FORESIGHT INSTITUTE

2023 Space Workshop

Chaired by:

Allison Duettmann
Foresight Institute

Creon Levit
Planet Labs

Fifty Years, San Francisco
June 5-6, 2023

Table of Contents

Executive Summary

It is a unique time in human history where space technology is no longer limited to governmental entities and is now increasingly explored by private businesses, research institutions, and passionate individuals. There is finally a sense of urgency and excitement in the air as space technological capacities grow, and it is not unthinkable that we are on the precipice of major breakthroughs.

This workshop was designed with this reality in mind. We wanted to create a forum where leading researchers, entrepreneurs, and funders could explore newly emerging opportunities and collaborate to drive progress on shared long-term goals of space development and exploration.

The format of the workshop involved rapid keynote presentations followed by working groups. These groups curated opportunities for talent and funders to take on, not only during the workshop but also in the future. Focus areas that were explored include satellite applications for biodiversity protection, debris removal, space medicine, space law, reducing launch costs, asteroid mining, and refocusing efforts toward Mars exploration.

Workshop attendees were given an opportunity to vote for the project they deemed most promising. The winning project received a development grant to kickstart initiatives aimed at tackling their area of interest.

The pages that follow offer an overview of the proceedings, the ideas shared, and the potential avenues for collaboration discovered. The workshop also considered societal impediments to space progress, which are detailed in the notes at the end of the report.

For an interactive overview of the space domain, including major needed technical capabilities, existing actors, and outstanding challenges, please see Foresight Institute's technology tree: https://foresight.org/ext/ForesightSpaceTree.

We extend our heartfelt gratitude to all participants, and to Creon Levit for chairing the workshop. We welcome those interested in supporting ongoing projects to reach out and look forward to next year's workshop to further build on occuring progress.

Allison Duettmann
President & CEO
Foresight Institute
a@foresight.org

About Foresight Institute

Foresight Institute is a research organization and non-profit that supports the beneficial development of high-impact technologies. Since our founding in 1987 on a vision of guiding powerful technologies, we have continued to evolve into a many-armed organization that focuses on several fields of science and technology that are too ambitious for legacy institutions to support. From molecular nanotechnology, to brain-computer interfaces, space exploration, cryptocommerce, and AI, Foresight Institute gathers leading minds to advance research and accelerate progress toward flourishing futures.

Workshop Chairs

Allison Duettmann
FORESIGHT INSTITUTE

Allison Duettmann is the president and CEO of Foresight Institute. She directs the Intelligent Cooperation, Molecular Machines, Biotech & Health Extension, Neurotech, and Space Programs, Fellowships, Prizes, and Tech Trees, and shares this work with the public. She founded Existentialhope.com, co-edited Superintelligence: Coordination & Strategy, co-authored Gaming the Future, and co-initiated The Longevity Prize. She advises companies and organizations, such as the Consortium for Space Health, and is on the Executive Committee of the Biomarker Consortium. She holds an MS in Philosophy & Public Policy from the London School of Economics, focusing on AI Safety.

Creon Levit
PLANET LABS

Creon Levit has worked at Planet Labs since 2015, where he is the Chief Technologist, Director of R&D, and a Planet Fellow. Prior to that, he worked at NASA Ames Research Center in Silicon Valley, where he was one of the founders of the NAS (NASA Advanced Supercomputing) division, co-PI on the Virtual Wind Tunnel project, co-founder of the NASA Molecular Nanotechnology Group (the first federally funded research lab devoted to molecular nanotechnology), co-PI on the hyperwall project, investigator on the Columbia accident investigation board, member of the NASA engineering and safety center, investigator on the millimeter-wave thermal rocket project, the Stardust re-entry observation campaign, PI on the Light Force Project, special assistant to the center director, and chief scientist for the programs and projects directorate. From 1999 to 2001, Levit was director of the International Space Sciences Organization – a privately funded R&D organization with about 15 full-time employees investigating and funding breakthrough technologies for space propulsion and energy production. Levit is the author of numerous papers, book chapters, and software packages. He serves on the advisory boards of several aerospace and biotechnology companies and has served on numerous NSF, DARPA, and NASA committees including (from 2010 to the present) on the NASA Institute for Advanced Concepts (NIAC). He is the recipient of many awards and prizes, including the 1997 Richard P. Feynman Award for Molecular Nanotechnology, and he is a senior research fellow at the Foresight Institute.

