Insights from Reverse Pitches to Innovate For Mars & Deliver Value to Earth

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See full event guide here: Mars Innovation Workshop 2025 Full Guide
See full session transcript here: Session Transcripts: Mars Innovation Workshop
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Long Article (1813 words)

Reverse Pitches: Identifying the Hardest Problems for Mars and Earth

At the 2025 Mars Innovation Workshop hosted by Explore Mars, we set aside a few special sessions to challenge participants to rethink how they approach problem-solving. Why? Because these participants came from a variety of backgrounds, including startups, nonprofits, academic research, public entities, investment, the arts, and the private sector. The workshop was designed to elicit diverse perspectives and experiences and set the stage for them to come together in new and impactful ways.

To that end, instead of pitching solutions, we asked participants to define the most critical, unsolved challenges that must be addressed for humanity to thrive on Mars. This exercise, which we formulated as Reverse Pitches, forced participants to step back from immediate technological fixes and instead focus on the underlying problems that, if solved, would unlock transformative progress—not just for Mars, but for Earth as well.

Rather than framing discussions around existing frameworks like NASA's Civil Space Shortfalls, here we encouraged far-horizon thinking. We asked participants to identify challenges that might seem impossible today but could become solvable within the coming decades thanks to technological—and dare we say societal—progress. The goal was to find problems so fundamental that they would shape **not just survival, but the ability to build a thriving society in space—while delivering value on Earth starting today.**

Defining the Right Problems is Harder Than It Seems

One of the first hurdles we encountered was the instinct to jump directly to solutions. Many participants initially focused on existing technologies or incremental improvements rather than identifying the deep, unsolved problems that block progress.

To guide their thinking, we provided a structured framework, asking them to consider:

- What is the core problem?
- Why is it particularly difficult to solve?
- Why is it critical for Mars?
- How does solving it also create value on Earth?

This approach helped shift the conversation from surface-level technical challenges to **systemic issues that demand breakthrough thinking.**

The Hardest Problems We Need to Solve for Mars (and Earth)

Participants self-selected into groups to focus on key topic areas: health and well-being, food and food production, clean and renewable energy, habitability (with two separate groups tackling different aspects), materials, community life, digital life and work, and infrastructure. Each team worked to define the hardest, unsolved problems in their topic area that will **shape life on Mars while delivering value on Earth**.

After an intense first session focused solely on identifying audacious problems, participants regrouped to pitch their challenges to the full room. Each team had just three minutes to make the case for their problem: why it remains unsolved, why it is critical for Mars, and how solving it could create meaningful benefits on Earth. Unlike traditional pitch sessions, where participants try to sell solutions, this exercise forced everyone to stay in the problem space—a shift in thinking that proved both challenging and eye-opening. Some groups tackled the **physical necessities of survival**, while others explored the **social, economic, and psychological dimensions of building a lasting civilization.**

The Energy team made a compelling case for why **indigenous power generation** is essential for Mars. Existing space missions rely on imported solar panels and nuclear reactors, but a permanent settlement cannot depend on Earth for energy infrastructure. The team explored the potential for biological power generation, cosmic radiation harvesting, and hybrid energy ecosystems, arguing that breakthroughs in Mars energy solutions could also radically reshape how we generate power on Earth.

The Food & Nutrition team focused on a question that sounds simple but is deceptively complex: **What can we grow on Mars?** A regenerative, resource-efficient food system will be essential, but it must do more than provide calories. The team emphasized that food plays a vital role in culture, morale, and psychological well-being, meaning that a Martian food system must balance efficiency with variety, adaptability, and social connection. This problem is just as urgent on Earth, where climate change and soil degradation threaten global food security.

The Community Life team tackled a challenge that often gets overlooked: **How do we design governance and social structures that foster long-term stability and cooperation?** They argued that traditional governance models might not work in extreme, isolated environments like Mars communities; they proposed exploring new incentive structures that promote cohesion

while preventing factionalism and instability. Clearly, solutions to this problem would positively impact life on Earth, starting today.

The Habitability groups approached their problem from two distinct perspectives. One team focused on **how to transition from mission-style support to true self-sufficiency,** recognizing that current space missions rely heavily on constant oversight from Earth. The other team explored the **"threshold of habitability"**—the moment when a settlement moves beyond mere survival and becomes a thriving community. Both groups saw habitability as an evolving challenge, but one approached it from a logistical standpoint, while the other framed it as a cultural and psychological milestone. The conversation highlighted a deeper question: How do we measure success in space settlement?

