2018 RASC-AL Q&A Transcript
Monday, October 23, 2017

Note from Patrick Troutman, LaRC Human Exploration Strategic Analysis Lead: RASC-AL is the Human Exploration Program's way of reaching out to the university to get what we call 'architecture ideas.' There are a lot of student design competitions where they design a widget or some other type of science but, RASC-AL is all about the architecture. My job here at NASA is a space architect; I architect how the missions will go in the future, and what you guys do is supply us with ideas that form various types of architecture. That can be seen in one or two themes; we have an inter-planetary spacecraft with one option being just a standard spacecraft - theme two is an artificial gravity version of that. While we're asking for both of these, we're also interested in the costs associated with the challenges of artificial gravy. NASA tends to fall back on the least risky, most reliable solution but that imposes another set of risks from the technical restraints involving humans now that they have to expose themselves to long durations of microgravity.

The themes won't be judged against each other, they'll be judged as their own themes but it's very interesting to give folks a set of constraints and to see what innovation you get. That's what RASC-AL is all about; it's about the innovation. Our challenge at NASA is to get people to the surface of Mars, and the majority of the topics have to do with a transport that goes to Mars. You just can't do that without a supply chain, so that's why there is the emphasis on the propellant resupply. You might be able to build the best rocket ship available, but if you can't reuse, resupply or get your value out if it, it actually isn't the best in the long term. That's why we ask teams to look at the propellant resupply strategies for these vehicles too.

For the last theme you might be familiar with the National Space Council when the Vice President came out and said, "*And before we go to Mars we're going to have American footsteps on the moon*." Well, we've been expecting some sort of pivot towards the moon but never really given up on Mars, so that's why you see Theme 4 in there. That was a little prep work and a little strategic thinking on our part, to make sure that you also have that included in the strategy. We don't know what the response NASA is going to give to the Space Council yet, but we do know there will be more lunar images than there was 6 months ago. Theme 4 is about a robotic invasion of the moon and how would we start getting the gear ready for doing that; that's why we're talking about a class of rovers that could evolve into something more useable.

That's the context for these themes and why we put them into place. There's Mars, there's moon, but it's all about exploration and getting people at a lower orbit to something better and greater in the future.

Questions for the 2018 RASC-AL Q&A Session

Reusable Hybrid Propulsion Stage

Q1: Can parts be replaced during the lifespan of the reusable hybrid propulsion stage?
A1: Yes.

Q2: What defines the end of life for the reusable hybrid propulsion stage?
A2: It will have performed three round-trip missions to Mars.

Q3: Are there any technical archives or documents outlining specifications of the Baseline SEP Stage and Habitat?
A3: Yes, search the NASA Technical Reports Server for the Hybrid Propulsion Stage, Deep Space Transport or the Evolvable Mars Campaign. These are good terms to use to start your search.

Q4: Are the launch site, Mars drop location, and specific launch date left to the discretion of individual teams or are they predetermined?
A4: Launch from KSC, stop at a 5-sol Mars orbit, ready for first mission in 2029.

Q5: Will there be humans aboard when the spacecraft launches on SLS?
A5: No, they will come up separately.

Artificial Gravity Reusable Crewed Deep Space Transport

Q1: Can we use more solar arrays than the 750 kW Limit for Theme 1 if we are pursuing Theme 2? (Can our habitable module have solar arrays that increase our total output?)
A1: Still limited to 750 kW BOL arrays. If you go online and pull up the reports, the NASA concept is 500 kW so we've given you lots of room to wiggle.

Q2: Can this statement from the theme description be clarified? "The size and mass of the fully provisioned baseline habitat should be used, but augmentations and changes in floor plan can be considered for artificial gravity application."
A2: The current habitat estimate used by NASA is considered aggressive enough, using a much lighter value will invalidate your transportation system sizing. We need a credible estimate of what that artificial gravity transportation system would look like. We're really not looking for you to design a habitat, we're really looking for you to design a transportation system, of something that weighs about this much and is about that big. We want to know your innovations for how you might reconfigure that due to the integration of artificial gravity.

Q3: What was NASA's intent for the baseline habitat?
A3: The habitat supports 4 crew for ~1000 days in space; see Theme 1. The average is 1000 days; depending on which Mars opportunities you go after, the range is 900 - 1200 1200 days.

