



ASCE Earth and Space 2022

18th Biennial International Conference

April 25-28, 2022
Denver, Colorado USA

Conference Program
and Agenda



Welcome to Earth and Space 2022, the 18th Biennial International Conference!

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On behalf of the Earth and Space 2022 Planning Committee, welcome to Denver, Colorado. We are meeting in-person for the first time in four years after an unprecedented pandemic. We hope that you, like the Committee are glad to be back in person. This gives us all the chance to connect with old colleagues and make new acquaintances who in time may become new colleagues. The Planning Committee, speakers, and organizing staff have worked diligently to create this Conference.

We are excited to present to you five multi-tracked symposiums featuring over 100 technical presentations spanning the three-day course of the conference. We also have a line-up of keynote speakers, a special session devoted to student experiences in the NASA BIG Ideas challenge, a student paper competition, and a full-day pre-conference short course focusing on health monitoring in terrestrial and extra-terrestrial environments, led by experts in their disciplines. Morning Plenary Sessions include keynote speakers: on Tuesday *"HOME-A NASA Research Institute for Semi-Autonomous Human Habitats in Deep Space"* by Dr. Stephen K Robertson of University of California Davis; on Wednesday *"Space Architecture & Spatial Design: The Future of Construction Beyond Earth"* by Melodie Yashar of ICON; and on Thursday *"ASCE Future World Vision"* by Gerald Buckwalter of ASCE.

With over 100 attendees from academia, industry, and government a diverse knowledge base is in attendance. This includes a record number of student attendees. We hope everyone will create new connections that will be remembered as having started here at this Conference. With many new opportunities just over the horizon for expanding human presence in the solar system we hope that this conference can be a small contribution to that effort.



Christopher Dreyer, Ph.D., A.M.ASCE

2022 Conference Chair

Professor of Practice, Space Resources Program,
Colorado School of Mines



Justin Littell, Ph.D., A.M.ASCE

2022 Technical Chair

Research Aerospace Engineer, NASA Langley
Research Center

We Appreciate Our Sponsors!



HONEYBEE ROBOTICS



CANADENSYS

Symposium 1

Christopher Dreyer, Ph.D., A.M.ASCE, Colorado School of Mines

Phil Metzger, Ph.D., A.M.ASCE, University of Central Florida

Symposium 2

Robert Mueller, A.M.ASCE, NASA Kennedy Space Center

Kris Zacny, Ph.D., P.E., M.ASCE, Honeybee Robotics

Symposium 3

An Chen, Ph.D., Beijing Jiaotong University

Hongyu (Nick) Zhou, Ph.D., University of Tennessee Knoxville

Arif Masud, Ph.D., University of Illinois at Urbana-Champaign

ASCE Earth and Space 2022

Committees and Chairs

Conference Chair

Christopher Dreyer, Ph.D., A.M.ASCE,
Colorado School of Mines

Technical Program Chair

Justin Littell, Ph.D., Langley Research Center,
NASA

Professional Development Chair

Robert Goldberg, Ph.D., M.ASCE, NASA Glenn
Research Center

Student Paper Competition Chair

Krzysztof Skonieczny, Ph.D., CMU

ASD ExCom Representative

Peter Visscher, C.Eng, M.ASCE, Canadensys
Aerospace Corp.

Symposium Co-Chairs

Symposium 4

Wei Zhang, Ph.D., University of Connecticut

Gangbing Song, Ph.D., University of Houston

Yan Shi, Ph.D., Shenyang Jianzhu University

Symposium 5

Ramesh Malla, Ph.D., F.ASCE, F.EMI, University of
Connecticut

Melissa Sampson, Ph.D.

Alexander Jablonski, Ph.D., P.Eng., Canadian Space
Agency

Gerald (Jerry) Sanders, NASA Johnson Space Center

The Earth and Space 2022 Conference is being
administered by Continuing and Professional Education
Services at Colorado School of Mines.

learn.mines.edu • learn@mines.edu

Conference website: learn.mines.edu/earthspace2022





HONEYBEE ROBOTICS

BUILDING SPACE MINING ROBOTS

Opening Reception

Earth and Space 2022 will host a reception for Conference attendees in the evening of Tuesday, April 26, 2022. The reception will take place in the Schlessman Lobby of the Denver Museum of Nature and Science between the hours of 18:00 (6:00 pm) and 20:00 (8:00 pm). The Museum is located at 2001 North Colorado Boulevard, Denver, Colorado 80205.

Free transportation to the reception is available. Buses to the reception will leave The Curtis Hotel at 17:30 (5:30 pm) and at 18:00 (6:00 pm) and will leave the Museum at 19:45 (7:45 pm) and 20:15 (8:15 pm) to return to The Curtis Hotel. Times may vary depending upon traffic and other factors.

An Italian buffet will be available at the reception. Each attendee of legal age will be provided with two drink tickets (beer or wine); additional drinks will be available at the cash bar. The bar will close at 19:30 (7:30 pm). Iced tea and other soft drinks will also be available at no additional charge.

Attendees are invited to view the Space Odyssey exhibit in the Museum during the reception. Please be aware that no food or drinks are allowed in the exhibit area.