The Materials group presented their problem with humor (yes, there was singing) but made a serious point: everything on Mars must be built from something, and we don't yet have a clear plan for **how to source, process, and recycle materials sustainably.** They emphasized that a closed-loop, adaptable materials ecosystem is essential for Mars—and could also revolutionize sustainable manufacturing on Earth.

The Infrastructure team framed their challenge as an opportunity to **rethink utilities—water, power, waste management—from the ground up.** Existing infrastructure models are costly, fragile, and heavily dependent on centralized networks. In contrast, Mars provides a testbed for modular, decentralized, and scalable infrastructure solutions, with applications ranging from disaster relief zones to rural communities on Earth.

Finally, the Health and Well-Being team asked a crucial question: **Are we humans prepared for the psychological and physiological toll of indefinite survival in isolation?** Using the pandemic as a reference point, this team emphasized that mental health isn't just a side concern—it's a critical factor in long-term mission success and human sustainability. Their work highlighted the need for proactive strategies to support social resilience, identity, and emotional well-being in extreme environments, with solutions poised to help daily life on Earth, too.

Complexities and Areas of Disagreement

As each team pitched their Hardest Problem, discussions emerged around how to define "hard problems" and where to set priorities. One of the biggest areas of disagreement centered on what kinds of problems should take priority. Some participants focused on **basic survival challenges that must be solved first**, such as radiation shielding, food production, and life support. Without these, no settlement could exist. Others argued that **civilization-building challenges—governance, community well-being, and economic structures—are equally essential.** They pointed out that history shows that societies don't succeed on infrastructure alone; they need cultural, political, and ethical frameworks.

Another overarching debate arose around the role of **AI in life on Mars.** Space missions today rely heavily on Earth-based mission control, raising concerns about how much decision-making power should be retained on Earth versus shifting entirely to Mars. Some participants

envisioned AI-driven systems optimizing governance, resource allocation, and even dispute resolution to minimize human bias and inefficiency. Others warned that over-reliance on AI could erode human agency, embed biases into decision-making, and create power imbalances if not designed with transparency and oversight. Are human-led structures essential for long-term societal cohesion? The big question is: Should Mars settlements experiment with fully autonomous AI-driven decision-making, or should humans remain central to all major choices?

There was also a divide between those who saw Mars primarily as a **technological challenge** and those who viewed it as a **sociological experiment**. Some participants framed Mars as a hardware problem—requiring breakthroughs in energy, materials, and infrastructure—while others emphasized governance, psychology, and human cooperation as the real bottlenecks.

The Infrastructure team sparked a final disagreement over **centralized vs. decentralized models**. Should Mars rely on large-scale, high-efficiency infrastructure akin to Earth's cities, or should it develop a decentralized, self-sustaining model with minimal points of failure? The conversation mirrored ongoing debates about urban resilience, smart cities, and decentralized infrastructure on Earth.

And the Hardest Problems Are …

With the pitches complete, it was time to vote. Each participant had **three votes** to distribute among the challenges they found most compelling. The **top three Hard Problems** at this workshop were:

1. **Energy**: How can we develop sustainable, redundant, and autonomous power generation for Mars?
2. **Food & Nutrition**: What will a fully regenerative Martian food system look like?
3. **Materials**: How can we build, repurpose, and recycle materials in an environment where every resource is precious?

Wouldn't these Hard Problems make excellent prize challenges, which are powerful ways to motivate innovation? Think about XPRIZE's ability to "catalyze entire markets by incentivizing entrepreneurship." Explore Mars has offered to work with the winning teams to further develop their Hard Problems into seeds for future prize challenges.

From Defining Problems to Motivating Action

As the session wrapped up, participants reflected on the challenge of **staying in the problem space.** Many admitted it was difficult to hold back from jumping to solutions, but ultimately, this approach led to deeper, more fundamental insights. Some participants noted that in real-world applications and policy, solutions are often implemented before problems are fully understood, leading to wasted resources and unintended consequences. Plus, participants walked away from these sessions with a greater appreciation for the **interconnected nature of technical and societal challenges** in space.

By taking the time to properly define the hardest problems, these sessions created **a roadmap for high-impact innovation**, ensuring that the solutions we develop for Mars are solving the right problems—not just the easiest (or most profitable) ones.

And perhaps most importantly, it reinforced the idea that **solving for Mars is solving for Earth.** Whether tackling energy independence, food security, governance, or infrastructure, the biggest challenges of a Mars community mirror the biggest challenges we face today. If we can get it right in space, we can transform life on our own planet.

