# TABLE OF CONTENTS

## Volume 1

Retrospective on a Rocket Pioneer: Robert C. Truax and American Rocket Development ........................................... 1  
  **R. Stardevant**

On the Cutting Edge: Space Adventures in the ’60s ........................................................................................................ 21  
  **R. Brodsky**

Major Challenges Met by Atlas in 50 Years of Flight .................................................................................................... 48  
  **D. Heald**

International Space Station National Laboratory: The Next Decade of Human Space Flight ...................................... 61  
  **B. Carpenter**

Matrix Methods Analysis of International Space Station Logistics .................................................................................. 66  
  **A. Siddiqi, S. Shull, O. de Weck**

Simulating International Space Station Issue Resolution .......................................................................................... 79  
  **H. Johnson, R. Madachy**

An Autonomous, Real-Time Asset Management System for the International Space Station: Net Present Value Analysis .............................................................................................................................. 93  
  **A. Grindle, O. de Weck, S. Shull**

Timing is Everything: Issues of Disparate Temporal Regimes in Space Operations ................................................. 112  
  **M. Dudley-Flores, T. Gangale**

Keys to Successful Partnership Aerospace Projects ................................................................................................. 122  
  **I. Rosenberg, J. Marriott**

Space Flight Resource Management Training for International Space Station Flight Controllers ................................. 127  
  **W. O'Keefe**

Developing an Assistance Program to Navigate the Acceptance Process at a Federal Range ................................... 134  
  **P. McCarthy, A. Odyssey**

Spaceport America: The World’s First Purpose-Built Commercial Space ......................................................................... 137  
  **S. Landeen, L. Gomez, A. Prescott, B. Ziarnick**

Advanced TSTO Vessel Design for Safe and Inexpensive Human Orbital Access ...................................................... 144  
  **K. Erickson**

NASA’s Cryogenic Fluid Management Technology Project ........................................................................................ 160  
  **S. Motil, T. Tramel**

VASIMR Vx-100: High Power Electric Propulsion for Space Transportation Beyond LEO ..................................... 169  
  **E. Bering, B. Longmier, F. Chang Diaz, J. Squire, M. Brukardt, T. Glover**

  **J. Zhang, L. Liang, M. Liu, S. Bai, G. Zheng**

Bridging the Generation Gap: A Rapid Early Career Hire Training Program ............................................................. 206  

Employee Retention: A Success Story ......................................................................................................................... 219  
  **R. Herdy, L. Monaco, M. Weibert, B. Jacobs, B. Millwood**

Constellation Architecture Team-Lunar Habitation Concepts .................................................................................... 227  
  **K. Kennedy, L. Toups**

