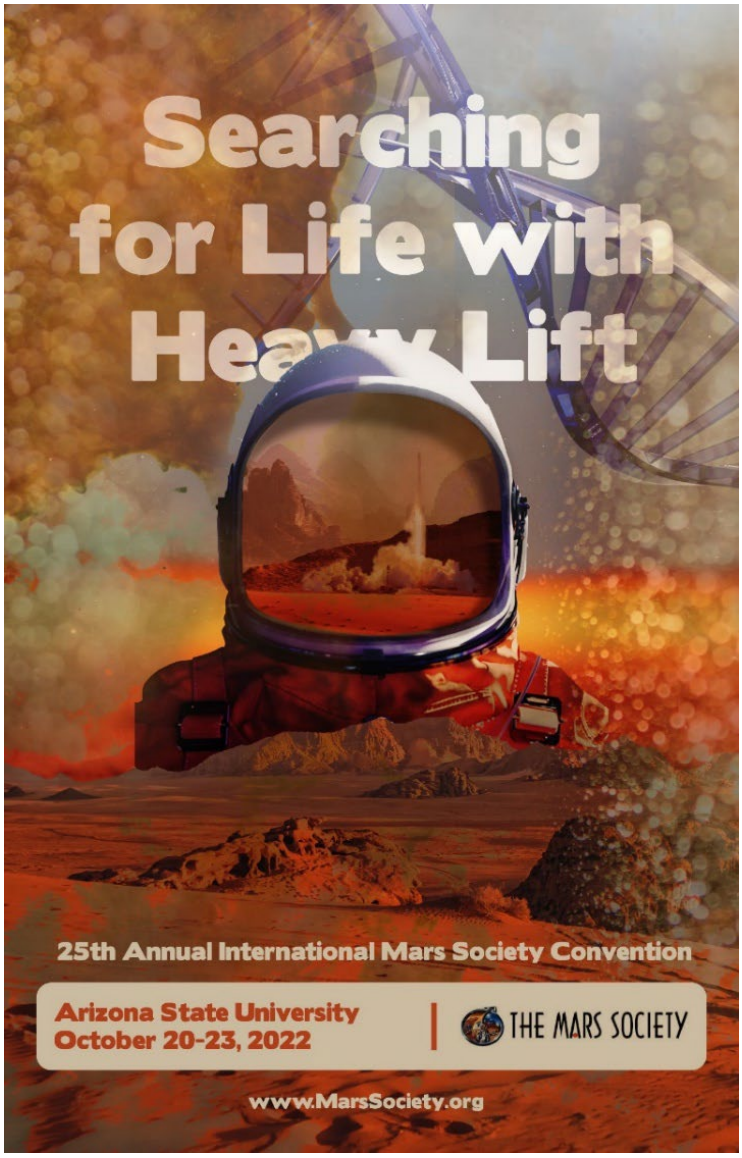
# THE MARS SOCIETY

The 25th Annual International
Mars Society Convention
October 20th - 23rd, 2022

# "SEARCHING FOR LIFE WITH HEAVY LIFT"

*An Hybrid (In-Person and Virtual) Event with the World's Top Mars Leaders and Experts*

**Questions and Requests:** *conference-staff@marssociety.org*

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L4 SPACE ENGINEERING

MILLION ON MARS

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## Convention Schedule

| *All Times are Arizona Time (MST / PDT)* | **Day 1 - Thursday October 20th** | | | | |
|---|---|---|---|---|---|
| | **Morning Plenaries** - *Arizona Ballroom* | | | | |
| **9:00 AM** | Dr. Robert Zubrin - Opening Remarks | | | | |
| **9:30 AM** | Dr. Jim Bell - Postcards from Mars: Curiosity & Perseverance Mission Update | | | | |
| **10:00 AM** | Dr. Marcia Rieke - The Webb Telescope's First Months: A Treasure Trove of Results | | | | |
| **10:30 AM** | Dr. Vandi Verma - Mars Rover Operations and Role of Autonomy and Humans in Sample Return | | | | |
| **11:00 AM** | Dylan Taylor - NewSpace 2025: How the Space Industry will Likely Evolve in the Next Few Years | | | | |
| **11:30 AM** | Steven A. Benner - The Case for Extant Life on Mars | | | | |
| **12:00 PM** | **Lunch Break (12pm - 1pm)** | | | | |
| | **Afternoon Track Sessions** | | | | |
| | **Special Presentations** *Arizona Ballroom* | **Political & Legal** | **Tech R&D A** | **Medical** | **Virtual Presentations** *(Online only)* |
| **1:00 PM** | Jan Spacek - ALFA Mars: Finding Extant Life on Mars Before Humans Arrive | Fabara, Lopin et. al. - The Martian Republic - A governance system for Mars | Libby Hubbard, EdD - Building Earth Arcologies as Precursors to Mars Colonies | Dr. Tamara Pack - Astro-Psychiatry: Mental Health & Space Exploration | Akhilesh Jhawar - Design of a Lambda Based Suspension for Space Missions (V) |
| **1:30 PM** | Miroslav Rozloznik - Underwater Analog Space Missions (V) | Nina Kojima - Ethics in Extraterrestrial Nanotechnology | Grant Strem - Direct "Air" Capture of CO2 using Humidity Swing Adsorption on Mars | Harley Jackson - Comparative Behavior of E. coli Cultured in Simulated Microgravity or Earth Gravity | Alejandro Salinas-Téllez - Crop Production for LD Space Missions (V) |
| **2:00 PM** | Jacek Wyszyński - Occupy Mars: The Game (V) | Lauer & Earnshaw - The Martian Papers: Stewardship of the Planet | Colin A Lennox - Harvesting Rare Earth Elements using Bioreactors | Barnabas Pasztor - Food and Nutrition Plan for Spaceflight to Mars | Alessandra Calanchi - Heretical Science and an Interplanetary Human Race (V) |
| **2:30 PM** | Ashley Kowalski - SIRIUS-21 Spaceflight Analog Mission | Trevino et. al. - Microgreen Feedstock for In-situ Utilization on Mars | Patrick Selby - When will humans go to mars? | Susan Ip-Jewell - HOLOTRIAGE: A VR Sim for Medical Training | Sumanarathna - A Feasibility Study of Space Tourism using Augmented Reality (V) |
| **3:00 PM** | **Peter Beck - CEO, Rocket Lab (V)** *Arizona Ballroom* | | | | |
| **3:30 PM** | | | | | |

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|---|---|---|---|---|---|
| 4:00 PM | James Burk, Jeff Rayner - Mars VR & Field Science Demos | James Gilley - The Martian Papers: A Case for a Sovereign Mars | Jie Xu - Tapping water reservoirs hidden in hydrate minerals | M. Turner - Organization of Gravity on the Functional Movements of the Human Body | Art Harman - Politics, Mars and YOU (V) |
| 4:30 PM | Dr. Shannon Rupert - Education Initiatives at MDRS (V) | Dr Joseph Michalski - Analysis of China's Space Program (V) | Douglas Hamilton - Software to Calculate a Mission's Medical Mass, Power and Volume | Emmy Jewell - MEDINAUT -The Flying "Da Vinci" Telerobotic-Telesurgical Drone-Rover | Davey Sapinski - Interstellar Education Foundation (V) |
| 5:00 PM | Panel on MDRS Analog Suits - Davis, Reed, Kuznetz, Burk (Moderator) | Edward Heisler - A military war will China will prevent the human settlement of Mars | Gary Johnson - Engineering Lander/Rover for Mars | William Gardiner - Long Duration Space Flight Using Nutrition Plans | David Nordling - Low-Gravity Orbiting Centrifuge Manned Habitat (V) |
| 5:30 PM | Peter Dekluyver - Dressing for the consumer space race | Lev Reznikov - Hi-Energy Impact Engineering | Pooja Kasiviswanathan - Farming on Mars (V) | Douglas Hamilton - Astronauts and their Biomes for a Mars Mission | Scott Balcao - Radiation Effects on Plants in Space Flight (V) |
| | **Dinner Break (6pm - 7pm)** | | | | |
| | **Thursday Evening Program** | | | | |
| 7:00 PM | Public Event at ASU: **Search for Life on Mars Panel** (Arizona Ballroom)<br>Robert Zubrin, Steven Benner, Jan Spacek, Jim Bell | | | | |
| 7:30 PM | | | | | |
| 8:00 PM | | | | | |
| 8:30 PM | | | | | |

| *All Times are Arizona Time (MST / PDT)* | **Day 2 - Friday October 21st** |
|---|---|
| | **Morning Plenaries -** *Arizona Ballroom* |
| 9:00 AM | Dr. Jan Millsapps - Model Mars |
| 9:30 AM | Dr. Greg Autry - Artemis and the Moon as a capabilities building destination for Mars |
| 10:00 AM | Dr. Jim Green - Former NASA Chief Scientist |
| 10:30 AM | Dr. Bhavya Lal, Associate Administrator, NASA - Nuclear Propulsion for Mars |
| 11:00 AM | Pamela Melroy - Deputy Administrator, NASA - The Human-Machine Teaming Path to Get Us There |
| 11:30 AM | Dr. Ezinne Uzo-Okoro, Asst. Dir., Space Policy, The White House - In-Space Capabilities for Mars & Beyond (V) |
| 12:00 PM | **Lunch Break (12pm - 1pm)** |

| | Afternoon Track Sessions | | | | |
|---|---|---|---|---|---|
| | **Special Presentations** *Arizona Ballroom* | **Analog Research & Facilities** | **Tech R&D B** | **Permanent Settlement** | **Virtual Presentations** *(Online only)* |
| **1:00 PM** | James Burk - The Mars Society: Programs & Initatives | Dr. Jonathan Clarke - Mars Analogue Research Station for Australia (V) | Doug Plata - The Artificial Gravity Prescription for Mars | Frank Schubert - Construction on Mars (What it will take) | Collier-Wright & Bögel: Magnetoplasmadynamic Thrusters (V) |
| **1:30 PM** | James Melton - Mars Society Ambassador Program | Julio Rezende - Underwater activities in Space Analog Station Habitat Marte (V) | Jason Evans - MarsXR Hazard Management System (HMS) | Stellie Ford - Feeding a Colony: ISRU in early space habitats | *Open Slot* |
| **2:00 PM** | *Ambassador Presentations:* Roger Gilbertson Garland Rush | Gary Johnson - Suits and Hab Atmospheres | John Parks - Interplanetary Application of Ecological Learning: Ten Lessons from Managing Earth's Oceans to Guide In Situ Resource Utilization on Mars | Daniel Ives - Biological-age control to maximise the settlement-rate of new planets | Francis Desilets-Mayer - In-situ production of rocket propellant on Mars using the Sabatier reaction: a feasibility study (V) |
| **2:30 PM** | | Wayne L. White - The South Pole and Mars | Donald Jacues - In Search of Biological Life Support | Richard L Poss - Mars the New World: Reflections on the 500 Year Metaphor | Cynthia Hills - Living With Children on Mars (V) |
| **3:00 PM** | Kent Nebergall - Accelerate Like Elon 2022: Updated Methodologies | Jason Simpson - Digital EVA Tracking for MDRS | Holger Isenberg - 24 Color Cameras to answer "Red or Blue Sky on Mars?" | John Brandenburg - Past Events that may have Devastated the Planet | James Secosky - What have we found on Mars? (V) |
| **3:30 PM** | Michael Helton & Dimitrie Grigorescu - The Expansion Effect | Kristen Miller - AARG: Developing a Program for Student Research and Leadership | *Open Slot* | Stuart Nelson - Community Building System for Mars and Earth | Jim Pass - The "Astrosociology in the Classroom" Program: Contributions of Social-Scientific Space Education and Research (V) |
| **4:00 PM** | Jayden Sage - The Martian Economy | Will Green - MarsSuits, An Overview of the Technology Needed for Martian EVAs | Eric Robinson - Hydrogen Powered Hypersonic Launch Colonize Mars Sustainably | Gonzalo Munevar - Some Scientific Challenges in the Exploration of Mars | Jim Plaxco - How Not to Design a Martian Economy (V) |
| **4:30 PM** | Mackenzie & Lutz - Mars University Planning and Focus Group (V) | Susan Ip-Jewell - A New Analog Facility for Training "SPACE MEDICS" Astronauts | *Open Slot* | Doug Plata - Meteorites for Early Metals on Mars | Joshua Sparber - Parameters of Life (V) |
| **5:00 PM** | Don Lefevre - Companion Dogs in Space? | Scott Balcao - Mountaineering: An Analog for Human Space Training (V) | Gary Johnson - Orbital Propellant Depot | Robert Mills - Surviving and thriving for 5–10-years | Julia Alvarez Vallero - A potential solution to deal with charged particles on Mars (V) |

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| **5:30 PM** | Paul R. Kan - Buzzed Lightyear: Tapping Into Beer's Interplanetary Future | Julio Rezende - Brazilian Mars Analog Simulant (V) | Mackenzie - Analog Mars Settlement (V) | Doug Plata - Full Self-reliance 15 Years Sooner | Sam Ross - Syrtis: A new tool for habitat thermal analysis (V) |
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| | **Friday Evening Programs** | | | | **Virtual Presentations** *(Online only)* |
| **6:00 PM** | **Reception** at ASU NewSpace Dept (ISTB4) Plus Tours of ASU Space Exhibits | | | | Balcao - Polar Expeditions as Case Studies (V) |
| **6:30 PM** | | | | | *Open Slot* |
| **7:00 PM** | | | **Live Music Event** (21+) - F. Shubert & TBD Local Act - Last Exit Live (downtown PHX) | | *Open Slot* |
| **7:30 PM** | | | Transportation will depart from ISTB4, and return to area hotels approx 10pm | | Manousos Chairetis - Power Space Peace (V) |

| ***All Times are Arizona Time (MST / PDT)*** | **Day 3 - Saturday October 22nd** | | | | |
|---|---|---|---|---|---|
| | **Morning Plenaries -** *Arizona Ballroom* | | | | |
| **9:00 AM** | Dr. Albert Haldemann - ESA Mars Chief Engineer (V) | | | | |
| **9:30 AM** | Dr. Jekan Thanga & Dr. Sergey Shkarayev - Mars Exploration Using Sailplanes and Balloons | | | | |
| **10:00 AM** | Dr. William Bianco - Russia & The Limits of Global Space Cooperation | | | | |
| **10:30 AM** | IMM Team 2 - N.E.W. E.R.A. Mars Mission Proposal | | | | |
| **11:00 AM** | International Mission to Mars (IMM): Mars Society's Engineering Design Course & Competition for High Schoolers | | | | |
| **11:30 AM** | Dr. Kris Zacny - Future of Robotic Mars Exploration | | | | |
| **12:00 PM** | **Lunch Break (12pm - 1pm)** | | | | |
| **12:30 PM** | | | | | |
| | **Afternoon Track Sessions** | | | | |
| | **Telerobotic Competition** *Arizona Ballroom* | **Humanity's Future** | **Tech R&D C** | **Student Competitions** | **Virtual Presentations** *(Online only)* |
| **1:00 PM** | *Telerobotic Competition Finalists* | Erik Bethke, CTO - Million on Mars game | Oleg Mansurov - History and Future of Russian space programs to Mars | IMM Team 3 - Polemos I: The Foundation for the Future of Mars Exploration | Mikolaj Sobocinski - Invincible Games & Omnipresent Simulations (V) |
| **1:30 PM** | *Telerobotic Competition Finalists* | Michael Laine - Starship Singularity | Jason Achilles Mezilis - The Future of Sound on Mars | IMM Team 1 - Valles Marineris Exploration Mission | Hussain - Hybrid Power Generation Method (V) |

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| **2:00 PM** | *Telerobotic Competition Finalists* | Charles Letherwood - The Mars Leap: Putting YOU on Mars | Dr. Peter Swan - Massive Lift to Mars Everyday as fast as 61 Days Delivery | IMM Team 5 - Ares-1: A Student-Designed Mars Mission | Manjunatha - SLS ARYA (ಅಕ್ಷಿತ ಆರ್ಯ) - Heavy Lift Rocket Architecture (V) |
| **2:30 PM** | *Telerobotic Competition Finalists* | Stellie Ford - Decentralized Funding for Public Access to Space | Richard L Poss - Mars the New World: Reflections on the 500 Year Metaphor | *Martian Greenhouse Session One (V)* | Bary Maxime - Building a pressurized dome on Mars (V) |
| **3:00 PM** | *Telerobotic Competition Finalists* | Alexander Shenderov - Homo Exploratoris | Scott Van Hoy - Observing Facial Emotion Recognition Accuracy and Psychological Health Indicators during Short-Duration Space Analog Missions | *Martian Greenhouse Session Two (V)* | Priscilla Chase Thomas - Womens Contributions to Our Push for the Stars (V) |
| **3:30 PM** | *Telerobotic Competition Finalists* | James Gilley - Resource Conflict and Great Power Politics in Space | Gary Johnson - "Starship" at Mars | *Martian Greenhouse Session Three (V)* | Mackenzie - Bio-Plastic Mars Habitat (V) |
| **4:00 PM** | *Open Slot (Room Prep Time)* | Brandenburg - A Scenario Where a Mars Colony Saves Humanity | Douglas Shull - Lunar Lava Tube Bases for Telescopes (V) | *Martian Greenhouse Session Four (V)* | Cambise - Modular Radiation-Resistant Shell for Mars Habitat (V) |
| **4:30 PM** | *Open Slot (Room Prep Time)* | Gary Johnson - Colonizing Mars | Christian Lewis - Trajectories for the Human Exploration of Mars and Ceres | *Martian Greenhouse Session Five (V)* | Eddie Zhuang - Caution! This is not a meteor shower! (V) |
| **5:00 PM** | *Open Slot (Room Prep Time)* | Kent Nebergall - Independence – Mapping a Multi-Planet Species | M K Borri - Rover Fleet Design (V) | Bob Barboza - Planning for the First School on Mars (V) | *Open Slot* |
| **5:30 PM** | *Open Slot (Room Prep Time)* | Frank Moreno - Martian transhumanism (V) | Vadym Romanko - Ice base (V) | Vatasta Koul - Human Desire to Explore Mars (V) | Art Harman - Space Race or Space War? China, Russia and the Free World (V) |
| | **Saturday Evening Program** | | | | |
| **6:00 PM** | **Saturday Banquet**<br>Speakers:<br>Michael Edmonds - Blue Origin<br>Erdenebold Sukhbaatar - MARSA (Mongolian Aerospace, Research and Science Association)<br>plus Awards Ceremony. | | | | |
| **6:30 PM** | | | | | |
| **7:00 PM** | | | | | |
| **7:30 PM** | | | | | |

| | Sunday October 23rd |
|---|---|
| | **Morning Plenaries -** *Arizona Ballroom* |
| **9:00 AM** | Dr. Jingnan Guo, The University of Science & Technology of China (V) |
| **9:30 AM** | Sabine Heinz - Space Renaissance International - Art on Mars (V) |
| **10:00 AM** | Maria Perino - Thales Aerospace Italy (V) |
| **10:30 AM** | Kai Staats - Mars Analog and Research Station at Biosphere 2 |
| **11:00 AM** | Alfredo Munoz - The Off-World Metaverse: Digital Simulation of Martian Settlements |
| **11:30 AM** | Sergey V. Ushakov - CALPHAD-Assisted Thermal Analysis for water-free production |
| **12:00 PM** | Dr. Stefano Nerozzi - International Mars Ice Mapper Measurement Project |
| **12:30 PM** | Maraia Tanner - Star Harbor Academy |
| **1:00 PM** | Dr. Robert Zubrin - Closing Remarks |
| **1:30 PM** | |

## 25th Annual International Mars Society Convention
## October 20-23, 2020

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# THURSDAY AFTERNOON SESSIONS

## Special Presentations

### ALFA Mars: Finding Extant Life on Mars Before Humans Arrive

**Jan Špaček**

**Firebird Biomolecular Sciences, LLC**

Before the first crewed Starship departs for Mars, hundreds of tons of Martian glacial ice must be robotically mined to make propellant for the returning vehicle. This offers an unparalleled opportunity for astrobiological research. The mid-latitude glacier ice to be mined is geologically young and contains matter, including potential traces of life, blown there by wind from all known and unknown near-surface ecosystems. This sampling is precedented on Earth, where every glacier contains a record of preserved microorganisms from Earth's entire surface. We propose to use this in situ-mined water as a massive sample from which genetic molecules will be extracted using our Agnostic Life Finder (ALF). Although we do not know what molecules Martian life holds, we know that the molecules that it must have to store hereditary information must be charged polymers. If any site on Martian surface contained life in the last 100,000 years, ALF will be able to find its record stored in the glacial ice.

ALF is a shoe box-sized concentrator that uses electric fields to separate charged molecules from tons of mined water. It concentrates polyelectrolyte genetic biopolymers from a sonicated stream of water, with dirt and small ions discarded in separate streams. ALF is thus uniquely able, at little added cost, to analyze the entire Martian surface for a truly agnostic biosignature. ALF increases the sensitivity of state-of-the-art analyzers by at least 6 orders of magnitude, proportionally increasing the chance to accurately assess the presence of life on Martian surface in the short time remaining before the first humans arrive there.