What became clear was that **Mars isn't just a technological challenge—it's a civilization-scale challenge.** The solutions we develop for sustaining life on Mars will ultimately shape the future of human expansion into space—and provide **new models for addressing Earth's greatest challenges today.**

How Can You Help?

Whether you're an investor, entrepreneur, researcher, policymaker, or simply someone who believes in a positive future for humanity, there's a role for you in shaping the future of technology and innovation for space and Mars. Here are some steps you can take:

- Join the Explore Mars community to connect with innovators tackling the biggest challenges of interplanetary and Earth-based sustainability.
- Become a sponsor or donor to support Explore Mars programs that drive collaboration, research, and real-world impact.
- In your local community and your industry, advocate for policies that accelerate space commercialization and ensure that technology benefits all of humanity.

And most importantly, stay engaged. The Hardest Problems "for Mars" can empower us to solve some of Earth's greatest challenges. Are you ready to be part of the solution?

Medium-length Article (853 words)

Reverse Pitches: Rethinking the Hardest Problems for Mars and Earth

At the 2025 Mars Innovation Workshop hosted by Explore Mars, we flipped the traditional view of innovation on its head. Instead of pitching solutions, we challenged participants to **define the hardest, unsolved problems** that must be addressed for a thriving human presence on Mars. This exercise, which we called Reverse Pitches, forced participants to step back from immediate technological fixes and focus on fundamental challenges—the ones that, if solved, could **drive transformative progress for both Mars and Earth, starting today**.

Participants from startups, research institutions, public agencies, investment, the arts, and industry worked in groups to define these problems across health and well-being, food and food

production, clean and renewable energy, habitability (with two separate groups tackling different aspects), materials, community life, digital life and work, and infrastructure. Staying in the problem space proved difficult but invaluable, leading to deeper insights into why certain problems remain unsolved and what breakthroughs are needed to unlock solutions.

The Hardest Problems We Need to Solve

The Energy group highlighted the need for autonomous, sustainable power generation on Mars, as reliance on imported energy infrastructure is not a long-term solution. Their pitch underscored how solving this challenge could also revolutionize clean, resilient energy solutions on Earth.

The Food and Nutrition group tackled how to create a regenerative food system that provides nutrition, cultural connection, and psychological well-being—key concerns not just for Mars, but also for climate-stressed regions on Earth.

The Community Life group questioned how governance and social structures should be designed in an extreme, isolated environment. They debated whether existing Earth-based models should be adapted or if Mars provides an opportunity to rethink governance from the ground up.

The Habitability groups took two approaches: one explored how to transition from Earth-dependent mission support to full self-sufficiency, while the other asked when a settlement stops surviving and starts thriving.

The Materials focused on a serious issue: how to build and recycle in an environment where every resource is precious. They emphasized that closed-loop material ecosystems developed for Mars could radically improve sustainability and resilience on Earth.

The Infrastructure group proposed rethinking how water, power, and waste systems are designed. Instead of replicating Earth's large, centralized infrastructure, they envisioned investigating modular, decentralized solutions—with potential applications for Earth, starting today.

The Health & Well-Being group warned that mental and social resilience is just as critical as physical survival. They argued that long-duration isolation presents unprecedented risks, requiring new strategies for maintaining psychological health. These challenges are present no matter where humans call home.

Where the Conversation Got Interesting

Some participants focused on **basic survival challenges** (radiation shielding, life support, food production), while others argued that **governance, culture, and well-being are just as essential.** There was also debate over **AI-driven decision-making**: should Mars settlements experiment with autonomous AI governance, or should humans always remain in control?

The biggest philosophical divide? Whether Mars is primarily a **technological challenge** (requiring better infrastructure, energy, and materials) or a **social experiment** (focused on governance, psychology, and human cooperation). A "yes, and" mindset was empowering here.

And the Hardest Problems Are …

Each team had just three minutes to make the case for their problem: why it remains unsolved, why it is critical for Mars, and how solving it could create meaningful benefits on Earth. Unlike traditional pitch sessions, where participants try to sell solutions, this exercise forced everyone to stay in the problem space. After a round of voting, the most compelling Hard Problems were:

1. **Energy** – How can we develop sustainable, redundant, and autonomous power generation for Mars?
2. **Food & Nutrition** – What will a fully regenerative Martian food system look like?
3. **Materials** – How can we build, repurpose, and recycle materials in an environment where every resource is precious?

What's Next? Turning Problems Into Action

Wouldn't these Hard Problems make excellent prize challenges, which are powerful ways to motivate innovation? Think about XPRIZE's ability to "catalyze entire markets by incentivizing entrepreneurship." Explore Mars has offered to work with the winning teams to further develop their Hard Problems into seeds for future prize challenges.

