29TH INTERNATIONAL MARS SOCIETY CONVENTION

PHOBOS

DEIMOS

2026 CONVENTION PROGRAM GUIDE

SPACEX STARSHIP

BLUE ORIGIN NEW GLENN

RISING ABOVE

October 22–24, 2026

Los Angeles, CA

OUR MARS TECHNOLOGY INSTITUTE & MTI PARTNER SPONSORS

THE MARS SOCIETY

SPACEDIRT

UNLEASHED ROBOTICS

MIFECO

NORTH BEND

A Letter from the Executive Director

To the members and friends of the Mars Society:

Welcome to Los Angeles and the 29th Annual International Mars Society Convention! Whether this is your first convention or your twenty-ninth, thank you for joining us at the University of Southern California.

We gather at a remarkable moment. In April, the Artemis II crew flew around the Moon and came home safely, the first human voyage beyond low Earth orbit since 1972. NASA has committed to building a permanent Moon Base, and in July we marked 50 years since Viking 1 touched down on Mars. The idea this Society has championed since 1998, that humans belong on the surface of other worlds, is moving from argument to action. Our job is to make sure Mars follows the Moon.

Here is what you, our members and volunteers, made possible over the past year.

Our analog research program had a strong year. The 2025 to 2026 field season at the Mars Desert Research Station (MDRS) in Utah opened last October with Crew 319, part of the World's Biggest Analog, a globally coordinated two-week simulation. It closed in May with Crew 337, six students from the Florida Institute of Technology flying the pilot mission of their university's analog research program. Along the way, a $20,000 community crowdfunding campaign and the hands-on work of our volunteers gave the station a modern solar power system and a refreshed interior, and Harper's Magazine published a feature written from inside an MDRS crew.

We also celebrated one of our own. Dr. Jessica Watkins, an alumna of our MDRS program, was named commander of NASA's SpaceX Crew-13 mission to the International Space Station.

In the Canadian High Arctic, Crew 19 completed a successful July mission at the Flashline Mars Arctic Research Station on Devon Island, our fourth consecutive year of research there. An advance team upgraded the station's heating, electrical, and ventilation systems, and an all-volunteer mission control team from Canada and the United States supported the crew from start to finish.

The University Rover Challenge keeps growing. A record 116 teams from 18 countries applied for the 2026 competition, and 38 teams from 11 countries earned a place in the finals at MDRS in May. We welcomed Honeybee Robotics as a sponsor and the INCOSE Foundation as an educational partner, which brings a new award for excellence in systems engineering.

Our education programs reached students around the world. More than 100 students from 20 countries took part in our fifth annual International Mission to Mars Engineering Design Competition, led by Education Director Nicole Willett. Our education team launched Why Mars Matters, a 25-part short video series, and we again opened MDRS to Utah K-12 teachers through Spaceward Bound.

The Mars Technology Institute (MTI), our initiative to develop the technologies people will need to live on Mars, is gaining momentum. MTI partner Unleashed Robotics was selected by NASA for negotiation of a $225,000 Small Business Innovation Research award to advance robotic core drilling for planetary exploration. MTI's partner companies were featured on Red Planet Live, and the Institute was represented at the Nobel Prize Dialogue in Seoul.

One announcement deserves special mention. In July, through our Seattle chapter, the Mars Society signed a 10-year agreement with South Seattle College to build a Moon and Mars analog research

station on its campus, with a targeted opening at the start of the 2027 to 2028 academic year. It will be our third analog station and our first on a college campus. It comes paired with a space studies curriculum, student capstones and internships, and a workforce pathway into the skilled trades that exploration depends on. The partnership is featured on the cover of the current issue of Northwest Aerospace News Magazine.

We kept our voice in the national conversation. The Society joined The Planetary Society and other organizations in urging Congress to reject proposed cuts to NASA science, and we welcomed NASA's Ignition initiative while pressing for a coherent path to Mars. Our president and founder, Dr. Robert Zubrin, made the case for Mars on CNN and in print, and The Economist profiled him this month. The New York Times covered last year's convention, and Red Planet Live, hosted by Ashton Zeth, brought leading voices in science and exploration to our community throughout the year.

Around the world, our chapters carried the mission forward. Association Planète Mars hosted the European Mars Conference in Paris, Mars Society Hellas ran a Mars analog simulation for schoolchildren in Greece, and our Missouri chapter launched the Imagine Mars story contest. In India, we were proud to partner in the HOPE analog station in Ladakh.

None of this happens without you. The Mars Society runs on its members, volunteers, and donors, including the Silent Donor community that contributed over $100,000 this year.

This weekend you will hear from Dr. Adam Steltzner, Dr. Vint Cerf, Dr. Garrett Reisman, Dr. James Green, and many others. Listen, debate, meet someone new, and find the project that needs your skills. If you are not yet a member, please join us. If you are, bring a friend next year.

Thank you for an extraordinary year.

On to Mars!

James L. Burk
Executive Director, The Mars Society

Contents

A Letter from the Executive Director 3

Thursday, October 22 7

Schedule 8

Plenary and Evening Program 10

Opening Plenary: Dr. Robert Zubrin 10

Building the Road to Mars: The State of the Society and What Comes Next 10

Plenary: Humphrey "Hoppy" Price 11

Consilience. The Life Living Today in Martian Soils 11

Chiral Labeled Release: An Experiment to Irrefutably Prove Extant Microbial Life on Mars 11

Solar System Internet 12

Evening Talk: David Brin 12

Designing a Human Mars Campaign Using Current Technologies 12

Evening Panel: Did Life Begin on Mars? 13

Afternoon Breakout Sessions 13

Lunar and Martian Regolith Simulants Differentially Influence Microbial Viability and Stress-Related Gene Expression 13

InterPlanetary Atomic Swaps as a Settlement Primitive for the Earth–Mars Economy 14

MARIE: Maximizing Artemis's Resource and Infrastructure Efficiency 14

Moon First, Mars in the 2040s? We Are Martians, Not Moonies 15

A Calendar System for Mars: Customizing Timekeeping for the Red Planet 16

It's Getting Real: China, Artemis and the Race to the Moon 16

Autonomous High Efficient Solar-Powered UAV for Atmospheric Reconnaissance 17

Cancer as a Design Constraint for Human Settlement of Mars 17

Property Rights for Space Colonists 18

Engineering Design Considerations for a Martian Autonomous Controlled Environment Growing-Living Space 18

Space Philosophy: Ethics of Exponential Technologies in Space Medicine 19

CIRES: A Sustainable, Scalable, Evolvable, Closed Loop Life Support System 19

Postcards from Mars: Bright Views for Humans! 19

The Road to Mar$ Goes Mainly Through the Moon 20

Harnessing Star Power: A Public Trailer and Highlight Reel for The Case for Nukes (film) 20

High Temperature Nuclear for Lunar and Martian ISRU 21

If Starship Underachieves: Alternative Orbital Refueling Ideas for Mars Missions 21

Friday, October 23 23

Schedule 24

Plenary and Evening Program 26

Plenary: Garrett Reisman 26

Plenary: Dr. Ashwin Vasavada 26

Plenary (one hour): Tim Ellis 26

Flashline Mars Arctic Research Station Crew 19 Mission Panel 27

Rethinking Electric Propulsion with Naphthalene 27

How High the Moon, Why Not Mars? 27

Networking Evening 28

Afternoon Breakout Sessions 28

Mars Technology Institute Company Talk: Unleashed Robotics 28

Alignment Over Enforcement: Cognitive Design for Early Martian Civilisation 28

Mars Transit Direct 29

Water First: Building a Supply Chain Beyond Earth (Mars Technology Institute company talk) 29

Project ARES: A Roadmap for a Large-Scale Martian Colonization Program 29

Growth Potential of Salad Crops in Simulated Martian and Lunar Regoliths 30

Using Harnessed AI to Accelerate Scientific Discovery, Engineering and Space Operations 31

A New House on Mars: A Strategy to Make Mars Settlement Easier, with a Beginning Launch by 2028 31

Neo-Derinkuyu: An Autonomous Underground Mars Habitat Design Driven by AI Algorithmic Infrastructure 32

Materials by Prediction: Why Mars Can't Afford Trial and Error 32

Mars: The Path for Peace on Earth 33

Biological Sentinel Networks for Early Detection of Mars Habitat Instability 33

BioPills: Engineering a Portable Microbiome for In-Situ Soil Regeneration, from Earth to Mars 34

2026 Mars Society Chapters Update 34

Increasing Power-to-Calorie Efficiency with Non-Photosynthetic Food Technologies 34

Considerations of Building a Dyson Sphere for Our Solar System 35

The Year of Earth and Space (YES) 36

Direct to Mars in 40 Million Kilocalories ... 36
Agentic AI: The Essential Infrastructure for Sustainable Mars Settlement and Planetary Civilization ... 36
Fun and Fund: The Nineteen-Year Quest to Make Mars Worth Owning ... 37
Mars Against Hunger Finalist: Davi Souza ... 37
Comet Impact Terraforming ... 38
Human Mars Expedition: When Will We Go? ... 38
Mars Against Hunger Finalist: Lawrence T. Beckerle ... 38

Saturday, October 24 ... 39
Schedule ... 40
Plenary and Evening Program ... 42
Private Property in Space: The Missing Ingredient ... 42
MarsSuit Live Demonstration ... 42
Plenary: Dr. Carol Stoker ... 42
Plenary: Fabrizio Pisani ... 43
Plenary: Patrick Beatty ... 43
Convention Banquet ... 43
Afternoon Breakout Sessions ... 44
Collagen-Based Artificial Muscles ... 44
Power and Politics on the Red Planet ... 44
From Mars's Deepest Basin: A Settlement That Builds Itself ... 45
GOLDEN Framework: Enabling Human-AI Coevolution for Mars and Beyond ... 45
Thermal Control for Mars Exploration Spacecraft in an Uneven Solar Radiation Environment ... 45
The Mars Leap ... 46
Psychological and Demographic Predictors of Willingness to Participate in Analog Astronaut Missions ... 46
Protecting Life on Mars with Martian Basalt ... 46
Going to Mars? Better Join the Navy First ... 47
Exploring Amino Acids as a Biosignature via Novel Spectrophotometer Design ... 47
Prototype for an Autonomous Payload Containment in a Martian Analog Environment ... 47
Simulated Microgravity Modulates Neutrophil Activation and Extracellular Vesicle Release ... 48
Cybermars: A Home Synced with Real Mars ... 48
The Case for Design for Reliability for Growing and Living Spaces on Mars ... 48
Exocracy: A Structural Optimization Blueprint for Infinite Scaling and Civilizational Expansion ... 49
Practical Antimatter Propulsion: A Manhattan Project for Interstellar Capability ... 49
JOVINAUT (JM-V1): Multi-Megawatt Architecture for Deep-Space Logistics ... 49
SuperMIRC: Breeder Reactors to Power Mars Industrialization ... 50
Viability of Fission-Powered Rovers in Extended-Stay Human Mars Missions ... 50
New MDRS Suit Demonstration: Enabling Human Work on the Martian Surface ... 51

Notes ... 52

Thursday, October 22

Day 1 of the 2026 International Mars Society Convention

Schedule

Plenary and Evening Program, Grand Trojan Ballroom

Time	Session	Speaker
8:00 AM	**Registration & Doors Open**	Badge pickup outside the Grand Trojan Ballroom (lower level)
9:00 AM	**Opening Plenary**	Dr. Robert Zubrin, President, The Mars Society
9:30 AM	**Plenary**	James Burk, Executive Director, The Mars Society
10:00 AM	**Plenary**	Humphrey "Hoppy" Price, Chief Engineer, Robotic Mars Exploration Program, NASA JPL
10:30 AM	**Consilience. The Life Living Today in Martian Soils**	Dr. Steven Benner, Foundation for Applied Molecular Evolution
11:00 AM	**Chiral Labeled Release: An Experiment to Irrefutably Prove Extant Microbial Life on Mars**	Ron Levin
11:30 AM	**Solar System Internet**	Dr. Vint Cerf
12:00 PM	**Lunch Break**	
1:00 – 5:00 PM	**Afternoon Breakout Sessions**	See breakout schedule below
7:00 PM	**Evening Talk**	David Brin, Author
7:30 PM	**Designing a Human Mars Campaign Using Current Technologies**	Dr. Jim Green
8:00 PM	**Evening Panel: Did Life Begin on Mars?**	Steven Benner, Ron Levin, and Robert Zubrin; moderated by Ashton Zeth

Afternoon Breakout Sessions, 1:00 to 5:00 PM

Time	Room 1: Grand Trojan Ballroom	Room 2: TCC 350/351	Room 3: TCC 450 (Forum)
1:00 PM	**Lunar and Martian Regolith Simulants Differentially Influence Microbial Viability and Stress-Related Gene Expression** *Solange Massa, EcoAtoms*		**InterPlanetary Atomic Swaps as a Settlement Primitive for the Earth–Mars Economy** *Lennart Lopin*
1:30 PM	**MARIE: Maximizing Artemis's Resource and Infrastructure Efficiency** *Stewart Peterson, Midwest Applied Physics*	**Moon First, Mars in the 2040s? We Are Martians, Not Moonies** *Edward Heisler, Mars Society Ambassador*	**A Calendar System for Mars: Customizing Timekeeping for the Red Planet** *Hal Fulton*
2:00 PM		**It's Getting Real: China, Artemis and the Race to the Moon** *Art Harman*	**Autonomous High Efficient Solar-Powered UAV for Atmospheric Reconnaissance** *Vishak Meenachi, Little Rock Central High School / University of Arkansas, Little Rock*

Time	Room 1: Grand Trojan Ballroom	Room 2: TCC 350/351	Room 3: TCC 450 (Forum)
2:30 PM	**Cancer as a Design Constraint for Human Settlement of Mars** *Samuel McKee, University of Cambridge*	**Property Rights for Space Colonists** *John Amabile*	**Engineering Design Considerations for a Martian Autonomous Controlled Environment Growing-Living Space** *Peter Vorobieff*
3:00 PM	**Space Philosophy: Ethics of Exponential Technologies in Space Medicine** *Dr. Maria Harney*	**CIRES: A Sustainable, Scalable, Evolvable, Closed Loop Life Support System** *Donald Jacques, EarthSeed*	
3:30 PM	**Postcards from Mars: Bright Views for Humans!** *Holger Isenberg, Areo Info*	**The Road to Mar$ Goes Mainly Through the Moon** *Darrin Taylor*	
4:00 PM	**Harnessing Star Power: A Public Trailer and Highlight Reel for The Case for Nukes (film)** *Michael Strickland, MD*	**High Temperature Nuclear for Lunar and Martian ISRU** *Dr. Kevin Hickerson, The Earthineering Company*	
4:30 PM		**If Starship Underachieves: Alternative Orbital Refueling Ideas for Mars Missions** *Ben Switala*	

Plenary and Evening Program

Grand Trojan Ballroom

Opening Plenary: Dr. Robert Zubrin

Dr. Robert Zubrin, President, The Mars Society

Dr. Robert Zubrin is the founder and President of The Mars Society and President of Pioneer Astronautics, a private company that conducts research and development on innovative aerospace technologies. A nuclear and astronautical engineer, he holds a master's degree in Aeronautics and Astronautics and a Ph.D. in Nuclear Engineering from the University of Washington.

