CONVENTION PROGRAM GUIDE

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THE MARS SOCIETY

The 28th Annual International Mars Society Convention

"MARS: THE TIME HAS COME!"

USC

University of Southern California
Taper Hall of Humanities
3501 Trousdale Parkway, Los Angeles, CA 90089

October 9th – 11th, 2025

An In-Person Event with the World's Top Mars Leaders and Experts

Program Guide Created by The Mars Society Staff:
James Burk, **Executive Director**
Leah Malmos, **Creative Director**
Molly Gray, **Lead Conference Organizer**

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

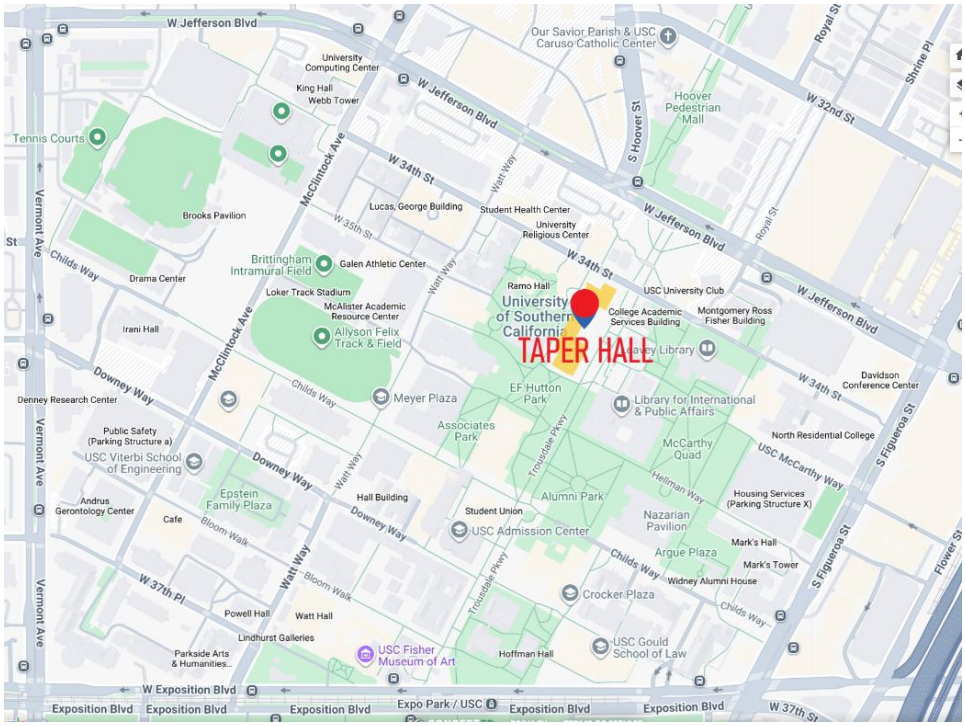
CAMPUS MAPS

Location of Conference:

Taper Hall (THH)
3501 Trousdale Parkway
Los Angeles, CA 90089

All main & track sessions will be in Taper Hall.

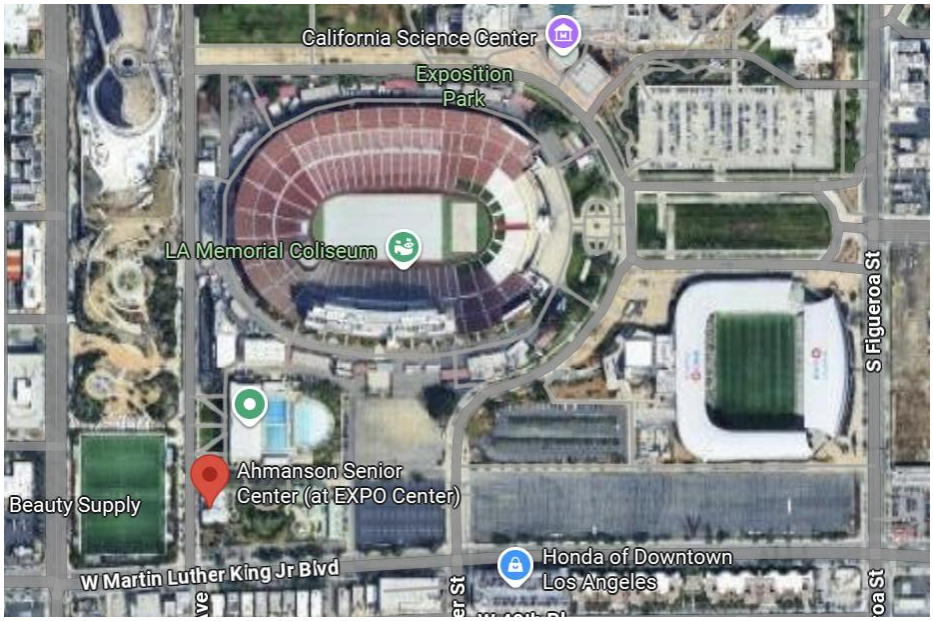
The gates to use are the McCarthy Way Entrance, along S. Figueroa, and the closest one to the venue, and the McClintock Way Entrance, along Jefferson Boulevard.



Guests driving to campus can park at the **McCarthy Way Parking Structure**, which is next to the entrance. Its address is **620 W. McCarthy Way, Los Angeles, CA 90089**

Location of Friday Banquet:

Ahmanson Senior Center
(at EXPO Center)
3990 Bill Robertson Lane
Los Angeles, CA 90037



About the Mars Society

Our Mission

The Mars Society is the world's largest and most influential space advocacy organization dedicated to the human exploration and settlement of the planet Mars. Established by Dr. Robert Zubrin and others in 1998, the group works to educate the public, the media and the government on the benefits of exploring Mars and creating a permanent human presence on the Red Planet. Our **Founding Declaration**[1] describes our goals and our creed.

In order to accomplish our mission, the organization actively seeks to:

1. Organize public outreach with the aim of fostering a deep interest in Mars
2. Promote broad international support for government-funded Mars research and exploration
3. Advocate the establishment of commercial space ventures that will help achieve Mars exploration and settlement

Programs & Initiatives

Mars Society activities include our global leadership of the Mars analog research community, including our three analog station programs:

- **The Mars Desert Research Station (MDRS)** near Hanksville, Utah, USA
- **Flashline Mars Arctic Research Station** on Devon Island, Nunavut, Canada
- **Himalayan Outpost for Planetary Exploration (HOPE)** in Ladakh, India

The Mars Society is also recognized as a global leader in Mars-focused public outreach and educational programs such as the annual **University Rover Challenge,** political advocacy efforts, privately-funded research, chapter meetings and workshops in the U.S. and around the world, and the annual International Mars Society Convention.

Volunteer

The Mars Society is a volunteer-driven non-profit organization dedicated to the exploration of the Red Planet. To find out about the latest volunteer opportunities, visit our website or email info@marssociety.org with a letter of interest and CV.

[1] https://www.marssociety.org/founding-declaration/

About our Sponsors

HUBA Technology

HUBA is a wearable technology company established 10 years ago in London, United Kingdom.

HUBA passionately designs, develops and markets state-of-the-art AR Smart Glasses and VR Glasses for consumers around the world.

HUBA introduced Buddy ZOOM AR, World's 1st Consumer Smart Glasses in 2016, at the Wearable Technology Show in Silicon Valley, United States. In 2017, HUBA has commercially launched ZOOM VR, company's virtual reality glasses brand across European markets.

HUBA is recognized as the Best Wearable Technology Company in Europe (2019) and listed among the Top 50 Smart Glass Companies in the World.

In our 10th year, HUBA is firmly positioned in 20 countries with its strong commercial & technology partners. We work smartly to make most advanced but easy-to-use, social, entertaining, all- purpose AR Smart Glasses and VR Glasses for consumers to use everyday.

Boeing

A leading global aerospace company and top U.S. exporter, Boeing develops, manufactures and services commercial airplanes, defense products and space systems for customers in more than 150 countries. Our U.S. and global workforce and supplier base drive innovation, economic opportunity, sustainability and community impact. Boeing is committed to fostering a culture based on our core values of safety, quality and integrity.

Boeing has a long tradition of aerospace leadership and innovation. The company continues to expand its product line and services to meet emerging customer needs. Its broad range of capabilities includes creating new, more efficient members of its commercial airplane family; designing, building and integrating military platforms and defense systems; creating advanced technology solutions; and arranging innovative financing and service options for customers.

With corporate offices near Washington, D.C., Boeing employs more than 170,000 people across the United States and in more than 65 countries. This represents one of the most global, talented and innovative workforces anywhere. Our enterprise also leverages the talents of hundreds of thousands more skilled people working for Boeing suppliers worldwide.

Boeing is organized into three business units: Commercial Airplanes; Defense, Space & Security; and Global Services.

In addition, functional organizations working across the company focus on engineering and program management; technology and development-program execution; advanced design and manufacturing systems; safety, finance, quality and productivity improvement and information technology.

Starlink

Starlink is the world's most advanced satellite constellation using a low Earth orbit to deliver broadband internet capable of supporting streaming, online gaming, video calls and more.

Starlink's primary objective is to make reliable, high-speed internet access available to billions of people worldwide, especially those in rural areas or regions lacking traditional connectivity. It also supports various use cases, including education, healthcare services, disaster relief communications, and connectivity for businesses, at sea, and on battlefields.

Starlink is a division of SpaceX.

AIAA

AIAA, the American Institute of Aeronautics and Astronautics, is the world's largest technical society dedicated to the aerospace community, formed in 1963 from the merger of two prior organizations. It serves as a professional society, membership organization, and leader in

aerospace technology, promoting innovation, providing scholarly resources like journals and publications, and supporting aerospace professionals and students through its foundation and various programs.

Our purpose is to ignite and celebrate aerospace ingenuity and collaboration, and its importance to our way of life. Our promise is to be your vital lifelong link to the aerospace community and a champion for its achievements.

AIAA exists to help aerospace professionals and their organizations succeed. AIAA's vision is to be the voice of the aerospace profession through innovation, technical excellence, and global leadership. AIAA's tagline is "Shaping the Future of Aerospace." It reflects our belief that AIAA members are continually shaping the future of Aerospace through their creativity, ingenuity, and passion for Aerospace engineering and science.

Mars Technology Institute

The **Mars Technology Institute (MTI)** is a forward-looking initiative dedicated to advancing technologies that will enable sustainable human settlement beyond Earth, with Mars as the central focus. MTI serves as a hub where engineers, scientists, entrepreneurs, and visionaries collaborate to develop solutions for the most pressing challenges of space exploration—ranging from life-support systems and energy generation to robotics, in-situ resource utilization (ISRU), and habitat construction. By aligning research, education, and industry partnerships, MTI aims to bridge the gap between emerging technologies and the practical needs of future Mars missions.

Beyond technical development, MTI strives to inspire the next generation of explorers and innovators by fostering a culture of imagination, problem-solving, and resilience. Through strategic partnerships with startups, academic institutions, and established aerospace companies, MTI positions itself as both a thought leader and an incubator of real-world solutions. Its mission extends beyond Mars: the innovations cultivated at MTI are designed to benefit humanity as a whole, driving advancements in sustainability, energy, and robotics that will transform life on Earth as much as they will shape our destiny among the stars.

At the Mars Technology Institute, we believe the future of space settlement will be built through collaboration. We invite forward-thinking companies, researchers, and investors to join us in shaping technologies that will not only enable life on Mars but also transform sustainability, energy, and robotics here on Earth. Visit our website **marstechnology.institute**

Archipelago Space Research

Archipelago Space Research began as a Mars Society Chicago project to advance science, simulation, and safety technology for analog missions.

Crew EVALink (pronounced “E-V-A”) is a digital communications and tracking platform - built for EVA operations and space analog research centers. It keeps crews connected, maps positions in real-time, and captures mission telemetry for research. It is currently deployed at the Mars Desert Research Station (MDRS).

Powered by peer-to-peer mesh technology, EVA crews can exchange text messages, share real-time position data, and transmit critical telemetry directly from the field. Unlike line-of-sight radios, the network sustains connectivity across rugged terrain and extreme environments - enhancing crew safety and situational awareness. Mission control monitors real-time maps with crew locations, relay status, and environmental data, while message and sensor data is automatically archived into EVA logs. The result is a comprehensive digital record that supports post-mission analysis, scientific research, and knowledge sharing across teams.

Space Settlement Fund by Bill Maloney

Settling space requires funding. I am hoping to start a fund that makes settling space a more accessible opportunity for people to be a part of. Building a fund now will help us be ready to settle a space settlement once technology makes that possible. By being amongst the first in space, you can participate in the greatest wealth opportunity since the gold rush. More importantly, you can help pioneer and lead a new era in humanity as we become multiplanetary.

For more information, reach out to Bill Maloney: cty15maloney@gmail.com – (917) 399-6201

14 Space Engineering

Committed to helping individuals to imagine and have both the passion to make a difference in the space world and the technical know-how to achieve it.

Our Vision
To transfigure the future of space technology and thus creating the next generation of leaders in the space technology industry in Africa.

Mars Training Camp

The goal of our simulation games is to encourage youth to enter Science, Technology, Engineering and Math (STEM) education and careers.

Vision
We hope to inspire future generations of Mars pioneers.

TABLE OF CONTENTS

Convention Schedule

Consult the MARSSOCIETY.ORG website for the latest updates!

THURSDAY SCHEDULE

All Times are Pacific Time (PDT)	Day 1 - Thursday October 9th			
	Morning Plenaries - *THH 201*			
9:00 AM	Dr. Robert Zubrin - Opening Remarks			
9:30 AM	Speaker TBA			
10:00 AM	Humphrey Hoppy Price - NASA Mars Exploration Program			
BREAK	*Break (10:30-10:45)*			
10:45 AM	Rinaldi-Semione - No wobble in the inheritance: building a world that is better than us			
11:15 AM	Dex Hunter-Torricke - AI for Mars & Earth			
11:45 AM	Edwin Kite - Mars Terraforming Research Update			
12:00 PM	**Lunch Break (12:15-1:30PM)**			
	Afternoon Track Sessions			
	Analog Research THH 201	**Future of NASA**	**Biotech**	**Mars Technology Institute**
1:30 PM	Sergii Iakymov - MDRS Update	Kojima - Nanotechnology on Mars	Kevin - Money from Methanol: Fish food to rocket propellant for Mars and beyond	James Burk - MTI Tier 1 & 2 Programs
2:00 PM	Ben Stanley - Journal of Space Analog Research	Vadjina - Mars: From Vision to Reality — Strategic Foresight and Science Fiction as Catalysts for Martian Innovation	Jim Sears - Now on the Table: Fresh-Cooked Food in Space	Samantha Dominguez
2:30 PM	Yashar - Task Eternal Mars Habitat: The Wall Assembly as a Technological Service System	Politics and Advocacy Factors Affecting Mars Exploration	Nakagawa - In-situ resource extraction for Mars terraforming aerosol feedstock	Quinn Morley - BoreBots
3:00 PM	Henley - Hypothesis of Mars Chasms Formed by Moon Impacts;Potential for Terraforming Mars	Schmalzl - Holistic and Systemic Approaches to Mars Mission Planning	Turkar - Systematic Environmental Psychology Approach to Astronaut Well-being in Mars Missions	Erik Kristoff - EVALink
3:30 PM	Bill Maloney - Quantum Information Science	Plata - Early, Full Self-Reliance on Mars	Gardinier - Advances in Reducing Susceptibility to Ionizing Radiation in Travel to Mars	Freeland - Building the Infrastructure to Reach Mars
4:00 PM	Mackenzie - StarShip Mars Base	Heisler - Have No Fear, Humans! Humanoid AI Robots Are Here To Help - Not Replace Us - on Mars	Ranalli - Alunite in Cross Crater, Mars: Evidence for a possible site of ancient life	Phil Swan
4:30 PM	F. Jiang - Tibet Mars Analog	Harman - In Defense of Space Tourism	Villa Massone - Marslink: Pioneering High-Speed Earth-Mars Connectivity via a Heliocentric Constellation	Bill Maloney - Settlement Investment Fund
	Dinner Break (5pm - 7pm)			
	Thursday Evening Program			
7:00 PM				
7:30 PM	**PANEL - THE STATE OF NASA** Casey Drier Robert Zubrin Dr. Tiffany Vora			
8:15 PM				
8:30 PM				