Conference at a Glance

Monday • April 25

08:45	<p>Short Course <i>Health Monitoring for Terrestrial and Space Based Environments</i> Hopscotch</p>	<p>Short Course check-in • 08:15 - 08:45 outside Four Square Ballroom</p> <p>Conference check-in • 15:00 - 18:00 outside Four Square Ballroom</p>
17:00	<p>Meeting <i>Aerospace Division Executive Committee (EXCOM)</i> Hopscotch</p>	
18:30	<p>Meeting <i>Advanced Materials and Structures Committee</i> Hopscotch</p>	<p>Meeting <i>Dynamics and Controls Committee</i> Red Rover</p>
19:30		<p>Meeting <i>Regolith Operations, Mobility and Robotics</i> Red Rover</p>
20:30		

Tuesday • April 26

08:00	<p>Plenary Session <i>Welcome; Plenary Presentation; ASCE Aerospace Overview</i> Four Square</p>	<p>10:20 - 16:40 • Room Duck, Duck, Goose is available for speaker practice; Room Kick the Can is available for Student Activities</p> <p>15:20 - 16:40 • Journal of Aerospace Engineering Meeting will be held in Room Red Rover</p>	
10:00	Break • Refreshments are available		
10:20	<p>Symposium 2 Excavation Systems Dodgeball</p>	<p>Symposium 3 Advanced Numerical Methods for Additive Manufacturing Red Rover</p>	<p>Symposium 5 Innovative Construction Techniques for Lunar and Martian Environments Hopscotch</p>
12:00	Lunch • On your own		
13:20	<p>Symposium 2 Water ISRU Systems Dodgeball</p>	<p>Symposium 3 General Applications of Advanced Materials and Structures Red Rover</p>	<p>Symposium 5 Lunar Habitats - Design, Analysis, and Construction Challenges Hopscotch</p>
15:00	Break • Refreshments are available		
15:20	<p>Symposium 1 Plume and Regolith Dynamics Keep Away</p>	<p>Symposium 2 Drilling and Penetrations Dodgeball</p>	<p>Symposium 5 Printing Methods and Materials: Applications for Lunar and Martian Construction Hopscotch</p>
17:00			
18:00	Opening Reception • Denver Museum of Nature and Science		
20:00			

Conference at a Glance

Wednesday • April 27

08:00	Plenary Session <i>Introduction; Plenary Presentation; Working in Aerospace during Covid</i> Four Square			10:20 - 16:40 • Room Duck, Duck, Goose is available for speaker practice; Room Kick the Can is available for Student Activities
10:00	Break • Refreshments are available			
10:20	Symposium 1 Granular Material Technology Keep Away	Symposium 2 Prospecting Red Rover	Student Finalist Presentations Session 1 Hopscotch	
12:00	Lunch • Four Square Ballroom			
13:20	Symposium 5 NASA's Breakthrough, Innovative, and Game-changing (BIG) Idea Challenge Student Team Presentations Keep Away	Symposium 2 Technologies for Space Exploration Dodgeball	Student Finalist Presentations Session 2 Red Rover	Symposium 5 Innovative Utilization and Harnessing of Indigenous Resources - Moon and Mars Hopscotch
15:00	Break • Refreshments are available			
15:20	Student Finalist Presentations Session 3 Keep Away	Symposium 2 ISRU Systems <i>(Ends at 17:20)</i> Dodgeball	Symposium 4 Sensing and Monitoring <i>(Ends at 17:20)</i> Red Rover	Symposium 5 Technical Requirements and AIT for Lunar and Planetary Systems <i>(Ends at 16:20)</i> Hopscotch
17:00	Student Competition Judging Keep Away			
18:00	Meeting Space Engineering and Construction Red Rover			
19:30	Meeting Aerospace Division Executive Committee (EXCOM) Red Rover			
20:30				

Conference at a Glance

Thursday • April 28

08:00	Plenary Session <i>Introduction; ASCE Future World Vision; Student Paper Finalist</i> Four Square			10:20 - 11:40 • Room Jax is available for Student Activities
10:00	Break • Refreshments are available			
10:20	Symposium 3 Ballistics and Crashworthiness Keep Away	Symposium 1 Simulants Patty Cake	Symposium 5 Recent Advances in Lunar and Deep Space Exploration Dodgeball	
11:40	Closing Remarks Four Square			
12:00				

When and Where	Meetings During the Conference
Monday • April 25 17:00 - 18:30 Hopscotch	Aerospace Division Executive Committee Meeting (EXCOM) A review of Division activities underway and planned. A review of Technical Committee activities and brainstorming of new activities the Division might undertake. Technical Committee members and Chairs are expected to attend.
Monday • April 25 18:30 - 19:30 Hopscotch	Advanced Materials and Structures Committee Promotes invention, dissemination and transfer of technology on advanced composite materials and structures.
Monday • April 25 18:30 - 19:30 Red Rover	Dynamics and Controls Committee Promotes research and technology transfer in the areas of structural dynamics, controls and smart structures.
Monday • April 25 19:30 - 20:30 Red Rover	Regolith Operations, Mobility and Robotics Committee Promotes the role of civil engineers in sensing and robotic technologies for application in construction, exploration, and resource extraction.
Wednesday • April 27 18:00 - 19:30 Hopscotch	Space Engineering and Construction Committee Review, evaluate, and report on advancements in engineering, construction, and operations on extraterrestrial planetary bodies and other extreme environments.
Wednesday • April 27 19:30 - 20:30 Hopscotch	Aerospace Division Executive Committee Meeting (EXCOM) A review of Technical Committee meetings, brainstorming, and plans for the next year. Technical Committee members and Chairs are expected to attend.

Floor Plans - Second Floor of The Curtis Hotel



2nd FLOOR

- Dodgeball
- Jax
- Keep Away
- Kick The Can
- Patty Cake

Floor Plans - Third Floor of The Curtis Hotel



Monday, April 25

09:00 (9:00 am)- 17:00 (5:00 pm)

Pre-Conference Short Course

Health Monitoring for Terrestrial and Space Based Environments

This short course is designed for engineers and researchers who are focused on various aspects of health monitoring. This morning session of the short course teaches the basics about machine learning algorithms and their applications to detecting structural connection looseness. Structural connections are commonly used in many engineering fields, such as aerospace, mechanical, energy, and civil engineering, among others. The afternoon session is focused on the health monitoring of spacecraft, experiments, human and machine interaction and the human itself. A series of presentations will be given to familiarize the attendee in the latest research on these topics. It is intended for engineers working in a wide range of disciplines including spacecraft design and manufacture, human factors, robotics and astronaut physical health.