Zubrin began his career at Martin Marietta (later Lockheed Martin) as a Senior Engineer designing advanced interplanetary missions. He was the driving force behind Mars Direct, a mission architecture that dramatically reduces the cost and complexity of human Mars exploration by producing oxygen, water, and rocket propellant from the Martian atmosphere. A modified version of the plan was adopted by NASA as its Design Reference Mission.

In 1998 he founded The Mars Society and led its successful effort to build the first simulated human Mars exploration base in the Canadian Arctic. He is the author of more than 200 technical and non-technical papers and numerous books, including The Case for Mars, The Case for Space, and The New World on Mars.

Building the Road to Mars: The State of the Society and What Comes Next

James Burk, Executive Director, The Mars Society

The Mars Society stands at an inflection point. As global interest in human Mars exploration accelerates and new players enter the arena, the organization is evolving to meet the moment with expanded programs, deeper partnerships, and modernized infrastructure across every dimension of its mission.

This talk provides a comprehensive look at the Society's progress over the past year and the strategic direction ahead. On the analog research front, the 2025-26 MDRS field season has delivered significant campus upgrades, a successful community-funded solar overhaul, and continued growth as part of the World's Biggest Analog initiative. FMARS operations on Devon Island have drawn renewed institutional interest, with partners like The Aerospace Corporation sending crew for Arctic analog research. The 2026 University Rover Challenge shattered participation records, with 116 teams from 18 countries competing for 38 finalist slots.

Beyond the stations, the Mars Technology Institute is taking shape as a vehicle for applied research and workforce development. New institutional partnerships are broadening the Society's reach into crew preparation, habitat technology, and international collaboration. The fifth annual International Mission to Mars Design Competition continues to grow our pipeline of young engineers and advocates. And behind the scenes, investments in volunteer governance, digital infrastructure, and AI-assisted operations are positioning the organization to scale its impact without losing the grassroots energy that has defined it for nearly three decades.

This is your invitation to see where we've been, where we're going, and how you can help us get there.

Plenary: Humphrey "Hoppy" Price

Humphrey "Hoppy" Price, Chief Engineer, Robotic Mars Exploration Program, NASA Jet Propulsion Laboratory

Humphrey "Hoppy" Price is Chief Engineer of NASA's robotic Mars Exploration Program at the Jet Propulsion Laboratory and was the architect of JPL's minimal architecture for sending humans to Mars.

Over a JPL career that began in 1978, he served as Project System Engineer for the GRAIL mission to map the Moon's gravity field, Configuration Engineer for the Cassini Saturn orbiter, Flight System Engineer for the Prometheus/JIMO Phase A project, and supervisor of the systems engineering group for Entry, Descent, and Landing on the Mars Exploration Rovers project. He has led and participated in many formulation studies of spacecraft and advanced propulsion systems, including Mars Sample Return, interstellar missions, solar sails, and fusion rockets.

He holds an M.S. in Nuclear Engineering from the University of Texas at Austin. He decided to become a "spaceman" in the fourth grade after staying home from school to watch the first close-up images of Mars from Mariner 4.

Consilience. The Life Living Today in Martian Soils

Dr. Steven Benner, Distinguished Fellow, Foundation for Applied Molecular Evolution

Dr. Steven A. Benner is an American chemist and Distinguished Fellow of the Foundation for Applied Molecular Evolution, which he founded in 2005 along with The Westheimer Institute of Science and Technology. He earned his B.S. and M.S. in Molecular Biophysics and Biochemistry at Yale University and his Ph.D. in Chemistry at Harvard University, and has held professorships at Harvard, ETH Zurich, and the University of Florida, where he was the V.T. & Louise Jackson Distinguished Professor of Chemistry.

Benner and his colleagues were the first to synthesize a gene encoding a protein, launching the field of synthetic biology. He created the field of paleogenetics, in which genes and proteins from extinct organisms are resurrected to understand how they functioned, and was the first to make DNA with more than four nucleotide building blocks, expanding the genetic alphabet from four letters to twelve. His work on the origin of life and the chemistry of early Mars has made him a leading voice in the question of whether life began on the Red Planet.

He has also founded the companies EraGen Biosciences and Firebird BioMolecular Sciences LLC.

Chiral Labeled Release: An Experiment to Irrefutably Prove Extant Microbial Life on Mars

Ron Levin, Raytheon Technologies (RTX)

In 1976, my father Dr. Gilbert Levin, a principal investigator on the Mars Viking lander, discovered extant microbial life on the Martian surface. His experiment, Labeled Release (LR), met all of NASA's prelaunch criteria for declaring a positive result. On Mars the LR gave positive results at both landing sites separated by two thousand miles. Control runs using heat sterilized soil were negative at both sites. The LR experiment has been tested on thousands of terrestrial soil samples yielding no false positives and no false negatives, a perfect Receiver Operating Characteristic (ROC) curve. Debated for years, this comprehensive result has not gained wide acceptance. My father devised a new experiment to provide irrefutable proof of Martian biology called the Chiral LR. This experiment uses mirror image molecules to separate biology from chemistry. In 2023 SpaceX liked the idea so much that they promised a free ride

to Mars on an early StarShip mission. Using the LR with chirally separated media will provide the absolute proof or extant life that the scientific community has been waiting for.

Solar System Internet

Dr. Vint Cerf, Tolero Networks

Dr. Vinton G. Cerf is widely recognized as one of the "fathers of the Internet." With Robert Kahn he co-designed the TCP/IP protocols and the architecture of the Internet, work for which the two received the 2004 A.M. Turing Award, the highest honor in computer science, as well as the U.S. National Medal of Technology and the Presidential Medal of Freedom.

Cerf holds a bachelor's degree in mathematics from Stanford University and master's and doctoral degrees in computer science from UCLA. During his time at the U.S. Defense Advanced Research Projects Agency (DARPA) he led the development of Internet and Internet-related data packet and security technologies. As vice president of MCI Digital Information Services he led the engineering of MCI Mail, the first commercial email service connected to the Internet. In 1992 he and Kahn founded the Internet Society, and from 2005 he served as vice president and Chief Internet Evangelist at Google.

For more than two decades Cerf has worked with NASA's Jet Propulsion Laboratory on the Interplanetary Internet, extending delay- and disruption-tolerant networking across the solar system. He is now a founder of Tolero Networks, a Mars Technology Institute company building the Solar System Internet, which he unveils in this plenary.

Evening Talk: David Brin

David Brin, Author

David Brin is a scientist, speaker, technical consultant, and world-renowned author. Born in Glendale, California, in 1950, he earned a B.S. in astrophysics from Caltech, an M.S. in electrical engineering (optics) from UC San Diego, and a Ph.D. in space physics from UC San Diego in 1981.

Brin worked as a research engineer at Hughes Aircraft Research Labs, taught physics and writing at San Diego State University, and was a fellow at the California Space Institute and at the Jet Propulsion Laboratory, where he studied spacecraft design, cometary physics, and the likelihood of life in the universe.

His novels have been New York Times bestsellers and have won multiple Hugo, Nebula, and other awards. His 1989 ecological thriller Earth foreshadowed global warming, cyberwarfare, and the World Wide Web, and his bestseller The Postman was the basis for a major motion picture. His Uplift series remains among the most influential works of modern science fiction. He lives in San Diego, California.

Designing a Human Mars Campaign Using Current Technologies

Dr. Jim Green, Former NASA Chief Scientist; CEO, Space Science Endeavor

Dr. James L. Green served NASA for 42 years, retiring in December 2022 after serving as the agency's Chief Scientist from 2018 to 2022. He was the longest-serving Director of NASA's Planetary Science Division, leading it from 2006 to 2018. Under his leadership the agency flew the New Horizons flyby of Pluto, MESSENGER to Mercury, Juno to Jupiter, GRAIL to the Moon, Dawn to Vesta and Ceres, and landed the Curiosity rover on Mars.

Green received his Ph.D. in physics from the University of Iowa in 1979 and worked at Marshall Space Flight Center and Goddard Space Flight Center, where he was deputy project scientist on the IMAGE, WIND, and POLAR missions. Early in his career he was also a safety diver in the Neutral Buoyancy Simulator supporting NASA's crewed spaceflight program, logging more than 150 dives.

His honors include the Arthur S. Flemming Award, Japan's Kotani Prize, NASA's Exceptional Achievement Medal for the Pluto flyby, and NASA's Distinguished Service Medal. Asteroid 25913 Jamesgreen is named in his honor. He is now CEO of Space Science Endeavor.

Evening Panel: Did Life Begin on Mars?

Panelists: Dr. Steven Benner, Ron Levin, and Dr. Robert Zubrin. Moderated by Ashton Zeth.

Dr. Steven Benner, Distinguished Fellow, Foundation for Applied Molecular Evolution

Dr. Steven A. Benner is an American chemist and Distinguished Fellow of the Foundation for Applied Molecular Evolution, which he founded in 2005 along with The Westheimer Institute of Science and Technology. He earned his B.S. and M.S. in Molecular Biophysics and Biochemistry at Yale University and his Ph.D. in Chemistry at Harvard University, and has held professorships at Harvard, ETH Zurich, and the University of Florida, where he was the V.T. & Louise Jackson Distinguished Professor of Chemistry.

Ron Levin, Raytheon Technologies (RTX)

Ron Levin is an engineer at Raytheon Technologies and the son of the late Dr. Gilbert Levin, Principal Investigator of the Viking Labeled Release experiment, which returned a positive response for metabolism on Mars in 1976. He continues to advocate for a definitive follow-up test, the Chiral Labeled Release experiment, which he presents in his Thursday plenary.

Dr. Robert Zubrin, President, The Mars Society

Dr. Robert Zubrin is the founder and President of The Mars Society and President of Pioneer Astronautics, a private company that conducts research and development on innovative aerospace technologies. A nuclear and astronautical engineer, he holds a master's degree in Aeronautics and Astronautics and a Ph.D. in Nuclear Engineering from the University of Washington.

Ashton Zeth, Host of Red Planet Live, The Mars Society

Ashton Zeth is the host of Red Planet Live, The Mars Society's live video broadcast and podcast, where he interviews planetary scientists, STEM experts, commercial space leaders, and advocates about the work being done to make human exploration and settlement of Mars a reality. The show offers a raw, off-the-cuff look at all things Mars, covering space exploration, STEM education, astrobiology, and the aerospace industry.

Afternoon Breakout Sessions

Breakout talks run 25 minutes plus 5 minutes of Q&A.

Lunar and Martian Regolith Simulants Differentially Influence Microbial Viability and Stress-Related Gene Expression

Solange Massa, EcoAtoms

Complete title: Lunar and Martian Regolith Simulants Differentially Influence Microbial Viability and Stress-Related Gene Expression (but we could not submit because it was too long) With human exploration advancing beyond low Earth orbit, microorganisms in crewed habitats and bioregenerative systems will interact with extraterrestrial surface materials. Limited data exist on how distinct lunar and Martian regolith analogs affect microbial physiology and molecular adaptation. This study examined two lunar simulants (South Pole highland LSP-2 and mare LMS-1E) and two Martian simulants (JEZ-1 and MSG-1, with or without 0.5% calcium perchlorate tetrahydrate) using Escherichia coli and Saccharomyces cerevisiae. Viability was tracked by CFU counts over 30 days; RT-qPCR measured expression of genes linked to oxidative stress (soxS, YAP1), biofilm/adhesion (csgA, FLO11), nutrient scavenging (DAL5), and the stringent response (spoT). LMS-1E produced the most persistent viability reductions in both species, while LSP-2 caused only transient declines followed by recovery. Martian simulants had subtler effects, and perchlorate addition produced limited impacts under the tested conditions. Transcriptional changes were stronger in E. coli than in yeast; soxS showed the most consistent modulation across simulants, pointing to oxidative stress as a key response. Biofilm and nutrient-related genes varied more by simulant type. Microbial responses were driven more by the physicochemical properties of individual regolith analogs than by planetary origin. This comparative analysis of physiological and molecular endpoints across multiple lunar and Martian simulants informs Artemis and Mars missions, bioregenerative systems, and planetary protection.

InterPlanetary Atomic Swaps as a Settlement Primitive for the Earth–Mars Economy

Lennart Lopin, The Marscoin Foundation

Every financial transaction in human history has occurred within one light-speed boundary. Mars breaks that assumption. The 3–22 minute one-way delay, together with two-week solar conjunction blackouts every 26 months, makes centralised exchanges and custodial bridges structurally unviable for Earth–Mars commerce. This paper argues that the correct primitive already exists and has since 2013: the on-chain Hash Time-Locked Contract (HTLC). We call its interplanetary specialisation the InterPlanetary Atomic Swap (IPAS). The cryptographic atomicity of an HTLC is distance-agnostic: the hash does not know what planet its preimage was revealed on, and block-height timelocks do not require the two chains' wall clocks to agree. Its operational safety, however, is distance-sensitive: refund windows, monitoring latency, fee buffers, and conjunction handling must be sized against the physics of the link. We present (i) a two-domain systems model in which Earth and Mars maintain locally-validating chains linked only by delayed cross-chain observation; (ii) a timeout-sizing inequality with numerical values for close-, average-, far-, and conjunction-spanning orbital regimes; (iii) the destination-address construction that turns a bilateral swap into a three-party commerce primitive without a third trusted role; (iv) a bandwidth analysis showing a Mars settlement can mirror Bitcoin at ≈9MB/hour; and (v) a critical comparison with the Lightning-based proposal of Puente and Puente [2025], arguing that on-chain HTLCs are simpler, more transparent, and better suited to Mars than off-chain channels. The paper is anchored to an existence proof: on 12 April 2026 the Marscoin Foundation completed the first mainnet BTC↔MARS atomic swap using 4h/8h timelocks. IPAS extends those parameters - a configuration change, not a protocol change - to 72h/144h at average Earth–Mars distance and multi-week windows across conjunction. For a civilisation in which physical cargo takes months between planets, a six-day financial settlement is effectively instant.

MARIE: Maximizing Artemis's Resource and Infrastructure Efficiency

Stewart Peterson, Midwest Applied Physics

Proposed architecture to update NASA DRM 5.0 for distributed launch is presented. One SLS, two New Glenn, and 22 Falcon Heavy launches place Skylab B and ISS Node STA, with ISS systems and ISPR attach fixtures, into orbit around Mars, using Orion as crew transfer vehicle and Blue Moon Mark 2 as landing vehicle. JPL MSL parachutes and TPS on new aeroshell cut Blue Moon descent propellant use by 94%; use of Skylab systems during 500-day quiescent period and reprovisioning of Orion ECLSS from Skylab cuts consumables to be carried by Orion to 140-day minimum. Anything not needed during coast phase (VEEGA trajectory) is pre-positioned in Mars orbit via HTV-XG (for ISPRs) and Cygnus (for consumables) along with comsats and relay at Sun-Mars L5; scientific analysis equipment in ISPRs serves as a "flying base," replacing Apollo's Lunar Receiving Lab; crew operates this equipment during 500-day orbital mission. Orion main propulsion system is replaced with Apollo SPS and performs Skylab orbit insertion burn; tankage added to Cygnus allows Orion to be reprovisioned for departure burn without a new departure stage. Analogous system to be placed around the Moon to test science hardware, comsats, and reprovisioning operations, using one SLS to launch MSFC's stored S-IVB (#211) and 11 Falcon Heavy vehicles to launch modified Dragon for crew and cargo, ISPRs on HTV-XG, hypergolic propellant on Cygnus, and modified copy of Apollo LM with MSL avionics as landing vehicle. This eliminates Starship and cryogenic propellant transfer from Artemis critical path while not precluding their use if available. Architecture eliminates LOR black zones and increases lunar surface crew utile time by a factor of 9 over Apollo and a factor of 60 over Artemis while introducing no new hazards and requiring no new major program elements.

