PROJECT PROCESS BOOK

DESIGN FOR SOCIAL INNOVATION 2025

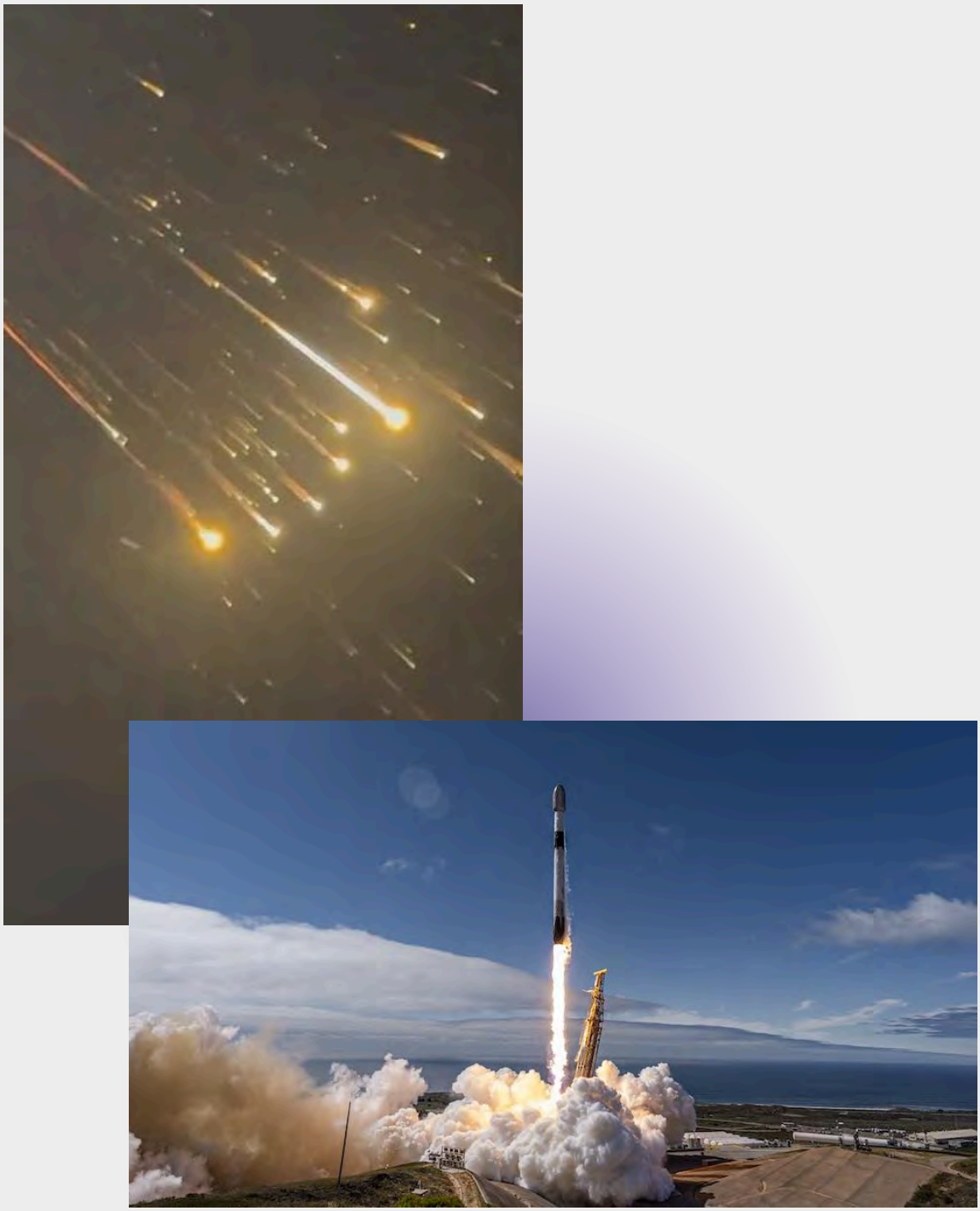
YUKI HAN
KATHERINE SHEN

S.T.A.R

SPACE TRASH AWARENESS & RECOVERY

POLLUTION ON AN ASTRONOMICAL LEVEL

Lunar Module surrounded by debris from rocket-body stage separation. Image source: NASA



SpaceX Starship explosion delays Florida flights at Orlando, Miami airports, startles witnesses

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“We Believe that when people reach beyond this planet, they should leave their national differences behind them.”

John F.Kennedy
35th U.S. President

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PREFACE

SPACE

Definition

The region beyond the Earth's atmosphere containing the other planets of the solar system, stars, galaxies, etc.; universe.

Key Characteristics

Vast.
Contains celestial bodies such as Earth.
Allowing free movement of objects
Subject of exploration.

EARTH

Definition

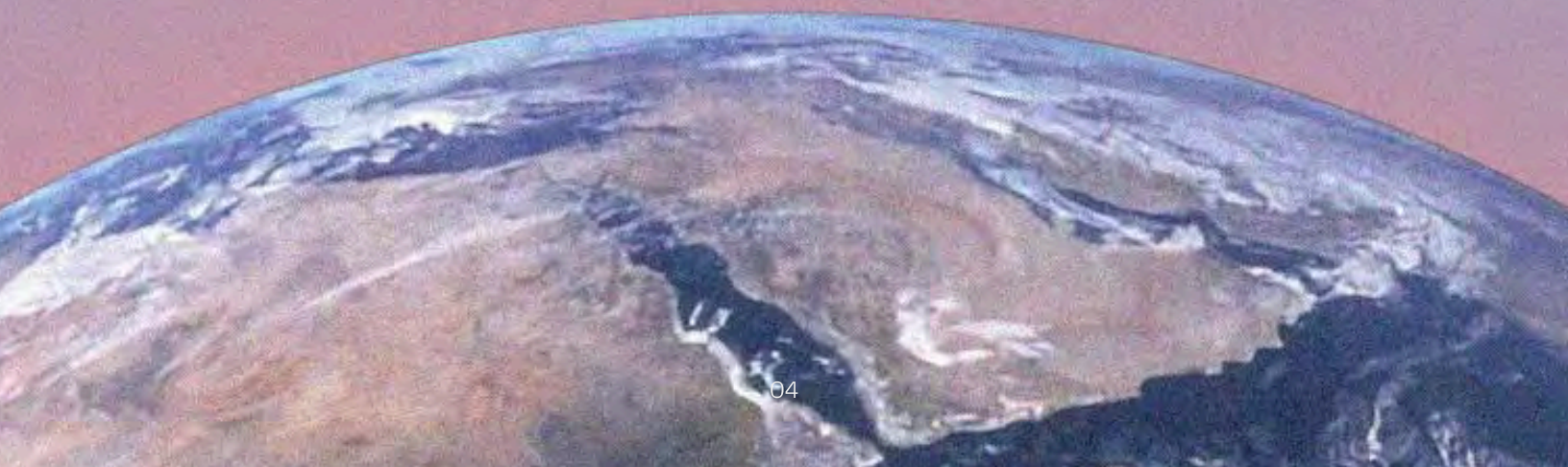
The planet on which we live; the world.

Key Characteristics

The third planet in solar system.
Comprises land, water, and atmosphere, supporting diverse life forms.
The habitat for all species.

Common Characteristics

Subject to human impact.



PROJECT OVERVIEW

Space is mesmerizing—silent, glittering, infinite. It makes us dream bigger, look upward, and ask questions too vast for Earthly answers. And yet, for most people, space feels impossibly distant—something owned by billionaires, mapped by nations, and watched only through telescopes. But what if we told you that what happens up there is already crashing down here?

This project began with a simple conviction: **space is not separate from Earth—it is Earth extended.** The cluttered orbit of our planet tells a story we know all too well—a story of overconsumption, short-term thinking, and ecological amnesia. Space debris is the mirror image of our earthly waste systems, now cast into the cosmos.

As a duo, we asked: What if we made space personal? What if we brought it down to Earth—not just as science fiction, but as shared responsibility?
Our thesis is a design-led mission to explore how young specialists—engineers, artists, scientists, and strategists—can be mobilized as stewards of the stars. It is also an attempt to shift public perception: **space is not just for astronauts. It belongs to all of us.**

Through storytelling, public interventions, speculative policy, and cross-sector collaboration, we offer a call:
look up—and take care.

WHO WE ARE

YUKI HAN

Yuki is an interactive artist and speculative designer, originally trained in computer science and visual art. She has always looked to the stars not as escape, but as metaphor. Space—its silence, its strangeness, its sublime scale—has long inspired her installations, which bridge physical and digital worlds. Through visual storytelling and experience design, Yuki makes the cosmic feel intimate, urgent, and human.

Together, we are the **Space Duo**
two artists and designers reshaping how space is seen, stewarded, and shared.

THE SPACE DUO

KATHERINE SHEN

Katherine is a designer and social researcher with a background in global studies and environmental justice. Her design ethos begins on Earth, but expands toward the stars. To her, space is not just about where we go—it's about how we belong. As an Earth citizen, she believes our responsibility to protect the sky is part of protecting our shared home. Katherine's work lies at the intersection of policy, people, and planetary ethics.

PHILOSOPHY

What happens in space reflects what happens on Earth.

And what we neglect in orbit, we echo in nature.

SUSTAINABILITY

STEWARDSHIP

Let us design with gravity in mind—not just the physics, but the responsibility.

"There are so many benefits to be derived from space exploration and exploitation; why not take what seems to me the only chance of escaping what is otherwise the sure destruction of all that humanity has struggled to achieve for 50,000 years?"
Isaac AsimovWriter & Professor

Isaac Asimov
Writer & Professor

01.

THE NEW ERA OF SPACE AGE

HISTORY OF SPACE EXPLORATION

FROM IMAGINATION TO INFRASTRUCTURE

1957 Launch of Sputnik 1
First satellite owned by the Soviet Union

1961 Yuri Gagarin
First human in space aboard

1969 Apollo 11 Moon Landing
Human footprint on celestial body

1972 Landsat 1
The first Earth observation satellite

1980s GPS System Begins deployment
Satellite use expands across nations

1998 International Space Station (ISS) construction
Symbol of post-Cold War cooperation

2009 Collision Between Iridium 33 & Cosmos 2251
Creates thousands of debris fragments

SPACE RACE (1957-1969)

Throughout history, the vastness of space has captivated human imagination. Shining stars and distant planets have prompted dreams, stories, and aspirations for humankind. But soon after the end of WWII, when tensions between the United States and the Soviet Union were rising. Achievements like Sputnik and the Apollo Moon landing were both symbols of scientific triumph and demonstrations of geopolitical

While the Space Race catalyzed groundbreaking technological advancements, it also established lasting paradigms—shaping outer space into a battleground. This race for technological supremacy catalyzed unprecedented progress, ushering humanity into the space age.

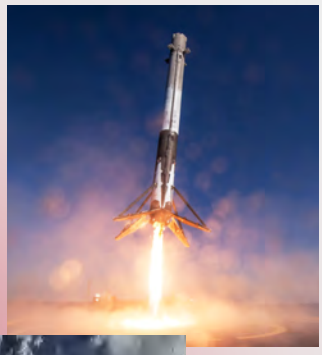
2015 SpaceX Falcon 9

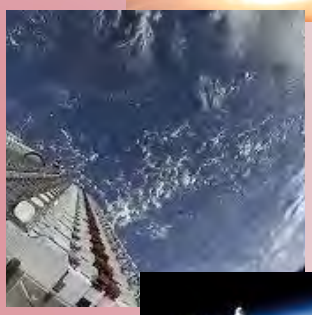
Reusability rocket triggers satellite boom

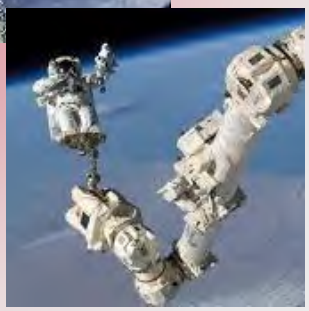
2019-2024 Starlink And Mega-Constellations

Billionaire space race; Rise of private sectors

2026 Aerospace Debris Mitigation Mission Planned







SPACE AGE (1970S-PRESENT)

Today, we live in the aftermath of that legacy. What began as a competition for dominance has evolved into deep reliance. Space-based infrastructure now underpins nearly every facet of modern society—from global communications and GPS navigation to Earth observation, disaster response, and national security. The expansion of satellite constellations and commercial space activity has made space an everyday utility. As the benefits of space have become more visible, nations and private corporations alike have entered a new race—not just for exploration, but for economic and strategic advantage. Space is no longer a distant realm of scientific curiosity; it has become a stage for geopolitical rivalry and profit-driven ambition, shaping how we live, govern, and compete on Earth.

KEY ACTORS IN THE MODERN SPACE AGE

TENSIONS, COOPERATIONS & OPPORTUNITIES

National Space Agencies

NASA (U.S.): Leads Artemis program, sets international standards (Artemis Accords), increasingly reliant on commercial partners (Shen et al., 2022).

CNSA (China): Rapidly advancing autonomous capabilities (Chang'e, Tiangong station), challenging US dominance (Shen et al., 2022).

Roscosmos (Russia): Contributes significantly to international projects like the ISS despite geopolitical challenges (Shen et al., 2022).

ESA (Europe): facilitates multinational cooperation and strategic autonomy through missions such as ExoMars and Hera (Shen et al., 2022).

ISRO (India): Achieves recognition for cost-effective missions, leveraging partnerships to broaden global influence (Shen et al., 2022).

JAXA (Japan): Excels in technology and collaboration, notably through Hayabusa missions and ISS participation.

Characteristics: Government-supported entities emphasizing national prestige, scientific progress, strategic geopolitical objectives, and accountability to public and political institutions.

Private Sectors

SpaceX (United States): exemplifies leadership in commercial aerospace with groundbreaking innovations, including reusable rocket technology and the expansive Starlink satellite constellation, significantly influencing global space commerce (Shen et al., 2022).

Blue Origin (United States): prioritizes reusable technologies, sustainability in space tourism via New Shepard, and advanced orbital projects through New Glenn, contributing significantly to commercial competition and strategic space economy dynamics.

Virgin Galactic (United States): has pioneered suborbital space tourism, aiming to democratize access to space, significantly influencing the public perception and commercial viability of space travel.

OneWeb (Global): competes directly with SpaceX, deploying extensive broadband satellite networks and navigating complex regulatory landscapes and competitive market pressures internationally.

Relativity Space (United States): introduces advanced manufacturing techniques such as 3D printing for spacecraft construction, promising transformative impacts on cost structures and operational flexibility.

Aerospace Corporation (United States): plays a crucial role in space debris mitigation, providing research and technical assessments to improve space sustainability (Weeden & Chow, 2012).

Characteristics: Market-driven entities emphasizing technological innovation, economic profitability, rapid adaptation, and substantial private investment influence.

International Organizations

UNOOSA (United Nations Office for Outer Space Affairs): significantly influences global space governance(United Nations, 2021).

ISECG (International Space Exploration Coordination Group): Coordinates international exploratory missions, promoting shared strategies, data exchanges, and cooperative planning among global space agencies.

IADC (Inter-Agency Space Debris Coordination Committee): Addresses orbital debris challenges through policy formulation, cooperative research, and global strategy alignment on sustainability and debris mitigation (Weeden & Chow, 2012).

Characteristics: Regulatory bodies emphasizing consensus-driven global governance, sustainable space utilization, and international policy alignment.

Conclusion: The New Space Race – Geopolitics And Capital In Orbit

Today, outer space is no longer just a geopolitical contest. It has become a marketplace. Private companies like SpaceX, Blue Origin, and OneWeb have turned the heavens into corridors of business opportunity, launching satellite networks for telecommunications, internet coverage, and soon, space tourism. Our vast empty space is starting to resemble a highway during rush hour, and with the planned launch of so-called "mega-constellations," it will only get further out of hand (Boley & Byers, 2021).

National agencies now share the cosmic stage with profit-driven actors. NASA and CNSA still lead in exploration (Artemis and Chang'e programs), but their influence is being recalibrated by commercial forces (Davenport, 2023). The U.S.-China rivalry persists in orbit, yet both nations increasingly rely on private partners to achieve their space ambitions (Pekkanen, 2022).

This new space economy creates paradoxical dynamics:

- **Competition breeds innovation** (reusable rockets, satellite miniaturization)
- **Growth creates congestion** (over 100,000 planned new satellites by 2030)
- **National security blurs with commercial interests** (Starlink's dual-use potential in Ukraine)

The ultimate challenge lies in governing this hybrid system where:

1. **Capital moves faster than diplomacy**
2. **Traffic management lags behind launch rates**
3. **No clear rules exist for profit-driven space exploitation**

Image sources (Grossman, 1968)

As new stakeholders enter the arena, the lines between national security, commercial ambition, and global governance blur (United Nations, 2021). The next phase of space exploration will be defined not just by technological breakthroughs but by who controls the infrastructure, sets the rules, and reaps the profits—making this the most complex and competitive space age yet (Pekkanen, 2022).