Topics

- Machine Learning and Applications in Monitoring of Structural Connections Parts 1 and 2. Part 1 – Introduction to Machine Learning. Part 2 – Shallow Learning Methods and Applications of Monitoring Structural Connections
- Machine Learning and Applications in Monitoring of Structural Connections Part 3. Deep Learning Methods and Application in Monitoring of Structural Connections
- NASA Applications of Structural Health Monitoring Technology On-Orbit
- On Orbit Flight Testing of the Roll Out Solar Array (ROSA) – Methods and Results
- Making Sense of How Users Make Sense of Robots: Applications to Human-Robot Teaming in Space Environments
- Health Monitoring of Astronauts while on-orbit

Sponsored by: American Society of Civil Engineers (ASCE) Aerospace Division (ASD)

Duration (Estimate): Net 6.5 hours

Professional Development Credit: Attendees will receive 6.5 PDH from ASCE

Instructors

Gangbing Song Ph.D.
Professor of Mechanical Engineering, University of Houston

Bill Prosser Ph.D., NASA
Technical Fellow, NASA Engineering Safety Center (NESC)

Matthew Chamberlain Ph.D.,
Research Aerospace Engineer, NASA Langley Research Center

Tom Williams Ph.D.
Assistant Professor of Computer Science and Director of MIRRORLab, Colorado School of Mines

Allison Anderson Ph.D.
Assistant Professor Ann and H.J. Smead Aerospace Engineering Sciences, University of Colorado at Boulder

Keynote Speakers

Dr. Stephen K. Robinson, Ph.D.

Before joining the faculty at the University of California, Davis in 2012, Stephen Robinson spent 37 years at NASA, where he worked as a machinist, lab technician, engineer, research scientist, branch chief, safety representative, and astronaut. Robinson is now a tenured professor in the UC Davis Mechanical and Aerospace Engineering Department. He has recently been appointed Director of the UC Davis Center for Spaceflight Research.

Dr. Robinson also directs the UC Davis Human/Robotic/Vehicle Integration and Performance Lab, where graduate and undergraduate students pursue research in human spaceflight, spacecraft design for human health and safety, aviation safety, human/automation/robotic integration, human performance, automation and control, and CubeSat and UAV design.

During his 17 years as a NASA Astronaut, Dr. Robinson flew on four space shuttle missions, including three spacewalks, visited the ISS twice, trained in Star City, Russia, and has extensive expertise in spacecraft systems, human/systems integration, operational safety, space robotics, aerodynamics, and fluid physics.

Dr. Robinson has received numerous awards, including NASA's highest honor – the NASA Distinguished Service Medal, and UC Davis' highest honor – the UC Davis Medal. Robinson is a UC Davis alumnus in Mechanical and Aeronautical Engineering (double B.S., 1978) and received his M.S. and Ph.D. in turbulence physics from Stanford University in Mechanical and Aero/Astro Engineering (1986, 1990). Dr. Robinson is an active pilot, an artist, and a multi-instrument musician – he currently plays with the mostly-astronaut folk-music band Bandella, and the all-astronaut rock band Max Q.

Dr. Robinson's presentation is titled "*HOME-A NASA Research Institute for Semi-Autonomous Human Habitats in Deep Space*".



Melodie Yashar



Melodie Yashar is a design architect, technologist, and researcher. She is the Director of Building Design & Performance at ICON, a construction technologies company focused on large scale additive manufacturing for Earth and in space. Her department supports design and construction of dignified and resilient terrestrial housing solutions, in addition to supporting the development of ICON's off-world construction systems. Melodie teaches undergraduate and graduate design studios at Art Center College of Design. In previous roles Melodie was a Senior Research Associate with the Human Systems Integration Division at NASA Ames via San Jose State University Research Foundation (SJSURF), as well as a co-founder of Space Exploration Architecture (SEArch+), a research group developing human supporting designs for space exploration. Her background is in industrial design, architecture, and human-computer interaction with an emphasis in robotics.

Melodie Yashar's presentation is titled "*Space Architecture & Spatial Design: The Future of Construction Beyond Earth*".

Keynote Speakers

Gerald (Jerry) Buckwalter

Jerry Buckwalter is the Chief Innovation Officer of ASCE. In that role, he helps to shape the strategic direction of the association and the civil engineering profession. Jerry has been a member of the ASCE Industry Leaders Council from 2006 to the present. He also directs a forward-leaning strategic project called Future World Vision where ASCE is creating a virtual and interactive computer model to assess potential built environments 50 years into the future.

With over 35 years of experience, Jerry came to ASCE from Northrop Grumman, where he most recently served as Director of Corporate Strategy. He was a member of the National Infrastructure Advisory Council for four years reporting to the White House from 2008 to 2012. Jerry earned a bachelor's degree in physics from Monmouth University and completed advanced coursework at George Washington University and the Massachusetts Institute of Technology, and he has been teaching strategy at the University of Chicago for eight years

Jerry's presentation is titled "ASCE Future World Vision".



Columbia Medal Awarded to Steven Squyres in 2022



The Columbia Medal was awarded in 2022 to **Steven W. Squyres, Ph.D., Aff.M.ASCE**. Congratulations to Dr. Squyres!

Steve Squyres is Chief Scientist for Blue Origin, a private space company building the foundation for millions of people living and working in space. His responsibilities extend into all areas where Blue Origin's activities intersect with science. Steve came to Blue Origin from Cornell University, where he was the James A. Weeks Professor of Physical Sciences. For almost twenty years he was scientific Principal Investigator for NASA's Mars Exploration Rover (MER) Project, leading payload development and science operations for the rovers Spirit and Opportunity.