Moon First, Mars in the 2040s? We Are Martians, Not Moonies

Edward Heisler, Mars Society Ambassador

For more than five decades, Americans have heard explanations for why human exploration of Mars must wait. The latest is the Trump–Musk–Isaacman "Moon first, Mars later" strategy: astronauts must spend years operating from a lunar outpost before it will be safe or practical to send humans to Mars. This presentation challenges that argument. The Moon is closer to Earth, but that does not automatically make it safer or more survivable for humans than Mars. An open-ended lunar program could become another decades-long detour rather than a stepping-stone to the Red Planet.

A second danger is growing public disillusionment with Elon Musk's erratic behavior and political divisiveness. Some critics now say they cannot support SpaceX or Starship as long as Musk remains involved. But Starship is far greater than any one individual. Thousands of engineers, scientists, technicians, construction workers, and other skilled employees are designing, building, testing, and improving this extraordinary vehicle. Gwynne Shotwell and SpaceX's experienced leadership provide essential operational knowledge and stability.

Mars advocates should neither excuse Musk's mistakes nor abandon Starship. We can criticize poor technical decisions and divisive conduct while continuing to support the SpaceX workforce and Starship's historic potential. Musk should provide the necessary funding and resources; the Starship team should be empowered to do the work. Musk has also made decisions that deserve criticism. One example was launching Starship without a flame trench and a fully developed water-deluge system. The resulting damage to the launch site contributed to delays and extensive reconstruction.

We can criticize Musk when criticism is deserved while still supporting the thousands of people working to make Starship successful. Wanting SpaceX to succeed does not mean approving everything Elon Musk says or does.

After more than fifty years of delay, it is time to choose Mars—and go.

On to Mars!

A Calendar System for Mars: Customizing Timekeeping for the Red Planet

Hal Fulton, Open Space Foundation

Despite the fact we have not yet visited Mars, more than seventy calendar systems have been proposed. Designing a Martian calendar turns out to involve more than astronomy: it raises questions of engineering, psychology, culture, software, and the long-term identity of a future planetary civilization.

This talk surveys several major approaches to Martian timekeeping, including scientific mission clocks, stretched-time systems, decimalized proposals, fixed-week calendars, and culturally neutral systems. It then introduces the Martian Common Era (MCE) calendar as a case study in human-centered calendar design.

The MCE system attempts to balance mathematical simplicity with cultural familiarity through a 24-month structure, a Mars-specific leap-year system, retention of the seven-day week, and an epoch aligned near the terrestrial Common Era. The presentation also examines alternate approaches to Martian clock time, including stretched clocks and extended-day systems.

Beyond mechanics, the talk explores broader questions future settlers may face: Should Mars preserve Earth traditions or create entirely new temporal systems? How do holidays, birthdays, weekends, and seasonal rituals evolve on another world? What tradeoffs exist between elegance, scientific precision, and everyday human usability?

Drawing on both historical calendar design and practical software implementation experience, this presentation argues that a standard calendar system may become one of the earliest and most important cultural infrastructures of a permanent human civilization on Mars.

It's Getting Real: China, Artemis and the Race to the Moon

Art Harman, The Coalition to Save Manned Space Exploration

Artemis II was a great success, and Artemis III is now being stacked. The SLS and Orion for Artemis IV may be ready in two or three years. But can SpaceX and Blue Origin have their landers ready for use before China claims the strategic south pole as theirs? What are the greatest challenges Starship must overcome? New Glenn got set back by a year or more with their pad explosion--can they test their lander in time to be in competition? What are the critical points for both? Another key element is the readiness of the Axiom lunar surface spacesuits. China is breaking out with amazing test successes for their Long March rocket, their capsule, their Apollo-like lander—and even reusing their boosters. Could China do an Artemis-I-like mission early next year? And an Artemis-II-type crewed mission later that year? How about a crewed landing two years from now? Why do they want to beat us? There are a great many elements and risks with readying Artemis IV. And potential political risks if the next president once again cancels or infinitely delays the return to the Moon. Who will win—and does it really matter anymore? Is the Chinese threat more than trivial? You will get an analysis about the Chinese lunar program including the tell-tales to watch for, their threats to the free world and commercial exploration of the Moon—and Mars, and the immense challenges that face both SpaceX and Blue Origin to land and return our astronauts. I will also make the case that prioritizing a continuing presence on the Moon will help forestall a Chinese territorial claim. Lessons learned on the Moon will also make Martian missions and colonies safer and more successful.

Autonomous High Efficient Solar-Powered UAV for Atmospheric Reconnaissance

Vishak Meenachi, Little Rock Central High School / University of Arkansas, Little Rock

As human settlement and robotic exploration of Mars expand, the demand for high-resolution aerial mapping, localized weather tracking, and rapid surface reconnaissance beyond the range of ground rovers becomes critical. This paper presents the design, aerodynamic integration, and power architecture of an ultra-lightweight, autonomous solar-powered Unmanned Aerial Vehicle (UAV) optimized for low-density atmospheric flight.

To address the severe aerodynamic constraints of operating in low atmospheric pressures while maintaining positive energy margins, the platform incorporates a high-efficiency photovoltaic surface array paired with a low-voltage (2S) energy storage system. Parasitic drag is minimized through structural integration techniques, including flush-mounted navigation modules and a low-profile folding propeller mechanism driven by a high-KV brushless propulsion system.

Flight control and navigation are managed via an isolated-rail Pixhawk autopilot architecture, separating high-frequency telemetry link processing from primary actuator power to ensure fault-tolerant autonomous operation. Simulated and localized flight testing data demonstrate that the optimized power-to-drag profile significantly extends flight endurance and loiter time.

This research highlights a scalable, low-cost framework for deploying persistent aerial sensing platforms on Mars, bridging the operational gap between orbital satellites and surface rovers

Cancer as a Design Constraint for Human Settlement of Mars

Samuel McKee, University of Cambridge

Human exploration of Mars is moving increasingly from a mission architecture problem to a settlement architecture problem. Whilst considerable attention has been devoted to propulsion, life support, radiation shielding, and utilization of in-situ resources, comparatively little attention has been given to cancer as a fundamental constraint upon the long-term viability of human settlement beyond Earth. Here I shall argue that cancer should be considered an expected operational challenge rather than a rare medical contingency in permanent Martian populations. Exposure to galactic cosmic rays and solar particle events, combined with different gravity, environmental stressors, and extended mission durations, is expected to increase cumulative genomic damage and elevate cancer risk over time. For settlements intended to last decades or generations, the emergence of cancer cases is not a question of if, but when. Drawing on current knowledge of DNA damage, DNA repair pathways, hereditary cancer predisposition, and genomic medicine, this paper examines how cancer risk may influence the design of future Martian settlements. Particular attention is given to genomic screening, precision medicine, radiation-resistant habitat design, longitudinal health surveillance, and ethical implications of genetic risk stratification in astronaut populations. This paper further proposes that future Mars settlements will require medical capabilities extending beyond emergency care and trauma management to include cancer prevention, detection, molecular diagnostics, and personalized therapeutic strategies. Within this framework, genomic medicine becomes a critical component of settlement infrastructure rather than merely a supplementary healthcare service. Understanding cancer as a "design constraint" provides a new perspective on the biological limits of human expansion into the Solar System and highlights the importance of integrating biomedical resilience into how we plann sustainable extraterrestrial communities.

Property Rights for Space Colonists

John Amabile, Writer

Why has the United States failed to colonize Mars despite 80 years of progress with space technology?

By looking at successful colonization efforts on Earth, particularly England's colonization of the United States, we can identify the legal, technological, and economic differences between the consistent and successful colonization of Earth versus the stalled colonization of Mars.

We have not been able to colonize Mars because the Outer Space Treaty removed property rights from Martian colonists and their investors. Colonization on Earth has always been tied to real estate development, from Polynesians to the British Empire. The Outer Space Treaty also banned the use of nuclear weapons in space, including the use of nuclear devices for civil engineering projects. Ice-moons, comets and asteroids could be quickly broken apart and pushed into Mars to modify the planet's topography and terraform it. Virginia started as the Virginia company, and we should not expect Mars to be different.

We can profitably terraform Mars in less than 100 years, if we privatize it and allow the use of nuclear devices to move terraforming material around Solar System 1.

I would love to give a short presentation on my historical and technical research at the Mars Society Convention.

Sincerely, John Amabile 9102245358

Engineering Design Considerations for a Martian Autonomous Controlled Environment Growing-Living Space

Peter Vorobieff and David F. Menicucci, University of New Mexico

If current trends hold, humans will set foot on Mars within 15 years, followed by a human colony before 2075. The University of New Mexico Mechanical Engineering Department has begun the engineering design for the structures that will comprise the Mars base.

Energy is a key requirement for a Martian habitat, where the sun is the primary indigenous energy resource. While the solar constant on Mars is about 40% of that on Earth, the surface resource near the equator, averaged over a Martian year (~669 sols), is about half of Earth's. Solar energy has powered space vehicles and some of the Mars rovers for decades. It is the most feasible primary energy source for controlled-environment habitat structures, with passive solar technology offering several advantages: it is well-developed for growing and living spaces on Earth, is low-maintenance, and can use vernacular materials.

We present a design approach to passive solar structures suited to the Martian environment. We discuss the specific requisites for such structures and the current state of the technology, noting that the efficiency of converting solar radiation to thermal energy makes passive solar superior to photovoltaics for habitat temperature management. In passive buildings, solar radiation enters through a glazed surface and heats the insulated interior thermal mass, which then releases the stored energy into the structure overnight.

These structures can utilize the natural environment, for example, by being partially bermed into the interior wall of a crater to manage heat loss and to capture reflected radiation from adjacent, white-painted crater walls. Design considerations include siting, material needs, environmental management

and requirements, transportation methods, construction techniques, water extraction and synergies with other habitat requirements, such as radiation protection. Design-for-reliability requirements and methods are also addressed.

Space Philosophy: Ethics of Exponential Technologies in Space Medicine

Dr. Maria Harney, Scientist

As humanity advances toward sustained exploration and settlement of Mars, exponential technologies, such as gene editing, neural augmentation, AI-assisted diagnostics, and autonomous medical systems, will become crucial for survival in deep-space environments, even as they blur the boundary between therapeutic intervention and human redesign. These capabilities introduce unresolved ethical tensions: who bears moral responsibility when AI systems perform triage or life-support decisions under communication delays? How should closed ecological systems allocate scarce medical resources without compromising human dignity and autonomy, particularly in AI-mediated triage protocols and radiation-adaptive biomedical interventions?

Drawing on Aristotelian hylomorphism, Kantian accounts of rational agency, and contemporary neuroethics, this paper argues that space medicine is not simply a clinical practice but a form of civilizational design. Technological capacity is advancing more rapidly than the ethical frameworks required to govern its use, necessitating deliberate philosophical integration into mission planning, crew training, and institutional governance. Core principles of human dignity, accountability, and practical wisdom, must guide decision-making while remaining adaptable to the constraints of small crews and emergent settlements. The norms established in extraterrestrial medicine will shape not only off-world survival, but the moral trajectory of humanity itself.

CIRES: A Sustainable, Scalable, Evolvable, Closed Loop Life Support System

Donald Jacques, EarthSeed

EarthSeed, Inc has spent the last 15 years in the search for and development of a closeable, ecologically sustainable, and scalable habitat life support system. This is a system to not only recycle resources, but grow a wide variety of food products - including meat protein. While developed here on Earth, the architecture can be adapted to the Moon, and Mars. CIRES, Compact Intensive Regenerative Ecological System, is a scalable, ecologically based architecture built on natural symbiotic relationships. As a Constructed Ecological System, each selected species contributes to and draws sustenance from the system. This circular economy offers near-complete closure of key ecological cycles with minimal Earth-reliance. Scalability is achieved by incrementing core resources: water, energy, biomass, and working space. As populations naturally expand to fill the available footprint, the overall capacity increases, allowing larger species to be integrated at production volumes that support them. I will present the full architecture, list the species and their relationships, and discuss how to scale the system to support not only a small team of astronauts, but grow to support a community, or more.

Postcards from Mars: Bright Views for Humans!

Holger Isenberg, Areo Info

Most Mars images shown in public taken on the surface during various robotic landing missions present an almost hostile-looking environment, with dark low contrast colors under a smog-like overcast butterscotch-brown sky. Such an environment would have health implications on human explorers like it is known as seasonal affective disorder on Earth. To prepare for the first human landing, ground truth is

needed, but usable primary data about the sunlight spectral conditions on the surface was never collected by any NASA mission. Fortunately, individual camera component data is available, like the camera sensors' spectral sensitivity functions, which allow applying professional photographer's standard software on the raw image data. The resulting surprisingly crisp clear colors and bright sky shown in this presentation provide a much different new image of Mars, almost inviting for humans. Most images shown here are taken by the engineering cameras on NASA Perseverance Rover, some from Curiosity Rover and some from the Viking Landers 50 years ago in 1976.

Note: Would also fit into the Human Exploration track. I'll also bring a poster.

The Road to Mar$ Goes Mainly Through the Moon

Darrin Taylor

The prime metric of mars colonization is tons delivered per synod.

Mars has a 26 month synod and the moon is reachable in 2 weeks round trip.

A many times reusable rocket suitable for Mars that has rapid reusability, and low cost will inherently be better at depositing mass on the moon than Mars because of the roughly 50 to 1 difference in moon round trip vs Mars.

This talk will examine how to get mass to Mars below $100/kg and potentially at $0/kg. It will also explore how Moon solar economics will allow cheaper solar on the moon than on the Earth. This is possible because the moon has a 1.3x intensity advantage and a 2.18 more available sunlight because the moon has 50% duty cycle and best Earth has about 5.5/24 hours. This gives 2.83X advantage to the moon regarding solar. 3kw/kg solar reduces the cost of carrying solar to the moon to the point that is is no longer a sizable addition in cost per watt.

This talk will explore a method to get Moon mass delivered at $25/kg and how this will permit an average delivery to the moon of 1 Million tons per year and an average of 20 thousand tons to mars per year. All on a US budget ongoing of $50B/yr and a one time buy down of $800B.

It will discuss how the moon has a inherent value of $750 trillion dollars per year once it is 80% covered in solar. Focusing on moon development first will colonize Mars faster than any alternative because it meets the primary metric of more mass to mars per synod.

Harnessing Star Power: A Public Trailer and Highlight Reel for The Case for Nukes (film)

Michael Strickland, MD

Robert Zubrin's 2023 book, The Case for Nukes (along with The Case for Space, 2019) constitutes a profound, encompassing vision and blueprint for a brighter future for humanity. In response to his call for outreach, our Emmy Award-winning documentary and public relations team launched a global outreach initiative designed to address widespread fear surrounding “all things nuclear” and replace it with curiosity, understanding, and informed public engagement. To that end, we interviewed Dr. Zubrin, along with Dr. Dennis Whyte, then director of MIT fusion research, and Andrew Holland, founder/CEO of the Fusion Industry Association; released in October 2024 as a short video series on our Youtube channel, at harnessingstarpower.com. In December 2025, we published a companion guide: Energy Economics and the Power of Freedom. To date these videos have obtained more than 10.5 million views.