Participants

Adam Brown - STANFORD
Allison Duettmann - FORESIGHT INSTITUTE
Andrew Siemion - SETI
Bob Zubrin - MARS SOCIETY
Carol Stoker - NASA
Chris Boshuizen - DCVC
Creon Levit - PLANET LABS
Danielle Fong - LIGHTCELL ENERGY
David Furman - FURMAN LAB
Ekaterina Ilin - ALTAIPONY
Gustavs Zilgalvis - CENTER FOR SPACE GOVERNANCE
Ian Brooke - ASTRO MECHANICA
Ilaria Cinelli - AIKOS SPACE
James Bennett - CHIEF REGULATORY OFFICER, IMMORTAL DATA, INC.
Jay Lewis - IDEAL FRONTIERS
Jessy Kate Schingler - OPEN LUNAR
Kevin Lalli - HYDROSAT INC.
Konstantinos Konstantinidis - MASP
Kyran Grattan - BREAKTHROUGH INITIATIVES
Larry Lemke - NASA
Martin Elvis - HARVARD SMITHSONIAN
Mike Grace - LONGSHOT
Mike McCullogh - PLYMOUTH UNIVERSITY
Mike Safyan - PLANET LABS
Nathan Johnson - SPACE COURT FOUNDATION
Patrick Finley - COLLEGIATE PROPULSIVE LANDER CHALLENGE
Rachit Bhatia - LEOLABS
Rand Simberg - INTERGLOBAL MEDIA LLC
Romain Fonteyne - EUROPEAN SPACE AGENCY
Ryan Kushner - THIRD DERIVATIVE
Ryan Singer - VEX CAPITAL LLC
S. Pete Worden - BREAKTHROUGH INITIATIVES
Steve "Bucky" Butow - DEFENSE INNOVATION UNIT
Tomas Gesino - YLLA SPACE
Will Marshall - PLANET LABS
John Karcz - NASA

These icons, found throughout the report, link to recordings of each presentation


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benefit of life.


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Keynote Presentations

All workshop presentations are clickable via the play button

Allison Duettmann, Foresight Institute

Foresight Space Workshop '23 Introduction

SUMMARY

Allison Duettmann walks through Foresight Institute's mission, and history. Foresight Institute's aim is to realize better futures through collaboration and cooperation in areas such as cryptography, security, AI, molecular nanotechnology, brain-computer interfaces, longevity biotech, and space. Through virtual seminars, in-person events, prizes, fellowships, and workshops, Foresight Institute creates platforms for collaboration and exploration of undervalued opportunities, with a focus on long-term thinking. This Space Workshop hopes to address challenges, explore technicalities, and motivate progress. Foresight Institute offers support to projects beyond the workshop, recognizing the struggle to sustain momentum. She notes that this workshop aims to foster co-creation, inspire new ideas, and encourage long-term thinking in space exploration.

Adam Brown, Stanford

Cosmological Constant

SUMMARY

Adam Brown discusses the cosmological constant and its implications for space exploration and technology. He explains that the discovery of the cosmological constant, which indicates the accelerating expansion of the universe, poses challenges for accessing distant galaxies and utilizing their resources. However, Brown suggests that the constant might be manipulatable, offering the possibility of extracting energy from it to prevent the heat death of the universe. Brown draws an analogy to manipulating an electric field to extract energy, highlighting the potential for accessing unlimited free energy if the cosmological constant can be controlled. He notes that the detectability and impact of the cosmological constant depend on its distance and location, and the bleeding off of the constant's energy might be observable rather than the constant itself. However, manipulating the cosmological constant could have consequences, such as affecting the laws of physics, including gravity, electromagnetism, and the strong force. Adapting to new laws of physics would require transforming ourselves into a medium suitable for these changes. Brown emphasizes the important role of the cosmological constant's power density in understanding the dynamics of the universe and raises the question of whether it is possible to overcome the limitations imposed by the constant's acceleration of the universe's expansion.

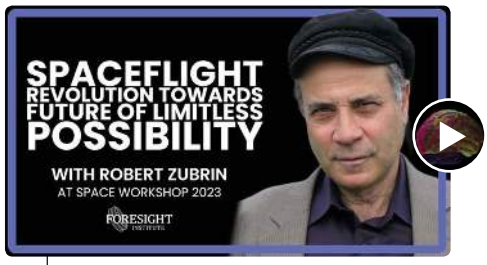
Keynote Presentations

Andrew Siemion, SETI

Progress in the Detection of Extraterrestrial Life

SUMMARY

Andrew Siemion discusses the progress in detecting extraterrestrial life – with the average number of planets per star and the existence of planets similar to Earth, the question of other life in the universe remains a mystery. He discusses how the Galileo spacecraft used a unique approach to detect signs of life on Earth, such as disequilibrium chemistry in the atmosphere and the presence of plants; however, that techno signatures, like narrow-band radio emission, are more feasible indicators of intelligent technological activity. He highlights how collaboration between astronomers and engineers has become a significant part of SETI research, and how the public's interest in ET life discovery depends on the specific detection. Siemion concludes that directed energy propulsion systems and anomaly detection are viable strategies for detecting advanced civilizations.



