

Accelerating Space Commerce, Exploration, and New Discovery Conference (ASCEND 2023)

Las Vegas, Nevada, USA
23 – 25 October 2023

Volume 1 of 4

ISBN: 978-1-7138-8608-2

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 34922 Uwytkug'Xcmg{'Ftkxg.'Uwky'422, Reston, VA 20191, USA.

TABLE OF CONTENTS

VOLUME 1

INVESTMENT AND FINANCING APPROACHES

Private Entities as Actors in Regional Space Governance Organizations.....	1
<i>Alyson C. Decker</i>	
Start-Up Space: Update on Record Investment and Global Trends in Commercial Space Ventures and Its Implications on the Expansion of Space Commerce.....	10
<i>Carissa B. Christensen, Brian Dunn, Hanh Nguyen Le , Ryan Puleo, Carie Mullins</i>	
The Spacescape: Understanding the Trends and Breath of Investment in the Space Industry and Exploring Impacts on the Industry and Society.....	29
<i>Emma M. Louden, Rachel Venn, Eli Bennett, Carie Mullins, Carissa B. Christensen</i>	
Valley of Death Survival Tips: Transitioning Commercial Space Technologies to Defense Programs	40
<i>Karen L. Jones</i>	
Is Investment into Infrastructure Needed to Achieve Affordable Space Launch?	53
<i>Phil L. Swan</i>	

ARTEMIS EFFORTS AND LESSONS LEARNED

Replication of Segments of STS-94 as a Lunar Surface Mission	65
<i>Robert L. Howard, Ruthan Lewis</i>	
Artemis and Ethics Workshop Lessons Learned	83
<i>Katherine T. McBrayer, Zachary Pirtle</i>	
Surface Engineering Polymeric Materials Towards Lunar Dust Mitigation.....	95
<i>Keith Gordon, Lopamundra Das, Christopher Wohl, Glen King, Valerie Wiesner, Jonathan Hernandez</i>	
USC CHASE II - Commercial Human Spaceflight Expeditions Part I – Artemis Rising	101
<i>Madhu Thangavelu</i>	
On the Health Management of ARTEMIS Operations: Lunar Dust Mitigation	129
<i>Ronald H. Freeman</i>	

FUTURE PLANS FOR MISSIONS

Roadmap to the Moon	136
<i>James L. Green, Doug Cooke, Arthur W. Beckman, Kristine M. Ramos</i>	
CAPSTONE: Mission Updates and Ongoing Efforts at the Moon.....	148
<i>Thomas Gardner, Bradley Cheetham, Miekka Clarkson</i>	
System-Of-Systems Analysis Approach to Establishing Lunar Infrastructure	162
<i>Luis F. Carrio, Rowan Palmer, Austin Lillard, Sommer Hilliard, Jesse Morzel, Alice Harvey, Nathan Ball, Ariel Gebhardt, Harley Dietz, Timothy Cichan</i>	

SPACE MEDICINE AND HUMAN HEALTH

Using Analog Astronautics to Advance Human Mars Exploration.....	194
<i>Kshitij Mall, Adriana Brown, Mason Kuhn, Ariel Black, Kenneth A. Pritchard, Madelyn Whitaker, Megan Rush, Cesare Guariniello, Marshall Porterfield, Daniel DeLaurentis</i>	
Commercial Space Rescue Vehicle Reentry Concepts of Operation Using Six Degree-Of-Freedom Analysis.....	209
<i>Benjamin Johnis</i>	
Design Considerations for LTV HITL Testing of Pressurized Suited Crew on a Motion-Based Platform.....	227
<i>Robert L. Howard, Harry L. Litaker, Mark Cramer, Athena Frangoudis, Sarah Margerum, Nadia Scharunovych</i>	
Habitability Insights from Selected NASA Habitat Mockup Testing Campaigns	237
<i>Robert L. Howard, Harry L. Litaker, Vicky E. Byrne</i>	

SPACE RESOURCE STEWARDSHIP I

Logistics Rates and Assumptions for Future Human Spaceflight Missions Beyond LEO	282
<i>Chase Lynch, Kandyce E. Goodliff, Chel Stromgren, Jon Vega, Michael K. Ewert</i>	
Take Material to Space Or Make it There?.....	301
<i>Harry W. Jones</i>	
Minerva Station: An Orbital Gateway Station to Support the Long-Term Human Exploration of Mars.....	309
<i>Roberto Rodríguez Otero, Jay K. Ainslie, Francisco Pacheco, Francisco Pico, Sofia Gaston, Lisa K. Johnson</i>	
Assessing Configurations for a Cryogenic Propellant Depot	352
<i>Thomas M. Perrin</i>	
Lunar Mining and Processing: Considerations for Responsible Space Mining & Connections to Terrestrial Mining.....	368
<i>Gerald B. Sanders, Julie E. Kleinhenz, Dale Boucher</i>	

TECHNOLOGIES FOR SURFACE OPERATIONS, CONSTRUCTION AND INFRASTRUCTURE

Scenario-Based Uncertainty Quantification for Optical Link Analysis.....	390
<i>Julia Milton, Daniel E. Hastings</i>	
Lunar Site Preparation Requirements for Construction of Infrastructure Elements	411
<i>Ian Jehn, Christopher B. Dreyer, Paul J. van Susante, Joe Primeau</i>	
Concepts for the Liquefaction of Hydrogen for In-Situ Operations on the Lunar Or Martian Surface	423
<i>Wesley L. Johnson</i>	
Low Mass Method for Lunar Regolith Surface Compaction.....	436
<i>Charles Carey, Robin Austerberry, Parker Bradshaw, Paul J. van Susante</i>	