Design Development and Testing for an Expandable Lunar Habitat .......................................................................... 267  
  **J. Hinkle, A. Dixit, J. Lin, K. Whitley, J. Watson, G. Valle**
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and Field Test of a Mass Efficient Crane for Lunar Payload Handling and Inspection: The Lunar Surface Manipulation System</td>
<td>277</td>
</tr>
<tr>
<td>Why Space Research and Space Exploration?: NASA Ames Research Center Contributions to NASA's 50 Years</td>
<td>289</td>
</tr>
<tr>
<td>The Surly Bonds of Earth: Observations Upon the Loss of the Challenger and Columbia Space Shuttles</td>
<td>308</td>
</tr>
<tr>
<td>A History of Meteoroid Shielding for the Apollo Lunar Mission</td>
<td>316</td>
</tr>
<tr>
<td>A Cooperative P2P Refueling Strategy for Circular Satellite Constellations</td>
<td>326</td>
</tr>
<tr>
<td>A Practical, Affordable Cryogenic Propellant Depot Based on ULA’s Flight Experience</td>
<td>340</td>
</tr>
<tr>
<td>NASA Partnerships with the Emerging Commercial Space Sector</td>
<td>353</td>
</tr>
<tr>
<td>Ground Support Process Time Refinement for Reusable Launch Vehicle Regeneration Model</td>
<td>359</td>
</tr>
<tr>
<td>Assessing the Value Proposition for Operationally Responsive Space</td>
<td>367</td>
</tr>
<tr>
<td>Implications of DoD Acquisition Policy for Innovation: The Case of Operationally Responsive Space</td>
<td>378</td>
</tr>
<tr>
<td>Geostationary Small Satellite for Operationally Responsive Space (ORS) Communications Missions</td>
<td>391</td>
</tr>
<tr>
<td>Operational Pre-Planning for Intensive Science Periods: The New Horizons Jupiter Flyby</td>
<td>405</td>
</tr>
<tr>
<td>RBSP Mission Operations Center Core Software Selection Process</td>
<td>426</td>
</tr>
<tr>
<td>An Efficient Uplink Pipeline for the MRO CRISM Instrument</td>
<td>434</td>
</tr>
<tr>
<td>Dual Spacecraft System</td>
<td>442</td>
</tr>
<tr>
<td>Alternative Space Vehicle Launch Systems</td>
<td>448</td>
</tr>
<tr>
<td>Activity-Based Simulation of Future Launch Vehicle Ground Operations</td>
<td>457</td>
</tr>
<tr>
<td>Radiation Exposure Assessments for Solar Proton Ground Level Enhancements</td>
<td>469</td>
</tr>
<tr>
<td>NPOESS: Advancing Weather Forecasting and Climate Monitoring</td>
<td>480</td>
</tr>
<tr>
<td>Evaluating a System of Systems Approach for Integrated Global Weather, Climate, Hazard Monitoring</td>
<td>481</td>
</tr>
</tbody>
</table>
NPOESS: Improving Operational Global Earth Observations from Space ........................................494
D. Stockton, C. Hoffman, J. Haas, C. Nelson, R. Birk, R. Ohlemacher

Design of a Robotic Lunar Lander for Lunar South Pole Exploration .............................................502
C. McLean, J. Crock, M. Riesco, I. Gravseth, R. Dissly, M. Riesco

Innovative Methods for Planetary Atmospheric Sounding by Lasers ...........................................518
R. Sabatini, M. Richardson

C. Fong, N. Yen, V. Chu, C. Hsiao, M. Lin S. Chen, J. Miau, Y. Liou, S Chi

A Review of NASA's Radiation-Hardened Electronics for Space Environments Project ............576
A. Keys, J. Adams, J. Cressler, M. Johnson, M. Patrick

LIMIT: Lunar Infrared Modular Interferometric Telescope ................................................................583

The Paradox of Pre-Industrial Space Tourism Public Relations .........................................................595
D. Gibson, A. Bittrler, C. Sanchez

A Critical Analysis of the International Space Station as a Space Tourism Destination ...............610
D. Gibson, B. Jaramillo, S. Anaya, F. McKenzie

Lunar In-Situ Resource Utilization: Regolith Bags Automated Filling Technology ..................621
F. Ruess, K. Zacny, B. Braun

Use of Lunar Outpost for Developing Space Settlement Technologies .........................................629
L. Purves

Logistics Considerations for Privately-Built Manned Orbiting Vehicles .....................................642
A. Carlson

Use of Small Logistics Containers for Crewed Lunar Exploration Campaigns .............................675
A. Guest, W. Hofstetter, P. Cunio, E. Crawley, J. Hoffman, O. de Weck

Volume 2

Design of Experiments in Campaign Logistics Analysis ..............................................................687
G. Lee, E. Jordan, R. Shishkho, O. de Weck, N. Armar, A. Siddiqi

D. LoBosco, R. Golding, G. Cameron

LEO Mobility Vehicle for Space Situational Awareness .................................................................710
J. Pearson, E. Levin, J. Oldson

Space Systems Operations Integration: Integrating New Systems Into Legacy Ground Sites ........716
D. Frostman, B. Pimentel, A. Hart, P. Pinarretta

Operationally Responsive Space C2 Options ..................................................................................730
R. Ryals, J. Rendleman

Space Shuttle Bearing Displays: From Concept to Spaceflight ......................................................737
L. Roberts, A. Klausman

Mission Risk Evaluation and Communications Tool .................................................................769
D. Gingerich

Improved Estimates of Spitzer Space Telescope Data Volumes with Error Bars .............................774
M. Sarrel, M. Turmon

