RETH Workshop - Grand Challenges and Key Research Questions to Achieve Resilient Long-Term Extraterrestrial Habitats

October 22 - 23, 2018

Purdue University

Agenda Day 1

7:30 am — Breakfast and Registration (*Stewart Center, room 218*)

8:15 — Welcome and Opening Remarks (*Stewart Center, room 218*)
Moderator: Julio Ramirez, Kettelhut Professor of Civil Engineering, Purdue University
Speakers: Peter Hollenbeck, Vice Provost for Faculty Affairs, Purdue University
Melba Crawford, Associate Dean for Research in the College of Engineering, Purdue University
Elizabeth Taparowsky, Associate Dean for Research and Graduate Education in the College of Science, Purdue University

8:50 — Agenda and Objectives of the Workshop (*Stewart Center, room 218*)
Moderator: Shirley Dyke, Professor of Mechanical and Civil Engineering, Purdue University

9:00 — Plenary Session Invited Talks (*Stewart Center, room 218*)
Moderator: Shirley Dyke, Professor of Mechanical and Civil Engineering, Purdue University
Coordinator: Anahita Modiriasari, Postdoctoral Research Assistant of Civil Engineering, Purdue University
Speakers: Dan Dumbacher, Executive Director, American Institute of Aeronautics & Astronautics (AIAA)
Junichi Haruyama, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (JAXA)
Larry Toups, Systems Engineer, NASA, Johnson Space Center

10:00 — Q/A Session (*Stewart Center, room 218*)
Moderator: Shirley Dyke, Professor of Mechanical and Civil Engineering, Purdue University

10:20 — Break (*Stewart Center, room 218*)

10:40 — Joint Session - Panel Session (*Stewart Center, room 218*)
Moderator: Antonio Bobet, Professor of Civil Engineering, Purdue University
Coordinator: Anahita Modiriasari, Postdoctoral Research Assistant of Civil Engineering, Purdue University
Panelists: Lindsay Aitchison, Program Executive, Life Support and EVA, NASA Headquarters
William O'Hara, Principal Systems Engineer, Sierra Nevada Corporation
Mike Grichnik, Emerging Technologies Program Leader, Caterpillar
Anita Gale, Co-Founder, Space Settlement Design Competitions
Barry Finger, Chief Engineer/Director of Life Support Systems, Paragon Space Development Corporation
Jay Melosh, Distinguished Professor of Earth, Atmospheric, and Planetary Sciences, Purdue University

11:40 — Joint Session - Expectation and Organization of Afternoon Breakout Sessions (*Stewart Center, room 218*)
Moderator: Antonio Bobet, Professor of Civil Engineering, Purdue University

12:00 pm — Group Picture (*Purdue Memorial Union)*

12:15 — Lunch (*Purdue Memorial Union, West Faculty Lounge*)

1:15 — Breakout Sessions – I *(The breakout sessions are concurrent. The scope of each breakout session includes (but is not limited to) the following subjects.)*

Theme A - Hazards (Events) (*Stewart Center, room 278*)

Session Scope:

- ✓ *Science and current state of the art in space extreme environment and hazards (e.g. radiation, meteorite impacts, extreme temperatures, seismicity, etc.)*
- ✓ *Technology to quantify and qualify hazards*

- ✓ *Impacts of hazards on human exploration and survival*
- ✓ *Hazard mitigation*

Moderator: Gayle Woloschak, Professor of Radiation Oncology and Radiology, Northwestern University
Coordinators and Recorders: Daniel Gomez, Graduate Research Assistant of Civil Engineering, Purdue University
Anthony Boener, Undergraduate Researcher, Department of Earth, Atmospheric and Planetary Sciences, Purdue University
Panelists: David Cappelleri, Associate Professor of Mechanical Engineering, Purdue University
Karen Marais, Associate Professor of Aeronautics and Astronautics, Purdue University
Jay Melosh, Distinguished Professor of Earth, Atmospheric, and Planetary Sciences, Purdue University
Julio Ramirez, Kettelhut Professor of Civil Engineering, Purdue University
Nicholas Schmerr, Assistant Professor, Department of Geology, University of Maryland
Elizabeth Silber, Defence Scientist, Defence Research and Development Canada (DRDC)
Michelle Thompson, Assistant Professor, Department of Earth, Atmospheric and Planetary Sciences, Purdue University
Kathleen Vander Kaaden, Research Scientist, Jacobs, NASA Johnson Space Center

Zackary Burman, Undergraduate Researcher of Planetary Geomorphology, Purdue University
Jory Lyons, Undergraduate Researcher of Aeronautics and Astronautics, Purdue University

Theme B - Resources (Harvesting and Utilization) (*Stewart Center, room 279*)

Session Scope:
- ✓ *Resources and supplies needed for permanent habitats, e.g. food, water, energy, construction materials*
- ✓ *Sources of resources and supplies*
- ✓ *Mining, harvesting methods and technologies*
- ✓ *Reutilization*
- ✓ *Current state of the art in manufacturing and construction technologies (Robotics and Automation, Additive Manufacturing, 3D Printing, etc.)*
- ✓ *Improvements to manufacturing and construction for hazardous environments*