Bob Zubrin, Mars Society

Spaceflight Revolution Towards Future of Limitless Possibility

SUMMARY

Bob Zubrin explores the emergence of civilizations on Mars, focusing on technological, economic, social, and political aspects. He believes that intellectual property will be the main export of Mars, as the challenges faced by a Mars settlement will drive innovation. These challenges include a labor shortage, limited acreage for agriculture, and the need for energy. To overcome these challenges, Zubrin suggests in-situ resource utilization (ISRU) and the development of a Martian economy based on licensing inventions and innovations. The Mars Society aims to establish a Mars Technology Institute to develop the necessary technologies for colonization. While initially a non-profit organization, it may transition to a for-profit entity in the future. He notes that the Mars Society is seeking support to create the institute and contribute to the economic development of a Mars colony.

Keynote Presentations

Creon Levit, Planet Labs

Sustainable Farming

SUMMARY

Creon Levit combines various topics including biology, biotech longevity, molecular nanotechnology, space, and existential hope, emphasizing the importance of biology and showcasing the complexity of cell machinery. He then dives in to the application of space technologies in regenerative agriculture, specifically regenerative grazing. Levit discusses the benefits of regenerative grazing and introduces the utilization of space technology in animal movement and grazing decisions: his vision would be to integrate all five kingdoms of life for the benefit of the biosphere and conscious creatures. He also highlights that sustainable farming is both hopeful and feasible with near-term applications. While he primarily focuses on science and technology, he acknowledges the importance of engaging with policy makers and discusses the challenges of incentivizing sustainable farming practices through policy. Finally, he emphasizes the synthesis of traditional knowledge, scientific knowledge, and technology to find the best solutions for sustainable farming: he calls for envisioning the future of agriculture and emphasizes the need for practical and sustainable solutions.

David Furman, Furman Lab

Space Longevity

SUMMARY

David Furman discusses how he studies the risks associated with space flight and aging, aiming to develop countermeasures. Leveraging partnerships with SpaceX and Axiom, Furman collects biological data from astronauts during and after space flight. Using microgravity simulation, Furman's team accelerates aging in organoids to study functional changes and identify drug candidates for age-related dysfunction. Access to space data and ground analogues helps map findings to diseases of aging. Furman also emphasizes the need to improve infrastructure for clinical trials in space.

Keynote Presentations

Ilaria Cinelli, Aikos Space

Space Medicine Innovation

SUMMARY

Ilaria Cinelli provides an overview of space medicine, which involves caring for people in space. This field comprises two main branches: preventive medicine, which focuses on preventing health issues, and acute care, which deals with medical emergencies in space. On the International Space Station, any crew member can be the medical officer, but in deep space missions, a trained physician is required. Deep space missions face unique challenges such as distance from Earth and variable gravity. Innovation in space medicine is crucial for improving healthcare in space, but it must be adapted to the specific requirements of deep space missions. She notes that to fully understand the impact of space on human beings, it is necessary to consider the entire system and conduct tests that replicate the consequences experienced by humans. She then highlights that as the selection criteria for astronauts evolve, a greener pig system is needed to collect and analyze data, providing a comprehensive understanding of the human system in space. Her conclusion is that safety in deep space exploration is a paramount concern for future space missions.

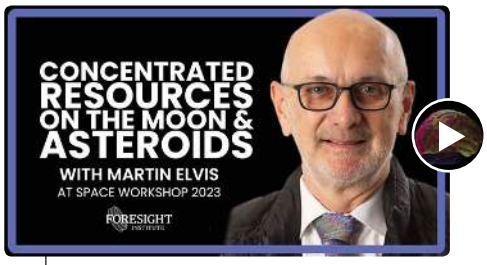
Larry Lemke, NASA

Big Frickin' Rockets are a Big Frickin' Deal

SUMMARY

Larry Lemke presents a talk on the revolutionary potential of ultra heavy spacecraft, specifically focusing on the game-changing capabilities of Starship. He explores the impact this development will have on space exploration, predicting a radical reduction in the cost to orbit. However, he also highlights society's underpreparedness to take advantage of Starship's potential, emphasizing the need for self-organization and capitalization on the opportunities it presents. Case studies on interplanetary missions and geoengineering are presented, showcasing the diverse potential uses of Starship. He stresses the importance of collaboration and an integrated plan to optimize investments and resources. Additionally, Lemke advocates for new engineering methods that prioritize reliability and affordability, suggesting a central approach to engineering may benefit everyone.

Keynote Presentations



Martin Elvis, Harvard Smithsonian

Concentrated Resources on the Moon & Asteroids

SUMMARY

Martin Elvis discusses the valuable and finite resources found on the Moon and asteroids. He firstly discusses how on the moon concentrated resources are mainly located in small regions, such as the South Pole, where "peaks of eternal light" provide continuous power through solar panels and permanently shadowed regions hold the potential for water. He then dives into resources on asteroids, where certain resources like platinum are only found in select areas, raising concerns about their accessibility, use, ownership, and governance. Additionally, he raises the concept of utilizing asteroids as both radiation shielding and habitats is explored, yet the challenge of moving bulk materials through the solar system remains.