Thermal Propellant Gauging, SpaceBus 2000 (Turksat 1C) Implementation .................................791
B. Yendler, I. Oz, L. Pelenc
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telemetry Prognostic for Upgrading Space Flight Equipment Design, Manufacturing, Test, Integration, Launch and On-Orbit Satellite Operations</td>
<td>797</td>
</tr>
<tr>
<td>L. Losik</td>
<td></td>
</tr>
<tr>
<td>Notes on Thresholds and Persistence</td>
<td>825</td>
</tr>
<tr>
<td>M. Khuzadi, C. Easton</td>
<td></td>
</tr>
<tr>
<td>Adaptive Cost Models for Rapidly Evolving Technologies</td>
<td>835</td>
</tr>
<tr>
<td>C. Hutchings, E. Stump</td>
<td></td>
</tr>
<tr>
<td>I-RaCM: A Fully Integrated Risk and Life Cycle Cost Model</td>
<td>846</td>
</tr>
<tr>
<td>D. DePasquale, A. Charania</td>
<td></td>
</tr>
<tr>
<td>A Series of Unforeseen Events: The Space Shuttle, Mission Evolution, and Flexibility</td>
<td>868</td>
</tr>
<tr>
<td>J. Lafleur, J. Saleh</td>
<td></td>
</tr>
<tr>
<td>Stakeholder Value Network Model for Earth Observation Campaigns</td>
<td>881</td>
</tr>
<tr>
<td>T. Sutherland, E. Crawley</td>
<td></td>
</tr>
<tr>
<td>Survivability and Resiliency of Spacecraft and Space-Based Networks: A Framework for Characterization and Analysis</td>
<td>899</td>
</tr>
<tr>
<td>J. Castet, J. Saleh</td>
<td></td>
</tr>
<tr>
<td>Schedule Risks Due to Delays in Advanced Technology Development</td>
<td>916</td>
</tr>
<tr>
<td>J. Reeves, E. Lim, K. Kayat</td>
<td></td>
</tr>
<tr>
<td>Leading Indicators for Requirements and Design of Large-Scale Systems</td>
<td>928</td>
</tr>
<tr>
<td>R. Selby</td>
<td></td>
</tr>
<tr>
<td>Parameter Selection for a Space Power Grid</td>
<td>937</td>
</tr>
<tr>
<td>N. Komerath, V. Venkat, A. Butchibabu</td>
<td></td>
</tr>
<tr>
<td>Myths of the Moon Agreement</td>
<td>948</td>
</tr>
<tr>
<td>T. Gangale</td>
<td></td>
</tr>
<tr>
<td>Societal Drivers and Expectations of Space Exploration</td>
<td>972</td>
</tr>
<tr>
<td>E. Ng</td>
<td></td>
</tr>
<tr>
<td>European Space Policy &amp; Economics - An Intergovernmental Perspective Analysis</td>
<td>987</td>
</tr>
<tr>
<td>V. Sundararajan</td>
<td></td>
</tr>
<tr>
<td>From NASA to a National Space Exploration Administration</td>
<td>999</td>
</tr>
<tr>
<td>A. Hingerty</td>
<td></td>
</tr>
<tr>
<td>Inducement Prizes: Lowering Entry Barriers and Promoting Growth &amp; Innovation in Commercial Space</td>
<td>1005</td>
</tr>
<tr>
<td>A. Grindle</td>
<td></td>
</tr>
<tr>
<td>UK Policy on Return to the Moon</td>
<td>1016</td>
</tr>
<tr>
<td>P. Norris</td>
<td></td>
</tr>
<tr>
<td>Concept Design of Quick Orbit Transfer Vehicle</td>
<td>1022</td>
</tr>
<tr>
<td>P. Lei</td>
<td></td>
</tr>
<tr>
<td>Re-Usable Launch Revisited: Low Cost Potentials?</td>
<td>1032</td>
</tr>
<tr>
<td>G. Woodcock</td>
<td></td>
</tr>
<tr>
<td>Cryogenic Moisture Uptake in Foam Insulation for Space Launch Vehicles</td>
<td>1048</td>
</tr>
<tr>
<td>J. Fesmire, B. Coffman, T. Smith, B. Meneghelli, M. Williams, J. Sass</td>
<td></td>
</tr>
<tr>
<td>Space Systems Engineering Technology Improvements using STARMAD (Space Tool for Advanced and Rapid Mission Analysis and Design in the Design Process)</td>
<td>1062</td>
</tr>
<tr>
<td>D. Starnone</td>
<td></td>
</tr>
<tr>
<td>Responsive Systems Comparison Method: Case Study in Assessing Future Designs in the Presence of Change</td>
<td>1081</td>
</tr>
<tr>
<td>A. Ross, H. McManus, D. Rhodes, M. Richards, D. Hastings, A. Long</td>
<td></td>
</tr>
<tr>
<td>Software Design and Development Principles for Large-Scale Mission-Critical Embedded Systems</td>
<td>1090</td>
</tr>
<tr>
<td>R. Selby</td>
<td></td>
</tr>
</tbody>
</table>
CubeSat: The Pico-Satellite Standard for Research and Education ................................................................. 1097
A. Chin, R. Coelho, R. Nugent, R. Munakata, J. Puig-Suari