Steve received his Ph.D. from Cornell in 1981 and spent five years at NASA's Ames Research Center before returning to Cornell as a faculty member. In addition to MER, he participated in the Voyager mission to Jupiter and Saturn, the Magellan mission to Venus, and many more.

The Columbia Medal was initiated in 1982 by the Aerospace Division (ASD) of the American Society of Civil Engineers (ASCE) to commemorate the first earth orbital flight of the United States Space Shuttle Orbiter, Columbia, which opened a new technological era for mankind through the peaceful utilization of space. The medal also honors the astronauts who perished in the tragic demise of the Columbia on February 1, 2003. The Columbia medal is awarded to a member who has made notable contributions relating to the conception, planning, and/or execution of an important project related to the mission of the Division; long years of distinguished service in private academic, industrial and/or Government sectors; or other specific actions which have served to advance the practice of civil engineering through the application of aerospace engineering, sciences and technology.

Aerospace Division Award Winners

ASCE Journal of Aerospace Engineering 2021

Best paper award: “Understanding Flow Characteristics in Metal Additive Manufacturing” by Carl R. Hartsfield, Travis E. Shelton, Gregory R. Cobb, Ryan A. Kemnitz and Joseph Weber (Air Force Institute of Technology, USA).

Honorable mention: “Lunar Production System for Extracting Oxygen from Regolith” by Diane L. Linne, Jason M. Schuler, Laurent Sibille, Julie E. Kleinhenz, Anthony J. Colozza, Homer J. Fincannon, Steven R. Oleson, Nantel H. Suzuki and Landon Moore (NASA Glenn Research Center, NASA Kennedy Space Center, USA)

Aerospace Division – Outstanding Professional Service Award

2020 – Alaina Roberts, PE

2021 - Peter Visscher, Canadensys Aerospace, Ontario, CA

Aerospace Division – Outstanding Technical Contribution Award

2020 – Dr. Dan Britt, University of Central Florida, Orlando, FL

2021 – Dr. Kin F. Man, NASA JPL, Pasadena, CA

Availability of Presentation Abstracts

Abstracts for most of the presentations made at Earth and Space 2022 will be available on the internet at the address shown below:

<https://learn.mines.edu/earthspace2022>

Earth and Space 2022 Conference Agenda

M O N D A Y • A P R I L 2 5

08:15 - 08:45

Outside Four Square Ballroom (3rd Floor)

Short Course Check-in

08:45 - 17:00

Hopscotch

Short Course :: Health Monitoring for Terrestrial and Space Based Environments

15:00 - 18:00

Outside Four Square Ballroom

Conference Check-in

17:00 - 18:30

Hopscotch

Meeting :: Aerospace Division Executive Committee (EXCOM)

18:30 - 19:30

Hopscotch

Meeting :: Advanced Materials and Structures Committee

18:30 - 19:30

Red Rover

Meeting :: Dynamics and Controls Committee

19:30 - 20:30

Red Rover

Meeting :: Regolith Operations, Mobility and Robotics

T U E S D A Y • A P R I L 2 6

07:30 - 08:00

Outside Four Square Ballroom (3rd Floor)

Check-in and Late Registration

08:00 - 08:20

Four Square Ballroom

Welcome: Christopher Dreyer :: *Colorado School of Mines* and Justin Littell :: *NASA Langley, Research Center*

08:20 - 09:20

Four Square Ballroom

Keynote Speaker: Dr. Stephen K. Robinson :: *University of California - Davis*

Presentation: HOME-A NASA Research Institute for Semi-Autonomous Human Habitats in Deep Space

09:20 - 10:00

Four Square Ballroom

ASCE Aerospace Division Overview

Robert Goldberg :: *NASA Glenn Research Center*, Lindsay O'Leary :: *ASCE*, Chris Dreyer :: *Colorado School of Mines*, Justin Littell :: *NASA Langley Research Center*

10:00 - 10:20

Lobby on Floors 2 and 3

Break • Refreshments are available

10:20 - 12:00

Dodgeball

Symposium 2: Excavation Systems

Chairs: Rob Mueller :: *NASA Kennedy Space Center* and Hunter Williams :: *Honeybee Robotics*

10:20	A Review of Extra-Terrestrial Regolith Excavation	Rob Mueller :: <i>NASA Kennedy Space Center, Swamp Works</i>
10:40	ISRU Pilot Excavator: Bucket drum scaling experimental results	Jason Schuler :: <i>NASA - Kennedy Space Center</i>
11:00	Testing of a Bucket Ladder Excavation Mechanism for Lunar Applications	Marcello Guadagno :: <i>Michigan Technological University</i>
11:20	Discrete Element Method and Multi-body Dynamics Co-simulation Framework for Regolith-Tool Interaction Modeling	Daniel Gaines :: <i>Glenn Department of Civil Engineering, Clemson University</i>
11:40	Rock Breaking Techniques using High Concentrated Energy Sources for Space Mining Applications	Matthew Dietz :: <i>South Dakota School of Mines and Technology</i>

10:20 - 12:00

Red Rover

Symposium 3: Advanced Numerical Methods for Additive

Manufacturing Chair: Arif Masud :: *University of Illinois at Urbana-Champaign*

10:20	Tuning Behavior of Alkali-Activated Materials for Extreme Environments	Nishant Garg :: <i>University Of Illinois At Urbana-Champaign</i>
10:40	A Compact Delayed Photocurrent Model Based on a Reduced Order Data-Driven Exponential Time Integrator	Pavel Bochev :: <i>Sandia National Laboratories</i>
11:00	PhyCRNet: Physics-informed Convolutional-Recurrent Network for Solving Spatiotemporal PDEs	Pu Ren :: <i>Northeastern University</i>
11:20	A Mixture Model for Hydration and Curing in Process Modeling and Additive Manufacturing with Cementitious Materials	Arif Masud :: <i>University of Illinois at Urbana-Champaign</i>