With NASA continuing to resist missions to Mars that search for extant life, we are building an international team, ALFA Mars, needed to extract and analyze Martian genetic material in the next 4 years. For more details visit alfamars.org and primordialscoop.org/tag/alf.

### Underwater Analog Space Missions

**Miroslav Rozloznik**

**Centre of Hyperbaric Medicine, Faculty of Medicine, University of Ostrava**

**& Ostrava City Hospital, Czechia**

**Mironaut, s.r.o., Slovakia**

Research habitats, where analog space missions are conducted are usually located in Isolated, Confined, and Extreme environments such as deserts, polar regions, lava fields, bunkers, and underwater. The underwater analog space missions are considered high-fidelity environmental spaceflight analog. Currently, there are 3 underwater research analog habitats operational worldwide, two located in the ocean and one located in sweet water.

During my presentation I will review the most current underwater analog space missions and outline the challenges which should be addressed during the future missions.

## Occupy Mars: The Game

**Jacek Wyszyński**

Occupy Mars is a highly technical, open-world sandbox game about Mars colonization inspired by the most promising technologies and companies that are working toward becoming a multi-planet species. Build and upgrade your base, discover new amazing regions, conduct mining operations, retrieve water, generate oxygen, grow crops, fix broken parts, and learn how to survive on Mars!

## SIRIUS-21 Spaceflight Analog Mission: 8 Months Living and Working in Isolation and Confinement from the Crew's Perspective

**Ashley Kowalski, William Brown**

**SIRIUS 21 Crewmembers**

The SIRIUS-21 mission (Scientific International Research In a Unique terrestrial Station) is one of a series of long-duration spaceflight analog missions meant to simulate and study the effects of isolation and confinement on human psychology, physiology, crew dynamics, crew autonomy, and the general behavioral health of the crewmembers living and working in this type of unique environment. In addition to these goals, the crewmembers also participated in many operational tasks, including but not limited to VR docking simulations, simulated Extravehicular Activities (EVAs), regular exercise, greenhouse upkeep, robotic arm training, and lunar sample assessment.

SIRIUS-21 was a combined effort between NASA and Russia's Institute for Biomedical Problems (IBMP). It was an 8-month long mission held at IBMP's historic Ground-Based Experimental Complex / Nazemnyy eksperimental'nyy kompleks (NEK), where many other spaceflight analog missions, including Mars 500, were also held. The SIRIUS-21 crew, which was composed of representatives from the U.S., the UAE, and Russia, recently completed their 8-month journey on July 3, 2022. The U.S. crewmembers, Ashley Kowalski and William Brown, will openly speak about their first-hand experience. The format of this session will be more interactive, with the audience highly encouraged to ask questions of the crewmembers.

## Mars VR & Field Science Demos

**James Burk, Jeff Rayner**

**The Mars Society & MXTReality**

MarsVR is the Mars Society's multi-phase effort to establish the capability of using Virtual Reality to assist with the initial human exploration of landing sites. Over the past five years, the team has created a high-fidelity digital twin of the Mars Desert Research Station in Utah, including a square kilometer of Mars-like terrain, and crew trainings procedures within the application including manipulation of objects and information about our analog research program.

The team now is focused on the emerging field of CrowdExploring and its use for field science within analog missions. We are preparing a field demo that would demonstration how an analog astronaut on EVA would have real-time support from a crewmember in VR to explore sites of scientific interest.

### Farming on Mars

**Pooja Kasiviswanathan**

A fundamental challenge in human missions to Mars is producing consumable foods efficiently with the in situ resources such as soil, water, nutrients and solar radiation available on Mars. The low nutrient content of martian soil and high salinity of water render them unfit for direct use for propagating food crops on Mars. It is therefore essential to develop strategies to enhance nutrient content in Mars soil and to desalinate briny water for long-term missions on Mars. We report simple and efficient strategies for treating basaltic regolith simulant soil and briny water simulant for suitable resources for growing plants. We show that alfalfa plants grow well in a nutrient-limited basaltic regolith simulant soil and that the alfalfa biomass can be used as a biofertilizer to sustain growth and production of turnip, radish and lettuce in the basaltic regolith simulant soil. Moreover, we show that marine cyanobacterium Synechococcus sp. PCC 7002 effectively desalinates the briny water simulant, and that desalination can be further enhanced by filtration through basalt-type volcanic rocks. Our findings indicate that it is possible to grow food crops with alfalfa treated basaltic regolith martian soil as a substratum watered with biodesalinated water.

### Dressing for the Consumer Space Race

**Peter Dekluyver**

I have a $200,000 Lunar EVA suit made for under $4,000. Historically Lunar “EVA” space suits were extremely expensive and practically unobtanium. Dr. Smith (Pacific Space Flight) pioneered low-cost pressure suits last decade. I was lucky to learn from him to start on my own suit. My goal is to add to his work and make it fully mobile for up to a 3-5H walk on the moon or mars.

Mid 2022 I committed to build a working EVA suit and life support system with the goal to get the cost under $10k. By utilizing simplified means of build methods and off-the-shelf parts I have managed to reduce the cost to below $4,000. The key was to use as common hardware and materials as one can find: Gas fittings, Zippers, connection rings. Etc. And Modding them to spec.

Realizing that the cost and time for a basic EVA suit is mostly inflated numbers. Sorry. Here is my conclusion: Yes you can not only build a space suit for cheap. But one with a working EVA pack to let you roam free too!

## Political & Legal

### The Martian Republic - A governance system for Mars

**Sebastian Fabara, Lennart Lopin, Philipp Puaschunder, Matt Wise**

**Marscoin Foundation**

The Martian Republic is a suite of online tools built into an online non-custodial wallet, allowing the early Martian settlement to offer all necessary civic tasks in building a direct participatory democratic society. This new form of blockchain-based “Republic As Software” achieves a high level of transparency in direct and immediate consent of and by the governed. Each participant is an active member utilizing censor-resistant public forums and casting

cryptographically secured and end-to-end auditable votes. The very codebase on which this Republic runs becomes its Constitution and remains a reflection of the will of the people. Each individual directly interacts with society leveraging the advantages of trust-less ledger technology for notarized on-chain actions. The client-server, open-source, second-layer caching solution provides a scalable architecture. To this end, the project ties together a classic and secure (proof-of-work) blockchain (Marscoin) and a modern distributed data storage system (Interplanetary File System or IPFS ). We propose this coordinated toolset approach that links a wallet, a dynamic public voter registry, a public forum, and a coin-shuffle-protocol-based secure ballot issuance method to derive a unified public consensus. We present this combination of an initial set of tools, the Martian Republic, as a unique governance platform to which other organizational features can be added dynamically over time and which, being software itself, is allowed to consensually develop as society evolves.

## Ethics in Extraterrestrial Nanotechnology

**Nina Kojima**

**University of Glasgow/ Partisan Media**

With the launch of the first satellite into Earth's orbit, we became an extraterrestrial civilisation. And we are set to go further, to form human colonies and settlements on the Moon and Mars, and perhaps in the near future on another object in our solar system or beyond.

This transition of humanity into extraterrestrial spaces has once again raised philosophical questions that were at the heart of civilisations long before ours: who are we, why are we here, where do we go, and why do we exist? In modern times, we can add the questions: how long can we exist on this planet? And does the Universe belong exclusively to us?

An equally important question is what is our relationship with the rest of the Universe, and can we implement our ethics in space exploration? And what kind of ethics – are they deontological? How can we possibly act as ethical human beings in a lethal environment, a planet we are not made of, and in circumstances where our survival is challenged every second of our life?

In order to understand what ethics in space exploration means, we must first answer the fundamental question, which is not why we are going to space, but how.

Are we going to colonise, are we going as part of our evolution, or are we going as part of our evolution and to colonise? I will support my argument that the ethical norms are different regarding all three proposed variants.

## The Martian Papers: Stewardship of the Planet

**Brendan Lauer, Hannah Earnshaw**

**Mars Ethical Settlement Alliance**

In this paper we address the question of how humans living on Mars will live and interact with the planet and its resources. The primary goal of the settlement project is for humans to live permanently on Mars without the requirement of anything from Earth for survival. To achieve this, we need to consider two principal phases of establishment: immediate short-term survival and sustainable long-term self-sufficiency. Actions taken on Mars should be undertaken with both of these aspects in mind, with short-term survival taking precedence at early times, but aiming to be consistent with the long-term well-being of an established settlement in the future. We propose that the model of environmental stewardship, with both humans and potential Martian life being considered part of the Martian biosphere, is one that can help humanity develop a lasting good relationship with the planet they live on right from the beginning of Martian inhabitation. As part of the Martian Paper series, we present the case for planetary stewardship of Mars being vital for the entirety of human presence on the Red Planet.

**Arthrospira Platensis/Hawaiian Spirulina as a Microgreen Feedstock for In-situ Utilization on Mars and Other Planetary Bodies**

**Terry Trevino, Larry Harrison, Erin Stamper, Brian Murphy, and Emma Follis**

**APUS Space Studies Research Group**

Our study evaluated the efficacy of Hawaiian *Spirulina Arthrospira Platensis*, a cyanobacteria, to enhance the growth of microgreens in simulated Martian regolith (MGS-1). We evaluated growth rates over a range of regolith-soil mixtures. We also evaluated growth in environments with a 660 nm wavelength light source, under heat duress, in elevated levels of CO2 concentrations by performing the study using the greenhab module in the Inflatable Lunar/Mars Analog Habitat (ILMAH) located on the University of North Dakota campus. In each case, growth rates were measured as a function of time, and plant/root health was evaluated. This study will support NASA's long-term objectives for in-situ resource utilization in space exploration.

**The Martian Papers: A Case for a Sovereign Mars**

**James Gilley**

**Hannah Earnshaw**

**Brendan Laurer**

**Mars Ethical Settlement Alliance**

The popular imagination holds that Mars will one day seek its independence from Earth, and many fictional accounts of a Martian settlement are focused on the political struggles for independence. Scholarly work has highlighted that another model is possible, one that creates a Martian settlement as independent from the beginning. Sara Bruhns and Jacob Haqq-Misra (2015) argue that Mars should be made independent as the best way to protect the common heritage of Mars for humanity and science. Haqq-Misra (2015) further argues that Mars should be, in his words, liberated from Earth to allow for a second instance of human civilization to emerge. Mars must be established as an independent and sovereign entity with similar legal stature as terrestrial nations. While traditional imaginings of human settlement of Mars revolved around the nation-state centric model of space exploration, or even lean towards some form of

corporate oversight in the model of the Dutch and British colonial companies, for a Martian Settlement to be functional in the long-term it must be independent. This paper will argue the case for Martian Independence and sovereignty, from the start of the settlement. This case for an independent Mars will be based on three different areas: 1) the legal case for independence, 2) the strategic case for independence, and finally 3) the philosophical case for independence. As a part of the Martian Paper series, this particular presentation will make the case that Mars must be a sovereign political entity from its first settlement.

## The greatest danger to the human settlement of Mars is a war between the United States and China

**Edward Heisler**

Spreading misleading information, false claims, half-truths and outright lies has become the norm in the propaganda wars of nations in economic or military conflict.

This is the operating mode of the non-stop 24/7 propaganda offensive against China. The tariff/economic war against Chinese capitalism proclaims China is the number one enemy of humankind, democracy, and the United States in a new cold war.

The big corporate owned media has signed on to this narrative in a massive way. Reporters who challenge the pro-war talking points are getting less airtime, print space or have been fired.

The only political writers challenging misinformation and lies in the mass media have a small audience on traditional right-wing Republican (not Trump supporters) publications such as “The American Conservative” and the “National Review” and liberal/left-wing publications (not woke or other ultra-left political sects) like “The Nation” and “The Progressive”.

Using different approaches writers for these publications have reached the same ominous conclusion. The United States is on a collision course into a direct military conflict with China and neither nation can win that war!

A war with China could quickly degenerate into an all-out nuclear exchange between China and the United States. All Chinese and American space exploration rocket launching pads would become the prime targets of the first nuclear attacks. They would be turned into radioactive dust.

Plans for the direct human settlement of Mars by China and the United States would disintegrate in mere minutes. Mars exploration would again be placed on hold for at least another half century. Can we stop that march toward war? We must. And if we succeed that will prove in action that we are becoming a multi-planetary civilization just beginning our long journey into the cosmos. That is our destiny!

## Building Earth Arcologies as Precursors to Mars Colonies

**Libby Hubbard, EdD**

**Patrick Arnesen**

**The Arcology Channel**

Arcologies are a halfway-point between conventional cities and Mars colonies. They are towns and cities that produce their own power, regulate their temperature throughout, grow their own food indoors, have advanced, car-free transportation systems, and close their bio-cycles.

Arcologies would allow civilization to thrive under the hothouse-earth conditions of extreme heat and drought that will soon affect large swaths of the Earth's surface. In that sense, they are a necessary social and technological development for surviving climate change.

Like a Mars Colony, an arcology will require closed-loop systems and levels of integration and cooperation that are incompatible with our current socio-economic system, and so we propose modified institutions, everything from new forms of digital money, democratic corporations, and intentional villages. The components of this new system mesh together and support one another, making the whole viable.

Get these institutions wrong on Mars and you have a dead colony. Arcologies provide the opportunity to test and refine on Earth first, thus reducing the risks for Mars colonization.

At thearcologychannel.org, we are working on achievable, financially affordable plans to develop Arcologies as an adaptation strategy for global warming and for building a better way of life. We hope to work together with pro-Mars groups to achieve both our goals together.

## Direct "Air" Capture of CO2 using Humidity Swing Adsorption on Mars

**Grant Strem**

**Proton Technologies Canada Inc.**

Mars' atmosphere is overwhelmingly CO2 dominated, and while directly freezing CO2 out works best in some places, or some places for certain parts of the night, the most robust system for Mars is to adsorb CO2 on "hairy mops" from the low-density atmosphere, similar to what the University of Arizona has experience with on Earth. To get the CO2 out of the mops, future Martians like me will simply dunk it in water within a container. Easy peasy, carbon cheesy. The CO2, once purified, in this and other methods will be a major feed-stock for carbonate soils, hydrocarbon fuels, proteins, and a bunch of other useful things which we shall speculate upon together near the end of this brief but important talk.

**Harvesting Manganese and Rare Earth Elements from Martian Regolith using Self Organizing Wetland Bioreactors, Based on Experiences from Commercial Terrestrial Analogues Cleaning Appalachian Coal Mine Waters**

**Colin A Lennox**

**EcoIslands LLC**

Biogenic In-situ Resource Utilization (BISRU) will be necessary for permanent Martian habitation. An ISRU strategy that incorporates self-organizing wetland bioreactors (sowbs) can reduce total energetic inputs by 1-2 exponents while providing a broad range of products necessary to agriculture and industry.

We explore several critical products to permanent settlement, focusing on manganese oxides (MnOx) and rare earth elements (REEs) for energy storage and electronics production. Commercial sowbs reclaiming coal mine impacted rivers in Appalachia have been shown to produce high purity MnOx as a product of bacterial cellular metabolism (chemo-litho-autotrophic). These same metabolic processes can be used to catalyze BISRU Mars.

Self-selection leading to self-organization, based on the 100 year old Winogradsky column, can also further refine MnOx or other products through metabolic reduction and re-oxidation in flow through or batch reactors. Concerning REEs, low pH iron (Fe2) oxidation in sowbs is a method of terrestrial in-situ REE capture for further offsite refining. Agricultural and sewerage wastes from habitations are incorporated into the process, providing valuable metabolites and biofilm growth matrix for the mining side of the process while cycling the plants/food/human wastes, though that is another discussion.

**When will humans go to mars?**

**Patrick Selby**

Elon speaking to the Mars Society in 2020 - "..if we do not see something close to an exponential improvement in our rate of innovation we will not reach mars"
When will humans go to mars? In 10 years? 20 years from now? It's hard to predict.
We do know for the 1st time in human history it just might be possible. We are on the cusp of turning something impossible into something possible. Science Fiction will soon become science fact. And while travel to Mars seems so close we can touch it, it is not inevitable. Some have said and I agree, we have only a small window of time in order to get there. A small window before optimism of this generation gives way to ignorance, the status quo and all the hundreds of reasons that has kept humankind tethered in LEO for the past 50 years. While getting to Mars is not inevitable, our fate is in our hands. What can we do? Plenty! This talk will propose a challenge to the Mars Society and all its members. We will discuss how we can organize, optimize and push the envelope of innovation. Using the latest best practices, and proven methodologies learn how to design a Agile Human Project Management System that will take millions of tasks to get to mars and streamline the critical path to get there sooner. With the Mars Society organizing Communities of Practice thousands of volunteers around the world can bring their unique skills to each part of the project. And this is just the beginning, there are endless ways to accelerate innovation like modeling and

simulation, and 3D printing and more!

To quote everyone's favorite martian, lets science the shit out of this and get there faster!

### Tapping water reservoirs hidden in hydrate minerals

**Jie Xu , Hongwu Xu, Alexandra Navrotsky**

**Arizona State**

The discovery of various types of hydrate minerals in significant abundances on Mars attests to the planet's watery past. Some of these hydrate minerals contain substantive amounts of water. For example, gypsum (CaSO4·2H2O), kieserite (MgSO4·H2O), jarosite (K, Na, H3O)Fe3+3(SO4)2(OH)6), and alunite (KAl3(SO4)2(OH)6), all of which have been identified on Mars (sub)surface, respectively contain 20.9%, 13.0%, 20.3%, and 24.3% of water by weight. Further, gypsum and kieserite were indicated to be relatively stable on Mars surface conditions, and in some cases, more resistant to loss of structural water than phyllosilicates (Vaniman et al., 2004; Cloutis et al., 2007; Chipera and Vaniman, 2007; Robertson and Bish, 2013). Based on all these facts, if we assume water was lost quickly, forming sulfate minerals in the last stages of water loss (e.g., Mars since late Hesperian), should we consider sulfate hydrate minerals as relatively secure water reservoirs, trapping OH or H2O in their structures that may later be made bioavailable under certain conditions. To test the hypothesis that structural water in hydrate minerals may be recycled on Mars to support life activities, we have designed a systematic of experiments to resolve possible abiotic and biological pathways that may enable the water release. We wish to present the general idea and some previous results at the conference.

### A Web-Based Environment to Calculate the Medical Mass, Power and Volume for a Mars Mission

**Douglas Hamilton, Dean Yergens**

**University of Calgary**

Introduction: The ability to deliver an evidenced-based Medical Mass/Power/Volume (MPV) calculation for a Preliminary Design Review of any space mission has been a challenge. This presentation demonstrates a web based method for determining the MPC of Mars Mission. Methods: A cloud-based relational database was created to develop the requirements of a Mars Medical Care System (MMCS). The MMCS catalogs the resources needed to treat to resolution more than 300 medical conditions considered likely by several space agencies. Based on worst-case outcomes for each condition, the supplies needed were entered into the database. The MPV needed to provide primary and secondary medical prevention strategies for each condition was also included. The MMCS can therefore track the cumulative MPV required to maintain the heath and performance of all crewmembers. To bound the MMCS MPV, certain assumptions must be made, however they can also be dynamically changed (i.e., Only one crew member can be ill at one time). Crew training and competency maintenance required to mitigate each condition can also be tracked. Results: The MMCS supports the creation of

multiple mission versions (destination, levels of gravity, crew compliment, length of mission, medical conditions supported, levels of care, etc..) resulting in different MPV requirements. Due to the complexity of the data, a report generator was created to publish the MPV based on each condition and the total MPV for the mission.
Discussion: When a Mars mission is created or altered, the MMCS reports can be rapidly regenerated. To aid in the data management and collation of information, this web based MMCS will allow experts to collaborate in the creation and assessment of medical literature required for each condition.

### Engineering Lander/Rover for Mars

**Gary Johnson**

There are two fundamental lacks in common among all the modern proposals for manned missions to Mars. Those are (1) a need for a large, relatively smooth, and rather flat landing area, with a surface strong enough to support what we send there, and (2) a source of ice from which to make drinking water, breathing oxygen, and even rocket propellants for the return flight home.

Sensing from orbit can determine whether a landing area is large enough to cover the uncertainty of touchdown, and it can suggest where significant ice might be buried, even at the lower latitudes of interest. However, it cannot reliably determine local slope variations on a meter scale, surface obstructions such as boulders on a meter scale, or the presence of meter-scale gullies. It cannot determine surface bearing strength at all! It cannot determine how deeply the ice is buried, how massive the ice deposits might be, or anything at all about the quality and purity of that ice!

A dedicated engineering lander/rover could do all of those things with far more precision than we have ever seen before, by carrying a deep-drilling rig, and a simple soil strength tester. This paper looks at a revisit of the MER designs (Spirit and Opportunity) to land such a rover at every potential manned landing site. That allows sending the correct equipment with the crew to the selected site or sites. The proposed idea takes a cue from the “Skycrane” approach used by Curiosity and Perseverance, to delete the MER self-righting lander in favor of a slightly-larger rover. Educated guesses for launch costs, program costs, and schedule are included.

