Notes from Excavation & Construction Monthly Meeting

June 2020

Quantitative Info

76 in-app attendees, 12 dial-in attendees, 88 attendees total

Notes

From Discussion

Longform notes available on page 7

::Conference referenced by Athonu::

- LSIC activities will be informed by the 2024 Artemis timeline but not tied to it. Will be informing NASA about what's going on in the industry with an eye towards 2024 timeframe
- In the first year LSIC will be discussing what types of technologies to pursue and what kinds of reference objectives should be prioritized

- While LSIC's meetings and listservs are open for international participation, NASA is running international partnerships

- An opt-in member directory will be available for networking and collaboration
- Networking opportunities will also be built into large-scale LSIC events

From Chat

Full chat transcript available on page 3

Pleased to see focus on:

- Alternatives to AM
- Lunar construction on loose regolith and the civil engineering aspect

Questions from participants:

- What about subtractive processes, such as extraction water from regolith in PSR on the lunar poles - will this make the regolith more or less tractable in excavation?
    - UNANSWERED
- How will the lunar environment (temperature swings, seismic activity, dust, abrasive regolith, etc.) impact how we excavate and construct infrastructure elements?
    - UNANSWERED
- Will there be interest and investment from NASA and this community in developing high-fidelity simulation environments (e.g., VR) where we could virtually test equipment performance under conditions that cannot be readily emulated on earth (esp at realistic scale) — e.g., reduced gravity, nearly no atmosphere, radiation — for both short and long duration operations?

    - UNANSWERED
- How are you going to archive this information?
    - For now information will be available at LSIC website (lsic.jhuapl.edu)
- Are there documents available that define the NASA lunar Excavation developments to date and plans for the future, with links to those documents?
    - See links in “Shared resources” below
- What is NASA's position on lunar surface property rights? Has anyone looked at the enabling role of private property in securing private finance?
    - UNANSWERED
- haven’t heard anything about LUSTR lately. Are there any updates?
    - UNANSWERED
- I have a professional colleague that automated several pieces of underground mining equipment for a major Canadian mining company in the mid 90s using 386 processors and ~2 seconds of latency - would this committee be interested in hearing a presentation on this work?
    - UNANSWERED
- What kind of information is available on NASA testbeds for excavation & construction?
    - UNANSWERED

Shared resources:

- LPI Lunar Science and Exploration information portal (Leslie Gertsch)
- For hard rock tunneling and mining using autonomous collaborative robots: www.offworld.ai (Jim Keravala)
- https://space.nss.org/space-manufacturing-library/, https://space.nss.org/space-resources-library/ (Brad Blair)
- The Space Resources Roundtable website archives over 20 years of such work (ISRUinfo.com) (Leslie Gertsch)
- the proceedings of the ASCE Earth & Space conference held bi-annually since 1988 (Paul van Susante)

Chat Transcript

Rachel Klima: It does seem like the slides may be frozen

Rich Antcliff: I am not seeing the slides moving?

Rachel Klima: The joys of remote meetings

Leslie Gertsch: Equipment always goes slowest when everyone is waiting on it ..

Rich Antcliff: Thank you

Morgan Gendel: Very pleased to see you will devote some time to alternatives to AM.

Craig Peterson: What about subtractive processes, such as extraction water from regolith in PSR on the lunar poles - will this make the regolith more or less tractable in excavation? We have a novel system for in situ extraction using mobile rovers that return the extracted water to a central site for processing, but what will the regolith be like after we extract the water?

Jennifer Edmunson: How will the lunar environment (temperature swings, seismic activity, dust, abrasive regolith, etc.) impact how we excavate and construct infrastructure elements?

Akbar Whizin: Very happy to see that lunar construction on loose regolith and the civil engineering aspect will be discussed

Shumaker, Nicole: Will there be interest and investment from NASA and this community in developing high-fidelity simulation environments (e.g., VR) where we could virtually test equipment performance under conditions that cannot be readily emulated on earth (esp at realistic scale) — e.g., reduced gravity, nearly no atmosphere, radiation — for both short and long duration operations?

Leslie Gertsch: How do we access the google survey? I don't recall receiving a link.

Brad Blair: Is anyone at NASA looking into deep underground excavation and tunneling technology? The lunar subsurface naturally mitigates radiation and lava tubes are not available at the lunar poles.

Rachel Klima: I believe the google survey will be distributed after this

Leslie Gertsch: Thank you.

vickers: I think the consortium is very exciting and will help the community of govt, industry and academia reach our objectives faster and easier. Because this has never been done before we will learn a lot from each other.

Craig Peterson: Brad, we are looking at a combination of trenching and then using the displaced regolith as shielding over the habitats place in the trenches.

Leslie Gertsch: An excellent set of resources is available online at the LPI Lunar Science and Exploration information portal, so we can minimize re-inventing of wheels.

Don Barker: Does anyone anticipate significant and dedicated amounts of private funding and time being committed/used without any distinct NASA plans or near term funding oportunites?

Brad Blair: Is NASA actvely seeking international partnerships with the mining industry? What kinds of technology would be of interest?