In March of 2026, we attended the sold out FIA annual policy conference in Washington, D.C. A number of presenters, including IAEA director Rafael Grossi, concluded their remarks by noting that some of the main problems remaining to be solved include overcoming the public's ingrained fear of all things nuclear, educating them on the differences between fission and fusion, and sparking an interest among younger people in studying and entering these fields, and their related supply chains. These are all among the intended goals of our effort, and I spoke with Director Grossi and many others to this effect.

I hope here at the Mars Society to provide professional attendees with a tool that might be used to reach out to those outside of their technical fields, in addressing some of these concerns, and to stimulate further refinement and improvement of this message to the world at large.

High Temperature Nuclear for Lunar and Martian ISRU

Dr. Kevin Hickerson, The Earthineering Company

In-situ resource utilization (ISRU) on the Moon and Mars starts off by the need for heat. Lunar and Martian regolith contains water, oxygen, common metals, and critical minerals all needed for constructing a base. But extracting these all require molten regolith, which requires temperatures exceeding 1400ºC. While nuclear reactors have the best weight to power or any energy source, the production of electricity adds a significant weight burden of radiators and Carnot loss. Electrical generation on the Moon requires additional launch burdens for power converters and massive radiators to provide a cold dump in the Carnot cycle. A better approach is to use heat directly, at a temperature high enough to melt regolith directly. The Earthineering Company is developing a reactor that will meet this need using advanced alloys and TRISO fuel that can safely reach these temperatures without melting. This very-high-temperature gas-cooled reactor (VHTGR) architecture uses helium heat transport to deliver direct high-temperature process heat to lunar industrial systems. Access to abundant molten regolith on the Lunar and Martian surface will allow humanity to start small, building bricks and structures, extract water, oxygen and hydrogen, and eventually mine for critical minerals, helium-3 and rare elements. Earthineering's process-heat-first reactor architecture could support a wide array of industrial applications, including the production of landing pads, berms, shielding, and construction materials. By using direct nuclear heat, the system enables regolith melting and vitrification, oxygen-bearing mineral processing, and thermal conditioning of regolith for volatile release. This architecture provides a significant advantage for payload delivery, as the design targets a 4x–8x mass advantage for equivalent heat output in launch cost savings per deployment.

If Starship Underachieves: Alternative Orbital Refueling Ideas for Mars Missions

Ben Switala

This presentation proposes a hybrid Mars-transfer architecture that combines a modestly redesigned Falcon Heavy upper stage (termed “Franken Heavy”) with limited Starship tanker support to deliver up to ~45–50 metric tons per launch to trans-Mars injection (TMI). The concept explores at least three variants of the Franken Heavy. In all of the variants, the upper stage of Franken Heavy is launched from Earth minimally fillled to increase payload mass to low-earth orbit. In two of the variants, extra fuel capacity is included by various means in the upper stage. In all of the variants, a single Starship tanker fully refuels Franken Heavy in low Earth orbit before Franken Heavy departs for TMI.

This architecture is motivated by operational concerns surrounding full Starship refueling, which may require 10–15 tanker flights per mission—an approach that compounds risk, cadence pressure, and mission-level reliability. By contrast, Franken Heavy leverages proven Falcon hardware, accepts the need

for longer Merlin Vacuum burns, and uses Starship only in a limited, near-term-achievable role as a bulk propellant provider.

A fifty-ton payload to TMI is about three times more than what a conventional Falcon Heavy can achieve. This could result in about ten tons of useful payload landed on the surface of Mars – a tenfold increase of the maximum useful payload ever landed on the surface (the current record is about one ton, the Perseverance rover). Additionally, this architecture presents opportunities in comparison to Robert Zubrin's proposed Small Falcon Ship and Dragon Direct concepts.

This study argues that a refueled, moderately redesigned Falcon Heavy could serve as a pragmatic bridge architecture for early Mars cargo delivery while Starship matures.

Friday, October 23

Day 2 of the 2026 International Mars Society Convention

Schedule

Plenary and Evening Program, Grand Trojan Ballroom

Time	Session	Speaker
8:00 AM	**Registration & Doors Open**	
9:00 AM	**Plenary**	Garrett Reisman, USC; Former NASA Astronaut
9:30 AM	**Plenary**	Dr. Ashwin Vasavada, Curiosity Project Scientist, NASA JPL
10:00 AM	**Plenary (one hour)**	Tim Ellis, Co-founder, Relativity Space
11:00 AM	**Flashline Mars Arctic Research Station Crew 19 Mission Panel**	Moderated by Ashton Zeth, Host of Red Planet Live, The Mars Society
11:30 AM	**Rethinking Electric Propulsion with Naphthalene**	Jonathan Huffman, Orbital Arc (Mars Technology Institute)
12:00 PM	**Lunch Break**	
1:00 – 5:00 PM	**Afternoon Breakout Sessions**	See breakout schedule below
7:00 PM	**How High the Moon, Why Not Mars?**	Dr. Lawrence Kuznetz
7:30 – 9:00 PM	**Networking Evening**	Grand Trojan Ballroom

Afternoon Breakout Sessions, 1:00 to 5:00 PM

Time	Room 1: Grand Trojan Ballroom	Room 2: TCC 350/351	Room 3: TCC 450 (Forum)
1:00 PM	**Mars Technology Institute Company Talk: Unleashed Robotics** *Quinn Morley*	**Alignment Over Enforcement: Cognitive Design for Early Martian Civilisation** *Bonnielee Cameron, The Safe Haven Sanctuary*	**Mars Transit Direct** *Darian Phillips*
1:30 PM	**Water First: Building a Supply Chain Beyond Earth (Mars Technology Institute company talk)** *Pete Freeland, Deep Space Logistics Systems*	**Project ARES: A Roadmap for a Large-Scale Martian Colonization Program** *Dennis Silin*	**Growth Potential of Salad Crops in Simulated Martian and Lunar Regoliths** *Avetis Shahbazyan, California State University, Northridge*
2:00 PM	**Using Harnessed AI to Accelerate Scientific Discovery, Engineering and Space Operations** *Robert Mills*	**A New House on Mars: A Strategy to Make Mars Settlement Easier, with a Beginning Launch by 2028** *Lawrence T. Beckerle, former Adjunct Professor, Glenville State College*	**Neo-Derinkuyu: An Autonomous Underground Mars Habitat Design Driven by AI Algorithmic Infrastructure** *Onur Çakır*
2:30 PM	**Materials by Prediction: Why Mars Can't Afford Trial and Error** *Michael Rudolph, Velar Scientific*	**Mars: The Path for Peace on Earth** *Danny Quintana*	**Biological Sentinel Networks for Early Detection of Mars Habitat Instability** *Anshul Modi and Saahil Modi*

Time	Room 1: Grand Trojan Ballroom	Room 2: TCC 350/351	Room 3: TCC 450 (Forum)
3:00 PM	**BioPills: Engineering a Portable Microbiome for In-Situ Soil Regeneration, from Earth to Mars** *Melissa Esquivel Solano*	**2026 Mars Society Chapters Update** *Ron Storie, Director of Chapters and Membership, The Mars Society*	**Increasing Power-to-Calorie Efficiency with Non-Photosynthetic Food Technologies** *Bill Maloney, Maloney Space Research*
3:30 PM	**Considerations of Building a Dyson Sphere for Our Solar System** *Dr. Wilson Hago, Hago Energetics*	**The Year of Earth and Space (YES)** *Jerry Edling*	**Direct to Mars in 40 Million Kilocalories** *Abbie Watson*
4:00 PM	**Agentic AI: The Essential Infrastructure for Sustainable Mars Settlement and Planetary Civilization** *Matthew Douglas, Founder & Chief Architect, KISOS*	**Fun and Fund: The Nineteen-Year Quest to Make Mars Worth Owning** *Lisa Ice, Mars Territory*	**Mars Against Hunger Finalist** *Davi Souza*
4:30 PM	**Comet Impact Terraforming** *David Ong, PhotonBytes*	**Human Mars Expedition: When Will We Go?** *Madhu Thangavelu, USC*	**Mars Against Hunger Finalist** *Lawrence T. Beckerle*

Plenary and Evening Program

Grand Trojan Ballroom

Plenary: Garrett Reisman

Dr. Garrett Reisman, Professor of Astronautical Engineering, USC; Former NASA Astronaut

Dr. Garrett Reisman is a Professor of Astronautical Engineering in the Viterbi School of Engineering at the University of Southern California and a Senior Advisor at SpaceX. He attended the University of Pennsylvania and received his Ph.D. from Caltech in 1997.

Selected by NASA as a mission specialist astronaut in 1998, Reisman flew to the International Space Station aboard Space Shuttle Endeavour in 2008 for a 95-day expedition, returning on Discovery, and flew again aboard Atlantis in 2010. Across these missions he performed three spacewalks, operated the Station's robotic arm, and served as a Shuttle flight engineer. He was also an aquanaut on NEEMO V, living for two weeks in the Aquarius undersea habitat.

After leaving NASA in 2011 he joined SpaceX, where as Director of Space Operations he helped prepare the company for human spaceflight. He stepped down from his full-time role in 2018 to join the USC faculty.

Plenary: Dr. Ashwin Vasavada

Dr. Ashwin Vasavada, Project Scientist, Mars Science Laboratory (Curiosity), NASA Jet Propulsion Laboratory

Dr. Ashwin Vasavada is a planetary scientist at NASA's Jet Propulsion Laboratory and Project Scientist for the Curiosity rover, leading the international team of scientists exploring Gale Crater. He joined the Mars Science Laboratory mission as deputy project scientist in 2004 and became project scientist in January 2015, guiding the rover's science through development, launch, landing, and more than a decade of surface operations.

His passion for planetary science began at age 10 when he saw the surface of Mars in an image from the Viking 2 lander. He holds a B.S. in Geophysics and Space Physics from UCLA and a Ph.D. in Planetary Science from Caltech.

Vasavada's research covers the climate history of Mars, the weather of Jupiter and Saturn, and polar ices on Mercury and the Moon. He has also contributed to the Galileo mission to Jupiter, the Cassini mission to Saturn, and the Lunar Reconnaissance Orbiter.

Plenary (one hour): Tim Ellis

Tim Ellis, Co-founder, Relativity Space

Tim Ellis is an aerospace engineer and the co-founder and former CEO of Relativity Space, the launch company that pioneered the use of large-scale metal 3D printing, machine learning, and robotics to build rockets in days instead of years. He founded Relativity in 2015 with Jordan Noone and led it through the development of the Terran 1 and Terran R launch vehicles.

Ellis grew up in Plano, Texas, and holds B.S. and M.S. degrees in Aerospace Engineering from the USC Viterbi School of Engineering, where he held leadership positions in the USC Rocket Propulsion Lab and

helped launch the first student-designed and built rocket into space. He completed three internships at Blue Origin and later worked there as a propulsion engineer, where he introduced metal 3D printing of rocket components.

In 2018 Ellis was named to the National Space Council Users' Advisory Group, and he has been recognized on the Forbes 30 Under 30 list.

Flashline Mars Arctic Research Station Crew 19 Mission Panel

Moderated by Ashton Zeth, Host of Red Planet Live, The Mars Society

In July 2026 The Mars Society deployed Crew 19 to the Flashline Mars Arctic Research Station (FMARS) on Devon Island in Nunavut, Canada, roughly 900 miles from the North Pole. Commanded by Trevor Jahn of The Aerospace Corporation, the five-member international crew of Trevor Jahn, Dr. Laura Thomas, Dr. Lisa Rand, Anderson Wilder, and Adrian Oberland brought expertise in engineering, psychology, behavioral science, geology, and the humanities.

During the multi-week mission the crew conducted research and field studies in exploration science, operational readiness, environmental monitoring, technology demonstration, and analog astronaut activities, operating under full Mars-mission simulation in one of the most Mars-like environments on Earth. In this panel, crew members share what they learned and how the mission advances preparations for future Moon and Mars expeditions.

Rethinking Electric Propulsion with Naphthalene

Jonathan Huffman, Founder, Orbital Arc (Mars Technology Institute)

Jonathan Huffman is the founder of Orbital Arc, a Houston-based deep-tech spacecraft propulsion startup established in 2023 and a Mars Technology Institute company. Orbital Arc is developing Gas-Phase Field Effect Electric Propulsion (Gas FEEP) thrusters and the RIOT Drive for satellites and in-space transportation.

At the heart of each Orbital Arc thruster is a chip embedded with millions of micrometer-scale, positively charged nanotips and gas channels. Naphthalene, the main ingredient in mothballs and an inexpensive refinery byproduct costing about $1.50 per kilogram versus roughly $3,000 per kilogram for xenon, flows past the tips, is polarized and ionized, and exits as thrust. The design shrinks a multi-kilogram thruster to a chip about an inch across at roughly one-eighth the mass, with calculations showing a 30 to 40 percent improvement in power efficiency.

How High the Moon, Why Not Mars?

Dr. Lawrence Kuznetz, Planetary protection Inc.

The notion that Artemis 2, etc., will pave the way to Mars from the Moon is not only unlikely but damaging. The following factors will be discussed for consideration.

The obstructionist role of the DOD and the military budget The lack of hard data backing up the claim that helium 3 and terratons of ice buried in Shackleton crater justify a lunar base The fallacy that training on the Moon and ISRU will accelerate a human program to Mars The wonton disregard of the opinions of the Giants, whose shoulders we are supposed to be standing on that Mars should be our next step not the moon The delusion that the reason for a Lunar base is science when it’s obvious it will become another Cold War race with China with extremely questionable scientific benefits The tendency to

ignore the lessons of history in programs like this The fuzzy line between space and defense related projects exhibited by the contractors who build the space launch system, Orion and the other hardware of the Artemis program The vested interest of senators and congressman to justify jobs in their congressional districts, regardless of their value even when those jobs, promote war and destruction within the same companies that are supposedly building the pieces of Artemis The failure to understand that the message of patriotism and America above all else imprinted on us as children is responsible for the friction between red and black states, as well as the friction between America, Russia, China, and other countries, and that puffing out your chest as Americans has done nothing but kill people and alienate us in the six wars and 60 years since Eisenhower warned us about the military in industrial complex

Networking Evening

Grand Trojan Ballroom, 7:00 to 9:00 PM. An informal evening for attendees and speakers to meet and connect.

Afternoon Breakout Sessions

Breakout talks run 25 minutes plus 5 minutes of Q&A.

Mars Technology Institute Company Talk: Unleashed Robotics

Quinn Morley, Unleashed Robotics

Unleashed Robotics is commercializing a NASA-funded Mars drilling technology for subsurface resource prospecting on Earth and beyond. Our patent-pending FractalMining™ approach uses swarms of autonomous drilling robots to conduct subsurface radar surveys in the most remote regions of the planet, like a telescope into the underground.

Our Borebots™ drilling technology began with a NASA Innovative Advanced Concepts (NIAC) award, a grant from one of the highest-risk and most forward-looking programs in the federal R&D pipeline. That study was to investigate deep drilling into the Martian polar layered deposits (PLDs). Since that time, the concept has matured from a single Mars study into a space-resources platform spanning three worlds: critical-minerals prospecting on Earth, water-ice prospecting on the Moon, and in-situ resource utilization of water-ice for colony-scale subsistence and fuel production, enabling continued interplanetary transit. Our technology will also enable groundbreaking astrobiological and planetary protection investigations.