## Medical

### ASTRO-PSYCHIATRY: A Novel Solution For Mental Health For Space Exploration

**Dr. Tamara Pack, Maria M. Harney, Romulo T. Velasco III, Susan Ip-Jewell**

**Mars-Moon Astronautic Academy and Research Sciences (MMAARS)**

To date, problems related to major psychiatric issues (eg, bipolar disorder, psychotic episodes) have not been reported during space missions. However, these syndromes have been reported

in up to 5% of less well-screened people working in space analog environments, such as submarines and Antarctic bases. With the increasing presence of humanity in space, the risk and occurrence of mental health issues will become inevitable. Currently, the Diagnostic and Statistical Manual of Mental Disorders V (DSM-V) is the gold standard classification manual used by mental health professionals in the diagnosis and treatment of mental disorders. With the help of the DSM V, we provide a workable and efficient way to develop the Integrated Space Psychiatry System - Virtual Embodiment Telepsychiatrist Avatar (ISPS-VETA). ISPS is an AI-powered program designed to enhance astronauts' psychological well-being and be used as a countermeasure to psychological problems. VETA is a multi-modality holo-assisted digital telepresence that offers customized therapy interventions and diagnostic tests. Psychiatry and psychology are the two modes available on the ISPS-VETA. The Psychology mode integrates holistic principles of Body, Mind, and Spirit, or the "overview effect" of Space, using clinically validated therapeutic procedures, such as Cognitive Behavior Therapy to enhance mental well-being. During missions, the Psychiatric mode will concentrate on identifying and treating potential mental disorders. By combining astronauts' indications and symptoms experienced during deep space travels in unique mission design and variable gravity conditions, the ISPS-VETA system will enable DSM V scientific knowledge expansion. As a novel concept, ISPS-VETA will offer personalized mental health assessment and evaluation, including preventative measures and predictive analytics to significantly improve astronauts' performance, well-being, and mental health, ultimately enhancing mission success.

### Comparative Behavior of E. coli Cultured in Simulated Microgravity or Earth Gravity

**Harley Jackson, James Secrest, Ian McCann, Margarita Belali**

**Offworld Biotech**

Looking forward to long-term human space settlement and crewed deep space missions, this study seeks to take critical steps toward engineering an extensive library of microbes that thrive in microgravity. We are selecting E. coli as the pilot microbe, since it is relied on heavily for the biomanufacturing of recombinant proteins, testing the functionality of proteins, and preserving DNA sequences from animals. Moveover, E. coli has proven to be particularly beneficial to molecular studies, as it is relatively simple to propagate in a laboratory. Firstly, we seek to answer the question of whether E. coli cultured in a random positioning machine (RPM), which has been programmed to simulate microgravity, will display statistically significant phenotypic variations from an Earth gravity sample, similar to as though the E. coli were really in space. We have carried out the experiment on K12 strain E. coli as a baseline, and we have run the experiment with four separate cultures of an E. coli strain that expresses a single chain fragment variable (scFv) or antibody fragment, with varied exposure times for each of the four cultures. For the scFv samples, we will look for statistically significant variations in the quantity of scFv between the case samples in simulated microgravity and the controls in Earth gravity. The scFv strain was licensed from North Carolina State University’s Biomanufacturing Training and Education Center (BTEC) for R&D purposes only, and the study is being carried out by Offworld Biotech as a preliminary validation of the RPM’s efficacy in prompting microbes to respond as though they are really in space.

## A Food And Nutrition Plan For Space Flight To Mars

**Barnabas Pasztor, Zsuzsanna Benyo**

**Milestone Institute/ Space ABC**

NASA is planning missions that will put the first woman and next man on the moon this decade and will send humans to Mars next decade. Hence, providing food and nutrition in deep space becomes a significant challenge. Therefore, if we aspire to send people to distant planets, space food research has never been more important. In these deep space missions besides physiological adaptation to the new circumstances, changes in the human body can be also experienced, more precisely in the cardiovascular and musculoskeletal systems, metabolic and neurobehavioral health and immune function. To keep astronauts healthy on their trip to Moon, Mars and beyond and their return to Earth, a variety of precautionary measures before and during the space flights need to be taken. Nutrient supply must be optimized for exploration missions. Moreover, disease risks need to be mitigated as well. Food intake is linked to changes in the gut microbiome composition, so it influences the production of key resources, digestion of nutrients, protection against pathogens, appetite, energy storage, immune- and neurobehavioral functions. Our breakthrough gene-based personalized space nutrition program, called SpaceABC provides the solution for this top priority issue; what astronauts' diet must include to keep humans in space healthy, and thus contribute to the success of space missions. The related study and business plan have been acknowledged by "The Martine Rothblatt Space Settlement in Our Lifetime Prize" organized by the National Space Society. SpaceABC's innovative program comprises nutrigenetics, epinutrigenetics, personalized diet and AI-supported nutrition program integrating space-sustainable food, developed specifically for astronauts, analog astronauts and space travelers. Just recently, SpaceABC has been selected by the European Space Agency to participate in their space business incubation program.

## HOLOTRIAGE: A MEDICAL FIRST RESPONDER TRAINING SIM FOR ASTRONAUTS USING HOLOLENS 2 INTEGRATING AR/XR, AVATARS, AI & HAPTICS

**Susan Ip-Jewell MD, DCEG, DOD**

**Emmy Jewell BSc, MSc (cand)**

**AvatarMEDIC Inc**

Simulation based medical training is an effective method for preparing and training medical first responders and astronauts for medical interventions and life-threatening challenges. Virtual Reality (VR) has seen usage to run simulation training at lower cost, yet VR does not offer the direct connection to the material reality that first responders will be operating in. Thus, AvatarMEDIC INC has created HoloTRIAGE automated training platform utilizing Extended Reality (XR) or Spatial Computing. XR overlays digital assets onto the physical world so digital assets behave as if they are present in the physical world as AVATARS. XR devices like Microsoft HoloLens 2 and XR abilities are available on mobile devices which can be used on ISS for astronauts or medical providers in austere or disaster areas on Earth. Artificial Intelligence (AI) enables the HoloTRIAGE platform to automatically scan and segment the

environment for use in automatically constructing scenarios and placing virtual assets, with options to allow instructors to specify broad parameters and have specifics automatically implemented. Further, AI delivers realistic interactive virtual victims, and is utilized to assess trainee performance. Entirely new metrics are available, such as eye-tracking and body pose data, enabling new fidelity of assessments and responsive simulations. Avatars allow remote experts or specialist instructors to record themselves and/or be present in real-time to teach and participate. Haptics enables trainees to feel physical impressions of digital assets, including resistance, pressure, texture and temperature. HoloTRIAGE represent a new era for first response training using virtual assets in real context. This presentation will demonstrate the HoloTRIAGE application and discuss development and deployment of the technology and its potential application for space exploration and medical care delivery for astronauts.

### The Organization of Gravity on the Functional Movements of the Human Body

**Michelle Turner**

**Movement Lesson LLC**

It is thought that man's muscular force depends on the ratio of mass to maximum speed needed to perform an action under normal gravitational conditions. This paper presents, all gravitational conditions are normal to the nervous system; it's the experience of the other sub-senses that can cause issues with typical mass/might calculations. Newton's first law of motion offers that F=MA (Force = Mass X Acceleration) as compared to when the organism is at rest, offering F = M (Force = Mass). This equation might be true for simple single cell entities; however, a living organism, especially within the animal, amphibian, and plant genera, are almost never at rest. Variations in size quickly change any calculations of movement into the ability to use force. Therefore, the calculation of a body's weight subject to gravity, P = MG (where P is the weight of the body = Mass X Gravity) is only useful as a reference to the amount of movement within gravity when discussing a static, inanimate object; its usefulness ends when the discussion turns to the locomotion of living organisms within gravity. It is within a body's non-muscular mass where the capabilities of opposition through movement reside. A body needs to oppose not only gravity, but also perpetual motion. Perpetual motion is within the rotation of the muscle fiber, but it's the act of balance and counterbalance that creates the acceleration within the system mechanics of a human's body. Shedding new light on how muscles react to every single movement in opposition to gravity will create new insights and evaluation techniques on earth and beyond. Harnessing the powerful knowledge of gravity's relationship to movement is the key to overcoming our current limitations within existing space programs.

### MEDINAUT -The Flying "De Vinci" Telerobotic-Telesurigcal Drone-Rover

**Emmy Jewell BSc, MSc (cand)**

**Susan Ip-Jewell MD, DCEG, DOD**

**Jay velsaco BSc**

**AvatarMEDIC Inc**

MEDINAUT™ offers real-time tele-surgical and medical care in remote, austere environments on Moon, Mars and Earth. An integrated system on a drone-rover with multi-functional capabilities supported by the convergence of multiple exponential technologies, ie, spatial computing, AI, robotics, haptics and digital twin telepresence avatars. The system provides real-time medical triaging and surgical interventions during life-threatening injuries and can save astronaut lives in Space, on a planetary surface and battlefields on Earth. MEDINAUT™ is an innovative concept to test a flying "telerobotic, teleavatar-surgical drone-rover" that will offer real-time, remote relief and "just-in-time" surgical and medical care in dangerous, austere, isolated and confined environments for astronauts during deep space missions. Controlled via mix-modal, direct operation and autonomous pathfinding, it is designed as a hybrid flying vehicle drone/UAV allowing for vertical takeoff and landing (VTOL) and, as a rover-robot with four-wheel steering ability for ground mobility to traverse rough terrain. The advanced autonomous system will enable on-site medical providers and astronauts to have access to life saving interventions, training and provide ability to conduct rapid triaging during life threatening medical situations. Moreover, using the power of tele-mentoring the MEDINAUT™ can instruct and support medical and non-medical astronauts and personnel to render accurate life-saving aid. Capable of locating injured persons in remote environments, landing near, and moving towards the injury site and providing continuous real-time biomedical and data stream of injured astronaut status, thus, permitting remote medical team to make rapid medical decision supported by the internal system using Machine Learning (ML) and integration of Artificial Intelligence (AI) decision-tree algorithms. The drone features several "snake-arms" with end effectors for grabbing and precise cutting and suturing.

## Preparing Humans for Long Duration Space Flight Using Space Health Contestant Food and Nutrition Plans

**William Gardiner, Susan Ip-Jewell, Gerald McLaughlin, Sandra Worthington**

**National Space Society**

Respondents to an annual space health contest, 2019 through 2021, submitted food and nutrition plans (FNPs) to improve health for space flight to Mars. Rationale and guidelines were provided for their white papers. Four winning FNPs received on the NSS-SpacEdge Academy website were awarded cash prizes and scholarships to MMAARS Mars analog missions in the Mojave desert. Titles of the winning papers were "A Food and Nutrition Plan for Space Flight to Mars," "Martian Hardtack", "A Balanced, Plant-rich, and Time-Restricted Diet to Minimize Health Risks from Space and Improve Metabolic Health", and "IF is not an 'if', but a 'MUST' with Ketogenic-Mediterranean Diet to safeguard astronauts." In the first full year, 2020, a ketogenic diet could not be continued by one contestant and was not recommended by another. In 2021, reduction in carbohydrates was accomplished using intermittent fasting (IF) and Mediterranean diet. Reduced insulin resistance was recorded using measures recommended in medical literature. Metabolic syndrome, intestinal hyperpermeability, microbiome disruption, mitochondrial dysfunction, liver injury, systemic inflammation, toxic (oxidative) stress, and obesity were addressed in the FNPs. After the 2021 contest was complete, a contestant went on to win other funding to implement a business plan and website to offer diagnostic and

consultation services to anyone preparing for long duration space flight. Compelling rationales were presented for reducing space flight injury, genomic damage from ionizing radiation sources (GCR/SPE), and exposure to the SAD. In summary, the healthiest possible outcomes from the ventures into space are ready for further development studies and demonstration. Future MMAARS analog missions will perform these studies and assess their potential application to actual missions to Mars. During the presentation, updates and plans for continuing the contest and missions through 2023 will be produced.

### Astronauts and their Biomes for a Mars Mission

**Douglas Hamilton**

**University of Calgary**

Microorganisms first appeared on Earth around 3.5 billion years ago and over subsequent billions of years they and other life forms terraformed the planet. Now humans are planning to inhabit a new frontier… Mars. The life support system (LSS) for a Mars mission includes the modalities needed to support the activities of daily living and the health strategies (exercise, nutrition, medical monitoring, prevention, and treatment of illness and injury) needed to control the environmental hazards (altered gravity, radiation, social interactions, etc.). This requirement for life support is further complicated by the actual environmental biome which, in the case of the confines of a spacecraft, also comprises the human system.

Currently the LSS on all space vehicles are open and use a prohibitive amount non-renewable physical-chemical resources to maintain the functions needed for survival in space. How do we decide what components of the 3.5-billion-year-old Earth biome we utilize to create a closed LSS for Mars colonization? Despite our incomplete understanding of this biome, could a subset of Earths organisms be conscripted to compost human waste and provide food for a Mars mission? Would complex organisms such as insects, mammals and marine life have a role? Furthermore, deriving the selection criteria of astronauts which considers their genomic content and inherited or acquired mutations along with their possible transcriptomic responses to a hypothetical Mars biome is currently beyond the current scope of existing technologies. Perhaps future advances in Precision Medicine and ‘omic’ methodologies (genomics, transcriptomics, proteomics, and metabolomics) may reveal unique differences in individual crewmembers’ response to the Martian micro/macrobiome or space medical therapies.

This presentation will discuss the issues surrounding what genomes and how to introduce them into the new worlds beyond low Earth orbit.

## Virtual Presentations

### Design and Analysis of a Lambda Based Suspension for Space Exploratory Missions

**Akhilesh Jhawar, Saurabh Chaughule, Mohammad Abdul Sulaiman, Navneeth Krishna Vernekar V**

**Manipal Institute of Technology**

Efficient and safe traversal of the unknown Martian terrain is a considerable problem that hinders extra-terrestrial exploration when done using Autonomous Ground Vehicles (AGVs). A suspension system is employed as it allows for mobility and stability of the rover while traversing rough terrain. The objective is to design an efficient Mars Rover suspension system: a novel lambda suspension and study how it outperforms the widely used rocker-bogie system in various parameters. Exploration operations need high speed and long-distance traversal in a short mission period. Although the rocker-bogie suspension contributed to compact construction and equal weight distribution, this suspension posed its own set of drawbacks. On average, rocker-bogie drive systems can only travel about ten centimetres per second to maintain stability. With the improved lambda suspension, the rover can traverse extreme terrains at high speeds. The key feature of the novel suspension inspired by Chebyshev's mechanism is that the lambda mechanism converts the rotational motion of the bogie into linear motion, preventing overturn, which is one of the primary disadvantages of the rocker-bogie. The constrained straight-line motion coupled with a differential mechanism corrects other disadvantages of the rocker-bogie like excessive chassis pitching, toppling, and tipping of the rover. Mathematical modelling, CAD, and simulation have been used extensively to optimize and study the design to conclude the superiority of the novel lambda suspension over the rocker-bogie system in certain aspects of the rover's dynamics while traversing on the Martian terrain.

## Crop Production for Long-duration Space Missions

**Alejandro Salinas-Téllez, Federico Granados-Unger**

**Space Technology MX**

Food production for long-duration space missions still represents one of the greatest challenges in the space sector. The BioColchon Space Garden project was created to solve this problem, by incorporating biotechnological and agricultural techniques in the development of space technology that will enable different crops to grow sustainably under low gravity conditions.

The BioColchon Space Garden system consists of a device that enables the development of diverse crops in simulated microgravity conditions. Our creation has soil-monitoring and environmental-control systems that are capable of not only obtaining precise measurements of the substrate conditions, but also of providing the vegetables with isolation from microorganisms, an automatized irrigation system, and controlled environmental conditions. Together, these systems make it easier for vegetables to grow in the simulated microgravity conditions that they are subjected to.

One of the most recent and important milestones of the project is the growth of potatoes (Solanum phujera), corn (Zea mays), lettuce (Lactuca sativa L.), and radish (Raphanus sativus) in our system, achieving not only the successful sowing and germination of their seeds, but also their complete development. In addition to this, vegetables from the species mentioned above have participated in experiments where fully developed plants were exposed to adverse

temperature and humidity conditions, with the objective of determining their research potential in Analog Mars Missions, such as those offered by the MDRS, where our team seeks to participate.

## Heretical Science and the Construction of an Interplanetary Human Race: A lesson from Journeys to the Planet Mars by Sara Weiss (1903)

**Alessandra Calanchi, Simonetta Badioli**

**University of Urbino (Italy)**

This is the second step of a project we started in 2021 concerning a few narratives from the fin de siècle set on Mars. Last year we began with Unveiling a Parallel by Alice Ingelfritz Jones and Ella Merchant (1893), a novel which conveys extremely modern ideas about sustainable economy, gender equality, and environmental care. This year it is our intention to introduce Journeys to the Planet Mars (1903) by Sara Weiss (1834?-1904), written in the same years when astronomer Percival Lowell was publishing his essays Mars (1855), Mars and Its Canals (1906), Mars as the Abode of Life (1908).

Journeys tells of a series of séances through which the male protagonist travels to the Red Planet, a perfect world where the living and the dead can communicate with one another. Not only that – whoever travels to Mars gets back to Earth "renewed in health". Scientists on Mars study Biology and Chemistry, and what really counts is "scientific inquiry" and "investigations"; intriguingly, many characters of the book are famous scientists such as Alexander von Humboldt, Louis Agassiz, Charles Darwin, and Edward Bulwer Lytton.

The most striking encounter, however, is with the spirit of Giordano Bruno: it is extraordinary that an American woman writing about planet Mars chose this famous heretical scientist and philosopher (who was burnt for espousing the Copernican idea of a heliocentric universe and for believing in an infinite universe) with the aim of making him defend the freedom of speech and thought in the US. By interpreting desires and fears of Americans in an age of uncertainty, poised between religion and science, spiritism and rationality, male patriarchy and female emancipation, we do believe that Weiss offers readers of today many interesting suggestions about the reassessment of the human race as interplanetary.

## Multidisciplinary in Earth-Mars analogue via augmented reality technology: A feasibility study of Space type-terrestrial tourism in Sri Lanka and Morocco

**Aravinda Ravibhanu Sumanarathna, Majda Aouititen, Jason Kennedy, Abdelouahed Lagnaoui**

**South Asian Astrobiology & Earth Sciences Research Unit**

**Eco Astronomy Inc [Sri Lanka]**

Within the next decade, it is speculated that humans will build habitats on Mars to conduct research and make long-term settlements, including harbor life stations. The practical intention that underpins our research is to test the ability of human's thinking patterns to develop micro-business approach via space-type terrestrial tourism. One such example would be an augmented reality (AR) experience at a specific Earth location analogous to being on Mars. For instance, AR provides excellent scope for creating the experience of interacting with a Martian

harbor life station while remaining on Terran soil. To accomplish this goal, we developed an AR application that uses 3D computer-generated models of assets such as the Curiosity rover, an astronaut, a space shuttle, and a few other open-source extension models. These models synchronize in real locations of Sri Lanka [Usaangoda and Aruwakkalu] and Morocco [Central High Atlas], including a few urban areas and in-situ places as a test trial. Our approach supports monitoring the value of space-type terrestrial tourism as an accessible means to support sustainable microeconomies at the trial locations. Within this study, we use AR to produce immersion within a computer-simulated environment designed as a tourist attraction. We suggest that this approach can be used to stimulate and enhance eco/geo-type tourism. General and practical implications of further research are required in order to properly evaluate the sustainable and mega economy components via virtual reality or terrestrial type of advanced Earth-Mars analogues.

### Politics, Mars and YOU

**Art Harman**

**The Coalition to Save Manned Space Exploration**

As a former Congressional space advisor, I want to pass along lessons of the political processes in our space program—and show why politics matters. For decades, returning to the Moon and going to Mars always seemed a decade in the future. Yet we have much of the technology--now! Many adventurers would sign up for a Mars mission. But bureaucrats placed roadblocks on SpaceX's goals, and SLS was slow-rolled for years.

Why is it so tough?

Politics. Most politicians really don't care. They care about pork for their district, and if that includes space industries, fine. But few get excited about it. And the general public, while supportive, isn't enthusiastic—in part because the media pays only mild attention to it.

Why does politics matter? After all, Elon will build Starships and send colonists to Mars, right? Don't bet your life on it. Market crashes, wars and other calamities could change the game overnight. Colonies would need massive trade to keep supply flights going absent philanthropy. We've spent trillions for health and social programs over the past several years, but there wasn't one dime for space. That's sad, and that's a failing of space activists.

Without greater Congressional support and a wider corporate community, actually getting to Mars and particularly creating colonies is not assured.

So what can YOU do? Get involved. Get to know your members of Congress. Talk to their NASA advisors. Write letters to the editor and more.

I want you to better understand the political barriers and the opportunities to advance the day that we become a spacefaring, multi-planetary civilization.

There's much more you'll learn about the politics of space exploration, and how your participation can make a real difference.