ORBITAL DEBRIS MITIGATIONS I

Orbital Debris Encounter Estimation for International Space Station Orbit Companion Satellites	441
<i>Patrick Williams, Imraan Faruque</i>	
Air-Breathing Orbital Navigator for Active Debris Removal.....	452
<i>John T. Slough</i>	
Industry/Academic Collaboration in Efficient Orbit Debris Removal	461
<i>Dennis S. Lee</i>	
Preliminary Modeling of Not-Trackable Debris Collection Using a Passive Layered System	473
<i>Paula do Vale Pereira, Joao L. Silva Cotta, Jacob Mesley, Rodrigo Alarcon</i>	
ADR Mission Analysis Utilizing Nodal Precession	479
<i>Stanley Smeltzer, Nathan Wagner</i>	

SPACE ACCESS & SAFE OPERATIONS

PRO-Based Trajectory Planning for Spacecraft Close-Distance Flight Around a Client Satellite for Proximity Operations.....	490
<i>Dylan Roach, Andrew L. Barth, Ou Ma, Alex Fleming, Michael Hernandez</i>	
Determining Predicted Trajectory Accuracy Requirements to Reduce the Aviation Impact of Space Launch and Reentry Operations	509
<i>Tim Gruber, Lesley A. Weitz, Nicholas Rozen</i>	
Interplanetary Terminal Procedure Design Applied to Lunar Landing.....	531
<i>David Zahn</i>	
Advancing Utilization of Spacecraft Swarms for Sample Return, Multipoint Observation and Space Traffic Management Using Inflatables	543
<i>Massimo Biella, Vivek Verma, Leonard D. Vance, Athip Thirupathi Raj, Sivaperuman Muniyasamy, Jekan Thangavelautham</i>	
Cislunar Orbit Determination Via Intercepted Communication Signals.....	555
<i>Stef Crum, Brian C. Gunter</i>	

SPACE RESOURCES IN SUPPORT OF PAST AND CURRENT COMMERCIAL SPACE VENTURES

Parameterizing the Energy Cost of Establishing Mining Outposts on Asteroids.....	575
<i>Korbin Hansen, Jekan Thangavelautham</i>	
RevOps of Sustainable Space Economy	593
<i>Sarolta Mohaine-Palfi</i>	

DEVELOPMENT AND TESTING PLATFORMS

Earth-Analogue Roving System Development and Testing for Lunar Surface Exploration.....	607
<i>Charlie Hanner, Nicolas Bolatto, David L. Akin, Nicholas Limparis</i>	

LSIC Lunar Proving Grounds Workshop: Efforts Toward Unifying Lunar Technology Testing Facilities	621
<i>Jodi Berdis, Danielle Mortensen, Jamie Porter, Charles Hibbitts</i>	
Initial Testing Results and Forward Design Considerations for the Tri-Rotor Hand Controller.....	640
<i>Robert L. Howard, Harry L. Litaker, Taylor Phillips-Hungerford, Mark Cramer, Athena Frangoudis, Sarah Margerum, Nadia Scharunovych</i>	
C2F: A Collaborative Code Framework for High Assurance Space Software.....	656
<i>Dylan Pfeifer, Carson Page, Scot Salmon, Daniel Barrera, Joseph Yu, Mark Senofsky, Steven Lentine</i>	
Design, Test, and Validation of a sub-Micro-Newton Torsional Thrust Balance for Performance Characterization of the Embedded Electrospray Thruster	670
<i>Antonio B. Robali, Alberto Meza</i>	

MARS TRANSIT CONSIDERATIONS

Overview of Crew Operations for Transit to Mars	680
<i>Nicole E. Piontek, Clare M. Luckey</i>	
Characterization of In-Space Propulsion Trade Space to Support Initial Human Mars Campaign	691
<i>Patrick Chai, Michelle A. Rucker, Laura M. Burke, Stephen J. Edwards, Michael B. Chappell, Douglas Trent</i>	
In-Space Transportation Sensitivity to Roundtrip Mission Duration and Mars Vicinity Stay Time.....	703
<i>Patrick Chai, Min Qu, Andrew J. Sais, Nicholas M. Gaug</i>	
A Tripartite Approach for Efficient Human Round Trip Missions to Mars and Ceres	715
<i>Lynnane E. George, Jonathan Garbrick, Benjamin Kopriva</i>	

OPPORTUNITIES WITH SLS

Single SLS Launched Dual Outer Planet Mission: Flagship Spacecraft Missions to Uranus and Neptune	723
<i>Ben B. Donahue, Matthew B. Duggan</i>	
Scientific Discovery and Societal Benefits with SLS Unique Launch Capability.....	729
<i>James L. Green, Doug Cooke, Arthur W. Beckman, Kristine M. Ramos</i>	
The NASA SLS Launched Crewed 2034 Venus Flyby Mission.....	739
<i>Ben B. Donahue, Matthew B. Duggan</i>	

VOLUME 2

NASA's Space Launch System: Artemis I Results and the Path Forward	746
<i>John Honeycutt, Sharon Cobb, John Blevins, William T. Bryan</i>	

ASTRONAUT SUPPORT TOOLS

Space Suit Boot Architecture: Analysis and Research for Foot and Ankle Protection	756
<i>Marc M. Cohen, Nathaniel R. Bennett, Pablo DeLeon</i>	

Comparing the Effects of Head-Worn Augmented Reality on Drone Piloting Performance.....	798
<i>Cian O'Regan, Niall Smith, Ted Scully, Alan Giltinan</i>	
BioElectromagnetic Wearable to Stimulate Blood, Cells, and Fluids	809
<i>Terry Trevino, Kolemenn Lutz, Tara Nibhanupudy</i>	
Long Term Human Presence in Space Requires Artificial Gravity and Radiation Shielding.....	819
<i>Harry W. Jones</i>	
Haptic Feedback for Reducing Disorientation Due to Sensory Conflict When Controlling an Aerospace Vehicle	826
<i>Chrishma Singh-Derewa, Karena Z. Fiore, Poonampreet Kaur Josan</i>	
Using Wearable Brain Sensing Glasses During Zero-G Flight for Hyperscanning: Preliminary Study.....	840
<i>Nataliya Kosmyna, Daniel Hails, Eugene Hauptmann, Christopher Markus, Zoe Lee, Gun Bolukbasi, Minsol Kim</i>	