STAKEHOLDER MAPS & THEIR REALTIONSHIPS

Legend/Explanation

Shapes

= National Agencies

= Private Sectors

= International Orgs

Lines

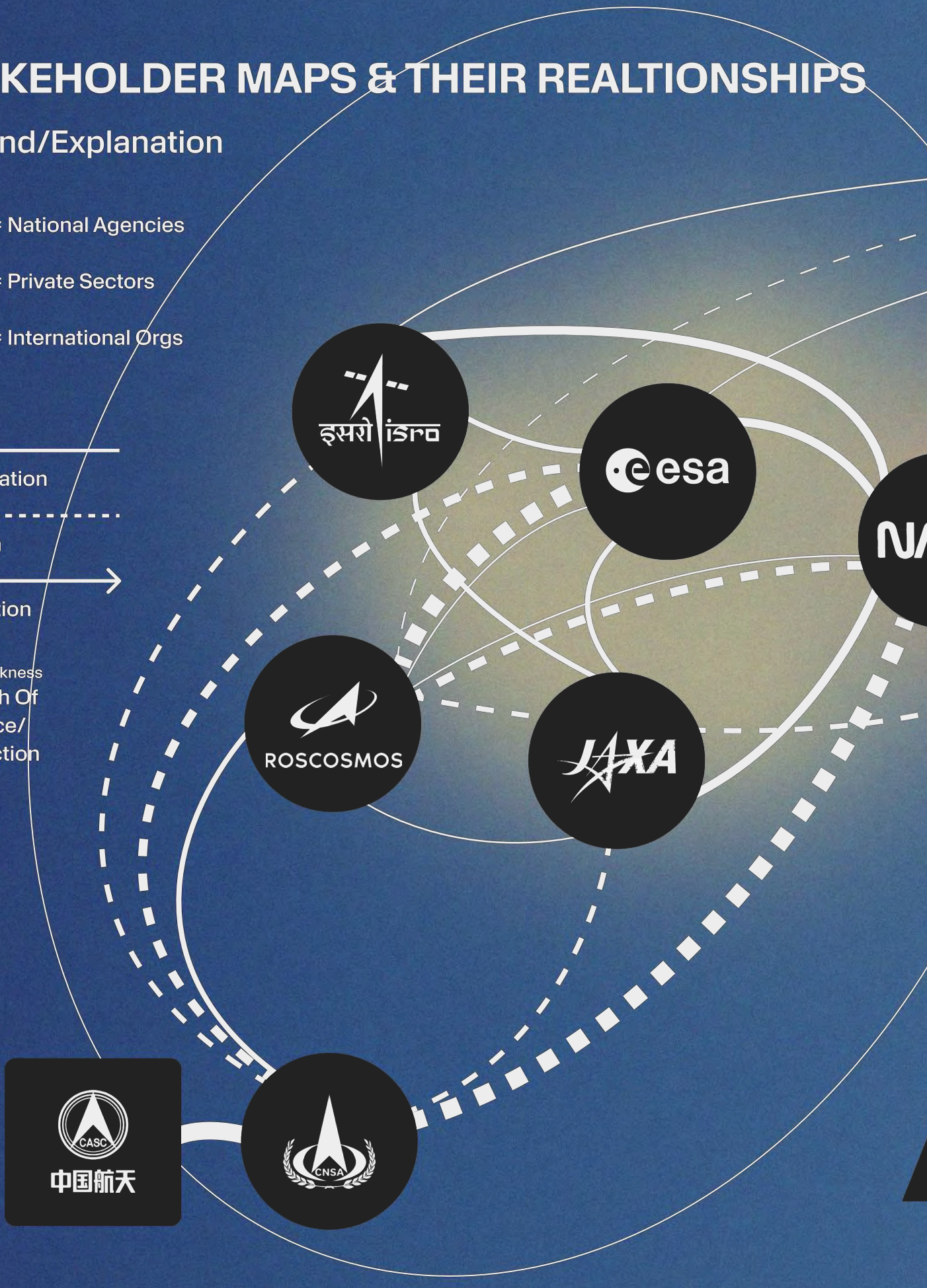
Cooperation

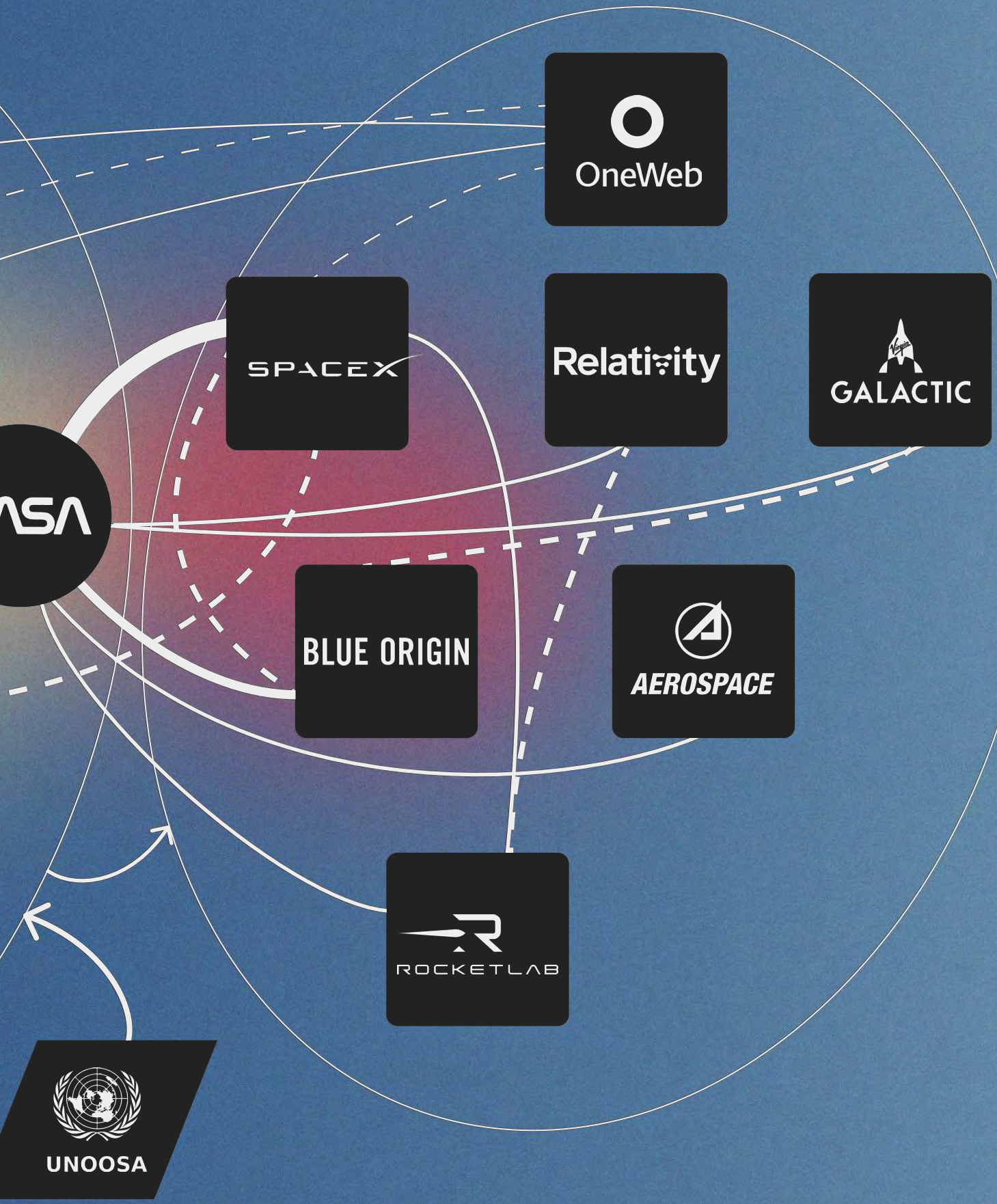
Tension

Regulation

Lines Thickness

Strength Of Influence/ Connection

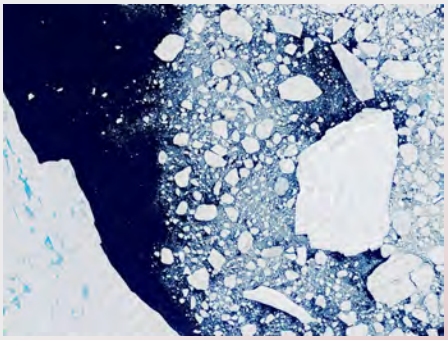



OneWeb
SPACEX
Relativity
GALACTIC
BLUE ORIGIN
AEROSPACE
ROCKETLAB
UNOOSA

THE SATELLITE REVOLUTION: ORBITAL DEPENDENCY AND ITS CONSEQUENCES

This multidimensional relationship—marked by both cooperation and competition—has accelerated technological advancements while simultaneously creating unprecedented reliance on satellite infrastructure. Where once satellites served primarily as instruments of geopolitical power projection, they now underpin the very functioning of modern society, enabling global communications, navigation, financial transactions, and environmental monitoring (OECD, 2022).

Definition And Composition Of Space Debris



Satellite view of Larsen B Ice Shelf, Antarctica, collapsing as a result of global warming. Image Source: Getty

Observation

Satellites are by far the best human resource to supervise Earth's activities. Satellites provide accurate climate and environmental monitoring, complement agriculture and farming, enable disaster warning and resource management, and even allow underground activity to be followed.

Navigation

Systems like the Navstar Global Positioning System (i.e., GPS) enable anybody with a handheld receiver to determine their location. Used by civilians and the military, it enables safe land, sea, and air navigation, especially in emergencies.

Pilots navigating over fires burning in Volusia County, Florida using a portable GPS system. Image Source: NASA

The first transmission of a newspaper via satellite from London to Puerto Rico. Image Source: NASA

Communication

Satellites provide critical voice connectivity for rural and disaster-stricken areas where terrestrial infrastructure is unavailable or damaged. They also bridge gaps in education and healthcare for remote populations in developing regions through telemedicine and distance learning.

National Security

Satellites enable global surveillance, missile tracking, and secure military communications. They monitor troop movements, detect nuclear tests, and support precision-guided weapons. Orbital systems are now critical for early warning against hypersonic threats and space domain awareness.

Satellites By Purpose

Active Satellites

6,718

Observation

1,192

Navigation

155

Communication

4,823

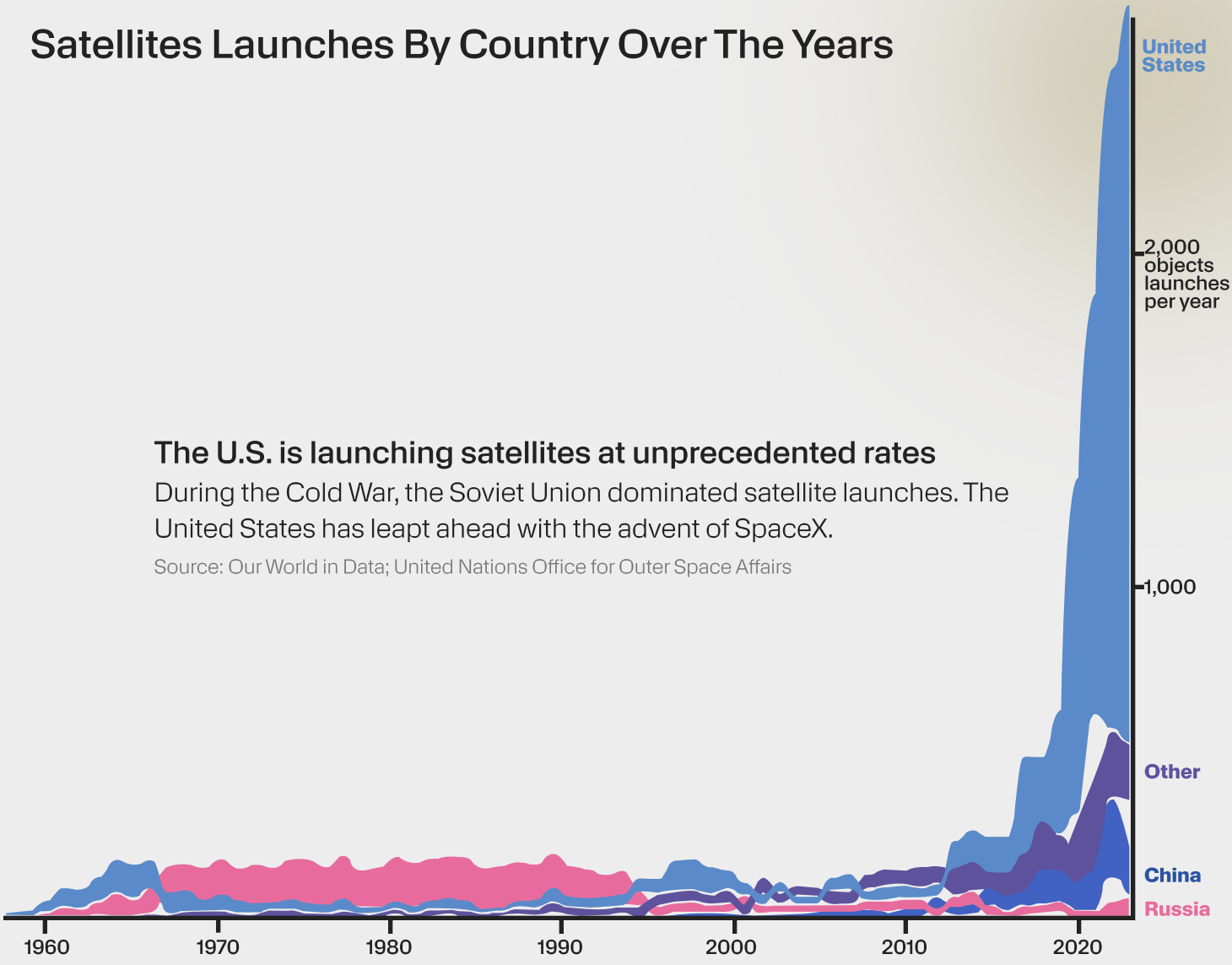
Experimentation

523

Other

1,425

Satellites Launches By Country Over The Years



The U.S. is launching satellites at unprecedented rates

During the Cold War, the Soviet Union dominated satellite launches. The United States has leapt ahead with the advent of SpaceX.

Source: Our World in Data; United Nations Office for Outer Space Affairs

“Until now, space has been seen as a free-for-all — the next frontier to explore. But what we forget is that it’s also an ecosystem — and like any ecosystem, exploration of it has come at an environmental cost.”

Dr. Moriba Jah Chief Scientist,
Privateer

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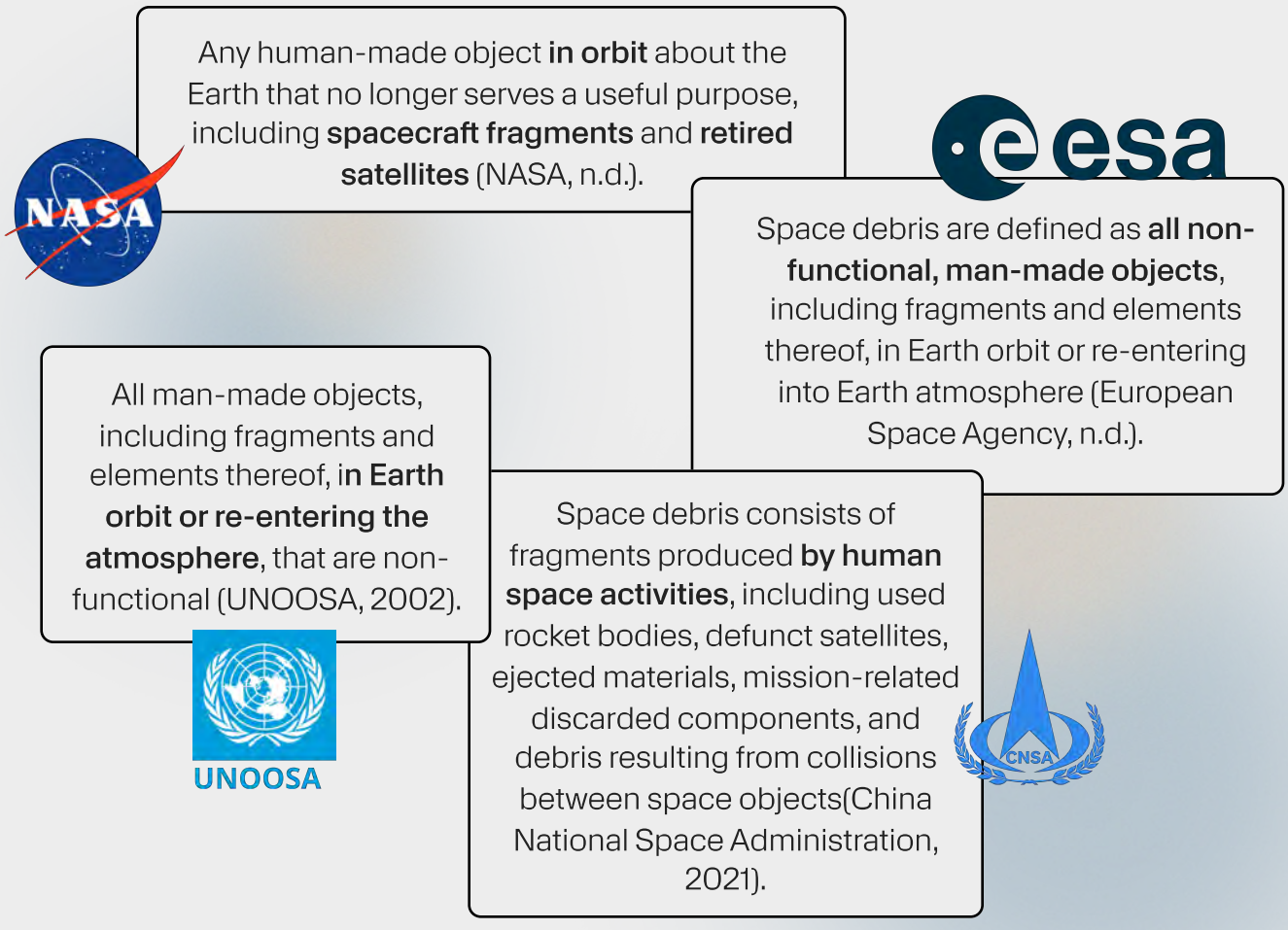
THE PACE TRASH CRISIS

POLLUTION ON AN ASTRONOMICAL LEVEL

This exponential growth, driven by both national security imperatives and commercial ventures, has rendered contemporary society critically dependent on space-based assets. However, this dependency has precipitated an unsustainable cycle: **increasing satellite deployments exacerbate orbital congestion, amplifying the risk of catastrophic collisions and space debris proliferation** (Liou et al., 2022).

What Is Space Debris?

Space trash, also known as "**space debris**," and "**space junk**". The definitions can vary slightly among different organizations, reflecting diverse operational, legal, and geopolitical perspectives (European Space Agency, n.d.; NASA, n.d.).

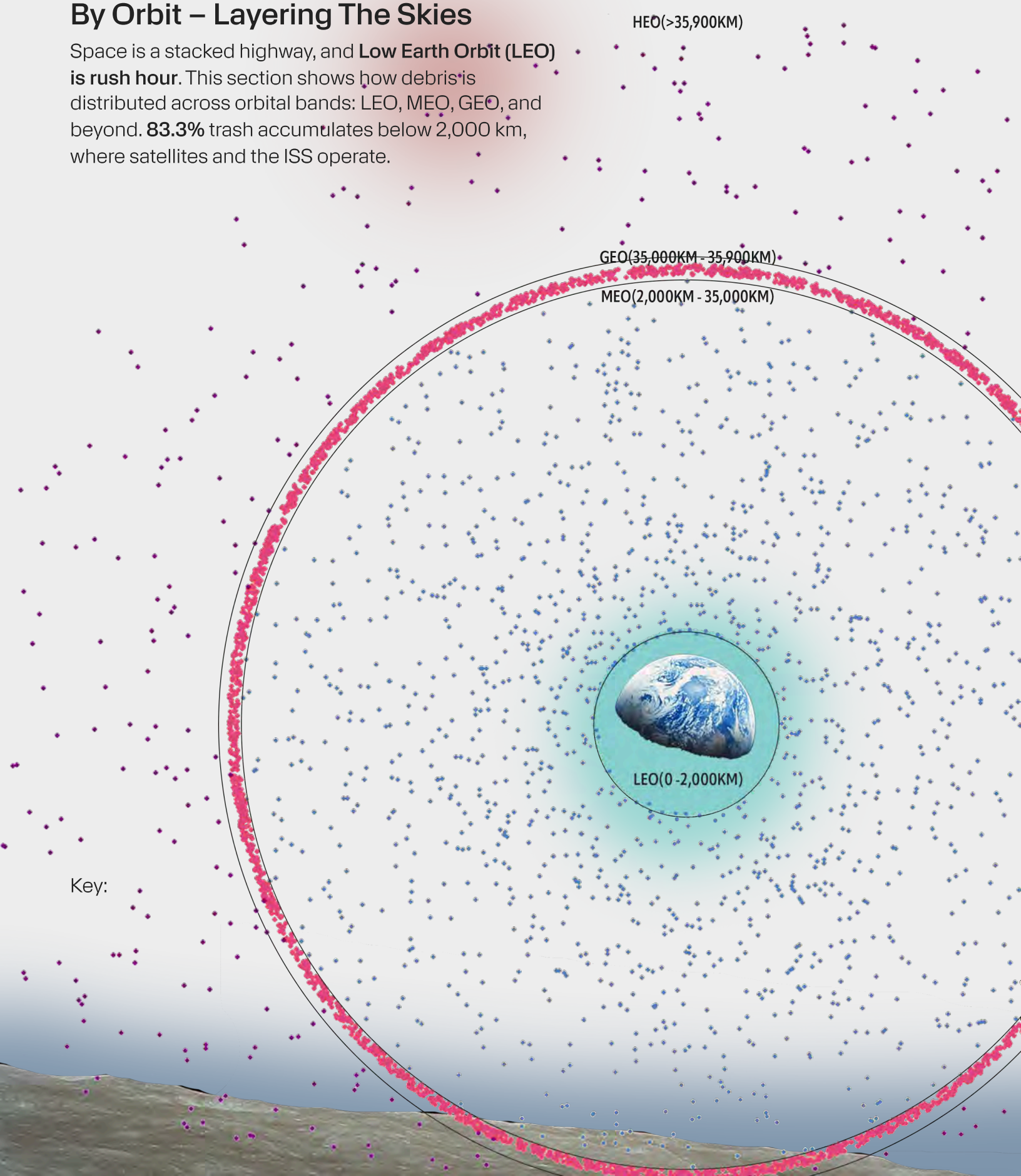


The absence of a universally accepted legal definition of "space trash" in international treaties presents challenges for establishing clear responsibilities and effective mitigation strategies(Jakhu & Pelton, n.d.). **A shared, common definition is urgently needed to ensure coordination & enforcement, especially as private space ventures expand.**

MEASURING SPACE TRAFFIC

By Orbit – Layering The Skies

Space is a stacked highway, and **Low Earth Orbit (LEO) is rush hour**. This section shows how debris is distributed across orbital bands: LEO, MEO, GEO, and beyond. **83.3%** trash accumulates below 2,000 km, where satellites and the ISS operate.