### Interstellar Education Foundation

**Davey Sapinski**

As we move into inhabiting a new frontier we must look at how we will educate future civilizations as they arrive on Mars. Questions such as, What subjects are future folks going to

need to learn? How can we develop curriculum for these subjects and what are the content delivery methods?

When we begin setting up civilization and establishing habitable environments on Mars education is going to become necessary for future people to sustain life on Mars. We will have to educate them on food growth, water sustainability, oxygen management, technology maintenance, along with a host of other life sustaining techniques. This teaching of new habitants will need to be established by curriculum development from experienced educators from around the globe. We will need to develop delivery methods of our lessons which will include platforms related to online meetings such as Zoom.

In conclusion I wrote the paper I'm pulling this abstract from in hopes that education will not be overlooked as we begin our journey as humans to inhabit other planets.

## LOW-GRAVITY ORBITING CENTRIFUGE MANNED HABITAT

**David Nordling**

**Merchant Rocket LLC**

The long-term effects of hypogravity (0.38G) on the human body are only speculative at this time. An orbiting centrifugal manned laboratory in LEO built with existing technologies and minimal launches could provide a valuable research platform for future work. A systems architecture study reviews this idea posing further questions for a conceptual design. This idea is not new and has been presented by others in the past. This paper seeks to revitalize this idea and advocate for continued action to implement it.

## Radiation Effects on Plants in Long-Duration Space Flight

**Scott Balcao**

**Lockheed Martin**

Plants are quite persistent and can grow in less than optimum conditions. One external environment that has a profound impact on a plant’s life cycle is radiation. Radiation can either improve or hinder a plant’s ability to flourish. From the research gathered it has been concluded that plant’s ability to tolerate radiation and still grow is determined by four conditions: (1) When in the plant’s life cycle the radiation is emitted, (2) The duration of the exposure, (3) the type of radiation being emitted, (4) The type of plant that is being exposed to the radiation. Under the right conditions plants could grow faster, yield more, and create a newer generation of radiation resistant plants. This knowledge could prove essential for long duration space mission like to Mars. Such knowledge would have a huge impact on an astronaut's diet, layout of the habit module, maintenance schedule, cost, etc.

# FRIDAY AFTERNOON SESSIONS

## Special Presentations

### The Mars Society: Programs & Initiatives

**James Burk**

James Burk is the Executive Director of the Mars Society, the world's largest space advocacy organization dedicated to sending human explorers to the planet Mars. A former Microsoft engineer and technical project manager, James leads the fundraising and program development activities of the organization. In this presentation, he will deliver remarks about the current and newly formed programs, initiatives, partnerships and activities of the Mars Society.

### Become a Mars Society Ambassador, The Voice of the Mission

**Dr. James Melton, PhD**

**The Mars Society**

How would you like to be the person who represents the Mars Society to boost and promote the public's understanding of the current plans for us to become a spacefaring civilization? Connecting with the general public to convey a short presentation of this vision is simple, valuable and exciting.

The Mars Society recently announced its new Ambassador Program to expand public awareness of the importance of planning the human exploration and settlement of Mars.

With the direction and support now available through the Ambassador Manual, it will become clear that sharing this unfolding vision can be easy and highly rewarding. New doors can open to the Ambassador and the audience attendees.

Chief Ambassador, James Melton offers methods to reignite the spark among people to become more curious and excited about humanity's future in space just as we did when we went to the moon more than 50 years ago.

Highlights

- How to raise the level of public awareness.
- What role will you play in moving people to action?
- Why is it important to step forward and act now?

As Mars Society Executive Director James Burk states, "This is an inspiring, adventure-filled journey that resonates with people of all ages, cultures, and backgrounds."

### *Ambassador Presentation:* Seven Things I LOVE About Living on Mars!

**Roger G Gilbertson as "Marty Marineris"**

**Solax Media**

Just a few generations ago, my ancestors all lived by farming, with fire as their primary source of heat and light in the long cold winters. But the scientific and industrial revolutions changed everything, enabling my great grandfather Lars to emigrate to the New World, and my grandmother Florence to fly above their farm when she just a young woman. In my youth humans set foot on the Moon, and soon, living on Mars will bring greater and grander adventures to new generations.

Imagine in a few years time attending a presentation by an actual resident of Mars, eager to spread their passion for their new home. Their write-up might looks something like this:

Join Martin Marineris, four-year Mars resident, as he shares some of his favorite features about living and working on the new human world. As the "fourteen hundred and fourth" person to arrive, Marty offers his first-hand experiences in dealing with the Red Planet's low gravity, long seasons, unique geography and challenging climate.

Learn about the surprising challenges he faced in adapting to the society's unique timekeeping, calendars, habitats, foods, holidays and more. Hear Marty's stories about working at the rapidly expanding Ophia Chasma North settlement, working on a "water team" to tap into underground aquifers, helping in the production of food, and his suggestions for how to watch the two moons cross paths in the sky. Learn his secrets to surviving the long Martian Mardi Gras celebration, and find out how you too can become a first generation Martian!

### Ambassador Presentation: Shifting Paradigms While Blowing Bubbles

**Garland Rush**

The presentation will include dialogue and illustrations introducing and supporting entirely new techniques and technologies aimed at the construction of visually pleasing orbital and planetary "sustainable" space colonization and tourism transparent bubble habitats.

These processes will radically cut all costs, including the initial and continuing heavy lift of bulky building materials, to lessening the need to haul up sustenance for occupants, with the ultimate goal of needing no re-supply from Earth.

As mentioned, this idea will use new building materials, including Graphene; the high percentage of carbon dioxide in the Martian atmosphere readily lends itself to the production of Graphene. This concept will make a pleasing visual statement along with providing maximum meteorite impact resistance, solar energy collectivity, light shielding, size and location versatility, speed of construction, and more. Furthermore, once established, all materials will be produced on site.

## Accelerate Like Elon 2022: Updated Methodologies

**Kent Nebergall**

**MacroInvent.com**

The methods used by Elon Musk's enterprises radically outperform competition and push back the edges of the technology curve. This talk is an update of the popular "Accelerate Like Elon" speech from 2018 (14,000 views on YouTube after being described in the blog Next Big Future). Classical methods such as first principles and Platonic ideals are merged with modern concepts of entrepreneurship such as minimum viable products and agile. We also review new information from SpaceX and Tesla, both announced and observed, that refine and expand these methods. Finally, we will assess how it is going and any strengths or weaknesses the enterprises will face in the future.
The goal is to describe the templates that others can follow to build enterprises that will democratize space settlement. There must be thousands of such businesses at every scale to fill the solar system with life.

## The Expansion Effect

**Michael Helton, Dimitrie Grigorescu**

**Helton Associates**

The Expansion Effect (TEE) is the positive psychological realization that the human race can expand its domain of existence by becoming interplanetary travelers. This realization will be the latest in a long string of realizations and will precipitate other realizations that we can increase the human capability to include countless advantages and achievements by increasing our human exploration into other parts of our solar system. Mars settlements and resulting increased planetary knowledge is just one example.

To achieve this effect it has been proposed to NASA to take a photo view of the Earth in time-lapse mode as the first human crew transitions away from the Earth and then to take a photo view of Mars the same way as the crew approaches that planet. From this photo data a number of videos can be made: one showing the same face of the Earth as the spacecraft recedes away showing the Earth as a large globe and reducing down to eventually a pale blue dot. At this point the camera shows Mars as a pale orange dot and then growing bigger as the spacecraft approaches. Other videos can be assembled from this data including to show the Earth rotating as we recede, and we see Mars rotating as we approach. These views will be experienced by the crew real time, and a video would allow this experience to be shared worldwide later.

These videos will remain a record of this first human planetary voyage, and can be used in schools and museums to show this effect of interplanetary travel. A simulation of this video is shown in this presentation. The presentation also includes a brief history of human realization of domain expansion with increased knowledge of the Universe.

**The Martian Economy**

**Jayden Sage**

**Celestial Ventures**

Humanity's dream of Martian settlement is filled with grandiose concepts with visions of perfection beyond compare. However, the reality will be far more sober for the first 20 years of our presence. Due to interplanetary distances, the economy of Mars will need to be far more independent and resilient than sheer reliance on Earth dynamics. It will be a humble economy that is laden with basic needs fulfillment. As the colony becomes larger, the more robust will become its underpinnings.

The initial settlement will be underground in the lava tubes to mitigate the risks associated with terrestrial settlement. The ideal section of the lava tube will be one where there is liquid body of water. Once this section of the lava tube is closed off on both ends the economics may commence. The best course of action will be to first create a sealed environment from collected rocks and soluble sealants. This will be followed by brick walls made of extra strength mushrooms. Other mushrooms will be grown as food. With the advent of plants that facilitate oxygen and carbon recycling, we will have the environment needed for a stable settlement. Only once this is achieved will economics permeate the living environment of Mars.

The first Martian economy will resemble that of a city state of the past. While we will not resort to bartering, the fulfillment of basic human needs will the strongest driver of Martian economics. The nurturing of food sources, plants and animals, will be one of its elements. Next will be housing maintenance. After which will be entertainment. This will be utmost importance as Martian life will be quite isolating even if the colony consists of a couple of hundred people. The need to find ways to divert the mind will be quite valuable a resource. The first wealth creation will occur from Mars specific enhancements to these basic needs. This will be the Level 1 Martian economy where peoples basic needs will be the driver for the economics of Mars.

Eventually as the colony expands outward and begins to explore its environment new discoveries will be made. Everything from new minerals and elements to possible life forms will become the Level 2 economy (L2). The L2 Economy will address the needs of Martians, Earthlings, or both. This will be the scale up of trade intra and inter-Martian. The ensuing economy will then grow by leaps and bounds. L2 Economy will bring in the wealth that allows the expansion of colonies. Prosperity of the colonists will allow them to expand in numbers (organically and by immigration) to levels which require multiple colonies. The L2 Economy will command that not only are multiple city states established but the creature comforts contained in future iterations be magnitudes better than the previous ones. L1 & L2 economies of Mars will foster the permanency of Martian settlement. Martian economy when fostered with strong foundational underpinnings will achieve the self-sustainability that is requisite to building a new society that is not beholden to Earth's follies.

## Mars University Planning and Focus Group

**Bruce Mackenzie, Kole Lutz**

The Mars University has been giving on-line courses related to Mars and Mars settlement, such as Mars Geology, Human Factors, Astrobiology. (Some activities were canceled due to the Covid pandemic,) MarsU has also sponsored web presentations and webinars. MarsU is planning a future expanded 10 week online program, and graduate level research programs.

What additional programs, courses, research or other activities would you recommend the Mars University conduct? And, would you like to help? Depending on your experience and qualifications, you could participate as: student, instructor, researcher, guest lecturer, or a management position. If unable to attend at the time, please contact Info@Mars.University

## Companion Dogs in Space?

**Don Lefevre**

**Saphir Electronics Corp.**

One of the greatest challenges for voyages to Mars will be the interactions between crew members. Biosphere I, Biosphere II, and other efforts have demonstrated that human interactions in closed spaces over long times can become very difficult. Stays on the International Space Station have only been as high as 340 days, roughly half the time of many Mars mission scenarios. The human interaction problem is “highly non-linear,” in realms of psychology and emotions. This paper proposes converting some of this non-linear, complex problem to more solvable problems by taking pets, dogs, to Mars. Dog owners (the author does not own a dog) describe the great comfort and benefit they get from their dogs. Many emotionally injured people get great benefit from service dogs. Dogs or other pets on space missions will have problems of sanitation, health, allergies, etc. But these problems may be more solvable than the difficulties of anger, arguments, resentment, irritation, disgust, etc., between crew members. After a heated argument a person can spend time with the crew dog and be calmed and soothed. Research has shown that dogs and their owners have increased oxytocin levels when they are together. The relief from spending time with a beloved animal can mitigate the effects of bad interactions with others. Such dogs would be selected for compatibility with the spacecraft, ease of care, etc. Such animals would need to be small and calm. Yorkshire Terriers come to mind since they are small and reported to be lovable. Crew members on such a mission would have to accept dogs and have no allergies to them. The purpose of this paper is to start a debate on having “Dogs in Space” as a means of mitigating the psychological stresses of long voyages, particularly voyages to Mars.

**Buzzed Lightyear: Tapping Into Beer's Interplanetary Future**

**Paul R. Kan**

**Burd's Nest Brewing Company**

For Elton John's Rocket Man, "Mars ain't the kind of place to raise your kids." But it might be the kind of place to brew your beer. In 2017 Budweiser pledged to be Mars' first brewery, and astrobiology students at Villanova University successfully grew hops in simulated Martian soil. The feasibility of brewing beer on Mars is not only about science. Beer's history, and its current state, on Earth hold lessons for bringing beer to the Red Planet. This paper will cover the basics of beer brewing; the scientific challenges of brewing on Mars; the societal role beer might play in the colonization of Mars; and the current social concerns affecting beer that will follow it to Mars.

## Analog Research & Facilities

**Underwater activities in Space Analog Station Habitat Marte**

**Julio Rezende**

**Habitat Marte space analog station/ Mars Society Brazil**

This research evaluates the practice of Space Analog Extravehicular Activity in a swimming pool during space analog missions developed in space analog station Habitat Marte in Brazil.

The activities of Space Analog EVA in a swimming pool was developed as an experiment since mission 80, during September 2021, and become a permanent protocol had been applied in more than 10 missions. Space Analog EVA in a swimming pool is done with mask, snorkel and buoyance compensator.

Some reasons to practice underwater Space Analog EVAin Habitat Marte:
1. Experience an analog outer space experience;
2. Experience the perception of absence of gravity, as in outer space;
3. Develop the breathing techniques;
4. Permit an opportunity to experience self-awareness during the diving;
5. Bring awareness on health and wellbeing;
6. Possibility to bring outputs to daily life since the astronaut can practice the breathing technics in regular situations;
7. Permits an overview effect experience;
8. Learn more about Extravehicular Activities.

To evaluate underwater activities was applied a survey with the participant before the dive and after. The results:
83% considered the water cold;
75% considered the environment cold;
75% felt good and 25% very well physically;
75% felt psychologically good and 16,7% very well;

66,7% felt the breathing calm and 16,7% very calm;
58,3% felt the heart frequency calm and 33,3% very calm.

As a conclusion, was observed the opportunity to keep the application of the survey with analog astronauts to create a large database. In general, was observed contributions to a better mental and physical condition of analog astronauts.
Underwater activities also occur in diving training developed in Neutral Buoyancy Laboratory (NBL) located at the Sonny Carter Training Facility Texas (United States).

**Suits and Hab Atmospheres**

**Gary Johnson**

Space habitation atmospheres interact with pure oxygen space suit designs via the NASA no pre-breathe criterion. Habitat atmospheres are subject to a long-term hypoxia criterion and a fire danger criterion. Space suit pressures are subject to short-term hypoxia criteria. I used a long-term hypoxia criterion based on studies of chronic mountain sickness in populations living at high elevations, plus historical experiences with pregnancy and childbirth during the Spanish conquest in South America.

I used short-term hypoxia criteria for the space suit derived from pilot experiences with vented oxygen masks. I used a fire danger criterion for the habitat based on the oxygen concentration in a typical 1-step 2-component Arrhenius reaction rate model.

I used a common basis for calculations and criteria resembling the first term in the Alveolar Gas Equation, ignoring the second term, which is fraught with garbage-in/garbage-out problems. I finish by recommending a habitat atmosphere that meets all appropriate criteria, even leaked-down 10% in pressure, which is easily compatible with a 3 psi pure oxygen spacesuit, thus requiring no pre-breathe time, per the usual NASA criterion for that.

This issue is a part of the required supporting technology base for going anywhere in space, including Mars.

**The South Pole and Mars**

**Wayne L. White**

**Mars Society member and The Explorers Club**

After spending three Antarctic winters as the Winter Site Manager at the Amundsen-Scott South Pole Station, I wrote my book “Cold: Three Winters at the South Pole.” The book chronicles the selection, training, deployment, and the actual winter experiences of three crews at the South Pole. This will be the topic of my discussion.
While the Mars Desert Research Station is a great start in preparing for an actual Mars mission, the South Pole’s Amundsen-Scott South Pole Station during winter has several features that make the experience more realistic. At the South Pole the short summer with 24 hours of light and milder average temperatures -18F (-22C) runs from

November 1 st to February 15 th . The winter is the rest of the year with an average temperature of -76F (-60C.) The last aircraft departs the station on February 15th and a winterover crew with no way out will experience months of cold and darkness that few can imagine.
I will discuss issues that we now face at the South Pole and could face in upcoming Mars missions especially during colonization. Starting with crew selection, choosing the right people that are not only the best in their field but can get along with others. This is not always easy to do. I will discuss topics that some might consider mundane like food, activities, traditions, and personnel issues which loom so large during a South Pole winter and may someday loom so large on Mars.

## Digital EVA Tracking for MDRS

**Jason Simpson, Kent Nebergall, Eric Kristoff**

**Chicago Chapter, Mars Society**

The Chicago Mars Society chapter is researching and designing a digital communication and logging system for MDRS. The communication system can record GPS data points for sample collection and relay emergency beacons back to the hab in the event of an accident in the field. This same long-range network can be used with weather and science stations. We are also researching four options for mid-range digital voice/data networks that complement the low-power, long range systems we are prototyping.

The MDRS logging system would be for EVA planning and journaling, sample collection data, and science work on samples collected. It can also record the engineering and other reports in a consistent database across crews. As a result, samples collected and analyzed, both at MDRS and afterwards at university/etc. labs, can be journaled together into a common science library. Combined with the navigation and sample logging system, incoming crews can determine where to plan new EVAs based on past field research. Over time, the area around MDRS becomes a heat map for sample collection types such as microfossil, microbe, and geological specimens. This science/engineering database is then mirrored onto the web for citation in professional publications and long term analysis. This effort can complement MARS VR and other mapping (GIS) systems at the hab and online.

The system can be expanded to take in weather stations, and even use LORA to receive data from passing weather balloons and cubesats as a side project. Logs and reports can also be recorded to show the overall health and demands of the station over extended periods and plan maintenance. The systems will be open source for other field researchers in polar and wilderness locations.

**Kristen Miller, Scott Van Hoy, Edward Albin**

**The American Public University System**

**The American Public University System (APUS) Analog Research Group (AARG): Developing a Virtual, Asynchronous Program for Student Research and Leadership**

Analog research is vital to human space exploration. NASA encourages the use of terrestrial analogs to simulate crewed missions to Mars because they provide a high-fidelity environment in which a wide range of research can be performed, and highly diverse crews tested, much less expensively than in space. AARG is a student run, faculty supported online program which trains students to work as both crew and mission support in terrestrial space analogs. AARG has developed a full planning staff, including teams that specialize in recruitment, training, research development and coordination, risk management, and outreach. AARG currently has approximately 30 active members and has successfully completed 3 analog missions, with 5 missions planned in the next two years, including a mission at the Mars Desert Research Station. The AARG model emphasizes student management experiences and research opportunities across a range of disciplines, including psychology, physiology, nutrition, botany, and extravehicular activities (EVAs). Through the AARG program, students work under faculty direction to create, develop, and execute research projects, gaining experience in project planning, learning the challenges of living and operating within isolated, confined, and extreme environments, resource management, proposal writing, and authoring presentations/publications.

**MarsSuits, An Overview of the Technology Needed for Martian EVAs**

**Will Green**

**University of North Dakota**

The surface of Mars is unlike any other place humanity has gone before. The unique gravity, atmosphere, and geological conditions pose difficult challenges to spacesuit designers. Lots of theoretical work has been done proposing different technologies to make Martian Extra Vehicular Activities (EVAs) possible. These range from new materials, life support systems, and spacesuit architecture. All of these will be needed for humans to safely walk on Mars. This talk will be an overview of the challenges of performing EVAs on the red planet, the work that has been done to address these issues, and how these technologies could be realized in an actual Martian spacesuit.

**THE SPACE CLINIC: A Medical Science and Research Analog Facility to train "SPACE MEDICS" Astronauts**

**Susan Ip-Jewell, Emmy Jewell**

**MMAARS, Inc**

MMAARS Inc (Mars-Moon Astronautics Academy and Research Sciences) in partnership with AvatarMEDIC Inc has initiated the development of a Space Medical Training facility "The Space Clinic" located in Mojave Desert in California. The medical facility will train future commercial astronauts called "Space Medics" and Space Physician-Scientists in critical life-threatening

interventions and continuous care for maintaining physical and physiological health and mental wellbeing of astronauts for deep space missions and off-world habitation. The Space Clinic focuses on integration of cutting-edge novel, frontier visions with innovative, transformative exponential technologies in Medtech and healthcare for astronauts including the development of novel, new biological systems, development of a new sub-specialty of behavioral health called "Astro-Psychiatry", personalized medicine, genomics, translational medicine and integration of complementary medicine modalities. The facility will test and train analog astronaut crews in new medical and surgical protocols and procedures for microgravity and deep space environments. We will present an overview of the developing architecture and infrastructure of the Space Clinic and our vision and mission to support permanent settlement in Low Earth Orbit, (LEO), Moon and Mars including updates on some of our medical technology prototypes and current phase of the project.