FRIDAY SCHEDULE

All Times are Pacific Time (PDT)	Day 2 - Friday October 10th			
	Morning Plenaries - *THH 201*			
9:00 AM	Steven Benner			
9:30 AM	Dr. Tiffany Vora			
10:00 AM	Dr. Erika Alden DeBenedictis			
BREAK	*Break (10:30-10:45)*			
10:45 AM	Dr. Vandi Verma			
11:15 AM	Dr. Kris Zacny			
11:45 AM	Dr. Bhavya Lal			
12:00 PM	**Lunch Break (12:15-1:30PM)**			
	Afternoon Track Sessions			
	Mars Against Hunger Competition	**Legal & Political THH 201**	**Astrobiology**	**Technology**
1:30 PM	Finalist #1	Beckerman - Debating the Martian Constitution: Has Academia, Industry, or Fiction Proposed the Best Model to Date?	Spacek - Implications of Detecting Active Martian Life During a Crewed Mission	Perry - The Mars Indigenous Reactor Concept (MIRC)
2:00 PM	Finalist #2	Letherwood - The Mars Leap Begins!	McKee - DNA repair and living on Mars	Simplistic Martian Habitats: An Experimental Design Leveraging Plant Resilient Ecosystems in Martian Regolith
2:30 PM	Finalist #3	Harman - Your Voice in Congress Matters for a Spacefaring Future	Burk, Greco, Jahn - Flashline Mars Arctic 2025 Field Season Report	Enabling Mars' Asteroid Economy: The Case for a Space Mining Patent Office in the Isle of Man
3:00 PM	Finalist #4	Nebergall - Red Planet, Blue Ocean - Creating New Businesses for the Mars Age	Jewell - A Multi-Agent AI Governance System for Behavioral Health (MAGSBH) Model for Space Exploration	Brewing Quality Coffee on Mars: Technologies, Challenges, and Lessons from the ISS and Finland's Coffee Culture
3:30 PM	Finalist #5	Smith - What Myth and History can Teach Us about the Future	Plata - GreenHab: Complete Nutrition Demo	Powering the Mars Base: Energy Challenges for Sustainable Settlement
4:00 PM	Finalist #6	Khan - GOX-Paraffin-Based Hybrid Rocket Engine	Parks - A Framework for Responsible and Sustainable In-Situ Resource Utilization on Mars and the Asteroid Belt	Mars Transparent Habitats: Large Monolithic Glass Domes for Low-Gravity Environments
4:30 PM	Student Competition Presentations	Schouten - The Lukashian Calendar: Bringing Time to Mars	Harney - Human Health in Space: Comparing Astronautic Exploration Missions and Civilian Space Settlements	MarsDAO: A Decentralized Framework for Martian Civilization
	Dinner Break (5pm - 7pm)			
	Friday Evening Program -			
7:00 PM	**Evening Banquet** Keynote Speaker: Rob Manning, Emeritus Chief Engineer, Jet Propulsion Laboratory (NASA/Caltech) Other Speakers: Flashline 2025 Field Season Report 14 Space Engineering			
7:30 PM				
8:00 PM				
8:30 PM				

SATURDAY SCHEDULE

All Times are Pacific Time (PDT)	Day 3 - Saturday October 11th			
	Morning Plenaries - *THH 201*			
9:00 AM	HOPE Station Panel			
9:30 AM	Dr. Abigail Fraeman			
10:00 AM	Dr. Victoria Hamilton			
BREAK	*Break (10:30-10:40)*			
10:40 AM	David Malott			
11:10 AM	Luther Beagle			
11:40 AM	Albert Haldeman			
12:10 PM	Andrew Jones			
	Lunch Break (12:40pm - 1:30pm)			
	Afternoon Track Sessions			
	Legal & Political	**Technology**	**Analog Stations THH 201**	**The Mars Society**
1:30 PM	Jewell - Neuroethics and Agent AI in Analog Missions and Underwater Habitats	Plata - The First Crewed Missions to Mars	Phil Swan & Ben Stanley	Burk - Mars Society Executive Director Update
2:00 PM	Yeara - Mars Bound: Measuring Public and Industry Support for a Crewed Mission	Lohrke - 3D Printing for Long Term Habitation on Mars	Yuan - UMIC- PECA Interstellar Lab: an underwater habitat test platform for Analog Aquanaut Training Missions	Storie - Chapters and Membership Status
2:30 PM	DeGraaf - The Mars Generation: Now	Dumitrescu - Towards a precursor mission to demonstrate the building blocks of Mars aerosol warming	Torres - From Lunar Regolith to Martian Readiness: TOM's Scalable Path Toward Off-Earth ISRU	Heisler - 2026: A Turning Point for Mars Society Growth, Renewal, and Global Impact
3:00 PM	Mehrnia - Engineering Realities of a Martian Colony, Humanoids & Superintelligence on Mars	Clogher - Adaptations of Planetary Sunshade Technologies for Mars	Raul -Pharmaceutical Discoveries during analog missions	Mars Society Ambassador Program
3:30 PM	Kalinin - A proposal design of socio-economic experimental research based on smart-grid co-production approach	Nebergall - Modular Rover Technology for Human Outposts	Chen - SHARP, ISEE, and iNSPIRE Cognitive Mapping: What Astronauts Teach Us	Mars Society New Volunteers
4:00 PM	Harman - Don't Skip the Moon!	Perera - BioOxyNode-X:M: A Self-Powered Perchlorate-Based Oxygen Generation System for Martian Deployment	Harney - Russian vs. U.S. Astronautic Missions and Civilian Space Settlements	Mars Society Social Mixer
4:30 PM	Rozich - Sustainability Approach for Mars Colonization	Barredo - Cryofuel: Building the Backbone of Interplanetary Logistics to Enable the Case for Mars	Perry - Alternate historical analogues for human space settlement: Polynesian settlement of the South Pacific	
	END OF PLANNED CONFERENCE ACTIVITIES			
	Networking & Sightseeing Activities in Los Angeles			

THURSDAY SESSIONS

MORNING PLENARIES

Dr. Robert Zubrin
Founder & President, The Mars Society

Dr. Robert Zubrin is an American aerospace engineer, author, and prominent advocate for human exploration and colonization of Mars. He founded The Mars Society in 1998 and serves as its president, driving initiatives to establish a human presence on the Red Planet. Zubrin developed the influential Mars Direct mission architecture, outlined in his bestselling book *The Case for Mars* (1996). He holds a B.A. in applied mathematics from the University of Rochester, an M.S. in Aeronautics and Astronautics from the University of Southern California, and a Ph.D. in Nuclear Engineering from the University of Michigan. Previously a staff engineer at Lockheed Martin, he recently founded Pegasus Aerospace and has authored numerous works on space policy, energy, and futurism.

Humphrey Hoppy Price
NASA Mars Exploration Program

Humphrey “Hoppy” Price is the Chief Engineer for NASA's robotic Mars Exploration Program at the Jet Propulsion Laboratory (JPL). He served as the Project System Engineer for the GRAIL mission, which mapped the Moon's gravity field, and is renowned as the architect of JPL's minimal architecture for human missions to Mars. A graduate of Alamo Heights High School (1972), Price is a space systems engineer with expertise in advanced propulsion concepts like solar sails and interstellar probes. Outside his NASA role, he is an aspiring science fiction writer, having penned unpublished novels and short stories exploring futuristic themes.

Dr. Juliana Rinaldi-Semione
No wobble in the inheritance: building a world that is better than us

"Can we make Mars the first slavery-free planet? As we progress toward settling on Mars, this is the kind of question we must start asking one another. Most conversations about space colonization focus on pragmatic, near-future challenges in areas such as engineering, technology, resource management, or survival. Conversations about society, public policy, and justice are rare and often relegated to the realm of the so-called “soft sciences.” But this belies an incomplete understanding of sustainability in space on the part of the most active actors and influencers. We must expand our understanding of sustainability on Mars to include the full scope of sustainable development.

The three foundational elements of sustainable development are economic growth, social inclusion, and environmental protection. If we don't build and balance our plans upon these from the start, we will burden future Martian generations with entrenched imbalances and injustices that mirror our own — a kind of "wobble" in their inheritance that degrades our legacy and compromises their potential. Interdisciplinary research and case studies around Sustainable Development Goal 8 (Decent Work and Economic Growth) demonstrate how economic growth, social inclusion and environmental protection are interconnected. They further demonstrate the consequences of an imbalance among them.

Building a sustainable society means building one that is resilient and just across the full spectrum of development. We need not look further for our starting point than the commitments we have already made, in principle, to one another and to future generations. These are reflected in the Universal Declaration of Human Rights, the Outer Space Treaty, and Our Common Agenda - three documents that are prima facie distinct but intrinsically linked. The time has come to build a world that honors our most virtuous aspirations - not the world of our dreams but the one our values demand and our future generations deserve.

Dex Hunter-Torricke
AI & the Future of Humanity: Navigating Opportunities and Challenges on the Path to Mars

His plenary talk, "AI & the Future of Humanity: Navigating Opportunities and Challenges on the Path to Mars," will explore the emerging role of artificial intelligence as a critical enabler for long-term human settlement on Mars. From autonomous systems and machine learning-driven habitat construction to ethical considerations and terrestrial benefits, Dex will examine how the intersection of AI and space exploration could reshape the future of both Earth and Mars.

Edwin Kite
Mars Terraforming Research Update

It has been understood for more than 50 years that making Mars' climate and atmosphere more suitable for life as we know it would involve two steps: first warming the surface as a necessary condition for a photosynthetic biosphere, followed by photosynthetic build-up of atmospheric oxygen. Recently, new ideas for warming Mars have been proposed (DeBenedictis et al. Nature Astronomy 2025, Wordsworth et al. Nature Astronomy 2019), and the cost of access to space continues to fall, making a new look at Mars terraforming timely. We are investigating warming Mars using engineered aerosols (Ansari et al. Science Advances 2024; Richardson et al. arXiv:2504.01455). Recent advances include: (1) Development of an open-source 1-D radiative-convective model for screening of candidate Mars-warming aerosols, (2) Production of small batches of candidate Mars-warming aerosols for validation of their radiative properties, (3)

Prototyping of particle release and tracking methods for a small-scale precursor mission concept to Mars's surface, (4) 3-D climate modeling of warming by different particle types that could be produced from CO2 feedstock or from regolith. At the conference, we will describe initial results from climate feedback simulations, and provide an overview of pathways to warm Mars and critical decision points for development of Mars-warming technology over the next five years.

ANALOG RESEARCH TRACK SESSIONS

Sergii Iakymov
The Mars Society
sergii@marssociety.org

Mars Desert Research Station Update

Sergii Iakymov, who has completed three field seasons as Director of the Mars Desert Research Station, presents on the latest status of our flagship analog research program.

Analog research plays a crucial role in preparing for human missions to Mars, the Moon, and beyond. By simulating space environments here on Earth—whether in deserts, polar regions, or underwater habitats—scientists and mission planners gain critical insights into the technical, operational, and human challenges of long-duration spaceflight.

Ben Stanley
The Mars Society
bstanley@marssociety.org

Journal of Space Analog Research – Launch Presentation

The Journal of Space Analog Research (JSAR) is a forthcoming, peer-reviewed publication from The Mars Society, dedicated to advancing our understanding of human space exploration through terrestrial analog studies. JSAR will serve as a central platform for researchers, mission planners, engineers, scientists, and policy makers involved in analog missions and simulation environments around the world.

JSAR will publish high-quality original research, case studies, reviews, and commentary on topics.

Call for Papers

JSAR welcomes contributions from professionals and students worldwide. Submissions will undergo a rigorous peer-review process to ensure the publication of high-quality, impactful research. For more information on the submission process, visit our website JSAR.SPACE.

Melodie Yashar
info@melodieyashar.com

Task Eternal Mars Habitat: The Wall Assembly as a Technological Service System

In preparation for future long-duration Mars missions, surface habitats constructed through in-situ methods must advance to higher levels of technological maturity. These systems must support not only safety and survivability, but also autonomy and long-term operational resilience. Aenara is developing next-generation habitat wall assemblies conceived as “technological service systems”—integrated infrastructures that embed life-sustaining and mission-critical systems directly within the structural envelope of in-situ-manufactured habitats.

With the support of Powerhouse Parramatta, a full-scale mockup using representative materials is planned for construction in 2026 as part of an upcoming international exhibition titled “Task Eternal.” Building on operational precedents aboard the International Space Station (ISS), the study explores modular habitat systems as platforms for embedded infrastructure optimized for in-situ resource utilization (ISRU) and autonomous construction. These include integrated interfaces for power and energy distribution, environmental control and life support (ECLS), data and communications, and thermal regulation. The research examines the use of 3D-printed regolith as the primary structural and radiation-shielding material, incorporating embedded voids and lattice channels for utility runs. Modular inserts—fabricated on-site from refined metal oxides or sintered composites via microwave sintering or electrolysis—are explored as interface modules. Drawing inspiration from the ISS Express Rack system, which consolidates fluid and data connections behind payload modules, the proposed in-situ-manufactured service spine organizes and secures utility lines tagged for maintenance and diagnostics. Structural interfaces being explored include printed-in-place service panels with bolt-in redundancy modules to support flexibility and repairability. Additional opportunities for ISRU include the fabrication of wall spines, conduits, thermal insulation lines, and ECLSS umbilicals. Recognizing that many technologies—particularly for power, next-generation ECLSS, thermal and data routing—are still in development, the study identifies key technological gaps and presents a framework of use cases for further research and prototyping.

Mark Henley
mark.w.henley@gmail.com
Hypothesis of Mars Chasms Formed by Moon Impacts;Potential for Terraforming Mars

We will examine the hypothesis that inner moons of Mars previously experience orbital decay which caused them to re-enter and create large chasms on Mars. This hypothesis was originally suggested by Tom Van Flandern (see " The origin of valles marineris", https://metaresearch.org/solar-system2/mars/the-origin-of-valles-marineris). In summary, the inner moon Phobos is expected to break up and impact Mars within a geologically short time period, and perhaps other inner moons shared the same fate in the past.
Alternatively, one might consider Phobos to be a remnant of a larger moon which broke apart due to tidal forces, with the missing part forming the Chasms. The large Stinkney crater on Phobos, oddly placed at one end of the oblong moon, might even be considered as a separation scar, after a larger moon was stretched by tidal forces to the breaking point.
The near-equatorial location of chasms and their E-W trend are consistent with this hypothesis. The chaotic terrain to the East of the chasms would also be a logical location for ejecta impact, and we might expect that terrain would also be inundated by torrential rainfall after release of subsurface water by the impact.
Prior moon impacts on Mars which caused extensive water to be released would also substantially increase the atmospheric pressure and temperature. If this has happened in the past, one might consider using similar impacts of parts of Phobos to intentionally change Mars to make it more hospitable for human inhabitants in the more distant future.

