

Gordon Woodcock Space Architecture Award 2020

Candidate: A Scott Howe

To the AIAA Space Architecture Technical Committee, thank you very much for nominating me for this award. I feel humbled, and I'm sure there are many worthy candidates. I feel as though I have been busy in some distant corner of the field, but I am very pleased that Space Architecture has grown to what it is today. The following are my statements and comments as requested – please let me know if further information is needed.

1. **Statement confirming you've been involved in the field for at least 10 years:** I was at the impressionable age of 9 years old when Neil and Buzz walked on the moon and was interested in space ever since. However, the idea of working for NASA seemed way beyond my reach, and didn't seem compatible with my desire to become an architect so I went straight into architecture. I worked in terrestrial architecture since 1978. A turning point came when I began working in Japan in 1988, and got involved with the folks doing robotic construction. I began considering the issue of large-scale construction using entirely autonomous, mechanized means, and in the late 1990's was introduced to early AIAA Design Engineering Space Architecture WG efforts by Marc Cohen and Ted Hall. I submitted my first Space Architecture paper, discussing a robotic outpost construction system in 2000 and increased my involvement in AIAA after that. I became a full-time Space Architect in 2007 when I joined the NASA Jet Propulsion Laboratory and have been working on robotic construction for planetary surfaces, the design of outposts and habitats, and pressurized vehicles ever since that time.
2. **Contribution to the profession**
 - a. **Key concepts:** My main contribution has been to robotic construction concepts for planetary surfaces, and how to configure modules, vehicles, operations, techniques for assembling surface outposts from multiple manifests.
 - b. **Management responsibilities:** Management opportunities include chair of SATC, and session/track chair at conferences. For NASA work, I have functioned as Constellation vertical cylinder habitat (option 12.1) lead, Design Integration Lead on the Habitat Demonstration Unit (HDU, now changed to Human Exploration Research Analog HERA), and am currently leading the JPL All-Terrain Hex-Limbed Extra-Terrestrial Explorer (ATHLETE) mobility system team.
 - c. **Papers, books, journal articles, etc:** A full list of published papers, books, and journal articles is attached. Out of 126 publications, notable papers include:
 - AS Howe; BH Wilcox; H Nayar; RP Mueller; JM Schuler (2020). Maintenance-optimized Modular Robotic Concepts for Planetary Surface ISRU Excavators. *IEEE Aerospace Conference 2020*, Big Sky, Montana, USA, 7-14 Mar 2020. New York, New York, USA: Institute of Electrical and Electronics Engineers.
 - AS Howe; A Austin; T Colaprete; J Elliott; T Fong; S Magnus; P Metzger; A Parness; R Polit-Casillas; HH Schmitt; B Sherwood; M Sims; MW Smith; G Voecks; K Zacny (2019). Planetary Autonomous Construction System (P@X). *70th International Astronautical Congress IAC2019*, 21-25 October 2019, Washington DC, USA.
 - AS Howe (2015). 50-year Window to Establish a Space Faring Civilization (AIAA-2015-4565). *AIAA Space 2015 Conference & Exhibition*, Pasadena, California, USA, 31 Aug – 2 Sep 2015. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.
 - AS Howe (2015). A Modular Habitation System for Human Planetary and Space Exploration (ICES-2015-4). *45th International Conference on Environmental Systems (ICES2015)*, Bellevue, Washington, USA, 12-16 July 2015. Lubbock, Texas, USA: Texas Tech University.
 - AS Howe; K Kennedy; T Gill; et al (2013). NASA Habitat Demonstration Unit (HDU) Deep Space Habitat Analog (AIAA2013-5436). *AIAA Space 2013 Conference & Exhibition*. San Diego, California, USA, 10-12 Sep 2013. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.
 - AS Howe; B Wilcox; C McQuin; J Townsend; R Rieber; M Barmatz; J Leichy (2013). Faxing Structures to the Moon: Freeform Additive Construction System (FACS) (AIAA2013-5437). *AIAA Space 2013 Conference & Exhibition*. San Diego, California, USA, 10-12 Sep 2013. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.
 - AS Howe; KJ Kennedy; P Guirgis; R Boyle (2011). A Dual-Chamber Hybrid Inflatable Suitlock (DCIS) for Planetary Surfaces or Deep Space (AIAA2011-5064). *41st International Conference on Environmental Systems (ICES2011)*, Portland, Oregon, USA, 17-21 July 2011. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.
 - AS Howe (2007). Self-assembling Modular Robotic Structures (M-RA.2007.908986). *IEEE Robotics & Automation Magazine*, Volume 14, Issue 4, pp26-33. ISSN 1070-9932.