Q4: Are you expecting us to design a rotating spacecraft or come up with an original idea for creating artificial gravity that hasn't been done yet?
A4: You should come up with the best design you can, and justify it.

Q5: Do we have "control" over the purpose of the artificial gravity areas of our design?
A5: Yes, but make sure they have adequate justification. If you want to penalize yourself by going heavier than the habitat we specified that's fine, but you won't be able to close the architecture as well as you'd like. If you can't make it out of unobtanium and have quite the half the same functionality, you'll lose all technical credibility.

Q6: Do we need to do extensive research of our own or go off of the findings and background of other artificial gravity projects?
A6: You can use what's been done before to help, but remember you must meet all of the constraints of Themes 1 and 2.

Q7: We found architecture for a similar Mars Mission. In that, we discovered that Mars missions require first sending several landers to Mars. Is there a standard Mars Mission Architecture that we should assume to follow to get an idea on how many launches we need?
A7: This theme is focused just on the design of a crewed vehicle, not on the entire complete architecture. You can learn more about the associated architecture if you need to by researching the Evolvable Mars Campaign. We don't want you to focus on the broader aspect, but if you have an innovative idea that adds extra value to your plan that's great.

Q8: Is the 2007 design of the Joosten artificial gravity spacecraft the most recent design?
A8: That's for you to determine from your literature review.

Q9: How many people will be on the crew? Is there a weight to assume per person?
A9: Four crew. There is existing literature for the typical mass of a crewmember for Mars.

Q10: Do the astronauts require any kind of EGRESS or EVA during the mission for spacewalks?
A10: No. We have an allocation for an EVA lock, but don't know what it can be used for yet. It can be added to your plan, but it's not necessary.

Q11: Is there a docking standard that the modules of our design should follow?
A11: Research and follow NASA docking standards.

Q12: How much consideration do we need to devote to the propulsion system? Do we need to supply power/fuel to it? Can we assume that anything will be beyond our focus?
A12: You need to address how the propulsion system as described in Theme 1 interacts with your artificial gravity concept. We expect there will be some significant changes you have to address to the course of how that propulsion system relates to the habitat. An example of solar propulsion is low thrust; always steady on and you want to fire it off the velocity vector. (To get the best performance out of the solar electric propulsion stage, you always want it on and thrusting in the direction of the spacecraft's velocity vector). Teams will need to keep that constraint in mind in the design of their propulsion stage.

Research Human Outer Planet exploration from other configurations with constant low thrust on a rotating space craft. There are lots of ideas out there, and what we want to do is take the particular Mars transport habitat we have and come up with what you think is the best answer to doing that. We'd rather you come up with a new, innovative idea that no one has ever thought of.

Q13: What chemical system is being used for the high thrust propulsion?
A13: It is a Nitrogen Tetroxide/Mono-methyl hydrazine system. For more details, research the Hybrid Propulsion System and the Deep Space Transport. That's what we chose in our design, but we're open to the use of any high thrust chemicals that have not been considered, for example lox methane or lox hydrogen. There are issues associated with lox methane and lox hydrogen - why we didn't choose it. We're not limiting you to our design, but to our requirements of sending that habitat from cislunar space to the module and back on one tank of propellant. See question about metallic propellants for more information.

Q14: Are there any papers or research we can access about the hybrid low thrust solar and high thrust chemical system?
A14: Use the NASA Technical Reports Server to find information about the Hybrid Propulsion System and Deep Space Transport.

Propellant Resupply Capability

Q1: Is the refueling required to take place in cislunar orbit, or can we coordinate with our partner team for refuel elsewhere?
A1: It has to take place in cislunar space. Cislunar space is any orbit between space or around the moon; it won't be refueled in Mars or low-Earth orbit.

Q2: Are there requirements for propellant supply beyond the requirements of our partner team (would our system be employed to refuel other craft in the future)?
A2: You must be able to support whatever your partner team requires, as well as a manifest of cargo flights as described in the Evolvable Mars Campaign (searchable on the NASA Technical Reports Server).

Q3: Is the Propellant Resupply theme responsible for delivering only fuel to the Mars surface cargo mission in 2037, or is it also supplying the cargo?
A3: Only the propellant for the cargo missions.

Q4: What is your opinion on the viability of metallic propellants?
A4: You can try to make the case for metallic propellants, but you need to justify how you would develop the necessary technologies to transfer them in space given the timeframe, and why they would be superior to the propellants in use on the Hybrid Propulsion System and Deep Space Transport.