Sample Manipulation System for Sample Analysis at Mars ................................................................. 1108
E. Mumm, T. Kennedy, L. Carlson, D. Roberts, M. Rutberg, J. Ji

Orion Project System Optimization Methodology Overview ................................................................. 1114

Orion’s Command and Data Handling Architecture ............................................................................. 1120
G. Eger

Seven Vehicles in One: Orion GN&C ........................................................................................................ 1127
R. Chambers

Orion Vehicle Descent, Landing, and Recovery System Level Trades ................................................ 1157
C. Johnson, R. Hixson

Logistics Modeling for Lunar Exploration Systems............................................................................... 1173
M. Andraschko, R. Merrill, K. Earle

SpaceNet: Modeling and Simulating Space Logistics ........................................................................ 1182
G. Lee, E. Jordan, R. Shishko, O. de Weck, N. Armar, A. Siddiqi

A Comparison of Probabilistic and Deterministic Campaign Analysis for Human Space Exploration ................................................. 1195
C. Stromgren, R. Merrill, M. Andraschko, B. Cirillom K. Earle, K. Goodliff

Matrix Modeling Methods for Space Exploration Campaign Logistics Analysis ............................................ 1205
A. Siddiqi, O. de Weck, G. Lee

National Security Space Industrial Base Study for the Quadrennial Defense Review .......................... 1219
S. Miller, J. Thurman

Launch and Range Lessons Learned Database: Searching, Sorting, Reporting ............................................. 1226
K. Kemp

Considerations for Successful Reuse in Systems Engineering ................................................................. 1243
J. Fortune, R. Valerdi

A Predictive Model for Earth Orbital Unmanned Spacecraft ................................................................ 1251
L. Fischman

Software Cost Estimation for Fractionated Space Systems .................................................................... 1273
A. Brown, B. Boehm, R. Moazeni

International Space Station Transportation Challenges ........................................................................ 1282
S. Scimemi

System-of-Space Systems Architecture Utilizing Existing Space Assets to Complete and Re-Supply the International Space Station ................................................................. 1288
M. Foster

Design and Development of an In-Space Deployable Sun Shield for Atlas Centaur .............................. 1302
M. Dew, J. Lin, B. Kutter, A. Madlangbayan, K. Allwein, J. Ware, C. Willey, B. Pitchford, G. O’Neil

Cryogenic Propellant Insulation System Design Tools for Mass Optimization of Space Vehicles ......................................................... 1313
W. Johnson, S. Sutherlin, S. Tucker

S/C Behavior Modeling Using SysML for Model-Based Systems Engineering Support ....................... 1322
A. Peukert

Defining the Mars Ascent Problem for Sample Return .......................................................................... 1332
J. Whitehead

Framework for Modeling and Evaluating Earth Observation Campaigns .............................................. 1340
T. Sutherland, J. Colson, E. Crawley

A Disciplined Standard Evaluation Methodology for a Future Lunar Outpost ....................................... 1346
S. Coleman, J. Pellegrino
### Applying the UK's PPP Lessons to NASA's Commercial Development Policy