Mike Grace, LongShot

Why Rockets for Space Launch?

SUMMARY

Mike Grace, gives an overview of his alternative kinetic launch technology: the Longshot space launch project. Grace highlights how the system uses compressed air to accelerate projectiles to hypersonic speeds for launching payloads into space. He also recognizes the technical challenges involved with heating, stability, and high-G forces. He then discusses the physcial site, the market demand for launching satellites to specific inclinations, and the goal of reducing space launch costs. He concludes that the Longshot space launch project aims to make access to space more affordable through this innovative alternative technology.

Keynote Presentations

Mike McCullogh, Plymouth University

How Quantised Inertia Can Revolutionise Space Travel

SUMMARY

Mike McCullouch discusses how the theory of quantised inertia can revolutionize space travel, which proposes a new understanding of inertia and has been successfully tested with astronomical data. McCullouch suggests that it is possible to produce thrust from the quantum vacuum using capacitors, leading to potential applications in satellite propulsion, travel to Alpha Century, and travel to the Oort cloud. By combining quantum mechanics and relativity, McCullouch explains that an object accelerating to the right experiences new radiation, resulting in inertial mass. At low accelerations, the horizon moves back and the collapse of symmetrical horizons eliminates inertia. Capacitor experimentation has shown promising results in predicting thrust variation. McCullouch also highlights the potential applications of quantised inertia, including expedited trips to the Oort cloud and Proxima Centauri. However, further experimentation and enhancements are necessary to refine the theory and improve thrust generation. McCullouch's research finally suggests that rapid waves and interference could disrupt physical objects, and there is a question regarding the correct colors of the unreal radiation.

Patrick Finley, Collegiate Propulsive Lander Challenge

A Pipeline for the Future of Propulsive Landing

SUMMARY

Patrick Finley presents his new initiative: the Lander Rocket Challenge, where rocketry teams from universities worldwide are challenged to build self-landing rockets with the chance to win substantial prizes. He notes how over 20 teams, including notable universities such as Stanford and UC Berkeley, have signed up to participate. He also announced plans to develop a state-of-the-art Rocket Lab at Georgia Tech. While the organization is continuously raising funding, they are also seeking a program director to manage their initiatives. He also mentions how, although teams face challenges in designing and building their own engines, the organization as a whole is exploring the idea of a scalable engine that can benefit numerous teams.

Keynote Presentations

Rachit Bhatia, LeoLabs

Space Behavior Awareness at Scale

SUMMARY

Rachit Bhatia discusses the importance of space behavior awareness in lower Earth orbit, and LeoLabs' efforts to track and monitor objects in space. He discusses how they operate a network of ground-based Radars and aims to increase their radar network to improve tracking capabilities in LEO – they offer various services and data products, including collision assessment and real-time alerts. He also notes that them main challenge is establishing policies and regulations while creating awareness about their products. To this end, he notes that collaboration with other stakeholders is crucial for effective space behavior regulation. Lastly, Bhatia discusses data: providing data to operators is also important for ensuring space safety.

Peter Worden, Breakthrough Initiatives

Life in the Universe & Private Sector Space Science Initiatives

SUMMARY

Peter Worden explores the possibilities of discovering new planets and life in the universe. He challenges the notion that there is no "Planet B" and emphasizes the need for continuous adventure in space exploration. Worden introduces the privately funded Breakthrough Initiatives, this $100 million effort aims to find intelligent signals and signs of life in the universe. Though a detected signal turned out to be interference, Breakthrough Initiatives remains determined. The program also includes plans to observe the Alpha Centauri system and explore the possibility of sending a spacecraft through the Breakthrough Starshot program. Worden highlights the use of light sails propelled by a high-power laser as a potential propulsion method. Sharing his experience in private sector space science initiatives, Worden mentions the challenges faced when implementing projects and the importance of communication with government authorities.

Keynote Presentations

Steve Butow, Defense Innovation Unit

Space Domain Awareness

SUMMARY

Steve Butow emphasizes the importance of space domain awareness in building enduring advantages in space, specifically addressing issues such as debris and near-Earth objects. His goal is to improve detection and tracking capabilities, develop sustainable practices for space traffic management, and promote the removal of active space debris through a commercialization model. Setting standards of conduct and property in space is crucial, as is the involvement of industry in solving tough problems and providing comprehensive data. With advancements in commercial technology, there is an opportunity to expand knowledge, reduce error bars, and increase maneuverability in space operations. He notes that the Defense Innovation Unit's reach extends to moon and Mars projects, and the importance of balancing defense-related national security with commercial interests is acknowledged.