- AS Howe (Feb 2006). *Cassette Factories and Robotic Bricks: a Roadmap for Establishing Deep Space Infrastructures* (SAE 2005-01-2911). *2005 Transactions Journal of Aerospace*, pp330-363. ISBN 0-7680-1687-8. Warrendale, PA: Society of Automotive Engineers.

Technical books include:

- AS Howe & B Sherwood (eds) (2009). AIAA History of Spaceflight series, *Out of This World: The New Field of Space Architecture*, ISBN 978-1-56347-982-3. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

Science Fiction Novels:

- AS Howe (2012). *Waterball*. Science Fiction Novel. ISBN 13-978-0985076511. Apple books or Amazon.com.
- AS Howe (2013). *Blister*. Science Fiction Novel. ISBN 13-978-0985076542. Apple books or Amazon.com.
- AS Howe (2014). *Chronosphere*. Science Fiction Novel. ISBN 13-978-0985076559. Apple books or Amazon.com.

Non-fiction (religious commentary):

- AS Howe; RL Bushman (2012). *Parallels and Convergences: Mormon Thought and Engineering Vision*. ISBN 978-1-58958-187-6. Draper, Utah, USA: Greg Kofford Books.

- d. **Professional Society membership:** I have been a member of the American Institute of Architects (AIA) for many years (off and on), a member of the Architectural Institute of Japan (Nihon Kenchiku Gakkai) for ten years, a member of SAE for many years, and a member of the AIAA.

3. **Commercial and academic contributions:** Academic contributions include teaching at University of Oregon Department of Architecture 1998-2001, and Hong Kong University Department of Architecture 2001-2007. Hong Kong University studio projects included robotic construction topics, ground facilities for space agencies, and extreme environments including high-altitude, undersea marine, in-flight lighter-than-air hotels, floating factories, etc.

4. Additional considerations

- a. **Terrestrial architecture:** I have practiced architecture since 1978, and became a licensed architect since 1990 with California, eventually obtaining licenses in Oregon and NCARB. A mostly complete list of work can be viewed on my website <http://www.plugin-creations.com/us/ash> (flash required), which lists degree of involvement. Terrestrial architecture building projects in the United States with Barmakian-Wolff-Lang-Christopher or WLC Architects include fire stations, hospital work, civic centers, apartment complexes, speculative office projects, factory buildings, airport facilities, church buildings, community centers, residences, banks, and restaurants. Built projects in Japan with Kajima Corporation include highrise office buildings, subway stations, studio / showroom complex, and Olympic ice skate arena. Non-built concept projects in Japan include indoor ski resort, expo pavilions, cultural centers, headquarters buildings, etc. Robotic construction concepts are also listed on the webpage. Plug-in Creations projects include residences, greenhouses, off-road mobile habitat construction, and robotic construction concepts.
- b. **Artwork, music, etc:** Personal interests include outdoor camping, backpacking, scuba (getting harder at my age), extreme weather shelters, firearms, study of deep physics (quantum physics, entropy, spacetime symmetry, holographic theory, etc), science fiction, philosophy, religion, and hacking together high-tech off-road vehicles.
- c. **Committee service:** I have been a member of the AIAA Design Engineering Technical Committee since 2000, whereupon I became co-chair of the Space Architecture Working Group in 2006. In 2008 I led the effort to create an independent AIAA Space Architecture Technical Committee and became the first chair of the SATC. Since that time I have actively served as paper writer, paper reviewer, session and track chair.
- d. **AIAA membership:** I have been a member of AIAA 2000 to 2018, whereupon I took an early retirement from the AIAA. I have since re-applied for membership through JPL encouragement and backing.