*D. Iron, K. Davidian*

---

### Ares V: Progress Towards a Heavy Lift Capability for the Moon and Beyond

*S. Creech, P. Sumrall*

---

### Analysis of Launch and Earth Departure Architectures for Near-Term Human Mars Missions

*W. Hofstetter, A. Guest, R. McLinko, E. Crawley*

---

### Strategic Analysis Overview

*W. Cirillo, K. Goodtiff, C. Stromgren, K. Earle, J. Reeves, M. Andraschko, R. Merrill*

---

### Supportability and Operability Planning for Lunar Missions

*J. Green, J. Watson*

---

### Micro-Logistics Analysis for Human Space Exploration

*C. Stromgren, R. Galan, W. Cirillo*

---

### National Positioning, Navigation, and Timing Architecture

*P. Huested, P. Popejoy*

---

### Building on Fifty Years of Mission Operations Experience for a New Era of Space Exploration

*J. Onken, C. Singer*

---

### Resource Planning Considerations for Long-Duration Space Missions

*D. Gingerich*

---

### Operational Lessons Learned Supporting NASA’s Desert Research and Technology Studies (D-RATS)

*S. Shull, K. Peek*

---

### Lunar Extra-Vehicular Activities and Colonization Strategies

*M. Snyder, E. Joyce*

---

### Keys to Evaluating and Conveying Credible Space Systems Cost Estimates to Acquisition Management

*M. Eisman*

---

### Economic Interaction Modeling for a Space Economy

*N. Komerath, U. Nair-Reichert*

---

### What Drives Innovation in Communication Satellites? Lessons from History

*Z. Szajnfarber, M. Stringfellow, A. Weigel*

---

### Measurement-Driven Return-on-Investment Analysis for Software Defect Prevention

*R. Selby*

---

### Outreach Development Public Private Partnerships for Space Exploration

*T. Taylor, W. Kistler, B. Citron*

---

### Establishing a Policy Framework for Global Change Earth Observations

*R. Ohlemacher, D. Johnson*

---

### Innovation and New Markets: Entrepreneurship and Investment in Space Commerce

*P. Eckert*

---

### Boeing Design Trades in Support of the NASA Altair Lunar Lander Concept Definition

*M. Benton, G. Caplin, K. Reiley, B. Donahue, R. Messinger, D. Smith*

---

### Effects of Control Power and Guidance Cues on Lunar Lander Handling Qualities

*K. Bilimoria*

---

### Co-Storage of Cryogenic Propellants for Lunar Exploration

*S. Mustafi, E. Canavan, R. Boyle*
Orion Thermal Protection System Design Development .......................................................... 1613
C. Sipe, B. Hinde

Helicopter Flight Demonstration of Lunar and Planetary Lander Technologies ....................... 1621
M. Bayer, S. Berg, M. Hardesty

Development and Simulation of an Analytic Skip Earth Re-Entry Guidance Algorithm ............... 1631
S. D'Souza, N. Sarigul-Klijn, C. Cerimele

Universal Long Duration Tug Concept .................................................................................. 1648
Sarigul-Klijn

Ares I-X Flight Test: The Future Begins Here .......................................................................... 1657
S. Davis

Ares-I-X Stability and Control Flight Test: Analysis and Plans ..................................................... 1668
J. Brandon, S. Derry, E. Heim, R. Hueschen, B. Bacon

Analysis of Stationary, Photovoltaic-Based Surface Power System Designs at the Lunar
South Pole ................................................................................................................................. 1685
J. Freeh

Scalable Millimeter Wave Wireless Power Receiver Technology for Space Applications .......... 1704
N. Marzwell, M. Mojarradi, G. Chattopadhyay, H. Manohara, T. Vo, H. Mojarradi, S. Bae

Life Support Systems Functional Stability and Human Control Limitations: An
Astrosociological Approach ................................................................................................ 1709
Y. Rygalov, D. Livingston, M. Marsh

A Review Of Challenges To Corporate Expansion Into Outer Space ..................................... 1718
C. Hearsey

'Symbiocracy': The Structuring of New Societies in Space Based on the Principles of
Mutualism and Symbiotization ................................................................................................. 1736
E. Lockard