Alignment Over Enforcement: Cognitive Design for Early Martian Civilisation

Bonnielee Cameron, The Safe Haven Sanctuary

As humanity advances toward becoming a multi-planetary species, current aerospace discourse naturally privileges the physical, mechanical, and logistical engineering required for transit and physical survival. However, long-term multi-planetary success heavily depends on the foundational socio-cultural framework established during early settlement. To safeguard and expand human consciousness, the initial Martian societal code must be built on alignment rather than enforcement, utilising environmental and infrastructural design to organically elevate human behaviour.This presentation introduces a blueprint for an "Organic Civilisation"—a model where goodness and cooperation function as default behaviours because of heightened conscious awareness. By operating on a psychological

clean slate free from Earth's historical geopolitical and national biases, early Martian infrastructure can be intentionally engineered to encourage internal cultivation over external extraction.The framework outlines four core, non-coercive design principles:The Architecture of Stillness: Dedicated structural public zones engineered to preserve quiet mental bandwidth.The Exploration Curriculum: Open educational ecosystems centred on cosmic history and emotional literacy.Frictionless Digital Systems: Internal communication networks designed purely to mitigate cognitive fatigue and eliminate divisive, addictive algorithms.Organic Unity: A voluntary cultural ethos rooted in collective psychological growth.By pivoting away from rigid, mandatory societal rules and focusing instead on supportive, open environmental design, Mars can naturally cultivate an aligned, thriving civilisation. This session will explore how these subtle infrastructural shifts can actively mitigate early settlement friction and safeguard human cognitive evolution.

Mars Transit Direct

Darian Phillips, Mars enthusiast

Mars Transit Direct is a project that utilizes an interplanetary spaceship called The Hermes. From for to aft it's essentially an IDA port, modified Bigelow Galaxy module. Thence flight deck/ crew lounge, a modified Bigelow NautilusX module. Thence workout room, modified Bigelow Sundancer. Thence cafeteria, a modified NASA Transhab. Thence 5 state rooms, modified Bigelow BEAM modules mounted on the V1 truss, a vertical circle. Thence bathroom, a modified Bigelow B330. Thence vertically a science lab with MAV and storage room with Mars lander. Thence 800 feet of fuel tank with 60 SpaceX Raptor engines. All modules assembled via SpaceX Starship. Attitude controlled via tethered MAV and Mars lander, using OMS thrusters from each spacecraft. Dry mass about 2 million lbs. Wet mass about 30 million lbs. Crew of 5 will be used for the mission. Commander, Executive Officer, Crew Engineer, Crew Geologist, PR Media Officer. Vehicle can be assembled by the late 2030s.

Water First: Building a Supply Chain Beyond Earth (Mars Technology Institute company talk)

Pete Freeland, Deep Space Logistics Systems (Mars Technology Institute)

Pete Freeland is the founder of Deep Space Logistics Systems, a Mars Technology Institute company focused on building the water and propellant supply chain that sustained operations beyond Earth will depend on. An aerospace engineer, he studied Aerospace Engineering at the University of Southern California on a full presidential scholarship and later completed a master's degree.

After high school he joined the U.S. Air Force and attended flight school, flying the B-52, B-1, and EA-6B Prowler, including combat missions in Operation Desert Storm. He then worked as a civilian flight test engineer and test pilot in California and Europe before joining the Space Shuttle program in Palmdale, California, where he became Chief Test Conductor for the shuttle orbiters and Lead Integration Test Engineer on the X-37 and X-38 experimental vehicles. In 2015 he was selected to train as one of the first commercial space astronauts through Project PoSSUM. He has also developed and taught introductory aerospace engineering courses and trained STEM educators nationwide.

Project ARES: A Roadmap for a Large-Scale Martian Colonization Program

Dennis Silin, Exodus Orbitals

Project ARES is an attempt to define large-scale interplanetary colonization roadmap for establishing a sustainable, large-scale human presence on Mars, taking into account the following requirements: scalability, risk reduction and conservative technological approach. A list of major objectives and technology milestones are summarized in the presented roadmap, to be implemented through “iterate and scale” approach. The roadmap proposes four distinct stages of colonization program. First, unmanned satellite constellations and robotic landers establish communications, navigation, weather forecasting, and terrain mapping capabilities. Second, small, highly trained scout crews conduct geological reconnaissance to identify optimal settlement locations. Third, specialized builder teams deploy energy and agricultural infrastructure for both surface and orbital installations. Finally, settlers can move in to develop the colony’s economy, culture, and industrial sectors. To scale the pool of trained colonists and achieve technology maturation in critical areas, including artificial gravity, in-situ resource utilization, space-based nuclear power, agriculture, and manufacturing, a multi-stage training pipeline should be established first, incorporating Earth surface facilities, low-Earth orbit stations, and lunar surface bootcamps. Risk reduction represents another major pillar of the ARES roadmap. Rather than attempting direct surface landings, it advocates for establishing an orbital base in areosynchronous Martian orbit, leveraging well-understood orbital operations, superior solar power availability, and access to the resources of Mars’ satellites, Phobos and Deimos. To put Martian colony on sustainable growth trajectory, the roadmap proposes to set the population goal above the genetically defined minimal viable threshold of 4,000-5,000 people, optimally up to an equivalent of medium-sized city of approximately 50,000-100,000 inhabitants. To achieve robustness against extraterrestrial environment challenges, colony development should develop redundant energy infrastructure leveraging both solar and nuclear power sources, local transportation network and food self-sufficiency and map mineral resources of the entire Martian system through both orbital and surface geological reconnaissance.

Growth Potential of Salad Crops in Simulated Martian and Lunar Regoliths

Avetis Shahbazyan, California State University, Northridge

Authors and Affiliations: Thilini Imandi1, Binal Patel2, Avetis Shahbazyan3, and Chandak Basu4*

1, 2, 3, 4 Department of Biology, California State University, Northridge, Northridge, California, USA
*Corresponding author. chhandak.basu@csun.edu

Future long-duration human missions to the Moon and Mars will require sustainable approaches to food production and life-support systems. Plants can play an important role in these missions by providing food, contributing to the regeneration of atmospheric oxygen, and supporting resource recycling. We wanted to test the hypothesis that plants can be grown in simulated Martian and Lunar regoliths. However, growing plants in Martian and Lunar regolith can be challenging due to the regolith’s unique physical and chemical characteristics. Our experimental study examines the growth potential of salad crops in Martian and lunar regoliths with varying percentages of simulated regolith supplemented with Earth’s soil. We aim to study how plants grow and respond phenotypically, physiologically, and biochemically under simulated extraterrestrial soil conditions. Five salad crops—lettuce, arugula, spinach, kale, and mustard—were grown under controlled conditions using simulated lunar and Martian regoliths. Plant growth performance was examined by germination percentage, relative water content, root and shoot growth, leaf area, number of leaves, and number of stomatal openings. We also quantified chlorophyll and carotenoids to assess photosynthetic performance. Currently, we are studying the minimum water requirements of these plants for efficient growth in water-limited extraterrestrial environments. We hope to contribute to the emerging field of space biology, which involves the sustainability of long-duration human exploration of Mars and the Moon.

Using Harnessed AI to Accelerate Scientific Discovery, Engineering and Space Operations

Robert Mills, MIFECO & MTI

Space exploration demands systems that can operate intelligently, adapt quickly, & solve problems in environments where human intervention is delayed or impossible. Harnessed agentic artificial intelligence is emerging as a critical technology for meeting these challenges, offering the potential to accelerate scientific discovery & engineering, improve mission safety, and enable a new generation of autonomous space operations. By combining large language models (LLMs), reasoning systems, memory architectures, and autonomous agents, these technologies move beyond simple automation toward intelligent collaboration between humans & machines.

The rise of agentic AI represents a major shift in computational capability. Early AI systems could process information, but modern agents can plan, reason, use tools, and coordinate complex workflows with minimal supervision. Frameworks such as Hermes, OpenClaw, and their successors demonstrate how open and modular agent ecosystems are rapidly evolving into practical engineering platforms. These systems can integrate scientific databases, simulations, robotics, telemetry, and operational software into unified decision-making environments capable of supporting demanding aerospace missions.

To safely deploy these capabilities in space, specialized AI harnesses are required. These harnesses provide structure, validation, oversight, and mission-specific constraints that allow agents to operate reliably in high-risk environments. Custom harnesses designed for space applications can support autonomous spacecraft operations, robotic planetary exploration, orbital maintenance, habitat management, anomaly detection, mission planning, and real-time scientific analysis. They also create pathways for adaptive systems capable of learning from mission conditions and responding dynamically to unexpected events.

Looking forward, harnessed agentic AI may fundamentally reshape humanity's approach to space exploration and engineering. As these systems become more capable, efficient, and trustworthy, they could evolve into persistent scientific and engineering partners that extend human presence into the solar system. The convergence of AI agents, robotics, and aerospace has the potential for resilient, scalable, & intelligent infrastructures for the future of exploration beyond Earth.

A New House on Mars: A Strategy to Make Mars Settlement Easier, with a Beginning Launch by 2028

Lawrence T. Beckerle, former Adjunct Professor, Glenville State College

A new house on Mars, a strategy to make Mars settlement easier with a beginning launch by 2028. by Lawrence T. Beckerle

ABSTRACT: Humans on Mars will need shelter that provides compressed air, food, fuel, good quality daylight, oxygen, water and tolerable temperatures. Shelter should include access to artificial gravity and protection from cosmic rays, so that astronauts can stay away from planet Earth longer than the current NASA limit of two years. This paper explains how to design a new house on Mars to provide these needs, using prebuild daylight measurements for creating more informed designs. (When sunlight passes through a window it is called daylight.) This vision for Mars also illustrates how to include prebuild daylight measurements and light shelves to build better dormitories, hospitals, housing and schools on Earth. Construction of a new house on Mars begins with a moisture-accumulating oasis-type high tunnel that can include a light shelf. Light shelves are needed to separate cosmic rays from sunlight

and to reflect sunlight into window-walls of a new house. The materials for construction should be launched from Earth to Mars in 2028. The new house uses two outward sloped walls of windows near the equator, but at upper mid-latitudes it uses a hybrid of one outward sloping window-wall and one inward sloping window-wall. so the house looks like it is leaning towards the sun at midday. With enough light shelves to reflect light into window-walls, the roof can better shield residents from cosmic rays. The new house will facilitate drilling to access lava tubes, buried glaciers and permafrost. It facilitates simpler access to lava tubes through shaft boring that needs neither compressed air nor water to dispose of drill cuttings. This system creates an environment that colonists can inhabit and enjoy for decades.

Neo-Derinkuyu: An Autonomous Underground Mars Habitat Design Driven by AI Algorithmic Infrastructure

Onur Çakır, Siirt

As humanity transitions from initial scouting missions to permanent settlement on Mars, surface radiation, extreme thermal fluctuations, and atmospheric pressure deficits necessitate a shift toward subterranean architectural solutions. This paper introduces "Neo-Derinkuyu," an innovative, fully autonomous underground Mars habitat design utilizing local Martian lava tubes to ensure long-term human survivability. The core of the Neo-Derinkuyu project lies in its integration of advanced computational modeling and in-silico simulation techniques. Instead of relying solely on physical prototypes, the habitat's life support systems (ECLSS), thermal regulation, and resource distribution loops are fully orchestrated by a custom-developed artificial intelligence algorithmic infrastructure. This AI system continuously adapts to environmental data, performing predictive maintenance, dynamic micro-climate zoning, and optimized power allocation under varying constraint models. Through rigorous in-silico simulation testing, the project provides specific quantitative data on atmospheric preservation, water recycling efficiency, and behavioral layout scaling for long-duration crews. By blending subterranean safety with autonomous algorithmic governance, Neo-Derinkuyu offers a scalable and viable framework for Martian colonization.

Materials by Prediction: Why Mars Can't Afford Trial and Error

Michael Rudolph, Velar Scientific

Every roadmap for Mars settlement depends on materials no one has made before: structural glass and ceramics from regolith, photovoltaics from local feedstocks, semiconductors and optical components produced without a terrestrial supply chain. On Earth, new materials come from iteration. We build a candidate, test it, learn, repeat. The lithium-ion battery took four decades to go from laboratory discovery to ubiquity. The silicon anode took eleven years of cycling experiments backed by the entire terrestrial industrial base. Iteration assumes cheap feedstock, fast turnaround, and deep supply chains, and Mars has none of them. A settlement cannot iterate its way to the materials it needs. It has to predict how a material will behave before committing scarce mass, energy, and time, which puts predictive materials simulation on the critical path for settlement.

This talk examines why current simulation tools cannot deliver that capability: quantum-chemistry methods do not scale to device-relevant sizes, and continuum models require measured parameters that do not exist for novel Mars-made materials. I then describe an alternative approach under development at Velar Scientific, a solver that operates on a geometric-algebra formulation of electrodynamics to compute material response directly from field dynamics without material-specific fitted parameters. I will survey the Mars applications where this matters most, including nonlinear-

optical materials for high-bandwidth laser communication, radiation-tolerant electronics, and photovoltaics from local feedstocks. Along the way I will draw on nine years of instrument systems engineering at NASA JPL (Europa Clipper) and flight machine-learning compute work for an IM-2 lunar mission payload to outline what materials autonomy on Mars would require.

Mars: The Path for Peace on Earth

Danny Quintana, Global High Seas Marine Preserve

We can end our constant wars by working together on exploration of the solar system. The geopolitical architecture of the 21st century remains anchored in militarized industrial economies. This paper proposes a radical pivot: redirecting global defense expenditures and industrial capacity toward a unified, international mission to explore Mars and the solar system. By transforming the space race from an arena of nationalist competition into a collaborative global endeavor, humanity can establish a practical mechanism for demilitarizing Earth's economy. This must be done as each war pushes us toward a nuclear conflict and a dystopian future. The execution of this initiative relies on a phased, three-tiered technical framework. First, all spacefaring nations will coordinate the deployment of massive robotic fleets to map and scout the Martian surface. Second, the coalition will jointly fund and develop advanced propulsion systems—such as nuclear thermal and high-efficiency electric propulsion—drastically reducing transit times and logistics costs. Third, this shared infrastructure will support the deployment of an international crew for rotating, short-stay missions, establishing a continuous human presence while building the foundation for terraforming a dead planet and bringing it back to life. By binding the industrial, financial, and scientific resources of competing nations to a singular, complex frontier, the logistical demands of Mars exploration can absorb the excess capacity currently dedicated to global military build-ups. Ultimately, the path to peace on Earth lies in giving the world's spacefaring powers a shared challenge too grand to tackle alone, converting the machinery of war into the architecture of human expansion.

Biological Sentinel Networks for Early Detection of Mars Habitat Instability

Anshul Modi and Saahil Modi, Peel District School Board

Long-term habitats on Mars will require the close management of the environment since slight perturbations in the atmospheric composition, water quality, temperature, radiation dose, and nutrient cycling can happen before raising alerts through traditional engineering monitoring systems. This proposal offers the use of biological sentinels based on environmental sensors combined with biological responses of short-generation organisms and crops.

The biological sentinels build upon our concept VIREO-Bio experiment as well as the sensor-enabled greenhouse architecture used in the experiment. Populations of Drosophila melanogaster would be tracked over several generations for reproduction, development time, locomotion, stress tolerance, and stability. In parallel, greenhouse systems would monitor plants' growth, root health, water efficiency, nutrient status, and environment through a set of distributed sensors.