A. Scott Howe, PhD bio summary

Tel: +1.818.354.4492, Email: A.Scott.Howe@jpl.nasa.gov

A. Scott Howe has a PhD in architecture from University of Michigan, and a second PhD in Industrial and Manufacturing Systems Engineering from Hong Kong University, focusing on self-assembling structures and modular robotic construction systems.

Dr. Howe is a Space Architect and Senior Systems Engineer at Jet Propulsion Laboratory (JPL). He has served as a licensed practicing architect emphasizing modular compact buildings, habitats, and deployable structures, and has 29 years of experience engineering robotic construction systems with significant skills in configuration, structures, and hands-on hardware assembly. Dr. Howe has 10 years experience working in Japan on building design, kit-of-parts modular building systems, and automated construction research with Kajima Corporation, Shimizu, and Hazama. He speaks, reads, and writes fluent Japanese on a technical level. He is widely published in journals, conferences, and has contributed to book projects as editor and chapter contributor. Selected projects and publications can be viewed on his webpage: <http://www.plugin-creations.com/us/ash/>

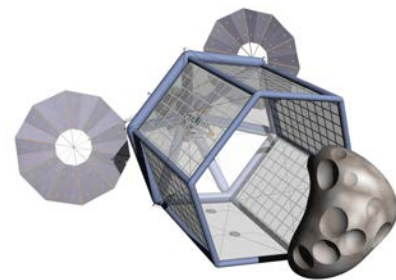
Dr. Howe supports the NASA Space Technology Mission Directorate (STMD) In-Situ Resource Utilization (ISRU) Excavation team and JPL Robotic Lunar Surface Outpost (RLSO) efforts. Other significant participation includes exoplanet telescope (HabEx) mechanical / configuration lead, the Next Mars Orbiter (NeMO) design team, Mars2020 rover support, Europa lander support, Asteroid Redirect Mission (ARM) capture mechanism team, multi-center Human Architecture Team (HAT) mission planning, and as a member of the JPL All-Terrain Hex-Limbed Extra-Terrestrial Explorer (ATHLETE) robotic mobility system development team. Dr. Howe has extensive experience on site supporting field analog studies including NASA Desert Research and Technology Studies (D-RATS).



ATHLETE



Habitat Demonstration Unit



Asteroid Redirect Mission

Before joining JPL, Dr. Howe served as faculty member at University of Oregon for 3 years, and Hong Kong University for 6 years. He is the former Chair for the Space Architecture Technical Committee (SATC) in the American Institute of Aeronautics and Astronautics (AIAA), and has experience organizing and chairing technical conferences, tracks, and sessions.

Dr. Howe is committed to the development of advanced robotic machines and infrastructures and their integration with human space exploration objectives. He believes it is the destiny of humankind to learn to live and work in space, and eventually become a space-faring civilization.

A. Scott Howe, PhD

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EDUCATION:

- 2007 DOCTOR OF PHILOSOPHY (Industrial and Manufacturing Systems Engineering), Hong Kong University Department of Engineering, Hong Kong. Thesis: modular robots for self-constructing building systems.
- 1998 DOCTOR OF PHILOSOPHY (Architecture), University of Michigan School of Architecture + Urban Planning, Ann Arbor, Michigan. Major: design methods, minor: engineering design. Thesis: a new paradigm for life-cycle management of kit-of-parts building systems.
- 1997 MASTER OF SCIENCE degree, University of Michigan School of Architecture + Urban Planning, Ann Arbor, Michigan.
- 1989 MASTER OF ARCHITECTURE degree, University of Utah Graduate School of Architecture, Salt Lake City, Utah, including one year at Kanagawa University, Yokohama, Japan.
- 1987 BACHELOR OF UNIVERSITY STUDIES degree (with emphasis on East Asian Studies), University of Utah, Salt Lake City, Utah, Minor in Japanese language.