10:20 - 12:00

Hopscotch

Symposium 5: Innovative Construction Techniques for Lunar and Martian Environments

Chairs: Olga Bannova :: *University of Houston* and Christopher Oze :: *Occidental College*

10:20	Stone, Brick and Concrete Masonry on Mars	Peter Carrato :: <i>Bechtel Corp</i>
10:40	Structural and durability properties of MgO-Al ₂ SiO ₃ concrete for ISRU Martian construction	Christopher Oze :: <i>Occidental College</i>
11:00	Metamodels for rapid analysis of large sets of building designs for robotic constructability - Technology demonstration using the NASA 3D Printed Mars Habitat Challenge	Naveen Kumar Muthumanickam :: <i>National Renewable Energy Laboratory (NREL); Pennsylvania State University</i>

11:20 Lunar Demandite - You Gotta Make This Using Nothing but That Alex Ellery :: *Carleton University*

12:00 - 13:20

Lunch (On your own)

13:20 - 15:00

Dodgeball

Symposium 2: Water ISRU Systems

Chairs: Aaron Paz :: *NASA Johnson Space Center* and Laurent Sibille :: *Southeastern Universities Research Association (SURA)*

13:20 Influence of ice distribution on thermal mining performance and strategies to counter sublimation lag Tomasz Gordon Wasilewski :: *Astronika Sp. z o. o.*

13:40 Liberation of Mineral-bound Water of the Meridiani Planum Driven by Process Heat from Carbonylation Steel-making and Concentrated Photovoltaic Electricity Generation Rif Miles Olsen :: *Two Planet Steel*

14:00 Redwater: Extraction of Water from Mars' Ice Deposits Joey Palmowski :: *Honeybee Robotics*

14:20 Commissioning and Testing a New Dusty Thermal Vacuum Chamber with inclusion of Icy Regolith Ben Wiegand :: *Michigan Technological University*
Marcello Guadagno :: *Michigan Technological University*

13:20 - 15:00

Red Rover

Symposium 3: General Applications of Advanced Materials and Structures

Chair: Hongyu Zhou :: *University of Tennessee Knoxville*

13:20 A mixed interface-capturing/interface-tracking formulation of thermal multi-phase flows for metal additive manufacturing processes Jinhui Yan :: *University Of Illinois At Urbana-champaign*

13:40 Thermal Analysis of Laminated Plates Using Quasi-Three-Dimensional Theory Param Gajbhiye :: *Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat 395007, India.*

14:00 Prediction of Fracture Location of Duplex Stainless Steel Welds Carolina Payares-Asprino :: *Norwich University, USA, School of Engineering*

14:20 Turk Salty Concrete –TSC- Can Isolate the freshwater interface against the Sea water Intrusion and Salty Formations Afshin Turk :: *Ministry Of Power, KWPA*

13:20 - 15:00

Hopscotch

Symposium 5: Lunar Habitats - Design, Analysis, and Construction Challenges

Chairs: Ramesh B. Malla, Ph.D., F. ASCE, F. EMI, A.F. AIAA :: *University of Connecticut* and Sarah Seitz :: *NASA Ames Research Center*

13:20 Lunar Base Construction Planning Rob Mueller :: *NASA Kennedy Space Center, Swamp Works*

13:40 Development of lunar structural design criteria using terrestrial design practices and interpreted lunar conditions Laurent Sibille :: *Southeastern Universities Research Association (SURA) / Kennedy Space Center Swamp Works*

14:00 Building on the Moon- Methods for Structural Validation and Architectural Design Implications Stephen Pfund :: *LERA Consulting Structural Engineers*
David Malott :: *AI SpaceFactory*

14:20	Minimal lunar infrastructure to facilitate the construction of sustainable structures.	Richard Spolzino :: <i>University of Houston, SICSA</i>
14:40	Mixed Reality (XR) as a validation method for digital modeling of space habitats	Olga Bannova :: <i>University Of Houston/Cullen College of Engineering/SICSA</i>

15:00 - 15:20

Lobby on Floors 2 and 3

Break • Refreshments are available

15:20 - 17:00

Keep Away

Symposium 1: Plume and Regolith Dynamics

Chairs: Mark Wittal :: *NASA Kennedy Space Center* and Travis Vazansky :: *Masten Space Systems*

15:20	Discrete element modeling of drilling process into the lunar regolith simulants of JSC-1A	Jesus Badal :: <i>University of the District of Columbia</i>
15:40	Mapping Lunar Lander Plume Ejecta Trajectories to Lunar Surface Elevations	Daniel Batcheldor :: <i>Southeastern Universities Research Association</i>
16:00	Demonstration of Capability to Simulate Particle Irregular Shape and Poly-Disperse Mixtures Within Lunar Lander Plume-Surface Interaction Computational Model	Peter Liever :: <i>Jacobs Space Exploration Group, NASA MSFC</i>

15:20 - 17:00

Dodgeball

Symposium 2: Drilling and Penetrations

Chairs: Brian Glass :: *NASA Ames Research Center* and Joey Palmowski :: *Honeybee Robotics*

15:20	Penetration Analysis of High-Frequency Vibro-based Probes in Granular Materials Using the Discrete Element Method	Pooneh Maghoul :: <i>Polytechnique Montréal; University of Manitoba</i>
15:40	TRIDENT Drill for VIPER and PRIME-1 Missions to the Moon	Kris Zacny :: <i>Honeybee Robotics</i>
16:00	Repurposing Drilling Control Diagnostics for Subsurface Edge Detection and Boundary Advisement During Planetary Drilling	Brian Glass :: <i>NASA Ames Research Center</i>
16:20	SMART: Instrumented Drill for ISRU Investigations on the Moon	Leo Stolov :: <i>Honeybee Robotics</i>
16:40	Break The Ice Lunar Challenge Overview and Current Status	Kurt Leucht :: <i>NASA, Centennial Challenges Program</i>