### Mountaineering: An Analog for Human Space Training (V)

**Scott Balcao**

**Lockheed Martin**

Astronauts use many analog missions to simulate, train for space exploration, and gather results regarding human factors in a controlled environment. The Human Exploration Research Analog (HERA) at Johnson Space Center is a unique three-story habitat designed to serve as an analog for isolation, confinement, and remote conditions. The Human Exploration Spacecraft Tested for Integration and Advancement (HESTIA) is being developed as a high-fidelity, human-in-the-loop, Lunar/Mars surface analog in support for next generation human exploration missions. NASA's Extreme Environment Mission Operations (NEEMO) is an underwater habitat that sends groups of astronauts, engineers, and scientists for up to three weeks at a time to allow trainees to experience some of the same challenges that they would on a distant asteroid, planet, or a moon. BIOS 1, 2, 3 tests the efficiency of a closed recycle system. The MARS 500 simulated a Martian mission by confining participants to severe habitats that simulated Mars' atmosphere and surface. There are many more analog missions that astronaut trainees use to experience and simulate the harsh environment of space. I believe mountaineering is another analog that would be beneficial as it is an extreme environment that stresses the human body both physically and mentally. Such training could be vital in for deep space travel as mountaineering can teach astronauts teamwork, pre-planning and preparation, how to adapt and survive in cold and hypoxia environment, and how to exercise good judgement.

### Brazilian Mars Analog Simulant:
### experiments developed by Habitat Marte space analog station

**Julio Rezende**

**Habitat Marte space analog station/ Mars Society Brazil**

This research identified in Brazil a Mars analog soil in Brazil. As a methodology to collect soil and analysis, as a first step, was planned a mission to collect soil and rock as part of Extravehicular Activity (EVA). 2nd - The EVA departed from Habitat Marte space analog

station, 40 minutes driving to Cabugi Peak site; 3rd - During EVA was used recipients to collect the soil; 4th - The soil was collected and brought to Habitat Marte.

Analysing the Mars analog soil sample: Was contacted the Mineral Technology Center (CT-Mineral from Technology Education Federal Institute-IFRN in Rio Grande do Norte State - Brazil) to develop the soil analysis. The analysis presented the following characteristics: 1. Semi-quantitative chemical analysis by portable X-ray fluorescence spectrometry; 2. Kiln drying at 60º; 3. Mill ring spraying of Fe-Cr / 250 g / 95%> 75 µm; 4. Analysis; and 5. Release of technical report.

Was identified Iron oxide ($Fe_2O_3$) in 36,38%; Silicon dioxide ($SiO_2$) in 28,82%; Calcium oxide (CaO) in 10,92%; Aluminum Oxide (9,77%); Titanium dioxide ($TiO_2$) in 6,15%; Iron Pentoxide ($P_2O_5$) in 3,72% and other elements. These features present some similarities with Mojave Mars Simulant (MMS) used by Jet Propulsion Laboratory – JPL (NASA).

Some applications of Mars analog soil in Brazil:
Imagine and develop the possible space applications research :
- food cultivation on Mars and Moon;
- additive printing of items / products;
- additive printing of habitats.

As conclusions: Brazilian Mars Analog Simulant can be seen as a very promising achievement for future research.
Habitat Marte is looking for academic partners and funding to acquire equipment and perform other scientific and technological experiments.
Also is important identify other possibilities since is happening other in person missions in Habitat Marte and the station is receiving international researchers from many different fields.

## Tech R&D B

### The Artificial Gravity Prescription for Mars

**Doug Plata**

**The Space Development Network**

Mars settlement plans typically contain the subconscious assumption that Martian gravity levels will be sufficiently healthy long-term. Yet it is generally recognized that we don't currently have enough evidence to support that assumption.

Unfortunately, there is some evidence that suggests that Mars-level gravity will cause significant health consequences. A study was conducted in which the tails of rats were suspended in order to unload the hind legs to Martian levels of weight. The result was that those rats developed osteoporosis in their hind legs.

If Martian gravity causes unacceptably high health consequences then artificial gravity may provide the solution. Given SpaceX's intended timeline for crew to the surface of the Moon and Mars, it may be that it would be faster and simpler to conduct the artificial gravity prescription experiments in a crew centrifuge on the lunar and Martian surfaces rather than develop a free flyer experiment in LEO. Also, the artificial gravity prescription is not likely going to be one specific gravity level but what percent of the day that residents are getting a full gee of artificial gravity.

Determining the artificial gravity prescription for healthy gestation and childhood is critical before an accidental pregnancy occurs on the way to or on the surface of Mars. A set of studies using specific mammal species is proposed to determine the prescription in the shortest amount of time.

### MarsXR Hazard Management System (HMS)

**Jason Evans, Sanjit Singh, Valerie Hubener, Darlene Villicana, Nurenyx Inc.**

Exploration of Mars requires operational flexibility with shifting levels of autonomy for exploration missions. Navigation tools assist astronauts with increasing autonomy during extravehicular activity (EVA) operations. EVA is an extremely dangerous activity of human space exploration. Astronaut safety must be ensured for mission success and risks and challenges with EVAs must be effectively managed.

This project collaboration was for the NASA MarsXR Challenge. Project input included published journal articles and interviews conducted with aerospace professionals regarding EVA operations for space exploration. Our proposed Hazard Management System (HMS) provides crews on Mars with real-time hazard identification information during navigation while supporting the safe and effective execution of EVAs.

HMS is a Blazor Hybrid web portal and mobile application (Apple and Android) system that leverages the ASP.NET Core Multi-platform App UI (.NET MAUI) framework. A database management system enables authenticated business end-users to easily manage data that is needed for end-users within the connected Unreal Engine 5 (UE5) Extended Reality (XR) application. Data is stored within two databases (SQL and SQLite) and is pushed to an interactive billboard dashboard that end-users consult with via the XR UE5 application while navigating over 400 square kilometers of photorealistic Mars terrain data. Without the real-time support of Mission Control on Earth, HMS assists crew members with data services for complex operations during EVAs for real-time exploration.

The novel Blazor MAUI application companions the UE5 XR application billboard system for on-demand data analytics and reporting for end-users during the simulation of EVAs for Mars exploration. Data is easily managed by business users through mobile applications and web-based portals on a routine basis to ensure relevant and reliable data is available in the XR environment for end-users to interact with when needed to manage risks.

## Interplanetary Application of Ecological Learning: Ten Lessons from Managing Earth's Oceans to Guide In Situ Resource Utilization on Mars

**John Parks, Tetra Tech**

With preparations underway to depart humanity's cradle, it is important to review and apply relevant lessons learned from natural resource management on Earth that can be applied to Mars, and beyond. Fortunately, we have a wealth of experience from marine resource management and deep-sea ocean exploration that can be adapted and applied toward in situ resource utilization (ISRU) during the initial settlement and permanent habitation of Mars. Toward this objective, there are ten key lessons learned from marine resource management on Earth that are relevant for adaptation and application on Mars. The first four lessons learned relate to minimizing the costs associated with accessing scarce, high value natural resources from remote and inhospitable locations. The next three lessons relate to managing the inevitable emergence of a socioecological system associated with ISRU on Mars. The final three lessons relate to how to address sustainability concerns and resource conservation needs proactively, rather than reactively. Each of these ten marine resource management lessons will be introduced with recommendations on how they can be adapted and applied in the context of Martian ISRU. Successful adaptation and application of such natural resource management lessons from Earth will not only increase the likelihood of efficient and optimal ISRU during initial settlement, but also long-term ISRU sustainability in the context of permanent habitation of Mars and elsewhere in the solar system, including as it relates to minimizing human conflict over available natural resources and competing interplanetary extractive objectives.

## In Search of Biological Life Support

**Donald Jacues**

**EarthSeed, Inc**

Present and past CELSS systems work from the position that a human being requires 38 kg of "consumables" per day of air, water, and food, i.e. we "consume food" and "excrete waste". This mind-set assumes supplying consumables to the humans. However, this mind-set excludes the very premise on which an ecosystem works, by attempting to remove the human from the ecosystem, treating that human as a consumer, instead of a participant.

We are working to change the perspective from humans-as-consumers to instead say, humans-as-participants, participating in the biomass conversion and material transitions of the ecosystem. Maintenance of the ecosystem-as-life support is applied as a shepherding or stewarding process, rather than a controlling process.

Within Earth's biosphere, myriad life forms are supported by a complex system that includes material recycling through interactions of the many life forms living within that biosphere.

One major positive attribute of an ecological system is that it is dynamic. Participatory species

interact on multiple levels to maintain a floating equilibrium. This floating equilibrium provides the buffer of both time, and resources to protect against abrupt system failure. Automation of such a complex system is still well out of reach of even the most intensive systems today, primarily because the equilibrium target of a successful ecosystem is a moving target. There is an ebb and flow of life as different species live and die, their populations growing, and shrinking as time carries forward.

CIRES, Compact Intensive Regenerative Ecological System represents a model of biological life support that embraces this ecological model of life. The implementation and integration of Aquaculture, Agriculture, Aviculture, Algaculture, and Vermiculture provides the foundation for a long term sustainable and regenerative system to support earth-life beyond Earth.

### 24 Color Cameras to answer "Red or Blue Sky on Mars?"

**Holger Isenberg**

**areo.info**

12 robots and 41 color cameras have been operated since 1976 on the Martian surface. However, the question of the visual color experience on the surface for humans is still unsolved. While robots don't care whether the sky appears red or blue, humans' psychophysical well-being is highly dependent on this. Research papers discussing this topic do exist, but actual color calibration anchors barely exist. The current Mars Perseverance rover and Ingenuity helicopter, which doubled the total number of color cameras on the surface, should be able to shine a light on this topic due to the diversity of its camera models and the choice of commercial off-the-shelf image sensors for most of them. As the author and operator of the free Mars Rovers color camera daily archive https://areo.info I investigated this question by applying standard software for photographic raw image processing using a few new calibration anchor points. I'm presenting recent results and conclusions from comparing calibrated images from Viking Lander through Ingenuity.

### Hydrogen Powered Hypersonic Launch Colonize Mars Sustainably

**John Hunter, Rob Fryer, Don Whitney, Green Launch Inc.**

Green Launch is dedicated to delivering satellites and supplies to Earth Orbit using a sustainable Hydrogen Launcher. Based on a system built at Lawrence Livermore National Laboratory. Our C.T.O. Dr John Hunter and his team, designed, assembled and operated the world’s largest hydrogen Launcher. This system, launched hypersonic vehicles at world record speeds and was used to test SCRAM jets.

With Light-Gas launch all gases can be captured and re-used indefinitely, unlike rocket propellant. This recapture after each launch reduces the amount of additional rocket propellant required for successive launches to near zero. A Martian Green launch system accelerates vehicles to 4 km/s to deliver goods, including propellant for Starship, to Mars orbit to prepare for return to earth. If heated to 1700K, even ambient CO2 can be used to launch payloads to orbit

from Mars.

Rocket emissions and debris from spacecraft falling out of orbit are having effects on global atmospheric chemistry. Through improved monitoring and regulation we can create an environmentally sustainable space industry. Our current Green Launch system at Yuma Proving Grounds is preparing to sample the Mesosphere. Hydrogen Launch can cleanly sample at this altitude which is too high for balloons and too low for satellites.

This disruptive technology is cheaper and more flexible than conventional rockets. It is also more environmentally friendly since it produces zero hydrocarbons with the first/main stage. We do not have significant physical limitations in reaching our velocity requirements. The record for a projectile launched with hydrogen propellant is 11.2km/sec. We plan to limit our launch velocity to 6 km/sec to extend reusability and prevent wear on the barrel. Our rocket would need to produce an additional, and achievable, 3 km/sec to circularize and achieve orbit.

## Hi-energy impact engineering in a planetary environment for rapid space colonization

**Lev Reznikov**

**CRYOFOR**

The objects of space colonization are the planets, their satellites, and asteroids.
The main tasks for colonization are:
- Construction of facilities, infrastructure, and shelters with complexes of life support systems and logistics.
- Power generation for the mission.
- Extraction, processing for use of resources in place (ISRU).
- Redesign, correction, and adaptation of the relief.
- Geoengineering, creation, and restoration of the optimal gaseous atmosphere.

As we presented earlier, the excessive kinetic energy of the landing interplanetary spacecraft should be used cost-effective rapid construction of mission infrastructure.
The infrastructure of the settlement is located on the surface and underground and interacts with the main components of the ecosystem:
- The surface of the mainland.
- Cryosurface of predominantly frozen gases or glaciers.
- shallow subsurface layers.
- Hot and deep subsurface, including molten rocks, lava, magma, tephra and natural cavities, chambers, channels, lava tubes, solids and minerals, superheated fluids and brines and other sources for geothermal energy production and mining.
- an atmosphere like the earth's, can be created by processing of local planetary resources in the form of layers of gases interacting with open space, and the planetary surface.

Presented here are new technologies that further enhance the ability to use kinetic energy as a trigger, in combination with natural resources, to arrange the functional infrastructure ultra-fast before the crew has landed, based on already proven military and industrial processes and

technologies. Such a program could be co-financed with existing space exploration programs and would not require significant additional funding.
The project can be the key to future intensive, fast, and economically beneficial space colonization.

### Orbital Propellant Depot

**Gary Johnson**

This article describes a concept for an on-orbit propellant depot capable of refilling visiting craft, which presumes the visiting craft have rendezvous and docking capabilities. This is only a concept, which has not had any serious design analysis.

Such a depot will have to handle both storable propellants used mainly for attitude thrusters, and the largely-cryogenic main-stage propellants. The main stage propellants must be handled in very large quantities.

There are very effective ullage solutions for storable propellants in zero-gee conditions. These are various bladder geometries within the tanks. That solution still eludes application to the cryogenics, leaving ullage thrust and spin ullage as the most practical solutions. Rifle-bullet spin geometry is selected for this depot concept.

Such a depot needs orbit adjustment, reboost, and debris avoidance propulsion capability. There is the option to propel the depot sufficiently that it might “go where the job is”, instead of having the visiting craft come to it, which could assist with some aspects of orbital debris removal. But because the facility is so large, a separate space tug to bring the job to the depot is a far better option for such missions.

## Permanent Settlement

### Construction on Mars (What it will take)

**Frank Schubert**

**Combined Solar Technologies, Inc**

The first crews on Mars will likely not be building structures, equipment or roads. These crews will be largely made up of scientists and engineers that will be studying Mars for signs of live and other scientific endeavors. However, there will be a need for crew members with construction skills such as welding, equipment maintenance, water system repair, etc. etc. With the arrival of the second expedition work will likely begin on the constructing a permanent base. This activity will require not only engineers but people who are well versed in the actual activity of construction. The skills needed will include plumbing, welding, equipment operators etc. etc. Also important will be the mission will be an adequate supply of spare parts

For survival on Mars during this mission, the life support and water filtration systems as well as the Mars Lander must be always kept operational. In order to ensure that water filtration systems can be repaired in the event of an emergency, it is very important to have the capability to weld. A better understanding of welding in the Mars environment is important to ensure that repair welds are possible if the habitat capsule/Mars lander or water filtration system is damaged at any point while on the surface of Mars.

Additional considerations for construction on Mars include power supply issues, radiation, using local materials and doing physically hard work in the Martian environment.

**Feeding a Colony: ISRU in early space habitats**

**Stellie Ford**

**Mars Society of Philadelphia**

Sci-fi often depicts long duration space habitats with a lush gardening system, giving the impression that colonists will be producing a significant portion of their own food. Unfortunately, this vision might be a bit further off than most people realize. Through a quantitative analysis of our ability to produce nutritional food, and a cost benefit analysis of the expense of doing so I outline the approximate timeframes and project scales for when we may begin to see ISRU menus.

There is some tradeoff in resource allocation to production, but the economies of scale in terrestrial agriculture strongly favor larger farms, but the nutritional and emotional demands of long duration space habitation are an important consideration for all future Martians.

**Biological-age control to maximise the settlement-rate of new planets**

**Daniel Ives**

**Shift Bioscience**

If we want to settle local planets and farther exoplanets at a maximal rate, it is necessary to maximise our population and increase their biological resilience. In the context of a sudden decrease in birth-rate, control of biological age to minimise frailty, disease and mortality of living individuals offers a primary solution. It has recently been shown that biological age can be reversed in human cells by applying four protein factors, but these factors significantly increase the risk of tumor formation in whole animals. Our group is focused on locating a safer set of factors for biological age control through an active machine learning approach, promising a new drug class that provides our population and biology the necessary support to realise our space ambitions.

**Richard L Poss**

**University of Arizona**

**Mars the New World: Reflections on the 500 Year Metaphor**

Arguments for and against space exploration and the settlement of Mars invariably make use of a grand metaphor – that the next 500 years of exploration will be analogous to the last 500

years of European exploration and settlement of the Americas. That the settlement of Mars will be similar to the past in some ways, but different from the past in other ways, is a useful framework for anticipating the triumphs and challenges that lie ahead. This paper will examine a series of "parallels" between past and future developments, trying to gain insight into what will be humankind's greatest adventure.

We can regard the period roughly from 1500 to 2000 as the exploration and settlement of the New World by the European powers. We will explore and settle Mars from roughly 2000 to 2500. How do we plan for the developments we can foresee, and how do we guard against challenges no one could predict? Historical perspective can only do so much. Still, the analogy has value. This paper will go through several features of exploration in the past 500 years and study the degree to which we can expect similar challenges on Mars.

The open American landscape inspired new possibilities, as the open landscape of Mars will open the minds of humans to do things undreamed of on Earth. Mars will produce new music, poetry, philosophy, and an explosion of science. No one in Columbus' time could imagine the freedom and bounty of educational, artistic, scientific, medical, religious, and recreational institutions the new world would generate. How many times will life on Earth be saved by scientific advances made on Mars?

## EVIDENCE OF MASSIVE R-PROCESS EVENTS ON MARS IN THE PAST THAT MAY HAVE DEVESTATED THE PLANET

**John Brandenburg**

**Kepler Aerospace LLC**

On Mars, the nearest Earthlike planet in the cosmos, there exists, relative to other planets and other solar system reservoirs, a hyperabundance of 129Xe in the Martian atmosphere[1]. This hyperabundance of 129Xe which defies conventional explanations[2], and which appeared late in Mars geologic history, is apparently the result of massive R-process events. Such R-process events, featuring intense high energy neutron bombardment of heavy elements, occurs in supernova cores [3,4]. This hyper abundance of 129Xe is not consistent with a natural nuclear reactor that went unstable, which requires thermal neutrons. Evidence exists in young Mars meteorites, from 80Kr abundance, of intense 1014/cm2 flux over the Northern young part of Mars. These explosions left no visible craters, indicating that they occurred, like the Tunguska Event, several kilometers above the surface. However, there is no evidence the Tunguska Event involved nuclear energy releases. Thus, Mars was apparently the site of a large and violent nuclear events. These events can be estimated to be of similar energy to the Chicxulub event on Earth. [1]Conrad et. al., "In situ measurement of atmospheric krypton and xenon on Mars with Mars Science Laboratory," Earth and Planetary Science Letters Volume 454, 15 November 2016, Pages 1-9 [2]Hunten , D. M., Pepin, R. O. and Walker, J. C. G. ,(1987) "Mass Fractionation in hydrodynamic escape, " Icarus, 69 p. 532-549. Also in Mars , H.H. Kieffer et al. editors, University of Arizona Press, (1992) p. 127.[3]J. D. Gilmour and G. Turner , CONSTRAINTS ON NUCLEOSYNTHESIS FROM XENON ISOTOPES IN PRESOLAR

MATERIAL, The Astrophysical Journal, 657:600Y608, 2007 March 1[4]K. Saebo and P.K.Kuroda , " Anomalous Xenon Isotopes in Carbonaceous Chondrites", Geochemical Journal Vol 19. pp 251-257, 1986.

## Community Building System for Mars and Earth

**Stuart Nelson**

**ArcologyX**

Communities of families living on Mars will face many new problems. Humanity needs to solve most of these problems on Earth, where system failures will not mean extreme hardship or death. We also need many people who have experience living in a Martian style habitat to become the colonists who will raise families on Mars. What is needed is a Martian habitat that is adaptable to Earth, accessible to many people and a desirable place to raise a family on Earth and Mars.

We make use of the unique geometry of the cuboctahedron as the basis for a simple, flexible, inexpensive building system that can serve as the framework for these habitats. The basic form of the building is a large hexagon with the outer wall transparent and an open area in the middle which becomes an "outdoor" area. The roof of the Martian version is ten meters of regolith supported by internal air pressure. The outer wall allows a view of the Martian surface.

An Earth variant of this design can be used as a platform for people to develop, implement, use, and iterate on the many technologies required to turn a building into a community sustaining environment. This development will happen with an open and accessible design philosophy so the end product is something people feel comfortable building, living in and maintaining. On Earth we can start small, adding components incrementally until we have a complete system. The mature Earth versions can be located at high elevation and maintain sea level internal air pressure. These will be platforms for communities learning how to live as Martians while gaining experience and confidence with the technologies which sustain them. When these communities are successful on Earth, humanity will be prepared to send families to Mars.