Q5: Are there any other fuels we should stay away from?
A5: Nuclear propulsion concepts are not allowed. This isn't about technology, it's about politics and getting programs ramped up in the right amount of time. If one team chooses nuclear propulsion it'll be superior to the other teams. This doesn't mean it's a bad choice, it's just outside our choice box for NASA.

Q6: Are there any limits on the processing or recycling of waste products in space as part of our concept?
A6: No, but you must credibly justify their use with technologies that can be developed and ready for operation by 2033.

Lunar Polar Sample Return Architecture

Q1: Could you clarify the meaning of 'scale' or 'scalable'? Does it mean the size of the sample?
A1: The architecture should be able support an initial single use sample return from the Moon to the Deep Space Gateway as well as the more challenging Block 2 operations. We're looking for you to show hwo your system evolves from that Block 1 initial capability to the larger, more challenging Block 2 capability.

Q2: What is the range of sample mass?
A2: That is for you to determine from your analysis.

Q3: Where is the sample located? Lunar surface? or under the surface? Do we need to define this?
A3: You define where the sample comes from. An easily accessed sample may not be as much value as a hard-to-access sample. Give rationale for your mission design.

Q4: Are 'Surface power concepts' not allowed to Block 2?
A4: Surface power concepts are allowed (and indeed likely necessary) for both Block 1 and Block 2; however, they cannot be nuclear. The power will have to come from solar, battery or fuel cells; something that is already existing.

Q5: Per the theme - "Nuclear-powered propulsion and surface power concepts are not allowed." What about using radioactive materials for heating?
A5: Yes, small RTGs and RHUs are permitted, the exclusion is aimed at the development of large fission power systems and nuclear thermal propulsion.

Q6: What do you mean by term 'surface power concepts'? Is it equivalent to the ISRU? Or, broader meanings, generating power/propellants on the surface?
A6: We're looking for some system that provides power on the surface, we're trying to rule out the possibility of a large nuclear fission or fusion process in order to provide that power. The surface power concept is whatever system you're using to get the energy you need for your sample acquisition. Nuclear surface power concepts are not allowed.

Q7: Is there any limit on mass/size for the "any new payloads that would be delivered to the surface?"
A7: You should identify what the maximum mass and volume of payloads your Block 2 system is capable of delivering in both directions.

Q8: Is there any reason that we designate surface system to locate the sampling spot? Can it be done by other subsystems such as orbiter?
A8: You could use orbiting systems to locate the samples, but you must consider the surface systems that acquire the sample and prepare it for launch.

Q9: Where can we find more information about DSG, or what kind of assumptions about DSG can be made?
A9: Search the NASA Technical Reports Server, or other nasa.gov sites. There isn't a lot of information out there currently.

Q10: Is the DSG in polar or equatorial rectilinear orbit?
A10: It is in a near rectilinear halo orbit. Google Ryan Whitley for more information on the paper he wrote on the topic.

Q11: The deep space gateway has been defined as having a 'near rectilinear orbit'. Are there any more specific parameters of this orbit or can we just assume what it will be? Helpful parameters would be location of the perilune (north or south pole), radius, etc.
A11: You can learn more about near rectilinear halo orbits by searching the NASA Technical Report Server, or googling Ryan Whitley.

Q12: Are we able to refuel our vehicle on orbit at the DSG before landing on the moon?
A12: No, the DSG cannot be used for fueling of the vehicle prior to its initial mission on the Moon.

Q13: Is a docking port capable of refueling also the airlock on the DSG? Are there more specifics on the DSG-ATV interface? What assumptions can we make?
A13: You should evaluate what capabilities the airlock would need to have in order to support refueling. We haven't determined what the airlock on the DSG would be, but we want to know what capabilities would be required to support it in the gateway. This is your opportunity to set a standard for NASA.

Q14: Is it necessary to use 'vehicle' to ascend from the lunar surface to the DSG? Can we use another method to deliver the sample from the lunar surface to the DSG?
A14: You can use another method, but you must perform credible analysis to show that it can be deployed on a single commercial launch and has a wet mass at ascent of < 5000 kg. There's delivery, but capture and preservation of the DSG have to be accounted for as well; the sample and DSG need to be in tact at the end of the mission.