Instead of studying the mentioned biological systems separately, the new concept would correlate biological response with variations in environmental data collected from the habitat. The recurrent deviations between biological and engineering measurements would be considered as signals of declining habitat stability. Variations in development time, reproduction, plant growth, and root health would be tested against variations in temperature, humidity, radiation dose, atmospheric composition, and water quality.

In several generations, the biological data would provide baseline measurements for the proper functioning of the habitat as well as what types of biological responses are transitory, cumulative, and persistent.

The developed system would enhance traditional engineering life support monitoring through living organisms as indicators of the environment's quality. It would allow the crew on Mars to detect subtle habitat degradation before it reaches operational consequences.

BioPills: Engineering a Portable Microbiome for In-Situ Soil Regeneration, from Earth to Mars

Melissa Esquivel Solano, Mars Society Chapter of Costa Rica

Agricultural soil degradation, water scarcity, and the loss of beneficial soil microorganisms represent critical challenges for global food security, challenges that are further intensified in extraterrestrial environments, where Martian regolith lacks the organic matter and biological activity required to sustain plant growth. BioFix presents BioPills, a biodegradable biotechnology prototype designed to regenerate sterile substrates through passive water conservation and biological inoculation. Each sphere is 4 cm in diameter and weighs 45 g in a dehydrated state, and is structured in two functional layers: an external matrix of clay, biochar, and organic compost, and a biological core containing dormant nitrogen-fixing bacteria (Rhizobium for leguminous crops and Azospirillum for non-leguminous crops) together with arbuscular mycorrhizal fungi, both of which activate upon hydration. The prototype's geodesic surface pattern is hypothesized to mitigate water evaporation, a mechanism that remains under experimental validation rather than a measured outcome. The study follows a prototype-based engineering design methodology encompassing sustainable material selection, technical design, biological composition analysis, and evaluation of the activation mechanism and technical feasibility, with prospective applications in closed-loop cultivation systems such as NASA's Veggie plant growth system and space-based biodomes, as well as potential contributions to crew psychological wellbeing during long-duration missions. By concentrating biological regeneration capacity in a compact, low-mass unit rather than requiring the transport of fertile soil or water, BioPills directly supports In-Situ Resource Utilization (ISRU): its low unit mass would allow Martian regolith to be conditioned locally, reducing the payload weight required for future life-support and agricultural systems.

2026 Mars Society Chapters Update

Ron Storie, Director of Chapters and Membership, The Mars Society

The presentation will cover the growth of The Mars Society's chapter program, highlighting both U.S. and international chapter creation over the past two years. It will include examples of chapter collaboration, strategies for promoting The Mars Society through community outreach and social media, and conclude with overall chapter statistics, key accomplishments, and a roadmap for continued growth in 2027.

Increasing Power-to-Calorie Efficiency with Non-Photosynthetic Food Technologies

Bill Maloney, Maloney Space Research

The average photosynthetic efficiency on Earth is between 0.2 percent and 1 percent. If Mars had the same average photosynthetic efficiency, its settlements would be threatened.

Earth receives practically unlimited energy from the Sun for free, whereas Mars receives substantially less solar energy. Both atmospheric dust and global dust storms interfere with the Red Planet receiving sunlight. Additionally, settlements will be underground to protect Martians from radiation. The infrastructure needed to produce food on Mars will be very expensive in comparison to the infrastructure used for food production on Earth. Each part of the Red Planet used for making food needs to be pressurized and has to have a life-support system.

Non-photosynthetic food technologies are needed to increase the power-to-calorie efficiency on Mars. They are cheaper and food can be grown this way almost solely by robots or automated systems. Food is produced much more quickly and there is almost zero waste.

Aerobic hydrogen-oxidizing bacteria fermentation, precision fermentation, formose sugar synthesis, abiotic lipid synthesis, electro-agriculture, and mycelial bioconversion are examples of technologies that can provide the power-to-calorie efficiency necessary for Martian settlement. In comparison to traditional crop photosynthesis, these technologies offer a 4- to 12-fold increase in energy conversion efficiency. They are economically viable, highly reliable, compact, reduce labor demands, and integrate seamlessly into a closed-loop environmental control and life support system.

On Earth, these technologies can help us rewild farmland, safeguard our food supply against natural disasters like droughts or unseasonably cold weather, curb water waste and pesticide use, and expand food production in urban areas.

This presentation will offer a roadmap for how we can use non-photosynthetic food technologies to increase power-to-calorie efficiency so that we can settle Mars. It will also show how these technologies will be of great help to us on Earth.

Considerations of Building a Dyson Sphere for Our Solar System

Dr. Wilson Hago, Hago Energetics

The construction of a Dyson sphere represents perhaps the most ambitious engineering undertaking conceivable — a structure capable of capturing the entire solar output of a star. This paper examines the material and energetic feasibility of such a project within our own solar system, progressing from rigid shell designs to the more tractable Dyson swarm architecture. A classical solid Dyson sphere at 1 AU requires approximately 1.8×10^{27} kg of structural material — comparable to the mass of Jupiter. While the solar system's total planetary mass marginally satisfies this figure, the available inventory of processable solid material falls short by roughly three orders of magnitude, rendering a rigid shell physically implausible with solar system resources alone. A Dyson swarm of gossamer-thin solar collectors (~1 g/m²) dramatically relaxes these constraints: the asteroid belt alone provides sufficient mass for full stellar coverage. However, substituting functional habitats at ISS-class construction densities (~200 kg/m²) increases material requirements by a factor of 200,000, demanding planetary-scale disassembly for even modest coverage fractions. Focusing on a practical 4% swarm coverage target — achievable by consuming the solar system's rocky and icy minor bodies — we estimate a total construction energy budget of approximately $2–3 \times 10^{31}$ joules, dominated by manufacturing and gravity-well escape costs. The Sun radiates this entire budget in roughly three days. Solar energy is therefore never the limiting factor; the constraint is capture and deployment rate. Bootstrap modelling suggests that a self-reinforcing construction program, reinvesting harvested solar energy into swarm expansion, could achieve 4% coverage within 300–2,000 years depending on initial seed collector size and reinvestment fraction. The project is physically sound — the challenge is civilizational coordination, not physics.

The Year of Earth and Space (YES)

Jerry Edling, KNX

In 1957 and 1958, at the onset of the space race and at a time of extraordinary solar activity, scientists around the world collaborated on a coordinated research effort. The International Geophysical Year (IGY) led to unprecedented advances, such as artificial satellites and the discovery of the Van Allen Belts. The IGY was made possible in part by advances in technology. Cosmic ray recorders, spectroscopes and radiosonde balloons all contributed to a successful international effort. The launch of Sputnik 1 in 1957 galvanized the U.S. to a firm commitment to gain and maintain preeminence in space, so that when President John F. Kennedy announced the goal of a mission to the Moon years later, the nation was ready.

Today, the people of Earth face planetary challenges that are unprecedented in the history of civilization. It is another “Sputnik moment,” this time for the entire planet, not just one nation. I propose that the scientific community gather once again for a coordinated research effort. The Year of Earth and Space (YES), to be held in 2027 and 2028, on the 70th anniversary of the IGY, would be an international collaboration and competition to develop technologies that are applicable to both the exploration of the Solar System and the fulfillment of what is officially known as “Transforming our world: the 2030 Agenda for Sustainable Development."

Just as the IGY galvanized the space race, YES could energize the space economy; and it could do so in a way that benefits everyone. For example, sophisticated remote sensing technologies could assist in finding the ideal landing site for an interplanetary mission to Mars while at the same time locating nodes of population on Earth that are in need of basic healthcare (SDG 3).

The challenges await. It is up to us to say YES.

Direct to Mars in 40 Million Kilocalories

Abbie Watson

Abbie Watson is a bioinformaticist and health informatics engineer based in Austin, Texas, whose work applies clinical interoperability standards to the medical challenges of long-duration spaceflight. In April 2026 she presented HERMES, a FHIR-based space health electronic health record management system designed to support autonomous medical operations on long-duration missions, at the NASA Human Research Program Investigators' Workshop. In 2025 she presented on building a secure cislunar ecosystem, taking a holistic approach to infrastructure, cybersecurity, and human resilience, at the Space ISAC.

Agentic AI: The Essential Infrastructure for Sustainable Mars Settlement and Planetary Civilization

Matthew Douglas, Founder & Chief Architect, KISOS

This presentation argues that agentic AI, autonomous systems capable of planning, reasoning, coordinating, and executing complex objectives, will become a foundational layer of future Mars colonies. Beyond serving as advanced software tools, networks of specialized AI agents will function as the first workforce on Mars, enabling small human populations to achieve civilization-scale outcomes. Agentic AI can support every phase of Martian development, from mission design and interplanetary transit to robotic pre-deployment, infrastructure construction, resource extraction, scientific

exploration, healthcare, and colony governance. The presentation will explore how multi-agent systems can coordinate fleets of robots, autonomous mining operations, in-situ resource utilization (ISRU), energy management, agricultural production, and habitat expansion. Particular attention will be given to the concept of an “AI-native settlement,” in which thousands of interconnected agents continuously manage critical systems and execute tasks that would otherwise require a population many times larger than the initial human settlement. Additionally, the presentation will also examine key challenges associated with deploying agentic AI in extraterrestrial environments, including reliability, resilience, cybersecurity, human oversight, governance frameworks, and ethical considerations. Drawing parallels to historical advances in automation throughout the space program, the discussion will propose that the next major leap in space exploration is the transition from automated systems to autonomous mission ecosystems. The central thesis is that Mars colonization is not merely a transportation problem but an autonomy problem. While rockets will carry humans to Mars, agentic AI may ultimately determine whether humanity can build a permanent, scalable, and self-sustaining civilization there. This presentation seeks to stimulate discussion within the Mars Society community regarding the strategic role of agentic AI as a critical enabling technology for the future of human settlement beyond Earth.

Fun and Fund: The Nineteen-Year Quest to Make Mars Worth Owning

Lisa Ice, Mars Territory

In August 2008 I told this convention that Mars Territory was "99% ready" to sell virtual Mars property with an associated quit claim. I finished that last 1%. The store opened, priced from ten cents to a thousand dollars.

I sold one parcel, for twenty dollars.

Fun & Fund, I called it then. Creating the structure for funding was easy: write a quit claim, pledge a percentage of proceeds. What was hard was creating the fun — something people wanted to own and to share with their friends. Alone, I could build something with potential. I could not build virtual property that was fun to own and develop.

I kept trying to build that fun. A Google Earth Mars overlay, eighteen months before Google Earth had Mars. Star Territory. A Unity MMO. A Minecraft version. The Sandbox. Some reached a working alpha. Some I abandoned. None of them found players.

In early 2026 I tried agentic coding. I had built walkable Martian terrain once before, through manual steps too laborious to repeat. A weekend of agentic coding produced it again — and the code I have now will build it from any HiRISE digital terrain model, imagery and elevation both, and lay out parcels tied to real Mars coordinates. On top of that sit a simple Roblox game incorporating the parcels, and a new web application. A trust created in July permanently directs 10% of proceeds to Mars advancement.

I will demonstrate how far agentic coding has allowed Mars Territory to progress, and how human collaborators could carry it further — into something truly fun.

Mars Against Hunger Finalist: Davi Souza

Davi Souza, Habitat Marte

Davi Souza is a Brazilian greenhouse specialist, electrical engineer, space farming consultant, science communicator, and analog astronaut with more than six years of technical experience in controlled

environment agriculture and its application to future space habitats. He studied electrical engineering at the State University of Campinas (Unicamp).

He has served on analog missions at Habitat Marte, the Mars Society Brazil analog station in Rio Grande do Norte, where crews operate the BioHabitat aquaponic greenhouse that produces food for mission teams, and has contributed to projects with the Blue Marble Space Institute of Science, the Deep Space Initiative, and the Genomics for Climate Change Research Center. His goal is to develop food production techniques that succeed both in space greenhouses and in extreme environments on Earth.

Comet Impact Terraforming

David Ong, PhotonBytes

Examining the idea of deflecting a comet to impact Mars especially within the vicinity of a polar ice cap with the goal of warming up the planet and melting the ice caps to restore the mostly CO2 based atmosphere and resulting air pressure below the Armstrong limit. Examining the deflection process and the kinetic energy to thermal coupling of impact and the resulting restored atmosphere based on current Martian conditions including the scale height and absence of a magnetic field.

Human Mars Expedition: When Will We Go?

Madhu Thangavelu, University of Southern California

Madhu Thangavelu conducts the graduate Space Exploration Architectures Concept Synthesis Studio in the Department of Astronautical Engineering at the USC Viterbi School of Engineering and teaches the Extreme Environment Habitation Design Seminar in the USC School of Architecture, where he is a graduate thesis adviser. His background spans architecture (M.B.S., USC School of Architecture, 1989) and engineering (B.S.E., National Institute of Technology, Calicut, India, 1980), and he is a graduate of the inaugural 1988 summer session of the International Space University at MIT.

His master's thesis, MALEO: Modular Assembly in Low Earth Orbit, an alternate strategy for lunar base establishment, was published in journals worldwide. Since 1992 he has served as a creative consultant to the aerospace industry on space architecture concept synthesis. His concepts have been reviewed by NASA, the National Research Council, and the National Space Council, presented before the National Academy of Sciences, and he is a fellow of the NASA Institute for Advanced Concepts.

Mars Against Hunger Finalist: Lawrence T. Beckerle

Lawrence T. Beckerle

Lawrence Beckerle is an engineer presenting as a Mars Against Hunger finalist in the Friday afternoon breakout program.