The biggest takeaway? **Solving for Mars is solving for Earth.** The hardest problems in space—energy, food security, governance, and infrastructure—are also the greatest challenges we face today. If we can solve them for Mars, we can transform life on our own planet.

How Can You Help?

Whether you're an investor, entrepreneur, researcher, policymaker, or simply someone who believes in a positive future for humanity, there's a role for you in shaping the future of technology and innovation for space and Mars. Here are some steps you can take:

- Join the Explore Mars community to connect with innovators tackling the biggest challenges of interplanetary and Earth-based sustainability.
- Become a sponsor or donor to support Explore Mars programs that drive collaboration, research, and real-world impact.
- In your local community and your industry, advocate for policies that accelerate space commercialization and ensure that technology benefits all of humanity.

And most importantly, stay engaged. The Hardest Problems "for Mars" can empower us to solve some of Earth's greatest challenges. Are you ready to be part of the solution?

Social Media Post (point to long or medium article)

🚀 **What are the hardest problems we need to solve for Mars—and for Earth?** 🌍

At the 2025 Mars Innovation Workshop, we challenged participants to rethink problem-solving. Instead of pitching solutions, we asked: What are the fundamental, unsolved challenges that must be addressed for a sustainable human presence on Mars—all while delivering value to Earth?

From energy independence to food security, from mental well-being to governance, and from closed-loop materials to resilient infrastructure, the discussions revealed that the biggest challenges for Mars are also the ones shaping our future on Earth.

Participants pitched these hard questions:

- How can we develop sustainable, redundant, and autonomous power generation for Mars (without relying on Earth)?
- What will a fully regenerative and culturally rich Martian food system look like?
- How do we design governance and social structures that foster long-term stability and cooperation?
- When does a Mars community stop "surviving" and start "thriving"?
- How can we build, repurpose, and recycle materials in an environment where every resource is precious?
- How can we rethink water, power, and waste systems from the ground up?
- Are we prepared for the psychological and physiological toll of indefinite survival in isolation?

These challenges demand **breakthrough thinking, bold collaboration, and a willingness to rethink what's possible.** The solutions we develop won't just shape the future of space exploration—they'll help us tackle Earth's biggest challenges today.

The hardest problems are the ones worth solving. **Who's ready to build the future with us?** 🚀

Notes

Previous text (without part 2)

Redefining the Building Blocks of a Thriving Mars Civilization

The food and agriculture discussions provided a fresh perspective on space settlement. While space exploration often reduces food to a question of calories and logistics, participants in this group argued that **food is deeply tied to culture, well-being, and social cohesion**. They suggested that rethinking food production on Mars could shape not only physical survival but also community structures, governance, and economic systems. In other words, food isn't just a necessity—it's a building block of civilization.

Discussions on governance primarily emerged from the Community Life group, which explored how **Mars communities should organize themselves** politically, economically, and socially. A key debate centered on whether Mars should remain politically and economically tied to Earth or develop entirely new governance systems suited to its unique environment. Some participants argued that maintaining strong ties to Earth's institutions would provide stability and help prevent conflict, while others saw Mars as a chance to potentially start fresh, free (or more free) from the geopolitical entanglements and inequalities of Earth. This discussion led to bigger questions about whether Martians should adopt existing economic and political models or experiment with entirely new forms of governance suited to an off-Earth society.

One of the most pressing technical debates was over **how Mars should generate power.** Some participants advocated for small modular nuclear reactors as the best solution, given their energy density and reliability. Others raised concerns about the **r**isks of launching nuclear material to Mars and suggested alternative power sources such as solar, geothermal, or bioengineered energy systems—each of which comes with its own benefits and drawbacks. Ultimately, the conversation pointed toward a **hybrid model**, where nuclear power serves as a backbone but is supplemented by **renewable and biological energy sources** for long-term sustainability.

From Brainstorming to Action: What's Next?

After extensive discussion, each group was tasked with selecting **one major problem** to refine into a concise, **three-minute pitch.** These refined problem statements were then prepared for the **next session, where participants would vote on the most compelling challenge.**

The **winning pitch** would receive **support from Explore Mars** to develop a formal **XPRIZE proposal**, with the potential to become a globally recognized challenge.