John Karcz, NASA

Near and Long Term Space Progress

SUMMARY

John Karcz discusses the progress of space in the near and long term, highlighting the benefits of new commercial capabilities for space science, which expand scientific goals. Karcz suggests that government agencies should design programs that advance both science and private sector activity without creating accidental barriers. Furthermore, he believes that scientists should actively explore how to exploit new commercial capabilities and companies should consider the scientific applications of their work.

Keynote Presentations

Carol Stoker, NASA

The Search for Extant Life on Mars

SUMMARY

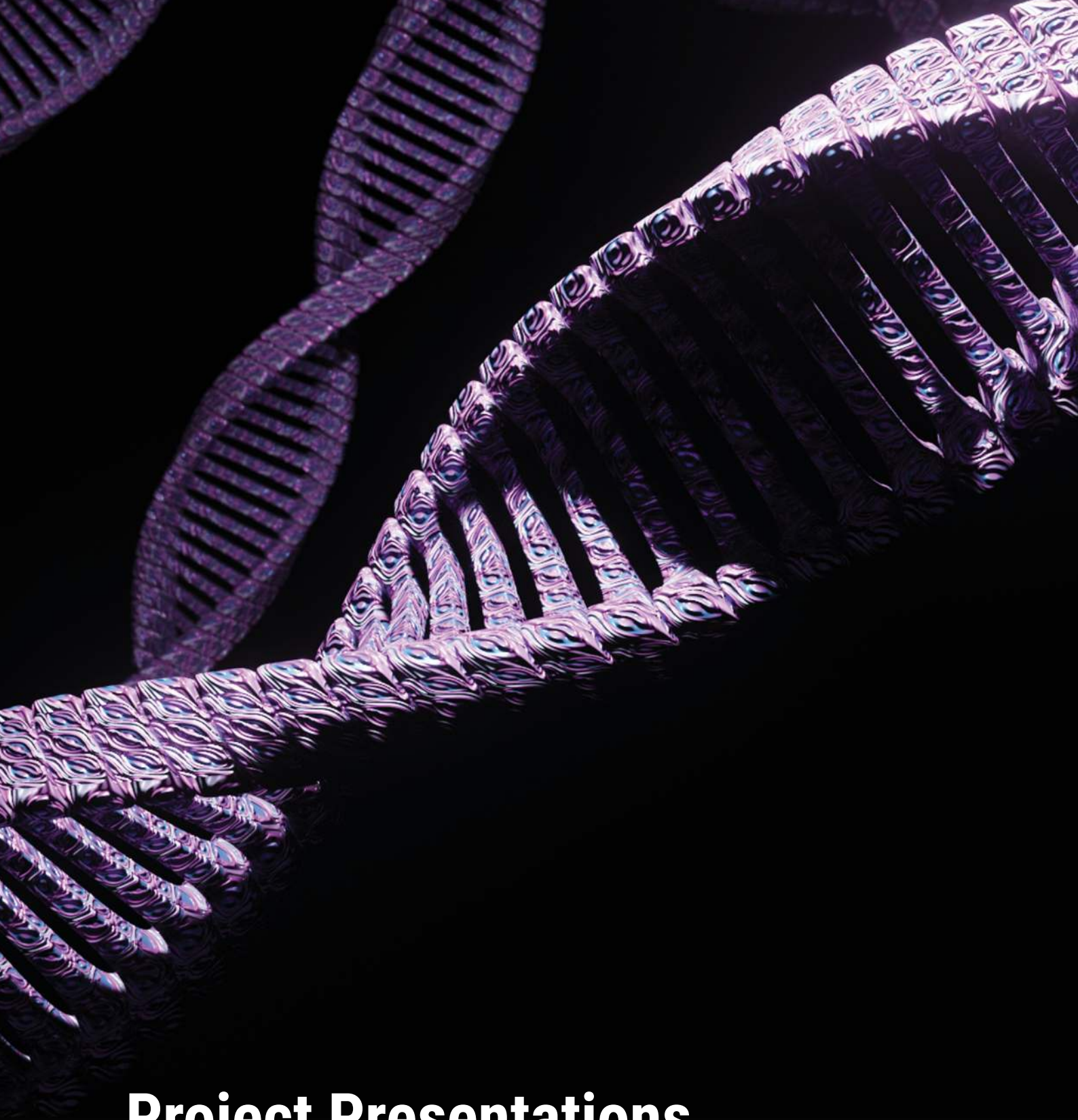
Carol Stoker presents on the search for extant life on Mars. She first provides an overview of the pioneering Viking missions in 1976, which detected metabolism on the planet but faced challenges in confirming it as biological. She then explores the three potential habitats for life on Mars: salts and brines, ground ice, and caves. Salts, including perchlorate brines, have the potential to create liquid water environments, while ground ice contributes to saturated conditions. Mars caves, with their warmer and wetter conditions, offer the possibility of habitable environments. However, Stoker highlights the limitations of previous Mars missions, which primarily focused on rocks and lacked the necessary instrument capabilities for identifying biosignatures of life. Finally, she emphasizes the potential conflict between sending humans to Mars and the search for life due to contamination risks – she believes that assessing the risks of human exploration on Mars, particularly the consequences of bringing Martian biology back to Earth, is crucial before any manned missions.