Prediction of Reliability and Cost for Environmental Control and Life Support Systems .......... 1746
H. Jiang, L. Rodriguez, S. Bell, D. Kortenkamp

Lunar Habitat Construction Utilizing In-Situ Resources and a Self-Propagating High-
Temperature Synthesis Reaction (SHS) .................................................................................. 1766
E. Faierson, K. Logan, M. Hunt, B. Stewart

Habitat for Space and Lunar Environments: Light Weight Structure Concept ......................... 1774
P. Slysh, P. Rohl, J. Carsten, A. Jabola

Impact of Water Ice on Lunar Propellant Production ............................................................... 1789
C. Reynerson

Architecture Modeling of In-Situ Oxygen Production and its Impacts on Lunar Campaigns ......... 1803
A. Chepko, O. de Weck, D. Linne, E. Santiago-Maldonado, W. Crossley

Pneumatic Excavator and Regolith Transport System for Lunar ISRU and Construction ........ 1817
K. Zacny, G. Mungas, C. Mungas, D. Fisher, M. Hedlund

Constraining Particle Variation in Lunar Regolith for Simulant Design .................................... 1840
C. Schrader, D. Rickman, D. Stoermer, H. Hoelzer

Responsive Small Satellite Mission Operations Using an Enterprise-Class Internet-Based
Command and Control Network .............................................................................................. 1848
C. Kitts, M. Rasay, I. Mas, P. Mahacek, G. Minelli, J. Shepard, J. Acain

J. Kramer, M. Walker

Analyzing and Detecting Problems in Systems of Systems .................................................... 1871
M. Lindvall, C. Ackermann, W. Stratton, D. Sibol, S. Godfrey

Optimized Architecture for Passenger Spacecraft .................................................................. 1882
C. Adams, G. Petrov, C. Ciardullo, F. Levy, A. Clinton
Selection of a Carrier Aircraft and a Launch Method for Air Launching Space Vehicles .................1901
  M. Sarigul-Klijn, N. Sarigul-Klijn, G. Hudson, B. McKinney, J. Voss, P. Chapman, B. Morgan, J.
  Tighe, J. Kramb, K. Doyle, M. Quayle, C. Brown

SpaceX Products—Advancing the Use of Space ..................................................................................1912
  M. Vozoff, J. Couluris

Dream Chaser for Space Transportation: Tourism, NASA, and Military Integrated on a
Atlas V ................................................................................................................................................1921
  F. Taylor, R. Howard

Next Generation Advanced Video Guidance Sensor: Low Risk Rendezvous and Docking
Sensor ................................................................................................................................................1950
  J. Lee, C. Carrington, S. Spencer, T. Bryan, R. Howard, J. Johnson

A Passive Microscale Solar Sail ...........................................................................................................1961
  J. Atchison

A Scalable, Time-Dependent Model of Shared Knowledge in Concurrent Spacecraft
Design ................................................................................................................................................1979
  M. Avnet, A. Weigel

Monitoring of International Space Station Telemetry Using Industry-Standard Control Charts ......1990
  J. Gouveia, J. Fitch, S. Hernandez, A. Hillin, A. Simon

A Formal Approach for the Verification Process of Space Software .............................................2003
  M. Alves, C. Dantas, N. Arai, R. Silva

Framework for the Parametric System Modeling of Space Exploration Architectures ....................2012
  D. Komar, J. Hoffman, A. Olds, M. Seal

Reactive, Safe Navigation for Lunar and Planetary Robots .................................................................2033
  H. Uitz, T. Ruland

Volume 4

Lessons Learned from All-Terrain Hex-Limbed Extra-Terrestrial Explorer Robot Field
Test Operations at Moses Lake Sand Dunes, Washington .....................................................................2044
  D. Mittman, M. Powell, R. Torres, C. McQuin, M. Vona

Extravehicular Activity Technology Development Project ..............................................................2054
  R. Trevino, D. Westheimer

NASA In-Situ Resource Utilization (ISRU) Project: Development and Implementation ..................2084
  G. Sanders, W. Larson, K. Sacksteder, C. McLemore

