might provide a good mitigation even if not a complete mitigation.

49. **How do lander-dust interactions currently take place?**
    a. Teams should perform a literature search to understand plume-surface interaction effects. Two places to start are this white paper: [2102.12312] Understanding and Mitigating Plume Effects During Powered Descents on the Moon and Mars (arxiv.org) And this presentation: An Overview of Plume-Surface Interaction Testing and Research - NASA Technical Reports Server (NTRS)

50. **How fine is lunar dust?**

a. Characterization of the lunar environment, including dust and regolith, is available in SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE), available from the NASA Technical Reports Server here: SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE) - NASA Technical Reports Server (NTRS). The Lunar Sourcebook is another valuable resource which is available here: Lunar Sourcebook (usra.edu). Lunar soil is known to have particles as fine as 0.02 microns, which is extremely fine. A paper that measured the ultra-fine particles in lunar soil (finer than 1 micron) is here: https://www.researchgate.net/profile/Kenneth-Kihm/publication/228342547_Characterization_of_Lunar_Dust_for_Toxicological_Studies_I_Particle_Size_Distribution/links/565b44f208aefe619b24339d/Characterization-of-Lunar-Dust-for-Toxicological-Studies-I-Particle-Size-Distribution.pdf

**51. What is the density of lunar dust floating above the surface? Distinctly layered like Earth? Gradient?**

a. Near-surface natural lunar dust transport in specific situations due to the plasma and charging environment is plausible but has not been fully confirmed in-situ. This likely does not cause dust to "float." The Surveyor horizon glow observations and experimental work suggest particles could loft to heights under ~50 cm (Rennilson and Criswell 1974, Wang et al. 2016).

Characterization of the lunar environment, including regolith density, is available in SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE), available from the NASA Technical Reports Server here: SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE) - NASA Technical Reports Server (NTRS). The Lunar Sourcebook is another valuable resource which is available here: Lunar Sourcebook (usra.edu)

**52. What are the special characteristics of lunar dust? How does this dust compare to that of Earth?**

a. Characterization of the lunar environment, including dust and regolith, is available in SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE), available from the NASA Technical Reports Server here: SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE) - NASA Technical Reports Server (NTRS). The Lunar Sourcebook is another valuable resource which is available here: Lunar Sourcebook (usra.edu)

**53. Are we limited to 1 landing or is it possible to have multiple landings, such as with a rover?**

a. You are not limited to one landing. However, "Design Constraints and Guidelines" in the proposal guidebook states "minimal landings required" as one of the design constraints.

**54. Under Pg. 9 in the Competition Guidelines Document, it states, "Proposals should include - "Realistic technology assumptions, including realistic NASA technology Readiness Level Definitions and justifications where appropriate." It is not clear what the document in the link explains about. How should we use it in our proposal?**

a. We encourage you to read more about NASA Technology Readiness Levels (TRLs) at the following links to aid your proposal justification:
   i. NASA Technology Readiness Levels
   ii. Technology Readiness Level (TRL) as the foundation of Human Readiness Level (HRL)

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## QUESTIONS RECEIVED IN ADVANCE: PROGRAMMATIC

**1. Do prototypes (physical prototypes that require hardware/experimental setups) need to be completed by the March 4 proposal submission deadline?**

a. No. Prototypes are optional, and finalist teams who design/build prototypes should plan to bring them to the onsite Forum in June to demonstrate during their presentation and the poster session.

2. **Does the proposal submitted need to include experimental results, or working software/model/simulations?**
    a. No. The proposal needs to include enough information to convince the judges that your proposed concept is credible and valuable and provides confidence that your team can successfully implement the work proposed.

3. **Are students on a visa in the US allowed to participate?**
    a. Foreign Nationals (FNs) attending the proposing U.S.-based university can fully participate on a HuLC Team, and at most of the HuLC Forum event (with some exceptions) – including those on student visas. We can never guarantee whether a FN will be granted access to any Forum events held onsite at a NASA facility. See Question 4 below.

4. **How can a team member of foreign nationality send a request for approval to come to the main HULC Forum in Alabama during the Final event? Are there any special exceptions?**
    a. Please read the HuLC Competition Guidelines, Eligibility: Foreign Students/Universities section for full information. Foreign Nationals (FNs) attending the proposing U.S.-based university can fully participate on a HuLC Team, and at the HuLC Forum if their team is selected as a finalist, with several notable exceptions:

       Due to prohibitive restrictions and ever-changing NASA security regulations, foreign nationals may not be approved to attend culminating HuLC Forum events that take place on-site at a NASA Center (including tours). HuLC Program Staff will not know if Foreign Nationals are approved to attend events at a NASA Center until shortly before the Forum. If Foreign Nationals are approved to attend events on a NASA Center, they will need to provide current passport information via their Forum Registration, ~1.5 months prior to the Forum.