## Some Scientific Challenges in the Exploration of Mars

**Gonzalo Munevar**

**Lawrence Technological University (Professor Emeritus)**

In my upcoming book The Dimming of Starlight (to be published by Oxford University Press), I discuss several critical concerns about the exploration and settling of Mars. I intend to present some of them at the convention. First, a critique of proposed solutions to the problems of radiation and microgravity for the crew in the long mission. Second, concerns about not interfering with the search for life fossils, or life itself, on Mars. CRISPR-Cas9 has been proposed to turn on genes or to insert them (from other species) to protect against radiation. Unfortunately, the genomic damage from distal deletions may lead to cancer and other pathogenic consequences. Instead, cosmic rays can be stopped by walls with water in

polyethene bags, reinforced by hydrogenated boron nitride nanotubes, an ideal shield being developed by NASA, a material that can also be made into yarn to clothe the explorers themselves on Mars. Medical implants to deal with the effects of microgravity are also unwise. I suggest instead applying scientific principles, developed by Gerard O'Neill and others, about rotating structures: instead of stacking up the spaceship, the rocket would be in the middle and the other two compartments (supplies and crew) connected to the rocket by a thin structure, hundreds of meters apart from each other, and made to rotate. Astronauts, inside their compartment as it rotates, are subjected to acceleration approaching 1g. The search for life in Mars and other places could have profound implications for biology and medicine. We should explore so as to preserve such potential scientific treasures. The National Academy of Sciences, at NASA's request, has provided new guidelines for the biological burden to be placed on missions to Mars. I will explain those guidelines.

## Meteorites for Early Metals on Mars

**Doug Plata**

**The Space Development Network**

Mars is located near the asteroid belt which contains the large metallic asteroid Psyche. Our rovers on Mars have seen roughly 60 nickel-iron meteorites on the surface in the roughly 60 km that they have collectively driven.

Communications with a Mars rover scientist (Horton Nelson) working with Curiosity's Mast Cam resulted in the rough estimation that there is about 878 kg of nickel-iron meteorites per km2.

A largely self-reliant settlement would be able to produce practically unlimited amounts of plastic at a single location. So, self-reliant settlements should use plastic as much as possible and use metal for only those components which absolutely require it.

It is proposed that a comprehensive survey of the locations of nickel-iron meteorites be conductive using drones that fly to a certain height, scan all around looking for nickel-iron meteorites and then fly to the next hexagonal grid coordinate where its solar panels can recharge it to repeat that process. After the locations of the metallic meteorites are known, robotic or crewed rovers could drive to those points, collect the meteorites, and return them to base.

**Robert Mills**

**MIFECO**

**Surviving and thriving for 5–10-years**

Envisioning a 5–10-year life support

The first step in inhabiting Mars is to set up habitats that allow humans to live on Mars for extended periods of time. Early habitats will need life support to last not only for an initial visit, but long enough for a 2-year mission (and allowing for problems, another 2 years). This will require life support for more than 5 years). Bringing supplies for such an extended period is a problem even for heavy lift missions. In this session we will envision what a mostly closed loop system for a small habitat might look like. (Requiring external power, stored gases, and local water). We will talk about what exists and what needs to be developed. Many groups have worked on bits and pieces of this problem but in this secession, we will look at them together as a single solution using computer control of hybrid life science and mechanical solutions. Such a system needs to be designed with a minimum of parts and complexity and then tested and improved here on Earth to be ready to support near future Mars missions. Once designed, systems like this can be rapidly manufactured to support as many people and habitats as we can deliver to Mars.

Goals

- Fit into a volume of 50 cubic Meters
- Support 4 to 8 people
- Provide purified water, Air mix maintenance, waste management and recycling, food production, etc.
- Works with Mars gravity in a temperature controlled pressurized container
- Require human maintenance and gardening
- Operate for more than 5 years
- Highly closed loop
- External supply of power, water, Martian soil, Martin atmosphere
- Fault tolerant and redundant
- Reserves Air, food, and water for emergency use

**Full Self-reliance 15 Years Sooner**

**Doug Plata**

**The Space Development Network**

Elon Musk has indicated that one of the main goals for SpaceX's Starship is to establish a city on Mars with a population of a million. The rationale for this goal is to establish a second, independent branch of humanity in order to ensure its long-term survival. However, it is possible to achieve full self-reliance on a much smaller scale and hence earlier. It is estimated that this could be achieved perhaps 15 years earlier than Musk's city approach. To achieve this, reasoning should be based upon first principles rather than by analogy.

In order to achieve full self-reliance, it will be necessary to produce materials in situ including water, oxygen, food, plastics, and metals. Power systems will also be needed to be produced in order to operate everything. Fortunately, the resources of Mars are easily accessed and the production of materials and structures over a generation doubling rate is achievable with a relatively few number of crew.

Habitat and internal structures should be produced from plastics as much as possible. Metallic meteorites are numerous and readily available and provide a good source of initial metals. Shielded crew rovers could retrieve them. An intensive GreenHab, efficiently run, would provide all of the necessary nutrition. It is proposed that such a fully self-reliant base could be developed and operated without the need for manufacturing integrated circuits.

Finally, a minimally viable population could be achieved using frozen embryos and durably stored, curated information would ensure the ability for resilient, long-term growth.

## Virtual Presentations

### State of the Art Review in Superconductor-based Applied-Field Magnetoplasmadynamic Thruster Technology

**Marcus Collier-Wright, Elias Bögel, Kapish Aggarwal, Manuel La Rosa Betancourt**

**NeutronStar Systems**

Applied-Field Magnetoplasmadynamic (AF-MPD) thrusters, have long been considered as one of the most promising technologies for high-power electric propulsion of spacecraft. This is based in their unique combination of properties such as: propellant flexibility, high thrust density, scalability to very high powers, as well as their throttleability and ability to operate at high specific impulses and high thrusts. Due to the extreme power consumption of conventional AF-MPD electromagnets, high-temperature superconductors (HTS) have been applied in AF-MPD thruster prototypes in several institutions around the world.

The University of Stuttgart has achieved record-high thrust efficiencies of 62% in the SX3 thruster, using a conventional electromagnet. Concurrently, several countries have initiated efforts to combine HTS with AF-MPD thrusters as part of their electromagnets. At research institutes in China, research activity is ongoing to develop high-powered thrusters of up to 500kW. In Russia, the development of a 25kW MPD thruster is underway as a cooperation between the National Research Nuclear University and SuperOx. A working prototype has already been tested for both the Chinese and Russian programs. Furthermore, New Zealand's Robinson Research Institute has also initiated research of comparatively lower power superconducting MPD thrusters. Europe presently has development activities ongoing in form of the SUPREME concept from the private company NeutronStar Systems. This system is designed for a variety of operating powers, for small satellites up to large-scale interplanetary cargo or manned missions, such as to Mars.

This work gives a critical review on global recent developments in superconductor-based AF-MPD thruster technology. It presents the current state of the ongoing research and development of the programs in Russia, China, New Zealand and Germany, and shows its importance for large-scale missions, as those on the horizon for Mars travel.

### In-situ production of rocket propellant on Mars using the Sabatier reaction: a feasibility study

**Francis Desilets-Mayer, Joya Yamagishi, Kenza Belmir, Gibran Alamgir**

**UBC Mars Colony**

In-situ resource utilization (ISRU) of the Martian atmosphere is often a central element of the many proposed manned mission to the red planet. In conjunction with ice deposits, the carbon dioxide rich air can be used for in-situ production of liquid methane and oxygen, a rocket propellant mixture called Methalox. In 2016, Elon Musk made public a mission architecture centered around ISRU for propellant production. As part of this plan, a SpaceX's Starship would be refueled with Methalox produced on Mars for its trip back to Earth. Building upon this proposal, UBC Mars Colony conducted a feasibility study on propellant production on Mars. This is a sub-project of the benchtop Sabatier reactor project, where our team built a prototype reactor. Our analysis includes a full plant design, a process flow simulation, an approximation of energy consumption and an estimation of equipment sizes. To our knowledge, this is the most detailed public study on the subject.

In our simulation, the propellant plant produces 1095 tons of liquid oxygen and 257 tons of liquid methane over the course of 26 months. These targets are enough to refuel one of SpaceX's Starship with a 3.66 fuel ratio during a single synodic period. The design of the plant was inspired by equipment used in the chemical industry and by previous Martian ISRU work. Among others, our team simulated a Sabatier reactor, a water electrolyzer, various gas conditioning systems, a forced convection air cooling system and a cascading liquefaction unit with 4 refrigerants. Using the simulation, our team determined that the Methalox plant would occupy 41 cubic meters and would operate on a continuous 573 kW of electricity. Conclusively, the Sabatier Methalox plant was found to fit within the 1000 m3 cargo zone of SpaceX's Starship.

### Living With Children on Mars

**Cynthia Hills**

**ArcologyX**

If humans are eventually to travel and colonize other star systems, that will involve centuries long voyages. Most discussions of human space travel tend to focus on the scientific and logistical challenges of getting there and surviving. Almost entirely overlooked is how we will raise the children that will be born either as we are traveling or when we arrive at our destination. We will need to find ways to have and raise children in space. A good first step in

that project will be learning how to raise children on Mars.

It is likely that people will be living on Mars within the lifetimes of now-living residents of Earth. Children will be born and grow up there. Families will grow and communities will be created and developed. In many ways raising children there will be identical to what happens on Earth. But there will be new challenges to overcome as we enter this new frontier due to Mars' inhospitable environment and the remoteness of the planet itself. Telling the kids to go out and play will have an entirely different meaning. It's not too early to plan for other methods and spaces for children to access as freely as they do here on our home planet.

We will consider how families and communities on Earth and Mars will be both similar and vastly different. We'll examine the possibility that some of these ideas about life with children on Mars might also be of interest and use to families here on Earth. One of humanity's greatest strengths is our ability to adapt to new ideas and new circumstances. It's certain that the move to another planet, and the subsequent adaptations of our familial and social behaviors will influence those same behaviors here on Earth.

**What have we found on Mars?**

**James Secosky**

**Bloomfield Central School (retired)**

After over 50 years of studying Mars with increasing sophisticated instruments, we have learned so, so much about the Red Planet. Today's cameras can see things the size of houses or even cars. This talk deals with what the surface looks like—looks like from maybe a helicopter or from a plane. For possible use by teachers, two quizzes are included at the end of the presentation.

Many things like river valleys, rock layers, sand dunes, volcanoes, and landslides are common on both planets. Others are widespread on Mars, but not so common on the Earth. Mud volcanoes, dust devil tracks, and rootless cones are in that class. Then there are ones that seem unique to Mars: dipping layers, ring-mold craters, dark-slope streaks, lobate debris aprons, brain terrain, and spiders. I will focus on features that do not seem to exist on the Earth.

To best present them, mostly HiRISE images will be used. Most of the pictures came though the HiWish program, which since 2010 has allowed amateurs to select locations for NASA to photograph with the powerful HiRISE. HiRISE images are about 5 km wide, but only have a 1 km wide band in the center that is in color. Colors for HiRISE images are different than the human eye would see; HiRISE only sees in only 3 colors and sometimes infrared is used rather than red. The use of these colors tells us more about minerals. Also, pictures from spacecraft are enhanced to bring out subtle details.

Similar pictures are shown in the Marspedia article called "HiWish program" and in the videos "Features of Mars with HiRISE under HiWish program" (https://www.youtube.com/watch?v=b7q1Xyz_LBc) and "HiRISE images from HiWish Program" (https://www.youtube.com/watch?v=nhYQEzK-MYE).

## The “Astrosociology in the Classroom” Program: Contributions of Social-Scientific Space Education and Research

**Jim Pass**

**Astrosociology Research Institute**

The Astrosociology Research Institute (ARI) was founded by this author in order to help facilitate and contribute to the development of astrosociology, which is defined as the study of astrosocial phenomena (i.e., the social, cultural, and behavioral patterns related to outer space). As astrosociology is a multidisciplinary academic field that focuses on issues related to the human dimension, it is important to address what the social and behavioral sciences, humanities, and arts already contribute to the impact of outer space on humankind, both on Earth and beyond. A fundamental facet of ARI’s approach is the expansion of the “Astrosociology in the Classroom” program, which is underway in southern California among high school students, Harvard University students, and also ready to expand soon among students currently ranging from kindergarten to the post-secondary levels. Continued success depends on outside organizations and educators who accept the notion that revealing the very existence of astrosociology in the classroom is important for the successful continuation of space exploration and settlement into the future. Acknowledgment that an academic field exists that interjects a greater level of attention on social-scientific analysis into the issues related to outer space is sorely needed. Additionally, it is important for students to encourage their classmates and educators to accept that this academic field exists and is worthy of pursuing in academia. The relationship between humankind and space from a social-scientific perspective has been studied over several decades although this approach remains underemphasized compared to approaches based on the physical and natural sciences, technology, engineering, and mathematics (i.e., STEM). A fundamental objective here is to examine how the STEM disciplines and astrosociology already do, and will, interact in the classroom to achieve unprecedented results related to settling on Mars and in other space environments.

## How Not to Design a Martian Economy

**Jim Plaxco**

**Chicago Society for Space Studies**

A key component of the Mars Society's Mars City State Design Competition was the design of an economic system that would promote growth and economic independence. An analysis of one of the competition's entries reveals a number of critical policy decisions that would hinder economic innovation, limit the ability to attract outside capital investment, and retard the establishment of independent business operations. Some of the key policy decisions that would negatively impact economic vitality and innovation include the dominance of state owned enterprises, the absence of private property rights, state control of the labor market, and the state's role in the business decision making process. Policies established in the design submission are contrasted with policies that have been identified by the World Bank and Organization for Economic Cooperation and Development (OECD) Economic Studies as being

crucial to the creation of a dynamic, successful economic environment. Collectively, the system of incentives, the political and social structure, the relationship between industry and government, and the tension between central planning in the form of industrial policy and independent business operations are shown to create a rigid economic system when a flexible, responsive system is needed. Aspects of asteroid mining, space tourism, immigration policy, and Martian integration into a broader space economy, are also examined with respect to their role in the economic development of this particular Martian system.

## Parameters of Life

**Joshua Sparber**

Science has not focused on the internal factors of the possibilities of cosmic life. Now is the time to do that. Just like biology evolved from the Linnaeus descriptive classifications to become more focused on the true mechanisms of genetics and physiology, our understanding of life in the cosmos is undergoing a change based on new data and subsequent insights.
"To return to the history of population genetics and its impact on evolutionary theory, it should be noted that hard on the heels of the rediscovery of Mendel's Laws, systematic investigation of genetic inheritance was greatly intensified, notably, by Thomas Hunt Morgan (1866–1945)" (Academic Influence 2018-2022). This investigation became an intensified search for a more solid theoretical foundation, one departing from the presuppositions formed by previous thinkers and experimenters. Biology entered the twentieth century with a variety of outlooks: vitalism, Darwinism and its eclipse—followed by Neo-Darwinism, the morphogenetic field, organicism, the Three-Man-Paper of biophysics, the one gene-one enzyme hypothesis of Beadle and Tatum, Fischer's lock-and-key hypothesis of protein-substrate interaction, Pauling's quantum description of organic bonding, and Chargaff's Rule (Academic Influence 2018-2022). "Despite the firm empirical foundation now undergirding genetics, there was still lacking a sophisticated mathematical theory in the light of which the data might be usefully interpreted" (Academic Influence 2018-2022). The search for extraterrestrial life has indeed reached this stage. Instead of using the Drake equation guidelines to demark the possible existence of life in the cosmos, a framework of more focused presumptions could be formulated. Mars could provide a comparative example for the use of a new parametric framework.

## A potential solution to deal with charged particles on Mars

**Julia Alvarez Vallero**

**INVAP**

One of the most ancient desires regarding space exploration is landing on Mars, the red planet. Since Gagarin reached the outer space, men and women have been dreaming about their next challenge. Once Neil Armstrong, Edwin Aldrin and Michel Collins arrived to the Moon, human boundaries of what is possible keep broadening. From all these summits, people have had to think in a completely different way about what was going on in a place where they have never been nor stepped into.

Mars represents another hard dare to overcome. Earth is 59 million kilometers away from this planet, and to actually send someone there, first we must see and explore without our eyes in order to assure the best possible mission´s conditions. One of the most important questions regarding Mars is whether human life there could be possible or not.

In this context, it is important to understand the environmental condition of the space around Mars. It is known that Earth has an intrinsic magnetic field which captures most of the charged particles that come from the Sun or are generated by solar wind (and all the related phenomena). On the contrary, Mars does not have this permanent magnetic field, but it has an induced one, generated by the combination of plasma around the planet and solar wind. Thanks to MAVEN mission, the first current electric map of the martian atmosphere was created. With this information, it is possible to model the direction and variations of the induced magnetic field. On Earth, the magnetic field protects humans from the impact of some charge particles, but that could not be expected to happen on Mars' surface. The purpose of this article is to discuss what can be done in order to deal with these particles.

**Syrtis: A new tool for habitat thermal analysis**

**Sam Ross**

**Nexus Aurora**

Thermal control of crewed spacecraft and habitats is an essential life support function, and it must be addressed at every stage of the design process. The surface of Mars presents thermal challenges almost unique in the solar system - heat fluxes from convection, extreme temperature variation and variable solar heating make analysis challenging. This is vexing, as it prevents the informed inclusion of thermal issues in the design process and impacts the merit of habitat designs.

To rectify this, a new software tool called Syrtis has been developed. It uses engineering correlations to solve thermal balance for habitats very rapidly, and with a broad range of functions to assist engineers and designers in the analysis of their designs. By bridging the gap between order-of-magnitude calculations and full numerical analysis, it allows for informed decision-making and merit evaluation at every stage of the habitat design process.

The underlying theory and implementation of Syrtis is laid out, along with a full example of the simple usage to analyse a habitat. Some of the insights gained throughout the development are also presented.

**Polar Expeditions Case Studies for Deep Space Missions**

**Scott Balcao**

**Lockheed Martin**

Many system engineers, mission planners, project and program managers, as well as astronauts have used case studies to further understand and prepare for long duration space missions. One case study that has gain much attraction is studying polar expeditions. Polar expeditions have subjected crews to extreme stress and stress for months if not years at time. One polar explorer describes his time in the the frozen wasteland as “We are as hopelessly isolated as if we were on the surface of Mars and we are plunging still deeper and deeper into the white Antarctic silence.” This presentation will focus on several polar expeditions from Roald Amundsen, Ernest Shackleton, Robert Falcon Scott, Robert Peary, and John Franklin. We will focus on why some of these expeditions were successful and why some were not. More importantly, we will discuss what can be learned from these polar expeditions for deep space missions.

**Power Space Peace**

**Manousos Chairetis**

**THELLAS SA (under creation), RAeS, AIAA, IMechE, Technical Chamber of Greece**

“Power Space Peace” speech will present the perennial critical factors of human conflict causing humanity’s self-destruction and periodic historic catastrophes. A well justified and proven proposed solution of escaping forever the repetition of human regression will be given, through the unique ability we currently have to expand to Space, in such ways to save ourselves from ourselves flaws. The recording of the speech will be personally sent, and presented after the 25th Mars Society Conventions to all critical heads of states, political leaders, and decision makers of the fates of humanity, as well as thousands of key people who are able all together to contribute and implement the proposition actions, delivering our common progression to space.

# SATURDAY AFTERNOON SESSIONS

## Telerobotic Competition

In January 2022, the Mars Society announced the holding of an international contest for the best design plan of a robotic flotilla using a 10 metric ton Mars lander.

An essential requirement for any human Mars exploration mission is a system capable of landing payloads of 10 metric tons or more on the Martian surface. Such systems could first be demonstrated by being used to deliver expeditions consisting of platoons of robots, including wheeled or treaded ground rovers, helicopters, airplanes, balloons, or other types of flight vehicles, and legged robots, including those in humanoid, cat-like, or insectoid forms. Expeditions of this type could return scientific bonanzas while preparing Mars landing sites for human arrival.

The Mars Society is pleased to announce that six finalists have been chosen in the Telerobotic Mars Expedition Design Competition (TMEDC), an international contest announced in January which asked the entrants to design the best set of robotic exploration hardware using a 10-ton payload Mars lander.

The finalists include teams from the U.S., Canada, and Europe and are listed below:

| | |
|---|---|
| MIFECO Proposal – Robert Mills | United States (Michigan) |
| Carl Greenbaum | United States (South Dakota) |
| Moran_TMEDC_Team | United States (Virginia) |
| Innspace Team | Poland (Lodzkie) |
| Spaceship EAC | Europe (Germany + multiple team members) |
| Northern Shores Innovation Institute (NSII) | Canada (Ontario) |

The teams will now present in-person at ASU and virtually before the global community at the 25th Annual International Mars Society Convention at Arizona State University, scheduled for October 20-23, 2022, where the winners will be selected.

There will be a prize of $10,000 for first place, $5,000 for second, $2,500 for third, $1,000 for fourth, and $500 for fifth. In addition, the papers will be published in a new Mars Society book “Telerobotic Mars Expeditions: Exploring the Red Planet with Platoons of Robots.”