SPACE RESOURCE STEWARDSHIP II

A Multi-Use Resupply Platform at L1.....	852
<i>Lynnane E. George, Julius Lonksy</i>	
Designing Optimal Satellite Constellation Patterns with Facility Location Problem Models and Mixed Integer Linear Programming	870
<i>David O. Williams Rogers, Sung-Woo Kim, Myunghwa Lee, Yong-Hwan Kim, Hang Woon Lee</i>	
Development of a Predictive Model for In-Situ Resource Utilization of Space Exploration Waste.....	894
<i>Ray Pitts, Anne J. Meier, Joel A. Olson, Marisa Kelley, Morgan Benson</i>	
Long Duration Testing of a Rover-Mounted Chain Trencher Excavator in Simulated Lunar Surface Conditions	910
<i>Marcello Guadagno, Parker Bradshaw, Joe Primeau, Paul J. van Susante</i>	
Conducting Spectra-Spatial Investigations on the Big Island of Hawaii as a Lunar Surface Analogue	920
<i>Hao Wang, Krystal Arroyo-Flores, Frances Zhu</i>	

EVOLVING TECHNOLOGIES FOR SPACE EXPLORATION II

The Potential of Wind Energy on Celestial Bodies with Substantial Atmospheres.....	947
<i>Jason Noe, Paul J. van Susante</i>	

AUTONOMOUS SATELLITE OPERATIONS & INTEROPERABILITY ACROSS SPACE ASSETS

Trajectory Generation with Load Constraints for Robotic Manipulators	953
<i>David Bacher, John R. Cooper, Javier Puig Navarro</i>	
Envisioning Cislunar Formation Flight: A Survey and Analysis of Enabling Mission Topologies	959
<i>William A. Sherman, E. Glenn Lightsey, Mark Whorton</i>	

An Assessment of the Technology Readiness Level (TRL) and Policy Implications of Current Orbit Transfer Solutions..... 975
Celvi Lisy, Amanda Chang, Angela Huang, Whitney Lohmeyer

Sequential Control of Electromagnets for CubeSat Docking Attitude Alignment..... 988
Virupakshan Vilvanathan, Athip Thirupathi Raj, Leonard D. Vance, Eniko Enikov, Jekan Thangavelautham

ORBITAL DEBRIS MITIGATIONS II

4D LiDAR-Based Rate Estimation for Space Debris Synchronization..... 1002
Jun Yang Li, Sean Wolfe, M. Reza Emami

Viability of a Deployable Orbital Debris Collector: Aerogel Capture Material, Maneuvering, and Perception..... 1016
Ishriak Ahmed, Nafis Mohammad Nayeem, Christian Griffith, Md Arif Billah, Imraan Faruque

Worker Bee + ThinkPlatform: A Disruptive, Commercial Approach to Large Debris Remediation..... 1031
Hayden Burgoyne, Kieana Fana, Nicole Y. Shumaker, James MacConnell, Ryan Benson, Sushil Karam

The Current and Future State of Non-Geostationary Orbit (NGSO) Fixed Satellite Service (FSS) Interference Regulation Metrics 1040
Lieselotte A. Heinrich, Braden Oh, Whitney Lohmeyer

SPACE RESOURCES IN SUPPORT OF PAST AND CURRENT COMMERCIAL SPACE VENTURES

Applying FinTech Economic Models to Space Commerce..... 1054
Daniel J. Prejean, Jason Ruskowski

Addressing the Need to Couple Innovation and Scalability for Advanced Space Mission Concepts Through a Revised Program & Systems Engineering Management Model 1057
Griff Russell

An Analysis of Ground Test and On-Orbit Failures of American Spacecraft..... 1084
Stephen K. Tullino, Andrew Keys, Robert A. Bettinger, Amy M. Cox, David R. Jacques

MAJOR DRIVERS ENABLING EXPANSION OF COMMERCIAL SPACE

The Commercial Satellite Industry: Key Indicators and Global Trends in the Context of Expanding Capabilities..... 1098
Carissa B. Christensen, Tom Stroup, Cameron R. Herrera, Anton V. Dolgoplov, Fletcher Franklin, Carie Mullins, Ryan Puleo, Philippe M. Smith

The Economic Case for an Orbital Satellite Factory1106
Alejandro E. Trujillo, Anh Tu, Jacob Rome, Vinay Goyal, Jon Strizzi

Smallsats by the Numbers: Growing Smallsat Activity and Expanding Commercial Capabilities1122
Carissa B. Christensen, Cameron R. Herrera, Carie Mullins

An Examination of Historical Infrastructure to Provide a Roadmap for Future Space Infrastructure Development	1133
<i>Eric Wilson</i>	

Building a Next-Gen Space Ecosystem for Networking, Connectivity & AI.....	1143
<i>Ralph Grundler</i>	

DIGITAL ENGINEERING FOR FUTURE AUTONOMOUS MISSIONS

Digitally-Assisted Development of a Space Robotic Arm for Small Satellites Applications	1149
<i>Juan Molinar, Julio Garcia, Roberto Robles, Christopher Mendoza, Julio Reyes, Ahsan Choudhuri, Angel Flores-Abad</i>	

Robotic Software Architecture for In-Space Outfitting Operations.....	1170
<i>Amy Quartaro, John R. Cooper, Erik E. Komendera</i>	

Software Design for the Supervised Autonomous Assembly of a Tall Lunar Tower.....	1183
<i>Jacob T. Cassidy, Matthew Mahlin, Emma Kravets, Matthew Vaughan, Matthew Rodgers</i>	

Autonomous Logistics and Inventory Management in a Modular, Robotic and Extensible Space Station.....	1212
<i>Athip Thirupathi Raj, Jekan Thangavelautham</i>	