PROFESSIONAL EXPERIENCE:

LICENSED ARCHITECT: NCARB #53493, California #C21983, Oregon #4435.

- 2007-present SENIOR SYSTEMS ENGINEER, National Aeronautics and Space Administration (NASA) / Caltech, Jet Propulsion Laboratory, (JPL), Pasadena, California. Duties: systems engineering, mechanisms, mechanical design, deep space outpost design, robotic construction research, habitat design, vehicle design.
- 1998-present PRESIDENT of Plug-in Creations Architecture, LLC, Eugene, Oregon. Duties: extreme shelters design and construction, industrial design, construction robotics, human factors.
- 2006-2007 CONSULTING RESEARCH SCIENTIST, Carnegie Mellon Innovations Lab, Carnegie Mellon West Campus, NASA Ames, Moffett Field, California. Duties: automated construction.
- 2006 VISITING RESEARCHER, NASA Ames Research Center, Autonomous Systems and Robotics Area, Intelligent Robotics Group. Duties: modular robotics for planetary surfaces.
- 1988-1998 ARCHITECT with Kajima Corporation, Tokyo, Japan. Duties: Conceptual design, robotic construction, and building systems, human factors research.
- 1978-1984 DESIGNER and PROJECT MANAGER for Barmakian/Wolff/Lang/Christopher, Architects, Rancho Cucamonga, California. Duties: Full range of architectural services.

ACADEMIC EXPERIENCE:

- 2001-2007 ASSISTANT PROFESSOR (Lecturer), University of Hong Kong Department of Architecture.
- 1998-2001 ASSISTANT PROFESSOR (visiting), University of Oregon Department of Architecture, Eugene, Oregon.

OTHER EXPERIENCE & SKILLS:

- CAD TOOLS: SolidWorks, CATIA, Form Z, Siemens NX, other.
- OTHER: C, C++, Java programming languages. Matlab, STK, and other tools.
- LANGUAGES: Native English, fluent written and spoken technical Japanese, Japan permanent residency status.
- LICENSES: Amateur Radio Operator Extra Class N3ASH, ARRL Volunteer Examiner; Advanced Open Water SCUBA (both PADI & NAUI)

HONORS, AWARDS & PATENTS (selected) :

- 2001 SPECIAL PRIZE FOR DIGITAL PROCESS for Digiosk design and manufacturing in "Far Eastern International Digital Architecture Design" competition presented by the Far Eastern Foundation.
- 1990 PATENTS co-inventor of DYNAMIC INTELLIGENT BUILDING (DIB-200) technology: "Ultra-high Multi-story Buildings and Construction Thereof" Japan patent #2600489, US patent #5,377,465, Canadian patent #2,063,807 owned by Kajima Corporation.

NEW TECHNOLOGIES (selected) :