Bill Maloney
cty15maloney@gmail.com
Quantum Leaps Made Possible by Quantum Information Science

The transmission of communication between Earth and Mars is subject to communication latency. It is important for the development of both planets that we seek to minimize delays in communication.
One of the reasons that the modern world is so industrially developed and there are so many advancements in medicine and technology available to such a large population of the world is because of the speed by which information can be shared. Quick transmission of information leads to innovation after invention and also allows for the production of things at mass scale, which results in them becoming economical and affordable. The increase in the speed of information transmission has led to the increase of both the global GDP per person and the average person's quality of life.
Quantum information science is a field that I believe should be explored more for the advancement of Martian colonization efforts, as well as for the improvement of cooperation between civilizations on Earth and Mars. I would like to present on the field, including on topics such as quantum information, quantum computing, and quantum games.
I believe that advancements in quantum information science would allow for humanity to take quantum leaps, so to speak.
Quantum information science could lead to powerful new economies built on technologies that help us use our most powerful gifts, our wisdom and intellect. Quantum computers can power

artificial intelligence programs yet unimaginable, that, coupled with human wisdom and intellect, can propel humanity to the stars and beyond.
I also believe that as much as quantum information study will help us discover, create, and embrace the future, it will also help us understand more about the nature of the universe and who we are. In part of my presentation, I would like to talk about Dr. John Wheeler's "It from Bit" theory.

Bruce Mackenzie
bmackenzie@alum.mit.edu

StarShip Mars Base

We are designing how to live inside a SpaceX StarShip, after it has arrived on Mars, Luna, or in orbit as a space station or cycling craft. We propose outfitting the propellant tanks, as well as the crew/cargo compartment at the front.

The resulting “StarHabs” (t m) could include habitats, workshops, materials production, greenhouses, energy plants, storage, etc. Additional external inflatable modules would provide more greenhouses, rover garages, airlocks, and energy production. They would be covered by regolith for radiation shielding and temperature stabilization. In just 1 to 3 launches this provides a large, permanent base.

Phil Swan
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How the Future of a Space-Faring Civilization Hinges on the Economics of Imparting Kinetic Energy

This presentation examines the economics of imparted kinetic energy as the central factor shaping humanity’s expansion to Mars and beyond. The discussion emphasizes that the challenge is not only transporting people and payloads to Mars, but also enabling affordable and routine return from the Martian surface. The motivations for such missions will evolve over time—from initial geopolitical competition, to scientific exploration, and ultimately to sustainable commerce—and each stage places different demands on launch infrastructure. A key finding is that the scale of operations fundamentally alters the economics: what may appear infeasible at small scale can become viable, even advantageous, at large scale. To illustrate these dynamics, we compare alternative methods of imparting delta-v for both outbound and return trajectories, and examine how the ability to identify and develop terrestrial applications of these technologies will influence the pace at which they gain traction. Technologies with clear near-term Earth-based uses are likely to see earlier adoption, while others may await the pull of

larger economic forces. Together, these considerations highlight how the economics of kinetic energy will determine the pathways to a truly space-faring civilization.

FUTURE OF NASA TRACK SESSIONS

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Nanotechnology on Mars

As preparations for the first human landing on Mars accelerate—particularly under current U.S. space policy—it is increasingly likely that this milestone will be achieved by the end of this decade. In anticipation of this moment, critical attention must be given to the ethical and technological frameworks that will shape human life and labour on Mars. One of the core arguments of my research is that sustainable human presence on Mars will be possible only through the systematic integration of nanotechnology into Martian everyday life. Unlike Earth-based infrastructures, Martian colonies will face extreme environmental and logistical constraints, requiring autonomous, adaptive, and resilient systems—capabilities that nanotechnology is uniquely positioned to deliver.
My study situates the discussion within the broader context of technological convergence, especially the intersection of artificial intelligence (AI) and nanotechnology. Drawing on Nick Bostrom's theory of the singleton—a hypothetical future in which global power is consolidated under a single, superintelligent entity—it is predicted that such a development may materialise as early as 2025. Bostrom warns that nanotechnology should be introduced after the emergence of such a "supermachine," to avoid catastrophic misuse or existential risks. However, I argue that extraterrestrial contexts like Mars will disrupt this sequence. The necessity of deploying nanotechnology in advance, or independently of a centralised AI control structure, may arise from survival imperatives and autonomy requirements in space colonies. The research explores whether Earth-bound societies will be able to replicate or adapt the nanotechnological advances developed on Mars, or whether the Martian context will create an irreversibly divergent technological trajectory. Ethical, political, and epistemological questions arise from this divergence, including the potential for nanotechnology to exacerbate inequalities or enable unprecedented forms of governance. By examining these tensions, this work contributes to a more nuanced understanding of how nanotechnology could both enable and complicate the human expansion into interplanetary space.

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Mars: From Vision to Reality
Strategic Foresight and Science Fiction as Catalysts for Martian Innovation

Mars: The time has come. No longer the domain of fiction alone, the Red Planet stands at the frontier of human aspiration and technological ambition. As we prepare for sustained exploration and eventual settlement, we must go beyond engineering feasibility — and confront the deeper question: How do we shape the future we want on Mars?
This presentation proposes a novel approach that fuses strategic foresight with the imaginative power of science fiction to accelerate innovation for Martian development. Drawing on the method of backcasting, it argues that rather than extrapolating from current limitations, we must start with a bold, desirable vision for life on Mars and work backward to identify the critical technologies, systems, and decisions needed to get there.
From autonomous rovers to in-situ manufacturing, science fiction has long anticipated many of the challenges and solutions facing Martian pioneers. But these narratives are more than entertainment; they are ethical laboratories and speculative blueprints. When combined with foresight tools like scenario building and vision-to-action mapping, they provide a powerful toolkit for transforming high-level goals into actionable innovation pathways.
This talk will present a practical framework that helps technologists, mission designers, and policymakers use science fiction as a strategic resource, and backcasting as a planning method to align today's R&D efforts with tomorrow's Martian realities. The goal is not just to survive on Mars but to build futures that are sustainable, inclusive, and inspiring.
Because the time has come and the future of Mars won't build itself.

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Politics and Advocacy Factors Affecting Mars Exploration

Mars exploration is shaped by a variety of political, economic, and social forces, which have significant implications for the development and implementation of space missions. As interest in the Red Planet grows, both governmental and private entities are increasingly engaged in efforts to explore Mars, motivated by scientific curiosity, the potential for human colonization, and the search for extraterrestrial life. However, Mars exploration is deeply influenced by political factors, which include national priorities, international collaboration, budget constraints, and the strategic interests of space-faring nations.
Governments play a central role in shaping the direction of Mars missions. Space agencies like NASA, ESA (European Space Agency), and CNSA (China National Space Administration) drive Mars exploration through governmental policies and funding. Political leaders influence space exploration by determining budget allocations and setting the agenda for scientific and

technological advancement. For instance, the U.S. government's political support for NASA's Artemis program indirectly affects Mars exploration, as success in returning humans to the Moon is seen as a precursor to sending astronauts to Mars. Similarly, the shifting priorities in the U.S. Congress, as well as the election cycles of political leaders, can lead to instability in long-term planning for Mars missions.

International collaboration and competition also play significant roles. Space exploration is increasingly seen as a global endeavor, with countries like Russia, India, and the UAE entering the race to explore Mars. These nations seek to enhance their political prestige and scientific influence, which can foster partnerships but also lead to competition. International treaties, such as the Outer Space Treaty of 1967, which aims to prevent the militarization of space and promotes peaceful exploration, also affect the policy framework surrounding Mars exploration. While these agreements are designed to promote cooperation, geopolitical tensions can still create obstacles to shared missions.

In addition to government-driven efforts, private sector advocacy has become increasingly influential in Mars exploration. Companies like SpaceX, led by Elon Musk, advocate for Mars colonization as a long-term goal, with the hope of advancing human space travel through innovation and reducing costs. The role of private advocacy highlights the intersection of politics and the commercial space industry, where lobbying efforts, public-private partnerships, and market competition influence the pace and nature of Mars exploration.

Overall, the politics surrounding Mars exploration reflect a complex interplay of governmental interests, international relations, and private sector involvement. These factors will continue to shape the future trajectory of Mars exploration, balancing scientific ambitions with geopolitical realities and economic constraints.

Silvia Dr. Schmalzl
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Holistic and Systemic Approaches to Mars Mission Planning

Mars mission planning is a complex, high-stakes endeavor that demands more than technical precision - it requires a holistic, systemic perspective. This presentation introduces a novel approach that combines data-driven analysis with intuitive and empathic insights to optimize mission outcomes. Leveraging my background in systemic consulting and strategic business development, I will outline how integrating rational metrics, empathic field sensing, and systemic thinking can reveal hidden interdependencies and potential risks within mission architectures. This method enables teams to identify and resolve imbalances early, align diverse stakeholders, and adapt dynamically to evolving challenges. Real-world examples from interdisciplinary project leadership will illustrate the importance of striking a balance between complex data, human factors, intuition, and empathy. By embracing a holistic, systemic mindset, mission planners can enhance resilience, innovation, and sustainability, thereby laying the groundwork for a successful and long-term human presence on Mars.

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Space Development Network

Early, Full Self-Reliance on Mars

"Elon Musk has identified two rationales for establishing a city on Mars by about 2050. One is that it would be exciting to see humanity beginning to expand towards the stars. The second rationale is that a Martian city of about a million people should have enough industrial capability to produce everything that it needs just in case cargo deliveries from Earth stop coming for any reason. These reasons run the spectrum starting with banal causes such as an economic collapse to some existential event such as a huge asteroid hitting Earth.

There are some potential causes which could occur at any time such that it would be prudent to achieve full self-reliance (FSR) sooner than later. This presentation suggests an alternate path to FSR that could be achieved on a much smaller scale than a million-strong city. Using bottom-up reasoning to identify what exactly is needed for FSR, the presenter identifies 16 such factors and argues that none of them require large numbers of people to achieve. A critical insight is that it should be possible, in the Mars context, to achieve FSR without needing to produce integrated circuits. Stockpiling electronics could be a good temporary measure but eventually those will run out. Rather, equipment, sensors, vehicles, etc. can be constructed using local sources using 1950s approaches that don't require integrated circuits. This eliminates one single biggest challenge to achieving FSR.

The presenter will systematically go through the 16 components of FSR and describe how each can be achieved using a small crew. The case is made that this approach to FSR can be demonstrated in an analogue setting and then integrating them into the ultimate demonstration. The result would demonstrate that FSR can be achieved shortly after the first arrival of crew on Mars."

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Have No Fear, Humans! Humanoid AI Robots Are Here To Help - Not Replace Us - on Mars.

The future of Mars exploration is exciting—and it's human-led! Contrary to some academic predictions, humanoid AI robots won’t be replacing us on the Red Planet. Instead, they’ll be

supporting our efforts, playing a vital role in assisting the first human led missions to Mars—missions that will launch in this decade.

The pace of AI humanoid development over the past few years has been astonishing. It's almost a full-time job just keeping up with the breakthroughs! These advanced robots will provide crucial support services—making human-led missions safer, more efficient, and more achievable.

China and the U.S. are both on track to establish the first human-directed scientific outposts on Mars by the early 2030s, with human crews arriving as early as 2033. Their mission: to uncover the planet's geological history and search for signs of ancient—and possibly still existing—life beneath the Martian surface.

But make no mistake—only human explorers can truly make us an interplanetary species. Robots are essential tools, not our replacements. Even in the distant future of interstellar travel, it will be humans—not machines—who lead the way. Think of humanoid robots not as substitutes, but as crew members—like Star Trek's Commander Data—helping us reach for the stars.

In this presentation, we'll explore where technology stands today. What can these humanoid robots do? How will they assist human explorers on Mars? How autonomous are they—and can we take direct control if needed? What will they cost?

I'll answer these questions and more—plus share exciting video clips of some of the most advanced humanoid robots in action.

So, buckle up—and get ready for the near future of human and robotic collaboration on Mars!

Art Harman
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Coalition to Save Manned Space Exploration

In Defense of Space Tourism

We all cringed at the childish antics of the New Shepard NS-31 flight in April with Katy Perry. The crew didn't pretend to do any mock-science or offer profound insights;they just made teenage girl jokes. They hardly looked out the windows or tried floating free.

To many, it was the epitome of the brainless social media 'influencers' with their selfies and juvenile talk. And they're right. Even the media and social media that usually adore terrestrial influencers took exception--and the memes were brutal. Some also claimed it's unfair that only millionaires can afford a ticket.

But in a way they, and the serious space tourists are an unavoidable and necessary element on the road to commonplace, affordable spaceflight.

A hundred years ago, air travel was incredibly expensive. It was the wealthy that popularized flying for business and pleasure, and they subsidized the development of larger and faster aircraft that truly democratized air travel. Similarly, the first color televisions and personal computers were priced out of reach of most households.
What will the next decade or two mean for democratizing spaceflight? What are the elements necessary to create the future we've always dreamed about? Find out in this lecture. Ad Astra.

BIOTECH TRACK SESSIONS

Kevin Kelly
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Money from Methanol: Fish food to rocket propellant for Mars and beyond

The authors describe a business unit that supplies essential support to a Mars colony through a variety of finished products. Hydrogen (from water and energy) and carbon dioxide (from Martian atmosphere) are introduced to a catalyst bed, producing aqueous methanol. Technical details of production are discussed. Output from the reactor vessel becomes input for fish-food production and to fuel portable energy appliances.

The authors compare and contrast business models for the operation, beginning with public-private partnerships, then transitioning to franchise operations and cooperatives. A profit projection is provided.

The use of aqueous methanol for rocket propellant is also discussed, as a market expansion idea. Aqueous methanol can be ionized using an electrospray technique, then fed into a variable specific impulse magnetoplasma rocket (VASIMR) or a magnetoplasmadynamic thruster (MPD thruster). Potential uses for VASIMR and MPD-powered spacecraft include exploration and commercial development of the asteroid belt and deep-space missions to the outer solar system.

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Now on the Table: Fresh-Cooked Food in Space

For a successful manned mission to Mars, it is necessary to have Starship class rockets, planetary habitats, power systems and ECLSS systems perfected. However, they alone are not sufficient.

The missing elements are: 1) Guarantee of sustained public support and the funding that goes with it. 2) Long-mission ability to maintain astronauts's optimal physical and mental health. 3) People, the right people, who are willing to go.

With respect to #1:
Roughly 70% or Americans view space and Mars exploration as an abstract distant and not personally relevant concept. Everyone is related to food. Everywhere food goes, attention goes. Learning what astronauts cook up from nothing every day will be a daily whetting for what comes next on a mission to Mars.

With respect to #2 and #3:
On a Mars mission, an astronaut will be away from Earth for approximately 3 years, including being in microgravity for 12 to 18 months. Maintaining mental and physical health will be difficult to impossible over this time while eating nothing but the current 50 year old tradition of backpacking style bars, thermostabilized and freeze dried food packets.

SATED Space, a NASA Deep Space Food Challenge winner, has developed the following solutions that will be described in a talk:

Four TRL-3/4 technologies that, operating in tandem, will create a space food experience that helps attract the best science, engineering, exploration and commercialization talent to in-space careers.

Technology 1:
SATED (Safe Appliance, Tidy, Efficient and Delicious) uses centrifugal force to cook diverse foods in microgravity. SATED uses intrinsically fire/smoke safe ceramic heaters to simmer, boil, brown, caramelize, mix and layer re-hydrated food ingredients. Produced foods can range from crispy pizzas to rice, omelettes, potato dishes and even birthday cakes. Two SATED prototypes at the Jose Andres R&D food labs in Washington DC are being used to create new recipes for future use in space.

Technology 2:
SATED Space's Downdraft Workstation captures crumbs and particulates from crunchy foods and dry ingredients preventing them from escaping into the spacecraft/habitat. It's special surface also suctions down packaging and materials reducing the need for Velcro. The Workstation also includes a 6-axis stabilization saddle allowing two-handed cooking dexterity.

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In-situ resource extraction for Mars terraforming aerosol feedstock

Mars terraforming has been considered for over 50 years, attracting interest from both scientists and engineers. Most proposed schemes begin by raising the planet's surface temperature to thicken the atmosphere and warm both surface and atmosphere. Among various approaches, aerosol-based heating offers a promising first step: dispersing particles that trap outgoing infrared radiation while transmitting incoming solar radiation. Models indicate that global mean temperatures could rise by more than 30K, provided that million-ton scale quantities of aerosol are deployed. Transporting such vast quantities from Earth is impractical, which leads to the motivating in-situ production on Mars.