To help participants sharpen their problem statements, we encouraged them to **use AI-assisted drafting tools** such as ChatGPT. This aligned with a broader conversation on how AI can serve as **a creative partner in early-stage problem identification and research.**

Additionally, this session set the stage for **the "Artifacts of the Future" exercise**, where participants would **imagine tangible technologies or systems that could emerge** from solving these hard problems. This ensured that the ideas generated weren't just abstract concepts but could be translated into **practical innovations and speculative future-building.**

Rethinking the Future of Mars—and Earth

The **Reverse Pitches** session successfully shifted participants' thinking from **quick-fix solutions to deep, systemic challenges.** The disagreements that emerged—about governance, AI, energy, and cultural continuity—highlighted the **complexity of building a sustainable society on Mars.**

Participants walked away with a greater appreciation for the **interconnected nature of technical and societal challenges** in space. More importantly, they identified **specific, high-impact problems** that now have the potential to be developed into **funded research, startup ideas, or policy initiatives.**

What became clear was that **Mars isn't just a technological challenge—it's a civilization-scale challenge.** The solutions we develop for sustaining life on Mars will ultimately **shape the future of human expansion into space—and provide new models for addressing Earth's greatest challenges today.** 🚀

Summary & Key Insights, Part 2 (+ Disagreements)

Summary of Reverse Pitches Part 2: Presentations, Voting, and Shareback

Following an intense **problem-identification** session, participants reconvened to **pitch their hard problems** to the full group. Each team had three minutes to present their challenge, followed by a brief Q&A. The session concluded with voting, where participants used limited votes to select the most compelling problem.

The Pitches: Critical Challenges for Mars and Earth

Each group delivered a **succinct, high-energy pitch**, emphasizing why their hard problem is unsolved, why it is essential for Mars, and how solving it benefits Earth. Some key themes emerged across the presentations:

- **Energy:** The team highlighted the need for **indigenous energy sources on Mars**, arguing that reliance on imported solar panels and nuclear reactors is unsustainable. They proposed exploring biological agents that could generate power and novel methods of harvesting galactic cosmic radiation. Their pitch emphasized how off-world energy breakthroughs could **directly contribute to sustainable power solutions on Earth** in the face of climate change.

- **Food & Nutrition:** This group framed their challenge as **"What can we grow on Mars?"**, emphasizing the need for a **fully regenerative, resource-efficient food system** that can function in extreme environments. They drew strong parallels to food security on Earth, especially in **climate-stressed and non-arable regions.**

- **Community Life:** This team tackled the challenge of **designing governance and incentive structures** that would ensure **long-term stability and cooperation** in a Martian settlement. Recognizing that disagreements can be productive but also destabilizing, they proposed frameworks for fostering **social cohesion** while preventing factionalism and conflict—lessons that could also **inform governance in rapidly evolving industries and societies on Earth.**

- **Habitability:** Two groups tackled habitability from different angles. One group focused on **the invisible problem of mission support**—highlighting that current space missions require **constant oversight from Earth**. They argued that Mars missions must become **self-sustaining**, reducing dependence on mission control. The second group explored the **threshold between survival and true habitability**, proposing the need for clear frameworks to define when a settlement transitions from merely surviving to thriving.

- **Materials:** This team framed their challenge with humor but delivered a serious message: **everything on Mars must be built from something, and we don't yet know how to source, process, and recycle materials sustainably.** They outlined the three-step challenge of **mapping available resources, extracting useful elements, and building functional, radiation-resistant materials.** Their work underscored the urgent need for a **closed-loop, adaptable materials ecosystem**, which could also **revolutionize sustainable production on Earth.**

- **Infrastructure:** The infrastructure team tackled **the fundamental challenge of delivering essential utilities—water, power, and waste management—in low-resource environments.** They noted that existing infrastructure systems are **expensive, rigid, and unsuited to extreme conditions**, arguing that space provides an opportunity to **rethink infrastructure from the ground up.** Their vision was for **scalable, decentralized, and green infrastructure solutions that could be deployed anywhere, including underserved regions on Earth.**

- **Health & Well-being:** This group asked a stark question: **Are we prepared for the mental and physical toll of indefinite survival in isolation?** Using the pandemic as a reference point, they argued that **human health is not just about survival—it's about ensuring that people can thrive.** Their pitch focused on the intersection of **culture, connection, and self-care**, emphasizing that **community resilience is as critical as physical health.**

Key Areas of Disagreement & Debate

- **Defining the "Threshold of Habitability"** – Some participants argued that Mars should be built for **baseline survival first**, while others pushed for **designing for well-being and human flourishing from the start.** A few questioned whether leisure and play should be **early priorities** or **luxuries for later phases of settlement.**

- **Autonomy vs. Earth Dependence** – Several groups surfaced concerns about **how much autonomy Mars should have from Earth**, particularly in mission-critical areas like **energy, governance, and digital systems.** The habitability group pointed out that nearly all space missions today **depend on Earth-based mission control**, raising concerns about how Mars will function when real-time support is unavailable.