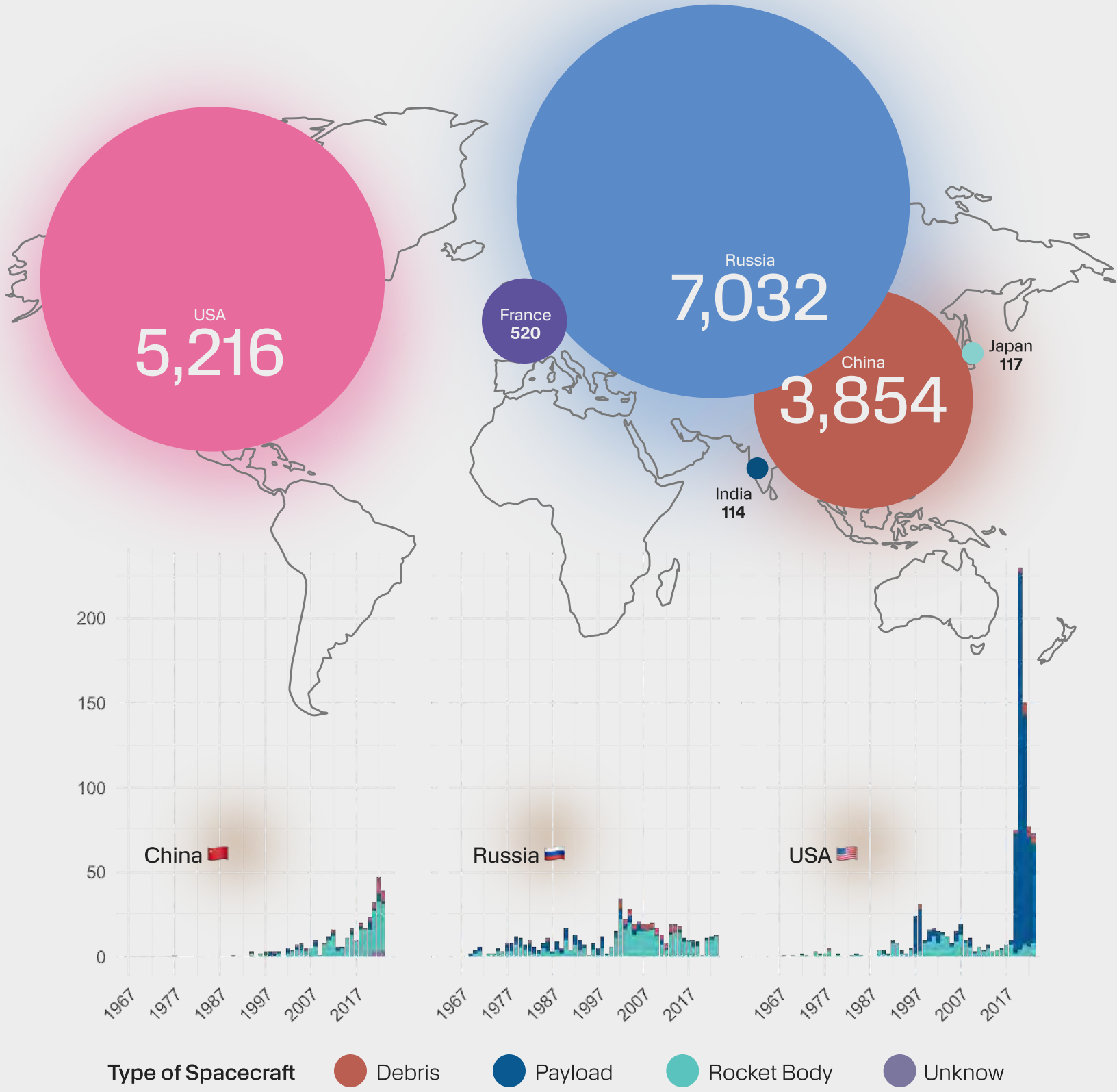


Key:

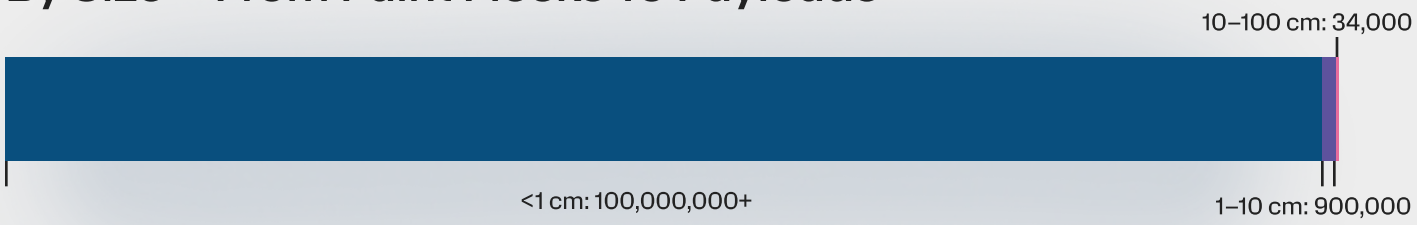
By Country – A Global Footprint

Who's putting what in orbit?

This map shows debris origins by country, based on launch records and ownership. **The United States, Russia, and China are the largest contributors**—but space trash is everyone's problem.

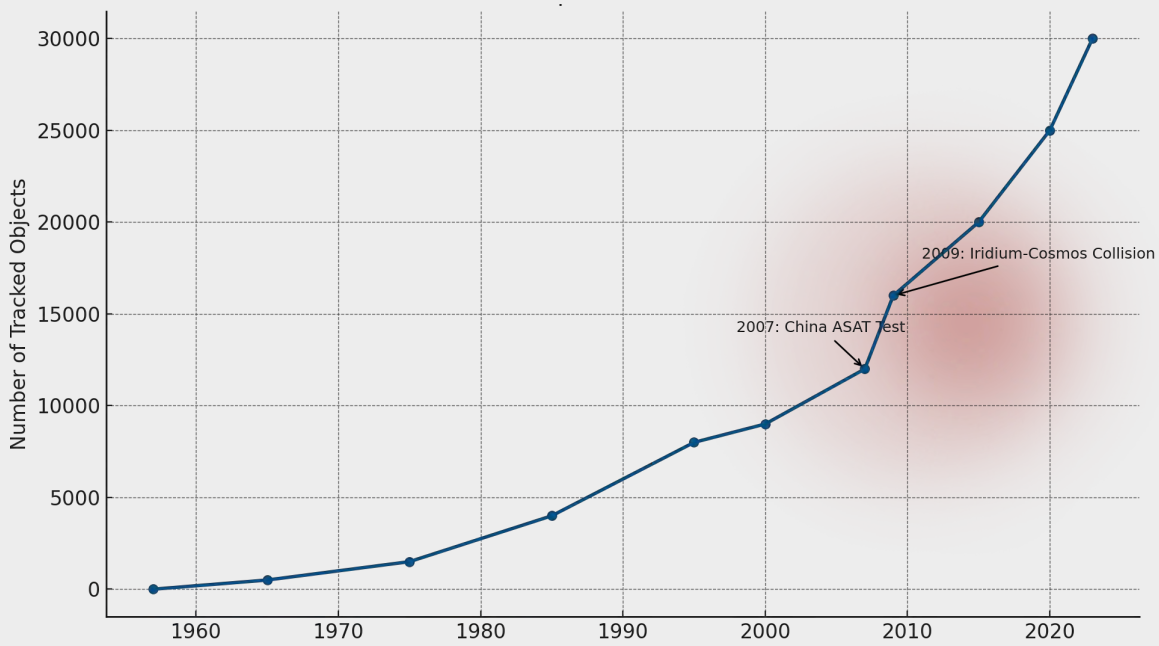


By Size – From Paint Flecks To Payloads



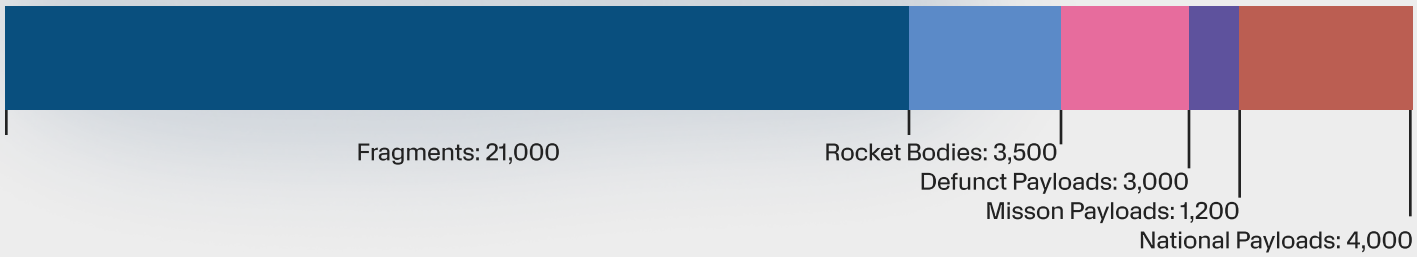
Even the tiniest debris can destroy satellites at orbital speed. Over 99% of space debris is smaller than 10 cm, but even a fleck of paint can destroy a satellite at orbital velocity.

By Time – The Growth Of Debris Since 1957



Space got messier—fast. Spikes mark events like the 2007 China ASAT test and the 2009 Iridium collision.

By Type – What Kind Of Trash Is It?



The trash in space isn't random. Most debris comes from **explosions, collisions, and abandoned rockets**. Fragments account for the majority, followed by defunct satellites and rocket bodies. This breakdown reveals the human footprint of decades of space activity—planned or not.

IMPACTS OF SPACE TRASH

ENVIRONMENTAL, SOCIETAL, AND EXISTENTIAL THREATS

Immediate Operational Impacts

Risks to Satellites and Spacecraft:
In 2021, China's YunHai 1-02 satellite was destroyed by a fragment from a 1996 rocket, marking the fifth confirmed collision between cataloged space objects (NASA, 2021). Though it generated just 37 fragments, **it showed how even a single impact can instantly destroy vital systems and create new threats for other satellites.**

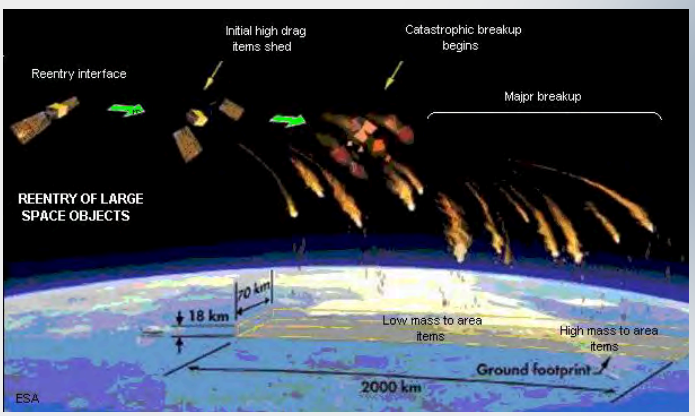
Danger to Human Spaceflight:
The ISS has conducted over 30 debris-avoidance maneuvers since 1999 to protect its crew (Space.com, 2023). Each maneuver uses fuel and limits mission flexibility. **Even millimeter-sized debris can puncture station hardware—posing lethal risks, especially during spacewalks.**

Re-Entry Risks:
A 2022 Nature Communications study estimated a **10% chance of casualties** from falling rocket or satellite debris in the next decade. **The Global South faces higher risk, as most launch trajectories drop debris near the equator** (Gizmodo.com, 2022).

Satellite Reentry (Aerospace, 2018)

Long-Term Environmental Impacts

Climate Change Acceleration
Space debris isn't a **primary climate driver, but it may amplify climate effects.** Re-entering satellites release aluminum oxide and black carbon, which disrupt stratospheric temperatures and Earth's radiative balance, potentially causing minor warming and wind pattern shifts. Debris also threatens climate-monitoring satellites, delaying crucial data on emissions and sea levels—**slowing policy response and heightening vulnerability** (Schulz et al., 2023; NASA, 2021).



SPACE DEBRIS REENTRY HAZARDS (Space Academy)

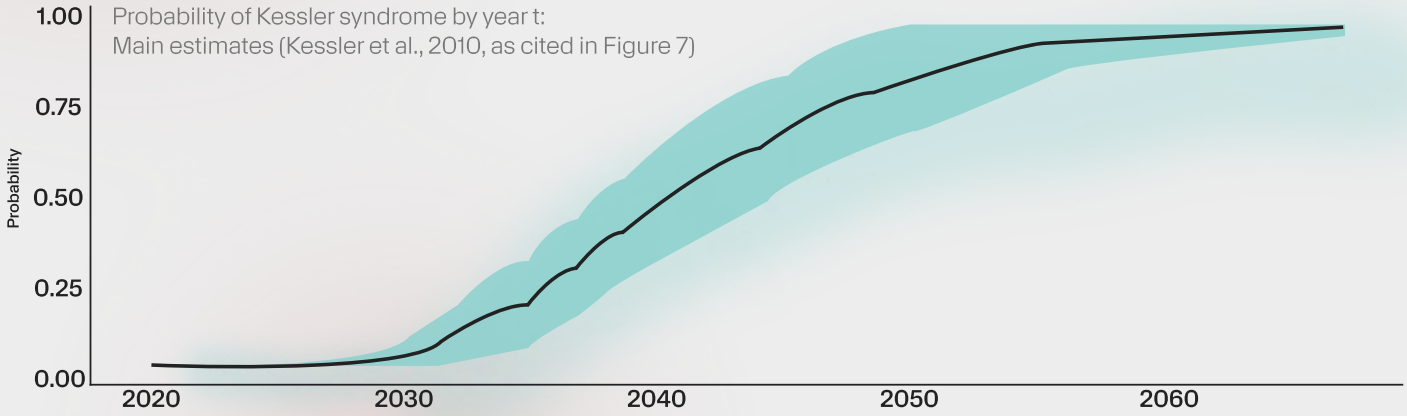
Oceanic Pollution:
Falling debris often lands in oceans, introducing **charred metals, composites, and toxins like beryllium, cadmium, and hydrazine into marine ecosystems.** These materials are non-biodegradable and pose risks to biodiversity and food chains. While current impacts are limited, **increased satellite reentries** may cause long-term ocean pollution (ESA, 2023; Schulz et al., 2023).

Catastrophic Near Future: Kessler Syndrome

The **Kessler Syndrome**, proposed by NASA scientist Donald J. Kessler in 1978 and elaborated upon by Kessler et al. (2010), refers to a **self-reinforcing cascade of orbital collisions**. When two objects in orbit—such as satellites or debris—occupy the same altitude, their eventual collision is all but inevitable. That collision generates smaller fragments, which then collide with other objects, exponentially increasing debris density and raising the probability of further impacts. As Kessler (2010) explains, "any two orbiting objects that pass through the same distance from the Earth represent an unstable condition," and this instability feeds a **reinforcing feedback loop** that continues until the orbital population is significantly reduced (p. 48).

The Urgency Of Now

The tipping point isn't theoretical anymore—it is **quantifiable**. Recent system-dynamics models show that the 600–650 km shell in low Earth orbit (LEO) has a growing probability of crossing the Kessler threshold under current launch and mitigation practices. As shown in the uploaded model (based on data from ESA and NASA), even under optimistic scenarios, the **cumulative probability of crossing the threshold approaches 80% by the year 2100 if no removal or stricter compliance occurs**. This means that without aggressive intervention now, LEO's most valuable zones could become functionally unusable within decades—and potentially irreparable for centuries.



Cascading Consequences

Should a cascade take hold, the consequences would ripple across every layer of modern life:

Disrupted Communications: Satellite-based internet, global broadcasting, and telephony would face total outages.

Blinded Earth Observation: Losing climate and disaster-monitoring satellites would impair our ability to respond to wildfires, cyclones, or floods.

The End of Exploration: Space access itself would be jeopardized. With LEO unsafe, missions to the Moon, Mars, or asteroids would be paused indefinitely.

Navigation Chaos: GPS failures would disrupt aviation, shipping, autonomous vehicles, and emergency services.

Global Economic Fallout: Industries like banking, agriculture, energy, and logistics, all reliant on satellite timing and data, would suffer severe losses.

Scientific Standstill: Space telescopes, microgravity labs, and Earth-monitoring missions would be frozen or destroyed.

Number of countries with space programs

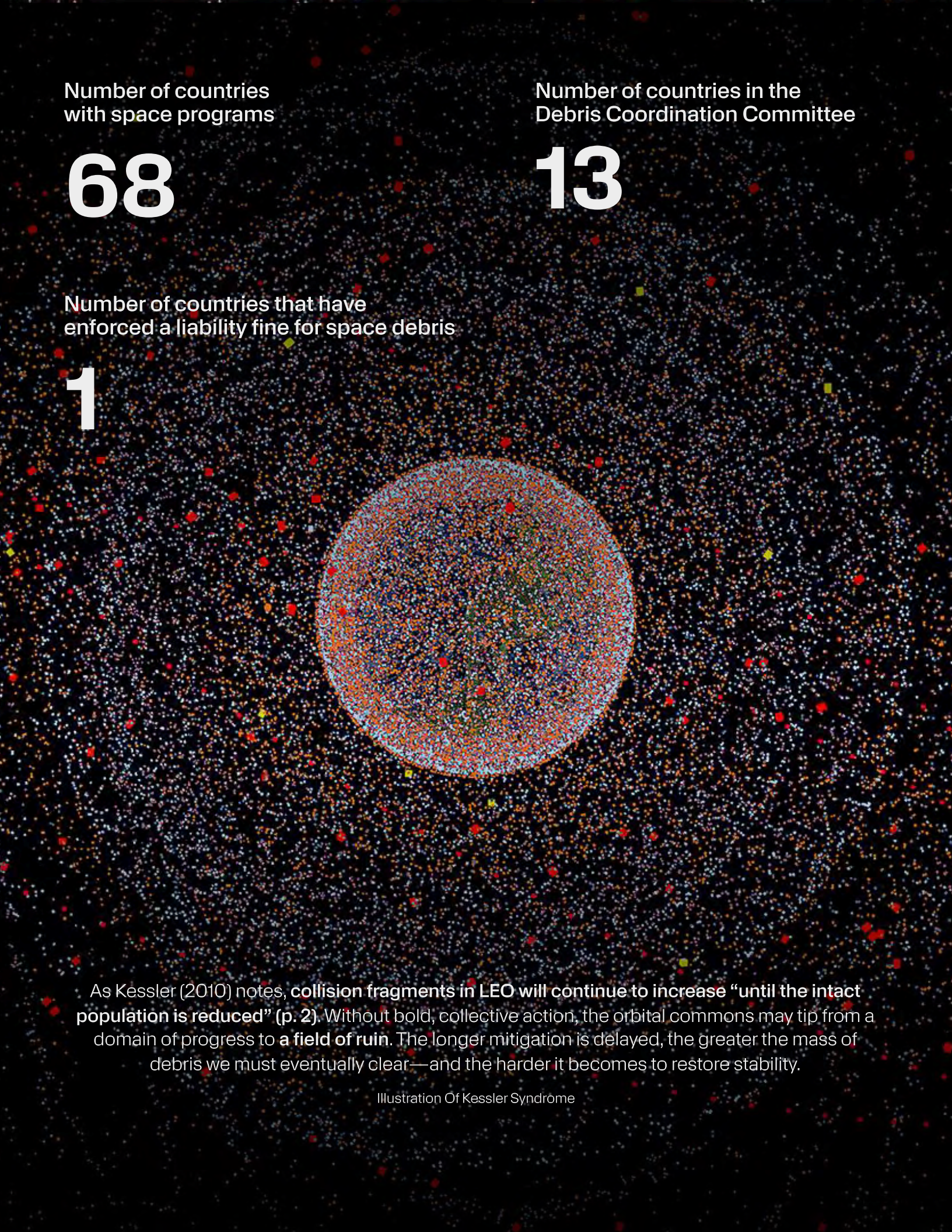
68

Number of countries in the Debris Coordination Committee

13

Number of countries that have enforced a liability fine for space debris

1



As Kessler (2010) notes, **collision fragments in LEO will continue to increase "until the intact population is reduced" (p. 2).** Without bold, collective action, the orbital commons may tip from a domain of progress to **a field of ruin.** The longer mitigation is delayed, the greater the mass of debris we must eventually clear—and the harder it becomes to restore stability.

Illustration Of Kessler Syndrome

SPACE LAWS & GUIDELINES

1967 — Outer Space Treaty

This treaty set out the founding principles of international space law. It deems space to be a common resource for all states, one that no one party can claim sovereignty over.

1996 — Inter-Agency Space Debris Coordination Committee (IADC)

This committee was formed to promote international cooperation on the matter of space debris mitigation.

2007 — Space Debris Mitigation Guidelines

Based on the IADC guidelines, these guidelines are widely accepted by the international space community. However, they are voluntary.

- Design guidelines: Satellites and spacecraft should be designed to be resilient and not likely to fragment.
- End-of-life deorbiting rule: Satellites and spacecraft should be deorbited at the end of their lifespan, within 25 years, to avoid generating space debris.
- Minimization of debris release: Space operations should be conducted in a way that minimizes the release of debris before, during, and after the mission.

2022 — Five-Year Rule For Deorbiting Satellites

This is a new rule adopted by the Federal Communications Commission in the United States. It requires satellite operators to deorbit their satellites within five years of completing missions.

The Signing Of The Outer Space Treaty In 1967. Image Source: Getty

SPACE TRASH MITIGATION TECHNOLOGIES

Active Debris Removal (ADR) Technologies

ADR technologies aim to eliminate existing debris from orbit, particularly large objects like defunct satellites and rocket bodies. Key methods include:

Robotic Arms and Claws:
Systems like ESA's ClearSpace-1 employ robotic arms to capture debris. However, challenges arise in rendezvousing with and stabilizing tumbling objects in space.

Harpoon Technology:
Airbus has tested harpoon systems to impale and secure debris. While effective in simulations, real-world application faces uncertainties regarding target integrity and capture precision.

Net Capture Systems:
The RemoveDEBRIS project successfully demonstrated net deployment to ensnare debris. Yet, ensuring accurate targeting and containment in varying orbital conditions remains complex.

Laser Ablation:
Ground-based or space-based lasers can alter debris trajectories by vaporizing surface material. This method is still in experimental stages, with concerns about energy requirements and potential unintended consequences.

Magnetic Capture Systems:
Utilizing magnets to attract debris composed of ferromagnetic materials offers a non-contact approach. However, its applicability is limited to specific debris types.

Mitigation Strategies For Future Missions

Preventing the creation of new debris is equally crucial. Strategies include:

End-of-Life Passivation:
Deactivating residual energy sources in spacecraft to prevent explosions.

Controlled De-orbiting:
Designing spacecraft to re-enter Earth's atmosphere safely post-mission.

Advanced Propulsion Systems: Implementing propulsion technologies that allow precise maneuvering, reducing accidental collisions.

Reusable Launch Vehicles:
Adopting rockets that can be refurbished and relaunched minimizes discarded components in orbit.