Rachel Klima: Leslie: I added a link to that site to our resources site on the LSIC website (I think I added the correct main site). If you have a look and there's a better location to direct to, please drop me an email

David L. Akin: How are you going to archive this information? For example, you said this telecon is recorded and the chat will be saved, but where will that be available to us? Will the slides from this meeting be available for download? Is there somewhere we can post papers (for example) that others in the group might find interesting?

Doyle Towles: Are there documents available that define the NASA lunar Excavation developments to date and plans for the future, with links to those documents?

David L. Akin: Where is the LSIC web site?

Rachel Klima: LSIC.jhuapl.eu

Rachel Klima: edu

Doyle Towles: Documents for Lunar Construction as well?

Rachel Klima: these will be available on that site—the recording, notes, and slides

Brad Blair: What is NASA's position on lunar surface property rights? Has anyone looked at the enabling role of private property in securing private finance?

Stephen Indyk: What content are you anticipating for the monthly news letter?

Shumaker, Nicole: On the topic of opportunities…I may have missed but haven't heard anything about LUSTR lately. Are there any updates?

Jim Keravala: www.offworld.ai

Jim Keravala: For hard rock tunneling and mining using autonomous collaborative robots

Brad Blair: Links to information: https://space.nss.org/space-manufacturing-library/, https://space.nss.org/space-resources-library/

Leslie Gertsch: Rachel: Yes, the https://www.lpi.usra.edu/lunar/ link on the LSIC resources page does indeed lead to the LPI archive, among other useful places.

Brad Blair: I have a professional colleague that automated several pieces of underground mining equipment for a major Canadian mining company in the mid 90s using 386 processors and ~2 seconds of latency - would this committee be interested in hearing a presentation on this work?

djeisenm: The list of technology topics or items shown earlier is a good start. But I suggest a little more formality in the list be used. Specifically, I suggest a WBS for these technology areas be started and expanded upon over time. For example tunneling/boring was just suggested. That should be on the WBS. Also, some of the current items could use clarify. For example "Financial Planning". Financial planning of what? For what? A technology? A mission? Of do you really mean something else like "Economic Assessment". Or something else?

Leslie Gertsch: Mishra: The Space Resources Roundtable website archives over 20 years of such work (ISRUinfo.com).

Paul Van Susante: also the proceedings of the ASCE Earth & Space conference held bi-annually since 1988

Mamur Hossain: Do we have any homework for the next meeting? :)

brmishra: Leslie thanks I will dig in!

Shumaker, Nicole: The NASA robotic mining challenge would be good to add to the list.

brmishra: And get some summary pounts

Brad Blair: What kind of information is available on NASA testbeds for excavation & construction?

Shumaker, Nicole: Thank you!

Leslie Gertsch: Enjoy!

Longform Discussion Notes

Athonu referenced a conference

Jim Keravala
Help me understand, just to dive in, coming from a place of ignorance right now in terms of what you – what's our timescale. This is a one-year exercise. What do we want it to be or? A 2024 set of outputs, or something for 2030? Are we free to imagine fantastical configurations and techs, or is this about what do we create as a next incremental experimental capability.

Athonu – Rachel, do you want to take that?

Rachel – The Consortium is building towards not the 2024 timeframe exactly, we know that the Artemis program and work going on at NASA is proceeding in that world. We're hoping to take the structure and technology being built from that, help the community learn from that, look forward to a longer timescale in terms of sustainable lunar, closer to end of decade. Technologies that we need. Given technology framework in place with earlier developments, what's needed, what do we need to build towards and invest in now to make that, to accomplish that. It's a little bit later of a timeframe than – we're not racing to try to get something that'll feed into the 2024 goals. But we're working in that same context so we want to provide feedback from NASA about what's going on there so the community isn't working to leapfrog without using what they've built as infrastructure. We're trying to set a year one goal, but don't anticipate dissolving after a year. We want to take little bites and build on it.

Jim – Do we have a sense of objectives of what type of things we want to build? Are there reference objectives like landing pads?

Rachel – That's something we'll be discussing a lot in this first year. We're hoping each of the focus groups next month will get info from NASA about what their short and long term thinking is, and pull that info from the community about what are the key pieces of infrastructure to get things where we want them to be and make it appealing for industry to make investments. Going to be discussing those key pieces to keep us marching along.

Athonu – I presented a couple slides on technology areas that community members identified as priorities. We will keep building on that and try to align it with NASA's objectives. Your participation at this stage and always is important.

Ken Segal – From NASA Goddard. Joining in, wanted to introduce myself work in mechanical structures, composite materials specifically. Listening in I think you just mentioned that you want to understand long and short term thinking from NASA. Who do you have on the team, who are you expecting to hear from specifically regarding that thinking and giving you those inputs.

Rachel – Rich and John, I hope it's okay for me to jump in. We initially didn't have a point of contact here from NASA because they were working out who would be the prime point of contact, but John Vickers, who's online, will be helping us with centralizing the NASA side. It's very fresh, I just got a message now from Rick Arncliffe that he was going to be our contact. We have someone, and John I don't know if you want to speak up.