LUNAR ENABLING INFRASTRUCTURE ELEMENTS

Three Regolith Simulant Conveyance Systems Tested in Vacuum and Atmospheric Conditions	1227
<i>Jason Noe, Paul J. van Susante, Laurent Sibille, Ben Wiegand, Elijah Sierra, Parker Bradshaw</i>	

Power Analysis for Optimum Illumination Conditions Using Lunar Operations Tower for Surface Activity.....	1235
<i>Min Seok Kang, Jekan Thangavelautham</i>	

Lunartrak: Lunar Rail Systems for High-Mass General Transport, Dust Mitigation, and Power Conveyance	1244
<i>Christine E. Gregg, Olivia Formoso, Greenfield Trinh, Kenneth Cheung, Frank Sebastianelli</i>	

Lunar Surface Relay - Mobile: Concept to Provide Relay Links to Surface Assets.....	1255
<i>Elizabeth R. Turnbull, Steven R. Oleson, Bushara Dosa, Maximilian Scardelletti, Michael Gasper, Richard Reinhart, Aaron Smith, Brandon Klefman, Benjamin Abshire, Lucas Shalkhauser, Brent Faller, Thomas Packard, Anthony Colozza, John Gyekenyesi, David Smith, James Fittje</i>	

NUCLEAR THERMAL POWER FOR FUTURE SPACE MISSIONS

Lunar In-Situ Resource Utilization of Aluminum Metal for Radiator Face Sheet Production of Pylon Fission Surface Power System	1271
<i>Diana Gorokhovskaya, L. Dale Thomas</i>	

How Can Microreactors Enable Space Security & Protection? Rolls-Royce Microreactor Programme Case Study	1285
<i>Katie Jarman, Oliver Ward</i>	

Design and Analyses of Lightweight Radiator Module for Nuclear Reactor Lunar Surface Power..... 1296
Mohamed S. El-Genk

Survive, Operate, Thrive: RHUs and RTGs to Enable Sustainable Exploration of the Lunar Surface
and Permanently Shadowed Regions..... 1308
Jacob Matthews, Alex Gilbert, Jaclyn Wiley

SPACECRAFT DESIGN APPROACHES

Rapid Assessment of a Lunar Surface Laboratory Module 1312
Robert L. Howard, Harry L. Litaker

Menagerie: An Automated Approach to Launch Vehicle Design 1339
Patrick D. Dees, Matthew C. Stockard

Developing a System Engineering Procedure for a Two-Stage Sounding Rocket 1349
Min-Seon Jo, Jongsu Oh, Inhoi Koo, Keon-Hyeong Lee, Si-Yoon Kang, JeongYeol Choi

SUPPORTING HUMAN HEALTH

Design for Reliability (DfR) in Space Life Support 1354
Harry W. Jones

Extending the Duration of Crewed Stays on the Lunar Surface 1363
*Garrett M. Carman, Michelle L. Nadeau, Emily Judd, Paul D. Kessler, Kevin T. Larman,
Richard L. Sutherland*

Sunlight-Induced Biosynthesis of Vitamins, Aminos, and Precursors..... 1372
Kolemann Lutz

SPACE LOGISTICS AND IN-SPACE SERVICING/ASSEMBLY/MANUFACTURING

Test Results for Autonomous Assembly of Modular Space Structures..... 1383
*John R. Cooper, Collin J. Cresta, Thea V. Avila, Radhika Rajaram, Andrew K. McQuarry,
Jacob Martin, Olive R. Stohlman*

Survey of Select Recent In-Space Servicing Assembly and Manufacturing Related Robotics
Projects at the Jet Propulsion Laboratory 1396
Rudranarayan Mukherjee

The Repair Maintenance and Fabrication Facility in the Common Habitat Architecture.....1411
Robert L. Howard, Tracie J. Prater, James Stott

The iSSI (intelligent Space System Interface) Modular Coupling Supporting Modular Architectures
and ISAM Development Across the Board 1426
Joerg Kreisel, Thomas A. Schervan, Steve L. Kwast, Dennis R. Wingo, David Barnhart

HALIE: Hybrid Approach to Lunar Inflatables and Erectables..... 1441
Madhu Thangavelu

Polymer-Based Manufacturing in Vacuum Using Robotics Technology..... 1460
*Andrea Vargas, Alejandro Silva Au, Juan Molinar, Yirong Lin, Ahsan Choudhuri, Angel
Flores-Abad*

EVOLVING TECHNOLOGIES FOR SPACE EXPLORATION I

- Navigation Sensor Technology Assessment Capability for Data-Driven Systems Analysis 1475
Esther Lee, Paul V. Tariabini, Brett R. Starr, Paul D. Friz, Christopher D. Karlgaard, Jamshid A. Samareh

VOLUME 3

- Development of an Integrated Motion Control and Actuation System for Extreme Space
Environments..... 1488
Alexander J. Ferreira, Lei Niu, Tyler Bond, Summer Ponce

- Dust Ejecta RADAR Technology (DERT): A Millimeter Wave Doppler Radar to Measure Plume
Surface Interaction Ejecta Velocities. 1505
*Austin G. Langton, James G. Mantovani, Beverly W. Kemmerer, Austin R. Atkins, Dan P.
Batchelder, Gary L. Bastin*

EDUCATING THE NEXT GENERATION OF SPACE LEADERS

- Educating Tomorrow's Space Leaders: Harvard Business School's Approach to the Space Economy..... 1514
Matthew Weinzierl, Brendan Rosseau

- Enhancing Space Workforce Education Through Innovative Delivery of a University of Hawai'i
Space Science and Engineering Program: A Strategic Outlook..... 1517
Peter Englert, Miguel Nunes, William Edmonson

- Life at the Edge: Design Concepts in Remote & Extreme Earth-Environments as Testbeds for
Future Lunar Development..... 1524
Melodie Yashar