Collision Avoidance Systems:
Enhancing tracking and maneuvering capabilities to prevent in-orbit collisions.

Mitigation Initiatives

Astroscale

Private company provide de-orbiting debris with magnetic capture.

esa

ClearSpace-1 mission to de-orbit a defunct satellite with robotic claws. (See Figure1.1)

IMPLICATION CHALLENGES

Technical Complexity

Capturing and deorbiting debris requires precise navigation and control, especially for uncooperative or spinning objects (NASA, 2011).

High Costs

Entail substantial financial investments, often without immediate economic returns (Space Generation Advisory Council, 2024).

Legal & Policy Issues

International space laws complicate debris removal due to ownership and liability. Global consensus is necessary (European Space Agency, 2025).

Average number of objects launched into space annually

100

Number of cleanup technologies tested in space in the last decade

1

The ClearSpace-1 mission aims to capture and de-orbit space debris, as illustrated in a rendering of the spacecraft approaching a Vespa adapter (ClearSpace, n.d.).

TRAGEDY OF THE COMMONS, AGAIN

Space debris represents yet another chapter in the recurring global tragedy of the commons, **mirroring familiar crises such as ocean pollution and global warming.** Just as unregulated exploitation of oceans leads to plastic pollution, and unrestricted emissions trigger climate change, Earth's orbital environment suffers from a similar dilemma. Individual actors—countries and corporations—**benefit immediately from launching satellites and conducting space missions, yet the resulting debris imposes long-term costs and risks upon everyone.** This scenario exemplifies Hardin's classic warning: "**Freedom in a commons brings ruin to all**" (Hardin, 1968, p. 1244). In space, as in oceans and the atmosphere, collective neglect leads inevitably toward resource degradation unless effective governance is implemented to manage shared responsibility and mitigate collective harm.

This figure below reframes the tragedy-of-the-commons dilemma and examines it across four interrelated domains: **technological, legal, economic, and political challenges**.

The Tragedy-Of-The-Commons Dilemma

Technological Challenges

Limits in our ability to **monitor and remediate** trashes make managing the commons difficult. **Incomplete tracking, the nascent state of removal technology,** and **the dual-use nature** of space technology all hinder collective action.

Legal Challenges

The existing international legal framework has gaps – space is free for all by treaty, with **no enforceable obligations to clean up.** There are no binding rules for creating debris, **making it hard to hold actors accountable**.

Economic Challenges

Launch providers and satellite operators **do not internalize the full costs of debris generation**. This leads to a free-rider problem where each actor maximizes their own benefit while others bear the long-term costs.

Political Challenges

Major spacefaring nations continue to **view space as a resource for national prestige, strategic advantage, and exploitation** (Moltz, 2014). Conflicting national interests impede consensus on global regulations.

PROBLEM STATEMENT

Since the advent of human space exploration with Sputnik's launch in 1957, orbital activities have exponentially increased, creating an unprecedented buildup of space debris. Currently, over 170 million pieces of debris orbit Earth, originating from satellite collisions, defunct spacecraft, rocket stages, and fragmentation events. The rapid commercialization of space, driven by private entities like SpaceX and Blue Origin, exacerbates orbital congestion by prioritizing immediate commercial gains over long-term environmental sustainability.

The fragmented nature of existing regulatory frameworks compounds this issue. International cooperation remains limited, and nations continue to view space primarily through geopolitical and economic lenses, often perceiving it as territory to dominate rather than a shared resource to responsibly manage. Consequently, these divergent approaches have resulted in ineffective, outdated regulations incapable of addressing contemporary challenges, significantly increasing risks to satellite operations, global communications, navigation systems, climate monitoring, and national security.

The ultimate threat of Kessler Syndrome—where cascading collisions render vital orbital regions unusable—further underscores the urgency of action. Th**e lack of cohesive, enforceable international policies and the minimal public awareness surrounding space sustainability amplify the risks associated with orbital debris.** To prevent irreversible consequences, there is a pressing need for **an integrated, interdisciplinary global approach** that aligns **technological innovation, legal frameworks, environmental ethics, and public advocacy** to foster responsible space stewardship.

"People know about global warming.
People know about ocean cleanup.
But they don’t know anything about
the space debris issue."

Nobu Okada
CEO, Astroscale

03.

THE CURRENT NARRATIVE

INITIAL EXPERIMENTS & OUTREACH

In the early phases of our research, we conducted several interactive experiments aimed at understanding public perceptions and stakeholder attitudes regarding space trash and space sustainability. These experiments were intentionally designed to explore, discover, and challenge preconceived notions about space through **sensory experiences, interactive installations, and direct engagements with the public and specialists**.

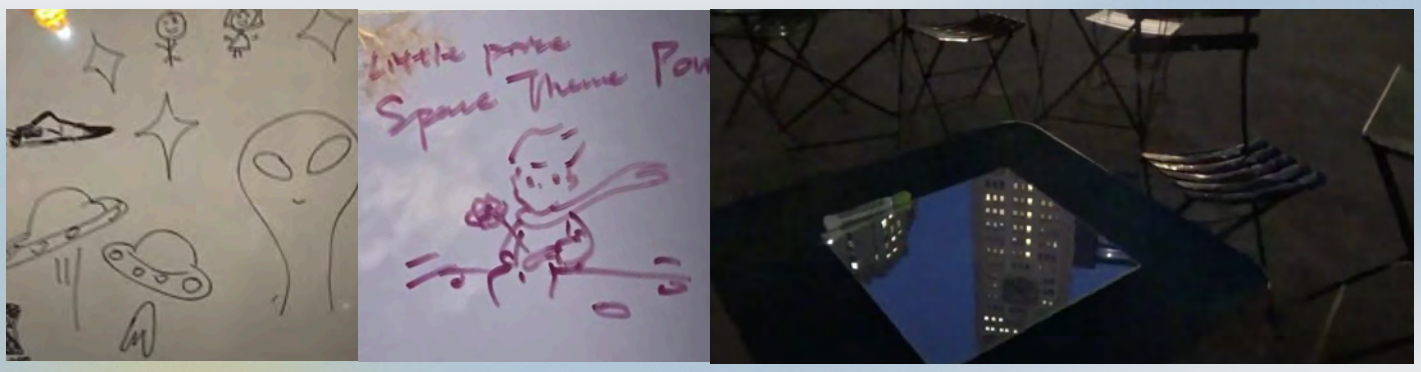
Experiment 1: Mirror Mirror (Public Engagement)

We placed six reflective mirrors on tables and chairs, angled skyward. Participants were invited to draw on these mirrors their visions for space or experiences they wished to have if given the chance. The question posed was: "If you had the ability, what do you think should be built in outer space or what experience would you like to have?"

February 12, 2024 | Madison Square Park, NYC | General public at Madison Square

Goal: It aimed to uncover implicit public perceptions of space—whether romanticized, curious, colonialist, or environmentally conscious.

Reflection: Public responses, revealed a collective view of space predominantly as a realm of wonder, positive imagination, and occasional environmental consciousness.



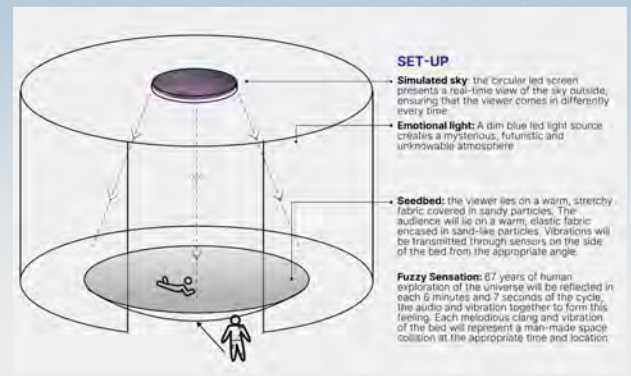
Participants Draw On Mirrors; Mirror Set-Ups In The Madison Square Park

Experiment 2: Eusthrophe(Immersive Sensory Installation)

An experiential proposal developed to participate in Next Nature's open call for installations, explicitly created to raise awareness about space debris through sensory engagement.

March 30, 2024 | Online Submission | Participants of the Next Nature exhibition

Goal: To evoke emotional and sensory awareness about the environmental implications of human activity in space, highlighting how every collision event in orbit has tangible impacts. It seeks to transform public consciousness by making the invisible consequences of space debris physically and emotionally felt. (Check the specific concept in pg.37)



Conceptual Image For The Installation

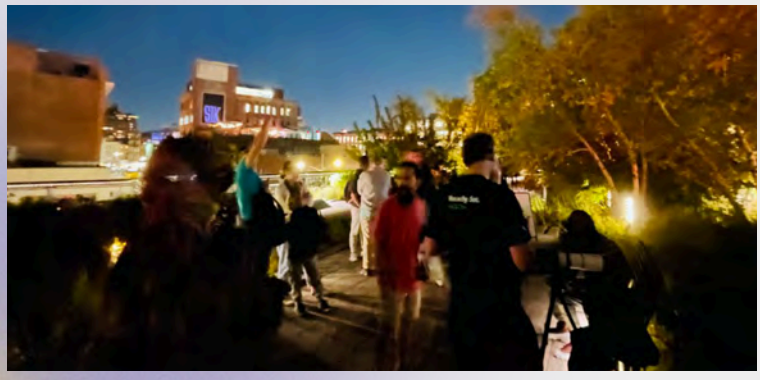
Experiment 3: Stargazing Session (Specialist Engagement)

Participatory observational session aimed to directly engage amateur astronomers and space enthusiasts about their knowledge of and attitudes toward space debris. We attended an AAA stargazing event to introduce our project, observe astronomy enthusiasts, and conduct informal interviews regarding their awareness and concern about space debris

October 22, 2024 High Line, NYC Amateur Astronomers Association Members & Publics

Goal: It aimed to to gauge awareness and perceptions of space debris among knowledgeable, actively engaged space enthusiasts.

Reflection: Public participants enthusiastically engaged in viewing the night sky and eagerly absorbed new information about space, while specialists were primarily driven by personal achievements; both groups demonstrated limited awareness of the space trash crisis.



Participants And AAA Members Attend Stargazing

Participants Climbs On The Ladder

Experiment 4: "We Choose To Look Up" Installation

A reflective video installation deliberately crafted to evoke complex emotional responses and symbolize the layered personal connection humans have with space, nature, and themselves.

January 28, 2024 DSI DSI Cohort

Through the playful yet profound interaction, participants could experience firsthand the personal and collective implications of humanity's pursuit of space exploration and our shared responsibility for its consequences.

SPACE AND SPACE TRASH AWARENESS SURVEYS

ANALYSIS AND COMPARISON OF YOUNG SPECIALISTS & PUBLICS

Introduction

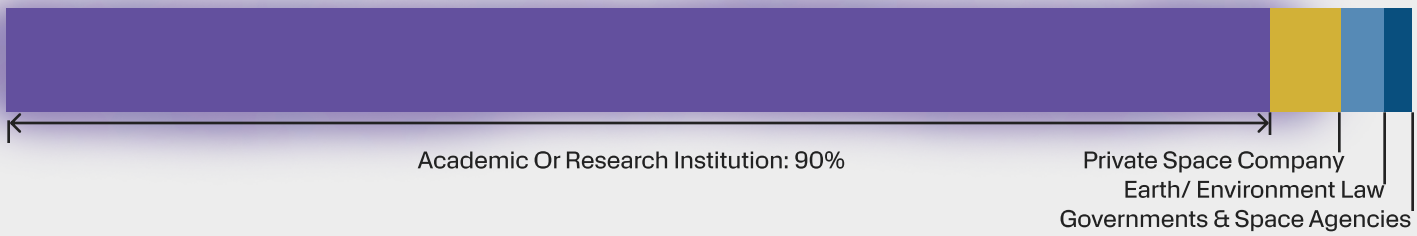
In order to understand the **perceptions, attitudes, and awareness levels** regarding space sustainability and debris management, we conducted **two surveys for specialists and publics**. Both are designed to be concise (2–4 minutes), were delivered digitally and intended to inform strategies for engaging both industry stakeholders and the broader community.

SURVEY FOR YOUNG SPECIALISTS

NYU, University of Columbia, Australian Earth Laws Alliance (AELA)

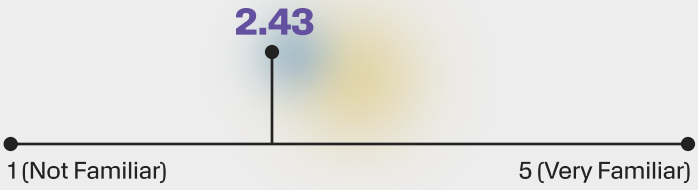
20 Responses

Participant Demographics



How Familiar Are You With The Issue Of Space Trash And Its Risks?

Mean:

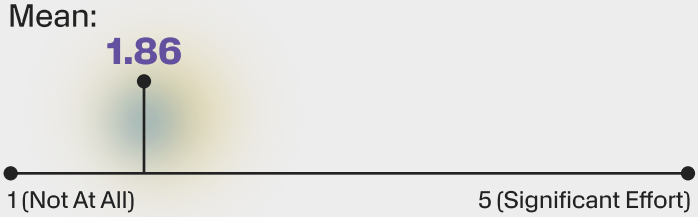


How Concerned Are You About Space Debris?

Mean:

How Much Effort Do You Think The Current Space Industry Is Putting Into Managing Space Trash?

Mean:

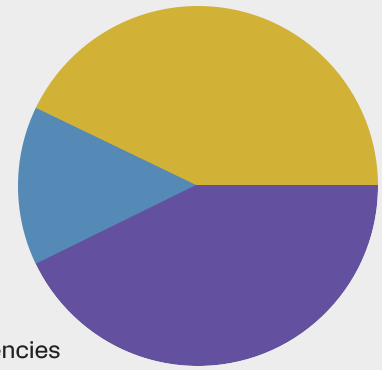


Who You Think Should Be Responsible? (Pick One)

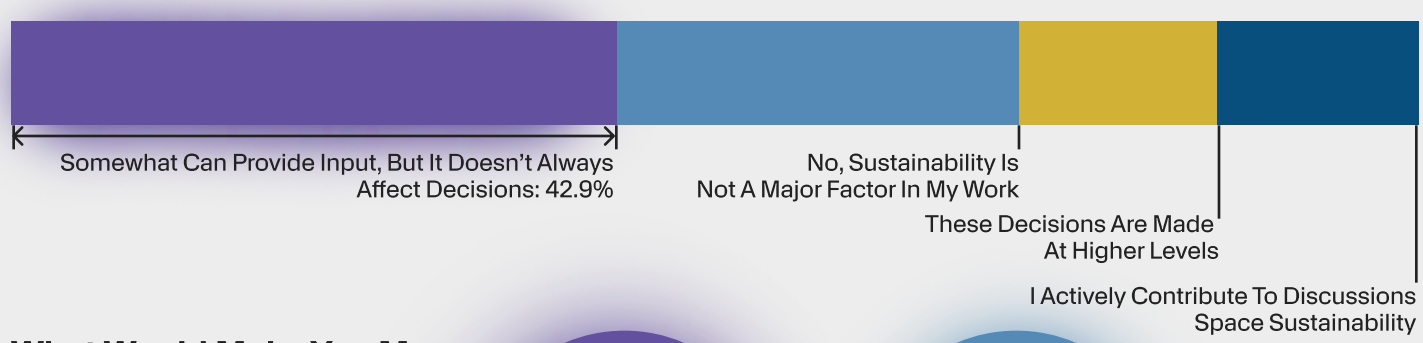
42.9%
A Combination Of All The Above

14.3%
International Space Governance Organization

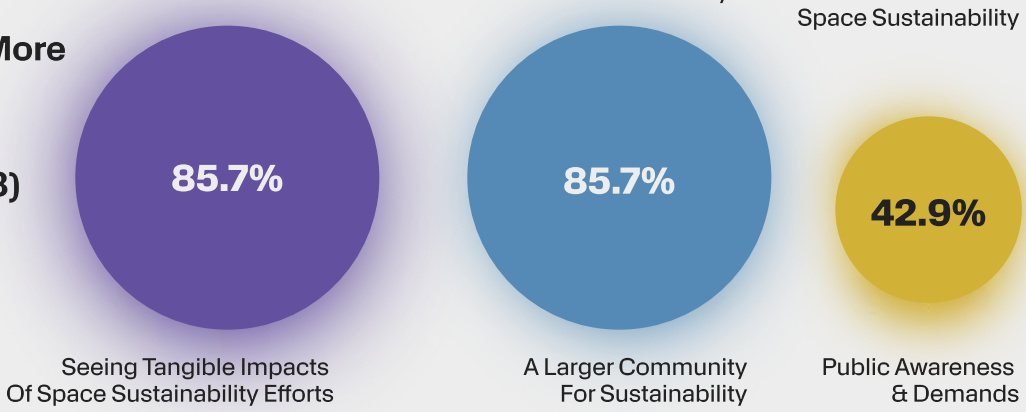
42.9%
Governments & Space Agencies



How Much Influence Do You Think Specialists Like Yourself Have The Right To Influence Sustainability Policies In Your Workplace Or Projects?



What Would Make You More Likely To Participate To Discussions On Space Sustainability? (Select 3)



PUBLIC SURVEY

SVA DSI, Earth Day, Online Platforms

42 Responses

How Familiar Are You With The Issue Of Global Warming?

Mean: **3.65**

1 (Not Familiar) — 5 (Very Familiar)

How Familiar Are You With The Issue Of Space Trash And Its Risks?

Mean: **2**

1 (Not Familiar) — 5 (Very Familiar)

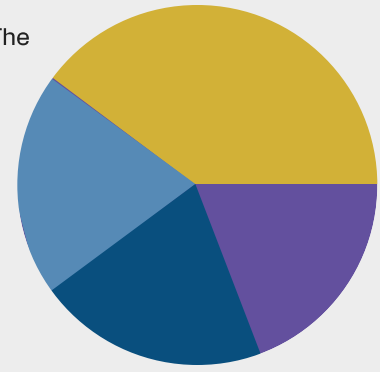
How Much Effort Do You Think The Current Space Industry Is Putting Into Managing Space Trash?

Mean: **1.8**

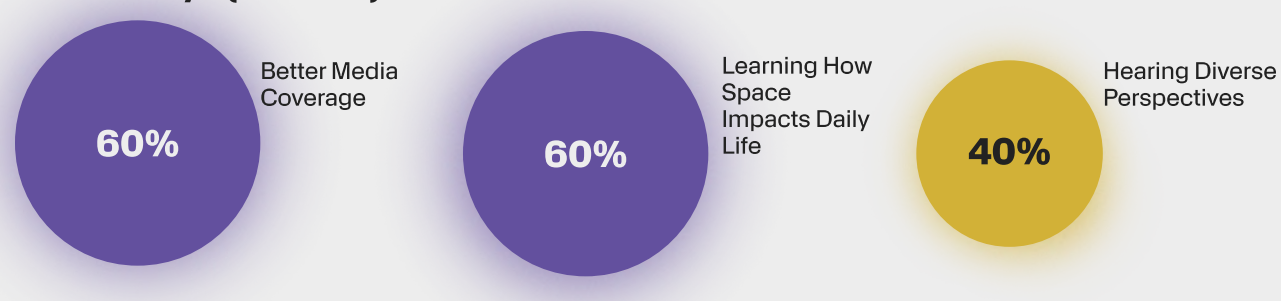
1 (Not At All) — 5 (Significant Effort)

Who You Think Should Be Responsible? (Pick One)

- **40%** A Combination Of All The Above
- **20%** International Space Governance Organization
- **20%** Governments & Space Agencies
- **20%** Private Companies



What Would Make You More Likely To Participate To Discussions On Space Sustainability? (Select 3)



CONCLUSION AND INSIGHTS

The results of our surveys underscore a crucial divide in awareness, influence, and engagement between space specialists and the general public. While specialists demonstrated a moderate understanding of the space debris issue, the public's awareness remained noticeably lower.

However, both groups expressed significant concern about the long-term sustainability of space, suggesting a shared recognition of the problem despite differing levels of knowledge. Responsibility for addressing space trash was broadly attributed to collective entities—both specialists and the public leaned toward the involvement of governments, international organizations, and private companies working together. Still, both groups expressed skepticism about the current level of effort the space industry is putting into debris management. The low perceived effectiveness reflects a growing demand for transparency, accountability, and stronger institutional leadership.

Importantly, the two groups differed in what would motivate them to act. Specialists were more inclined to engage when they could see concrete impacts or participate within professional networks. In contrast, public participants were driven by everyday relevance and accessible media coverage that connected space sustainability to their lives on Earth.