While lunar In-situ resource utilization (ISRU) technology have been explored intensively, Mars has higher gravity, different temperatures/pressure, and a chemically distinct soil and atmosphere, rendering lunar blueprints insufficient and necessitating further study.
Four candidate aerosols combine good Mars warming optical properties, such as having high transparency for visual light and low transparency for infrared light, with utilizing exclusively Martian natural resources. Graphite can be harvested from atmospheric CO_2 via high-temperature processing, aluminum nanorods can be extracted from silicates in the regolith, magnesium nanorods can be derived from magnesium-sulfate and regolith, and salt nanoparticles can be obtained using Mars large salt deposits which has been observed. We will present the first system-level comparison of these materials across excavation, conveyance, and target material extraction phases, using energy consumption, equipment mass, consumable mass, and production throughput required for the target heating under realistic Mars conditions as key metrics.

Our analysis will identify the most favorable options when traded off against resource requirements and system complexity from the perspective of material feedstock production. These findings will inform near-term technology development for the initial stages of Mars atmospheric engineering specifically increasing the temperature.

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Systematic Environmental Psychology Approach to Astronaut Well-being in Mars Missions

As humanity prepares to venture to Mars, astronauts are anticipated to face challenges such as isolation, confinement, limited social contact, communication delays, and disconnection from

Earth's circadian rhythms. These long-duration missions necessitate that the psychological well-being of astronauts is ensured before, during, and after the mission.

Current psychological support strategies for space missions primarily rely on behavioral and organizational psychology approaches, lacking systematic frameworks that can address how spacecraft environments directly impact crew well-being, particularly in long-duration missions. Recognizing that psychological responses of astronauts during spaceflight emerge from complex interactions across multiple environmental scales, this study proposes a framework that analyzes psychological stressors through three integrated levels: human-environment interactions, experiential modalities, and broader ecological contexts. Developed through thematic coding of space psychology literature, the framework creates distinct intervention pathways that can inform psychological countermeasure development for future deep space missions. For example, astronauts expressing frustration at being unable to adjust workspace lighting to their preferences would be identified in the framework as an environmental control stressor operating through spatial and autonomy pathways within the immediate spacecraft environment, bringing forth the need for interventions that address both the physical lighting system and crew autonomy needs. The temporal theme identified across studies in terrestrial analogs and the International Space Station (ISS) specifically addresses that stressors evolve across the phases of the missions and highlights the need to determine optimal timing for deploying countermeasures.

This systemic approach fills a critical gap in Mars mission planning by providing a comprehensive tool for designing targeted, phase-appropriate psychological countermeasures that will not only protect and enhance crew well-being but will be essential for mission success.

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Advances in Reducing Susceptibility to Ionizing Radiation in Travel to Mars

Credence has gathered to assure the established but largely unrealized basic of human physiological homeostasis. A 2020 published report by NASA biochemists, food scientists and NASA contractor biostatisticians "Comprehensive Multi-omics Analysis Reveals Mitochondrial Stress as a Central Biological Hub for Spaceflight Impact" identified mitochondrial injury as the center of study to improve the physiological response to the health barriers of spaceflight. The mitochondria are the cellular organelles that not only generate energy, but manage the response to injury and cell recovery, including the response to ionizing radiation of all kinds and sources. Described are work done by Prof. Yoshinori Maranaka at Kyoto University, Dr. Doug Wallace at Children's Hospital of Philadelphia, showing both the nature of these injuries as well as pathways to repair and healthy maintenance. In common to all such injuries is the excess production of lactic acid and reactive oxygen species released by stressed mitochondria into the

cellular microenvironment, recently identified as the interstitial fluid (IF). This fluid constitutes a circulating bodily fluid volume, as fundamental as the blood circulation and cytosol of the cells. When the acidity in the IF is restored to neutrality (not basic nor acidic) in test animals, mitochondrial function is restored and artificially induced cancer tumors are reduced in size. Prostate cancer is prevented in mice genetically engineered to grow prostate tumors. In an anecdotal study reported at the NSS 2025 ISDC Space Health Track, oral aqueous solutions of bicarbonate of soda and weak organic acid solutions put clinically presenting prostate cancer into remission in a 70 year old male in otherwise good health and practice (observing low carbohydrate intake and regular exercise). Dr. James Green, NASA scientist in attendance, said he felt confident that the problem of radiation in space is well underway to solution by various means.

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Alunite in Cross Crater, Mars: Evidence for a possible site of ancient life

Cross Crater is a 65 km impact crater located in the Noachian highlands of the Terra Sirenum region of Mars. Geochemical modeling indicates that alunite detected on the southwest wall of Cross Crater could have been formed by a fumarole upwelling into Cross Crater Lake and could indicate that an environment favorable to the development of life may have existed there billions of years ago. Alunite did not form when Noachian precipitation reacted with basalt nor when the sediments and groundwater resulting from this reaction were reacted with a fumarole. Only when Cross Crater Lake water was equilibrated with sulfuric acid, thought to be a major component of the atmosphere in the Hesperian, following reaction with fumarole groundwater, did alunite precipitate from solution. Kaolinite, silica or an Al-smectite such as montmorillonite detected by Tetracorder mapping of CRISM data of the southwest wall of Cross Crater also formed.
The proximity of Cross Crater to the Tharsis volcanic region relative to Columbus Crater may have resulted in larger amounts of magmatic water input to the lake from sources along fractures that extend westward from Tharsus. This could explain the more extensive deposit of alunite at Cross Crater relative to Columbus Crater.

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Dynamik Orbits

Marslink: Pioneering High-Speed Earth-Mars Connectivity via a Heliocentric Constellation

Marslink envisions a reliable, high-bandwidth communication network targeting ~1Gbps to bridge Earth and Mars, enabling seamless data exchange for Mars exploration, colonization, and transiting spacecraft. This study explores a large-scale heliocentric constellation of satellites, evaluating diverse design options including circular, eccentric, and mixed orbits, with varying ring counts and satellites per ring. Through systematic analysis, multiple constellation configurations are generated, and their performance is assessed against critical metrics such as data throughput, latency, coverage, reliability, and costs for satellite manufacturing, launch, and propellant for orbit insertion and maintenance. A high-performing, cost-efficient solution set is identified and further analyzed on a performance/cost basis. By optimizing these trade-offs, Marslink proposes scalable, cost-effective architectures for a robust interplanetary network, paving the way for sustained Earth-Mars connectivity.

MARS TECHNOLOGY INSTITUTE TRACK SESSIONS

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MTI's Tier 1 & 2 Programs

The Mars Technology Institute (MTI), initiated by the Mars Society, is a transformative platform designed to accelerate the development of technologies critical for human settlement on Mars. Through its Tier 1 and Tier 2 programs, MTI fosters innovation by supporting entrepreneurial ventures and aligning them with the technological roadmap for a sustainable Martian future.

Tier 1 Program: Tier 1 focuses on incubating early-stage companies in exchange for an equity stake, nurturing their growth from concept to viable enterprise. In select cases, MTI staff provide hands-on support for initial formation and operations, helping startups establish robust foundations. Tier 1 companies gain access to MTI's analog testing facilities at the Mars Desert Research Station (MDRS) and Flashline Mars Arctic Research Station (FMARS), along with expert mentorship and participation in forthcoming MTI and partner incubator/accelerator programs.

Tier 2 Program: Tier 2 establishes marketing partnerships with no financial exchange, targeting companies whose technologies align with MTI's prioritized technological roadmaps. These partners benefit from MTI's suite of free scientific and entrepreneurial tools, including access to analog mission data, networking opportunities with space industry leaders, and promotional support to amplify their Mars-relevant innovations. Tier 2 fosters collaboration without direct investment, enabling companies to refine and market solutions like advanced robotics & AI, biotech, energy systems, or closed-loop agriculture.

This presentation will outline program structures, highlight early successes, and announce open applications for 2026, inviting researchers, entrepreneurs, and technologists to join the mission to make Mars a self-sustaining reality.

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Mars Society Chicago / Archipelago Space Research

EVALink - Technology for Space Analogs

This is an update of the EVALink space analog technology platform, first presented in 2022. Created by Chicago Mars Society, this is an update on the system's expansion, research outcomes, and next steps. EVALink is an integrated system to track EVA activities, and enable coordinated field science between physical space analogs, and their virtual reality digital-twins. This improves science, situational awareness, and crew member safety at MDRS. Integration with virtual reality and other features expands crew research possibilities and opens the door to new scientific collaborations.

EVALink improves safety by providing long range, low power digital connectivity over ad hoc mesh network topologies. This enables short messages, such as an SOS, to be shared amongst users of the system, even if beyond line of sight.

EVALink improves situational awareness. Location telemetry of crew members is automatically collected and aggregated by a computer server deployed at MDRS. There it is logged and displayed for other crew members in real time. In the event of an accident or other need for assistance, crew members will know the locations of crew members in real time.

EVALink expands the kind of research possible at space analogs. It enables real time science collaboration between analog astronauts at MDRS, and colleagues in a virtual reality digital twin. For example, an analog astronaut collecting rock samples at MDRS will be able to interact with a user in a high-fidelity digital twin of the exact same location. Samples, experiments, and EVAs can be tagged with GPS coordinates, logged for research, and even for future crews to build on prior work.

EVALink has been featured in Wired Magazine and is now an MTI Tier 2 member

We will share progress against these objectives, plans for future development, and lessons learned from continued field experience.

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BoreBots™

Unleashed Robotics is set to disrupt the resource prospecting industry on Earth using a NASA-funded Mars drilling technology called Borebots™. Our FractalMining™ approach enables vast subsurface surveys by creating a network of branch boreholes (called FractalBores™) using helicopter-placed modules which deploy and manage a swarm of Borebot™ drilling robots. Large-baseline phased-array GPR is used to qualify and quantify critical resources like a telescope peering into the subsurface, even in the most remote regions of the planet. Our Earth-commercialization approach for this Mars-inspired technology aligns closely with the vision of the Mars Technology Institute, with whom we are proud to partner. Borebots™ started life with a NASA Innovative Advanced Concepts (NIAC) award – one of the highest-risk and most forward-looking technology programs in the federal R&D pipeline – to investigate the approach for Mars polar deep-drilling applications. Now, Borebots™ and FractalMining™ are poised to improve the quality of our lives on Earth by unlocking access to critical resources in remote regions of our own planet.

Samantha Dominguez

Pete Freeland
President & CTO, Space Ocean Corp

Building the Infrastructure to Reach Mars: Orbital Logistics, Fluid Transfer, and In-Space Power

As humanity pushes deeper into the solar system, reliable infrastructure in orbit becomes the cornerstone of every successful mission, whether scientific, commercial, or crewed. In this session, aerospace veteran Pete Freeland will present Space Ocean Corp's phased strategy for enabling scalable, serviceable, and mission-critical logistics beyond Earth orbit. From in-space refueling and water transport to integration with microreactor and robotic servicing platforms, Space Ocean is developing modular capabilities designed to reduce risk, extend spacecraft lifespans, and accelerate our path to Mars.

Freeland brings more than 35 years of experience in spaceflight systems, spacecraft operations, and aerospace program leadership. A former U.S. Air Force officer and senior engineer at Boeing, Raytheon, and Northrop Grumman, he has led projects ranging from human-rated vehicles to classified satellite systems. Currently serving as Space Ocean's President and CTO, and a scientist-astronaut candidate, Freeland combines deep technical insight with a passion for cross-disciplinary exploration. His presentation will offer a rare view into how early-stage infrastructure investments today can unlock the sustainable interplanetary transport systems of tomorrow.

Space Ocean Corp is building the infrastructure to enable a sustainable orbital and deep-space economy. As the first integrated logistics company focused on operations beyond Earth orbit, Space Ocean delivers in-space refueling, resource transfer, and modular infrastructure to support science, industry, and long-duration exploration missions, including those to Mars. https://spaceoceancorp.com/

Colin Lennox
EcoIslands LLC and Arcology Solutions

Terrestrial Arcologies as a Test Bed for Space Analogue Components

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Settlement Investment Fund

Settling space requires funding. I am hoping to start a fund that makes settling space a more accessible opportunity for people to be a part of. Building a fund now will help us be ready to settle a space settlement once technology makes that possible. By being amongst the first in space, you can participate in the greatest wealth opportunity since the gold rush. More importantly, you can help pioneer and lead a new era in humanity as we become multiplanetary.

FRIDAY SESSIONS

MORNING PLENARIES

Dr. Steven Benner
Foundation for Applied Molecular Evolution

Dr. Steven Benner obtained his B.Sc. and M.Sc. in Molecular Biophysics and Biochemistry at Yale University and his Ph.D. in Chemistry at Harvard University. He has been a professor at Harvard University, ETH Zurich, and the University of Florida, where he was the V.T. & Louise Jackson Distinguished Professor of Chemistry.

In 2005, he founded the Foundation for Applied Molecular Evolution (FfAME) and The Westheimer Institute of Science and Technology (TWIST). He also founded biotechnology companies, including EraGen Biosciences and Firebird BioMolecular Sciences LLC. He has also contributed foundational technology to a half dozen other biotech companies, including Alantos, Bayer, Siemens, and DNA Script for their drug discovery, diagnostics, and biotechnology platforms. His work has generated diagnostics products that are widely used in medicine, and ways to produce new classes of therapeutics.

His laboratory was the first to synthesize a gene encoding an enzyme, a foundation for the field of synthetic biology. This work contributed new methods for the syntheses of DNA and new methods to sequence DNA. He was also the first to make DNA with more than four nucleotide building blocks, expanding the "genetic alphabet" from four nucleotide "letters" to 12.

In biology, Steven was instrumental in establishing the field of paleo-genetics, where ancestral genes and proteins from now-extinct organisms are resurrected for laboratory study. He has also been active in the field of astrobiology, where his work has offered experimental paths for the origin of life, an understanding of exotic chemistry in planets and moons such as Venus and Titan, and new strategies to detect alien life that may differ in its fundamental chemistry from life on Earth.

His most recent book is Life, the Universe, and the Scientific Method. He is currently in works to publish a new book on extant life on Mars.

Dr. Tiffany Vora
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Explore Mars / Singularity University

Harnessing Synthetic Biology on Mars

Today we are at an exciting moment as exponential technologies break down boundaries between the living and nonliving worlds, enabling biology to be used as a technology for manufacturing. Synthetic biology—which merges biology, engineering, and other disciplines to design and construct new biological parts, devices, and systems that do not exist in the natural world and also to redesign existing biological systems to perform specific tasks—can enable sustainable human exploration and settlement of Mars. In this session, we will explore the findings of the Synthetic Biology Working Group hosted by Explore Mars. Key NASA taxonomy areas can be addressed with synthetic biology, delivering benefits such as mass reduction, resilience, and on-demand production of foods and pharmaceuticals. However, there are challenges that must be addressed to realize the potential of synthetic biology for space exploration, including more research and development into inputs, shelf-stable reagents, in-flight

hardware, chassis organisms, computational models, and regulatory and ethical concerns. Overall, synthetic biology has strong potential for sustainable, resilient, and flexible production and recycling of key components of a thriving community on Mars—while delivering important benefits to Earth, as well.

Dr. Erika Alden DeBenedictis
Pioneer Labs

I'm a computational physicist and molecular biologist. I'm interested in solving big problems using evolution. Today I'm a serial founder supported by The Astera Institute's Residency program.

I received a PhD in Biological Engineering from MIT in 2021 and a BS in Computer Science from Caltech in 2014. I did a postdoc in David Baker's Lab, where I worked on machine learning for protein design, and ran an academic lab for at the Francis Crick Institute in London. I've also worked at the Jet Propulsion Laboratory (JPL), Sandia National Laboratories, Dropbox, and D. E. Shaw Research.