- **Technology vs. Social Systems** – A broader conversation emerged in the **shareback session** about **whether Mars challenges are primarily technological or sociological.** Some saw Mars as a **hardware problem** (requiring better infrastructure, energy, and materials), while others emphasized that **human factors, governance, and cultural cohesion** would ultimately determine success or failure.

- **Centralized vs. Decentralized Infrastructure** – The infrastructure team framed their challenge as a chance to **redesign how infrastructure works from scratch**, but some participants questioned whether **established, large-scale infrastructure models** should be adapted rather than replaced entirely.

- **Decision-Making & Governance Models** – The governance discussion raised **concerns about regulating emerging technologies**, balancing **freedom with structure**, and ensuring that **power doesn't become concentrated in the hands of a few decision-makers.** Some proposed **entirely new governance models**, while others suggested starting with **Earth-inspired structures before evolving.**

The Voting Process & Winning Pitches

After the pitches, participants voted for the challenges they believed had the greatest **potential for impact on Mars and Earth.** Each person had **three votes**, which they could distribute however they wanted. The **top three problems selected for further development** were:

1. **Energy** (17 votes) – The challenge of **indigenous power generation for Mars** was seen as critical and transformative, with major implications for **Earth's transition to sustainable energy.**
2. **Food & Nutrition** (13 votes) – The need for **regenerative, resource-efficient agriculture** resonated deeply, especially given global food security concerns.
3. **Materials** (12 votes) – The challenge of **sourcing, building, and recycling materials sustainably** struck a chord, as it is foundational for all future Mars infrastructure.

Shareback Reflections: The Challenge of Staying in Problem-Space

As the session wrapped up, participants reflected on the experience of being **forced to stay in the problem space** without jumping to solutions. Many found this **frustrating but valuable**, as it **helped surface deeper, more fundamental challenges.**

- Some **thrived** in this mindset, arguing that **by focusing solely on the problem, the right solutions naturally began to emerge.**
- Others struggled, feeling like they were **holding back their instincts to problem-solve.**
- A broader reflection emerged about **how different disciplines approach problem-solving**—engineers and scientists often **default to technical fixes**, while **social scientists and systems thinkers** tend to explore **context, governance, and long-term adaptability.**

A final discussion point was **how this approach translates to real-world decision-making.** Participants noted that in industry, government, and research, **solutions often get implemented before problems are fully understood**, leading to **misaligned innovations, unintended consequences, and inefficiencies.**

Next Steps: Moving From Problems to Action

With the winning challenges identified, the next step is to **refine these problems into actionable research and innovation pathways**. Explore Mars will work with the **top-voted teams** to shape these challenges into **a potential XPRIZE pitch**, ensuring they **attract investment, research, and collaborative efforts to drive real-world impact.**

The session reinforced that **solving for Mars is solving for Earth.** The most pressing challenges for an off-world settlement—energy, food, materials, and governance—mirror the urgent sustainability challenges we face today. **By tackling these hard problems for Mars, we unlock solutions that can transform life on Earth.**

Summary & Key Insights, Part 1 (+ Disagreements)

Reverse Pitches: Identifying the Hardest Problems for Mars and Earth

At the **Mars Innovation Workshop**, participants engaged in a unique exercise: rather than pitching solutions, they were asked to **identify the hardest unsolved problems** that need to be tackled for a sustainable human presence on Mars. These challenges weren't just framed around survival in space—they were also required to **deliver value to Earth** in both the short and long term.

Facilitators encouraged **far-horizon thinking**, pushing participants beyond existing NASA priorities or technical feasibility. Instead, the session focused on **big-picture, systemic challenges that, once solved, would unlock entirely new possibilities for human settlement on Mars and innovation on Earth.**

This process revealed deep insights—and **uncovered areas of major disagreement** that showcased just how complex these challenges truly are.

Key Insights and Takeaways

Defining the Right Problems is Harder Than It Seems

A key theme throughout the session was the **struggle to stay focused on problems rather than jumping to solutions.** Many participants instinctively referenced **existing technologies or incremental improvements** rather than identifying **underlying, unsolved problems.**

To help guide thinking, facilitators provided structured templates for problem definition:

- **What is the core problem?**
- **Why is it particularly difficult to solve?**
- **Why is it critical for Mars?**
- **How does solving it benefit Earth as well?**

This helped shift the conversation toward **deep, cross-cutting challenges** rather than surface-level technological gaps.