Fabrication Capabilities Utilizing in Situ Materials .............................................................................2099
  J. Good, S. Gilley, C. McLemore, J. Fikes, C. Darby

Sustainable Human Presence on the Moon Using In Situ Resources ............................................2105
  C. McLemore, J. Fikes, K. McCarley, C. Darby, P. Curreri, J. Kennedy, J. Good, S. Gilley

Optimization of Resource Transportation and Energy Production for an Interplanetary
Civilization ...........................................................................................................................................2115
  D. Chipman, K. Skousen

Web-Based Simulation for Operations Support and Training Management on Future
Exploration Missions ..........................................................................................................................2136
  A. Megahed, T. Crabb, M. Gustafson

  G. Garcia

A New Flight Dynamics Solution for Operations of the Boeing 702 Satellite .................................2149
  M. Possner, M. Almendra, G. Garcia

On the Concept of Value and Its Importance to Space Systems Design and Acquisition ..................2159
  J. Brathwaite, J. Saleh
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Risk of On-Orbit Obsolescence: Justifiable Concern or Extenuating Circumstance for DOD’s Space Acquisition Practices?</td>
<td>2171</td>
</tr>
<tr>
<td>G. Dubos, J. Saleh</td>
<td></td>
</tr>
<tr>
<td>Value of the Probability of Success</td>
<td>2186</td>
</tr>
<tr>
<td>P. Collopy</td>
<td></td>
</tr>
<tr>
<td>Application of Value-Centric Design to Space Architectures: The Case of Fractionated Spacecraft</td>
<td>2192</td>
</tr>
<tr>
<td>O. Brown, P. Eremenko</td>
<td></td>
</tr>
<tr>
<td>Forecasting the Next 20 Years in Space: The New Race to Space</td>
<td>2223</td>
</tr>
<tr>
<td>B. Cordell, A. Hovey</td>
<td></td>
</tr>
<tr>
<td>International Cooperation and Competition in Space: Some Lessons and Projections for Space Commercialization</td>
<td>2229</td>
</tr>
<tr>
<td>R. Mains</td>
<td></td>
</tr>
<tr>
<td>Right Long Term Goals are Needed for Public Support of Space Policy</td>
<td>2236</td>
</tr>
<tr>
<td>R. Scaringe</td>
<td></td>
</tr>
<tr>
<td>Reviving Space Futurism: A New Focus on Long-Term Strategic Planning</td>
<td>2243</td>
</tr>
<tr>
<td>J. Vedda</td>
<td></td>
</tr>
<tr>
<td>Partial Rocket Reuse Using Mid-Air Recovery</td>
<td>2253</td>
</tr>
<tr>
<td>M. Gravlee, B. Kutter, F. Zegler, B. Mosley, R. Haggard</td>
<td></td>
</tr>
<tr>
<td>Systems of Systems Approach to Modeling Lunar Bases</td>
<td>2264</td>
</tr>
<tr>
<td>J. Held, J. Schlutz, B. Ganzer</td>
<td></td>
</tr>
<tr>
<td>Lunar Development Architecture Approaches Adaptable to International Cooperation</td>
<td>2282</td>
</tr>
<tr>
<td>D. Wingo, G. Woodcock</td>
<td></td>
</tr>
<tr>
<td>Solar System Longboats: A Holistic and Robust Mars Exploration Architecture Design Study</td>
<td>2300</td>
</tr>
<tr>
<td>D. Barker</td>
<td></td>
</tr>
<tr>
<td>Metrics for Evaluating Survivability in Dynamic Multi-Attribute Tradespace Exploration</td>
<td>2330</td>
</tr>
<tr>
<td>M. Richards, A. Ross, N. Shah, D. Hastings</td>
<td></td>
</tr>
<tr>
<td>S. Spremo, P. Khapar, J. Bregman, C. Dallara, S. Ghassemieh, J. Hanratty, E. Jackson, C. Kitts, M. Lindsay, I. Mas, N. Mattei, D. Mayer, E. Quigley</td>
<td></td>
</tr>
<tr>
<td>Space Technologies from the Portfolio of NASA’s Innovative Partnerships Program</td>
<td>2364</td>
</tr>
<tr>
<td>D. Comstock</td>
<td></td>
</tr>
<tr>
<td>Field Testing of Utility Robots for Lunar Surface Operations</td>
<td>2373</td>
</tr>
<tr>
<td>The Exploration Technology Development Program Multi-Center Cockpit</td>
<td>2388</td>
</tr>
<tr>
<td>D. Mittman, J. Norris, R. Torres, K. Hambuchen, R. Hirsh</td>
<td></td>
</tr>
<tr>
<td>FootFall: A Ground Based Operations Toolset Enabling Walking for the ATHLETE Rover</td>
<td>2400</td>
</tr>
<tr>
<td>V. SunSpiral, D. Chavez- Clemente, M. Broxton, L. Kelly, P. Mihalich, D. Mittman, C. Collins</td>
<td></td>
</tr>
<tr>
<td>Robotic Hovercraft for Surface Mobility on Titan A Moon of Saturn</td>
<td>2414</td>
</tr>
<tr>
<td>A. Lipin</td>
<td></td>
</tr>
<tr>
<td>Cost and Benefits of Automation for Lunar Surface Operations: Preliminary Results</td>
<td>2430</td>
</tr>
<tr>
<td>J. Frank</td>
<td></td>
</tr>
<tr>
<td>Development of an Active Dust Mitigation Technology for Lunar Exploration</td>
<td>2446</td>
</tr>
<tr>
<td>Comparison of Radiation Transport Codes for Solar Particle Events Space Environment</td>
<td>2454</td>
</tr>
<tr>
<td>R. Tripathi, J. Wilson, L. Townsend, T. Gabriel, L. Pinsky, T. Slaba</td>
<td></td>
</tr>
</tbody>
</table>
G. Scott, G. Meirion-Griffith, C. Saaj, E. Moxey