Dr. Vandi Verma
NASA Jet Propulson Laboratory

Dr. Kris Zacny
Honeybee Robotics

Dr. Bhavya Lal
Professor of Policy Analysis, RAND School of Public Policy

Bhavya Lal is a professor of Space Policy at the RAND School of Public Policy. Most recently, she served as NASA's Associate Administrator for Technology, Policy, and Strategy, advising the NASA administrator and senior leadership on a broad spectrum of domestic and international policy issues, strategic planning, and technology investments. She was also the first woman in NASA's history to be named Acting Chief Technologist. In the first 100 days of

the Biden Administration, she was the highest-ranking administration representative at NASA, also serving as its acting Chief of Staff. At NASA, she was instrumental in advancing the Moon-to-Mars Artemis program and spearheading initiatives in planetary defense, space sustainability, quantum science and engineering, artificial intelligence, space ethics, and space nuclear power.

Before joining NASA, Lal directed influential technology and policy analyses on space science, commercial space, and human exploration at the Institute for Defense Analyses' Science and Technology Policy Institute. Lal holds bachelor's and master's degrees in nuclear engineering from the Massachusetts Institute of Technology (MIT), a master's from MIT's Technology and Policy Program, and a Ph.D. in public policy and public administration from George Washington University. She is a member of the honor societies for both nuclear engineering and public policy and public administration. Her accolades include the NASA Distinguished Service Medal, induction into the International Academy of Astronautics and the YWCA's Academy of Women Achievers, and the American Institute of Aeronautics and Astronautics Public Service Award.

MARS AGAINST HUNGER COMPETITION

Mars Against Hunger Competition

Mars Against Hunger Competition Finalists will present during these times.

Student Mars Engineering Competition Presentations

Teams from the Summer 2025 Mars Society Engineering Competition will present here.

LEGAL & POLITICAL TRACK SESSIONS

Stacie Beckerman
U.S. Magistrate Judge Stacie Beckerman
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Debating the Martian Constitution: Has Academia, Industry, or Fiction Proposed the Best Model to Date?

Federal judge and space law enthusiast Stacie F. Beckerman will debate two current philosophy students from the University of Southern California to determine who has developed the best model for the Martian Constitution to date: academia, industry, or science fiction. The panelists

will critically evaluate current proposals and engage in a spirited debate on issues such as who is entitled to create the Constitution, the appropriate legal framework and core principles, and how the Constitution will govern Mars' relationship with Earth.

Judge Beckerman, a graduate of Harvard Law School, recently earned a master's degree in international human rights law from Oxford University. She has served on the federal bench in Portland, Oregon, for over a decade, and also serves as an adjunct law professor.

Charles Letherwood
The Mars Leap
themarsleap@themarsleap.com

The Mars Leap Begins!

Sponsored in part by The Mars Society, The Mars Leap is an immersive educational experience designed for large Science Centers around the country. Visitors join a team of astronauts using a Mars Direct mission plan to survey Mars for human colonization and development. From Mission Planning and Training to their first step out onto Mars, The Mars Leap will make Humanity’s future in Space relevant and realistic, but most of all personal… each visitor will be inspired, educated, and empowered to see their own future in Space. Last year we were able to tell you about our Sally’s Night event at Evergreen Aviation Museum, and this year we’ll be able to tell you about the Mars Leap program we designed for Evergreen’s 2024 Galaxy Camp. You’ll even be able to try a few of the interactives the kids used! It’s more exciting progress, and we look sharing it with you at the 2025 Mars Society Convention… The time has come, indeed!

Art Harman
art.harman@outlook.com
Coalition to Save Manned Space Exploration

Your Voice in Congress Matters for a Spacefaring Future

Politics is volatile! The past few decades has seen the return to the Moon started. Then cancelled. Then restored. Then slow-rolled. Currently, we are experiencing a chaos of leadership. Perhaps soon, we will have the leadership question settled and learn of the path forward to reach the Moon and Mars.

While NASA, SpaceX and others can propose great missions, Congress must authorize and fund them—or not. That’s where you and everyone can help, by talking to Members, staff and the committees—either on the phone or in person. The slogan is “the President proposes and the Congress disposes.” So Congress could reject proposed cuts to science and missions. They

could increase the budget to accelerate the return to the Moon and plans for Mars. Or not—your voice matters.

You'll learn from a former Congressional staffer how to reach the people that matter in Congressional offices and committees, and the right ways to gain their support and to build coalitions. How do you inspire a staff member or member who sees little value in the space program? You'll learn these and many other elements on how to make your voice heard in Congress—or get a refresher of your existing knowledge and experience.

Kent Nebergall
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MacroInvent.com

Red Planet, Blue Ocean - Creating New Businesses for the Mars Age

"In Entrepreneurship, ""Blue Ocean"" refers to a market with many opportunities and few competitors. This talk breaks down the first principles of technology revolutions and how they form, gain momentum, and become the new technology baseline. By understanding these principles, we can build start-ups and incubators for the coming Mars Age of interplanetary settlement and commerce.

MAIA – that is, Mars, Artificial Intelligence, and Androids, will be the defining technologies of the next decade. The talk will also include practical advice on getting small projects off the ground and gaining critical mass to start a larger, pioneering business. Most trillion-dollar companies were started by talented, hardworking visionaries in the right place and time to co-create a technology revolution. With three technology waves happening concurrently, what future will we build now? If your goal is to build something in the garage or laptop this year that opens an office on Mars by 2035, where do you begin and in what directions do you advance? We can use historic data to find the right anchor starting points and market directions for those starting these enterprises."

Pamela Jaye Smith
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What Myth and History can Teach Us about the Future

Humans have been searching for the Promised Land since we've learned to walk upright.

Many origin myths include a journey from afar, be it another country or the stars.

Out of Africa, into Australia, across the Pacific, along the Bering Strait, from the Fertile Crescent to Europe.

This search is reflected in our myths: the Hopi migration through four worlds, the Hebrews out of Egypt, Trojan Prince Aeneas crossing the Mediterranean to found Rome, Japanese royalty's descent from sun goddess Amaterasu, and others.

This presentation will reflect our quest to create a new world, looking at how it's worked – or not – in myth and history.

A dangerous challenge to the Martian traveler is societal: how to keep the group working towards a unified Vision, the agreed-upon Mission, and the Means and Methods to affect both.

Tribalism and selfishness can become real problems, manifesting as rivalries, separatism, and overweening ambition.

Jason and the Argonauts were slowed down when Hylas, sent ashore to find fresh water, was seduced by Nymphs and never came back.

Spanish Conquistadors sailed to the New World for the glory of God and Crown. However, many developed gold-fever and diverted from their original Mission.

Select your Team carefully, working from the motto E Pluribus Unum – Out of Many, One.

Teams have specialized individuals, but for any one to succeed they all have to work together. This is how it will be on Mars. People need to stay on Mission, aligned with the Vision, and using the appropriate Means and Methods.

Learn to recognize the language of dissension to counter problems before they occur. Caesar dined with his troops, learning ground truths about Means and Methods often invisible/hidden from command.

Myth and History can teach us much as we head to Mars.

The Time Has Come!

M Abdullah Khan

GOX-Paraffin-Based Hybrid Rocket Engine

In recent years, hybrid propulsion technology has garnered significant international attention as a promising alternative, offering the combined advantages of both solid and liquid rocket

engines. This study presents the development and experimental evaluation of a lab-scale hybrid rocket engine (HRE) utilizing solid paraffin wax as a high-regression-rate, liquefying fuel, and gaseous oxygen (GOX) as the oxidizer, designed to deliver an average thrust of 1000 N. To enhance the fuel regression rate, 5 percent of aluminum microparticles were mixed with the paraffin wax by weight. The primary objective of this lab-scale hybrid rocket engine (HRE) was to achieve combustion stability and develop an optimized methodology for fuel grain design and regression rate enhancement through additives. A comprehensive experimental campaign, comprising a series of cold-flow and hot-fire tests with a showerhead injector, was conducted to validate theoretical performance predictions, analyze the results from successive tests, and assess key performance metrics. The experimental results demonstrated consistent combustion stability, achieving an average thrust of 1000 N with a burn time of approximately 10 seconds, and minimal pressure oscillations. The efficiency, calculated by comparing theoretical and experimental thrust values, exceeded 95 percent, demonstrating the high performance of the system. This paper outlines the steps involved in the design, development, and testing of the lab-scale HRE, marking a significant milestone toward the development of a high powered hybrid rocket engine system.

David Schouten
Lukashian Calendar Project
The Lukashian Calendar: Bringing Time to Mars

The Lukashian Calendar is a proposed timekeeping system for Mars that accounts for the planet's unique sol (Martian day) length of approximately 24 hours 39 minutes, avoiding the distortions of stretching Earth time units. It divides the sol into 100 centisols for decimal simplicity, with subunits like millisols, and proposes Earth-compatible units for transition. Unlike arbitrary Martian hours or seconds, it uses natural divisions of the sol while maintaining scientific precision for measurements (e.g., MHz). This calendar supports scheduling for daily activities in settlements, fostering a distinct Martian temporal identity without conflicting with Earth standards. The presentation will outline its design, benefits for colonists, and implementation in habitats, drawing from historical calendar reforms and analog testing.

ASTROBIOLOGY TRACK SESSIONS

Jan Spacek
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Foundation for Applied Molecular Evolution

Implications of Detecting Active Martian Life During a Crewed Mission

The discovery of extant life on Mars would constitute one of the most consequential scientific breakthroughs in human history, but if such a finding occurs during a crewed mission, it would also trigger a complex ethical and policy crisis. Under current planetary protection policies, including COSPAR Category V (restricted Earth return) provisions, astronauts exposed to indigenous Martian life may be barred from returning to Earth until biosafety can be demonstrated to a high standard—potentially delaying crew return indefinitely. This creates a high-risk scenario in which scientific integrity may be compromised by psychological, geopolitical, or operational pressures to downplay detection results: ""Do I report the positive results, of will I have a chance to return home?""

In my talk I will present how to solve this issue before it becomes reality.

Samuel McKee
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DNA repair and living on Mars

Humans possess 5 methods of repairing damage to DNA. In the harsh environment of Mars, and the deep space travel to arrive there, all will be disrupted to fatal levels. The challenge of colonizing Mars will require some means of overcoming the immense assault on our DNA where radiation levels can reach 80 times the levels of Earth. Of particular threat is the double strand breaks caused by solar radiation and cosmic rays which, if severe enough, could kill instantly. In this paper I shall explore the current and prospective methods of dealing with damage to our DNA repair mechanisms to live on Mars, with particular attention given to double strand breaks. Along with questions of viability, we take note of the parallel benefits to life on Earth.

James Burk, Andy Greco, Trevor Jahn
The Mars Society

Flashline Mars Arctic 2025 Field Season Report

A panel discussion on the recently completed field season at the Flashline Mars Arctic Research Station on Devon Island (Tallurutit), Nunavut, Canada

More information on the web at fmars.marssociety.org

Susan Jewell
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A Multi-Agent AI Governance System for Behavioral Health (MAGSBH) Model for Space Exploration

As human spaceflight progresses towards long-duration missions and planetary settlement, the need to address the psychological and behavioral challenges astronaut crews face in Isolated, Confined, and Extreme (I.C.E.) environments becomes increasingly crucial. This proposal introduces SpaceGuardianGPT and ISPS-VETA, a groundbreaking multi-agent AI framework model designed to provide real-time behavioral health governance and psychological support during space analog missions and future deep space explorations. This innovative approach has the potential to revolutionize the way we support astronauts on their missions and pave the way for safer and more successful space exploration. The SpaceGuardianGPT project is a comprehensive, mission-adaptive, empathetic language model agent. It is trained to provide cognitive-behavioral coaching, emotional regulation guidance, and wellness support through natural language interaction. ISPS-VETA (Integrated Space Psychiatry System – Virtual Embodiment Tele-Psychiatrist Avatar) complements this by functioning as a virtual psychiatric triage and diagnostic system and integrates biometric data, voice sentiment analysis, and AI-assisted monitoring to detect early signs of cognitive and emotional decline. Together, they form the Multi-Agent Governance System for Behavioral Health (MAGSBH), ensuring autonomous coordination, early intervention, and mission-aligned emotional state management. The system will be rigorously tested in multi-fidelity analog missions, e.g., underwater aquanaut missions, Mars Ocean analogs, and high-altitude (Nepal, Everest) missions. The study will integrate DNA analytics tools, biometric wearables, XR interfaces, and psychological metrics to evaluate agent effectiveness, trust, and safety. Simulation studies will explore edge cases, escalation logic, and agent explainability to refine governance protocols. This research will generate a validated, ethics-informed behavioral AI toolkit for space agencies and commercial partners, alongside international policy recommendations on AI deployment for mental health support in space. MAGSBH aims to safeguard the human dimension of space exploration and provide scalable applications for terrestrial I.C.E. scenarios and remote healthcare.

Doug Plata
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The Space Development Network

GreenHab: Complete Nutrition Demo

Plans are under way for humans to land on Mars in the 2030s. Cargo before, during, and after the first landing will undoubtedly contain stockpiles of food. But, as the population on Mars grows, they will have to begin growing their own food rather than shipping it all.

The Intensive Space Agriculture Session (iSAS) will be a two-month session held in the summer of 2026 to demonstrate full nutrition production in an inflatable greenhouse measuring 60 meters by 60 meters. The session will be an academic activity with a leading space agriculture faculty and a dozen students.

The GreenHab will be constructed of sheet plastic to illustrate at full scale the growth of a wide variety of food plants. An associated organization will take the produce and, through menus, develop meals which will then be analyzed to confirm full nutrition production for an Initial Permanent Crew of eight.

The GreenHab will have a semitransparent roof which allows approximately 50% of the sunlight through to simulate Mars sunlight conditions. Radiation calculations confirm that no additional shielding is needed to protect either plants or crew from solar particle events or galactic cosmic rays.

Growth media will consist of gravel bed hydroponics in which crushed rocks provide regolith-free granules through which nutrient solution will flow. Other environmental factors will be adjusted to maximize yield, including CO2 levels and humidity. Our current plans are to maximize the growth area by limiting the number of aisles and using different strategies to allow crew to access plants throughout the growth area. Strategies for harvesting, storage, and managing plant waste will be discussed. Finally, a breakdown of the cost for the iSAS will be presented.

John Parks
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A Framework for Responsible and Sustainable In-Situ Resource Utilization on Mars and the Asteroid Belt

As humanity expands into the solar system, managing in-situ resources responsibly will be critical for settler survival and settlement sustainability. Cornerstone principles of natural resource management (NRM) learned on Earth can be adapted and applied offworld in the context of In-Situ Resource Utilization (ISRU) on Mars and the Asteroid Belt, promoting responsible and sustainable extraction. Six core NRM principles to be modified and applied within an ISRU framework include: socio-ecological systems thinking;taking an ecosystem-based management approach;managing uncertainty through use of the precautionary principle;resource conservation;adaptive management;and science-based decision making. This framework can be applied to support offworld settlement priorities such as closed-loop systems, management of finite in-situ resources, responsible exploration, preservation of scientifically-valuable features, resource conflict mitigation, and ISRU decision making grounded

in rigorous evidence. Application of an ISRU framework that adapts humanity's experience and learning from Earth offers an informed, flexible, and integrated approach to responsible, widescale ISRU and generalized offworld resource management. This framework can be adapted for application at differing scales of human exploration, including short-term return expeditions, an initial settlement period with limited habitation, and permanent colonization with settlement growth. Such an ISRU framework can guide private companies, national space agencies, and other relevant stakeholders in responsible and sustainable ISRU aiming to prevent repeating natural resource management errors made on Earth from being replicated on Mars and in the Asteroid Belt, encouraging humanity's responsible and sustainable interplanetary expansion into our wider Solar System.