- Project Caelus: High School Workforce Development Through Liquid-Fueled Rocketry 1535
*Harika G. Akundi, Alan J. Zhu, Tanmay Neema, Santiago D. Criado, Jessica Chen, Myles
Carley, Kiran Donnelly, Anish Paspuleti, Jenny Chen, Arjun Babla, Aarushi Bommidi,
Kritagya Khadka*

- Community Science on the Moon: The Great Lunar Expedition for Everyone..... 1558
Barbra Sobhani

WORKFORCE DEVELOPMENT FOR AN INNOVATIVE, DIVERSE, AND INCLUSIVE SPACE INDUSTRY

- TechPort - NASA's Portfolio Management Approach to Space Technology Investment Planning,
Integration, and Outreach 1565
Ryan J. Miller, Alesyn Lowry, Jonathan T. Bowie

INVESTMENT AND FINANCING APPROACHES

- Space Ecosystem: Collaborating for Continuous Development, Deployment, and Delivery 1584
Carrie O'Quinn, Robert M. Unverzagt, Ronald Birk, Ryan E. Conroy

EFFORTS TOWARDS NUCLEAR THERMAL PROPULSION

- Engine Cycle Comparison for Alternative Propellant Nuclear Thermal Propulsion Engines..... 1593
Daria Nikitaeva, Corey D. Smith, Matthew Duchek
- Instrumentation and Controls for Nuclear Thermal Propulsion Missions 1616
Claude R. Joyner, David E. Hanks, Tyler Jennings, James Larkin, Daniel J. Levack
- Parametric Modeling of NTP Engine Performance for a Crewed Mars Mission 1628
Matthew E. Duchek, Daria Nikitaeva, Christopher Harnack, Emanuel Grella, Sean Greenhalge

METHODS AND ASSESSMENTS OF AUTONOMY/AL/ML PROCESSES

- Deploying Artificial Intelligence Capabilities by Hybridizing a Neural Network on a Satellite..... 1640
Luis Chavier, Becca Bonham-Carter, Hugo Burd, Tim Heydrich, Galen O'Shea, Jacob Prud'homme, Nevedha Ayyappan, Mehsan Maharib, Thardchi Ganesalingam, Alan Higginson, Evan Smal, Samara Pillay, Kaizad V. Raimalwala, Yolanda Brown, Andrew J. Macdonald, Michele Faragalli
- Explainable Machine Learning and Uncertainty Quantification in Robotic Lunar Surface Traversal 1648
Zach Cleghern, Keith Rudd, Griffin Thornton, Alicia Fernandes
- Comparing Active Learning Performance Driven by Gaussian Processes Or Bayesian Neural Networks for Constrained Trajectory Exploration..... 1656
Frances Zhu

SPACE WORK SITES AND SETTLEMENT CONCEPTS

- Lunar Economic Village Initiative (LEVI)..... 1671
Zihang (Jim) Zhong, Melodie Yashar
- Generation of Functional Modular Space Station Configurations Using Genetic Algorithms 1688
Alton Zhang, Athip Thirupathi Raj, Jekan Thangavelautham
- Universal Design and Customization: Finding a Balance in Space Architecture 1700
Mahsa Moghimi Esfandabadi
- Selene: The First Real City on the Moon 1710
Manuel Pimenta

MANUFACTURING APPROACHES FOR ISAM

- The First Metal-Cutting in Space: Findings from a Demonstration of Friction Milling as an Essential Manufacturing Process in Space 1716
Robert Harris
- Assessment of Sensor Data Accuracy Within Gazebo/ROS for High-Precision Autonomous In-Space Robotic Operations 1759
Jessica S. Friz, John R. Cooper, Cameron Miksch, Shashank Kalluri
- Shape Error Budgets for Precision In-Space-Assembled Structures 1775
Manan Arya, Garrett C. Brown, Ashish Goel, Saptarshi Bandyopadhyay, Zaki Hasnain

Virtual Factories In-Space: Mapping Specifications for Digital Twin for ISAM Robotic Applications..... 1789
Tanvi Arey, Harsha Malshe, Salil Bapat, Ajay Malshe

Additive Manufacturing and Infrastructure Development Staging on the Lunar Surface 1799
David P. Purcell, Christopher B. Dreyer

EVOLVING TECHNOLOGIES FOR SPACE EXPLORATION II

Low Power LEDs for CubeSat Attitude Estimation and VLC During Proximity Operations 1814
Jaret Rickel, Athip Thirupathi Raj, Jekan Thangavelautham

Quantification of Electron/Positron Pairs for Matter/Anti-Matter Propulsion -- Recent Experimental Results 1829
Mark Pickrell

Electromagnetic Fields to Regulate Material Defects, Vacancies, and Properties 1838
Kolemann Lutz, Terry Trevino

An Analytical Trade Study on Pressure Reducing Systems for Space Applications 1849
Keith Brodek, Alexander Colletti, Thomas Buononato, Brian Ippolitto

Shape Memory Alloy Based Hard Docking Mechanisms for Two-Stage CubeSat Docking..... 1864
Nicolas Gross, Athip Thirupathi Raj, Jekan Thangavelautham

SPACE SUSTAINABILITY FRAMEWORKS

Towards Sustainable Space: Challenges and Solutions from Ground Level 1878
Niha Agarwalla

Revisiting Space Sustainability in the Quest for a Holistic Overview 1882
Amir Gohardani, Sam Kapreilian

WORKFORCE DEVELOPMENT FOR AN INNOVATIVE, DIVERSE, AND INCLUSIVE SPACE INDUSTRY

Diversity and Inclusion in the Aerospace Industry and the Role of Leaders 1895
Jackelynn P. Silva-Martinez

Stellar Solutions' Answer to Young Professional Development: STAR Program Case Study 1903
Jacquelyn Noel

ChatGPT Artificial Intelligence Responses Via Exercises for Extremely Divergent Subjects Such as the Process Management Tool Vdot and Neutrinos from Black Holes..... 1908
Joseph R. Herdy

Reimagining Aerospace Workforce Development in Higher Education 1935
Barbra Sobhani