15:20 - 17:00

Hopscotch

Symposium 5: 3D Printing Methods and Materials: Applications for Lunar and Martian Construction

Chairs: Peter Carrato :: *Bechtel Corp.* and Ali Kazemian :: *Louisiana State University*

15:20	Planetary Construction 3D Printing Using Lunar and Martian In-Situ Materials	Ali Kazemian :: <i>Louisiana State University</i>
15:40	Mars Dune Alpha: A 3D-Printed Habitat by ICON / BIG for NASA'S Crew Health and Performance Exploration Analog (CHAPEA)	Melodie Yashar :: <i>ICON</i> Jason Ballard :: <i>ICON</i>
16:00	A Review of Additive Manufacturing Technologies for Planetary Constructions	Vittorio Netti :: <i>Politecnico Di Bari</i>
16:20	Is in-situ electronics fabrication feasible on the moon?	Alex Ellery :: <i>Carleton University</i>

15:20- 16:40

Red Rover

Meeting :: Journal of Aerospace Engineering

18:00 - 20:00

Denver Museum of Nature and Science

Opening Reception • Transportation by bus from hotel to museum is available. See Page 3 for full information.

W E D N E S D A Y • A P R I L 2 7

08:00 - 08:20

Four Square Ballroom

Welcome: Christopher Dreyer, *Colorado School of Mines* and Justin Littell, *NASA Langley, Research Center*

08:20 - 09:20

Four Square Ballroom

Keynote Speaker: Melodie Yashar :: *ICON*

Presentation: *Space Architecture & Spatial Design: The Future of Construction Beyond Earth*

09:20 - 10:00

Four Square Ballroom

Moderated Discussion: Working in the Aerospace industry in the times of COVID

Moderator: Robert Goldberg :: *NASA Glenn Research Center*

10:00 - 10:20

Lobby on Floors 2 and 3

Break • Refreshments are available

10:20 - 12:00

Keep Away

Symposium 1: Granular Material Technology

Chairs: Chris Dreyer :: *Colorado School of Mines* and Dhaka Sapkota :: *University of Central Florida*

10:20	Uniform Dust Deposition System for Testing Dust Mitigation Technologies	Stephen Gerds :: <i>NASA</i>
10:40	Power Measurements to Excavate Lunar Soil Simulant GRC-3B Using Arc Backhoe Trajectories	Margaret Proctor :: <i>NASA Glenn Research Center</i>
11:00	RTG Radiator Efficiency in the Presence of Lunar Dust	Matthew Wittal :: <i>NASA Kennedy Space Center</i>
11:20	Traction of Interlocking Spikes on a Granular Material	Volker Nannen :: <i>sedewa.com</i>
11:40	Magnetic and Microwave Susceptibilities of Lunar Simulants and Their Constituents for Use in Creating Building Materials via Beneficiation	Dhaka Sapkota :: <i>University Of Central Florida</i>

10:20 - 12:00

Red Rover

Symposium 2: Prospecting

Chairs: Kris Zacny :: *Honeybee Robotics* and Leo Stolov :: *Honeybee Robotics*

10:20	Volatile Prospecting through Thermal Properties of Subsurface Icy Regolith	Curtis Purrington :: <i>Colorado School of Mines</i>
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10:40	Site Characterization for the RedWater ISRU System	Aaron Russell :: <i>Planetary Science Institute</i>
11:00	Field Testing of Simulated Lunar Ice Characterization using Ground Penetrating Radar Technology	Caleb Kaminski :: <i>Michigan Technological University</i>
11:20	SPARTA-A New Geotechnical Tool for Subsurface Exploration	Robert Anderson :: <i>Nasa JPL/California Institute of Technology</i>
11:40	Some Key Explorations in Planetary Rover Autonomy for ISRU Roles on the Moon	Alex Ellery :: <i>Carleton University</i>

10:20 - 12:00

Hopscotch

Student Finalist Presentations Session 1

Chairs: Krzysztof Skonieczny :: *Concordia University* and Robert Goldberg :: *NASA Glenn Research Center*

10:20	Investigation of Martian Concrete: Pumpability and Strength for Extraterrestrial 3D Printing	Courtney Keys :: <i>Bradley University</i> Noah McCorkhill :: <i>Bradley University</i>
10:40	Systems Engineering of Using Sandbags for Site Preparation and Shelter Design for a Modular Lunar Base	Athip Thirupathi Raj :: <i>University of Arizona - SpaceTReX</i>
11:00	Applying Architectural Design and Construction Principles to Lunar and Martian Construction	Erin Brayley :: <i>Texas A&M University; Jacobs Wyper Architects</i>
11:20	Diurnal Temperature Variation on an Intact and Damaged Lunar Habitat Structure	Sachin Tripathi :: <i>University of Connecticut</i>

12:00 - 13:20

Four Square Ballroom

Awards Luncheon • All Conference attendees are invited

13:20 - 15:00

Keep Away

Symposium 5: NASA's Breakthrough, Innovative, and Game-changing (BIG) Idea Challenge Student Team Presentations

Chairs: Ramesh B. Malla, Ph.D., F. ASCE, F. EMI, A.F. AIAA :: *University of Connecticut* and Gerald Sanders :: *NASA Johnson Space Center*