Kostas Konstantinidis, MASP

Space Technology Tree

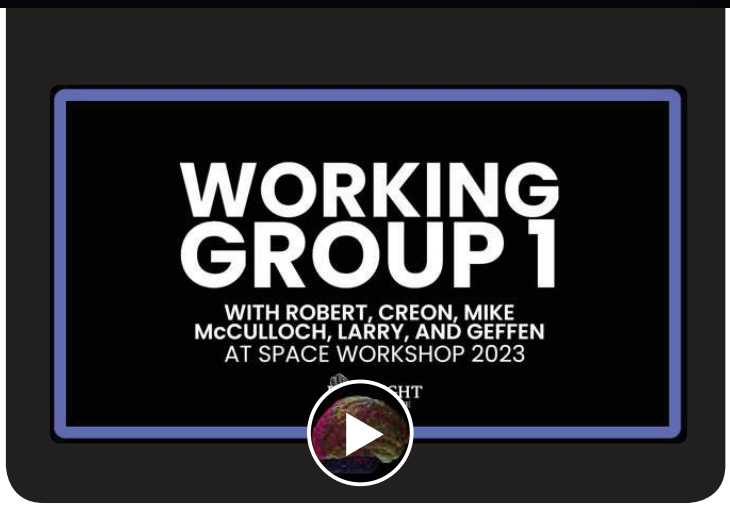
SUMMARY

Kostas Konstantinidis discusses the Space Technology Tree project, which aims to organize and connect space technologies and applications systematically. The project starts with developing a taxonomy of space technologies and then progresses to understanding space applications and missions. He highlights how challenges, stakeholders, and research costs are also considered in creating the tech tree, which is constantly revised and updated. The team encourages collaboration and outreach, welcomes contributions to the tech tree, and plans to engage policymakers and technologists. He encourages everyone to explore the tree and consider how it can be applied in their respective fields.



Project Presentations

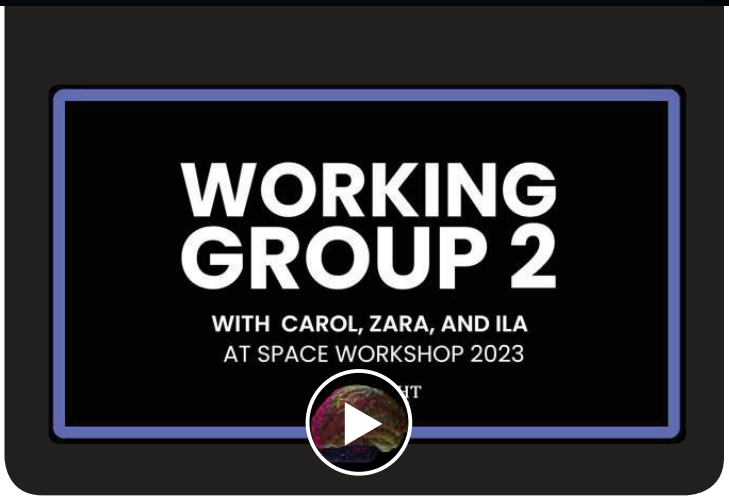
Self-funding Institute for Space Frontier and New realms of Physics



SUMMARY

Working Group 1 proposes the creation of an institute to self-fund and enable visionary projects with long-term payoffs, such as enabling food growth on Mars and facilitating rapid interstellar travel. Given the current funding limitations from for-profit, non-profit, and VC avenues for such endeavors, the new approach seeks to attract donations from high-net-worth philanthropists, especially those within the cryptocurrency wealth space, who prioritize glory over financial gain. These donors would be offered future revenue sharing from the developed technologies. Initial success is defined by raising $1M-$100M to establish each institute, while ultimate success entails creating self-funding institutes that generate intellectual property beneficial for space exploration and terrestrial applications alike. The project duration is open-ended, aiming for self-sustainability, and risks include possible backlash from missteps or negative outcomes. Moving forward, development grants will be utilized to build and test a 1U payload version of the horizon drive in a 1.5U cubesat in Low Earth Orbit (LEO), while additional steps include organizing workshops, seeking further funding, and engaging advisors and experts to realize project milestones.