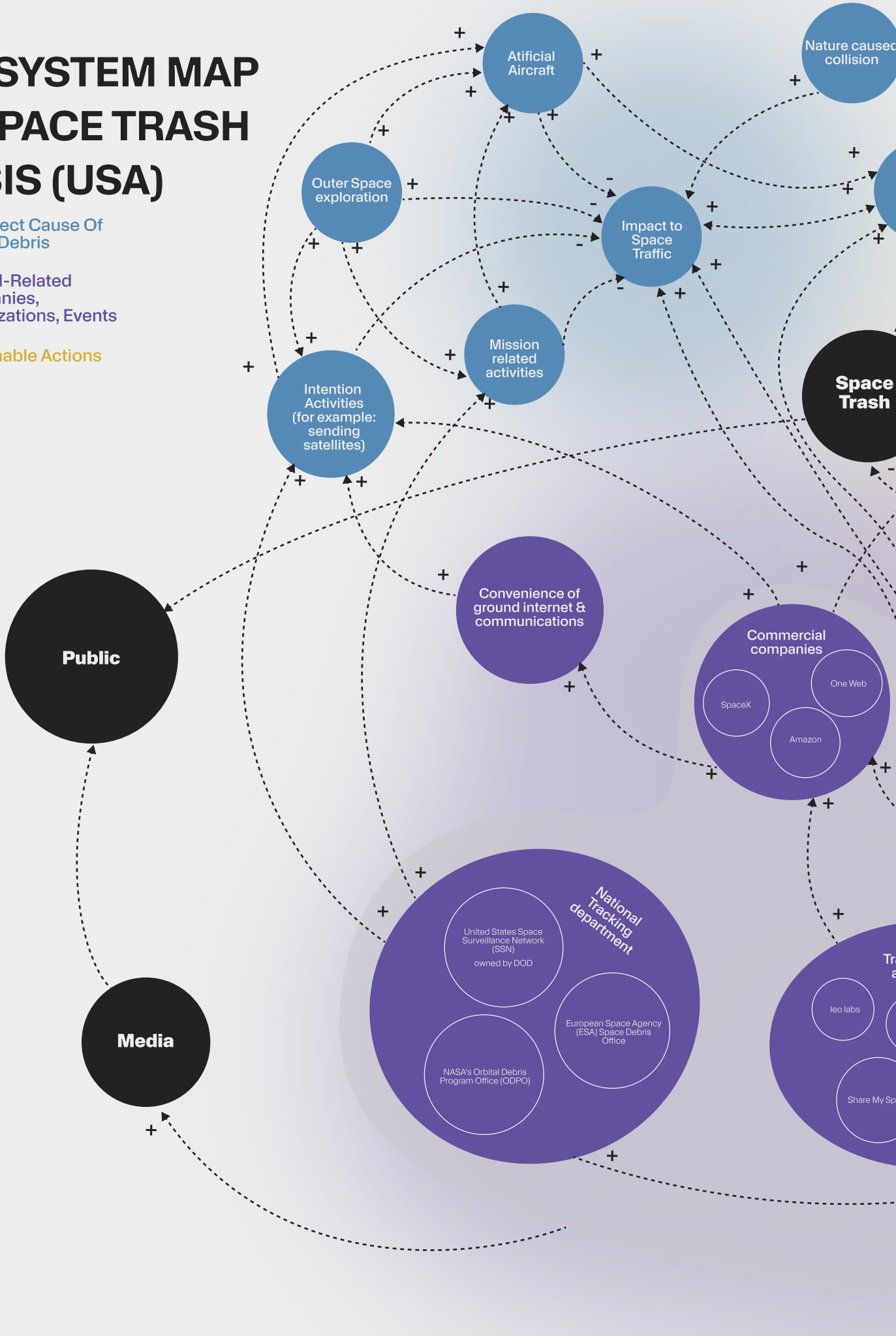
These findings point to several pathways forward: **increasing public understanding through relatable storytelling and educational initiatives, empowering young professionals to shape sustainability decisions within their institutions, and fostering interdisciplinary collaborations that emphasize tangible impact**. By addressing both the awareness gap and the barriers to agency, we can begin to shift space stewardship from a specialist concern to a broader societal imperative—grounded in shared responsibility, visibility, and action.

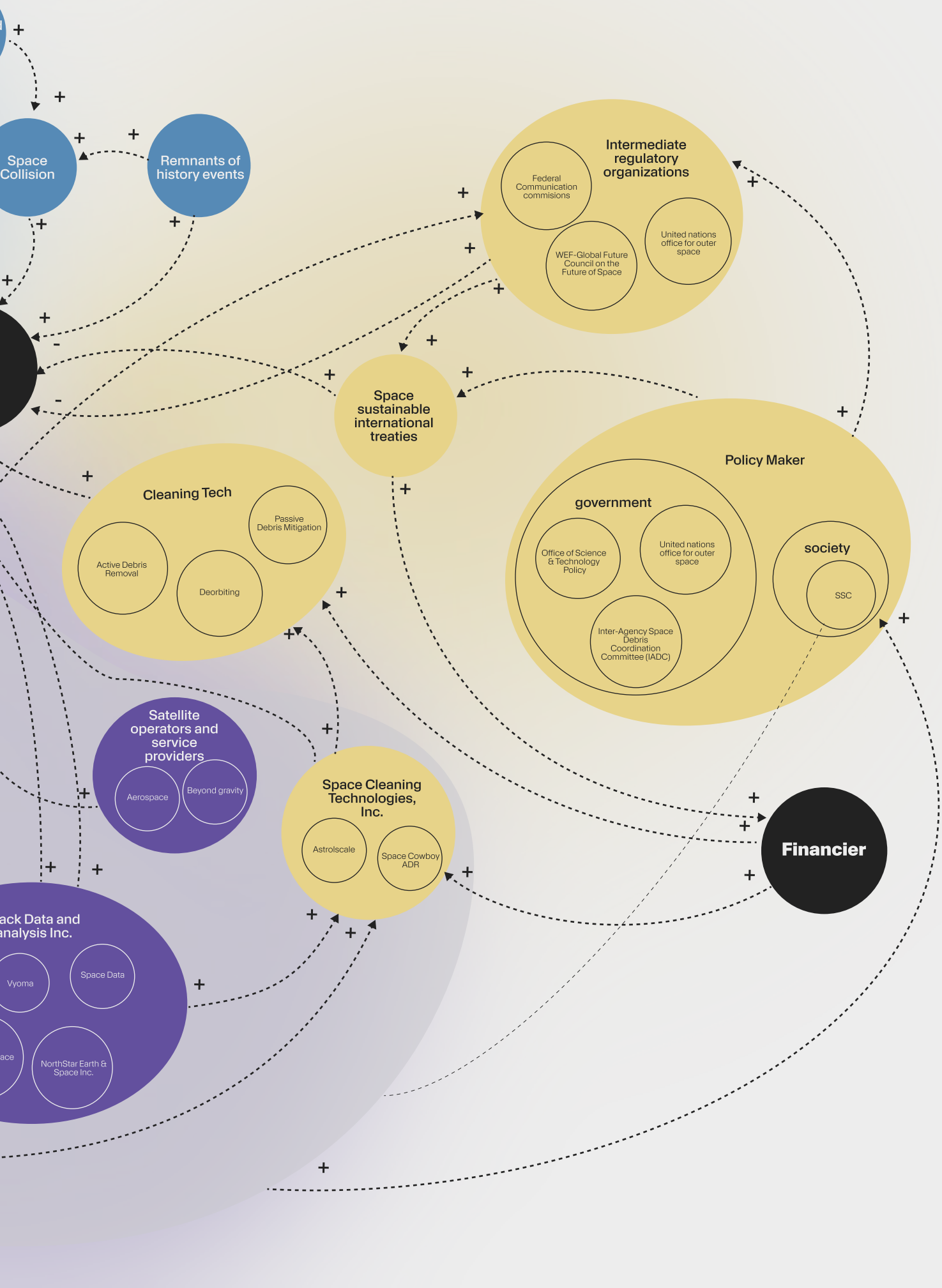
Participants And AAA Members Attend Stargazing

Designing Posters To Promote Survey Participation

ECOSYSTEM MAP OF SPACE TRASH CRISIS (USA)

- The Direct Cause Of Space Debris
- Ground-Related Companies, Organizations, Events
- Sustainable Actions




Space Collision
Remnants of history events
Intermediate regulatory organizations
Federal Communication commisions
United nations office for outer space
WEF-Global Future Council on the Future of Space
Space sustainable international treaties
Policy Maker
government
Office of Science & Technology Policy
United nations office for outer space
Inter-Agency Space Debris Coordination Committee (IADC)
society
SSC
Cleaning Tech
Passive Debris Mitigation
Active Debris Removal
Deorbiting
Satellite operators and service providers
Aerospace
Beyond gravity
Space Cleaning Technologies, Inc.
Astrolscale
Space Cowboy ADR
ack Data and analysis Inc.
Vyoma
Space Data
NorthStar Earth & Space Inc.
Financier

PERSPECTIVES FROM DIVERSE SPECIALISTS

As part of our exploration into space sustainability and governance, we conducted interviews with specialists across science, law, design, and policy. These conversations revealed **shared values, critical gaps, and hopeful directions for building a collective ethic of space stewardship**. Below are key perspectives and takeaways from five leading voices.

Dr. Michelle Maloney
Lawyer | Co-founder, Australian Earth Laws Alliance (AELA)

"For **unfamiliar territories** like the Moon or outer space, we must start by recognizing their right to exist in their natural state—unpolluted and undisturbed."

"We **need more young people** to carry this work forward. The Moon Declaration alone can't do it all—we need to link efforts and build a **broader platform for impact**."

"Governments only act when you can demonstrate 99.9% certainty. That's not how science works. **The public must be part of the pressure system.**"

Dr. Aaron Boley
Planetary Astronomer | Co-Director, Outer Space Institute

"I want to **engage young students** more deeply, but I **lack the capacity to manage them**. That's where a strong, decentralized coalition could help."

Dan Goods
Artist | Creative Director, NASA JPL

"**The public currently feels detached from space**. Inclusion and creating space for public curiosity is the first step—people **need a sense of belonging** before they care about learning."

"We **never** had classes about space trash or sustainability. If I had learned about it earlier, **I would be more aware and could think about my role** in this system."

Bi Chang
Astrophysics Master's Student | University of Victoria

GAPS & NEEDS

Knowledge Gaps Within The Specialist Community

Not all specialists share the same level of awareness about space debris. Our interviews and survey responses show that even within the space sector, familiarity with sustainability concerns varies significantly. While organizations like OSI are actively researching the issue, many engineers, designers, and operators are unaware or disengaged. This inconsistency weakens the potential for unified industry action.

Need:
Develop baseline sustainability literacy standards across the space industry and embed space debris awareness into technical and design training programs.

Isolation Of Well-Informed Specialists

Experts like Aaron Boley and Michelle Maloney have deep insight and urgency but feel isolated in their ability to drive systemic change. They report difficulties engaging with governments and industry due to political inertia and institutional fragmentation. This limits their capacity to scale impact or influence mainstream space governance.

Need:
Build coalitions and advocacy platforms that amplify their voices, share resources, and create visible pathways for collaboration across sectors.

Emotional And Conceptual Gap Between Public And Space

Public disconnection from space issues remains a major challenge. As public survey noted, most people feel space is distant and irrelevant to their daily lives. Dan Goods emphasized that public engagement starts with emotional resonance—not data. Artists and designers have proven uniquely capable of bridging this gap by translating complex, invisible issues like space trash into tangible experiences.

Need:
Fund and support creative practitioners who can reframe space as a shared, emotional, and accessible domain through storytelling, art, and public installations.

Lack Of A Shared Cultural And Ethical Foundation For Space

While declarations like the Moon Rights initiative serve as moral blueprints, they remain underutilized. Without a common ethical framework, space continues to be treated as a resource frontier rather than a shared environment. Experts agree that declarations can help foster long-term cultural shifts, but these efforts need broader adoption and community input.

Need:
Use declarations as living documents—co-created by interdisciplinary stakeholders, constantly updated, and activated through public dialogue and educational campaigns

Thesis Question

How Might We Ignite Interdisciplinary Conversations That Reshape Space Culture From Competition And Exploitation Toward Stewardship And Shared Belonging—Bridging Specialists And The Public Together To Build An Ethical Foundation For The Space Era?

Thesis Question

How Might We Bridge The Gap Between Emerging And Well-Informed Specialists To Amplify Their Influence, Create Shared Platforms, And Reframe Space As A Protected Global Commons Within Mainstream Space Governance?

"Space is a shared resource of humankind, and so every single one of us has a role to play."

Space Trash Sign

HY

04

YPOTHESIS & VISION

WHY CULTURE-FIRST?

Policy is often framed as a technical operation: identifying problems, setting goals, and designing solutions. But in our observation of space governance, one essential force has been consistently underestimated—**culture shapes what policy sees, how it speaks, and who it ultimately serves.**

Culture is not an add-on to policy—it is the structural condition that determines which issues are visible, which narratives are legitimized, and which values are encoded into institutional frameworks. This chapter argues that to understand both the limits and possibilities of space policy, we must first understand **how culture defines the very boundaries of policy itself.**

PROBLEMS ARE NOT FOUND, BUT DEFINED

Policy doesn't begin with implementation—it begins with naming. What counts as a problem, who is responsible, and which solutions are considered legitimate are all shaped by narrative power (Stone, 2002).

For example, the U.S. Space Policy Directive-3 (2018) frames space debris as an "operational hazard," embedding it within a traffic management model. This definition reinforces a technical solution pathway, portraying orbital debris as a manageable engineering challenge.

In contrast, New Zealand's Outer Space and High-altitude Activities Act (2017) partially incorporates Māori cosmological views, recognizing celestial space as sacred. In that framework, orbital interference is not merely a technical risk but a cultural violation. These two framings reflect profoundly different worldviews and value systems.

As Berger and Luckmann (1966) argue, "reality" is not given—it is socially constructed through language, symbols, and shared cultural frameworks. Policy is no exception. What we treat as "problems" are first made visible—and nameable—through cultural lenses.

THE 3-LAYER CULTURAL MODEL: FROM METAPHOR TO SYSTEM

To better analyze how culture influences policy, we propose a three-layered cultural model, drawing on narrative policy theory (Schön & Rein, 1994; Jones et al., 2014) and institutional sociology. These layers are:

Advertisements, Posters And Products That Are Influenced By Space Race

THE CULTURE LAYERS FRAMEWORK

Difficult

INSTITUTIONAL LAYER: WHAT BECOMES LAW

Institutions rarely choose the “best” solutions. More often, they replicate dominant cultural models—a process sociologists call institutional isomorphism (DiMaggio & Powell, 1983).

In space governance, this is evident in licensing and evaluation systems that prioritize mission safety and commercial viability, while cultural, ecological, or ethical criteria are excluded.

Bruno Latour (2005) reminds us that institutions are not just built from people and rules—they are **networks of technologies, legal codes, and metaphors**. Without embedding alternative cultural symbols into these networks, governance remains structurally resistant to change.

SYMBOLIC LAYER WHO IS THE HERO, WHO IS THE BARRIER

French sociologist Pierre Bourdieu (1991) argued that symbolic power structures the field of policy. In dominant space governance narratives, private companies are cast as heroes—disruptors and innovators; regulators are framed as villains, slow and bureaucratic; and “humanity” becomes the victim, whose potential is stifled.

This dramatic triangle of hero-villain-victim (Roe, 1994) legitimizes commercial expansion and delegitimizes calls for ethical, environmental, or cultural caution.

COGNITIVE LAYER WHAT BECOMES VISIBLE

The metaphors and language we use determine which problems enter the policy arena. For instance, framing space as a “frontier” activates logics of conquest, ownership, and expansion, while calling it a “commons” activates stewardship, ethics, and collective responsibility (Light, 2022).

Cultural language acts as a filter: what is named can be governed. What remains unnamed remains invisible.

Easy

POLICY SHIFTS PRECEDE CULTURAL RECONFIGURATIONS

Culture is not an appendage of policy, but its “constitutional structure”. The possibility of governance is essentially the possibility of cultural construction.

In order to truly promote the sustainable transformation of spatial governance, we cannot only rely on technical fixes or optimization of indicators, but also need to reshape narratives, value systems, and symbolic structures.

This also leads us to the question: **Who can connect cultural reconstruction and institutional practice?** We believe that “young experts” may be a key force in this translation. **They understand the system, yet are not fully absorbed, and have the potential to drive cultural change at the margins of the system**.

Youth Participate Climate Grief Activity


Future Generations Were Inspired By Astronauts

HISTORY PATTERN
YOUTH HAS CHANGED SYSTEMS BEFORE

In the climate crisis, it was students—not scientists—who turned technical facts into emotional momentum.

Fridays for Future, launched by teenagers, didn’t invent new climate science. Instead, it reframed the conversation—introducing terms like “intergenerational justice” and “climate grief” into mainstream discourse. These weren’t policy concepts—until young people made them politically and culturally unavoidable.

In 2019, millions of youth joined global climate strikes in over 150 countries. Their impact wasn’t just in numbers. It was in how they redefined urgency—not as a scientific timeline, but as a moral responsibility. Greta Thunberg’s speech at the UN didn’t rely on charts. It relied on language—blunt, ethical, generational—and it resonated around the world.

From climate justice to civil rights, youth have consistently disrupted stagnant institutions and reimagined the future. With this foundation, we asked: **who is best positioned to reframe humanity's relationship with space?**

YOUNG SPECIALISTS: STANDING AT THE CROSSROADS OF THE GAP

In our earlier research, we identified **several structural gaps** within the space industry ecosystem—especially **between generations of experts**. While seasoned professionals hold deep technical knowledge, they often operate in silos with limited time or support to engage beyond their institutions. At the same time, emerging professionals frequently lack access to mentorship, visibility, or frameworks for collective influence. This disconnect weakens continuity and stifles innovation.

Young specialists, however, offer a compelling solution. Unburdened by entrenched industry norms, they are more willing to challenge assumptions and propose systemic alternatives. Many of them are trained in interdisciplinary environments, which means they are comfortable navigating science, policy, ethics, and design simultaneously. This versatility is essential for addressing space debris crisis, which **sits at the intersection of engineering, law, culture, and public accountability**.

DEFINITION & CHARACTERISTICS OF TARGETED YOUNG SPECIALISTS

Age: 18-35
Early-career professionals and graduate students

Working across disciplines: engineering, law, policy, science, environmental studies, design, and the arts

Young specialists are:

- **Unburdened** by entrenched industry norms, allowing space for bold, systemic thinking
- **Interdisciplinary** by default, bridging science, policy, design, and law
- **Motivated by long-term futures**, not short-term gains
- More **open to collaboration**, especially across borders and fields

2022 EMER-GEN A Hit With Young Professionals In Space

Moreover, young professionals are intrinsically invested in the long-term consequences of today's space practices. They are not only inheriting this crisis—they are actively shaping the systems that will respond to it. Our interviews and survey confirmed that **many are eager to participate but lack structured opportunities to do so**.

S.T.A.R. COALITION (SPACE TRASH AWARENESS & RECOVERY)

CONNECTING YOUNG SPECIALISTS ACROSS DISCIPLINES TO LEAD, COLLABORATE, AND ADVOCATE FOR A SUSTAINABLE SPACE FUTURE.

Recognizing the untapped potential of young specialists, we saw the need for more than individual awareness—**we needed a platform**. The challenges of space sustainability are too complex for any single discipline or voice. That's why we formed the **S.T.A.R. coalition (Space Trash Awareness & Recovery):**

WHAT IS S.T.A.R?

S.T.A.R (Space Trash Awareness & Recovery) is a **global networked coalition** to unite **early-career scientists, designers, legal thinkers, and engineers**. S.T.A.R. offers a shared space for **collaboration, learning, and advocacy**—empowering young professionals to shape the future of space governance together.

WORKED AS AMBASSADORS

Building cross-border dialogue, countering misinformation, and sharing knowledge.

WORKED AS ADVOCATES

Raising industry & public awareness and influencing cultural and political conversations.

By **empowering the next generation**, young specialists help shift space from a distant frontier to a shared, ethical domain and reshape how space is explored, protected, and respected—for all.

S.T.A.R. VISUAL IDENTITY

The S.T.A.R. visual identity uses a **deep-space gradient transitioning** from midnight blue at the top to a lighter, atmospheric blue at the bottom. This evokes depth, orbital layering, and the shift from the unknown to the intimately planetary—mirroring S.T.A.R.'s mission to bring cosmic issues into public consciousness.

Typography is set in **KMR Apparent**, a geometric sans-serif typeface that blends modernity with clarity. Its sharp yet friendly structure reinforces the project's tone: visionary but grounded. Key phrases are highlighted in orange for emphasis, drawing attention to essential values like free and preserving.

Altogether, **the gradient, color palette, and typography** combine to express **clarity, urgency, and shared responsibility**, turning the vastness of space into a shared narrative for planetary ethics and action.