Moderator: Cary Mitchell, Professor of Horticulture, Purdue University
Coordinators and Recorders: Audai Theinat, Graduate Research Assistant of Civil Engineering, Purdue University
Ajay Radhakrishnan, Undergraduate Researcher of Mechanical Engineering, Purdue Student
Panelists: Hunain Alkhateb, Assistant Professor of Civil Engineering, University of Mississippi
Jared Atkinson, Senior Geophysical Engineer, Honeybee Robotics
Dan Dumbacher, Executive Director, American Institute of Aeronautics & Astronautics (AIAA)
Shirley Dyke, Professor of Mechanical and Civil Engineering, Purdue University
Mike Grichnik, Emerging Technologies Program Leader, Caterpillar
Ibrahim Emre Gunduz, Research Assistant Professor of Mechanical Engineering, Purdue University
Robert Haddon, Program Director, Aerospace Medicine Fellowship, Mayo Clinic
Briony Horgan, Assistant Professor, Department of Earth, Atmospheric, and Planetary Sciences, Purdue University
Jan Olek, Professor of Civil Engineering, Purdue University
Scott Peters, President, Construction Robotics
Florence Sanchez, Associate Professor of Civil and Environmental Engineering, Vanderbilt University
Justin Werfel, Senior Research Scientist, Harvard's Wyss Institute for Biologically Inspired Engineering
Jeffrey Youngblood, Professor of Materials Engineering, Purdue University

Leon Brendel, Graduate Research Assistant of Mechanical Engineering, Purdue University
Michael Kosson, Graduate Student of Chemical and Biomolecular Engineering, Vanderbilt University
Kinsey Larson, Undergraduate Student, Purdue University
Aryan Noroozi, Graduate Research Assistant of Civil Engineering, Purdue University
Babajide Onanuga, Graduate Research Assisstant, Department of Chemical Engineering, Tennessee Technological University
Josh Panos, President of Lunabotics, Purdue University

Theme C - Habitats (Preparation and Architecture) (*Stewart Center, room 218*)

Session Scope:
- ✓ *Habitation: mission, vision, and current state of the art*
- ✓ *Function and requirements*
- ✓ *Structural design parameters (robustness, performance and recovery, resiliency)*
- ✓ *Lunar and Martian habitats: surface vs. underground (Lava Tubes)*
- ✓ *Size and stability of natural lava tubes*

Moderator: Barry Finger, Chief Engineer/Director of Life Support Systems, Paragon Space Development Corporation
Coordinators and Recorders: Amin Maghareh, Postdoctoral Research Assistant of Civil Engineering, Purdue University

Anahita Modiriasari, Postdoctoral Research Assistant of Civil Engineering, Purdue University

Panelists: Lindsay Aitchison, Program Executive, Life Support and EVA, NASA Headquarters
Ernie Bell, Graduate Research Assistant, Department of Geology, University of Maryland
Antonio Bobet, Professor of Civil Engineering, Purdue University
Joseph Biernacki, Professor of Chemical Engineering, Tennessee Technological University
Charles Dischinger, Discipline Deputy for Human Factors, NASA
Anita Gale, Co-Founder, Space Settlement Design Competitions
Junichi Haruyama, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (JAXA)
Mohammad Jahanshahi, Assistant Professor of Civil Engineering, Purdue University
Ben Kosbab, Principal Engineer, SC Solutions
Ramesh Malla, Professor of Civil and Environmental Engineering, University of Connecticut
William O'Hara, Principal Systems Engineer, Sierra Nevada Corporation
Riccardo Pizzobon, Postdoctoral Researcher in Planetary Geology, University of Padova
Monsi Roman, Program Manager – Centennial Challenges, NASA
Larry Toups, Systems Engineer, NASA/Johnson Space Center
Haiyan Wang, Professor of Materials Engineering, Purdue University
Dawn Whitaker, Indiana Space Grant Consortium Associate Director, Purdue University
Kelsey Young, Research Space Scientist, NASA Goddard Space Flight Center
Pablo Zavattieri, Professor of Civil Engineering, Purdue University

Mark Gee, Undergraduate Researcher of Biological Engineering, Biochemistry, and Agronomy, Purdue Student
Yonggang Luo, Graduate Research Assistant of Physics, Purdue Student
Abdul Salam Mohammad, Post Graduate Research Assistant, Tennessee Technological University
Mohammadreza Moini, Graduate Research Assistant of Civil Engineering, Purdue Student
Danielli Moura, Graduate Research Assistant of Civil Engineering, Purdue Student
Yunlan Zhang, Graduate Research Assistant of Civil Engineering, Purdue Student

3:15 Break *(Stewart Center, room 218)*

3:30 Joint Session: Report- Results of Breakout Sessions – I (*Stewart Center, room 218*)
Moderator: Anita Gale, Co-Founder, Space Settlement Design Competitions

5:30 Joint Session: Expectation and Organization of Day 2 (*Stewart Center, room 218*)
Moderator: Antonio Bobet, Professor of Civil Engineering, Purdue University