## Humanity's Future

**Erik Bethke, CTO - Million on Mars game**

Million on Mars is a live massively multiplayer game with over 10,000 players. In a sense, we have 10k people living and working and trading resources on Mars right now! Million on Mars is a web3 enabled simulation where players own their own 40 acre plots of land on Mars. Players learn about the fabled Sabatier reaction and craft methane from the atmosphere and from electrolysis of water from water rich clays. We have hundreds of crafting recipes, and a vibrant in-game market where commodities on this virtual Mars are traded player to player at an annualized GDP of ~ $10m! With advice from Dr. Zubrin, we have recently added the Thorium

Salt Reactor to craft reliable energy at scale to augment solar energy. We are humbled to have currently serving astronauts, planetary scientists, nuclear engineers and geologists contributing back knowledge and extending the strength of the simulation. With the organic romance of exploring and settling Mars and the Solar system we have enjoyed robust and sustained revenue from our deeply engaged fans - even on the other side of this deep winter in the greater crypto and NFT space. We are currently running a promotion where purchase of the Thorium Reactor kit for $75 includes an annual membership to the Mars Society and in just a few weeks we have more than 100 new members!

## Starship Singularity

**Michael Laine**

**LiftPort Group**

The concept of the Starship Singularity is developed around the idea that 'everything changes' once (if!) the announced lifting capacity of SpaceX's Starship fleet is realized.
Elon Musk, founder, CEO, and Chief Engineer at SpaceX, has publicly declared (on Twitter ), "Starship design goal is 3 flights/day avg rate, so ~1000 flights/year at >100tons/flight, so every 10 ships yield 1 megaton per year to orbit."
Now, there is a lot in that quote that needs unpacking. But if he's right (and so far, he has been!), this new launch capacity – however it is applied – has the potential to change the Moon, his goal of Martian settlement, and our home down here on Earth.
If the SpaceX launch vehicle – Starship – launches three times a day with a capacity of 100 metric tons each, that's 661387 pounds to orbit every day.
Let that sink in a moment.

For a mental picture of this capability, that is the ability to launch 30% more than the entire International Space Station – in a weekend. (Starship per weekend is 1,322,772lbs versus the approximate mass of ISS at 925,000lbs.) It took about 15 years to construct the ISS…

There is evidence – even before the testing and first flight are completed – that this launch capacity has international ripple effects. More than twenty companies and countries are developing reusable launch technologies (vertical and horizontal takeoff and landing systems). And China is developing a reusable launch system that is 150 tons (50% bigger than Starship) to LEO, 65 tons to GEO, and 50 tons to Trans-Lunar Injection.
I believe these are just the beginnings of the vast array of changes resulting from the Starship Singularity.

## The Mars Leap: Putting YOU on Mars

**Charles Letherwood**

**IXITID Concepts**

When Armstrong landed on the Moon more than 50 years ago, every person on the planet knew their future lay in space. Today, the dreams seem different. Fewer see 'Space' as something for themselves, so they turn to Earthbound concerns instead.

But suppose someone could watch a sunrise over Martian mountains… just once… what would the dreams be like then?

“The Mars Leap” is designed to give each visitor a taste of their own possible future in Space, and then give them tools to make it a reality. It’s a traveling, immersive, interactive, educational exhibit for large regional science museums, letting visitors join a mission to scout the first Martian colonies.

They’ll live the experience from training and planning through liftoff and millions of miles of vacuum to Mars. They’ll ponder the Red Planet from an orbiting space station before dropping to the hostile surface. They’ll learn, firsthand, what it will take to shape humanity’s next frontier.

For the Mars Society members who have been so supportive of The Mars Leap at past conventions, this year we have exciting news. We’ve overhauled the entire concept to make it more expansive, inviting, and interactive. And this year, The Mars Leap is taking off! We’re actively recruiting Sponsors to make the Leap a reality, from the smallest crowdfunding Mars enthusiasts to the largest spacefaring industry leaders.

If Mars Can Be Ours, it can only be because humanity is ready, willing, and able to go. The Mars Leap will help provide the STEM tools, industry connections, and most importantly the inspiration to take us there.

## Decentralized Funding for Public Access to Space

**Stellie Ford**

**MoonDAO**

The number of launch companies has been rapidly increasing, and as they offer more and cheaper ways to get to space, the funding for space ventures is becoming more diverse. Decentralized financial structures like DAOs offer a novel way for groups to self fund and self govern as they pursue their journey into space. MoonDAO is an organization pioneering this business model and recently sent their first community chosen member, Colby Cotton of Dude Perfect, to space on the NSS-22 mission. The community has recently completed and approved a new constitution for governance, and outlined goals for the coming years.

As a body with a vested interest in the development of space infrastructure, MoonDAO also supports conversation on policy for surrounding access to the resources of space resources. The lessons learned in their journey offer insight into the future of private and public space ventures.

## Homo Exploratoris

**Alexander Shenderov**

Why haven't humans been to Mars yet? How come all the investment and drive and hard-won knowledge of the 1960s and 70s failed to get us there?

What let us down was a flaw in decision-making. We failed to stay committed. And this failure endangered not only our own long-term prospects, but those of entire Gaia – the biosphere of Earth. Why?

Humanity, imperfect as it is, is Gaia's only shot at immortality. A space-faring civilization is biosphere's evolutionary adaptation. Space is a shooting gallery, and every life-bearing planet will one day be sterilized one way or another – unless it sprouts a civilization that can protect it from global catastrophes, and/or plant its backup copies elsewhere. We humans could do it for Earth – if we choose to, and if we are lucky enough and persistent enough to succeed.

The same may apply even to the whole Universe. It' perishable too – unless it sprouts a civilization that helps it produce offspring in its image (e.g., by creating Universe's reproductive organs: black holes capable of producing daughter Universes).

There is no guarantee of success if we choose to shoot for the stars - only of failure if we don't. And the choice to go forth to the stars (vs. back to the caves) won't be available for long. Half-century from today, a barrel of oil - the miracle that fueled our civilization's recent advances - will contain less energy than it takes to extract it. We have no credible path to a scalable replacement of fossil fuels – and we won't unless we choose to believe in humanity. We can choose to take a chance on ourselves, - or let misanthropy and cynicism so fashionable these days become self-fulfilling prophecies.

## Cosmo-politcs: Resource Conflict, Great Power Politics, and Outer Space

**James Gilley**

**Nicholls State University**

Long the dream of science fiction authors, in the last several years serious discussion has begun in the realm of space resource utilization. That is to say the mining of resources and manufacture of materials beyond Earth's atmosphere. As it appears that this 21st century is becoming a century of great powers in competition and cooperation with each other over the use of resources and the downstream consequences of that resource utilization, the larger technological picture will deeply influence the actions of Great Powers within the international system. This paper will examine the impact of the nascent space resource utilization sector on the potential conflicts of this century between Great Powers. Building on the works of those like Daniel Duedney and Everett C Dolman, this paper will attempt to bridge the divides between state-sponsored space activities, non-state space activities, and conflict over resources in the coming years. As humanity expands beyond Earth's boundaries, it will bring its political, economic, and social realities along with it. We must examine the consequences of these large

scale political economic shifts on the decisions of major players in the international system, as they do have the potential to serve as existential threats.

## The War of the Singularity: The Human Race is Canceled- A Scenario Where The Existence of a Mars Colony Saves Humanity

**John Brandenburg**

**Kepler Aerospace LLC**

This talk will discuss the author's latest work of science fiction The War of the Singularity, The Human Race is Canceled, (under the pen name Victor Norgarde) a new Science Fiction Novel involving space travel, a Mars Colony and Asteroid Belt colonies of the future.
The premise of the novel is as follows: In the future, fusion power has solved the energy/climate problem, controlled gravity has allowed colonies to be safely established on the Moon, Mars and the asteroids. However, all is not well with the human race - it cannot seem to stay out of trouble.
Computing science in the area of AI ( Artificial Intelligence) and robotics has also advanced sufficiently in this future as to produce a series of conscious cybernetic entities called 'Cybercons' whose raw intelligence first equals and then exceeds that of human beings. Therein lies the root of the central conflict of the novel. Consciousness arose in nature as a neural architecture that enhanced survival of the organisms that possessed it. Self-awareness led to enhanced self-preservation and the result that the genes that produced this effect were passed on more successfully to following generations. Finally, taking advantage of the deployment of most of the Space-fleet to Mars stop a revolt there, it makes its Great Move. Now, the new reality emerges: only the remainder of the Space-fleet, the Mars colony and the Asteroid Belt colonies, stand between humanity and extinction.
Curiously, the book was first published on June 12th 2022, the day before the announcement of the possible existence of a conscious "chat-bot" at Google. It is the last of a cycle of novels that began with Asteroid 20-2012 Sepulveda and follows the same main characters.

## Colonizing Mars

**Gary Johnson**

A look at the history of colonizing the Americas and Australia 300-to-500 years ago provides very useful high-level approaches for colonizing Mars (or anywhere else) today. The most successful of those ventures followed a 3 step approach: exploration, experimental bases, and finally planting the actual colony. What was found in each step enabled the next. The characteristics and populations of each phase are quite different. The proper roles of government and private interests are also quite different in each phase. These phases are illustrated, and adapted, herein to eventually planting a thriving, prosperous colony on Mars.

**Independence – Mapping a Multi-Planet Species**

**Kent Nebergall**

**MacroInvent.com**

The goal of SpaceX is an independent civilization on Mars - one that can operate permanently without further imports from Earth. Elon Musk has said this requires one million people and one million metric tons of cargo flown to Mars. But he also said this is only accurate within an order of magnitude either way. What would an efficient path to space settlement and independence architecture look like with these goals in mind?

This is a deeper dive into the first principles of life, humanity, technology, and civilization. By examining these definitive foundations, we build a cleaner set of questions for science, technology and enterprise to resolve.

Note that this talk is not a map to the unknown future, but rather a star chart, compass, sextant, and theodolite for mapping unknown territory as we enter the future. It is the coordinate system and navigational language for finding efficient paths forward based on first principles from life itself.

The result will be an eclectic mix of primitive and complex methods and systems to efficiently create the most independent civilization quickly. Such models can help developing civilizations and create antifragile technologies on Earth as well. It pursues the mechanics that make the machines of a multi-planet civilization possible.

## Tech R&D C

**Exploration of Mars: history and future of Russian space programs to the Red Planet**

**Oleg Mansurov**

**Success Rockets**

Theses:

1. Soviet plans and projects related to the red planet.

2. Marian programs of modern Russia.

3. Plans for Russian missions to Mars in the foreseeable future.

4. The role of Russian private companies in the exploration of Mars.

**The Future of Sound on Mars**

**Jason Achilles Mezilis**

**Zandef Deksit Inc.**

(Intended for in-person presentation, with slide deck and sound reinforcement*)

Last year, on Feb 22nd the world heard, for the first time, a soft breeze on the surface of Mars. This audio was captured by the EDLCAM Microphone onboard the Perseverance rover, and a few years prior I had the distinctive honor of assembling a small engineering team of outside consultants to work alongside NASA/JPL in helping capture these first sounds for the world to hear.

Now, a year and a half later, this microphone continues to defy expectations in functioning to capture Martian audio both familiar and surprising, mostly noises from the rover itself as it creaks and crawls along the surface, actuating various instrumentation and taking stunningly impressive 'selfies' along the way. We will spend a few moments to indulge our live audience with these latest updated recordings, specially processed and "cleaned up" for ease of public enjoyment – with specific annotation to paint for all a truly immersive Martian audio experience.

But what of the future? How will capturing and monitoring audio on the surface be of benefit to our future explorers on the planet? We will examine this in detail and discuss concepts for integrating sound into everyday life of our future explorers; how this will benefit mental health and quality of life, as well as working and safety conditions in the brutal Marian environment.

**Massive Lift to Mars Everyday as fast as 61 Days Delivery**

**Peter Swan, Ph.D., Matthew Peet, Ph.D., Eugene Luevano**

**International Space Elevator Consortium and Arizona State University**

Joint research at Arizona State University has shown the transformational characteristics of Space Elevators will enable rapid buildup of logistics to Mars in a manner similar to trains. This research showed that leveraging Galactic Harbour layouts of Space Elevators will allow releases to the Red Planet any day of the year with early capability of 30,000 tonnes per year and travel times that vary depending on alignment of planets; however, departures each day could be established. This research was summarized by the investigators with the study report, "Space Elevators are the Transportation Story of the 21st Century." Since the summer of 2021, the joint study team of ASU and the International Space Elevator Consortium has investigated faster transits and more routine approaches using Space Elevators to supply settlements on Mars. Initial recognition that Space Elevators are routine, inexpensive, safe and environmentally friendly lead to the title: Space Elevators are the Green Road to Space. This research effort then focused upon a Dual Space Access Strategy, where advanced rockets and Space Elevators work cooperatively and collaboratively, to move people and supplies towards the various outposts and settlements. People through radiation belts rapidly using rockets leads

to early establishments of habitats – then Space Elevators can become operational and begin moving mass as a permanent space access infrastructure reaching for 170,000 tonnes of logistics per year towards Mars. Space Elevators beat the rocket equation, provide daily releases towards Mars, move massive cargo environmentally friendly, and minimize the travel time.

### Mars the New World: Reflections on the 500 Year Metaphor

**Richard L Poss**

**University of Arizona**

Arguments for and against space exploration and the settlement of Mars invariably make use of a grand metaphor – that the next 500 years of exploration will be analogous to the last 500 years of European exploration and settlement of the Americas. That the settlement of Mars will be similar to the past in some ways, but different from the past in other ways, is a useful framework for anticipating the triumphs and challenges that lie ahead. This paper will examine a series of "parallels" between past and future developments, trying to gain insight into what will be humankind's greatest adventure.

We can regard the period roughly from 1500 to 2000 as the exploration and settlement of the New World by the European powers. We will explore and settle Mars from roughly 2000 to 2500. How do we plan for the developments we can foresee, and how do we guard against challenges no one could predict? Historical perspective can only do so much. Still, the analogy has value. This paper will go through several features of exploration in the past 500 years and study the degree to which we can expect similar challenges on Mars.

The open American landscape inspired new possibilities, as the open landscape of Mars will open the minds of humans to do things undreamed of on Earth. Mars will produce new music, poetry, philosophy, and an explosion of science. No one in Columbus' time could imagine the freedom and bounty of educational, artistic, scientific, medical, religious, and recreational institutions the new world would generate. How many times will life on Earth be saved by scientific advances made on Mars?

### Scott Van Hoy - Observing Facial Emotion Recognition Accuracy and Psychological Health Indicators during Short-Duration Space Analog Missions

**Scott Van Hoy**

**American Public University System**

Analog space missions using terrestrial habitats is an accepted methodology to research human factors within isolated, confined, and extreme environments. By analyzing the crews of space analog missions, conclusions can be drawn to help predict the psychological impacts of the space environment on astronauts. The APUS Analog Research Group conducted observations of analog astronauts' ability to accurately recognize facial expressions and surveyed seven psychological and behavioral indicators (stress, depression, irritability, loneliness, risk taking, empathy, and intrinsic motivation) over the course of two 2-week long missions at the University

of North Dakota's Inflatable Lunar/Mars Analog Habitat (ILMAH) and is slated to conduct similar observations at the Mars Desert Research Station in February of 2023. Preliminary results from the two ILMAH missions show changes in the crew's ability to accurately identify facial emotions when comparing pre-mission, during-mission, and post-mission test results. The psychological and behavioral indicators offer insight into the causes and effects of these emotion recognition changes.

### "Starship" at Mars

**Gary Johnson**

SpaceX's "Starship" was evaluated for the roles it might play in the exploration and ultimate settlement of Mars. These evaluations were done simply, intended to guide where the more intensive effort of engineering design analysis might be focused. How "Starship" might serve depends upon the facilities available on Mars over time, the needs of the local population over time, and other transportation infrastructure, as it evolves over time. The history of colonization in the Americas and Australia from Europe, some 300-500 years ago, provides a good guide for organizing and estimating these constraints on how "Starship" might be used at Mars.

There are 3 phases to this ultimate settling of Mars: "exploration", "experimental base", and "permanent settlement". Facilities and infrastructure are lacking, and crews are small and non-permanent in residence, in the first 2 phases. In the third phase, there are considerable facilities and infrastructure available, and the populations are permanent, large, and growing larger as available infrastructure grows. This is also the phase where large orbit-to-orbit transport vehicles are finally flying, carrying large payloads, to and from Mars, the basis required for a 2-way trade economy. Without that, history says no colony will be successful.

SpaceX's "Starship" can serve well as an Earth-based transport during the first 2 phases, provided that it is equipped with rough-field-capable landing legs. Payloads returning to Earth are not that big an issue during these phases, and "Starship" has restricted return payload capability, particularly if fast trajectories are used. In the third "permanent settlement" phase, "Starship" looks very attractive as a "landing boat" based and refilled on the surface of Mars, employed to unload and load large orbit-to-orbit transports in low Mars orbit, that are carrying large payloads to and from Mars.

### Progress on Lunar Lava Tube Bases for Telescopes

**Douglas Shull**

**Noble Metals Environmental Systems**

Using the basis of the two presentations I gave to The Mars Society in 2019, explaining the initial Lunar base set-up, and in 2020, going forward with telescope systems on railcars, now on YouTube, I will report on my progress contacting railroaders and telescope companies for suggestions on going forward with the concept of Lunar lava tube based rail telescopes. This

includes determining their interest in a first ever collaboration of telescope manufacturers and railroaders to eventually create a full-scale mockup.

**Human Crewed Interplanetary Trajectories for**

**the Roundtrip Exploration of Mars and Ceres**

**Christian Lewis, Dr. Lynnane George**

**University of Colorado, Colorado Springs**

Nasa's latest project, Artemis, aims to not only put man back on the moon but also establish a permanent base on the lunar surface, allowing humans to travel to planets like Mars or Ceres with ease. Lambert's problem was used to plot launch energy (C3) contours, or porkchop plots, with respect to the departure and the arrival dates of the spacecraft. It was discovered, that it is optimal to conduct a combined human mission to Mars and Ceres in the year 2035. For the best balance between the time of flight and C3, two teams of astronauts would leave Earth in June 2035 and enter into an orbit around Mars using an Aerocapture maneuver, which uses the arrival planet's atmosphere, along with the craft's heat shielding, to slow the spacecraft instead of the use of rocket fuel. Once established in a stable parking orbit, one team will be sent to the Martian surface for research and exploration, while the other team remains on the primary shuttle to prepare for the trip to Ceres. The second transfer of the mission should take place in December 2035, allowing for the shortest possible time of flight to Ceres which carries many minerals rare to Earth. Resources expected to be found include water, ammonia, magnesium sulfate, and silicon dioxide. Once the second team arrives at Ceres, they will conduct mining research to confirm the composition of the planet's regolith, which until now has been understood very little. After the Ceres mission objectives have been completed, the crew will return to Mars to identify possible uses of Ceres' resources for ISRU, before completing the final transfer back to Earth. The entire mission will take roughly 5 years and will allow in person research to be conducted on two separate planets.

**Rover Fleet Design (V)**

**M K Borri, R August, K Winters**

**Robots Everywhere LLC**

**Rover Fleet Design**

Even if Mars-capable drones have been demonstrated and will only get better from here on out, crewed exploration and settlement will for the foreseeable future depend on rovers for any one effort that does not justify an orbital vehicle.

Martian high-endurance rover design is largely a solved problem at this point. A fleet-centric design that considers varying rover sizes intended to operate with each other will allow for efficient usage of scarce Earth-originated materials, redundancy, crew safety, and ability to transfer as much maintenance and later production Mars-side as quickly as possible.

Designing rovers to be part of a fleet, rather than as single entities, allows for addressing power considerations (solar vs. RTG vs. nuclear), crew fatigue and comfort, graceful degradation in

case of accidents or wear, etc.

Low Martian gravity and thin atmosphere making many aerodynamic considerations irrelevant in rover design can be treated as assets rather than obstacles.

### Ice Base

**Vadym Romanko, Ruslana Kolodnytska, Vladimir Vorotnikov, Yaroslav Yachmenov**

**Korolev Zhytomyr Military Institute (Ukraine)**

At the 2020 International Mars Society Convention, the Oases on Mars project was presented. The project was dedicated to the colonization of the glaciers of Mars. The project involves the creation of huge human-inhabited spaces in the glaciers of Mars, and takes an intermediate place by terraforming Mars and creating settlements on the surface. In the Oases on Mars project, these spaces are created using the energy of nuclear reactors, which are now used in industrial nuclear power plants. One of the vulnerabilities of the project was the difficulty of implementing the task of delivering these reactors to Mars. The proposed Ice Base project implements the launch phase of the Oases on Mars project.

The Ice Base project involves the use of submarine reactors to create large living spaces on Mars. And it is mainly devoted to the key problem of delivering these reactors to Mars and deploying them in one mission. SpaceX has now made the biggest real progress in delivering large payloads to Mars. Therefore, this project is maximally integrated into the technologies of this company, since there are no other real alternatives to the rapid implementation of a project of this magnitude. The project also involves optimizing StarShip technology to generate additional profits on Earth in the key to achieving the goal of colonizing Mars as quickly as possible. The design has been submitted to the Telerobotic Mars Expedition Design Competition, although it does not qualify for the competition due to its scale.