- 2020 • Random Access Frames (RAF) for dense packing logistics and workstations NTR48982 (AS Howe)
- 2019 • Deep Space Science Vessel MSC26559 (R Howard; AS Howe);
- Habitat for Long Duration Human Space Flight MSC26588 (R Howard; AS Howe)
- 2018 • Microwave Heating Methods for Extracting Volatiles from Regolith JPL NTR50068 (M Barmatz; G Voecks; AS Howe; D Steinfeld; D Hoppe)
- 2015 • Pressurized Adapter for "Shirt-Sleeves" Transfer and Universal Base Expansion (PASSTUBE) JPL NTR50097 (AS Howe)
- 2012 • Forward Osmosis Waterwall Logistics-2-Living (FOWL) NASA1321047279 (AS Howe; M Flynn; S Gormly; J Chambliss)
- 2011 • Deployable Extra-Vehicular Activity Platform (DEVAP) for Planetary Surfaces NASA1319237135 (A Dokos; D Rowell; AS Howe; A Cofield; J Merbitz; J Parr);
- Habitat Demonstration Unit (HDU) Vertical Cylinder Habitat NASA1321392739 (AS Howe; KJ Kennedy; T Gill; T Tri; L Toups; R Howard; G Spexarth; S Cavanaugh; W Langford; J Dorsey);
 - Exploration Launch-Optimized Folding Top (X-LOFT) NASA1321394165 (AS Howe; KJ Kennedy; T Gill; T Tri; G Spexarth; L Toups; R Howard);
 - Microwave Sinterator Freeform Additive Construction System (MS-FACS) JPL NTR48291 (AS Howe; BH Wilcox; MB Barmatz; MB Mercury; MA Seibert; RR Rieber);
 - Radial Internal Material Handling System (RIMS) for Curcular Habitat Volumes JPL NTR48293 (AS Howe; S Haselschwardt; A Bogatko; B Humphrey; A Patel);
 - Telerobotics Workstation (TRWS) for Deep Space Habitats JPL NTR48503 (DS Mittman; AS Howe; RJ Torres; JL Rochlis; KA Hambuchen; M Demel; CC Chapman)
- 2010 • Dual Compartment Inflatable Suitlock (DCIS) JPL NTR47786 (AS Howe; KJ Kennedy; PL Guirgis; RM Boyle)
- 2009 • ATHLETE - the All_Terrain Hex-Limbed Extra-Terrestrial Explorer JPL NTR47276 (BH Wilcox; JB Matthews; AS Howe)

PUBLICATIONS (selected) :

- 2020 AS Howe; BH Wilcox; H Nayar; RP Mueller; JM Schuler (2020). Maintenance-optimized Modular Robotic Concepts for Planetary Surface ISRU Excavators. *IEEE Aerospace Conference 2020*, Big Sky, Montana, USA, 7-14 Mar 2020. New York, New York, USA: Institute of Electrical and Electronics Engineers.
- 2019 TECHNICAL PAPER: AS Howe; B Sherwood; TW Hall; D Landau (2019). Gateway Gravity Testbed (GGT). (ICES-2019-023). *49th International Conference on Environmental Systems (ICES2019)*, Boston, Massachusetts, USA, 7-11 July 2019. Lubbock, Texas, USA: Texas Tech University.
- 2016 TECHNICAL PAPER: AS Howe (2016). Pressurized Adapter for "Shirt-Sleeves" Transfer and Universal Base Extension (PASSTUBE) (AIAA-2016-5393). *AIAA Space 2016 Conference & Exhibition*, Long Beach, California, USA, 13 – 16 Sep 2016. Virginia, USA: American Institute of Aeronautics and Astronautics.
- 2015 TECHNICAL PAPER: AS Howe (2015). 50-year Window to Establish a Space Faring Civilization (AIAA-2015-4565). *AIAA Space 2015 Conference & Exhibition*, Pasadena, California, USA, 31 Aug – 2 Sep 2015. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

- 2015 TECHNICAL PAPER: AS Howe (2015). A Modular Habitation System for Human Planetary and Space Exploration (ICES-2015-4). *45th International Conference on Environmental Systems (ICES2015)*, Bellevue, Washington, USA, 12-16 July 2015. Lubbock, Texas, USA: Texas Tech University.
- 2013 TECHNICAL PAPER: AS Howe; K Kennedy; T Gill; et al (2013). NASA Habitat Demonstration Unit (HDU) Deep Space Habitat Analog. *AIAA Space 2013 Conference & Exhibition*. San Diego, California, USA, 10-12 Sep 2013. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.
- 2013 TECHNICAL PAPER: AS Howe; B Wilcox; C Mcquin; et al (2013). Faxing Structures to the Moon: Freeform Additive Construction System (FACS). *AIAA Space 2013 Conference & Exhibition*. San Diego, California, USA, 10-12 Sep 2013. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.
- 2009 BOOK: A.S. Howe & B. Sherwood (eds.) (2009). *AIAA History of Spaceflight series, Out of This World: The New Field of Space Architecture*, ISBN 978-1-56347-982-3. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.
- 2007 TECHNICAL PAPER: A.S. Howe (2007). Self-assembling Modular Robotic Structures (M-RA.2007.908986). *IEEE Robotics & Automation Magazine*, Volume 14, Issue 4, pp26-33. ISSN 1070-9932.
- 2007 DISSERTATION: A.S. Howe (2007). *Modular Robots for Self-constructing Building Systems*. Ph.D. dissertation, University of Hong Kong.
- 1998 DISSERTATION: A.S. Howe (1998). A new paradigm for life-cycle management of kit-of-parts building systems. Doctoral Dissertation, University of Michigan.