EMERGING COMMERCIAL SERVICES AND CAPABILITIES

Continuous Production Agility: A System Dynamics and Policy Analysis on Rapid Space Architectures	1940
<i>Peter Liu, Daniel E. Hastings</i>	
All Liquid Fuel Space Launch System	1969
<i>Michael A. Paluszek, William Huang, Stephanie J. Thomas</i>	
Paradigm Shift in Optical Payload Development: Rapid TRL Increase for CubeSat Optical Payloads	1980
<i>Alicia Maccarrone, Christine Buleri, Cameryn Yow, Janak Carey, Alexander Halterman, Samantha Weiner, Shimshone Yacoby, Robert Damadeo, Charles Hill</i>	
GITAI USA: Providing Safe and Affordable Means of Labor in Space	2005
<i>Sho Nakanose, Keiko Nakamura-Messenger</i>	
Lunar Outpost Oceania Leads Australia's Moon to Mars Trailblazer Rover Lunar Mission.....	2011
<i>Andrew J. Gemer, Joseph Kenrick</i>	

ENABLING PROPULSION TECH FOR LANDERS/ASCENT VEHICLES

Benefits of MON-25 Propellant for In-Space Transport and Lunar Landing Applications	2017
<i>Christopher B. Reynolds, James F. Horton, Daniel J. Levack, Brian J. Muzek, Leslie Woodger</i>	
Crewed Mars Ascent Stages: Propellant Options, Configuration Alternatives and Performance Factors	2028
<i>Ben B. Donahue</i>	
Cryogenic Fluid In-Situ Liquefaction for Landers: Prototype Demonstration	2039
<i>Wesley L. Johnson, Ryan Grotenrath, Ramaswamy Balasubramaniam, Hon Mon Chan, James Smith, Patrick Giddens</i>	
Applying Machine Learning Algorithms to Track and Label Vibrational Mode-Shapes of a Generic Lunar Ascent Vehicle.....	2050
<i>Jamshid A. Samareh, Alexander Chin, Hilmi Alkamdawi, Sasan Armand</i>	

SPACE WORK SITES AND SETTLEMENT CONCEPTS

Mars Surface Habitat Concept Design	2077
<i>Ryan Hughes, David D. McGraw, Paul D. Kessler, Andrew J. Choate</i>	
Options for Offloading a 90-Ton Common Habitat from Its Lander on the Surface of Mars	2090
<i>Robert L. Howard, Scott Howe, Joshua Kivijarvi, Joseph Yao</i>	

ENABLING PROPULSION TECH FOR LANDERS/ASCENT VEHICLES

Agent-Based Models for Real-Time Fault-Recovery in Cyber-Physical Testbeds for Smart Habitats.....	2109
<i>Murali Krishnan Rajasekharan Pillai, Bernardo D. Alvarenga, Prathyush Ravula, Ilias Bilionis</i>	

TALL LUNAR TOWER EFFORTS ENABLED BY ISAM

Sizing, Buckling, and Thermal-Structural Analysis of Tall Lunar Tower.....	2127
<i>Kyongchan Song</i>	
Tall Lunar Towers: Systems Analysis of Lunar-Surface-Assembled Power, Communication, and Navigation Infrastructure.....	2139
<i>Daniel Tiffin, Matthew Mahlin</i>	
Scaling Climbing Collaborative Mobile Manipulators for Outfitting a Tall Lunar Tower and Truss Structures.....	2151
<i>John R. Merila, Jeremiah Neubert, Matthew Mahlin</i>	
Unreal Engine Testbed for Computer Vision of Tall Lunar Tower Assembly	2161
<i>Brian Notosubagyo, Matthew Mahlin, Jacob Cassidy</i>	

ISRU OF WATER

Commercial Scale-Up of Lunar Solid-Oxide Water-Electrolysis (SOEC) Fuel Production System Architecture	2180
<i>David Dickson, George F. Sowers, Christopher B. Dreyer, Gregory Jackson, John Schmit, Joseph J. Hartvigsen, Michele Hollist</i>	
Lunar Water Extraction Via Lunar Auger Dryer Isru (LADI)	2193
<i>Jacob Collins, Koorosh R. Araghi</i>	

VOLUME 4

A Mission Campaign Concept to Refine the Nature of Water Ice Reserves on the Moon.....	2222
<i>Charles Hibbitts, Michael E. Nord, Jodi Berdis, Claire Trop, Jeremy John, David O. Smith, Craig Knuth, Michelle Chen</i>	
Enhancing HabNet to Support Water Demand Estimates for Human and Scientific Exploration of Mars.....	2229
<i>Yana Charoenboonvivat, Olivier L. De Weck, Sydney Do</i>	
Thermal Model of Ice Growth in Vacuum for Lunar Water Production	2244
<i>Timothy Krause, Beau M. Compton, Leah M. Struchen Deans</i>	

POWER AND PROPULSION TECHNOLOGIES AND SUBSYSTEMS FOR SPACE EXPLORATION

Conceptual Design of a Lunar Drone Operated Using In-Situ Propellant.....	2256
<i>Chun-Wei Kong, Marcus Lo, Mirko Gamba, Giuseppe Santangelo</i>	
The Primary Propulsion System Module: An On-Orbit Replaceable Modular Propulsion Element for the AR SpaceCrane Family of LARS Transfer Vehicles	2274
<i>Peter D. Kinsman, Claude R. Joyner, Timothy S. Kokan, Daniel J. Levack, Dennis E. Morris, Mitchell Sack</i>	
Performance Study on Laser Hydrogen Space Propulsion & Power Generation System	2285
<i>Maged A. Soliman</i>	

Loxodon-1: Bi-Propellant Liquid Rocket Engine.....	2292
<i>Adriana M. Bonilla Romacho, Penelope Nieves, Giovanni Oliveras, Pedro Soler, Luis Rios, Jose Colon, John Bonilla</i>	