John Vickers – I'm used to being on the spot or skating on thin ice or hanging on by a thread. This news is fresh but I have been working in the area and I'm leading some complimentary work for NASA in this area, so it's not a new technology arena for me. When Rich asked me, I was very excited about it. I think the consortium of government, commercial, nonprofit, and academia will help accelerate the technology ideas in an area that is really new. We've never done any of this before. We have studied it and developed technologies and done demonstrations, but we haven't been there and haven't done it, and there's a lot left to do. I wrote a comment that I think we're going to learn an awful lot from each other. I'm really excited about this because it's going to make my job much easier than it was earlier today.

(Question from Brad Blair about international partnerships in chat)
John – I don't know if, I know that we are. But I don't know the specifics to answer that question. If Jerry Sanders is on, he's been leading more of the international relationship building in this area than I have. But I haven't seen Jerry online.

Bob Moses – I'm assisting Jerry Sanders in the construction portion of the …, in the int'l piece of that. We're just now walking through selecting Mars and lunar architectures. We've got a lot of work to do but Jerry plans to present whatever we come up with in the months ahead.

John V – Athonu, I wanted to ask what are the restrictions for international partnerships in the overall LSIC? Are there restrictions or is it open?

Rachel – That's something we're going to have to talk through. Right now LSIC, as far as our side we were asked to focus on US institutions in the partnerships because there's more, the international partnerships are being handled at a higher level than us. But as far as having participants that are international, I don't think there's a problem with that. A lot of organizations have employees who are non-US. But I do know, that's above our pay grade right now to do any kind of international partnerships, that's being handled elsewhere.

John V – What about this focus group, is it open to international partnerships?

Rachel – As far as telecons and emails, yes.

John V – I don't have a position, I'm just not aware.

(Question re: private funding from chat)
John Vickers – Not me today. We can take some of these questions since they're being recorded and take a look at them and get a more definitive answer than trying to answer on the spot.

(Question from Brad Blair about underground mining)
Athonu – I'm not aware of that, anyone else…

Jim Kervala – Can I speak without NASA's permission? My little company Offworld is building swarms of autonomous mining robots, we're undertaking our first full underground field tests later this year. But there is an expansion of those conops directly into tunneling, both using hard tools and energy dispersion tools. It's exactly the conops we hope to deploy on the lunar surface for deep hard rock excavation. Surface regolith utilization is great but underground is where we can scale as a community.

It's a point of reference, there are lots of groups doing many good things, this is what we're doing at our end. I'm dropping a URL in the chat.

Michael McDaniel – I have a question for the working group. Will we have some kind of roster or another way to facilitate communications between groups? At ICON we're looking at lunar construction, but looking to do partnerships with excavators and other types of technologies on the surface. A listing from the working group of other participants, companies, and what they're working on for cross-collaboration. Doesn't have to go through formal channels but

Rachel – So a lot of what we're hoping to do is exactly that kind of thing. We're going to have an opt-in member directory as we build out a member site so people can provide info about their institutions and work they do. Once we have the wiki set up, we'll going to start building up resources where people can share capabilities, share info on facilities, centralize some of these pieces of info for others. And there was a question about the monthly newsletter, so while I'm talking – our first newsletter is a bit more of an intro of who we are with focus on one of the institutions, but each month we'd like to focus, have a little blurb on the different work the participants in the consortium are doing. If you'd like to be featured in something like that you can drop me an email or do a website link that's something-web to let us know that's something you're interested in to help familiarize others in LSI with the work you or your institutions are / having going on.

Dana – To build on that, one of the things we want to do with our larger meetings, like the fall and spring meetings, is have a lot of time for networking so you can build those collaborations and partnerships and then twice a year there'll be a virtual meeting that's just this focus group where there will be a lot of opportunity to share what people are working on and get to know the community.

Brmishra – When we are looking into lunar mining and have connected our past mission, collecting of data has been done, it would be a good idea to have someone from NASA what has been known till now, what we don't know, it's a vast area, selective tools for mining with zero gravity conductors, sensors will play a key role. I think when it was done way back, it was done a different level and I don't think that goal was there. The goal was to get lunar material on earth to study. It would be good to know exactly what we're looking at, and we can go and spend time looking at different papers but it might be good to look at that paper. Anything related to mining, there are constraints that we go on when we design certain aspects, you have a certain angle, geometric function, weight of rod you consider, whereas there, what type of tool you need to create that small excavation will be a challenge, and people will use robots to do that. Having that general info can give the group a lot of ideas in terms of where we want to fit in and what tools are available on earth that can be directly modified to use there.

Athonu – Good points. We'll address those. At the monthly meetings we'll have tasks from the monthly NASA representatives

Brmisrha – Brad Blaire had a comment, it might be a good idea to look at what we have there and especially if there's a focus on remote mining then the whole thing changes. We're remote onsite exploration that'll be done, what tools do we need to have there. The tools we have are very cumbersome and it's not easy to – those things need to be known from the NASA side that we tried this and this is what it is, this is what we need to have.