ORGANIZATIONS & ACTIVITIES (selected) :

- 2000-present MEMBER American Institute of Aeronautics and Astronautics (AIAA) Space Exploration Process Committee (SEPC), and former CHAIR Space Architecture Technical Committee (SATC) see webpage: <http://www.spacearchitect.org>.
- 1980-1982 MISSIONARY in Fukuoka, Japan for The Church of Jesus Christ of Latter-day Saints (Mormon).

A. Scott Howe Publications (selected)

PUBLISHED:

AS Howe (2020). 宇宙に住む人間のための惑星上建設 (Planetary Construction for Humans Living in Space), SBM000443. 第64回宇宙科学技術連合講演会 (64th Japan Space Science Technology Symposium), 27-30 Oct 2020.

AS Howe; BH Wilcox (2020). High-capacity ATHLETE Offloader Mobility Constructor Concept for Human Surface Exploration (AIAA-2020-4190). *AIAA ASCEND 2020 Conference*, (virtual), 16-18 Nov 2020. Virginia, USA: American Institute of Aeronautics and Astronautics.

V Stamenkovic, et al (98 authors total) (2020). Deep Trek: Science of Subsurface Habitability & Life on Mars, A Window into Subsurface Life in the Solar System. White paper submitted to the National Academy of Sciences (NAS) addressing the Planetary Science and Astrobiology Decadal Survey 2023-2032.

CD Edwards, et al (101 authors total) (2019). Deep Trek: Mission Concepts for Exploring Subsurface Habitability & Life on Mars, A Window into Subsurface Life in the Solar System. White paper submitted to the National Academy of Sciences (NAS) addressing the Planetary Science and Astrobiology Decadal Survey 2023-2032.

A Austin; B Sherwood; J Elliott; A Colaprete; K Zacny; P Metzger; M Sims; HH Schmitt; S Magnus; T Fong; MW Smith; R Polit-Casillas; AS Howe; G Voecks; M Vaquero; V Vendiola (2020). Robotic Lunar Surface Operations 2. *Acta Astronautica*, Number 176, pp424-437. <https://doi.org/10.1016/j.actaastro.2020.06.038>

AS Howe; BH Wilcox; H Nayar; RP Mueller; JM Schuler (2020). Maintenance-optimized Modular Robotic Concepts for Planetary Surface ISRU Excavators. *IEEE Aerospace Conference 2020*, Big Sky, Montana, USA, 7-14 Mar 2020. New York, New York, USA: Institute of Electrical and Electronics Engineers.

AS Howe; A Austin; T Colaprete; J Elliott; T Fong; S Magnus; P Metzger; A Parness; R Polit-Casillas; HH Schmitt; B Sherwood; M Sims; MW Smith; G Voecks; K Zacny (2019). Planetary Autonomous Construction System (P@X). *70th International Astronautical Congress IAC2019*, 21-25 October 2019, Washington DC, USA.

A Austin; B Sherwood; J Elliott; A Colaprete; K Zacny; P Metzger; M Sims; HH Schmitt; S Magnus; T Fong; MW Smith; R Polit-Casillas; AS Howe; G Voecks; A Parness; M Vaquero; V Vendiola (2019). Robotic Lunar Surface Operations 2. *70th International Astronautical Congress IAC2019*, 21-25 October 2019, Washington DC, USA.