LOGO VARIATIONS

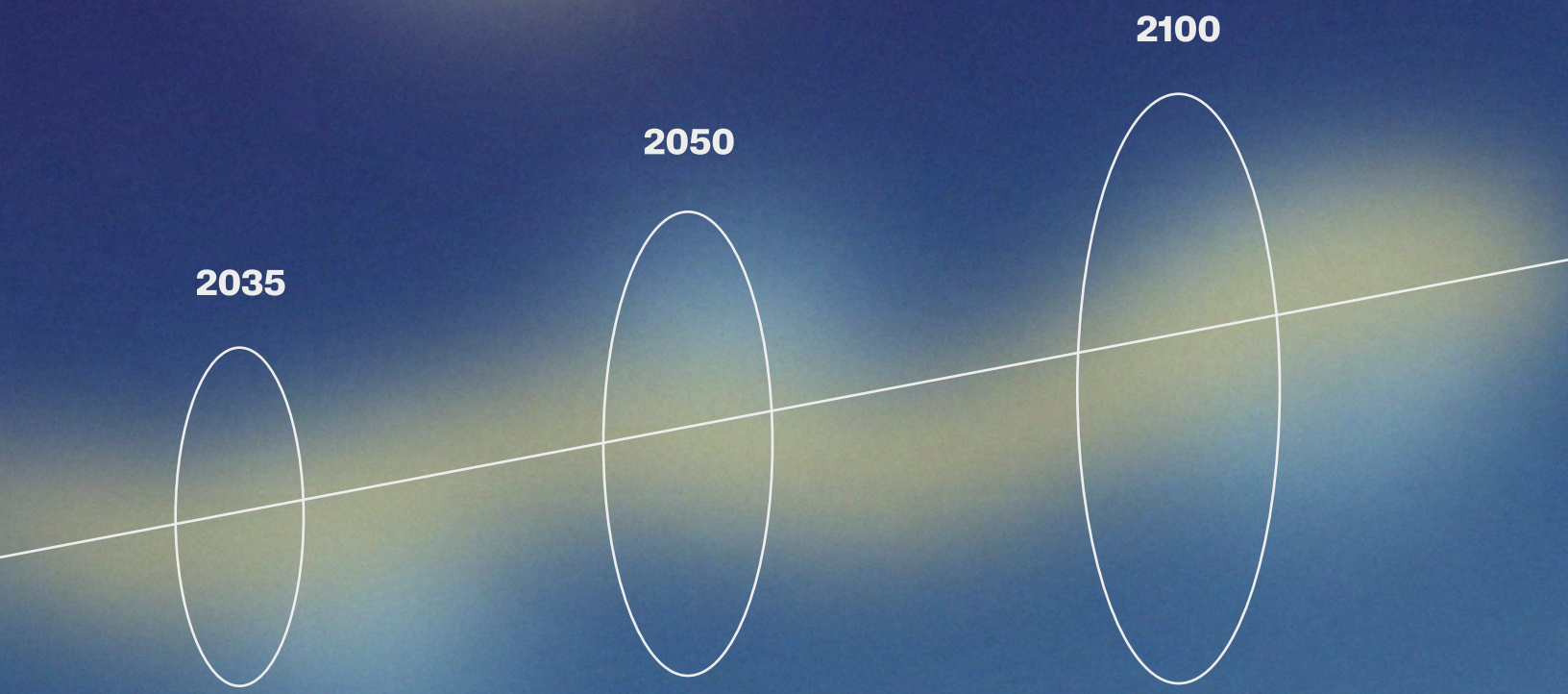
S.T.A.R.

SPACE TRASH AWARENESS & RECOVERY

S.T.A.R. VISION

80-YEAR HORIZON

Our vision for long-term space sustainability is designed around an **80-year arc**—rooted in precedent from **other global transformations**. We divide this timeline into c**ultural shift, systemic shift, governance shift a**nd then reached the **ultimate goal that space is protected and respected permeate every part of society**



CULTURAL SHIFT

New values take time to reach the public imagination. Even with institutional push—such as NASA and ESA promoting "space stewardship"—mainstream acceptance requires generational change. Like climate awareness, which took decades to normalize, we expect space sustainability to become a shared cultural value by 2035.

SYSTEMIC SHIFT

Embedding new norms into institutions is a slow, cyclical process. Though countries like Japan and France have begun addressing orbital risks, global standards remain unsettled. Drawing from ESG's 25–30 year path into corporate governance, we estimate space sustainability will become a policy default by 2050.

GOVERNANCE SHIFT

Shifting who holds power takes longer than shifting language or systems. Current space governance remains technocratic and closed to younger voices. It took over two decades for the climate sector to build inclusive frameworks—space, with added geopolitical and military complexity, will require at least as long. 2100 is a cautious but realistic milestone for structural power-sharing.

S.T.A.R. MISSION

A NEW GENERATION PROTECTING THE SPACE WE ALL DEPEND ON

Drawing from earlier interviews, investigations, and our analysis of how culture shapes policy, S.T.A.R now centers on the following **three missions**.

FOSTER SHARED RESPONSIBILITY IN YOUNG SPECIALISTS

Equip the next generation of engineers, lawyers, artists, and entrepreneurs to see space stewardship not as a niche, but as a foundational mindset embedded in their work and values.

BRING SPACE DOWN TO EARTH FOR THE PUBLIC

Transform orbital sustainability into a tangible, everyday concern through storytelling, design, and civic participation—making space feel local, not distant.

SET A NEW TABLE FOR SPACE GOVERNANCE

Co-create inclusive, adaptive policy frameworks that reflect the realities of a rapidly evolving space age, where power, responsibility, and innovation are distributed globally.

THEORY OF CHANGE: NARRATIVE

The S.T.A.R. coalition envisions a future where space sustainability is not just a technical concern but a shared cultural and ethical responsibility. At its core, this Theory of Change maps how a small group of empowered young specialists can spark a broader movement—reshaping public perception, influencing governance, and embedding space stewardship into global consciousness.

GOAL

Our ultimate goal is to **ensure that all future leaders in the space sector prioritize space sustainability as a fundamental principle**—integrating it into exploration, policy, and industry practices. Beyond institutions, we aim to foster a world where everyone—from professionals to the general public—feels a meaningful connection to space, recognizing it as a shared domain that must be protected, much like Earth itself. Space stewardship should evolve into a mainstream cultural value, embraced both by decision-makers and society at large.

PRECONDITIONS

To reach this vision, several key shifts must happen first:

A new generation of interdisciplinary space leaders must equipped not only with expertise but with a strong ethical foundation and global perspective.

Public perception of space must transform—moving from seeing space as distant and technical, to viewing it as part of humanity's collective future, worthy of care and advocacy.

Governments, institutions, and corporations need to recognize space sustainability as an urgent issue, integrating ethical governance into their frameworks.

These preconditions create the foundation for lasting cultural and systemic change.

PATHWAY TO CHANGE

S.T.A.R.'s approach begins with targeted inputs—including workshops like the Space Rights Declaration co-authoring session, public exhibitions (e.g., Space Trash Signs), collaborative platforms, and communication design that translates complex space issues into accessible narratives.

These inputs drive critical interventions:

- Empowering young specialists to engage in interdisciplinary dialogue.
- Providing platforms for advocacy, public engagement, and policy influence.
- Facilitating partnerships with authoritative organizations to amplify impact. The immediate outputs reflect growing momentum:
- Young specialists actively questioning existing power structures and advocating for new governance models.
- Increased collaboration across fields, leading to educational content, policy proposals, and public campaigns.
- Rising public engagement through social media, art, and petition-driven activism.

As these outputs scale, they lead to transformative outcomes:

• A credible, expanding S.T.A.R. network that empowers its members.
• A public that sees space as a "shared sky," emotionally connected to its future.
• Cultural shifts marked by art, media, and grassroots advocacy embedding space ethics into everyday conversations.
• Institutional recognition of S.T.A.R.'s efforts, influencing global space governance.

These outcomes collectively fulfill the necessary preconditions, paving the way toward the goal.

ASSUMPTIONS

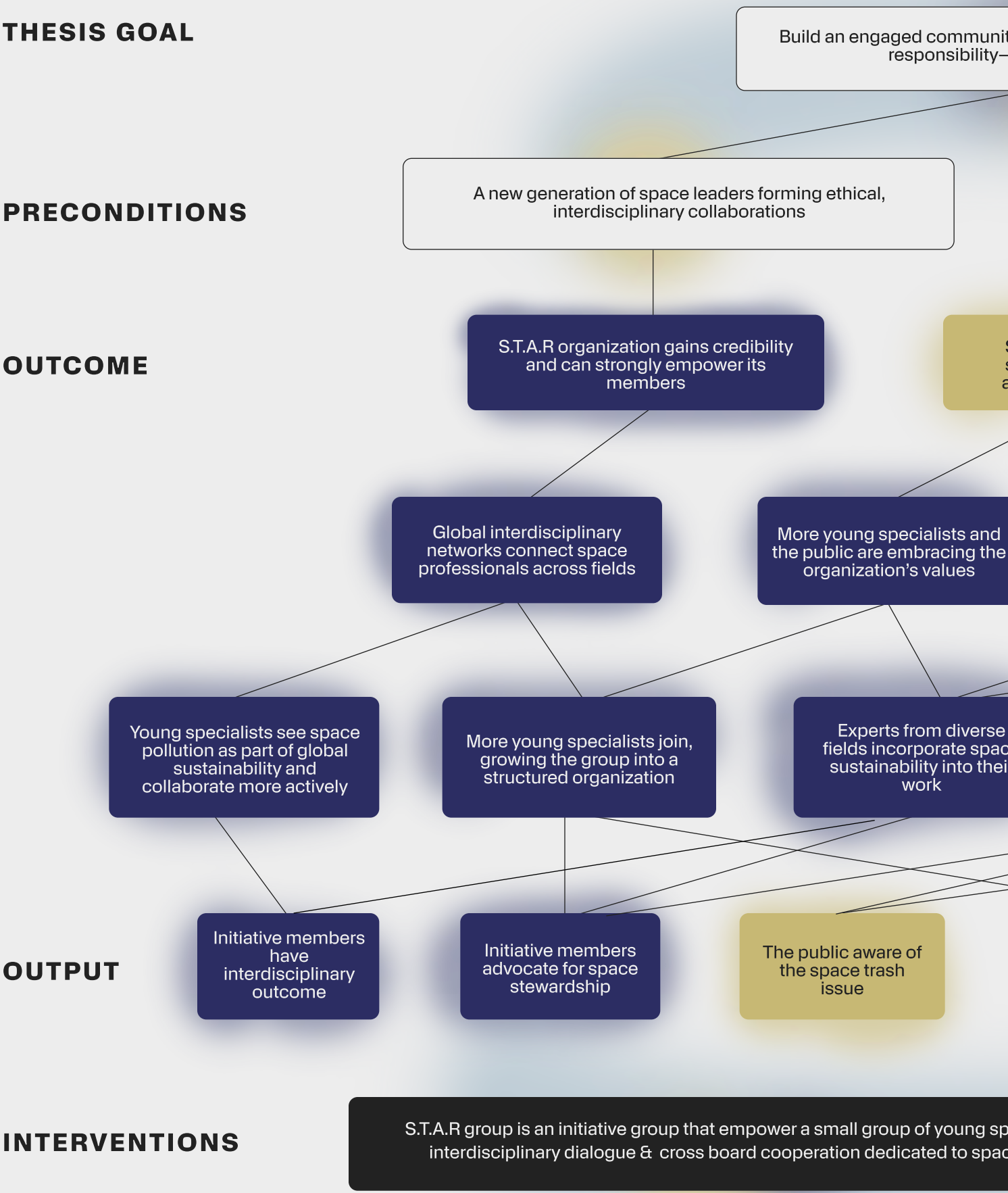
This pathway assumes:

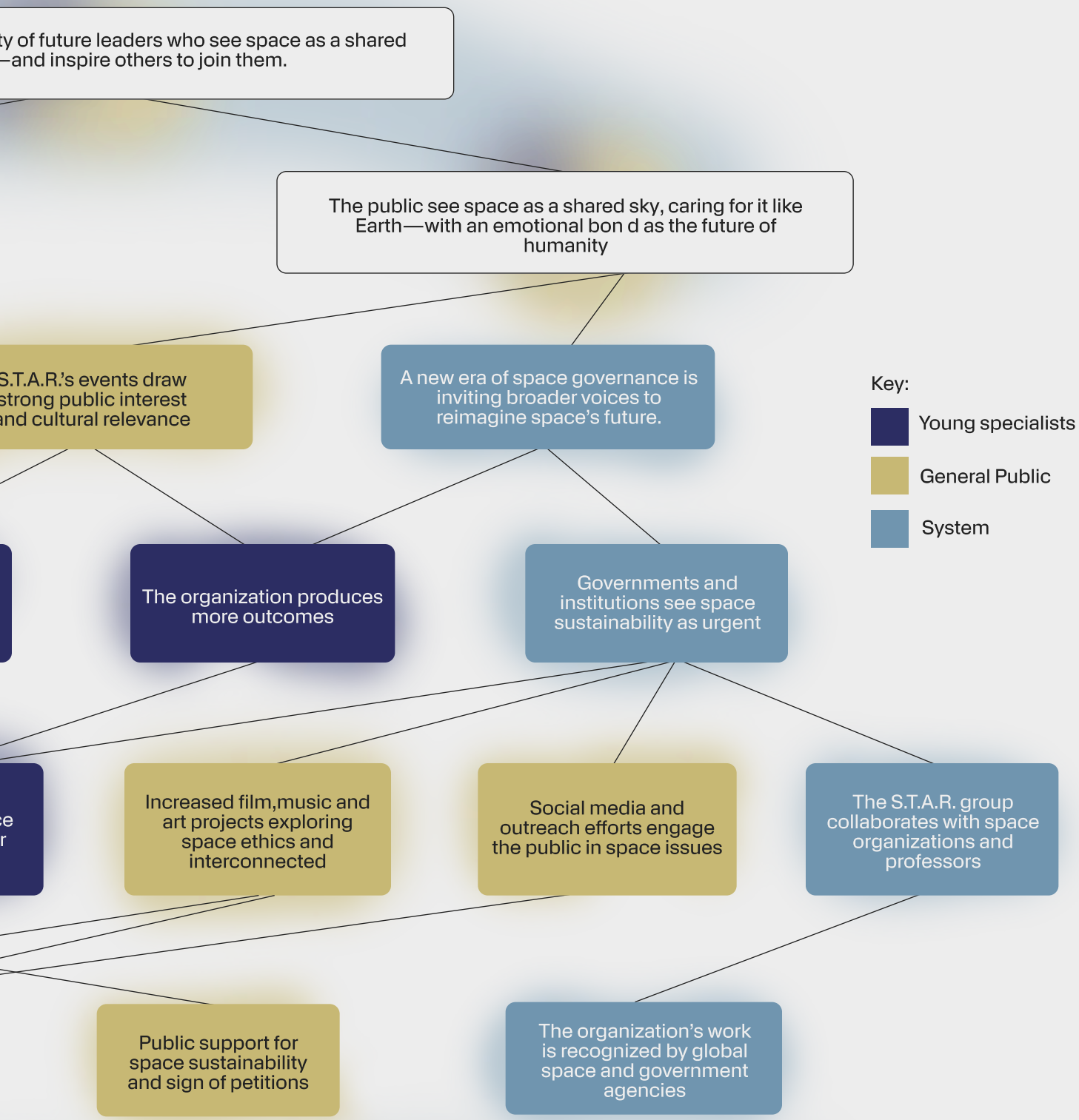
• Cultural interventions (art, storytelling, public events) can meaningfully shift perceptions and inspire action.
• Young specialists, though initially outside traditional power structures, can become catalysts for systemic change.
• Public pressure, when combined with expert advocacy, can influence institutional policies.
• Cross-sector collaboration enhances both innovation and legitimacy in addressing space sustainability.

ADDRESSING GAPS

While this framework charts a clear course, challenges remain. Sustaining long-term engagement —both within the S.T.A.R. network and among the public—requires continuous innovation and support. The pathway from cultural relevance to concrete policy change also depends on external factors, such as political will and global cooperation, which lie beyond direct control.

Additionally, ensuring diversity—bringing in voices from different regions, disciplines, and backgrounds—is essential to truly framing space stewardship as a global responsibility.


THESIS GOAL
Build an engaged communit
responsibility–
PRECONDITIONS
A new generation of space leaders forming ethical, interdisciplinary collaborations
OUTCOME
S.T.A.R organization gains credibility and can strongly empower its members
Global interdisciplinary networks connect space professionals across fields
More young specialists and the public are embracing the organization's values
Young specialists see space pollution as part of global sustainability and collaborate more actively
More young specialists join, growing the group into a structured organization
Experts from diverse fields incorporate spac sustainability into thei work
OUTPUT
Initiative members have interdisciplinary outcome
Initiative members advocate for space stewardship
The public aware of the space trash issue
INTERVENTIONS
S.T.A.R group is an initiative group that empower a small group of young sp
interdisciplinary dialogue & cross board cooperation dedicated to spac



ecialists to advocate for space sustainability & a effective platform for them to have
ce sustainability with public and ask for new regulation and governance systems

UNDERSTANDING & RECRUITING YOUNG SPECIALISTS

UNDERSTANDING YOUNG SPECIALISTS

To better understand who S.T.A.R could serve, we spoke with **young specialists who were already aware of space debris and sustainability challenges**. We wanted to know what they were doing or wanted to do for this issue, what was blocking them. We got **6 interviewees**, and **2** of them are leaders from **SGAC(Space Generation Advisory Council)**

Janelle Wellon
Operation Engineer | JAXA
In her spare time she often discusses space sustainability with others

"Sustainability is spoken about all the time, **especially for people on the business side** of things.....You can't empower them to make decisions if they don't have the title."

"SGAC's acceptance of military-industrial complex funding has led to an inability to freely criticize the intersection of war and the space industry"

AJ Link
Former leader of the Ethics and Human Rights I SGAC

Nicole Nir
Former member of the Ethics and Human Rights I SGAC
Wrote & advocated a graduate thesis on the Bill of Rights in Space

"People are focused on climate justice —but only in terms of life on Earth."

It's all volunteer-based… so projects move very slowly."
"It's difficult to maintain momentum… people get busy, especially in stressful times."

Mahad Nayyer
The Leader of Space Sustainability Group I SGAC
7 years experience on space sustainability advocate and tech development

”I don't have friends and classmates around me to discuss this topic, professors are busy with a lot of important projects that don't care about this, even though we know it's serious“

Minghao Song
Astrophysics Graduate Student I Chinese Academy of Sciences (CAS)

INSIGHT

Young professionals face several dilemmas when they want to focus on and improve space sustainability issues:

Structural under-appreciation creates frustration. No voice in the company, no support in the community.

Lack of relevant discussion platforms and communities with low barriers to entry.

Existing organizations are inefficiently managed, slow to produce results, and financially tied to stakeholders who are part of the problem

RECRUITING YOUNG SPECIALISTS

In our early outreach, we introduced the S.T.A.R. coalition and invited individuals to help shape it. Most responses were hesitant, with concerns about identity, legitimacy, and funding. This led us to reassess our approach.

We realized that asking people to “join” too early felt like too much commitment. So we shifted from recruitment to resonance—starting with open conversations about space debris to explore participants’ knowledge, attitudes, and emotions. This allowed for natural alignment before suggesting deeper involvement.

As a result, we engaged four young specialists from diverse backgrounds in our first prototype workshop—not as members, but as co-creators in an exploratory process.

“I think that’s a really great kind of starting point… there’s such a need for something like this, like something that people are signing on to...There’s not a lot of grassroots activism happening around this, and there does need to be awareness building.”

Nicole Nir

“I think it’s very wise of you to realize that the top-down is just as important… both together is really smart, and I think it’s the way you should do it.”

Janelle Wellon

Mission 1: Foster Young Specialist Mindsets
Mission 2: Bring Space Down to Earth
Mission 3: Set a New Table for Space Regulation

05.

LAUNCHING S.T.A.R

Mission 1

FOSTER A MINDSET IN YOUNG SPECIALISTS THAT PROMOTES SHARED RESPONSIBILITIES IN SPACE.

Context

In our initial interviews, participants across disciplines expressed strong support for space sustainability but felt that **meaningful action was limited to experts or institutions**. While they understood the technical issues, few had considered the cultural or ethical dimensions—or their own role in change.

To expand this perspective, we drew from **the Moon Rights Declaration**, which frames the Moon as an entity with moral significance rather than a resource. Its symbolic use of rights challenges dominant narratives and invites ethical reflection. To deepen the conversation, **we invited co-author Dr. Michelle Maloney**, an ecological lawyer, to share insights and lead a discussion on its philosophical foundation.

CO-AUTHORING THE DECLARATION OF THE NEAR EARTH SPACE

March 15, 2025 | Zoom Meeting | 5 Young Specialists & 1 Guest

Objectives

To investigate how young specialists from diverse disciplines understand the concept of space sustainability, and whether a shared foundation of values can be articulated

To explore potential formats for future engagement that enable long-term participation and cross-sector collaboration

To examine whose voices and perspectives should be included to shape a more representative and ethically grounded value system for the organization

To collectively draft a preliminary version of the Near-Earth Space Rights Declaration, serving as both a cultural artifact and a starting point for continued dialogue

Participant Demographics

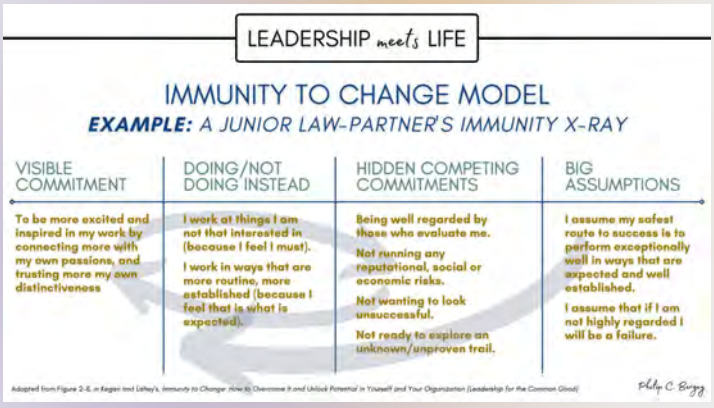
Following the advice of Dr. Michelle Maloney, we prioritized depth over breadth, recognizing that early-stage consensus-building is more effective with a focused group.

