BREAKOUT SESSION 11.
LIFE SUPPORT, HABITATION, SYNTHETIC BIOLOGY

Concern: Regarding hydrozene monitor, when it lands in water what kind of environment would it be in, would the monitor be outside or inside the vehicle?
Response: Inside the vehicle with rapid response time. The cabin vents with the outside atmosphere. If jets were used with re-entry, there may be residual hydrozene. Needs to be small, portable, with very quick response time.

Concern: For hydrozene measurement, you are looking for something that is capable of measuring the atmosphere outside and inside the vehicle?
Response: For both, it's inside the vehicle – within the air lock and within the cabin.

Concern: Rotary gas separator – is it for separating gas from the liquid?
Response: That was from the slide on systems maturation team that mentioned a multitude of capabilities, not really a request for that. Phase separation is a pretty common problem in spacecraft life support systems. Spin separators are a common way of doing it but there may be more options. May be in Solicitation sometime in the future.

Concern: Are there any needs for waste management system?
Response: Yes, we do. One of the technologies under development is a heat melt compactor. Should be a system that produces water or other liquids. There is also a need for phase separators.

Concern: Synthetic biology – are you talking about microbial application or going back to more fundamental, genetic modification? What is meant by this discipline?
Response: Hybrid-type needs of plant development; microbes; means for life support; converting to oxygen, etc. Trying to use biology where it makes sense. The synthetic biology program is one that looks at all biological aspects with the idea that there is some genetic engineering on microbes or plants that would be beneficial when applied in space. Microbial processing in space, integration of the hardware and the microbes themselves or the plants, interesting hybrid techniques that we can look at. We don't have a very strict definition of synthetic biology. Broad range of techniques.
Creating a sense of life that has not previously existed. More than gene editing. Going there at a systems level, from an engineering perspective, at higher level and as an organism. It is unlike computer programming where there is code, sub routines, useful and non-useful subroutines, ways of interplaying communities with each other. We have a broad definition of what synthetic biology means to us. If firms have ideas or things that they'd like to impart, we'd like to hear them.

Concern: Regarding the subtopic about the modeling and estimation of integrated vehicle design influences. Within the text it says "Currently there is no integrated framework in which to perform system design". Since we know design tools of this nature exist, I was wondering if you were referring to some specific capability that is lacking.
Response: There are no integrated capabilities or frameworks that take into account the different physiological things that occur to a human in space travel. At aspect needs to be integrated. There are some human performance models that exist but they are not integrated into spacecraft systems in a way that

will accept that different roles may change. A human may be more capable at some times than others. Sometimes better to let the robot do it than human, etc.

Concern: A follow up on this topic. The title is very vague in terms of design influences. Do you have ideas for the measurement part? How do you ensure that this model gives you the information that you need? Do you have specific systems of interest in mind? Or specific vehicles? Are you looking at retro-fit or redesign of existing systems versus creating a new design?
Response: What we are hoping is that we will get some novel ways of doing this as existing ones aren't emergent in their predictions. Need complexity of a human integrated with the vehicle models. A corollary Concern may be evolving an existing system. That is always less expensive.

We have a large set of information collected on performance shaping factors and some work on how they relate to each other. The framework we are seeking is something that has algorithms that can detect non obvious patterns in many to many datasets, and can help identify whether some correlations may need to be investigated and whether some countermeasures have confounding effects.

Concern: Would you be interested in tools that simulate the interaction through time event simulation of human, vehicle, habitat.
Response: Yes, and if it could compare different vehicle design options, that would be good. The idea is to design a vehicle to accommodate he human needs and take advantage of human influence.

Concern: What are the needs for cultivation of plant growth systems? How about the greenhouse structures that might be included in the vehicles?
Response: In respect the cultivation systems it is a combination of addressing needs from variety of different crop plants. Support for the roots, seeding, irrigation, etc. all that becomes the cultivation systems. A lot of work has been done in the area of lighting but the root zone and whole cultivation area taking it through a whole mechanization system, hasn't been done. With respect to the greenhouses, when we look at large quantity of food, we are look at glazing materials. A habitat that is in transit may have a smaller system and looking at the light. For the Sun, the vehicle might need to be turning. Environmental control for plants is very important. In a greenhouse, there is a lot of ventilation, ethylene is not a problem but on a spaceship it is and it may create a lot of trouble for the plants. How to manage the atmosphere and correct CO2 concentration, and how do we reduce atmospheric pressure.