R Polit-Casillas; A Austin; A Colaprete; J Elliott; T Fong; AS Howe; S Magnus; P Metzger; A Parness; R Polit-Casillas; HH Schmitt; B Sherwood; M Sims; MW Smith; G Voecks; K Zacny (2019). Architectural Design Considerations for a Robotic Power Infrastructure on the Moon. *70th International Astronautical Congress IAC2019*, 21-25 October 2019, Washington DC, USA.

J Elliott; B Sherwood; A Austin; MW Smith; R Polit-Casillas; AS Howe; G Voecks; A Colaprete; P Metzger; K Zacny; V Vendiola; (2019). ISRU in Support of an Architecture for a Self-Sustained Lunar Base. *70th International Astronautical Congress IAC2019*, 21-25 October 2019, Washington DC, USA.

BS Gaudi, et al (82 authors total) (2019). The Habitable Exoplanet Observatory (HabEx) Mission Concept Study Final Report. [arXiv:1809.09674](https://arxiv.org/abs/1809.09674)

B Sherwood; A Austin; T Colaprete; J Elliott; T Fong; AS Howe; S Magnus; P Metzger; A Parness; R Polit-Casillas; HH Schmitt; M Sims; MW Smith; M Vaquero; G Voecks; K Zacny (2019). Robotic Lunar Surface Operations 2. Solar System Exploration Research Virtual Institute (SERVI), NASA Exploration Science Forum (NESF 2019), 23-25 July 2019, NASA Ames Research Center.

B Sherwood; A Austin; T Colaprete; J Elliott; T Fong; AS Howe; S Magnus; P Metzger; A Parness; R Polit-Casillas; HH Schmitt; M Sims; MW Smith; M Vaquero; G Voecks; K Zacny (2019). Robotic Lunar Surface Operations 2. Space Resources Roundtable (SRR), Planetary & Terrestrial Mining Science Symposium (PTMSS), 11-14 June 2019, Golden, Colorado, USA.

AS Howe; B Sherwood; TW Hall; D Landau (2019). Gateway Gravity Testbed (GGT). (ICES-2019-023). *49th International Conference on Environmental Systems (ICES2019)*, Boston, Massachusetts, USA, 7-11 July 2019. Lubbock, Texas, USA: Texas Tech University.

BH Wilcox; H Nayar; AS Howe (2019). Autonomous Mars ISRU Robotic Excavation: Characteristics and Performance Targets. *IEEE Aerospace Conference 2019*, Big Sky, Montana, USA, 2-9 Mar 2019. New York, New York, USA: Institute of Electrical and Electronics Engineers.

BS Gaudi, et al (82 authors total) (2018). The Habitable Exoplanet Observatory (HabEx) Mission Concept Study Interim Report. [arXiv:1809.09674](https://arxiv.org/abs/1809.09674)

R Shishko; H Price; B Wilcox; A Stoica; S Howe; J Elliott (2018). An Affordable Lunar Architecture Emphasizing Commercial and International Partnering Opportunities. *IEEE Aerospace Conference*, Big Sky, Montana, USA, 4-11 Mar 2018. New York, New York, USA: Institute of Electrical and Electronics Engineers.

BH Wilcox; AS Howe (2018). Robotic Infrastructure for Mars Outpost Water Supply. *IEEE Aerospace Conference 2018*, Big Sky, Montana, USA, 4-11 Mar 2018. New York, New York, USA: Institute of Electrical and Electronics Engineers.

AS Howe (2016). Pressurized Adapter for "Shirt-Sleeves" Transfer and Universal Base Extension (PASSTUBE) (AIAA-2016-5393). *AIAA Space 2016 Conference & Exhibition*, Long Beach, California, USA, 13 – 16 Sep 2016. Virginia, USA: American Institute of Aeronautics and Astronautics.

AS Howe; MA Simon; S Wald (2016). Sizing a Common Habitat for Multiple Environments and Mission Durations (AIAA-2016-5455). *AIAA Space 2016 Conference & Exhibition*, Long Beach, California, USA, 13 – 16 Sep 2016. Virginia, USA: American Institute of Aeronautics and Astronautics.