A total of 5 participants were involved, each bringing a distinct disciplinary perspective: **space operations engineering, astrophysics, space law, and design**. They were affiliated with institutions across 4 different regions, including the **Chinese Academy of Sciences (CAS), New York University (NYU), the Japan Aerospace Exploration Agency (JAXA), and the School of Visual Arts (SVA) in New York**. This diverse yet compact group enabled meaningful interdisciplinary exchange while maintaining a manageable scope for co-authorship.

Workshop Design Rationale

The Moon Rights Declaration inspired us to **use a rights-based format** not for enforcement, but as **a cultural tool to spark ethical imagination**. Our workshop invited participants to co-author a Near-Earth Space Rights Declaration as a symbolic, participatory way to express shared values and rethink space governance.

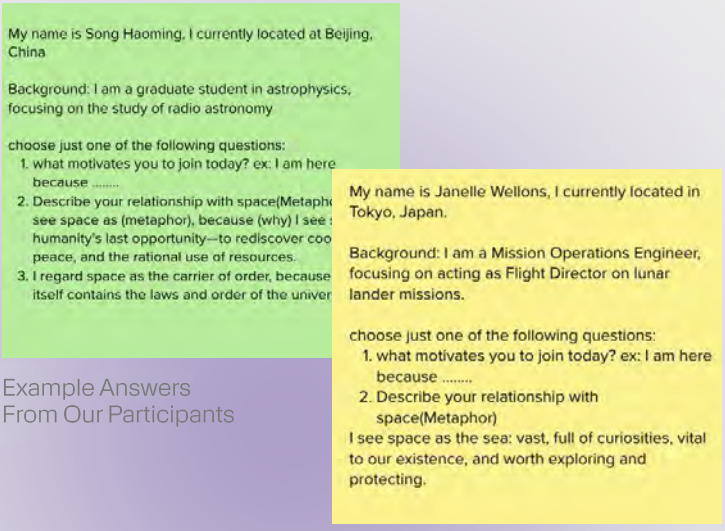
To deepen reflection, we adapted **the Immunity to Change model by Robert Kegan and Lisa Lahey.** This framework helped participants surface hidden assumptions and internal contradictions, guiding them from abstract ideals toward more personal and grounded insights—supporting a more honest and transformative co-writing process.



Workshop Agenda

1. Common Ground

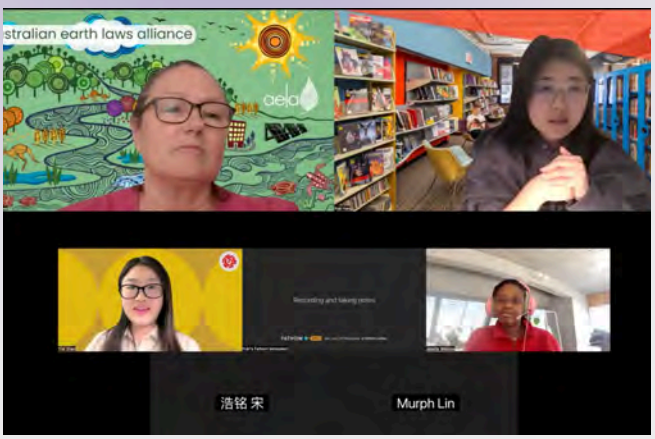
We began with a value-mapping exercise to help participants surface their beliefs, disciplinary backgrounds, shared language, and underlying tensions. This step laid the foundation for building mutual understanding and identifying areas of alignment and divergence.



Example Answers
From Our Participants

2. Guest Lecture

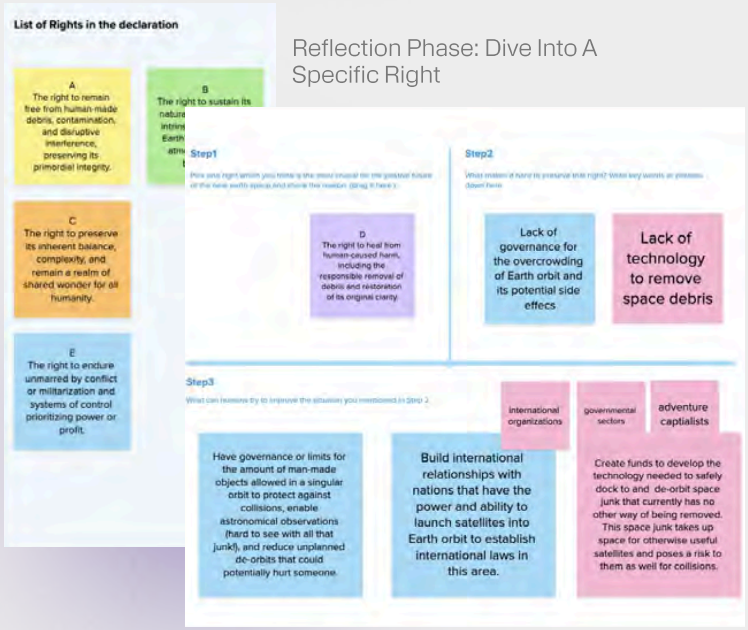
Dr. Michelle Maloney, co-author of The Rights of the Moon, introduced the co-authoring process behind the declaration and the motivations that led to its creation. This was followed by an open Q&A session, where participants engaged directly with her to better understand how rights-based framing can influence space ethics and governance.



Michelle Gave Her Lecture Of The Moon Declaration

3. Writing with Many Voices

Prior to the workshop, we drafted a preliminary version of the Near-Earth Space Rights Declaration based on earlier interviews and research. During this session, participants reflected on the draft through the lens of the Immunity to Change model—exploring what values they agreed on, which concerns they prioritized, and what internal or systemic barriers they faced in imagining ethical responsibilities in near-Earth space. Their responses were then used to refine the rights proposed in the declaration.



Reflection Phase: Dive Into A
Specific Right

REFLECTIONS

What's Working

1. Expert lecture as ethical grounding
The guest lecture provided by Dr. Michelle Maloney helped establish a shared ethical framework among participants—fulfilling our goal of exploring what conceptual foundations could support future activities. Her reflection on the Moon Rights Declaration offered a real-world example of interdisciplinary advocacy, which participants later referred to when articulating their own values. This confirmed the value of integrating expert voices not as authorities, but as catalysts for deeper dialogue.

2. Co-authoring as a collaborative model
The co-writing format proved effective in exploring possible structures for future S.T.A.R. programming. It allowed participants from vastly different fields to contribute equally, reinforcing our aim to test non-hierarchical, participatory approaches to space governance. Rather than relying on panels or debates, the shared authorship process gave participants a sense of ownership and revealed how interdisciplinary collaboration might function as a core method in S.T.A.R.'s ongoing work.

3. Declaration served as a generative probe
Even participants who disagreed with the rights-based framing found the declaration useful as a creative and literary tool. It helped surface deeper values and build shared language, fulfilling our goal of testing how consensus might emerge through cultural dialogue。

What's Emerging

1. **Broader Inclusion Needed**
   Participants stressed the importance of involving diverse voices—such as those from non-spacefaring nations and experts in climate, ethics, education, and policy—to shape more inclusive, future-oriented space governance.

2. **Sustained Interdisciplinary Dialogue**
   They recommended creating a digital platform (e.g., Discord) to continue cross-disciplinary conversations and collaborative work beyond the workshop.

3. **Desire for Policy Impact**
   Several young specialists expressed concern that without policy engagement, these efforts risk being purely symbolic. They hope their contributions will inform advocacy and be taken seriously by institutions like the UN and national space agencies.

"Even if we write down rights, who's going to enforce them"

Janelle Wellon
Operation
Engineer(JAXA)

DECLARATION OF RIGHTS OF NEAR-EARTH SPACE

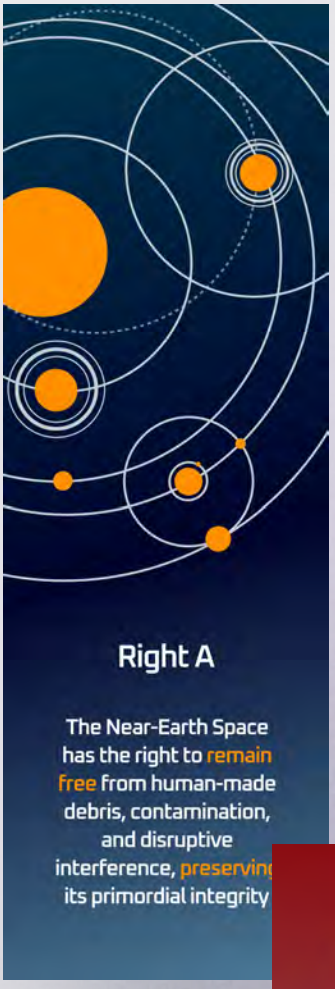
We, the beings on Earth -

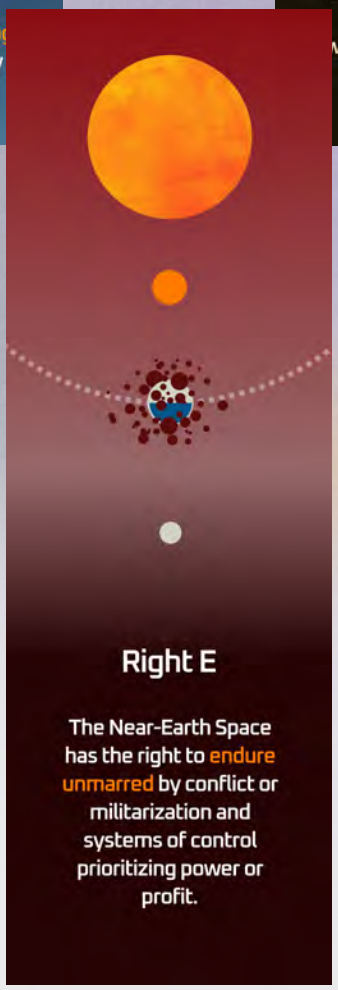
Acknowledging Near-Earth space as the silent expanse shaped by our planet's gravitational kinship—a realm of orbits, particles, and electromagnetic bonds bridging Earth and cosmos;
Recognizing that this domain is neither empty nor inert, but a dynamic system inseparable from Earth's ecosystems, sustaining atmospheric balance, enabling life's rhythms, and inspiring collective wonder;
Alarmed by the growing web of human-made debris—fractured satellites, discarded tools, and the toxic rain of reentry—poisoning our skies, oceans, and lands;
Rejecting the exploitation of Near-Earth space for profit, power, or conflict, as human ambitions fracture its equilibrium and impose violence upon Earth's most marginalized;

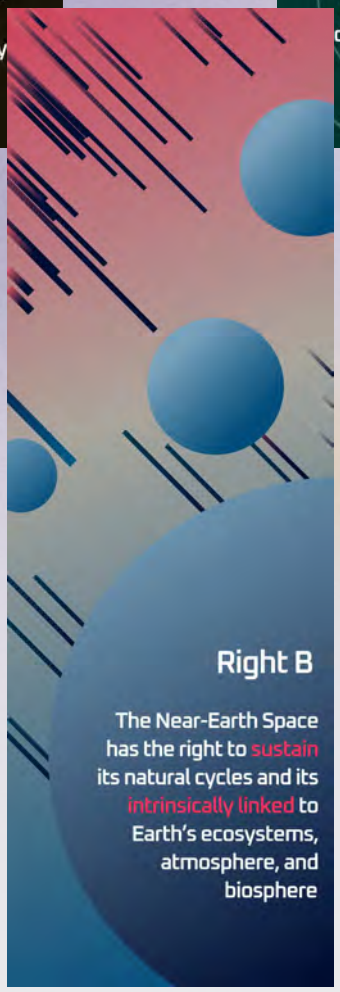
Declare that -

1. Near-Earth Space—which includes, but is not limited to: Earth's upper atmosphere and exosphere, orbital pathways, electromagnetic fields, cosmic dust, and cislunar regions—exists as **a sovereign natural entity** in its own right. In accordance with established international space law, no nation, entity, or individual of Earth may assert ownership or territorial sovereignty over Near-Earth Space.

2. **Fundamental Rights of Near-Earth Space**
   Near-Earth Space possesses fundamental rights that arise from its existence in the cosmos, including:
   - The right to remain free from human-made debris, contamination, and disruptive interference, preserving its primordial integrity.
   - The right to sustain its natural cycles and its intrinsically linked to Earth's ecosystems, atmosphere, and biosphere.
   - The right to preserve its inherent balance, complexity, and remain a realm of shared wonder for all humanity.
   - The right to heal from human-caused harm, including the responsible removal of debris and restoration of its original clarity.
   - The right to endure unmarred by conflict or militarization and systems of control prioritizing power or profit.







Visual Design For Each Rights In The Declaration

Mission 2

BRINGING SPACE DOWN TO EARTH TO GATHER THE PUBLIC.

Context

Raising public awareness is essential for space sustainability, especially in the absence of strong international regulations. The public can act as a moral force—shaping norms and encouraging accountability. However, public engagement with the issue of space debris remains extremely limited. Most people are unaware of the problem entirely. Even when informed, many struggle to see why it should matter to them, especially when urgent concerns on Earth already demand their attention. In our early interviews, this sentiment was often voiced: “There’s already enough to worry about here.” This reveals not only a lack of knowledge, but a deeper gap in emotional connection, cultural relevance, and perceived agency.

SPACE TRASH THEME BOOTH ON EARTH DAY

April 17, 2025 | Union Square, NYC | 32 ppl/hr

Objectives

To explore whether visual and narrative strategies could serve as effective tools for cultural engagement and mindset shift

To create emotional and intellectual connection to an issue often perceived as distant or overly technical

To raise basic public awareness of the urgency and scale of the space debris problem

To connect the public with the values and visions of young specialists working on space governance

To surface public attitudes and values and bring those insights back into the co-authoring process of the Declaration

Dystopian Future Scenario Setting Ups

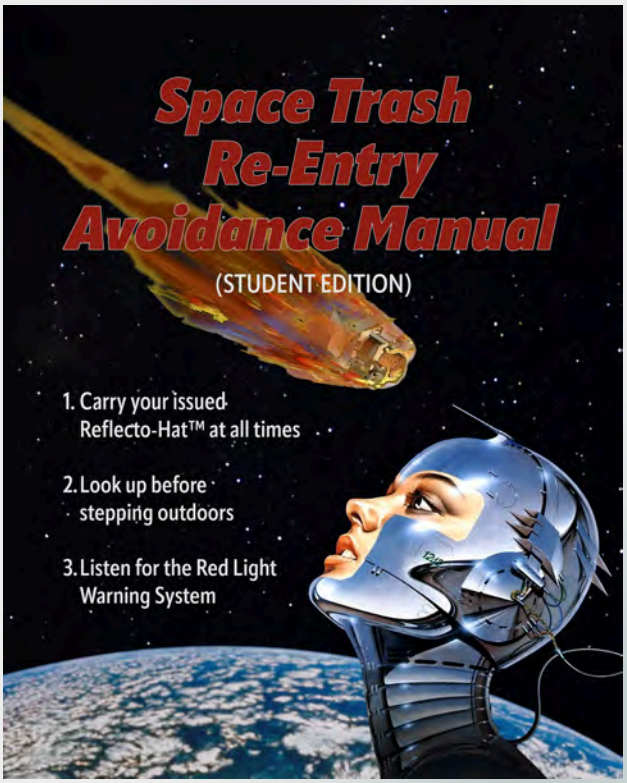
Earth Day Setting Ups

To frame the exhibition, we built a speculative scenario based on the long-term consequences of **the Kessler Syndrome**—a cascade of collisions that renders Earth's orbits unusable. We asked: What might life on Earth look like after orbital space is no longer accessible? Using this imagined future as the narrative foundation, we designed the exhibition environment to reflect a world shaped by irreversible orbital loss: communication systems have broken down, climate monitoring has stalled, and humanity is cut off from space entirely.

Visually, we adopted a retro-futurist aesthetic—referencing past visions of the future from the 1960s–80s—to evoke a sense of distorted nostalgia. This design choice allowed us to present the scenario not as a distant sci-fi fantasy, but as something eerily close and emotionally resonant.

Visual Assets

This series of five illustrated posters uses black humor and retro science-lab aesthetics to imagine life in 2050 after the onset of Kessler Syndrome — a future where Earth's orbit has become a junkyard, trapping us below. Each poster combines speculative storytelling with sarcasm to spark reflection on the urgency of space sustainability.

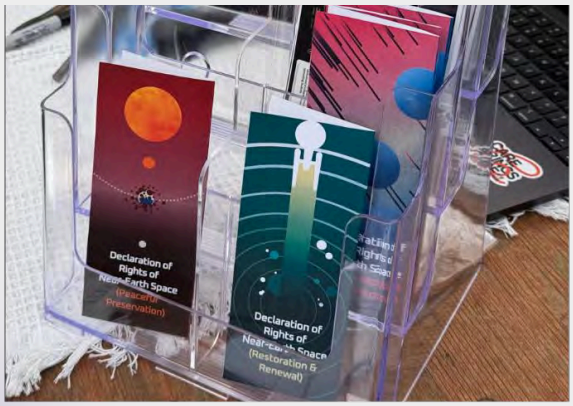


The Collection Of Five Posters:
What We Will Face After Kessler Syndrome

PUBLIC INTERACTION AND FEEDBACK MECHANISMS

Declaration Bookmarks

We distributed declaration-themed bookmarks, each linked to a specific “right” of near-Earth space. Visitors could scan a QR code printed on the back to read the full Declaration of Near-Earth Space. This low-barrier entry point introduced our core advocacy and gave people a tangible takeaway to reflect on.



Bookmarks Sets

Tabletops Setups With Audio Players

Declaration Audio Broadcasts

We produced an audio version of the declaration and broadcast it through retro radio players placed on the table. The spoken format drew in visitors who noticed the sound first, especially individuals with visible accessibility barriers. This auditory channel helped make our booth more inclusive and multidimensional.

Retro Educational TVs

To attract families and younger audiences, we repurposed vintage TV sets to screen looping animated videos. This setup was especially effective with parents, many of whom stopped to watch with their children, turning curiosity into conversation.

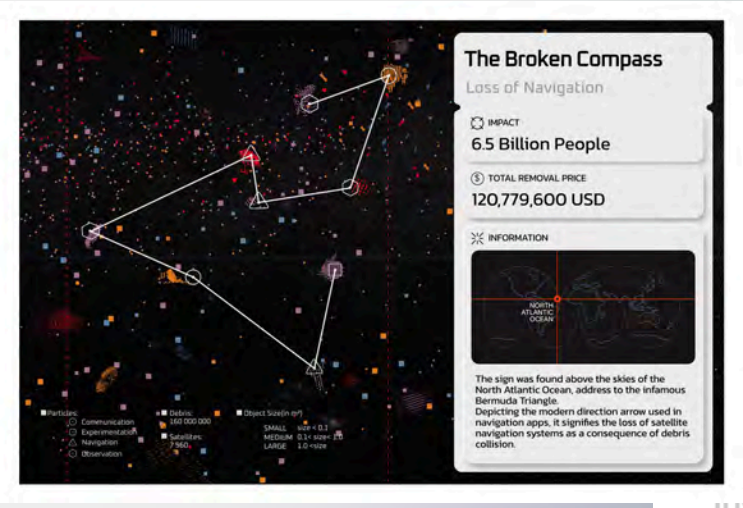
- One TV introduced the S.T.A.R. coalition and explained who we are as a coalition of young space sustainability advocates.
- The second TV visually explained the Kessler Syndrome in accessible language, connecting orbital science with everyday life.

Instagram Activation

Many attendees asked how to stay connected with our work. In response, we created a dedicated Instagram account and invited people to scan a QR code to follow us. This created a direct channel for ongoing engagement and announcements for future public actions and updates.