Tensions Between Immediate Needs and Long-Term Civilization Building

A central disagreement emerged around **what kinds of problems should be prioritized.**

- Some participants believed that **basic survival must come first**—solving issues like food, air, water, and radiation shielding before worrying about social structures or governance.
- Others countered that **history shows that societies are built around culture, governance, and purpose—not just shelter and calories.** They argued that **ignoring societal, psychological, and governance challenges would doom any Mars settlement to fail.**

This tension shaped how different groups framed their problem statements. Some focused on **technical bottlenecks**, while others proposed challenges related to **community-building, law, and ethics.**

Cross-Disciplinary Thinking Led to Breakthroughs

A major success of the session was the **diversity of expertise in each group**. Participants from non-traditional space backgrounds—including **biologists, social scientists, artists, and policymakers**—introduced fresh perspectives.

- One example was a **biologist proposing bioengineered solutions for energy production**—a challenge often framed purely in terms of nuclear or solar power.

- Another group highlighted **how cultural and psychological factors shape habitability**, arguing that purely technological solutions wouldn't be enough to **ensure long-term well-being in space.**

By blending **technical and human-centered approaches**, participants expanded the definition of **what's truly needed for a thriving Mars settlement.**

The Role of AI in Mars Governance Sparked Debate

A particularly heated discussion emerged around **whether AI should play a dominant role in governance and decision-making.**

- Some argued that **AI would be necessary to ensure fairness, reduce human biases, and optimize decision-making.**
- Others warned against **over-reliance on AI**, pointing out risks such as **algorithmic bias, reduced human agency, and potential overreach in personal autonomy.**

This disagreement underscored a broader theme: **technology is not neutral**—how it is implemented on Mars will shape **power structures, rights, and daily life.**

Food is Not Just Fuel—It's a Foundation for Civilization

The **food and food production** group made a particularly compelling case that **food is often overlooked in space planning—but it is central to building a lasting civilization.**

- Food isn't just about **calories and nutrients**; it's about **culture, social interaction, and mental health.**
- The group proposed that **rethinking food production could shape not just survival but governance, economics, and even the legal frameworks of a Mars settlement.**

This discussion reframed **food systems as a core pillar of civilization-building** rather than a secondary concern.

How Much Influence Should Earth Have Over Mars?

Another divisive topic was **whether Mars should remain politically connected to Earth or develop its own independent governance models.**

- Some believed that **Mars should be an extension of existing Earth institutions** to ensure stability and avoid repeating historical conflicts.
- Others argued that **Mars represents a blank slate—a chance to leave behind Earth's geopolitical baggage and start fresh.**
- This debate touched on **whether Mars should adopt Earth's legal and economic models** or experiment with **new, decentralized, or cooperative governance structures.**

While no consensus was reached, the discussion highlighted the **fundamental uncertainties about how humanity will organize itself in space.**

Energy Systems: Nuclear vs. Alternative Solutions

The **energy and infrastructure** group debated **whether nuclear power should be the primary energy source on Mars** or whether alternative systems—such as solar, bioenergy, or geothermal—should take priority.

- Proponents of **small modular nuclear reactors (SMRs)** emphasized their reliability and energy density.
- Critics worried about the **challenges of launching nuclear material, regulatory hurdles, and the need for extensive shielding.**
- Some suggested **hybrid models**, where nuclear provides baseline power but is supplemented by **renewables and biological energy solutions.**

This debate mirrored Earth's own **ongoing energy transition**, reinforcing the idea that **Mars challenges often reflect larger global issues.**

From Brainstorming to Action: What's Next?

After extensive discussion, each group **narrowed its ideas to a single "hard problem"** that they would refine into a **three-minute pitch** for the next session. The winning pitch would receive support from **Explore Mars** to develop a **formal XPRIZE proposal**, potentially turning it into a major funding opportunity.

To help refine ideas, participants were encouraged to **use AI tools like ChatGPT** for drafting and structuring their problem statements. This aligned with broader discussions on **how AI can aid early-stage research and problem definition.**

Additionally, this session **set the stage for a later exercise on "Artifacts of the Future,"** where participants would **imagine tangible technologies or systems that could emerge** from solving these hard problems. This approach bridged **problem identification with world-building**, ensuring that these challenges remained actionable.