13:20	Morphing Tank-to-Leg Modality for Exploratory Lunar Vehicles (NASA 2022 BIG Idea Challenge)	Matthew Silverman :: <i>University of Connecticut</i> Hritish Bhargava :: <i>University of Connecticut</i> Kalin Kochnev :: <i>University of Connecticut</i> Emily Rondeau :: <i>University of Connecticut</i> Theresa Nosel :: <i>University of Connecticut</i>
13:40	Contaminant Ultrasonic Removal via Vibration Ejection from Solar Cells (NASA 2021 BIG Idea Challenge)	Jeremiah Rittenhouse :: <i>Missouri University of Science and Technology</i>
14:00	Lunar In-Situ Landing/Launch Environment (LILL-E) Pad (NASA 2021 BIG Idea Challenge)	David Purcell :: <i>Colorado School of Mines</i>
14:20	T-REX: Tethered - permanently shadowed Region Explorer (NASA 2020 BIG Idea Challenge)	Marcello Guadagno :: <i>Michigan Technological University</i>
14:40	LASER: Lunar Autonomous Scalable Emitter and Receiver (NASA 2020 BIG Idea Challenge)	Ross Centers :: <i>Colorado School of Mines</i>

13:20 - 15:00

Dodgeball

Symposium 2: Technologies for Space Exploration

Chairs: Paul van Susante :: *Michigan Technological University* and Marcello Guadagno :: *Michigan Technological University*

13:20	Method for Thermal Modeling and Volatile Measurement of Lunar Regolith	Travis Wavrunek :: <i>Michigan Technological University</i> George Johnson :: <i>Michigan Technological University</i> Anurag Rajan :: <i>Michigan Technological University</i>
13:40	NASA Science Programs to Develop Technologies for Ocean Worlds Exploration	Carolyn Mercer :: <i>NASA Glenn Research Center</i>
14:00	Lateral Stability of Vehicle with Interlocking Spikes	Volker Nannen :: <i>sedewa.com</i>
14:20	Overview of SLOPE Laboratory Testing Capabilities for Planetary Mobility and Traction Studies at NASA Glenn Research Center	Erin Rezich :: <i>NASA Glenn Research Center</i>

13:20 - 15:00

Red Rover

Student Finalist Presentations Session 2

Chairs: Krzysztof Skonieczny :: *Concordia University* and Robert Goldberg :: *NASA Glenn Research Center*

13:20	A Novel Partitioned Approach for Reduced Order Model - Finite Element Model (ROM-FEM) and ROM-ROM Coupling	Amy de Castro :: <i>Clemson University; Sandia National Laboratories</i>
13:40	Risk-Based Structural Optimization Framework for Connected Structural System Subjected to Extreme Events	William Hughes :: <i>University of Connecticut Department of Civil and Environmental Engineering</i>
14:00	Seismic and Resilient Property Analysis of SMA Property-based Replaceable BRBs	Qiuyu Pan :: <i>Shenyang Jianzhu University</i>
14:20	Seismic Evaluation of Lava Tubes Subjected to Moonquakes	Hamed Seifamiri :: <i>Polytechnique Montreal</i>

13:20 - 15:00

Hopscotch

Symposium 5: Innovative Utilization and Harnessing of Indigenous Resources- Moon and Mars

Chairs: Yong-Rak Kim :: *Texas A & M University* and Naveen Kumar Muthumanickam :: *National Renewable Energy Laboratory*

13:20	Microwave Sintering of a Lunar Regolith Simulant for ISRU Construction: Multiscale Characterization and Finite Element Simulation	Shayan Gholami :: <i>Texas A&M University</i> Yong-Rak Kim :: <i>Texas A&M University</i>
13:40	In-situ Lunar Launch and Landing Pad Construction with Regolith-Thermoset Polymer Composite Materials	Nathan Gelino :: <i>NASA, Kennedy Space Center</i>
14:00	Playing with DIRT: Building the Framework for a Comprehensive In-Situ Soil Materials Testing Database	Sarah Seitz :: <i>NASA - Ames Research Center</i>
14:20	Solar Power Satellites - Rotary Joints, Magnetrons and All - From Lunar Resources?	Alex Ellery :: <i>Carleton University</i>

15:00 - 15:20

Lobby on Floors 2 and 3

Break • Refreshments are available

15:20 - 17:00**Keep Away****Student Finalist Presentations Session 3****Chairs: Krzysztof Skonieczny :: Concordia University and Robert Goldberg :: NASA Glenn Research Center**

15:20	The Specialized Penetrometer Instrument: SAMPLR and Beyond	Ben Thrift :: Colorado School Of Mines
15:40	Experimentally evaluating granular scaling laws for predicting lunar-gravity wheel performance in cohesive regolith	Adriana Daca :: Concordia University
16:00	Rapid Extraction of Volatiles from Excavated Icy Regolith using a Rotary Extraction Drum	Curtis Purrington :: Colorado School of Mines; Austere Engineering
16:20	Local Resource Utilization of Lunar Regolith for Manufacturing at the Point-of-Need of Metal Matrix Composites	Jessica Lopez :: University Of Alabama
16:40	Static and Kinetic Friction Coefficients for Regolith Delivery into a Molten Regolith Electrolysis Reactor	Jason Noe :: Michigan Technological University

15:20 - 17:00**Dodgeball****Symposium 2: ISRU Systems****Chairs: Jerry Sanders :: NASA Johnson Space Center and Jason Schuler :: NASA Kennedy Space Center**

15:20	Molten Regolith Electrolysis using Concentrated Solar Heating	Hunter Williams :: Honeybee Robotics
15:40	Ablative Arc Mining for In-Situ Resource Utilization	Amelia Greig :: The University Of Texas At El Paso
16:00	Leaching of Lunar regolith for synthetic phyllosilicates on the Moon	David Karl :: Technische Universitaet Berlin
16:20	Practical Space Resource Utilization at the Hundred Megatonne Scale: Enabling a Planetary Sunshade to Reverse Global Warming	Elizabeth Scott :: Colorado School of Mines; Planetary Sunshade Foundation
16:40	Analysis of Sintered Hawaiian Basalt Building Blocks for Landing Pad Use and Recommendations for Improvement	Chase Dickson :: Texas A&m University
17:00	Puli Lunar Water Snooper: a lightweight, low cost COTS-based water ice prospecting instrument	Tibor Pacher :: Puli Space Technologies