Humanity must unite to achieve the key goal of the development of Civilization. The development of the technology of colonization of the glaciers of Mars will allow the colonization of the boundless glaciers of the solar system and beyond. We are creating the future of our Civilization now.

## Student Competitions

### International Mission to Mars Design Course & Competition – Summer 2022

This summer, the Mars Society conducted a truly groundbreaking educational program for 40 high school students from around the world, modeled on the approach taken in engineering design courses at some of the best universities in the world. With this six-week virtual program, the Mars Society looks to make educational history by demonstrating the value of a new and much more creative way to teach science and engineering at the secondary school level than is currently being practiced. Tuition fee for the course was a nominal $50, making it possible for students of all economic levels to participate.

The first cohort represented a diverse and multicultural group of 40 high-school age students from around the world who were organized into five teams based on their time zones. Students

hailed from the U.S., Canada, Germany, Poland, the United Arab Emirates, Peru, the Philippines, Singapore and India.

During the program, the students were encouraged to communicate and collaborate using whatever tools and methods they were most comfortable with.

The participants were provided background lectures via Zoom video conferencing by some of the most prominent Mars experts in the world on a wide variety of topics. These include how to search for life on Mars, how to design spacesuits and other critical mission elements, and the science and technologies behind Mars exploration. The Mars Society has made nearly all of these educational lectures available to the general public via our YouTube Channel.

The program succeeded in teaching these high school students advanced concepts about science, engineering, technology and mission design. The participants then designed their own Mars surface mission, including its habitat, surface vehicles, scientific instruments, power system and other equipment and supplies, crew size and composition, mission location, scientific objectives, rations, duration, and exploration plan. They had 30 metric tons of useful payload that had already been delivered to the Martian surface, plus an ascent vehicle capable of returning up to six astronauts from Mars to Earth.

The students created mission design elements with four major factors in mind: Science, Engineering, Human Operational Challenges, and Cost. These factors were the key elements of the scoring rubric, and teams were organized to have students focused specifically on these areas, so that the proper discussion and tradeoffs could be made in their final designs. In addition to handling their own area as well as they can, the students worked out the best possible compromises to produce the best overall result.

The designs of each team were written up in a report, with each team member responsible for authoring a section. In addition, eight coaches/mentors were also assisting and supporting the students with their design work and presentation preparation activities.

The final shootout occurred in three rounds. During the first rounds, each team had 30 minutes to present their designs of a human Mars expedition to a panel of eminent judges. During the second round, each of the teams had 30 minutes to make criticisms of the other teams' designs. For the third round, the participating teams had 30 minutes to defend their design by rebutting the criticism advanced by the other teams, as well as to present a final "closing argument" on why their design was the best. All three rounds can be viewed on our Youtube Channel.

An expert panel of judges rated the participants' designs, presentations and rebuttals based on their technical and scientific merit and how they address the four major factors.

The team scoring highest in the competition was Team 2, who named themselves "N.E.W. E.R.A.", and consisted of students from across Asia and the Americas. We also provided individual winners for each of the four scoring categories: Team 5 won for Science, Team 3 won

for Engineering, Team 2 won for Human Factors, and Team 1 won for Cost. Four of the five teams are presenting at our conference this year.

The Mars Society is now seeking educational grants and other funding sources in order to continue and even expand this program next year. Inquiries can be directed to Mars Society Executive Director James Burk at jburk@marssociety.org

### Martian Greenhouse Project 3.0

The Martian Greenhouse Project 3.0, in collaboration with the American Institute of Aeronautics and Astronautics (AIAA) and the Aldrin Family Foundation brings international middle and high school student teams together for a collaborative learning adventure. Each student team designs a Martian Greenhouse via experiential, hands-on, and applied learning. The goal is to find solutions to enable us to overcome the technical and scientific challenges of producing food for human habitation on Mars. Students work with facilitating teachers', aerospace industry mentors and planetary scientists to learn how to grow plants on Mars. They are required to think critically in the framework of aerospace exploration and develop skills including problem solving, project management, public speaking, research, engineering practices, teamwork, planning, self-sufficiency, and goal setting. The top ten teams from this collaboration will present the resulting Martian Greenhouse designs at the Mars Society Convention.

*We hope these Mars Society presentations will inspire Mars Society members to attend our Tuesday meetups, attend the Final MG 3.0 Presentations, be available to help our teams, and Mentor Teams for Martian Greenhouse 4.0. For more details visit* ***onevoice4change.org***

**Session One**

- 2:30 - Intro (3 min.)
- 2:33 - MG 3.0 Group #1 (10 min.)
- 2:43 - MG 3.0 Group #2 (10 min.)
- 2:53 - Q & A / *Call To Action

**Session Two**

- 3:00 - Intro (3 min.)
- 3:03 - MG 3.0 Group #3 (10 min.)
- 3:13 - MG 3.0 Group #4 (10 min.)
- 3:23 - Q & A / *Call To Action

**Session Three**

- 3:30 - Intro (3 min.)
- 3:33 - MG 3.0 Group #5 (10 min.)
- 3:43 - MG 3.0 Group #6 (10 min.)
- 3:53 - Q & A / *Call To Action

**Session Four**

- 4:00 - Intro (3 min.)
- 4:03 - MG 3.0 Group #7 (10 min.)
- 4:13 - MG 3.0 Group #8 (10 min.)

- 4:23 - Q & A / *Call To Action

**Session Five**

- 4:30 - Intro (3 min.)
- 4:33 - MG 3.0 Group #9 (10 min.)
- 4:43 - MG 3.0 Group #10 (10 min.)
- 4:53 - Q & A / *Call To Action

## Planning for the First School on Mars

**Bob Barboza**

**Barboza Space Center**

California middle and high school students are helping to plan the First School on Mars. Astrosociologists Dr. Jim Pass, founder of astrosociology and CEO of the Astrosociology Research Institute (ARI), and Bob Barboza, CEO, of the Barboza Space Center (BSC) have been collaborating for the past two years to design a program that will get student excited about thinking differently about the future of education. Extending students' vision beyond Earthly matters has, indeed, increased their enthusiasm for space exploration and settlement.
The Barboza Space Center in conjunction with ARI trains tiger teams of junior astronauts, scientists, engineers, pilots, and now junior astrosociologists. Our This program was inspired by the NASA Tiger Team program. We are often referred to as NASA for kids. We follow a STEAMD++ project-based learning approach. STEAMD++ stands for (science, technology, engineering, visual and performing arts, mathematics, design, computer languages, and World languages.

Each student is provided an astronaut toolkit, custom software, mission control computers, astrosociology training materials, and Mars robot designs for Zoom robot simulation tools for Earth and Mars communications.

## SHOULD WE FOLLOW OUR HUMAN DESIRE TO EXPLORE MARS, OR DO WE NEED TO RECONSIDER OUR STRATEGIES THIS TIME?

**Vatasta Koul, Umang Jain, Srishti Bansal, Mrityunjai Verma**

**Space Generation Advisory Council**

The colonization of Mars is a frequently debated topic around the world, with efforts underway to make it a reality. We, on the other hand, fail to look before leaping. Once again, a few people's interests are presented as a widespread cause, and society is manipulated to impose it, which might result in a cascading catastrophic blunder or one of the world's greatest triumphs. The world is swayed by the glorious hope of making a mark on scientific history, but the cost of this achievement is significantly underestimated. Is it really worth while? Some authors debate the enterprise's merits and draw attention to its flaws. Ethics is concerned with concerns of right and wrong, as well as the behaviour that is morally required. With SpaceX announcing plans to land

the first man on Mars before 2030, it brings up the question of how prepared we are for the same and whether we will repeat the same mistakes because we now have the opportunity to reflect on our past experiences and improve our future decisions. To investigate the arguments in favour of colonisation, the technological capability and advantages will be highlighted first, followed by their relationship to ”How ethical it is to colonise Mars?” This also shows that the most complicated moral challenges associated with space missions may emerge not on Mars, but on Earth, when decisions about the enhancement of the pre-launch crew are being considered. This paper does not take a definitive stand in favour of any of the two approaches to entertain a better chance of actually leading to a constructive result. Keywords: Exploration, Mars colonisation, Space Ethics, SpaceX

## Virtual Presentations

### Invincible Games & Omnipresent Simulations

**Mikołaj Sobociński**

**American University of the Middle East**

Human beings are wired to play games. Whether for fun, for practice, for social interaction, for logical stimulation, or as fully-fledged training, casual games, serious games, and simulations abound in our surroundings. It so happens that another human drive, the need for constant exploration, feeds games produced daily by the entertainment industry. As a result, numerous games available at the market nowadays are closer to extensive training sessions and simulations that deal with real-life problems related to space exploration.

If we wish to investigate weather there are enough well-designed games that can function as adequate introduction or training for future engineers and space explorers, we should verify how well those games represent space exploration or training. For this reason, I would like to present a handful of representatives of table-top games, video games, and VR games.

At this introductory level, we should concentrate on the quality, scope, and quantity of possible training provided by games. Although, they are usually called games, some of the products available on the market are closer to simulations or serious games used in actual training by various national and private institutions. Secondly, the scope of games is another factor that may impact their perception. Although some of them may seem too limited in their representation of reality, and some may present a too-broad and general picture, combined with adequate quality those games may still function as adequate and goal oriented training. Finally, the quantity of games at our disposal may also fill in various needs and requirements of different training programmes.

The goal of this presentation is to provide an introductory evaluation of so called games and propose their wider application in general education, in advertising space exploration, and as reliable home-based training of future engineers, project managers, astronauts.

## A Novel Hybrid Power Generation Method for Mars

**Dr. Muhammad Akbar Hussain, Muhammad Mehdi Hussain, Muhammad Waqar Haider**

**Mareekh Dynamics**

One of the biggest challenges in establishing a long-term or permanent human settlement on Mars is finding a reliable, sustained and substantial source of power. Mars lacks conventional resources for power generation. This includes low solar flux which can also become unavailable for many months at a time during global dust storms, no harnessable wind power due to extremely thin atmosphere, absence of fossil fuel, no known geothermal or radioactive mineral reserves, and no prospect of any hydro or tidal sources of power. Solar power and limited nuclear power in the form of Radioisotope Thermoelectric Generators carried from Earth may not be able to sustain human settlements bigger or longer-term than small short-term research bases.

Mareekh Dynamics proposes a novel method of power generation on Mars which may be able to sustain a long-term and large-scale human settlement on the red planet. Our patented hybrid power generation technology will combine solar or limited nuclear power with a local and extremely abundant resource on Mars to generate sufficient amount of clean energy utilizing unique attributes of the Martian environment. This sustained power generation technology will enable establishment of a permanent human presence on Mars on a large scale.

This paper discusses the physical and engineering principles behind the concept and how this power generation method can be implemented in the existing technology.

## SLS ARYA (ಅಕ್ಷಿತ ಆರ್ಯ) – A Heavy Lift Rocket Architecture

**Krishnamurthy Manjunatha, Arya Manjunatha**

**Mars Home Base Organization**

SLS ARYA is a three stage rocket architecture with first two stages re usable. The third stage is designed for material re use on Mars. Yes! With the advent of 3D printing, we can do MORE of USE and LESS on THROW of materials used in rocket construction. In traditional rocket design (USE AND THROW), all stages are USED ONCE and THROWN away after use. SpaceX has shown how to REUSE first stage with their recovery methods (Falcon 9) on ground and sea. SpaceX is working on recovering second stage with total re-usability of entire vehicle with Star Ship architecture. Our approach, though looks similar to SpaceX in recovery of first and second stages, we do find it having a third stage in orbit and attempting to salvage third stage materials as usable input raw materials for 3D printing would be far more economical than bringing whole stage back to earth as part of second stage as in Star Ship. We think this approach is more logical as human settlement on Mars would need huge amount of metals like aluminium or steel/ metal alloys. Until factories can come up on Mars producing local mineral resources, carrying minerals from earth seems to be the only viable option and we think SLS ARYA architecture is going to be relatively economical compared to other designs.

## Building a pressurized dome on Mars

**Bary Maxime**

**Ecole Polytechnique**

If we want to colonize Mars, we will have to build permanent habitats for the future settlers. Hence we need vast pressurized open spaces on the Martian surface. The best way to endure the difference of pressure is to build domes, so that we need transparent domes on the Martian surface. We have designed such a glass and metal dome, able to resist to Mars constraints, under which settlers could live without a spacesuit.

Our hypothesis were the following :
1. availability of the SpaceX Spaceship, able to transport 100T of materials costing 2 millions dollars per ton, according to the projections of SpaceX;
2. a pressure of 0,69 bar under the dome and a constant temperature of 20°C is sufficient for a comfortable human life;
3. a lifetime of 20 years for the dome and a safety coefficient of 1,4 are sufficient.

The dome is 30m-radius 13m-height geodesic cap composed of triangle patterns, made of 9260 steel 1m-long bars with a T-shaped section. They are thermally isolated from the inside of the dome by polystyrene. 2,4cm-thick triangular double-glazing glass plates are pressed by the inside pressure on the edges of the bars. The dome is anchored to Mars by a 1m-wide and 1m-height armored sulfur-concrete ring in the rocky ground of Mars. Maintaining the inside temperature of the dome at 20°C requires 170kW.

Thus, bringing to Mars all the materials necessary for the dome would cost around 1 Billions dollars.

## Celebrating and Continuing Women's Contributions to Our Push for the Stars

**Priscilla Chase Thomas**

**Space Renaissance International and IAAA**

Potentially half of the world’s coming contributions toward a human presence on Mars could lie in the hands of women. They will surely help us get there - but – in order to get the full picture of how we got to this point, and to encourage future contributions, I submit that we should make clearly known our recognition of the contributions they’ve already made.

In my presentation, I will share and celebrate several “modern” key contributors, from Henrietta Leavitt to Sally Ride. I will include an offering of their backgrounds, hurdles, motivations, and contributions; presented through both word and art. Images will include special selections from a new art collection highlighting these space luminaries in portraits; portraits with unusual storytelling approaches, but using very classic and embracing styles.

Included will be women who have made contributions from Astronomy to Engineering,
from Apollo program seamstresses to astronauts;
from people who are household names to those whose names few are familiar with.

Highlighted will be the encouragement and assistance that these achievers and luminaries were offered from family and friends, both male and female. “No man... (or woman – OR GREAT ENDEAVOR)... “is an island”; and I will bring this to bear, through these examples of the importance of reaching out and encouraging all potential contributors and allies. Our progress towards a human presence on Mars is not to be viewed as inevitable. It is not inevitable without contributions and support from all.

I will close with a call to encourage, assist, and invest in future contributions from women.
The estimated time slot would be 30 minutes and can include time for Q & A.
This time frame can be expanded to fit your needs if requested.

**Bio-Plastic Mars Habitat**

**Bruce Mackenzie**

**Mars Society, Mars Foundation**

Can you build a house from thin air?
Could you also make furniture, kitchen utensils, clothing, and greenhouse from the thin air on Mars?

A small house is planned with furnishings made from bio-plastics, i.e. polymers made from plants or algae.

We should avoid the expense of shipping habitats and furniture from Earth.
Instead, grow plants and algae on Mars. Convert the biomass to various polymers. The polymers can be extruded as sheets, threads, or 3DP filament.
Some polymers with specific properties may be easier to manufacture chemically from CO2 and H2O.

Most furniture would be laser cut from sheets of acrylic. Kitchen utensils and other small items can be 3D printed. (Larger components of the 3D printers can themselves be manufactured on Mars).
Likewise, pumps, piping, racks for a greenhouse can be made from plastics.
For pressurized habitat shells and greenhouses, we recommend sheets of PET (soda bottles), or composites from polymer threads bonded with polyester.

Although not Bio-Plastic, other useful materials can be manufactured on Mars, instead of being brought from Earth.
These include:

Cement, Sorel cement, ceramics, brick, bamboo, fungus mycelium, recycled metal from spacecraft, recycled parachute cloth and cord.
A single machine with adaptors could make: paper, cardboard, pressboard, peat-pots, or felt.

The planned house will not actually be constructed of bio-plastics, but instead be of conventional construction, due to time constraints. However, it could be made of plastic, and many surfaces will look like plastic and other plant products.

We will quickly present a number of pictures, leaving plenty of time for discussion. We are especially interested in your suggestions of what to make on Mars.

## Design and evaluation of a modular radiation-resistant shell complementary to a habitat on Mars

**Vincenzo Cambise, Francisco Valdes, Francisco Quitral**

**UTFSM**

This project focuses on the design and construction process of a structure resistant to ionizing cosmic ray radiation, complementary to an inflatable habitat on the surface of Mars, using in-situ resources (ISRU), under a context of semi-permanent habitat in an intermediate colonization stage. The research focuses on the generation of a system of modular components based on high-density polyethylene (HDPE) and Martian regolith-based concrete, due to its anti-radiation properties and potential availability for in-situ manufacturing. The modularity of the structure would facilitate in-situ manufacturing and its application in various habitats or programs, which is of special importance on Mars due to the progressive need for independence from Earth of a hypothetical Martian settlement. Location selection criteria were established on the planetary surface by sites of scientific interest together with the availability of surface water ice, later this information is refined through a topographic selection algorithm, using maps provided by JMARS (NASA). In addition, an algorithm is generated for the optimization of radiation protection, which considers the nearby topographic context, generating a safe horizon under which protection can be dispensed with. This area is structured by means of inverted catenary arches subdivided into HDPE modules, using snap fit and friction joints between them. The results obtained when evaluating the folded shell together with the topography showed good mitigation against ionizing radiation, allowing a stay of up to 42 years inside the habitat, without considering exposure to solar flares. Future work includes the refinement of the design of HDPE modules considering the industrial processes from which they are generated and the possible development of a composite material from them. The performance and actual application of the proposed joints will be evaluated with scale models in order to facilitate the construction, structural maintenance and module transport.

**Caution! This is not a meteor shower!**

**Yutian (Eddie) Zhuang**

**The Mars Society China**

With the increase of space exploration missions around the world, huge amounts of rocket parts and retired spacecraft are left in space, which is indeed resulting in danger. Despite causing confusion for space observers on earth, the space in orbit taken by these space junks could be used for newer spacecraft that can potentially provide us tons of valuable data, rather than wasted as a garbage bin in space. In addition, uncontrolled space junks risk colliding with each other, resulting in thousands of debris flying free in space, which could easily put other operational spacecraft or even humans in danger. There are also cases when uncontrolled space debris hits the moon and even reenters the Earth's atmosphere and smashes into populated areas, which could easily result in the loss of lives. Besides, some retired spacecraft is indeed still operational if some additional power sources are provided to them. Therefore, it is time for a solution to solve this problem. First of all, promising to de-orbit all rocket parts and most spacecraft safely should be made mandatory for all launch providers. They either have to land and reuse their rocket parts, or they have to file a document to ensure that they have control of the giant debris falling back to Earth. Secondly, we should ask governmental agencies to develop reusable rockets since they typically have no money problems and do not focus on the reusability of spacecraft. And last but not least, we should encourage companies and agencies to develop plans to retrieve leftover spacecraft. They could be taken back to earth for scientific investigation, disassembly for parts or even refurbishments for re-flight. Cleaning up the orbital on a frequent basis would ensure our exploration into deep space and humans' presence on mother Earth would continue.

**Space Race or Space War? China, Russia and the Free World**

**Art Harman**

**The Coalition to Save Manned Space Exploration**

Looking just weeks ahead from this abstract, SpaceX may have tested their Superheavy booster and Starship. SLS may have launched Artemis I for a month-long unscrewed adventure in lunar orbit. Our future in space is incredibly bright, and sending humans to Mars looks closer than ever before.

But our future in space is also endangered by prospects of wars that could threaten everything. It is better to understand the threats, particularly if you are investing in or see your future in space.

Following the invasion of Ukraine, the ISS partnership with Russia became endangered and cooperation on other space projects has ended.

Russia has threatened to destroy NATO satellites, and views Starlink as a military threat. Should they escalate to war with NATO to win the Ukrainian war, ISS and commercial space

could be endangered. A ‘space Pearl Harbor’ could, to serve a short-lived military advantage, initiate a ‘Kessler syndrome’ cascade of space debris rendering LEO space unusable for decades.

As China prepares for a war to conquer Taiwan, their increasingly-open military aggression may embolden their already-promised claims on the Moon and Mars. China’s military doctrine includes space warfare, and they too may find a Kessler Syndrome merely a price to pay in their ambitions for global conquest at any price.

If China wants us to believe they won’t violate the Outer Space Treaty, they are setting a poor example by violating the WTO and Law of the Sea treaties. NASA Administrator Bill Nelson warned this year about Chinese “keep out” signs on the moon if we delay our return.
You’ll learn about the advances in human spaceflight by both China and Russia, as well as the strategic big picture and some of the ramifications of war to human space exploration.

**END OF ABSTRACTS**

**HAVE A GREAT CONFERENCE!!**

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