A Systems Engineering Process for the Development of Analog Missions for the Vision for Space Exploration
E. Deems, L. Baroff

LOCAD-PTS: Operation of a New System for Microbial Monitoring Aboard the International Space Station (ISS)
J. Maule, N. Wainwright, A. Steele

Design of Power Systems for Extensible Surface Mobility Systems on the Moon and Mars
S. Hong, J. Hoffman

Propellant Selection for the Lunar Lander Ascent Stage
G. Mills, M. Riesco

Managing Contact Dynamics for Orbital Robotic Servicing Missions
C. Henshaw, F. Tasker

Astronaut Interface Device (AID)

Automation for Operations
J. Frank

Analysis of Architectures for Long-Range Crewed Moon and Mars Surface Mobility
W. Hofstetter, S. Hong, J. Hoffman, E. Crawley

Preliminary Structural Design Considerations and Mass Efficiencies for Lunar Surface Manipulator Concepts
J. Dorsey, M. Mikulas, W. Doggett

Optimal Location of Relay Satellites for Continuous Communication with Mars
D. Byford, J. Goppert, T. Gangale

Exploration Development Lab: Industry Investments Supporting Constellation Risk Reduction
S. Stagliano, T. Nguyen, P. Goodwin M. Tichenor

Characterization of Life Support Mass Across Human Mars Mission Design Space and Advanced Life Support Technology Options
M. Simon, A. Wilhite, C. Jones, M. Rudisill

Linking Technology Capability to Human-Robot Mission Productivity

Dexterous Miniature in Vivo Surgical Robot for Long Duration Space Flight
N. Wood, A. Lehman, J. Dampert, S. Farritor, D. Oleynikov

A High Performance Command and Data Handling System For NASA's Lunar Reconnaissance Orbiter
Q. Nguyen, W. Yuknis, S. Pursley, D. Albajes, N. Haghani, O. Haddad

Technologies for Cooling of Large Distributed Loads
J. Feller, J. Maddocks, B. Helvensteijn, A. Kashani, G. Nellis

Ares-V Additional Mission Opportunities
B. Donahue, N. Graham, R. Lajoie, M. Farkas, S. Weisburg

Hierarchical Infrastructure for Integrated Space Operations
M. Kaplan, A. Anderson

Applying the UK's PPP Lessons to NASA's Commercial Development Policy
D. Iron, K. Davidian

Author Index