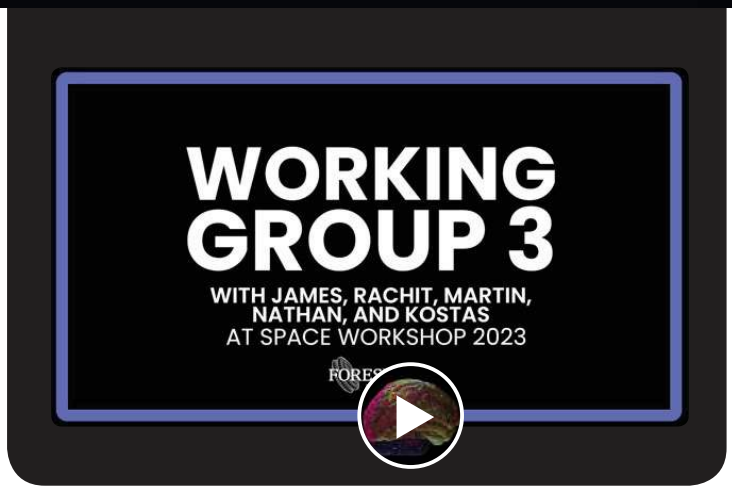
Can Mars Attack? Assessing Biological risks to Earth from Martian Exploration



SUMMARY

Working Group 2 aimed to scrutinize the potential biological risks Mars may pose to Earth; striving to preemptively mitigate any potential threat from Martian biology. The prevalent approach, primarily by NASA, has inadequately addressed the potential existence of life on Mars and showcased a notable communication gap between human exploration and scientific missions. Proposing a shift in perspective, the group suggests treating Martian biological risks similarly to other spacecraft risks, incorporating a risk mitigation plan and initiating a robotic precursor mission. Ensuring no life forms or biohazards are brought back to Earth demands a coordinated effort across different space exploration communities and implementing a baseline comparison by sending a life detection mission to Mars. While proving the absence of life (a negative) is inherently complex, it's vital to provide a stringent assessment to avoid false negatives that may misrepresent the existence of Martian life. When life is detected, thorough evaluations will be paramount to ensure it poses no threat to humans or Earth. An expenditure of approximately $1B is projected for a stationary lander mission, and the undertaking is slated to span five years, though funding and mission selection could extend this timeframe. Initial development grants would be directed towards fostering collaborative efforts, such as organizing events for workshop participants.

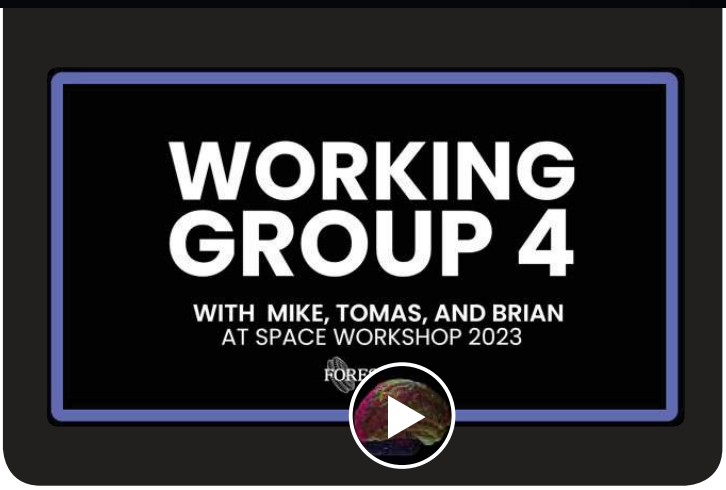
Law and Policy



SUMMARY

Working Group 3 emphasized the urgent need for revamped space laws, highlighting issues with existing regulations and the potential overreach of the Federal Communications Commission (FCC). The group proposed new U.S. legislation to foster certainty in markets and global dialogues, suggesting an industry-led regulatory approach to prevent unnecessary FCC interference and ensure beneficial regulations. The initiative seeks to consolidate regulatory authority, perhaps under a single agency like the Department of Commerce, to promote a growing and safe space economy. Recognizing risks such as potential delays in space advancements, a balance and consensus among stakeholders were deemed crucial. The group outlined next steps, including creating a white paper, hosting meetings to detail concepts, and conducting an "Asteroid Day" event to raise awareness and test ideas, with subsequent workshops and draft legislation development to follow. Estimated costs for initial planning stand at $100k, while legislative enactment may span 2-3 years and cost $1-3M.