Q15: What do you mean by term 'to-and-from' of the sentence, "Block 2 would be reusable/refuelable to-and-from the DSG"? Does it imply that Block 2 should be able to fuel the DSG with the fuel obtained from lunar surface?
A15: No, the Block 2 vehicle should be capable of being refueled at your choice of the DSG or the lunar surface to travel between those two destinations; it can be both if you choose.

Q16: Can we use existing or budgeted lunar orbiters (e.g., LRO) as communications relays?
A16: Yes, if you can justify their ability to support your operations.

Q17: Must surface operations be fully teleoperated? If not, to what extent can we autotomize operations?
A17: You may include autonomy, but you must credibly justify that such capabilities will be available by 2029. They do not have to be self-automated.

Q18: For Block 2, is there a yearly mass/volume fuel budget per year for the reusable ascent vehicle?
A:18 It is up to you to determine how much propellant your reusable ascent system will require (for at least one mission per year).

Q19: Is there a weight limit on the Lunar Surface System if it is separate from the Ascent Transfer Vehicle?
A19: The mass will be driven by what your lander is capable of delivering to the surface. It, along with all the other elements on the initial launch, must fit on a single commercial launch vehicle. That is the constraint on the mass. For Block 2, you are allowed to aggregate your systems with justifiable analysis.

Q20: Under the current Nuclear Energy rules, would a Radioisotope Thermoelectric Generator be allowed as a power source for the Surface System?
A20: Yes, at existing capability levels.

General Technical Questions

Q1: Are we creating a design concept or a design?
A1: This is a design concept. We do not expect to see detailed schematics.

Q2: Does t refer to metric or English tonnes?
A2: The "t" refers to the metric ton (or tonne), equal to 1000 kg.

Q3: What kind of statistical evidence/quantitative data is expected in our abstract? In our actual paper?
A3: You must make a credible case to the steering committee that you are capable of designing and assessing your concept to meet the requirements. How you do that is up to you, but we're expecting quantitative analysis to support your concept.

Q4: Is there a way to get access to software that isn't normally available to the public? (Ex: MALTO?)
A4: No, you will have to use what tools you can find through your school or publically available.

Q5: Where themes overlap, do we make assumptions to complete our own project or enter cross communication between themes?
A5: Theme 2 has most of the same requirements as Theme 1. Theme 3 depends on some of the requirements in Themes 1 and 2. If you need to make an assumption that isn't covered by the relevant theme, you must justify it.

Q6: What specific parts of the NASA budget are we assuming to be pulling funding from for the missions? Can we assume a constant increase in funding for the future budgets?
A6: For Theme 1, you must use the existing budget for NASA; you can use HEOMD's budget but must maintain support of any systems your concept relies on (e.g. SLS and Orion). For Themes 2 and 3, you should identify how much additional budget beyond what is available in Theme 1 is required. For Theme 4, you should identify how much budget is required to enable your concept.

Q7: Is there a resource that NASA uses to determine TRL or a database with TRL information of current technologies that NASA is planning on using or have used?
A7: Search the NASA Technical Report Server, as well as other NASA resources, to learn about current technology investments. If you read up on the work that Space Technology Mission Directorate (SPMD) you can find out about some of the current technologies that you may be able to use for any reason.

Q8: What TRL is considered acceptable for technologies deployable by 2029?
A8: A general rule of thumb is that a technology needs to be at TRL 6 by the time of the PDR of the system it will be used on.

Q9: Are teams allowed to assume the SLS block B will be available in 2028?
A9: You can assume the Block 2B is available in 2028.

Q10: Where can we find information about SLS Block 1A and Block 2B? We were unable to find reputable documents for 1A and 2B, only the 1, 1B, and 2.
A10: The 2B is the SLS 2. The 1A is the SLS 1.

Q11: Do we need to account for emergency scenarios in our mission analysis, propulsion needs, GNC capabilities, etc.?
A11: Your concept will be much more credible if you do.

Q12: Should we explore secondary missions (for example deep space biological research) or leave that to the scientists?
A12: You should focus on making sure your systems meet the requirements laid out in the themes.

Programmatic Questions

Q1: Why is the timeline relative to last year shifted back?
A1: It is due to a number of factors, including judges' schedules, hotel availability, and our attempt to avoid overlapping with other NASA summer engineering programs/events.