Maria Harney
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Human Health in Space: Comparing Astronautic Exploration Missions and Civilian Space Settlements

As humanity ventures beyond our home planet, understanding human health in space becomes paramount. This abstract focuses on the differences between astronautic exploration missions and civilian space settlements, considering various aspects: resource availability, infrastructure, biomes, social dynamics, and even legal aspects. We delve into the challenges faced by astronauts during exploration missions and the unique considerations for long-term habitation in space settlements. From managing limited resources to prioritizing physical and mental well-being, this presentation sheds light on the intricate interplay between human biology, technology, and social cohesion. Understanding this interplay is crucial for ensuring the success of the future space missions.

TECHNOLOGY TRACK SESSIONS

Joshua Perry
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The Mars Indigenous Reactor Concept (MIRC)

Nuclear energy is highly favorable as an energy source for any permanent Martian settlement due a relative lack of wind and solar energy resources, as well as superior power density, scalability, and reliability. The power demands of in-situ propellant production for large methane-oxygen rockets on the surface of Mars, as is proposed with the SpaceX Starship architecture,

stretch the limits of what is plausible with solar energy alone. However, nuclear reactors are the most challenging of all prospective energy sources to produce from the perspective of in-situ resource utilization (ISRU). The MIRC proposes how a 75-150MWe nuclear power plant could be constructed on Mars only with resources that could plausibly be found and utilized locally. This conceptual design seeks to minimize the number of separate industrial processes necessary to construct all key components and to minimize the size of the industrial equipment that would need to be imported, emphasizing modular design and construction. It also must deal with unique challenges posed by the Martian environment such as the difficulty of rejecting waste heat to an environment with no surface water and a thin atmosphere. The ultimate failure of the PM-3A reactor at McMurdo base in Antarctica illustrates the risk involved when relying on imported reactors rather than building up an industry on-site that could satisfy all maintenance and repair needs, as well as enabling a Martian settlement to bootstrap itself from an Antarctic-style research base into an economically self-sufficient city. The establishment of a nuclear industry entirely independent from Earth would also open up the entire solar system to eventual human exploration and settlement.

Lara Lloyd
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Simplistic Martian Habitats: An Experimental Design Leveraging Plant Resilient Ecosystems in Martian Regolith

Human presence on Mars hinges on the development of a ruthlessly efficient and minimalistic life sustaining habitat. We hypothesized that carefully selected plant species could thrive in Mars-analogous environments with radically reduced intervention, potentially eliminating the need for complex mechanical systems. Our experiment tested the viability of nasturtium, white Russian kale, and dandelions grown from seeds in Martian regolith simulant. These plants received only initial water and nutrient inputs before being sealed in isolated containers within a light and temperature regulating grow box. Despite the challenging soil conditions, all three species successfully germinated, with one dandelion achieving sustained growth beyond the substrate surface. Our results demonstrate that certain plant species can establish themselves in Martian soil analogs with only a single input of resources and no further human or sensor intervention even in un-idyllic conditions. If plant life can sustain growth in Martian regolith with only an initial startup, habitat design can reduce if not forgo additional systems such as irrigation, monitoring and maintenance, and active controls. This dramatically reduces cost, system complexity, and mission payload, supporting a simpler, more resilient model for sustaining life on Mars, though further research is needed to develop comprehensive habitat designs that leverage these findings.

Stuart Mullan
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Enabling Mars' Asteroid Economy: The Case for a Space Mining Patent Office in the Isle of Man

Mars' low gravity and favourable orbital location make it a potentially far more cost-effective base for asteroid mining logistics than Earth—by up to a factor of 100, as suggested by Dr Robert Zubrin in The New World on Mars (2024). This presentation proposes the establishment of a Space Mining Patent Office (SMPO) in the Isle of Man to encourage privately funded asteroid prospecting and to support Mars' emergence as an economic hub for in-space resource development.

The SMPO would grant 99-year intellectual property claims over asteroid survey data (e.g. 1 cm^2/pixel imaging), forming tradable rights that may align with the Outer Space Treaty by framing access as intellectual property rather than territorial sovereignty. This approach aims to create incentives for exploration while remaining consistent with international law.

With over 30 space-related firms and £400 million generated between 2008 and 2011, the Isle of Man is already an established space jurisdiction. Its neutral status as a Crown Dependency, supportive regulatory environment, and institutions such as the International Institute of Space Commerce make it an ideal host.

Enforcement of SMPO claims would rely on terrestrial mechanisms—such as excluding unregistered materials from global markets—thus avoiding the need for physical enforcement in space.

By establishing a practical legal and economic foundation for space mining, the Isle of Man could play a pivotal role in unlocking the asteroid belt's resources, positioning Mars as the "Seattle to the Yukon" in the next great gold rush. This proposal aligns with the 2025 Mars Society Convention theme, "Mars: The Time Has Come," by offering a viable Earth-based catalyst for Martian economic leadership.

Stuart Mullan
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Brewing Quality Coffee on Mars: Technologies, Challenges, and Lessons from the ISS and Finland's Coffee Culture

Producing high-quality coffee on Mars is essential for crew morale and productivity, drawing inspiration from Finland, the world's happiest country for eight consecutive years (2018–2025), where citizens consume ~12 kg of coffee per capita annually, relying on caffeine to thrive during long, dark winters. This presentation explores the technologies and challenges for sustainable coffee production on Mars, comparing them to current ISS solutions. On the ISS, astronauts use

instant coffee or espresso via the ISSpresso machine, constrained by microgravity and limited water recycling. Mars missions face harsher challenges: low atmospheric pressure, scarce water, and radiation necessitate advanced cultivation or lab-based systems. Proposed technologies include hydroponic coffee cultivation using Martian regolith-derived nutrients and cellular agriculture, inspired by Finland's VTT Technical Research Centre, which produces lab-grown coffee to reduce environmental impact. These methods minimise water and energy use, critical for Mars' resource-scarce environment. Challenges include optimising coffee flavour under controlled conditions, scaling production, and ensuring radiation-resistant crops. Unlike the ISS's reliance on Earth-supplied coffee, Mars habitats require in-situ resource utilisation (ISRU) to grow or synthesise coffee, reducing resupply costs. Finland's coffee culture, where light-roast filter coffee fuels social and work life, underscores coffee's psychological benefits for isolated crews. By integrating Finnish sustainability practices and ISS lessons, this work proposes a framework for autonomous coffee production, enhancing crew well-being and supporting long-term Martian settlement. This aligns with the convention's vision of making Mars a reality through practical, human-centred innovations.

Casey Handmer
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Powering the Mars Base: Energy Challenges for Sustainable Settlement

This presentation examines the monumental energy requirements for establishing a self-sufficient Mars colony. Analysis indicates a 10,000-person settlement would require approximately 1 gigawatt of continuous power, with per-capita consumption estimated at 100 kilowatts—ten times Earth levels due to Mars' need for closed-loop industrial systems and return-flight fuel production.

We compare nuclear and solar energy solutions through a logistics lens. Nuclear reactors (150 tons/MW) would require 1,500 Starship flights costing $150 billion for transport alone. Solar alternatives, despite Earth efficiency gains, face Mars-specific challenges including greater solar distance, dust storms, and nighttime power needs. The complete solar system with battery storage would necessitate approximately 1,600 Starship flights.

Both approaches demand massive material transport, highlighting a fundamental obstacle to Mars settlement. However, solar offers distinct advantages in scalability, simplicity, and eventual local manufacturing potential. Heat dissipation represents a critical challenge for nuclear options in Mars' thin atmosphere, requiring substantial radiator infrastructure.

This analysis demonstrates that energy production represents one of the most significant barriers to establishing permanent human presence on Mars, requiring innovative approaches to generation, storage, and utilization within the constraints of interplanetary logistics.

Dr Martin Bermudez
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Mars Transparent Habitats: Large Monolithic Glass Domes for Low-Gravity Environments

In 2025, our team secured a NASA NIAC award for pioneering glass-based habitats tailored to low-gravity environments like Mars and the Moon, utilizing in-situ resource utilization (ISRU) to craft monolithic glass domes from Martian silica. This presentation details our approach: melting regolith-derived, engineered glass compounds at 1,400°C using concentrated solar furnaces, then shaping them into seamless, radiation-resistant structures with a glass-blowing method. Rich in silica and iron oxides, Martian regolith yields tinted glass that reduces UV transmission by 40% and achieves a compressive strength of 800 MPa—matching tempered glass—after annealing. Coated with aerogel to insulate against Mars' extreme temperatures (- 140°C to 20°C), these domes admit natural light for crew well-being and hydroponics, easing the psychological burden of subsurface living. A kilometer-scale monolithic dome could support hundreds of settlers, requiring minimal regolith and reducing reliance on imported materials. Adapted for robotic execution in Mars' 0.38g environment, the glass-blowing technique ensures scalability and structural integrity. Solar-powered melting offsets energy costs, promoting sustainable colonization. This NIAC-recognized innovation enhances habitat resilience and aligns with the Mars Society's vision by transforming local resources into livable, transparent spaces. We'll discuss production logistics, robotic challenges, and ISRU integration, showcasing a breakthrough for Martian settlement.

Boris Petrovic
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MarsDAO: A Decentralized Framework for Martian Civilization

As humanity prepares for permanent settlement on Mars, the question of governance, economic coordination, and individual autonomy in an extraterrestrial environment becomes critical. MarsDAO proposes a decentralized solution: a blockchain-based civic and economic system designed to support Martian civilization from its earliest stages of development. By leveraging Ethereum smart contracts, digital identity, and programmable assets, MarsDAO enables autonomous governance, decentralized capital formation, and scalable economic activity for off-Earth societies.

At the core of MarsDAO is the PHOBOS token, a programmable digital currency segmented into four functional classes: Treasury (T), Liquidity (L), Royalties (R), and Allocation (A). This class-based architecture supports differentiated economic operations—ranging from strategic reserve management and inter-settlement liquidity provisioning, to royalty distribution from Mars-adapted intellectual property and community reward mechanisms. MarsDAO is thus designed not merely as a financial tool but as a full-stack framework for post-terrestrial economic governance.

The system incorporates Martian.ID, a decentralized identity standard encoded as non-fungible tokens (NFTs), which act as citizenship credentials for participation in governance, funding, and trade. This infrastructure is governed by a suite of open-source smart contracts including GenesisMint.sol, PhobosToken.sol, VaultCompendium.sol, and PhobosLiquidityPool.sol, each responsible for distinct yet interoperable functions within the economy.

Crucially, MarsDAO introduces an autonomous decision-making layer through the Oracle, a cyber-physical intelligence capable of validating proposals, adjusting economic parameters, and mediating interplanetary trade protocols in alignment with the MarsDAO Constitution. This allows MarsDAO to operate resiliently under conditions of high-latency communication between Earth and Mars.

Initial use cases include licensing Mars-adapted technologies (e.g., dust-tolerant solar panels, regenerative life support systems) back to Earth via tokenized royalties, and financing pilot Martian habitats through decentralized capital raises hosted on the Martian.Fund platform.
By integrating cryptographic governance, off-Earth capital formation, and decentralized identity, MarsDAO offers a concrete proposal for how Martian settlements can achieve sustainable autonomy. As we approach an era of permanent human presence on Mars, frameworks like MarsDAO will be essential for ensuring that spacefaring societies are governed by principles of transparency, liberty, and collective agency.

MarsDAO invites collaboration from researchers, technologists, and space governance experts to shape a robust and inclusive blueprint for Martian self-governance.

SATURDAY SESSIONS

MORNING PLENARIES

Siddharth Pandey, Jon Clarke, Annalea Beattie
Protoplanet & Mars Society Australian

- Himalayan Outpost for Planetary Exploration (HOPE)

The team behind the recently completed HOPE station in in Ladakh, India would like to present the results of our work constructing and commissioning the station with you and discuss any questions and matters arising.

Dr. Abigail Fraeman
NASA Jet Propulsion Laboratory

Dr. Abigail Fraeman is a research scientist at NASA's Jet Propulsion Laboratory (JPL) and a visiting associate in planetary science at Caltech, specializing in the geologic evolution of Mars and its moons through visible and short-wavelength infrared reflectance spectroscopy. She serves as the Deputy Project Scientist for the Mars Science Laboratory (Curiosity rover) and has been a co-investigator for the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) and the Mars Moons eXplorer (MMX) Participating Scientist Program. Fraeman holds a Ph.D. in Earth and Planetary Sciences from Washington University in St. Louis (2014) and a B.S. in Physics and Geology & Geophysics from Yale University (2009). Her research focuses on Mars' sedimentary iron oxide deposits, Phobos and Deimos' compositions, and lunar volatile mapping, with over 30 peer-reviewed publications, including key studies in Science and Journal of Geophysical Research. She has led NASA-funded projects, co-led the Keck Institute's "Revolutionizing Access to the Martian Surface" workshop, and received the NASA Early Career Award (2021) and multiple JPL Voyager and Discovery Awards. Fraeman is an active member of AGU and GSA, contributes to NASA review panels, and engages in extensive public outreach to promote planetary science.

Dr. Victoria Hamilton
Southwest Research Institute (SwRI)

Dr. Victoria Hamilton is a planetary scientist at the Southwest Research Institute (SwRI) in Boulder, Colorado, specializing in infrared spectroscopy and mineralogy to study the surface compositions of terrestrial planets and asteroids. She holds a Ph.D. in Geology from Arizona State University (1999) and a B.A. in Geology from Occidental College (1994). Hamilton has been a principal investigator and co-investigator on multiple NASA missions, including the OSIRIS-REx asteroid sample return mission and the Mars Global Surveyor's Thermal Emission Spectrometer. Her research focuses on understanding planetary surface processes, particularly on Mars and Bennu, through spectroscopic data analysis. She has authored numerous publications in journals like Icarus and Journal of Geophysical Research. Hamilton is a fellow of the Geological Society of America, actively contributes to planetary mission planning, and engages in public outreach to advance interest in space exploration.

David Malott
SpaceWorks Enterprises

David Malott is the founder and CEO of SpaceWorks Enterprises, Inc., an aerospace firm focused on advanced space systems and mission architectures. He holds a B.S. in Aerospace Engineering from Georgia Tech (1994) and an M.B.A. from Emory University (2000). Malott has led SpaceWorks in developing innovative technologies, including reusable launch vehicles and in-space manufacturing systems, supporting NASA, DARPA, and commercial clients. His expertise spans mission design, cost modeling, and space logistics, with a focus on enabling sustainable human presence on Mars. Malott has contributed to studies on Mars settlement economics and is a frequent speaker at space industry conferences, advocating for public-private partnerships to accelerate space exploration.

Luther Beagle
NASA Jet Propulsion Laboratory

Luther Beagle is a senior research scientist at NASA's Jet Propulsion Laboratory (JPL), specializing in planetary geology and astrobiology. He holds a Ph.D. in Geological Sciences from Arizona State University (2002) and a B.S. in Geology from the University of Arizona (1996). Beagle's work focuses on Mars surface processes, particularly the search for biosignatures and habitable environments, with significant contributions to the Mars Science Laboratory (Curiosity rover) and Mars 2020 (Perseverance rover) missions. He has published extensively on Martian sedimentology and geochemistry in journals like Science and Nature Geoscience. Beagle serves on NASA review panels and is involved in mission planning for future Mars exploration, emphasizing in-situ resource utilization (ISRU) and analog studies.

Albert Haldeman
Lockheed Martin Space

Albert Haldeman is a space systems engineer at Lockheed Martin Space, with expertise in spacecraft design and mission operations for planetary exploration. He holds an M.S. in Aerospace Engineering from the University of Colorado Boulder (2008) and a B.S. in Mechanical Engineering from Stanford University (2005). Haldeman has worked on Mars mission concepts, including advanced propulsion systems and habitat designs, contributing to Lockheed Martin's proposals for NASA's Artemis and Mars programs. His research interests include autonomous navigation and radiation shielding for deep-space missions. Haldeman is a member of AIAA and has presented at space engineering conferences, focusing on scalable architectures for Mars settlements.