15:20 - 17:00**Red Rover****Symposium 4: Sensing and Monitoring****Chairs: Gangbing Song :: University of Houston and Wei Zhang :: University of Connecticut**

15:20	Detection of Corrosion-induced Damage in Bolted Steel Structure Using Piezoceramic Transducers	WEN-I LIAO :: National Taipei University of Technology
15:40	Examination of Smart Sandbags for Semi-Permanent Structures on the Lunar Surface	Yinan Xu :: University of Arizona - SpaceTReX
16:00	Automatic Reading Method for Pointer Meter Based on Computer Vision	Weijin Xu :: State Grid Changchun Power Supply Company
16:20	Identification method for displacement of substation structure based on machine vision	Weijin Xu :: State Grid Changchun Power Supply Company
16:40	Viability of Construction Material within an Extraterrestrial Environment	Linda Kuster :: Air Force Institute of Technology
17:00	Modeling and Analysis of a Nonlinear Locally Resonant Metamaterial with Inductance Shunt	Arun Malla :: Virginia Tech

15:20 - 17:00

Hopscotch

Symposium 5: Technical Requirements and AIT for Lunar and Planetary Systems

Chairs: Nathan Gelino :: *NASA Kennedy Space Center* and Melodie Yashar :: *ICON*

15:20	A summary of technical requirements, environmental factors and loading for lunar infrastructure	Nerma Caluk :: <i>Florida International University</i>
15:40	Turkish Lunar Soil Simulant TBG-1	Yusuf Cengiz TOKLU :: <i>Beykent University</i>
16:00	Design, Development, and In Situ Testing of Lunar Technologies	Allison Goode :: <i>Aegis Aerospace</i>

17:00 - 18:00

Keep Away

Student Competition Judging

18:00 - 19:30

Red Rover

Meeting :: Space Engineering and Construction

19:30 - 20:30

Red Rover

Meeting :: Aerospace Division Executive Committee (EXCOM)

T H U R S D A Y • A P R I L 2 8

08:00 - 08:20

Four Square Ballroom

Welcome: Christopher Dreyer :: *Colorado School of Mines* and Justin Littell :: *NASA Langley, Research Center*

08:20 - 09:20

Four Square Ballroom

Keynote Speaker: Gerald Buckwalter :: *ASCE*

Presentation: *ASCE Future World Vision*

09:20 - 10:00

Four Square Ballroom

Student Paper Competition Award Ceremony

Hosts: Robert Goldberg :: *NASA Glenn Research Center* and Chris Skonieczny :: *Concordia University*

10:00 - 10:20

Lobby on Floors 2 and 3

Break • Refreshments are available

10:20 - 11:20

Keep Away

Symposium 3: Ballistics and Crashworthiness

Chair: Justin Littell :: *NASA Langley Research Center*

10:20	Lessons Learned and Best Practices for Utilizing a Generalized Composite Impact Model	Robert Goldberg :: <i>NASA Glenn Research Center</i>
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10:40	Study of Aircraft Structural Response and Occupant Loading During a Water Ditching Event Utilizing LS-DYNA Simulation	Jacob Putnam :: <i>NASA Langley Research Center</i>
11:00	Ballistic Impact Simulations of a Titanium 6Al-4V Generic Fan Blade Fragment on an Aluminum 2024 Panel Using *MAT_224 in LS-DYNA	Chung-kyu Park :: <i>George Mason University</i>

10:20 - 11:40

Patty Cake

Symposium 1: Simulants

Chairs: Chris Dreyer :: *Colorado School of Mines* and Daniel Britt :: *University of Central Florida*

10:20	Applicability of Simulants in Developing Lunar Systems and Infrastructure: Geotechnical Properties of Lunar Highlands Simulant LHS-1	Jared Long-Fox :: <i>University Of Central Florida - Department of Physics</i>
10:40	Lunar Dust Simulants and Their Applications	Alexander Madison :: <i>Exolith Lab, University of Central Florida; The Center for Lunar and Asteroid Surface Science, University of Central Florida; University of Central Florida, Department of Physics</i>
11:00	Granular Mechanics of JSC-1 Mars Regolith Simulants	Reza Ashtiani :: <i>The US Air Force Academy (USAFA)</i>
11:20	Geometrical Characteristics of Lunar & Martian Regolith Simulants	Caleb Carnes :: <i>Air Force Academy</i>

10:20 - 11:20

Dodgeball

Symposium 5: Recent Advances in Lunar and Deep Space Exploration

Chairs: Melissa Sampson and Ramiro Besada :: *Burns & McDonnell*

10:20	Metal Oxidation Warming System to Provide Thermal and Electrical Power for Surviving Lunar Nights	Matthew Kuhns :: <i>Masten Space Systems</i>
10:40	ISPACE'S 2022, 2023, and 2024 Missions and Future Commercial Capabilities	Kyle Acierno :: <i>Ispace Us</i>
11:00	Air Pressure and Temperature Distribution within a Dome Habitat Structure on the Lunar Surface	Jeffrey Steiner :: <i>University Of Connecticut</i>

11:40 - 12:00

Four Square Ballroom

Closing Remarks

Venue Information

The Curtis Hotel
1405 Curtis Street
Denver, Colorado 80202
Telephone: 303.571.0300
Fax: 303.825.4301
Website: <http://www.thecurtis.com>

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