Saturday, October 24

Day 3 of the 2026 International Mars Society Convention

Schedule

Plenary and Evening Program, Grand Trojan Ballroom

Time	Session	Speaker
8:00 AM	**Registration & Doors Open**	
9:00 AM	**Private Property in Space: The Missing Ingredient**	Dr. Rainer Zitelmann
9:30 AM	**MarsSuit Live Demonstration (one hour)**	Lawrence Kuznetz and Audrey Liddle
10:30 AM	**Plenary**	Dr. Carol Stoker, NASA Ames Research Center
11:00 AM	**Plenary**	Fabrizio Pisani, Astera Institute
11:30 AM	**Plenary**	Patrick Beatty, Beyond Earth Ventures
12:00 PM	**Lunch Break**	
1:00 – 5:00 PM	**Afternoon Breakout Sessions**	See breakout schedule below
7:00 PM	**Convention Banquet**	Dinner, Mars Society Awards, and keynote address by Dr. Adam Steltzner, NASA JPL, SR-1 Freedom Mars Mission

Afternoon Breakout Sessions, 1:00 to 5:00 PM

Time	Room 1: Grand Trojan Ballroom	Room 2: TCC 350/351	Room 3: TCC 450 (Forum)
1:00 PM	**Collagen-Based Artificial Muscles** *Ria Aggarwal*	**Power and Politics on the Red Planet** *Alexander de Graaf*	**From Mars's Deepest Basin: A Settlement That Builds Itself** *Basil Sultan, DexLab (Syria & Egypt), 1st Place Design*
1:30 PM	**GOLDEN Framework: Enabling Human-AI Coevolution for Mars and Beyond** *Dr. Jiangduo (Ginga) Chen, Florida Institute of Technology*	**Thermal Control for Mars Exploration Spacecraft in an Uneven Solar Radiation Environment** *Irene Jingqi Ou*	**The Mars Leap** *Charles Letherwood, IXITID Concepts*
2:00 PM	**Psychological and Demographic Predictors of Willingness to Participate in Analog Astronaut Missions** *Phoebe Fleshman, Embry-Riddle Aeronautical University*	**Protecting Life on Mars with Martian Basalt** *Roberto Montoya Jiménez, Universidad Fidelitas (presenting on behalf of Verónica Pérez Segura)*	**Going to Mars? Better Join the Navy First** *Art Harman*
2:30 PM	**Exploring Amino Acids as a Biosignature via Novel Spectrophotometer Design** *Diya Jaishankar, UC San Diego*	**Prototype for an Autonomous Payload Containment in a Martian Analog Environment** *Manfred Xirinachs Ugalde*	**Increasing Power-to-Calorie Efficiency with Non-Photosynthetic Food Technologies** *Bill Maloney, Maloney Space Research (rescheduled from Friday)*
3:00 PM	**Simulated Microgravity Modulates Neutrophil Activation and Extracellular Vesicle Release** *Alexander Terwindt, Emory University*	**Cybermars: A Home Synced with Real Mars** *Zhennian Liang and Leonardo Lei, Cybermars*	**Human Mars Expedition: When Will We Go?** *Professor Madhu Thangavelu, USC*

Time	Room 1: Grand Trojan Ballroom	Room 2: TCC 350/351	Room 3: TCC 450 (Forum)
3:30 PM	**The Case for Design for Reliability for Growing and Living Spaces on Mars** *Elmer Collins, University of New Mexico*	**Exocracy: A Structural Optimization Blueprint for Infinite Scaling and Civilizational Expansion** *Tiara Paxton*	**Practical Antimatter Propulsion: A Manhattan Project for Interstellar Capability** *Casey Handmer*
4:00 PM		**JOVINAUT (JM-V1): Multi-Megawatt Architecture for Deep-Space Logistics** *Kirsten Rosen, JOVINAUT*	**SuperMIRC: Breeder Reactors to Power Mars Industrialization** *Joshua Perry*
4:30 PM		**Viability of Fission-Powered Rovers in Extended-Stay Human Mars Missions** *Alexander Bendoyro*	**New MDRS Suit Demonstration: Enabling Human Work on the Martian Surface** *Peter Dekluyver and Matthias Beach*

Plenary and Evening Program

Grand Trojan Ballroom

Private Property in Space: The Missing Ingredient

Dr. Rainer Zitelmann, Private Researcher

The presentation is based on Chapter 10 of my book New Space Capitalism, which will be published by Skyhorse Publishing in June 2026 and has already been read by Robert Zubrin.The central thesis is that full property rights are a key prerequisite for the successful colonization of Mars and for its financing. Government funding alone will not suffice. Private financing, however, depends on clearly defined property rights on Mars. While the Outer Space Treaty of 1967 prohibits states from claiming sovereignty over celestial bodies, it remains disputed whether this prohibition also extends to private individuals and companies.I will outline the current legal situation and the ongoing debate among space lawyers. Drawing on the property theory of John Locke, I will argue why those who are capable of reaching and settling Mars should have the right to acquire property. For example, if SpaceX were to reach and develop a limited area on Mars, it should be permitted to claim property rights there. This area could then be securitized and listed on the stock market as a Real Estate Investment Trust (REIT), so that the corresponding Martian land would effectively belong to the shareholders. In this way, the financing of Mars colonization would become feasible. Settlers could receive shares in the REIT at a discount.

MarsSuit Live Demonstration

Dr. Lawrence Kuznetz, UC Berkeley, and Audrey Liddle, UC Berkeley

The MarsSuit Project is a radically different spacesuit concept designed for expeditionary work on the surface of Mars, created by Dr. Lawrence Kuznetz, a UC Berkeley professor and former NASA engineer with a long history of investigating Mars spacesuit concepts dating back to the Apollo program. Rather than a pressurized balloon, the MarsSuit aims to be a practical "blue-collar" suit that lets crews work effectively for long hours on the Martian surface.

The project is run as a collaboratory at UC Berkeley, where roughly fifty students participate through a design class, supported by a wider talent pool that includes the University of Helsinki, Texas A&M University, MIT, several NASA centers, and private organizations. Audrey Liddle, an astrophysics student at UC Berkeley and member of the MarsSuit team, joins Dr. Kuznetz for this live demonstration of the current suit.

Plenary: Dr. Carol Stoker

Dr. Carol Stoker, Planetary Scientist, NASA Ames Research Center

Dr. Carol Stoker is a staff planetary scientist at NASA Ames Research Center whose research focuses on developing the tools and science strategy to search for life on other planets, with an emphasis on Mars. Her recent work centers on instruments and robotic systems for space exploration, tested in terrestrial analog environments; she has led field experiments in the Antarctic, the Arctic, undersea, and in the deserts of the American Southwest to demonstrate robotic systems for searching for life.

Born in American Fork, Utah, Stoker graduated cum laude in physics from the University of Utah and earned her Ph.D. in astrogeophysics from the University of Colorado. Her mission experience includes

the Voyager flybys of Jupiter, Saturn, Uranus, and Neptune and the Mars Pathfinder and Phoenix missions. Her projects have won six NASA group achievement awards, and she has more than 100 publications.

Plenary: Fabrizio Pisani

Dr. Fabrizio Pisani, Lead R&D Engineer, Mars Terraforming Team, Astera Institute

Dr. Fabrizio Pisani is an aerospace engineer and entrepreneur who serves as Lead R&D Engineer for the Mars Terraforming Team at the Astera Institute in Berkeley, California, helping advance the technologies and engineering concepts that could make Mars more hospitable for human settlement. He is also the founder of Meta Futura Aerospace, which concentrates on next-generation in-space infrastructure and mission design for humanity's expansion beyond Earth.

His expertise bridges aerospace engineering, planetary science, and long-term human settlement. In this plenary he addresses the engineering challenges of building a sustainable human future on Mars, the latest advances in terraforming research, and how emerging technologies could transform science fiction into reality.

Plenary: Patrick Beatty

Patrick Beatty, Managing Director, Beyond Earth Ventures

Patrick Beatty is Managing Director of Beyond Earth Ventures, a venture fund founded in 2024 that invests in early-stage space technology and terrestrial deep-tech companies in energy, robotics, food technology, and biotechnology, focusing on innovations that solve both terrestrial and space challenges.

He has spent many years in venture investing, including at the Prosus Group, one of the world's largest venture firms, where he invested in and mentored companies across machine learning, synthetic biology, and space technology from Series A through late-stage rounds. He brings more than twenty years of experience as an operator and data science leader, with earlier roles at Northern Trust, Moody's Analytics, Fannie Mae, and Bank of America. His space background ranges from academic research using infrared spectroscopy to study comets to involvement with the XPRIZE and the International Space University.

Convention Banquet

Dr. Adam Steltzner, NASA Jet Propulsion Laboratory; HQ Chief Engineer for Special Projects, SR-1 Freedom Mars Mission

Dinner and the presentation of the Mars Society Awards, followed by the banquet keynote address.

Dr. Adam Steltzner is a NASA engineer at the Jet Propulsion Laboratory best known as the lead engineer for the Entry, Descent, and Landing phase of the Mars Science Laboratory mission, where he helped design, build, and test the Sky Crane system that landed the Curiosity rover in 2012. He went on to serve as Chief Engineer of the Mars 2020 project, which placed the Perseverance rover on Mars to collect samples for possible return to Earth.

Born in Alameda County, California, Steltzner earned a bachelor's degree in engineering from UC Davis, a master's in applied mechanics from Caltech, and a Ph.D. in engineering mechanics from the University of Wisconsin-Madison. Over his career he has worked on Galileo, Cassini, Mars Pathfinder, and the Mars Exploration Rovers. He is the author of The Right Kind of Crazy.

He now serves as NASA Headquarters Chief Engineer for Special Projects, encompassing Moon Base, SR-1 Freedom, and other priority initiatives. SR-1 Freedom (Space Reactor 1), announced in 2026 and scheduled to launch toward Mars in December 2028, is intended to be the first interplanetary spacecraft powered by a nuclear fission reactor. It pairs a closed Brayton-cycle reactor generating more than 20 kilowatts with the Power and Propulsion Element originally developed for the Lunar Gateway, and will deploy the Skyfall payload of three Ingenuity-class helicopters to scout future human landing sites and subsurface water ice.

Afternoon Breakout Sessions

Breakout talks run 25 minutes plus 5 minutes of Q&A.

Collagen-Based Artificial Muscles

Ria Aggarwal, The Village School

Microgravity negatively impacts astronauts' muscular systems by inducing atrophy, indicating a loss in muscle mass and strength. This occurs as microgravity can alter the cellular processes of muscles, particularly the ubiquitin-proteasome pathway (UPP). Specifically, the co-chaperone protein C-terminus of Hsc70-interacting Protein (CHIP) is upregulated as the environment reduces protein synthesis, stimulates inflammation, increases reactive oxygen species, and hinders mitochondrial function, which all promote protein degradation. To address this issue, the project was designed to address two aims: design and simulate collagen-based artificial muscles to be integrated with the regular muscles for strengthening, and identify nanobodies capable of blocking the interaction between CHIP and heat shock proteins (HSP) 70/HSP90, thereby preventing muscle protein degradation. Firstly, collagen-integrated artificial muscles can mimic natural muscle contractions, enhancing muscle strength. In this study, a collagen-based artificial muscle system containing six different collagen fibers was computationally designed and evaluated for both muscle-strengthening and targeted drug delivery applications. Molecular docking simulations were performed to analyze the stability of the collagen fibers under simulated mechanical pulling conditions. Secondly, ten different nanobodies and their capability in modulating CHIP activity were investigated using HDOCK. The results yielded collagen fiber number five to be the strongest fiber as it required the most strength to stretch under tensile force. Additionally, the results also deduced that nanobody II formed the most hydrogen bond interactions and exhibited the strongest binding affinity to CHIP. This indicates that under microgravity, nanobody II can aid in stabilizing the interaction between CHIP and HSPs, protecting proteins from cellular stress. Together, these approaches provide complementary strategies to mitigate microgravity-induced muscle atrophy. This research will help develop novel methods to make spaceflight safer through regenerative implants or engineered artificial muscles for a controlled delivery of therapeutic drugs, ultimately mitigating muscle atrophy.

Power and Politics on the Red Planet

Alexander de Graaf, Mars Society Ambassador

In my presentation, Power & Politics on The Red Planet, I will discuss how to operate a government that can help a settlement on Mars or in space run safely and effectively. First, we will look at how power should be shared within a government. This will include comparing different systems of government, how leaders are chosen, and what measures can be taken to stop one person from gaining too much control. Second, we will discuss how leaders can stay connected with the people they govern and how

information can be shared openly between them. Third, we will examine where our theoretical society fits on the political spectrum and how people with different beliefs can live together without creating division or conflict. Finally, when building a society on Mars, it is important to remember that it will be a completely different. Because life on Mars will be so different from life on Earth, the people living there are bound to develop different values from our own. For this reason, the government must be able to change and adapt as the society grows away from earth. Although a Martian society may be different from those on Earth, I believe that people are often more predictable than we think and that history is bound to show us the same power structures failing in the same ways. In light of this, throughout the presentation, we will examine quotes from history, philosophy, and literature to compare ideas from the past with the challenges of building a new society in space today. By doing this, we can see what lessons we can still learn and apply to the settlement of Mars.

From Mars's Deepest Basin: A Settlement That Builds Itself

Basil Sultan, DexLab (Syria & Egypt), 1st Place Design

GOLDEN Framework: Enabling Human-AI Coevolution for Mars and Beyond

Dr. Jiangduo (Ginga) Chen, Florida Institute of Technology

Future Mars missions demand a new generation of cognitive capabilities that enable humans and AI to communicate, reason, and learn together under uncertainty. Developed through a four-year research program on astronauts' cognitive mapping, the GOLDEN Framework emerged as an unexpected yet natural outcome of the study, establishing a structured protocol for Human–AI synergy—an ethical and reflexive partnership that enhances communication, scientific reasoning, and shared discovery. Sustained synergy, in turn, lays the foundation for Human–AI coevolution, through which both human cognition and AI-assisted reasoning progressively evolve together. The framework was iteratively developed and validated through large-scale qualitative analysis, integrating human interpretation with AI-assisted coding, thematic development, quantitative verification, and methodological reflection. Across six analytical phases, the Human–AI Synergistic Learning Curve (HASLC) captures how reserachers' cognition evolves through sustained collaboration with AI—from assisted problem solving to co-constructive scientific discovery. Beyond improving analytical performance, GOLDEN enhances communication between humans and AI, while simultaneously strengthening communication among human collaborators through greater transparency, traceability, and interpretive rigor. The framework further aligns with the AI4People principles of beneficence, non-maleficence, autonomy, justice, and explicability, embedding ethics throughout the entire research lifecycle. As humanity moves toward an interplanetary civilization, inter-intelligence becomes the first civilization we must first cultivate. Preparing for Mars therefore means preparing humans and intelligent machines to think, communicate, and learn together responsibly. The GOLDEN Framework offers a practical and empirically grounded pathway toward this future, inviting scientists, engineers, educators, and mission designers to view Human–AI coevolution as an essential capability for wiser partnerships between humans and AI.

Thermal Control for Mars Exploration Spacecraft in an Uneven Solar Radiation Environment

Irene Jingqi Ou, Shenzhen Midle School

Spacecrafts that head toward Mars operate in vacuum with uneven temperature environment between the Sun and Mars. Continuous solar radiation on one side of the spacecraft produces severe temperature difference, which leads to thermal expansion and deformation. This affects the precision of

scientific detectors during the long space journeys. The research establishes a one dimensional numerical model with one heat influx on one end to simulate three thermal control solutions: adopting highly conductive and low expansion metals for spacecraft, inserting conductive components to facilitate thermal conduction, and covering surfaces with reflective thermal coatings to reduce absorption. The model incorporates a variety of thermal properties, including conductivity, thermal expansion coefficient and its change with temperature, absorption rate, and emissivity. All numerical calculations are completed by Python codes. Five metal materials and four types of coatings are compared, and graphs of thermal expansion and temperature distribution are drawn. Simulation results prove that high conductivity materials embedding multiple conductive components covered by highly reflective smooth white coatings effectively minimizes temperature difference and deformation. The framework adopts one dimensional simplification, but it still fits the thermal conditions of the heat transfer between Sun and Mars. For Sun-Mars orbits, the quantitative results provide guidance to mitigate thermal deformation risks caused by uneven distribution of temperature and provides insight for thermal control to maintain stable operation of Mars exploration equipment.

The Mars Leap

Charles Letherwood, IXITID Concepts

Psychological and Demographic Predictors of Willingness to Participate in Analog Astronaut Missions

Phoebe Fleshman, Embry-Riddle Aeronautical University

Analog astronaut missions provide Earth-based settings for studying human performance under spaceflight-like conditions. This study aimed to identify factors that predict an individual's willingness to participate in analog astronaut missions lasting 7 days, 30 days, and 6 months, using a quantitative, non-experimental approach. A two-stage approach was used to develop regression equations and assess model fit. Four hundred participants were recruited, and the dataset was randomly divided into two groups. Stage 1 produced statistically significant models, which were validated in Stage 2. For 7-day missions, previous experience with isolation, perceived value, general affect, and fun factor explained 52% of the variance in willingness to participate. For 30-day missions, previous experience with isolation, age, gender, familiarity with analog astronaut missions, perceived value, general affect, and fun factor explained 48% of the variance. For 6-month missions, education, previous experience with isolation, age, ethnicity, risk propensity, familiarity with analog astronaut missions, and fun factor explained 41% of the variance. The findings identify factors associated with willingness across mission durations and may inform recruitment strategies and program design for analog astronaut missions.