Q2: What are the specific judging criteria? Could we see a rubric?
A2: Yes. Each deliverable (i.e., proposal, mid-project review, etc.) has its own set of evaluation criteria, which can be viewed by clicking on the "Learn More" button by the appropriate deliverable on the Requirements & Forms page of the RASC-AL website. They can also be found in the Competition Basics document you should have received after submitting your NOI.

- Abstract Evaluation Criteria:
  - Applicability to Theme Areas (Max – 30 points)
  - Amount of original and/or innovative approaches with supporting engineering analysis content (Max – 35 points)
  - Feasibility of mission/concept approach (Max – 35 points)
- The final scoring rubric for the 2018 RASC-AL Forum in June is called the "Project Evaluation Form" and can be found on the Requirements & Forms page (left-hand nav bar).

Q3: Will teams receive further resources or support beyond the 4 base documents from NIA or NASA (e.g. designs & external standards)?
A3: You can use the NASA Technical Reports Server and other NASA resources to learn more.

Q4: Does participating in multiple themes contribute to your overall score?
A4: No.

Q5: Are teams working on Theme 1 and Theme 2 allowed to coordinate?
A5: Yes, absolutely! We encourage it

Q6: Are there any major differences in the requirements for technical papers and presentations between teams partnering together and those that stayed independent?
A6: Your final deliverables should be able to stand on their own, so you need to summarize what your partner team has done in the space available in your own paper and presentation.

Q7: Are separate teams from the same university allowed to pair? If so, would patterning with a team from our university give us less of a preference from teams that pair from other universities. Also, is 3 team pairing allowed? (e.g., teams from theme 1, 2 & 3 all partner up and work together)
A7: Yes, you may pair with a university from another team. This will NOT give you less of a preference from teams that pair from different universities. Yes, 3 teams may pair to tackle themes 1, 2, & 3, respectively.

Additional Questions

Q1: Once a sample is retrieved and tested it, do we have to remove the hardware we're using on the surface on the moon?
A1: No. Some of your hardware can be used to support your Block 2 mission.

Q2: In regard to our structural, is there a safety factor you'd like us to incorporate into our structures of 1.15 or 1.25 like they typically do in aerospace applications?
A2: Typically, there is a standard for robotic systems, and there's a higher one for crew systems. You can take your own risk assessment and factor it in, and tell us why you chose that number.

Q3: Can you use SLS-2 in Theme 2?
A3: Yes.

Q4: Can you define monolithic?
A4: It means that the habitat system is coming up as one integrated piece as opposed to aggregating the habitat pieces over multiple launches.

Q5: University of Minnesota: Can theme 3 come up with our own refueling method?
A5: You can partner with a vehicle designer from Theme 1 or Theme 2 which would dictate how you refuel it. If you're doing Theme 3 by itself, you can include parts on the deep space transport vehicle to refuel it, or another method - but include the information on how you plan to do it.

Q6: Does Theme 1 have to use NASA docking system standard?
A6: Yes, but we're open to the proposal of other docking systems and they have to be justified.

Q7: For Theme 2, can we create our own habitat or are we constricted to using the baseline habitat?
A7: You're constricted to the mass and total volume, but we are open to configuration changes.

Q8: To clarify: we cannot construct or dock multiple components in space to complete an AG system? Does it have to be sent up as a single piece?
A8: The habitat is monolithic, the AG system itself can be brought up in different pieces and aggregated.

Q9: Is this a requirement also for Theme 3 or can we assemble in space?
A9: It's up to your discretion.

Q10: In regard to surfaceability, can components be replaced within the 15-year lifespan?
A10: Yes.

Q11: Will there be systems on DSC to analyze the sample?
A11: It will be in an airlock system, and the crews will not be handling the sample in any way.

Q12: With regard to our systems, would you like a system response plot to symbolize whether we were to go unstable? Or is that decided by us?
A12: It depends on what your concept is.

Q13: In Theme 2 for radiation protection, are we considering as low as reasonably achievable or is there a requirement for Mars?

A13: As low as reasonably achievable.

Q14: With regard to the information about the SLS Block 1A and B, we couldn't find anything specific regarding the difference between the 1A and 1B. We also found online that there wasn't a 2B currently being produced right now, so can you clarify the details to us?

A14: We recommend you referring to a public document called the SLS Mission Planner's Guide. This document can also be accessed on the Resources Page of the RASC-AL website, under "Recommended Reading."