Testing and Analysis of a Superconducting Tether for Power Transmission Inside of Lunar Permanently Shaded Regions	2319
<i>Travis Wavrunek, Nate Bruursema, George B. Johnson, Charles Carey, Hunter McGillivray, Paul J. van Susante</i>	

SECURING FUTURE SPACE ARCHITECTURES

Satellite Cybersecurity Testbed to Improve Commercial Space Security.....	2328
<i>Jeffery Finke, Rajiv Thummala, Rammah Elbasheer, Petersen Hansen, Wayne Henry, Dan Mamula, Abdul M. Noor, Travis York, Kangman Zheng, Gregory Falco</i>	

Cybersecurity Analyses of a Space Reactor Power System Under Simulated False Data Injection Attacks.....	2336
<i>Mohamed S. El-Genk, Timothy Schriener</i>	

Applying the SPARTA Matrix to Develop Intelligent Security Controls for Space Systems	2348
<i>Jill Slay, Uakomba Uhongora, Jordan Plotnek, Yee Wei Law, Ronald Mulinde</i>	

Game Theoretic Approach to Resilient Satellite Communications System Design Subject to Adversarial Interactions.....	2357
<i>Michael P. Jones, Olivier L. De Weck</i>	

MINIMIZING FUTURE PLANETARY AND ENVIRONMENTAL IMPACT

Evidence for Large Planetary Climate Altering R-Process Explosions on Mars in the Past	2370
<i>John E. Brandenburg</i>	

Preliminary Assessment of Environmental Impacts from the Demise of Reentering Satellites in the Upper Atmosphere.....	2405
<i>José P. Ferreira, Ken-ichi Nomura, Joseph Wang</i>	

Global Climate Effect from Space Debris Reentry: Engineering and Policy Implications	2414
<i>Asha Jain, Daniel E. Hastings</i>	

Exploring the Use of Daylighting on a Lunar Colony: Sustaining a Micro Aeroponic Farm and Conserving Lighting-Related Energy Costs	2426
<i>Nicolas D. Alvarado, Valerie Gacula, Dija Parish</i>	

SPACE DESIGN & ARCHITECTURES STUDENT COMPETITION WINNING TEAMS PRESENTATIONS

Pale Red Dot: A Large, Robust Architecture for Human Settlements on Mars	2441
<i>George C. Lordos, Madelyn Hoying, Yousif AlSadah, Liliana Arias, Ignacio Arzuaga Garcia, H Azzouz, John Beilstein, Wing Lam Chan, Ezra Eyre, Dane Gleason, Meltem Ikinci, Divya Iyer, Yuying Lin, Estelle Martin, Lanie G. McKinney, Duncan Miller, Cormac O'Neill, Omar Orozco, Palak B. Patel, Elizabeth Romero, Francisco Sepulveda, David Villegas, Alisa N. Webb, Kir Latyshev, Chloe Gentgen, Alexandros C. Lordos, Olivier L. De Weck, Jeffrey A. Hoffman</i>	

Permanent Research Outpost for Mars and Interplanetary Space Exploration (PROMISE).....	2459
<i>Wilbert A. Ruperto, Xiomara Vélez-Soto, Alanis Matías-Pérez, Irwin Alcantara, Francisco Rivera-Méndez, Roberto Rodríguez Otero, Nicole Matos, Marina Rodríguez, Nathalia Vega, Bárbara O. Calcagno, Yosefine Santiago, Rafael Rivera, Victor Morales, Bianca Cintrón, Antonio Quiles, Jason Gutiérrez, Hakeem Villegas, Andrés Pérez, Ian Santiago, Alejandro Rodríguez, Natalia Soto, Javier García, Sophia Mestres, Alana Cruz, Calleb Díaz, Diego Quiñones, Diana Berrios, Kyleshaquill Soto, Alejandro Morales, Chris Justiniano, Jovalice Torres, Joseliz Pérez, Diana Aponte, Elimelec Mercado</i>	
Transit, Rendezvous, & Taxi Launcher: A Proposal for a 2-Vehicle Autonomous Human Ascent from Mars.....	2501
<i>Jurist D. Chan, Elle S. Smith, Lonnie A. Webb, Trey Farmer, Aaron S. Hammond, Sparsh C. Desai, Pessi H. Laensirinne, George C. Blackwell, Reid D. Fly, Patrick Chai</i>	
Design of Dual Mars Ascent Vehicle MAVERICK.....	2525
<i>Basil P. Aranda, Daniella M. Dorantes, Amanda N. Ewing, Cesar Villa, Tyrone S. Collins, Fateme Tahmak, Ashley K. Anderson, Navid Nakhjiri, Patrick Chai</i>	
Crewed Orbit and Ascent Surface Transportation.....	2540
<i>Claire Keller, Kendall Seefried, Tabitha L. D'Amato, Satvik G. Kumar, Braden R. Kerstin, Rebekah R. Geil, Michael B. Keraga, Jonathan W. Lin, Landon B. Jarrel, Lachlan R. Holliday, Patrick Chai</i>	

CONCEPTUAL MISSIONS

Gateway Momentum Unloading Using a Solar Parasol.....	2561
<i>Stephanie J. Thomas, Michael A. Paluszek, Aniesha Dyce</i>	
SIZLE: Smallsat to Image Zodiacal Light Above Ecliptic.....	2573
<i>Melissa Buys, Evan H. Feinberg, Jonathon Gabriel, Charless Pett, Anmol Sikka, Salman Aslam, Abhishek Shastry, Dalan Loudermilk, Jack D. Crespo, Adam Yonas, Sara Miller, Max Yasgur, Aiden Herz, Yu-Jung Chen, Arvind Aradhya, Andrew van Paridon, Dmitry Svransky, James Lloyd, Elaine Petro</i>	
Evaluation of Spaciousness in Virtually Simulated Isolated and Confined Environments.....	2590
<i>Berk Diker, Halime Demirkan</i>	