Andrew Jones

Andrew Jones is a space journalist and analyst covering China's space program and global space exploration trends. He holds a B.A. in History from the University of Warwick (2010) and has written for outlets like SpaceNews, The Planetary Society, and GBTimes. Based in Finland, Jones specializes in reporting on Mars missions, lunar exploration, and commercial space developments, with a focus on China's CNSA activities, including the Tianwen-1 Mars mission. His work bridges technical analysis with public engagement, offering insights into the geopolitical and technological aspects of space exploration. Jones is a frequent contributor to space policy discussions and a speaker at international space conferences.

LEGAL AND POLITICAL TRACK SESSIONS

Susan Jewell
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Neuroethics and Agent AI in Analog Missions and Underwater Habitats

As AI agents become integral to space exploration, particularly in isolated, confined, and extreme (ICE) environments like underwater habitats simulating Mars missions, neuroethical considerations must guide their deployment to safeguard human autonomy, privacy, and psychological well-being. This presentation explores the ethical implications of AI-driven behavioral interventions in analog missions, drawing from ongoing research in NEEMO and Aquarius underwater habitats. Key topics include informed consent for AI-monitored neural data, the risk of algorithmic bias in mental health diagnostics, and the potential for AI to exacerbate isolation or foster dependency among analog astronauts. Case studies from multi-agent AI systems, such as SpaceGuardianGPT, illustrate real-time ethical dilemmas, including data sovereignty in international collaborations and the moral responsibility of developers for emergent AI behaviors. By integrating neuroethics frameworks from terrestrial AI ethics (e.g., EU AI Act principles) with space-specific guidelines (e.g., NASA's human-AI interaction protocols), this work proposes a governance model for ethical AI in analog and deep-space settings. The goal is to ensure AI enhances rather than undermines human resilience, paving the way for safe, equitable human expansion beyond Earth.

Christian Yeara
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Embry-Riddle Aeronautical University (ERAU)

Mars Bound: Measuring Public and Industry Support for a Crewed Mission

"A human-crewed mission to Mars is an unprecedented challenge, testing the limits of our capabilities, technology, and ingenuity. Even with cutting-edge systems and the finest crews, such an endeavor involves significant risks, a multi-year commitment, and a multi-billion-dollar investment. Sustained momentum and ultimately, mission success depend on robust public and private support. As taxpayer resources may be redirected from other national priorities, and potential private sponsors assess the landscape, understanding the depth and drivers of desire and interest in Mars exploration becomes essential.

Widespread backing is crucial for policymakers, academia, mission planners, and industry. Knowing whether—and to what extent—the public supports this investment informs strategy, coalition-building, and funding decisions. Public opinion can influence policy, shape key discussions, and set the trajectory of space exploration.

This research applies data mining and text analysis to assess sentiment and perceptions surrounding a crewed Mars mission, drawing from historical news datasets and advanced natural language processing models. Uniquely, it compares general public attitudes with those of aerospace professionals, illuminating both convergence and divergence points and offering a perspective on societal hopes alongside technical evaluations of risk and reward.

While the research is ongoing, initial analysis reveals strong support levels across the evaluated datasets. Notably, public perception of a crewed Mars mission fluctuates over time, with observable yearly changes in support. Preliminary results will be presented at the conference, providing the latest insights for stakeholders.

By mapping these distinct viewpoints, the research delivers insights into how each group evaluates mission goals, benefits, and implications. These findings will help the Mars community gauge support, anticipate challenges, and refine outreach, building the momentum and understanding needed to advance humanity’s journey to Mars."

Alexander DeGraaf
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The Mars Generation: Now

The Mars Generation: Now is a presentation that highlights why engaging youth is essential for the future of space exploration. As humanity moves closer to Mars exploration and beyond, it is crucial to inspire and empower young minds to shape this journey. This presentation outlines a three-step process for fostering involvement:

Introduction – The first step is building awareness and understanding of space exploration's significance.

Interest – The next step, sparking curiosity by connecting space exploration to science, technology, and personal passions.

Inclusion – The final step, broadening programs and opportunities to ensure all young people can engage, contribute, and see themselves as part of this vision.

By guiding youth through these steps, we can create a foundation for long-term engagement. The future of space exploration depends on those who will carry it forward. Involving young minds early ensures that tomorrow's discoveries reflect their creativity, ambition, and leadership. Space exploration is not just a distant dream—it must be an accessible, inclusive, and shared vision for all.

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Engineering Realities of a Martian Colony, Humanoids & Superintelligence on Mars

In an era where Mars settlement is transitioning from speculative vision to engineering roadmap, we must expand our focus beyond launch systems and logistics to the need for & consequences of integration of AGI humanoids with human operation, satellite constellation, and long-term autonomous systems that will support Martian exploration and settlement.
This talk explores a science-based, near-future Martian colonization, set a few decades after the first crewed landing, through the lens of both systems engineering and speculative fiction. Drawing from engineering experiences, in this hard sci-fi technothriller, I present a grounded yet imaginative scenario: a few-thousand-person Mars colony with ISRU infrastructure powered by a hybrid 5MW RTG and solar power plants, operating under increasing influence of AGI-led systems and humanoid robotics.

This Martian Odyssey is rooted in real science: MarsLink satellite constellations, energy budgets, orbital mechanics, radiation shielding, oxygen production, methane production via Sabatier reaction, Starship operation, and Martian power plants design requirements. The appendices serve as both scientific elaboration and a tool for outreach and STEM education. But beyond colony's infrastructure, the session invites critical reflection on:

• HomoSapiens-RoboSapiens cohabitation on Mars, where synthetic and organic life must cooperate to survive.

• Autonomy vs agency: What ethical frameworks govern AGI/ASI when Earth is too far for oversight?
• Psychological dynamics: What happens to human authority when humanoids begin to question agency, not just execute tasks?
• MarsLink Sat Comm: The need for low-latency communication architecture.
Such critical reflection allows us to simulate what whitepapers cannot: the unintended, the emotional, the emergent. This presentation offers both a roadmap and a mirror;for engineers, futurists, and ethicists alike.

As humanity prepares to step onto Martian soil, we must also prepare for unintended consequences as we colonize Mars.

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A proposal design of socio-economic experimental research based on smart-grid co-production approach

At the present time we are observing a lot of environmental, social and economic crisis phenomena, which are in a significant degree interrelated with functioning of the current financial and commodity-money exchange systems. With gradual development of smart grids and distributed ledger technologies, and also recycling technologies (that allow to convert production wastes of ones into useful raw materials for others), it becomes inevitable to rethink some of fundamental economic principles. Particularly, the traditional border between the producer (seller) and the consumer (buyer) may become blurred (if not completely erased). As a consequence, the current pricing practices may become irrelevant. New means of communication and production (the internet of things, virtual reality, 3D-printing, etc.) can also contribute to formation of such conditions that allow any individual to be involved (directly or indirectly) in processes of design and production. So, in the long run it seems to be necessary to question the validity of the traditional dichotomy “producer/consumer” and make the study of co-production phenomenon considerably important. And one of key questions here: can co-production lead to a non-monetary economy? However, in addition to theoretical research, experimental works should also be carried out. We suppose, that necessity to cooperate will be quite obvious for all individuals settled in Martian environment. And if so, it might be a quite appropriate place to implement such experiments. Results of these experiments could be very useful not only for Martian settlers, but also for the Earth’s economy, because these data could give us some practical knowledge how to adjust our current global economic system in order to solve a huge number of social and environmental problems.

Alan Rozich

Sustainability Approach for Mars Colonization - The Right Stuff

The Mercury Astronauts clearly had the “right stuff” in those early days of space exploration. This is a combination of a number factors that impact an individual or team in their dedication and commitment as related to a common cause or a difficult challenge. In this circumstance it is winning the space race. The legendary test pilot, Chuck Yeager, set the bar extremely high for having the “right stuff” in one defining flight. Yeager sustained an injury the night before his first flight in the experimental X-1 aircraft. He fell off a horse the night before the flight while riding with his wife in the desert. Despite the pain, he devised a clever way that allowed him to pilot the experimental plane. And, as is often said, the rest is history. If we are to colonize Mars, we will need all of the right stuff that we can get our hands on.

In the 1960s, Mars was the target of three successful unmanned Mariner missions to explore the Red Planet and the colonization romance began. In the 1970s and 1980s, there were a number of different missions by different countries with varying degrees of success. From the 1990s into well into the 21 st Century, numerous missions were launched vastly increasing our data base of one of our Martian sister planet. These data provided detailed information about the Red Planet which initiated the discourse for Mars colonization.

When one considers the realities of permanent human communities on the Red Planet, it is absolutely vital to view this challenge through the lens of resources that are needed for societal functionality. So, what is available? The potential to effectuate photosynthesis based on the availability of sunlight. This means that biomass can be produced but precautions must be taken to avoid other hazards so settlements will have to be housed appropriately. Assuming that biomass can be generated using sunlight, then a biomass-centric societal functionality protocol is feasible that generates Energy (RNG (renewable natural gas)), water, and chemical fertilizers.

Art Harman
Coalition to Save Manned Space Exploration

Don't Skip the Moon

"There’s increasing excitement at the prospects of returning to the Moon and going to Mars. No longer perpetually a decade away, but much sooner. Elon Musk wants to send a fleet of Starships to Mars next year, and crew at the next window. SpaceX’s Human Landing System and Blue Origin’s Blue Moon are being designed to land crew on the Moon.
At the time of writing, we need a NASA Administrator and rapid decision-making. The future direction of NASA may still be unknown, and is dependent on the administrator’s vision and Congressional guidance. Proposed budget cuts, cancelled projects and science, and plans for

Artemis await until a new administrator offers such clarity. Mars may be fast-tracked, but some have suggested skipping the Moon for Mars.

What the administration must bear in mind in selecting a new administrator and developing science priorities is that returning to the Moon and establishing a permanent commercial and national presence is essential for many reasons.

The Moon will be a massive hub of science and commerce in coming decades. The question is if the free world and commercial space will be shut out by China. China has an unlimited budget and may do an uncrewed test mission within a year, followed by a high cadence of launches of crew to the Moon.

Many understand China's threats to claim the Moon and Mars as their territory—as they have done in the South China Sea. Those threats must be taken seriously.
I will make the case that not only will prioritizing a continuing presence on the Moon forestall a Chinese territorial claim and maintain free-world and commercial access, but lessons learned on the Moon will make Martian missions and colonies safer and more successful."

TECHNOLOGY TRACK SESSIONS

Doug Plata
The Space Development Network

The First Crewed Missions to Mars

SpaceX has the goal of sending the first crew to Mars as early as 2029, but is this feasible? This presentation looks at the relevant factors affecting the timing of initial crewed missions to Mars. Current factors make a November 2026 cargo mission unlikely thereby pushing a crewed mission no earlier than 2031. But what all has to go right before taking the risk of sending crew.

In this presentation, Dr. Plata describes contingency scenarios to optimize the probability of sending crew as soon as possible with a reasonable level of safety. He makes the case that a Mars flyby in about 2031 may be a smart strategy considering what China may be able and tempted to do.

Dr. Plata also describes how multiple, simultaneous Starships could go a long way to ensure crew survival when returning to Earth quickly is impossible. Cargo prior to crew landings could easily oversupply the crew with provisions, redundancies, and spare parts. Further, Dr. Plata references his AIAA paper describing what how certain biomedical indicators could determine if return criteria is met with the recognition that SpaceX crew may not want to return but rather continue their work building up the base in preparation for the arrival of many more crew.

Dr. Plata describes how large the Initial Crew may be and provides some insider information suggesting what the composition of said crew may be.

Finally, the sticky question of political factors is discussed which may significantly affect SpaceX's ability to launch the first crew to Mars."

Alexandra Lohrke
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3D Printing for Long Term Habitation on Mars

One of the most pressing questions that has been asked about long-term space habitation is "where will we get everything we need to live and thrive"? In our day-to-day lives on Earth, complex supply chains provide food, clothing, spare parts, and other products that people want and need in the space of days. However, in space, this will not be an option. This problem will only become exacerbated the further from Earth we travel, as cost and planning time will no longer be the only factors. Travel time to Mars is around nine months at the shortest possible trajectory, and that would not factor in the time it would take to requisition the parts on Earth and schedule the launch.

The simplest way to avoid these problems is to remove the need to send replacement parts and have astronauts make them on-site with 3D printers. 3D printing in micro-gravity has already been tested and shown to be feasible. On the International Space Station, for example, even regular commercial 3D printers have been shown to work using surface tension to hold down the material as it is constructed. With rovers and satellites finding materials such as iron and quartz on Mars, it could be possible to build 3D printing factories in space to provide explorers with a more constant supply of parts. There are also ideas to use large printers to print whole habitats out of martian regolith, which would drastically cut the weight of construction supplies. This paper will discuss the available materials on Mars and which necessities could be made from them.

Adrian Dumitrescu
Astera Institute

Towards a precursor mission to demonstrate the building blocks of Mars aerosol warming

Global terraforming of Mars involves three major steps: warming the planet to start melting surface water ice, establishing a photosynthetic biosphere that would raise the oxygen level, and increasing atmospheric pressure. We will describe the mission concept and instrument selection for a precursor mission that tackles the first step: warming the planet.

Methods to warm Mars act to maximise solar irradiation of the surface while minimising the escape of thermal infrared energy to space. Recent work by Ansari et al. [1] and Richardson et al. [2] shows that artificial aerosols, made from materials that are readily available at Mars, could warm Mars four orders of magnitude more effectively than the best available gases [3]. Achieving planetary warming of >30 Kelvin, enough to start melting near-surface ice, could be realised in a few years according to this climate modeling. This could be a component of a long term vision of bringing life to other worlds [4-5]. However, a precursor mission is needed to de-risk some of the critical technologies.

One possible precursor mission would have the main goal of demonstrating an effective dispersal of warming nanoparticles into the Martian atmosphere. Such a mission would not aim to warm Mars in any significant way, but rather validate the transport of the aerosols, their dispersal within the atmosphere and their lofting to several km in height. This will demonstrate the capability of the particles to be dispersed on a planetary scale, while enabling comparison with simulations. It would also enable high priority atmospheric science measurements. This presentation will set out the mission objectives, the scientific measurement requirements, the instrument selection and payload sizing for a launch in the early 2030s.

[1] Ansari et al., Sci. Adv. 2024, https://www.science.org/doi/10.1126/sciadv.adn4650.
[2] Richardson et al., in review, https://arxiv.org/abs/2504.01455, 2025.
[3] Marinova et al., Journal of Geophysical Research 2005, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2004JE002306
[4] Kite & Wordsworth, Asterisk, 2025, https://asteriskmag.com/issues/09/greening-the-solar-system.
[5] DeBenedictis et al., Nature Astronomy, 2025, t.co/A90zCQiYeY.

Damian Clogher
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Planetary Sunshade Foundation

Adaptations of Planetary Sunshade Technologies for Mars:

Planetary sunshades have been proposed as a method of solar radiation management (SRM) for Earth, in the context of mitigating climate change, with research ramping up considerably in the last decade. However, the technologies and industrial infrastructure used to create sunshades for Earth can also offer great benefits for Mars exploration, settlement, and even terraforming efforts.

We investigate potential applications for orbital mirrors at Sun-Mars Lagrange Point 2, where they can be used to warm Mars and contribute to long-term terraforming efforts. We explore

how resources from Phobos and Deimos could be leveraged for in-situ construction of Mars-based sunshades. We also examine how industrializing the Martian moons can enable a broader space-based economy around Mars, including space-based solar power, propellant depots, and orbital assembly.