Protecting Life on Mars with Martian Basalt

Roberto Montoya Jiménez, Universidad Fidelitas (presenting on behalf of Verónica Pérez Segura)

Radiation is present throughout space, but it is harmful to the human body, which is not naturally adapted to withstand such high levels of radiation. This can lead to serious health problems that could affect future long-term space exploration. This article proposes a specific solution to this problem by using Martian basalt to manufacture modular shielding panels. The process begins with the collection stage, in which an autonomous rover, such as NASA´s RASSOR, collects basalt rocks near the location where the habitat will be built. The collected rocks are then crushed and screened. They first pass through a crusher that breaks them into smaller fragments and are then sorted by size to obtain a uniform material suitable for manufacturing the panels. The crushed basalt can be processed in two

ways. It can be compacted under high pressure to produce high density blocks or it can be sintered using heat to manufacture durable radiation shielding panels. During the installation stage, the finished panels are assembled around the habitat, creating a continuous protective barrier against space radiation. Studies conducted by Nasa and Esa indicate that approximately 3 meters of basalt surrounding a habitat are required to provide effective radiation shielding. Each panel is 50 cm thick, and six panels are stacked to achieve a total thickness of 3 meters, with a density ranging from 2800 to 3000 kg/m3. As a result, astronauts' exposure to space radiation can be reduced by approximately 70% to 95%, significantly improving crew safety while minimizing the need to transport large quantities of shielding materials from Earth. The panels are validated using Finite Element Analysis (FEA), which simulates the atmospheric pressure difference between the inside of the habitat 101.3KPa, and the Martian environment 0.6 KPa, demonstrating that the panels are capable of withstanding these extreme conditions.

Going to Mars? Better Join the Navy First

Art Harman

Exploring Amino Acids as a Biosignature via Novel Spectrophotometer Design

Diya Jaishankar, UC San Diego

Life-supporting processes at the cellular level require the proper functioning of key enzymes like those in the citric acid cycle and oxidative phosphorylation. Most of these are made up of amino acids that are L-alpha type of amino acids. One project being conducted by Yonder Dynamics at UC San Diego is to develop a replicable method of testing for the presence of these types of amino acids, not only for liquid samples, but specifically soil samples, with good reproducibility of results. After testing for one year we were able to find positive results in protein samples and noticed an interesting pattern in results upon testing in different types of soil. The samples were analyzed using a student-developed spectrometer, measuring at the peak wavelength for the biosignature – 570 nm. Future work will include determining the reason for the unique pattern in L-alpha amino acid concentration trends across soil types, and how to account for this in random samples, and the possible development of a more robust L-alpha amino acid detection assay. Our spectrometer's working principles and intricacies will also be discussed.

Prototype for an Autonomous Payload Containment in a Martian Analog Environment

Manfred Xirinachs Ugalde, Mars Society Chapter of Costa Rica

The validity of extraterrestrial and geological discovery relies entirely on uncompromised sample integrity. To empower this research, off-world missions require autonomous tools capable of immediate, on-the-spot analysis from the exact moment of collection. This paper presents the engineering, deployment, and fault-tolerance analysis of the Sample Collection and Containment Capsule (S.A.C.C.C), an independent mobile micro-laboratory designed to collect, contain, and continuously analyze samples in transit. Specifically, it is hypothesized that a decentralized, COTS-integrated micro-laboratory, protected by a multi-layered metallic chassis, demonstrates preliminary feasibility in maintaining internal payload integrity and uninterrupted high-frequency telemetry logging during a Martian analog deployment (simulating the MER-A Spirit Site at 175.478° E) subjecting the unit to >1.5 G kinetic shocks. To test this, the unit's mechanical isolation chassis, Bluetooth-enabled control systems, and independent 9-variable telemetry array were rigorously evaluated. Operating as an isolated analysis chamber, the capsule continuously monitors critical variables such as heat radiation, moisture, gas emissions, and internal movement. Despite sustaining exterior kinetic damage that

resulted in peripheral sensor failure, the core avionics maintained 100% operational uptime, logging over 108,000 data points with zero data corruption events. Furthermore, the payload bay successfully protected 1 soil sample and 4 distinct geological samples (spinel lherzolite fragments). A recorded thermal delta of +1.4°C internally was documented, providing an initial framework for a scalable, preliminary blueprint for autonomous, self-contained sample-return laboratories.

Simulated Microgravity Modulates Neutrophil Activation and Extracellular Vesicle Release

Alexander Terwindt, Emory University

Background Immune dysregulation is a well-recognized consequence of spaceflight and represents a significant challenge for astronaut health during long-duration missions. Neutrophils are the first responders of the innate immune system and play essential roles in host defense, inflammation, and tissue repair, however, the effects of microgravity on neutrophil activation remain poorly understood. We investigated whether simulated microgravity alters neutrophil activation and extracellular vesicle (EV) release using a Random Positioning Machine (RPM). Methods Peripheral blood neutrophils (PMNs) were isolated from two healthy donors and cultured at 1×10^6 cells per well in EV-depleted RPMI. Cells were maintained for 18 hours under either static control conditions or simulated microgravity using a two-axis RPM (time-averaged residual gravity of 0.038 g). Following incubation, neutrophils were analyzed by flow cytometry for the activation markers CD66b, CD63, CD11b, and PD-1. Extracellular vesicles were isolated from conditioned media using 300-kDa centrifugal filters and quantified by nanoparticle tracking analysis. Results Simulated microgravity significantly attenuated neutrophil activation compared with static controls. RPM-exposed neutrophils exhibited significantly lower surface expression of CD66b ($p = 9.3 \times 10^{-4}$) and CD63 ($p = 0.014$). Although not statistically significant, CD11b expression remained closer to baseline ($t = 0$) in RPM-treated cells, whereas static controls demonstrated greater spontaneous activation during culture. Similarly, PD-1 expression remained comparable to freshly isolated neutrophils following RPM exposure but decreased under static conditions. Additionally, RPM-exposed neutrophils produced more EVs relative to static controls, although this difference did not reach statistical significance. Conclusions Together, the attenuated spontaneous neutrophil activation and increased EV production in simulated microgravity suggest that microgravity differentially regulates neutrophil activation and secretory behavior. Collectively, our results provide new insight into innate immune adaptation under altered gravitational conditions and establish a foundation for developing strategies to preserve astronaut immune function during long-duration missions.

Cybermars: A Home Synced with Real Mars

Zhennian Liang and Leonardo Lei, Cybermars

The Case for Design for Reliability for Growing and Living Spaces on Mars

Elmer Collins, University of New Mexico

The Case for Design for Reliability for Growing/Living Spaces on Mars Elmer W. Collins, David F. Menicucci and Anthony R. Menicucci University of New Mexico Department of Mechanical Engineering

The sun is virtually the only indigenous energy resource on Mars. Thus, living and growing spaces will likely be solar-powered. Due to the generally clear Martian atmosphere, the total solar resource on the surface is about half that of Earth’s, even though the solar constant at Mars is about a third. We envision

Martian autonomous controlled-environment growing/living spaces (ACEGS) powered by passive-solar thermal systems for heat and to radiate plants, and solar photovoltaics (PV) for electricity. Passive solar systems convert solar energy to heat with efficiencies above 90%, about four times that of PV. Reliability and resilience are key features of Martian ACEGS systems to ensure colony survival. Resilience is integral to Design for Reliability (DFR) and focuses on survival of and recovery from unforeseen failures. Our design goal is to produce reliable and resilient ACEGSs integrated into Martian crater walls, with exposed glazing to collect direct solar radiation. We believe DFR principles should be a primary architectural design requirement for Martian ACEGSs. We discuss the DFR theory and methods applicable to the engineering systems in an ACEGS to provide confidence that these systems are reliable and fault-tolerant. Topics include characterization of Martian use environments, selection of materials consistent with those use environments, reliability trade-off studies to identify necessary redundancies, identification of key performance parameters linked to system state-of-health, and development of appropriate time-compressed test protocols to demonstrate margin to environmental extremes. The application of these techniques can result in a system design robust to environmental extremes, the elimination of single-point failures, and the identification of data collection methods that enable AI-based fault detection and health monitoring (predictive reliability).

Exocracy: A Structural Optimization Blueprint for Infinite Scaling and Civilizational Expansion

Tiara Paxton

Practical Antimatter Propulsion: A Manhattan Project for Interstellar Capability

Casey Handmer, Personal

Chemical propulsion, now largely solved by reusable rockets, cannot reach nearby stars at meaningful velocities. When antimatter encounters ordinary matter, they annihilate completely, converting mass directly into energy according to $E=mc^2$, the most energetic possible energy source. Notwithstanding engineering difficulties, this makes antimatter the logical next frontier, and the only known propellant capable of bridging the thrust–Isp gap that constrains chemical, electric, and nuclear-electric systems alike. The required quantities are relatively modest. A manned journey to Pluto and back in under twenty years would need just 45 grams of antimatter combined with 10 kilograms of uranium-238, together occupying roughly 500 cubic centimeters. The engineering problem decomposes into three tractable areas: production, storage, and use. Current production manages thousands of atoms daily at facilities like CERN—roughly analogous to plutonium production capacity in late 1940, prior to the enormous scale up at the Hanford facility during the Manhattan Project. Storage is the hardest problem: rather than massive magnetic rings, electrostatic containment of a cryogenic antihydrogen droplet, testable safely with ordinary hydrogen by inverting the charge, offers a launchable path. For the engine, antiproton-induced fission offers a potential path to a relatively simple, high thrust engine cycle.

JOVINAUT (JM-V1): Multi-Megawatt Architecture for Deep-Space Logistics

Kirsten Rosen, JOVINAUT

Establishing sustainable lunar bases and Mars colonies requires a paradigm shift in heavy-lift transport capable of conquering deep space logistics. This paper presents the architecture and telemetry validation for JOVINAUT (JM-V1), a vehicle utilizing design elements protected under USPTO Provisional Patent status as "A Crewed, Modular, Multi-Megawatt Deep-Space Transit Vehicle and Surface Infrastructure Habitat Platform". Built as a scalable solution for high-mass orbital and surface

deployment, its sheer performance capacity is demonstrated via a simulated extreme-envelope sprint to the heliopause boundary, or roughly 120 AU. Assembled in LEO via a dual-launch architecture, the vessel integrates a 55,000 kg core frame with 125,946 kg of propellant and cargo for a total initial LEO mass of 180,946 kg. JOVINAUT utilizes a 2.0 MW nuclear reactor coupled with a high-efficiency electric propulsion system running on liquid lithium. Operating at a target specific impulse (\(I_{sp}\)) of 5,392.3 seconds, it generates a continuous 51.36 Newtons of thrust over an 804-day active burn window. For heavy crewed deployments to Mars or interstellar space, the architecture incorporates a 1,570.8 m³ internal cabin volume featuring a 93% closed-loop ECLSS, a 120-day emergency oxygen buffer, a counter-rotating 0.00 N-m of net axial torque 1.0g/0.38g artificial gravity centrifuge, and a 35,103 kg thick-shell polyethylene radiation storm shelter. Flight telemetry modeling dictates a 130.5-day low-thrust LEO escape spiral followed by a rapid 118.5-day interplanetary cruise to Jupiter. Utilizing a precisely timed and powered gravity assist at a 35,746 km periapsis altitude, the trajectory injects a +28,008.0 m/s delta-V infusion, achieving a terminal velocity of 89,408.0 m/s (200,000 mph) and a 6.3-year sprint timeline from Jupiter to 120 AU. This architecture validates JOVINAUT as the definitive infrastructure platform for rapid interplanetary transit and permanent planetary colonization.

SuperMIRC: Breeder Reactors to Power Mars Industrialization

Joshua Perry

The task of industrializing a Martian settlement to the point of economic self-sufficiency is an extremely challenging one, in large part due to the scarce energy resources available. Any prospective energy system must produce much more total energy than it costs to manufacture. This energy return on investment (EROI) provides a method for evaluating prospective energy sources in terms of economic viability, and the rate of return on this energy investment also presents a hard limit on the rate of industrial growth that can be achieved indigenously. The previously described Mars Indigenous Reactor Concept (MIRC) proposes how nuclear power plants could be built on Mars entirely using local resources. Utilizing nuclear energy in this way is estimated to have significantly more favorable energy economics than solar or wind. However, if some of the original design constraints are relaxed, a different optimal design is found with far superior performance. A power plant based on a Molten Chloride Salt Fast Reactor is described which could be constructed from indigenous Martian materials, except for the initial seed fuel which would be imported from Earth. This reactor design is then compared in terms of energy economics to the original MIRC design and to solar energy. In addition to creating an abundance of electrical and thermal power, the SuperMIRC MCFR would produce enough fissionable material to continually ramp up nuclear energy production and fulfill all of a growing city-state's energy needs.

Viability of Fission-Powered Rovers in Extended-Stay Human Mars Missions

Alexander Bendoyro, University of Alabama in Huntsville

Exploring Mars requires reliable power to support long missions, but traditional energy sources like solar panels face challenges on the Red Planet like dust storms, limited sunlight, and the need for mobility. Introducing nuclear-powered rovers, a promising solution inspired by decades of research. These vehicles use fission energy to generate electricity (instead of radioisotope power like most modern robotic rovers), enabling extended propulsion and operation in harsh conditions.

Early concepts, like the 1998 "Robotic Fission Rover," were too bulky or lacked human-carrying capacity. Modern designs, such as the 10 kW fission rover proposed in this research, address these issues by combining simple and compact reactors with advanced shielding to protect both hardware and crews

from radiation. These rovers could power tools, heat habitats, and even transport cargo across vast distances, a capability solar-powered and radioisotope vehicles are less equipped for.

While challenges remain (like repairing nuclear systems in remote locations), recent studies show that fission rovers could be scalable, durable, and essential for future human missions. Researchers are also exploring how these vehicles might work alongside robotic systems, creating a flexible "team" of explorers.

This work builds on over 25 years of innovation, from early 1990s concepts to more modern designs. By learning from past attempts and focusing on practical, scalable solutions, scientists are paving the way for a new era of Mars exploration where nuclear power fuels humanity's journey to the stars.

New MDRS Suit Demonstration: Enabling Human Work on the Martian Surface

Peter Dekluyver and Matthias Beach

Peter Dekluyver is an independent spacesuit builder who set out in 2022 to prove that a working lunar and Martian EVA suit does not have to cost hundreds of thousands of dollars. Building on the low-cost pressure suit work pioneered by Dr. Cameron Smith of Pacific Spaceflight, he committed to constructing a fully mobile EVA suit and life support pack for under $10,000, and by using off-the-shelf hardware such as gas fittings, zippers, and connection rings modified to specification brought the cost below $4,000. He presented that first suit, Dressing for the Consumer Space Race, at the 2022 Mars Society Convention.

In February 2026 Dekluyver brought his latest pressurized suit designs to the Mars Desert Research Station as sponsor of Crew 329, where the suit was put through airlock cycles and a climb of the habitat stairs during a filmed demonstration. Matthias Beach, a member of that MDRS crew, joins him for this live demonstration of the new suit, intended to enable practical human work on the Martian surface.

Notes

Notes