5:45 Break

6:00 - 8:00 Reception with Poster Session *(Stewart Center, room 279)*
Coordinators: Daniel Gomez, Graduate Research Assistant of Civil Engineering, Purdue University
Audai Theinat, Graduate Research Assistant of Civil Engineering, Purdue University

Agenda Day 2

7:30 am — Breakfast (*Stewart Center, room 218*)

8:15 — Agenda and Objectives of the Workshop (*Stewart Center, room 218*)
Moderator: Jay Melosh, Distinguished Professor of Earth, Atmospheric, and Planetary Sciences, Purdue University

8:30 — Breakout Sessions – II

Theme D - Partnering Nationally and Internationally: Industry, Facilities and Research (collaborations, access) (*Stewart Center, room 278*)

Session Scope:

- ✓ *Requirements to make successful team collaborations*
- ✓ *Suggestions for resources of funding and partners (names and works)*
- ✓ *Approaches to make nationally and internationally collaborations*
- ✓ *Industry needs from academia*

Moderator: William O'Hara, Principal Systems Engineer, Sierra Nevada Corporation
Coordinators and Recorders: Daniel Gomez, Graduate Research Assistant of Civil Engineering, Purdue University
Anahita Modiriasari, Postdoctoral Research Assistant of Civil Engineering, Purdue University
Panelists: Jared Atkinson, Senior Geophysical Engineer, Honeybee Robotics
David Cappelleri, Associate Professor of Mechanical Engineering, Purdue University
Charles Dischinger, Discipline Deputy for Human Factors, NASA
Dan Dumbacher, Executive Director, American Institute of Aeronautics & Astronautics (AIAA)
Barry Finger, Chief Engineer/Director of Life Support Systems, Paragon Space Development Corporation
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Scott Peters, President, Construction Robotics
Julio Ramirez, Kettelhut Professor of Civil Engineering, Purdue University
Monsi Roman, Program Manager – Centennial Challenges, NASA
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Kathleen Vander Kaaden, Research Scientist, Jacobs, NASA Johnson Space Center
Haiyan Wang, Professor of Materials Engineering, Purdue University
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Yonggang Lou, Graduate Research Assistant of Physics, Purdue Student
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Aryan Noroozi, Graduate Research Assistant of Civil Engineering, Purdue University
Babajide Onanuga, Graduate Research Assisstant, Department of Chemical Engineering, Tennessee Technological University
Josh Panos, President of Lunabotics, Purdue University

Theme E - Forming the Right Research Team for Project Scope: Expertise, Interdisciplinary, Expected Contributions (*Stewart Center, room 218*)

Session Scope:

- ✓ *Priorities in research objectives*
- ✓ *Research approaches*
- ✓ *Required expertise and networking to accomplish research objectives*

Moderator: Dawn Whitaker, Indiana Space Grant Consortium Associate Director, Purdue University
Coordinators and Recorders: Amin Maghareh, Postdoctoral Research Assistant of Civil Engineering, Purdue University
Audai Theinat, Graduate Research Assistant of Civil Engineering, Purdue University
Panelists: Lindsay Aitchison, Program Executive, Life Support and EVA, NASA Headquarters
Hunain Alkhateb, Assistant Professor of Civil Engineering, University of Mississippi

Ernie Bell, Graduate Research Assistant, Department of Geology, University of Maryland
Antonio Bobet, Professor of Civil Engineering, Purdue University
Joseph Biernacki, Professor of Chemical Engineering, Tennessee Technological University
Shirley Dyke, Professor of Mechanical and Civil Engineering, Purdue University
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Robert Haddon, Program Director, Aerospace Medicine Fellowship, Mayo Clinic
Junichi Haruyama, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (JAXA)
Briony Horgan, Assistant Professor, Department of Earth, Atmospheric, and Planetary Sciences, Purdue University
Mohammad Jahanshahi, Assistant Professor of Civil Engineering, Purdue University
Cary Mitchell, Professor of Horticulture, Purdue University
Riccardo Pizzobon, Postdoctoral Researcher in Planetary Geology, University of Padova
Florence Sanchez, Associate Professor of Civil and Environmental Engineering, Vanderbilt University
Elizabeth Silber, Defence Scientist, Defence Research and Development Canada (DRDC)
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Ajay Radhakrishnan, Undergraduate Researcher of Mechanical Engineering, Purdue Student
Yunlan Zhang, Graduate Research Assistant of Civil Engineering, Purdue Student

10:00 Break (*Stewart Center, room 218*)

10:20 Joint Session: Report- Results of Breakout Sessions – II (*Stewart Center, room 218*)
Moderator: Larry Toups, Systems Engineer, NASA/Johnson Space Center

12:00 pm Summary and Closing Session- Expanding the vision of science and engineering to achieve resilient long-term extraterrestrial habitats (*Stewart Center, room 218*)
Moderator: Dan Dumbacher, Executive Director, American Institute of Aeronautics & Astronautics (AIAA)
Julio Ramirez, Kettelhut Professor of Civil Engineering, Purdue University

1:00 – 2:00 Lunch (*Purdue Memorial Union, East Faculty Lounge*)