Concern: Follow up Concern on what has been done in lighting?
Response: Success Story with Orbitec - LED panels with Veggie unit. There is always potentially room for improving on lighting. That is the area we are interested in.

Concern: In terms of gas contaminants CO2 – is there a need for personal monitors, or is that pretty much evolved already?
Response: That would be an issue if part of a vehicle was in a higher and another in a lower concentration zone. Not really sure there is a need for that.

Concern: As far as atmosphere control for the plant growth chambers, and control of ethylene and CO2 levels, is that something that would be responsive in terms of technology that would control those types of things?

Response: It is something that is part of the cultivation technology. The focus this year is on atmosphere environment.

Concern: With regards to CO2 specs, are you interested in more in a sorbent on its own or an entire package?
Response: Either. If the technology that is significantly better than what we have now. ISS is using sorbent system that is causing some issues with dusting creating problems in valves. Unexpected maintenance is needed. There are also issues with ability to maintain consistent products over many, many years. So developing systems that don't have the problem but still improve the mass power and volume requirements. When you go to a Phase 2, the level of work and effort has to reflect what you are asking for.
Concern: On component level, specifically mechanical equipment, will be there the opportunity to talk about logistic production for compressors, pumps. If we have something that could be reduction in SWaP, would there be an opportunity?
Response: In terms of process hardware, certainly there are common thing. Trying to reduce provisions and spares. Trying to think of the call in respect to logistics. I don't know that was what was in mind for that kind of call.

Concern: Would it fall under environment control and monitoring?
Response: Not sure we are looking for this in particular

Concern: How the Life Support/Habitation/Synthetic Biology/topic in general have to comply with the strict laws of planetary contamination? Planetary protection effects on life support.
Response: We don't want to contaminate the life on planets nor bring anything back to earth that may be harmful. When humans go to Mars, there may be some biological contamination that can take place. Requirements aren't that strict. Dispose of waste on planetary surface, need to determine how we do that and any determining factors will be reflected in the solicitation.

Concern: Can you please elaborate on requirements for bioreactors? What types of microbial production?
Response: Still in the process of determining that. There are a number of different matching systems. Need the right organisms, source of materials, bioreactors, to create a right amount of the products you need. So there is going to be a large difference between making something needed in mass quantities versus those needed in small amounts. The types of influences that your product will have and the mission you are making it for is paramount. Number of different technological products that could be useful in future missions. If you go to normal pharmaceutical production facility or biochemical engineering facility, it is large and regimented. Need to scale down. Convert those to materials that we need in a very efficient way. Getting materials into reactor, getting microorganisms, purify and make sure that from A-Z we have taken care of it. Automated, with minimal manual processing required. Stability of microbe. A number of different areas in there, any one of which if you have some good Responses to, we are interested.

Concern: In terms of utilizing planetary materials, is there some analysis of materials that has been captured somehow? So if you want to create a composite using 3D printing structures, is there a database of information on chemistry, etc.
Response: There is certainly a database being collected by landers, rovers. There are papers. Don't know if there are websites or publications with this information. You can research to find this information.

In Mars, we have a good idea of what is in the air and a growing idea of what is in the soil. Geology is very well studied and we are learning more and more every time we land a lander.

Concern: Oxygen separation from air - you are actually looking at oxygen separation rather than oxygen generation from water or CO2. Correct?
Response: Yes, in application can we reduce oxygen in the cabin? Or can we provide a source of oxygen?

Concern: Autonomous outputting capabilities. It seems you are interested in are technologies that support the unmanned supply mission to that habitat module that would just set up and stock the hub without the human interaction. Is this what you are looking for?
Response: Yes.

Concern: Would limiting the biofilm formation within the water and waste processing system part of the future agency priorities? Are there any current challenges for limiting the biofilm formation in space?
Response: That was in a call a few years ago. But not present in this year's call.

Concern: You mentioned in the presentation bio sensing. What applications are you looking at?
Response: Is there a way that can do it better with a bio-sensor? Long term food storage is an issue.

Concern: There are concept that provide a vehicle health monitoring. Where is the dividing line between being able to do the maintenance of this logistics system vs health monitoring that would move it between these two topics? Some of the identifying methods and sensors that you can create to facilitate that can also do significant amount of health monitoring.
Response: This is case where we focus on construction and implementation and putting in place components for hub outfitting, provisions crew accommodation. So it is for the deployment side.

Concern: In terms of monitoring health – is there interest in psychological monitoring? Stress, anxiety, fatigue?
Response: Yes