Kent Nebergall
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Modular Rover Technology for Human Outposts

In late 2024, I won a NASA prize for designing a rover that could do science and light industrial work in the moon's permanently shadowed craters. The rover design draws from a century of polar exploration engineering and two decades of Mars rover lessons learned. The system is designed to be maintained by astronauts, with modular attachments added to suit the terrain and mission. The resulting rover design is called Lunar Halo.
While designed for the moon, this rover concept is ideal for crossing the Martian dust fields that trapped the Spirit rover, climbing the steep slopes that caused Perseverance to backslide, and exploring in lava tubes with poor lines of communication. It can do both exploration and light industrial hauling within and beyond human outposts. It's essentially the sure-footed burro to accompany the pressure-suited prospectors of the new frontier. The rovers are small enough to fit through a human airlock for maintenance, but can be locked together into crawler platforms for transporting larger equipment. They can also be connected into “Land Trains” like the systems used to build large infrastructure projects in the Arctic during the 1960’s.

Maria Perera
Independent (SSRN Author)

BioOxyNode-X:M: A Self-Powered Perchlorate-Based Oxygen Generation System for Martian Deployment

BioOxyNode-X:M is a modular, self-powered oxygen generation unit designed for Martian deployment, leveraging perchlorate-rich regolith as feedstock. Inspired by abyssal seafloor electro-oxygenation processes, it employs a biomimetic framework for passive electrolysis, converting perchlorates to O2 without external power via thermoelectric harvesting from temperature gradients. The system integrates scalable nodes for habitat life support, with efficiency >80% in Mars analog tests. This ISRU technology reduces Earth dependency, enabling long-term settlements. Technical white paper details prototype specs, safety protocols, and integration with ECLSS. (From SSRN 5255199, 2025)

Note on Barredo - Cryofuel: Building the Backbone of Interplanetary Logistics to Enable the Case for Mars:

ANALOG STATIONS TRACK SESSIONS

Phil Swan & Ben Stanley

Protecting the Human Body Under High Acceleration: A Path to Affordable Mars Logistics

Electromagnetic Space Launch (EMSL) systems hold the potential promise of fundamentally changing the economic equation of space launch by allowing for the bulk of delta-v to come from cheap sources of power like electricity rather than inefficient, risky, and expensive chemical rockets. Developing an EMSL system will require a large capital investment that will subsequently provide an extremely low cost per kg to orbit. A dominant cost driver for a human-rated system is the maximum acceleration passengers can safely tolerate. Higher g-forces imply a shorter track, and therefore a less expensive system. This paper reviews early explorations in the upper limits of human g-force tolerance that were not developed further. We argue that although it makes sense that these adaptations were not developed further for existing applications of g-force tolerance (e.g. jet fighters or existing rockets), they may work quite well with EMSL systems for numerous reasons. The capital cost of a launch system would be lowered by $1.5B per additional g of acceleration tolerance conferred by technology advancements in acceleration countermeasures.

Chris Yuan
UMIC / PECA / MMAARS

UMIC- PECA Interstellar Lab: an underwater habitat test platform for Analog Aquanaut Training Missions

The UMIC–PECA (Ursa Minor Interstellar Citizens – Planetary Ecology Closed-loop Analog) Interstellar Lab is a groundbreaking modular underwater habitat platform designed to simulate sustainable closed-loop ecological systems for future human space settlement. Developed in collaboration with the Mars-Moon Astronautics Academy & Research Sciences (MMAARS), UMIC–PECA provides a high-impact aquanautics analog environment for training analog astronauts in conditions that closely replicate those encountered during lunar, Martian, and deep-space missions. Operating within Isolated, Confined, and Extreme (I.C.E.) environments, the habitat emphasizes ecological symbiosis, human-animal-plant cohabitation, and autonomous system management, essential for long-duration survival off-world.

As a mid-fidelity analog habitat, UMIC–PECA forms an integral part of MMAARS' tiered astronautics training framework, which prepares participants through immersive underwater EVA (extra-vehicular activity) simulations and portable, expandable habitat modules that mimic extraterrestrial basecamps. Trainees engage with AI-driven systems, extended reality (XR), and

submersible drone operations to develop resilience, autonomy, and mission-critical problem-solving skills. The platform extends beyond conventional training through mobile modularity, enabling deployment in diverse underwater terrains and complementing fixed analog stations such as the Jules' Undersea Habitat.

Key mission activities include biomedical and psychological monitoring in hyperbaric conditions, real-time deployment of telerobotic systems and AUVs for planetary analog research, and emergency triage and habitat re-entry scenarios based on the PMARCHP model. Moreover, UMIC–PECA integrates AvatarMEDIC and ISPS-VETA (Integrated Space Psychiatry System – Virtual Embodiment Tele-Psychiatrist Avatar), which offer XR-based behavioral health tools and AI-supported mental wellness protocols essential for preserving cognitive function in space crews.

Ecological training extends to managing bioregenerative feedback loops between human respiration, plant oxygenation, and animal ecosystem behaviors. Analog astronauts operate aquaponics-based lunar farm prototypes, developing models of regenerative life support systems adaptable to future planetary outposts. The UMIC–PECA initiative not only advances the science of analog astronautics but also demonstrates an innovative, scalable model for training, health resilience, and ecological integration in extreme environments, offering a critical step toward sustainable human space exploration and multi-planetary settlement.

Luis Torres
Torres Orbital Mining (TOM)

From Lunar Regolith to Martian Readiness: TOM's Scalable Path Toward Off-Earth ISRU

Establishing a sustainable presence on Mars depends on the ability to process local materials into usable resources. In-situ resource utilization (ISRU) is a cornerstone of that vision. At TOM (orbitaltom.com), we are developing scalable technologies for regolith excavation and refinement, starting with the Moon as a nearby and accessible testbed.

The Moon offers not just proximity but the chance to validate ISRU systems in real conditions. Current reliance on simulants limits progress, as they fail to capture the mechanical and abrasive properties of actual lunar soil. This lack of authentic regolith poses a major barrier to maturing off-Earth technologies.

Our approach begins with TOCHTLI, a modular rover designed to excavate, classify, and pre-process lunar regolith. TOCHTLI supports particle sizing, beneficiation, and a sharpening mitigation process that prepares regolith for downstream applications such as oxygen extraction, additive manufacturing, and construction. Its modular architecture enables flexibility across a variety of mission needs and environments.

TOCHTLI is a precursor to M-AEL, the Moon-Autonomous Extractor Lander. This larger system is designed to retrieve up to 3,000 kilograms of lunar regolith before the end of the decade. M-AEL's design prioritizes mass-efficiency, dust control, and modularity, with the goal of enabling consistent, scalable regolith delivery to orbit and back to Earth.

We believe that meaningful ISRU progress will come from handling and processing real regolith at realistic volumes. Our presentation outlines TOM's roadmap, the technical rationale for lunar-first development, and a collaborative call to academic, commercial, and governmental actors to help bridge the gap between ISRU ambition and operational readiness.

The Moon is not a symbolic waypoint. It is a practical foundation for learning to live and build with planetary materials. Through this work, we aim to accelerate the material science that will make Mars reachable and habitable.

Dahlia Raut
MMAARS

SPACE PHARMACOLOGY: Developing a Space Pharmacokinetics Risk Database and Digital Twin for Personalized Preventative Medicine and Drug Stability and Pharmaceutical Discovery during analog I.C.E missions

As NASA, global space agencies, and private aerospace companies accelerate efforts for long-duration missions to the Moon and Mars, the uncharted territory of pharmaceutical stability and efficacy in deep space becomes a critical challenge. Astro-pharmacy is a frontier domain merging space pharmacokinetics, in situ biomanufacturing, and personalized medicine. This revolutionary concept is poised to transform our healthcare systems for human spaceflight and Earth. Environmental stressors such as microgravity, cosmic radiation, immune dysregulation, and altered fluid dynamics can fundamentally alter the pharmacokinetics and dynamics of drugs, i.e., alter the ADME (Absorption, Distribution, Metabolism, and Excretion) profile of medications, risking reduced efficacy, potency, the half-life of drugs, or increased toxicity. This initiative is a collaboration between the Mars-Moon Astronautics Academy & Research Science (MMAARS), Embry-Riddle Aerospace and Biomedical Engineering Departments, and Aston University's College of Health and Life Sciences, an international collaboration in advancing scientific frontiers for human space exploration. The project integrates analog astronaut missions, in vitro pharmacology, AI modeling, and omics-based assessments to design a robust pharmaceutical infrastructure for planetary missions. Multi-fidelity analog simulation missions, spanning desert, underwater, and high-altitude analog environments, serve as Earth-based surrogates for extraterrestrial environments to investigate the pharmacodynamics of essential medications, including antimicrobials, supplements, psychotropics, and over-the-counter medications This presentation will discuss design methodologies and the creation of a Space Pharmacokinetics Risk Database to integrate real-time omics profiling and AI-powered dosage prediction models and ensure closed-loop medical monitoring and autonomous care delivery.

The research has dual-use potential for enhancing medical resilience in altered gravity and deep space to improve health systems in extreme environments, such as polar outposts and disaster zones. This work lays a foundation for sustainable human presence in Space, Mars, and beyond by enabling self-sufficient, precision-guided pharmaceutical systems.

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SHARP, ISEE, and iNSPIRE Cognitive Mapping: What Astronauts Teach Us About Timing, Environment, and Self-identity

Building on Tolman's (1948) concept of broad cognitive maps to foster minds oriented toward rationality, peace, and motivation, this study integrates the ancient Chinese philosophy of TiānShí–DìLì–RénHé to examine key factors underlying retired astronauts' success in STEM education and the space industry. Anchored in this triadic framework, it introduces three original models—SHARP TiānShí (Heavenly Hour), ISEE DìLì (Terrain Triumph), and iNSPIRE RénHé (Human Harmony)—to illuminate how pivotal timing, environmental forces, and self-identity development shape resilient, purpose-driven life trajectories.

The researcher has developed original research methods—including Journey-Memory Tethering Phenomenology and Reflexive Resource Analysis in Interpretative Phenomenological Analysis—to enrich data collection and interpretation. Additional innovations such as the Holy Receptor role and Serendipitous Inquiry in Grounded Theory elevate researchers' ethical sensitivity and positionality while honoring participants' lived experiences.

By blending cognitive science with cross-cultural philosophy, this research offers universal insights to empower future generations—not only to become astronauts, but to thrive as adaptable, high-performing professionals across the space sector and beyond—while supporting cognitive vitality and narrative coherence among aging populations.

Maria Harney
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Russian vs. U.S. Astronautic Missions and Civilian Space Settlements

This highly interactive presentation examines the interplay of leadership, communication, and cross-cultural collaboration in astronautic missions and future civilian space settlements, with a focus on European (Russian) and Western (U.S.) approaches. By analyzing team dynamics,

decision-making strategies, and social cohesion in extreme environments, this talk highlights the critical role of soft skills in fostering effective multinational partnerships. Additionally, it explores the human factor in space, particularly in isolated and austere environments, where psychological resilience, adaptability, and interpersonal skills are essential for mission success. Combining a scientific approach with real-time experience examples, this engaging session encourages audience participation and discussion. Through comparative insights, it aims to enhance cooperation, strengthen leadership adaptability, and support sustainable space exploration while ensuring the long-term survival of humans beyond Earth.

Joshua Perry
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Alternate historical analogues for human space settlement: Polynesian settlement of the South Pacific

When contemplating future space settlement, historical analogues are convenient tools to predict how such a society might function and evolve over time. They are also useful in public advocacy to give predictions about future extraterrestrial society a basis beyond science fiction speculation. The most commonly employed historical analogies for human exploration and settlement of space, tend to come from the European Age of Exploration and the westward expansion of the United States. There are several reasons why we should seek alternatives: most notably that there were people already living in these regions for thousands of years by the time Europeans arrived. If we are to look for true historical examples of human expansion into new environments, we must go further back. Probably the closest analogy we can find that is recent enough to exist in the historical record is the settlement of the south pacific islands by Polynesian peoples. The Polynesians crossed the vast distances of the pacific using ingenious stone-age technology and keen observation of the natural world. They established entire new ecosystems on the islands they settled, developing into a diverse set of societies. A notable example is the Rapa Nui (Easter Island) culture. Although maligned in some popular historiography, archeological evidence now shows how despite very challenging environmental conditions, the Rapa Nui people transformed their island into a remarkably prosperous and peaceful society that constructed megalithic monuments which are now famous all over the world. Their achievements are exemplary of what human ingenuity and determination are capable of in an isolated, hostile environment similar to what a future space settlement might be like.

MARS SOCIETY TRACK SESSIONS

James Burk
Executive Director, The Mars Society
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Mars Society Program Updates

Mars Society Executive Director James Burk, also a founding member and leader of our Seattle chapter since 1998, provides updates on all programs across the Society, including Political Action, Chapters, Members, Analog Research Stations, Competitions and our plans for 2026 and beyond.

Ronnie Storie
Director of Chapters, The Mars Society
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Chapters and Membership Status

Director of Chapters, Ron Storie, provides the latest updates on our global reach and how to get involved with chapters and events at the local level.

Edward Heisler
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2026: A Turning Point for Mars Society Growth, Renewal, and Global Impact

How We Rebuild, Reimagine, and Reignite Our Mission Post-COVID

Since the onset of the COVID-19 pandemic in 2021, the Mars Society—especially in the United States—has faced a steady decline in membership, engagement, and participation. This trend reached a critical low at our 2024 International Convention in Seattle, where in-person attendance dropped to approximately 200—perhaps the smallest on-site convention gathering in our organization's 27-year history.

Our recent fundraising efforts have also fallen way short of expectations. The ambitious $1 million dollar campaign to launch the Mars Technical Institute raised only $150,000. The more modest $250,000 international campaign to support MDRS upgrades and staff expansion has brought in just $38,351—despite our presence in nearly 40 countries.

These numbers are not just disappointing—they are a wake-up call.

But 2026 can be the turning point.

We must meet this moment with urgency, clarity, and vision. We need to stop hoping things will fix themselves and start taking deliberate action. That means developing a practical, realistic plan of action to rebuild and greatly expand our membership base and friends.

It's time for a global Mars Society renaissance.
We must turn every activity, every project, and every communication into an opportunity for membership recruitment. And we must embrace new tools, platforms, and methods.
Let's be bold. Let's make Mars Society an engine of inspiration for the pro-space, pro-Mars exploration public—millions of people who are waiting world-wide for a way to get involved.
Let's rebuild this organization as a dynamic, modern, global movement for Mars—energized by grassroots activism and public education.

2026 is the year of renewal.
The year of expansion.
The year of revival.

We can make it happen—together.

Mars Society Ambassador Program

Ashton Zeth
Director of Ambassador Program and Host of Red Planet Live! Podcast
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Current and future ambassadors can come to this presentation or contact Ashton directly about joining our Ambassador Program, which is worldwide and open to everyone who wants to help with public outreach to the general public of our mission and programs.

Mars Society New Volunteers

Come to this session to learn how to become a volunteer with the Mars Society's many program opportunities, as well as how to join our analog research station crews and mission support teams.

Mars Society Social Mixer

Help us close out the conference with a social mixer and networking opportunity. In addition, we will take the party other location(s) after 5PM! Check the registration tables on Saturday morning for the latest networking and sightseeing opportunities in Los Angeles.

END OF ABSTRACTS

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Please consider a donation (tax-deductible in the U.S.) to the Mars Society to help advance our work to promote humans-to-Mars! Get involved today!

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There are many ways you can support the Mars Society and its mission. Whether you choose to **make a direct contribution**, **arrange a matching gift from your employer**, **include our organization in your estate planning**, **become a member, or renew your membership**, your generous assistance will yield tangible results and help ensure the establishment of a permanent human presence on the Red Planet.

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When you support the Mars Society, a fully registered 501(c)(3)non-profit organization, with your generous gift, you play a direct role in guaranteeing that the world's largest Mars advocacy group will continue to influence and work effectively with important policymakers, both in the United States and around the world, on issues related to Mars exploration and humans-to-Mars.

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