R Mueller; S Howe; D Kochmann; H Ali; C Andersen; H Burgoyne; W Chambers; R Clinton; X De Kestellier; K Ebelt; S Gerner; D Hofmann; K Hogstrom; E Ilves; A Jerves; R Keenan; J Keravala; B Khoshnevis; S Lim; P Metzger; L Meza; T Nakamura; A Nelson; H Partridge; D Pettit; R Pyle; E Reiners; A Shapiro; R Singer; WL Tan; N Vazquez; B Wilcox; S Wilkinson; A Zelhofer (2016). Automated Additive Construction (AAC) for Earth and Space Using In-situ Resources. *Proceedings of the Fifteenth Biennial ASCE Aerospace Division International Conference on Engineering, Science, Construction, and Operations in Challenging Environments (Earth & Space 2016)*. Orlando, Florida, USA, 11 - 15 Apr 2016. Reston, Virginia, USA: American Society of Civil Engineers.

AS Howe; B Wilcox; M Barmatz; G Voecks (2016). ATHLETE as a Mobile ISRU and Regolith Construction Platform. Proceedings of the *Fifteenth Biennial ASCE Aerospace Division International Conference on Engineering, Science, Construction, and Operations in Challenging Environments* (Earth & Space 2016). Orlando, Florida, USA, 11 - 15 Apr 2016. Reston, Virginia, USA: American Society of Civil Engineers.

M Rucker; S Jeffries; AS Howe; R Howard; N Mary; J Watson; R Lewis (2016). Mars Surface Tunnel Element Concept. *IEEE Aerospace Conference 2016*, Big Sky, Montana, USA, 5-12 Mar 2016. New York, New York, USA: Institute of Electrical and Electronics Engineers.

AS Howe; B Wilcox (2016). Outpost Assembly using the ATHLETE Mobility System. *IEEE Aerospace Conference 2016*, Big Sky, Montana, USA, 5-12 Mar 2016. New York, New York, USA: Institute of Electrical and Electronics Engineers.

L Toups; M Simon; AS Howe; R Howard (2016). Part 3, Chapter 16: The Role of Soft Materials in the Design of Extreme Interior Environments for Space Exploration. In D Schneiderman & AG Winton (eds), *Textile Technology and Design: From Interior Space to Outer Space*. New York, New York, USA: Bloomsbury Publishing. ISBN 9781472528803

B Griffin; R Lepsch; J Martin; R Howard; M Rucker; E Zapata; C McCleskey; AS Howe; N Mary; P Nerren (2015). Small Habitat Commonality Reduces Human Mars Mission Costs (AIAA-2015-4455). *AIAA Space 2015 Conference & Exhibition*, Pasadena, California, USA, 31 Aug – 2 Sep 2015. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

MA Simon; L Toups; AS Howe; S Wald (2015). Evolvable Mars Campaign Long Duration Habitation Strategies: Architectural Approaches to Enable Human Exploration Missions (AIAA-2015-4514). *AIAA Space 2015 Conference & Exhibition*, Pasadena, California, USA, 31 Aug – 2 Sep 2015. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

AS Howe; M Gernhardt; AFJ Abercromby; SP Chappell; D Lee; Z Crues; H Nguyen (2015). Small Body Hopper Mobility Concepts (AIAA-2015-4566). *AIAA Space 2015 Conference & Exhibition*, Pasadena, California, USA, 31 Aug – 2 Sep 2015. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

B Wilcox; T Litwin; J Carlson; M Shekels; H Grip; A Jain; C Lim; S Myint; J Dunkle; A Sirota; C Fuller; AS Howe (2015). Testbed for Studying the Capture of a Small, Free-flying Asteroid in Space (AIAA-2015-4583). *AIAA Space 2015 Conference & Exhibition*, Pasadena, California, USA, 31 Aug – 2 Sep 2015. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

AS Howe (2015). 50-year Window to Establish a Space Faring Civilization (AIAA-2015-4565). *AIAA Space 2015 Conference & Exhibition*, Pasadena, California, USA, 31 Aug – 2 Sep 2015. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

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