LUNAR POWER INFRASTRUCTURE

Lunar Microgrid Trade Studies to Define Interface Converter Requirements.....	2608
<i>George L. Thomas, Matthew Granger, Jeffrey Csank</i>	
Supervisory Optimal Control of an Electric Power Microgrid to Enhance In-Situ Resource Utilization for Lunar Habitats.....	2622
<i>Joseph Young, David G. Wilson, Marvin Cook, Wayne Weaver</i>	
Lunar Array Mast and Power System (LAMPS) for a Scalable Lunar Power Infrastructure.....	2632
<i>Robert K. Van Ness, Dean Bergman, Evan Cloninger, Ray Crum, Brian Vogel, Vishnu Sanigepalli, Kathryn Bywaters, Kris Zacny, Murat Okandan, Jason Wilson, Kaveh Rouhani, Kevin Hell</i>	
A Modular AC to DC Interface Converter to Enable Lunar Surface Power Transmission.....	2644
<i>George L. Thomas, Matthew Granger, Brent Gardner, Luis Pinero, David Pike, Jeffrey Csank, Arthur Birchenough, Ajay Krishnan</i>	

SPACE TRANSPORT PROPULSION ENABLERS

A 1 MW Solar Electric and Chemical Propulsion Vehicle for Piloted Mars Opposition Class Missions	2657
<i>Steven R. Oleson</i>	
Combined 1-MW Solar Electric and Chemical Propulsion for Crewed Mars Missions.....	2671
<i>Laura M. Burke, Steven R. Oleson, Zachary C. Zoloty, David Smith, Maya Havens</i>	
Expanding the Mission Capture of the PPS®5000 Hall Thruster.....	2683
<i>Olivier B. Duchemin, Julien Rabin, Giovanni Coduti, David Le Méhauté</i>	
Capabilities Enabled in Cislunar Space by Low Specific Mass Solar Electric Power and Propulsion Systems.....	2698
<i>Christopher A. Dodson, Benjamin Jorns</i>	
A Magnetopause Model for Sizing Artificial Magnetospheres at Mars and Lagrange-1 Orbits.....	2713
<i>Scott A. Carpenter, Matthew Qi, Remy Xie, William Tang, Sophia Hu, Cherry Chen, Nathan Yao, Nicholas Chao, Alexander Lu, Skyler Mao, Seabert Mao, Ranya Zhang, Kris Luo, Edrea Jiang, Katherine Lu, David Zhao, Jesse Yao, Johnry Zhao, Daniel Chen</i>	

ISRU OF REGOLITH

Oxygen Production on the Lunar Surface: Modeling Molten Regolith Electrolysis and Water Electrolysis at Reduced Gravity Levels.....	2738
<i>Paul A. Burke, Michael E. Nord, Jodi Berdis, Charles Hibbitts</i>	
Producing Lunar Steel and Oxygen Using Molten Regolith Electrolysis	2748
<i>Palak B. Patel, Jose Soto, Scarlett Koller, Kir Latyshev, Lokesh Sangabattula, Zachary Adams, Kristoff Misquitta, Laman Jalil, Amber Cooper, Tom Nguyen, Jonatan Fontanez, Beverly Ma, Hyein Na, Jose Ramirez, Chiara Rissola, Inimai Subramanian, Dean Bergman, Antoine Allanore, Martin Culpepper, Olivier L. De Weck, George C. Lordos, Jeffrey A. Hoffman</i>	
Method for Quantifying Lunar Polar Volatiles in Regolith and the Development of a Thermal Model	2761
<i>Travis Wavrunek, George B. Johnson, Paul J. van Susante, Ellie Zimmermann, Ben Wiegand, Mason Krause, Anurag Rajan, Jeffrey Allen, Timothy Eisele</i>	
Development of the Advanced Regolith Ground Operations (ARGO) Test Bed – a Robotic Excavation and Construction Test Facility with Simulated Lunar Environments	2777
<i>Evan A. Bell, Nathan Gelino, Matthew Nugent</i>	
A Concept of Producing Aluminum In-Situ on the Lunar Surface Through Molten Salt Electrolysis	2802
<i>Jacob Ortega, Jeffrey Smith, Fateme Rezaei, David Bayless, William Schonberg, Daniel Stutts, Daoru Han</i>	

PLANNING FOR RESILIENCE IN FUTURE SPACE SYSTEMS

Critical Infrastructure Security Goes to Space: Leveraging Lessons Learned on the Ground – a Position Paper.....	2813
<i>Timothy Ellis, Briland Hitaj, Ulf Lindqvist, Deborah Shands, Laura Tinnel, Bruce DeBruhl</i>	

Common Aerospace Threats from Coding Practice to Full Exploit: Tracing Threat Angles..... 2826
Bryce L. Meyer

An Overview of High Altitude Platform Stations (HAPS) Systems, HAPS Vehicle Architecture, and
HAPS Cybersecurity 2841
Nicolò Boschetti, Jill Slay, Jordan Plotnek, Gunes Karabulut Kurt, Gregory Falco

SPACE SUSTAINABILITY FRAMEWORKS

A Case Study of International Collaboration Space Missions for Combating Global Climate
Change: Strategic and Technical Perspectives..... 2855
Venkatesan Sundararajan

CONCEPTUAL MISSIONS

Development of a Preliminary Design Methodology for Rotorcrafts in Martian Atmospheric
Conditions and Experimental Validation of the Method..... 2868
Moon B. Hazarika, Weixiao Wang, Mirko Gamba, Giuseppe Santangelo

Numerical Investigation of Multi-Element Low Reynolds Number Airfoils for Fixed-Wing Martian
Flight 2923
Absar A. Khan

EVOLVING TECHNOLOGIES FOR SPACE EXPLORATION I

The Latest Activities and Innovations for the Parachute-Free Landing Analysis Efforts for Mars
Sample Return Vehicle 2939
Cameron M. Grace, Scott Perino, Aaron Siddens, Javid Bayandor

Author Index