       Neither NASA nor HuLC Program Staff can sponsor travel from foreign countries, and students of any nationality attending foreign universities are ineligible to participate. Interested individuals for which this is applicable should make sure they have an up-to-date passport and any required travel documents once the team has been selected as a finalist.

5. **Can mentors (not affiliated to any university as a faculty, but are foreign nationals and high school professors) be a part of the team?**
    a. Teams must contain, at a minimum, one faculty advisor with an affiliation at the primary proposing university, and 2 students from that U.S.-based university who work on the project and present in-person at the HuLC Forum. As long as this minimum requirement is satisfied, your team may absolutely receive mentorship from outside advisors. They would not be considered part of the official team, however, but you could certainly give them credit as advisors on your proposal.

       However, the HuLC Competition is an undergraduate and graduate student challenge, and is not intended to be an industry competition. The bulk of the work should be conducted by the collegiate student team members.

6. **Since the NOI is non-binding, can I add/remove/replace team members and mentors?**
    a. Absolutely! You can make most changes without contacting us, but if your team leads or primary faculty advisor change, please send their updated name, email, and phone number to HuLC@nianet.org so we can update your team's contact information.

7. **If we have any queries along the way, until the deadline, whom can we contact?**
    a. If you have any additional questions, please reach out to the HuLC Program Team at HuLC@nianet.org and we will get a response for you from the appropriate person. All questions and their answers are ultimately posted to the HuLC FAQs webpage. We try our best to remove information that could give away a team's unique concept or design.

Please also be cognizant of weekends and holidays when sending your questions. Questions should be sent well in advance of the associated deadline to ensure a response is received with enough time for you to incorporate it into your work.

8. **Is remote participation in the HuLC Forum via video conferencing allowed?**
   a. No, there is not an option for HulC teams to participate in the Forum virtually. However, the team presentations during the Forum will be livestreamed so finalist teams can invite family, friends and colleagues to watch remotely.

      As a reminder, teams must send at least 2 students to attend and present at the in-person Forum. Teams may send up to 10 students to the Forum, and (space-permitting) there may be an option to send more than 10 students to the Forum with written approval from HuLC staff.

      If your team is selected as a finalist and you plan to send more than 10 students, please reach out to HuLC@nianet.org with your request to receive approval prior to the registration deadline.

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# LIVE QUESTIONS RECEIVED DURING THE Q&A SESSION

1. Will this Q&A Session be recorded and available after the fact? Where on the website will the recording would be available?
   a. Yes! The Q&A Session Meeting Recording, Chart Deck (Presentation Slides), and a Summary Document will be made available on the FAQs Webpage.

2. I understand that a big part of this challenge is to do some work to develop an idea which could then, given the appropriate resources, be fleshed out into a complete technology or idea in that 3-5-year timeline for our proposal in March. To what extent do we need to make a detailed effort to map out what that future development in theory would be if selected as a finalist?
   a. Yes, we're looking for something with a schedule and cost estimates and there are ways to make those types of estimates. You need to prove that it's a viable design.

3. There's a lot of ideas and like topics and areas of interest that you listed in the Competition Guidelines. Is there one that's most or more important?
   a. They are all important. Do some NASA website searches! There are maps that show what the plans are and what types of things are going to be needed. There's definitely work out there, particularly if you're searching for conference papers and research publications, that talk about plume surface interaction. They tell you where we are at this time, but there's no prioritization or anything to be inferred from that order that we've given there. PSI is such a complex and challenging problem that those are all areas you know in which work needs to be done.

4. How should teams navigate details that are important but uncertain and undisclosed to the public, like specifics on the Lander or landing processes?
   a. Your designs and concepts need to be viable, so that means they need to be based on principles and guidelines that are pretty standard for space systems and spacecraft. Define what you'll need and justify your reasonings. Why is it needed? Why is it important? You know on the NASA side, we are in the middle of planning for a big ground test in a really large vacuum sphere at NASA's Langley Research Center to try and get understanding of

what the environments these vehicles are going to produce. A lot of what we're basing on, we don't know what that's going to be either and we're not expecting that you will, too.

b. We won't totally solve PSI any time soon, but we're trying to increase our understanding of the problem and then, subsequently through that, have less risk to all these systems that that we're sending the moon as a result of these environments. A lot of these solutions are very much going to be about helping us understand PSI better because just by understanding it, it reduces the uncertainty we have in signing off that these systems are going to be ready to go. So, it doesn't need to solve PSI. It can be something that helps us understand PSI better.
c. Use the resources from the NASA Technical Reports Server (NTRS)!

5. Are our professors and faculty who do research in the area of lunar PSI and or do paid university research for NASA eligible to be advisors?
   a. Yes. You're absolutely allowed to work with any faculty at your university, even if they do have some funding from NASA to do some of the work in this area already.