American Institute of Aeronautics and Astronautics
Space Architecture Technical Committee
Meeting Minutes
2013/07/14-18
International Conference on Environmental Systems
Vail, Colorado, USA

1. Roll Call

Total members: 37
Participating members: 3

The SATC roster appears below. Membership categories are: Associate (A), Regular (R), International (I). Members participating in this conference are indicated by ✓.

Anton Andonov (I)
Payam Bahrami (I)
Olga Bannova (R)
Donald Barker (R)
Annette Barnes (R)
Lynn Baroff (R)
Maijinn Chen (R)
Marc Cohen (R)
Silvano Colombano (R)
Ondřej Doule (I)
Donna Duerk (R)
Maria João Durão (I)
Michael Fox (R)
Shai Gerner (I)
John Gulliford (R)
✓ Ted Hall (R), Chair
Patrick Harkness (I)
Sandra Häuplik-Meusburger (I)
✓ Scott Howe (R)
Ogbonnaya Iheukwumere (I)
Barbara Imhof (I)
Rohan Jaguste (I)
Päivi Jukola (I)
Mark Kerr (R)
Shahzad Khaligh (R), Treasurer
François Lévy (R)
✓ Renée Matossian (R)
Susmita Mohanty (I)
David Nixon (R)
Regina Peldszus (I)
Georgi Petrov (R)
Raúl Pólit Casillas (I)
Tomas Rousek (I)
Brent Sherwood (R)
Jacky Silva (R)
Frederick Slane (R)
David Wong (I)

1. Student Poster Session (2013/07/15)

There were about 14 student posters on display at the Monday evening reception. Two of them had some connection to the SATC:

- The team of Andrew Owens, Margaret Shaw, Ioana Josan-Drinceanu, Sydney Do, and Olivier de Weck, from the Massachusetts Institute of Technology, presented

"HabNet: A Generalized Habitat Modeling Environment." This poster tied for First Place in the poster competition. Ioana Josan-Drinceanu had e-mailed Ted Hall last March on the subject of a "Space habitat architecting tool."

(The other tied-for-First poster was from the same group. The team of Sydney Do and Olivier de Weck presented "An OPM-Based Grammar for Encoding and Synthesizing Life Support System Architectures within HabNet.")

- Christine Fanchiang, from the University of Colorado, presented "Defining a Crew Utilization Figure of Merit to Characterize Human Performance Influence on Spacecraft Design." Marc Cohen met her when he visited the University in April of last year, and she cites some of his publications. She's a student of David Klaus, of the AIAA Life Sciences & Systems Technical Committee (LSSTC).

2. Space Architecture Lunch; ORBITEC Reception (2013/07/16)

15 people gathered for a Space Architecture lunch on Tuesday, including not only the SATC members (Ted Hall, Scott Howe, Renée Matossian) and their family members, but also Ioana Josan-Drinceanu and teammates, Christine Fanchiang, David Klaus, Tom Taylor (President, Lunar Transportation Systems, Inc.), and others.

ORBITEC hosted a reception in the evening.

3. Conference Banquet and Keynote (2013/07/17)

The keynote speaker following the Wednesday night banquet was Taber MacCallum: Co-Founder, CEO, and CTO of Paragon Space Development Corporation. He was also a founding member of the "Biosphere 2" Design, Development, Test, and Operations team, and a crewmember for the first two-year mission. He delivered an excellent talk on the "Inspiration Mars" project, in which Paragon is a corporate partner. He drew from personal experience of confinement in "Biosphere 2."

Following the keynote was the announcement and presentation of the next ICES venue: Tucson, Arizona, USA, 13-17 July 2014, chaired by Chang Son. ICES is leaving AIAA management and going alone. This year's chair, Andrew Jackson, has helped arrange for his university, Texas Tech, to publish and archive next year's papers and assist in contracting with the conference hotel. Coincidentally, "Biosphere 2" is a short drive from Tucson.

4. Technical Sessions (2013/07/18)

ICES 502 A, B – Space Architecture
Chair: Ted Hall

Of the 12 initial abstracts, 3 were officially withdrawn by their authors and another 4 simply never produced papers. Ultimately, 5 papers were accepted and presented in 2 sessions on Thursday morning. The Thursday sessions are usually not as well attended as

sessions earlier in the week, because: the ICES banquet and dessert reception are Wednesday night, and participants are left "de-motivated" the following morning; and because other participants leave early to catch their flights home.

Our session attendance ranged from a low of 8 (for the first paper in the morning) to a high of 32.

Schlesinger, Thilini P.; Rodriguez, Branelle R.; Borrego, Melissa A. International Space Station Crew Quarters On-Orbit Performance and Sustaining Activities (AIAA 2013-3515). Presented by Branelle Rodriguez.

Limardo, José G.; Allen, Christopher S.; Danielson, Richard W. Assessment of Crewmember Noise Exposures on the International Space Station (AIAA 2013-3516). Presented by José Limardo.

Cohen, Marc M.; Matossian, Renée L.; Mancinelli, Rocco L.; Flynn, Michael T. Water Walls Life Support Architecture (AIAA 2013-3517). Presented by Renée Matossian.

Howe, A. Scott; Howard, Robert L.; Moore, Nathan; Amoroso, Michael. Designing for Virtual Windows in a Deep Space Habitat (AIAA 2013-3529). Presented by Scott Howe.

Chambliss, Joe; Studak, J. W. The Single Habitat Module Concept for Exploration – Mission Planning and Mass Estimates (AIAA 2013-3530). Presented by Joe Chambliss.