Key Takeaways and Looking Forward

The **Reverse Pitches** session successfully reoriented thinking toward **deep, systemic challenges** rather than quick fixes. The disagreements that arose—about governance, AI, energy, and cultural continuity—highlighted the **complexity of building a sustainable society on Mars.**

Participants walked away with a greater appreciation for the **interconnected nature of technical and societal challenges** in space. More importantly, they identified **specific, high-impact problems** that now have the potential to be developed into **funded research, startup ideas, or policy initiatives.**

This session reinforced that **Mars isn't just a technological challenge—it's a civilization-scale challenge.** The hard problems we solve for Mars **will shape the future of human settlement in space and influence how we address our biggest challenges on Earth.** 🚀

Summary & Key Insights, Part 1 (w/o disagreements)

Summary of the Reverse Pitches Session

The **Reverse Pitches** session at the Mars Innovation Workshop challenged participants to rethink problem-solving by focusing exclusively on identifying **hard problems** rather than jumping to solutions. The goal was to surface **critical, unsolved challenges** that—once solved—would provide value both for future Martian settlers and for life on Earth.

Facilitators emphasized **far-horizon thinking**, urging participants to resist NASA's existing civil space shortfalls as a framing device and instead generate fresh, cross-disciplinary problem statements. The session was structured to gradually refine ideas, beginning with open brainstorming and culminating in a **three-minute problem pitch** that would later be evaluated through participant voting.

Key Insights and Takeaways

- **Shifting from Solutions to Problems**: Many participants initially struggled with avoiding solution-oriented thinking. A common instinct was to identify existing technologies or startups working on partial solutions rather than articulating the underlying, unsolved problem. The facilitators provided **structured templates** to help guide participants through defining the **real** problem and its broader implications.

- **Dual Value for Mars and Earth**: The framing of "dual-purpose" problems was a central theme. Participants were encouraged to ensure that each identified challenge had applications both **for sustaining life on Mars and for addressing urgent needs on Earth.**

- **Topic Areas and Group Selection**: Participants self-selected into topic groups, including **health & well-being, food & food production, clean renewable energy,**

habitability, transport, materials (clothing and construction), community life, digital life & work, and infrastructure. Some groups merged related challenges to develop broader problem statements that touched multiple sectors.

- **Cross-Disciplinary Thinking Sparks New Perspectives**: One unexpected dynamic emerged when individuals from **non-traditional backgrounds (e.g., biologists, social scientists, artists, and policymakers)** introduced ideas that others had not considered. A notable example involved a **biologist proposing biological energy solutions**—an idea that had not been widely discussed in previous space energy conversations. Another discussion highlighted the **cultural and psychological dimensions of habitability and well-being**, demonstrating that purely technological solutions might fall short without incorporating **human-centered design**.

- **The Challenge of Community Building on Mars**: One group focused on the fundamental difficulty of establishing **social cohesion and governance** in an isolated Martian settlement. They noted that we still struggle with these issues on Earth, making it an especially daunting problem to solve in space. Discussions included **language evolution, shared governance structures, and ethical decision-making frameworks.**

- **Food as a Cornerstone of Civilization**: The **food and food production** group made a compelling argument that food is often overlooked in space innovation but is **the foundation of human civilization.** They stressed that food-related innovations have the potential to shape **culture, health, and even governance structures in space.**

- **Reframing Challenges Through a Long-Term Lens**: One group worked with the concept of **"thinking seven generations ahead,"** a mindset shift that forced participants to consider not just survival but **thriving** over multiple decades. They explored **sustainability, long-term social structures, and self-sustaining infrastructure.**

- **Selecting a "Favorite" Hard Problem**: After brainstorming multiple problems, each group was tasked with selecting their **single most compelling challenge** to refine into a three-minute pitch. Participants debated which problem had the most **far-reaching impact and potential to unlock further innovation.**

Actions and Next Steps Identified by Participants

- **Developing an XPRIZE Proposal**: The winning problem pitch would receive **support from Explore Mars** to develop a refined proposal for **submission to XPRIZE**, potentially leading to a future high-impact competition.

- **AI as a Pitchwriting Tool**: Participants were encouraged to **use AI, including ChatGPT, to refine their pitches** and structure their problem statements concisely. This

aligned with discussions on how AI could aid in **early-stage idea development and problem articulation.**

- **Integrating Reverse Pitches with Artifacts of the Future**: The session set the stage for later discussions on **developing speculative future artifacts** based on these identified challenges. The idea was to **bridge problem identification with visionary world-building.**

The **Reverse Pitches session** successfully **reoriented thinking** toward defining **unsolved, high-impact challenges** that will be essential for **long-term human presence on Mars.** These insights and next steps ensure that the most pressing, **dual-benefit challenges** are not just discussed but actively pursued—both for space exploration and for solving global challenges on Earth. 🚀