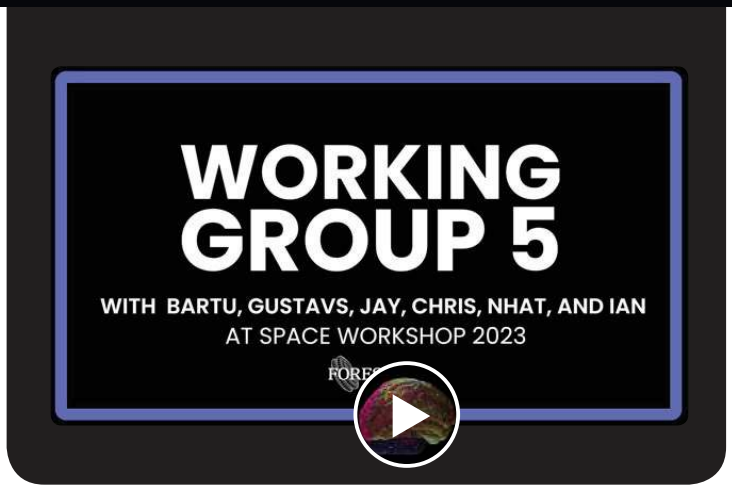
Launch Location Liberalization



SUMMARY

Working Group 4 focused on exploring strategies to reduce launch prices and optimize spaceport use in the United States, without favoring specific technologies or entities. Acknowledging the current congestion and regulatory challenges at U.S. spaceports, the team proposed liberalizing spaceport licensure and infrastructure, promoting smaller spaceports, and considering the establishment of a national spaceport system, inspired by models like New Zealand. They contemplated creative awareness and funding initiatives, such as a movie about China's first mission to Mars, to spur interest and financial support in space exploration. While acknowledging the risks, such as geopolitical and safety concerns, the group emphasized finding a balanced approach. Future steps include crafting a research paper on the benefits of easing U.S. spaceport regulations and conducting follow-on workshops to discuss potential solutions to launch congestion, with an eye toward involving regulatory experts and potentially forming new organizations or coordinating with existing ones.

Space Canvas



SUMMARY

Working Group 5 introduced a plan to construct the largest space structure to date using a specific aluminum material (80/20) and a new assembly method termed "shorts". This approach leverages small robots to make in-orbit assembly considerably more affordable and safe compared to the current Extra-Vehicular Activity (EVA) method, which is slow, costly, and risky. Despite challenges like human-robot interactions and untested struts, the group identified numerous potential advantages and monetization avenues such as space art, science equipment assembly, and in-space real estate. An estimated assembly time frame on Earth is three to six months with a budget of $5M and a project timeline of 6-12 months. The group encouraged support in various forms, including partnerships, sponsorships, and a Patreon campaign, and proposed next steps including crowdfunding via a video and fundraising campaign, material procurement, and coordinating with SpaceX for a launch. They invite further development through video workshops, space law workshops, and incentivizing space art projects, while exploring potential funding and partnerships and liaising with relevant organizations.

Meta Challenges to Progress in Space Development

Historical and Current Perspectives

Challenges in Funding

- The Gap Between Initial Successes and Long-term Goals: While we have achieved significant strides in communication, earth observation satellites, and military space systems, the bridge to long-term goals like asteroid mining remains elusive. Many believe that the challenge is primarily economic rather than technological, as substantial investments are needed for such ambitious goals.
- Coordination Across Funders: Government funds are largely allocated to defense, creating a complex relationship with private investors. A significant challenge for private funders is the perceived absence of substantial near-term profit opportunities in space.
- Bridging Solutions: Potential bridging mechanisms include space tourism, scientific experiments, and manufacturing in space. However, the lack of genuine progress and sustainable government funding remains a concern. One could argue that today's space development stagnation mirrors the situation in the 1980s, raising questions about societal courage and the need for shifting political visions. Notably, sustainability became mainstream despite limited economic incentives, largely due to shareholder activism related to climate change.

Regulatory Obstacles

- International Restrictions: The MTCR, a consensus-based international agreement, imposes restrictions that impact new space partnerships and endeavors.
- Regulation and Jurisdiction: A central challenge is determining the authoritative body for regulating space activities, especially concerning space traffic and debris.
- Private Property in Space: The absence of structures for staking private claims in space, such as mining rights, hinders speculative investment. Current precedents include the ambiguous mission authorization bill and the FCC's orbital degree mitigation.

Talent Acquisition Barriers

- Training and Mindset: Traditional aerospace training might be hampering innovative approaches to space development. Engineers deeply ingrained in established safety-first cultures might find it challenging to adapt to dynamic space environments.
- Rising Stars in Space: Contrarily, organizations like SpaceX employ a significant percentage of engineers from hands-on projects like solar car and liquid rocket teams. These engineers bring a fresh perspective, but their numbers are overshadowed by traditionally trained counterparts.

Educational Roadblocks

- Institutional Conservatism: Modern academic structures tend to marginalize unconventional ideas, creating a narrow narrative in space studies.
- Repression of Innovative Ideas: The present academic environment, underscored by a stringent peer review system, might be suppressing the courage to explore groundbreaking space research. There is a concerning trend of sidelining bold concepts, with platforms like Arxiv not immune.

In conclusion, while humanity's drive to explore space remains strong and exciting technical opportunities are emerging, these overarching challenges underscore the need for innovative solutions in funding, regulatory frameworks, talent acquisition, and education to truly progress in space development.