The last paper is problematic, and I must revert to the first-person voice to discuss it:

Two of the three reviewers utterly rejected the first draft on technical merit; the third thought that it was technically acceptable, but off-topic for the Space Architecture session. Among many other objections, reviewers stated:

> "The so-named SHM architecture is not invented by this paper; the concept is recycled. The paper evidences little understanding of the extensive pre-Constellation Mars-mission literature, but rather seems merely to posit an academic alternative to the Cx DRA, which itself is just the tip of the iceberg. The paper implies significant 'corporate memory' has been forgotten or is simply overlooked." [Reviewer 1]

> "This Single Habitat Module approach seems to reject nearly everything that NASA learned during the process of developing the Mars Design Reference Missions over the last 20 years." [Reviewer 2]

With the revised draft, one of the two original rejecters felt that it was still flawed but marginally acceptable.

I was on the verge of rejecting it, but finally tipped toward accepting it: This concept already has "legs" and the author is pursuing it, whether or not we accept it in our

session. He's a manager at NASA JSC, has already presented two papers on the subject (in 2012, at ICES and AIAA Space, but not in our sessions), and is promoting it through internal NASA channels. My rationale – perhaps naive – was that our best chance to exert any influence was to accept it in our session and hold it up to our public scrutiny.

I sent the following acceptance note to the author:

> As you know, the reviewers were conflicted in regard to your paper. I finally included it, based on a few premises:
>
> - This is a work in progress, that will continue whether or not included in ICES.
>
> - A conference paper is different than a journal article. Conferences provide an opportunity to *discuss* works in progress, as well as controversial or minority points of view.
>
> - Acceptance of a paper in a conference session indicates some threshold of technical merit, but does not constitute endorsement of policies, design decisions, etc.
>
> In that regard, please plan your presentation to fit within 20 minutes or less, to allow for open discussion afterward.
>
> My advice is to not spend much time talking about the procedure of mass estimation. It's not the principal interest here, and in any case, the process of integrating backward from the final to the initial mass is understood and not surprising.
>
> Instead, I ask that you focus your presentation more on the human factors issues.
>
> You write:
>
> > "because the SHM mission implementation was chosen to be for an exploration mission with 4 crew to spend 60 days on Mars and used technology options that are different than the 6 crew conjunction mission in the Mars DRA, a direct comparison is inappropriate."
>
> But some comparisons are inescapable. We have to compare in order to choose one or the other. And, it's not only a matter of IMLEO.
>
> - Why did several iterations of DRA favor split mission scenarios, and how does SHM overturn those conclusions?

- Why does DRA propose a crew size of 6 whereas SHM propose only 4? Are those numbers based on mission requirements and skill sets, or only on mass limitations?

- Is a "one size fits all" approach to habitat design really valid for microgravity and planetary-partial-gravity habitats?

- Though the DRA and SHM scenarios have similar total crew days (914 for DRA versus 944 or 886 for SHM):

  + The DRA allows 539 days for exploring Mars, in 0.38 g surface gravity and 2*PI steradians of radiation protection (from the planet itself), and requires "only" 375 days of confinement in microgravity and 4*PI steradians of radiation exposure (for 914 total crew days). Most of the "Mars surface mission" is spent actually on the surface of Mars.

  + The SHM allows only 60 days for exploring Mars in partial gravity and 2*PI radiation, and requires at least 826 days of confinement in microgravity and 4*PI radiation (for 886 total crew days). Less than 7% of the "Mars surface mission" is spent on Mars.

    How does SHM propose to keep the crew physically, mentally, and emotionally healthy? 886 days is more than twice the length of the longest endurance human spaceflight ever achieved, and 60 days in partial gravity seems unlikely to provide sufficient recuperation between the outbound and inbound legs.

Although this paper focuses mostly on the issue of mass, these human factors issues must also be addressed – if not in the paper / presentation itself, then in the follow-up discussion. Otherwise, any potential mass savings in the hardware is moot.

The author did not address these issues in his presentation, but stuck to his script. When he concluded, I insisted that my question come first: I asked him to address the issue of health preservation during 826 days of confinement in microgravity. He replied that the current trajectory was probably not optimal, and further speculated that improvements in nuclear-powered electric propulsion (a key element of his SHM concept) might enable further reductions in transit time. It was not really a satisfactory answer, but rather suggested that he sees the health issues as other people's problems. His sole focus in this project is on initial mass to LEO. His career has focused largely on thermal systems.

There was little public discussion following that. However, after I concluded the session, another engineer approached the author to tell him how much he liked the paper.

ICES has a policy of not recording the sessions, to promote open discussion "off the record." In that spirit, I will not name this engineer here. I will say only that he (like the author) is an ICES stalwart, a systems engineer in bioengineering, who has authored a number of papers on life support issues.

When I overheard his praise for this paper, I injected myself into the conversation again to assert that it will require a breakthrough in microgravity health preservation. The engineer's reply was that that was just one more in a long list of tradeoffs. After a little more back and forth about calculable risk, he shrugged and stated flatly, "You're going to have sick astronauts."

At that point, it seemed that any further discussion was futile. I didn't press the question: Regardless of IMLEO, what's actually saved if the crew arrives at Mars too sick to explore? Or if they arrive back at Earth so debilitated that no crew will consent to reuse the "reusable" elements that this concept claims to establish? Hasn't it all rather been a complete waste?

It's unfortunate that so few SATC members attend our own conference sessions, to participate in such discussions. Part of the commitment that every AIAA TC member agrees to, on the nomination form, is to attend meetings. Many SATC members have never attended a conference session; others have not attended any in recent years.

Following my exchange with the engineers, another ICES author – who had presented two papers in one of the radiation sessions – approached with a question. I heard him lead with a remark about the 400-day one-way transit time, but I had to attend to other business and didn't stay for the ensuing discussion. Having attended his presentations, my guess is that he was also critical of the SHM mission scenario.

— Ted Hall