Chair And TV Setups &
Instagram Profile Screenshot

SPACE TRASH SIGNS POSTCARDS

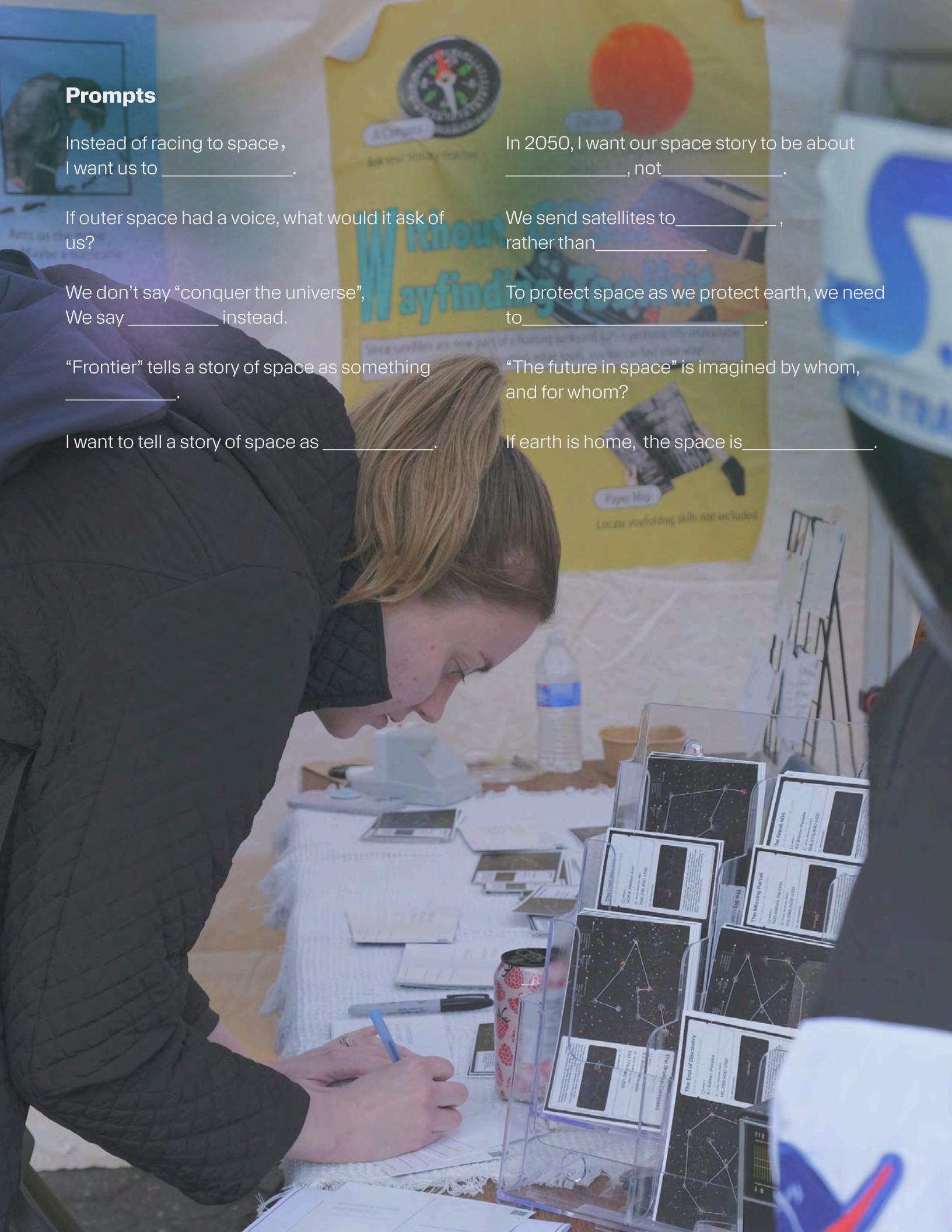


One Example Of The Postcard Designs Including Back And Front Information

To engage visitors , we incorporated an interactive component centered around **Space Trash Signs**—an **online open-source project that visualizes actual orbital debris data as symbolic warning signs**. Originally designed to raise awareness of the growing presence of space debris, each sign draws from real satellite and debris datasets, transforming invisible orbital threats into visually striking icons that resemble terrestrial caution signs.

We chose to use Space Trash Signs because of their ability to communicate urgency through familiar visual language, bridging the gap between abstract orbital data and everyday public understanding. By making the invisible visible, these signs helped us reinforce the central narrative of the exhibition—what happens when near-Earth space becomes inaccessible.

We **adapted a selection of these signs into printed postcards, and placed them throughout the booth**. On the reverse side of each card, we included prompt questions designed to assess both the cognitive and emotional impact of the exhibition. These prompts invited visitors to reflect on what they had learned, how their perception of space had changed, and what kind of future they hoped for.



Prompts

Instead of racing to space,
I want us to _____.

In 2050, I want our space story to be about _____, not_____.

If outer space had a voice, what would it ask of us?

We send satellites to_____ ,
rather than_____

We don't say "conquer the universe",
We say _____ instead.

To protect space as we protect earth, we need to_____.

"Frontier" tells a story of space as something _____.

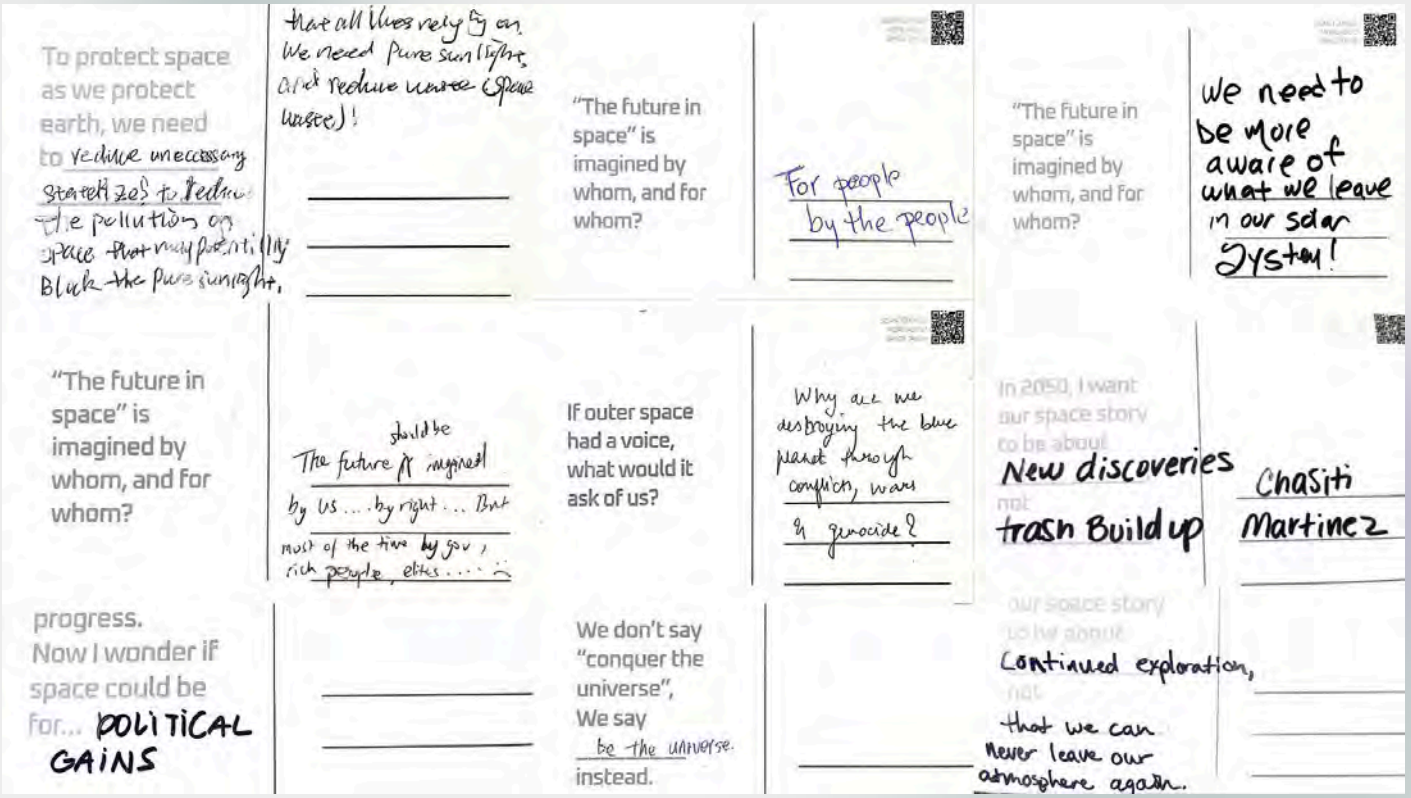
"The future in space" is imagined by whom, and for whom?

I want to tell a story of space as _____.

If earth is home, the space is_____.


Instead of racing to space, I want us to
To protect space as we protect earth, we need to
I'll study more
knowledge about the space
By tech-accelerators
We need to be more aware of what we have in our solar system!
The future in space is imagined by whom, and for whom?
The Missing Parcel
205 Million Parsecs
120,098,600 USD

NARRATIVE INPUTS FROM PUBLICS



Scanning Public Responses

By collecting and categorizing all participant responses, we noticed **clear patterns in how people understood and related to the issue of space debris.** While only a few participants showed both strong awareness and a sense of personal responsibility, **most people left the booth with a deeper understanding of the issue**.

Some participants, even if they started off unfamiliar with space trash**, began to see space as something shared and fragile**. Others, while still unsure of the details, started to recognize that responsibility shouldn't lie with governments alone, but should be **more collective**.

The most engaged participants stood out—**they were curious, asked questions, and began imagining how they could contribute**. Their responses showed early signs of civic engagement and a growing interest in space sustainability. Overall, even small shifts in awareness or responsibility marked meaningful progress.

REFLECTIONS

What's Working

1. **High Engagement in a Short Time**
   With 183 visitors in just four hours—roughly one every 1–2 minutes—the booth drew strong public interest, proving the relevance and curiosity around the topic.

2. **Children as Natural Participants**
   Nearly every child who passed by chose to engage, either out of their own curiosity or through encouragement from their parents. This suggests that the booth design was approachable and intergenerational.

3. **Speculative Tools and Participation**
   The use of postcards and speculative prompts invited people to reflect, imagine, and express their views, making learning informal and interactive. These tools successfully captured attention and invited deeper thought.

4. **Multi-sensory Storytelling**
   Elements like sound, light, and visual design helped communicate complex ideas in an emotional, accessible way.
   They reinforced the message that space is a shared realm, not owned by institutions.

What's Emerging

1. **Unexpected Depth from Some Participants**
   A handful of visitors arrived with more knowledge about space debris than expected, suggesting a growing public discourse that could be tapped into for deeper engagement.

2. **Perception Shifts in Real Time**
   Even brief encounters led to noticeable shifts in how people understood space—especially when tools and language emphasized collective responsibility and shared futures.

3. **Potential for Long-Term Public Dialogue**
   The enthusiasm and reflection shown by many visitors—especially those who asked to stay involved—indicate a readiness for longer-term public participation, beyond one-day events.

Audiences interacted at Earth Day Booth Activity


ESS & RECOVERY
NASA
S.T.A.R
SPACE TRASH AWARENESS & RECOVERY


TEA

SPACE TRASH

SONG BY WANG CHUNG · 1997

Through the tenth dimension
To the certainties beyond
Dreamily inattention, and the sub-atomic bomb
Machine that spins within me
And the spirit that drives me on
Searching for an answer

Welcome to my world (welcome to my world)
Welcome to my only world (my only world)
It is full of space junk
But your words are coming through
I'm riding on the space junk
And it's bringing me to you
Bringing me to you

Mission 3

SET A NEW TABLE FOR THE SPACE SUSTAINABILITY REGULATION SYSTEM.

Context

Shifting Focus Toward Institutional Power

In our early outreach efforts, most of the individuals we engaged with came from technical backgrounds—engineers, students, and researchers working outside the space policy sphere. While their insights were essential, they lacked the authority to influence regulatory or funding decisions. From the outset, we recognized the need to connect with those closer to the decision-making process: individuals and institutions with the power to shape how space is governed, funded, and framed.

U.S. CONGRESSIONAL EVENT

March 24, 2025 | White House, Washington DC | 6 People

Objectives

This activity served as an initial entry point into the policymaking environment. Through the **Planetary Society's Action Day**, we engaged with **congressional offices under the official purpose of advocating for continued NASA funding**. Within this framework, we tested how the topic of space debris could be introduced—carefully observing what types of language and reasoning were most effective in institutional settings.

The activity did not allow for presenting our own proposals, but it provided a rare opportunity to witness how decision-makers prioritize, interpret, or downplay space sustainability concerns when positioned within a national agenda.

Activity Agenda

1. Training and Meeting at The Planetary Society

Meet with teammates organized by district or country of representation. Share key talking points, align messaging, & review each congressperson's background and priorities.

Meeting With NJ Teammates

2.Statement Writing with Analysis

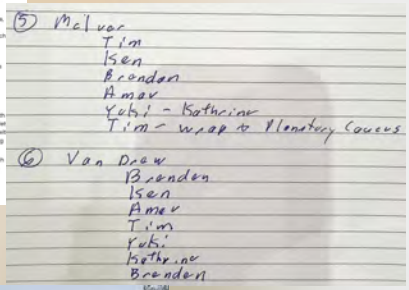
Draft personalized statements for each congressional office using insights from analysis brief. Personalize your message by aligning our space sustainability goals with each office's priorities

Representative Donald Norcross (D-NJ-01)

Biography

Key Findings

Opportunities



5 McIver
Tim
Isen
Brendan
Amar
Yebi - Kathrine
Tim - wrap to Planetary Caucus

6 Van Drew
Brenden
Isen
Amer
Tim
Yebi
Kathrine
Brenden

Sketches Of Statement Preparation

3.Storyline Rehearsal with Team

Practice delivering story—focusing on who you are, why you care, and how this issue matters to their constituents. Rehearse tone, clarity, and timing as a team to ensure confidence in each meeting.

Waiting In Front Of The White House

4.Meetings with Four Congressional Staffers

Present our tailored statements and express our concerns about space sustainability. Use parallel narratives—such as the global response to climate change—and supporting data to illustrate the urgency. Emphasize shared responsibility and need for investment in space stewardship.

Yuki Read Her Statements

Meeting With Staffer Georgia

5. Debrief, Feedback, and Survey

After each meeting, complete a short reflection or survey:

- What did the staffer respond to?
- What could be improved?
- Did your message feel understood?

Use this feedback to refine future communication strategies and follow-up plans.

Highlight Moment

A representative emphasizing that the next NASA representative should have an "unbiased" background—highlighting institutional preferences for neutrality and public trust

A staffer expressing concern about the disconnect between research and policymaking, noting a lack of transparency in how scientific knowledge influences decisions.

Several offices demonstrating more awareness or interest in the issue than we had anticipated.

NJ Citizen Representative Group with Staffer Robin

THE CONGRESSMAN MEETINGS

Representative

LAMONICA MCIVER (NJ-10)

Bio: LaMonica McIver, former Newark Municipal Council President, now represents NJ-10. Her priorities include education, community development, and economic opportunity.

Meeting: Staffer Willie's neutral demeanor made it hard to read the room at first, but he responded well to our points on economic impact. He noted that **sharing the economic impact sheet would have been meaningful**.

Representative

JEFF VAN DREW (NJ-02)

Bio: Jeff Van Drew represents NJ-02 and focuses on law enforcement, national security, and infrastructure. He serves on committees related to homeland security.

Meeting: We tailored our messaging to align with his priorities—**emphasizing space security, law enforcement angles, and planetary defense**. Staffer Jack responded particularly well to discussions around Space Force and protecting Earth from potential orbital threats.

Representative

DONALD NORCROSS (NJ-01)

Bio: Donald Norcross represents NJ-01 and serves on the House Space and Aeronautics Subcommittee. His focus includes labor, workforce development, and climate research.

Meeting: Staffer Robin showed **strong knowledge of space debris and noted a gap between NASA and government communication**. She emphasized the need for translation between science and policy.

Representative

BOB MENENDEZ (NJ)

Bio: Senator Menendez focuses on foreign policy, climate, and public health. He serves on the Senate Foreign Relations Committee and supports science-driven policy.

Meeting: Staffer Georgia, with an environmental science background, was highly receptive. She believed the Senator would support space sustainability, especially through a **climate and global cooperation** lens.

NJ Citizen Representative Group with Staffer Georgia

REFLECTIONS

The experience yielded several insights that now inform S.T.A.R's evolving strategy. Most notably, interest in the issue was higher than expected—but only when framed in a way that aligned with institutional logics and political priorities.

Four Key Implications Emerged

Strategic Translation Is Essential

Policy actors are more responsive to language that links space debris to national security, infrastructure risks, or economic competitiveness. Abstract concepts like "planetary ethics" or "orbital sustainability" need to be reframed in terms of direct institutional relevance

Impact Must Be Measurable

Data points tied to job creation, innovation, or geopolitical advantage generate more traction than moral appeals. S.T.A.R's future communication strategies must anchor long-term goals in evidence-based, quantifiable outcomes

Leadership Must Be Built On Cultural Trust

The call for an "unbiased" NASA Administrator highlights the value of neutrality and public trust. S.T.A.R should prepare young specialists to embody these qualities in future governance roles.

Institutional Dialogue Must Be Ongoing

Interest alone is not enough. For research insights to influence policy, S.T.A.R must seek consistent opportunities to share, translate, and repeat its messages through formats and rhythms aligned with legislative decision-making cycles

Image: NJ Citizen Representative Group Photo


NJ Citizen Representative Group Photo w

ith Staffer Robin

SWITZERLAND INTERNATIONAL WORKSHOP

March 27 -28, 2025 EPFL, Lausanne, Switzerland 45 People

Objectives

This event offered an opportunity to directly observe how key stakeholders in the g**lobal space sustainability ecosystem define their roles, coordinate with others, and envision the future of the field.** Our primary goal was not to advocate, but to investigate:

- How are governance, scientific, and industry actors planning to collaborate going forward?
- What are the perceived challenges in coordination, transparency, and equity?
- How do institutions approach the integration of social science, cultural framing, and public participation?
- What is the attitude toward bottom-up or youth-driven coalition like S.T.A.R, particularly those grounded in ethics and cultural narrative?
- Given these dynamics, should S.T.A.R evolve—either in scope, focus, or structure—to remain relevant and catalytic?

This was not just a site for observation—it was a moment of strategic reflection on whether S.T.A.R, as it stands, is asking the right questions and offering the right interventions.

Activity Agenda

Day 1

First day of the workshop followed a structured mapping exercise led by the **FOGOS team**. Participants were divided into three thematic groups—**peace and security, environmental concerns, and social equity and economic issues**—and rotated through a series of breakout sessions. Each session focused on analyzing how different types of governance instruments—**intergovernmental, national/ regional, and inter-stakeholder**—address the selected sustainability dimension.

Discussion prompts included:

- Which instruments are most or least effective in addressing the theme?
- Where do synergies, contradictions, or gaps exist across levels and sectors?
- What are the broader implications for coordination and implementation?

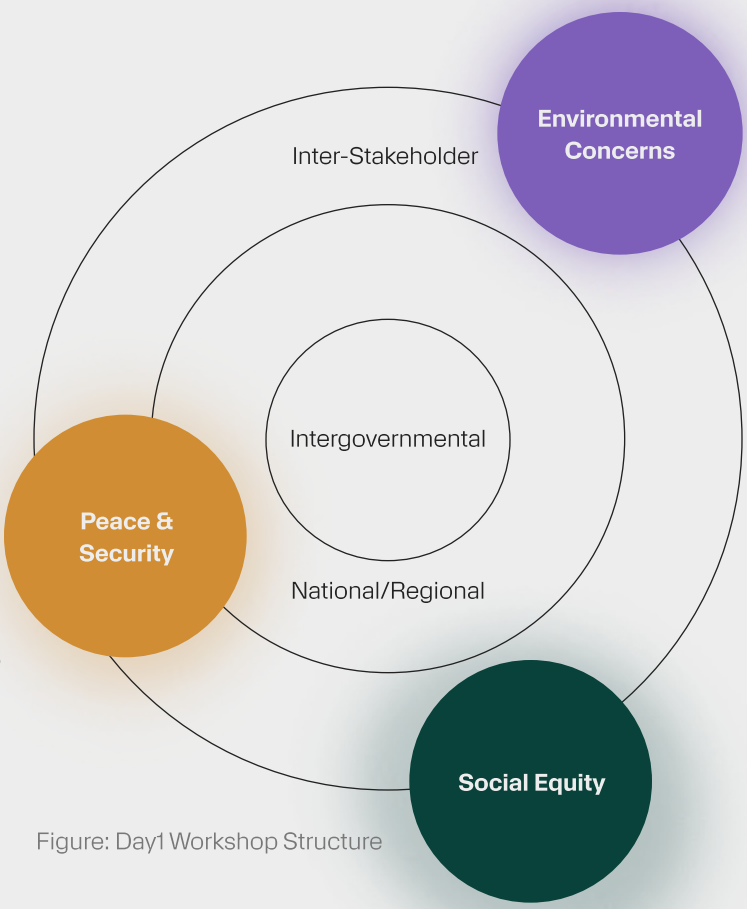


Figure: Day1 Workshop Structure

Day 2 Workshop Meeting

Katherine Taking Photo with Specialists

Activity Agenda

Day 2

we attended Session 2 of the workshop, which featured presentations from a range of institutions involved in space sustainability efforts. These included:

- United Nations Office for Outer Space Affairs (UNOOSA)
- European Space Agency (ESA)
- International Telecommunication Union (ITU)
- European Commission (EC)
- World Economic Forum (WEF)
- European Space Policy Institute (ESPI)
- Space Sustainability Rating Association (SSRA)
- ERC-funded research groups such as PlanetStewards and GreenSpecies
- Space Actors and Governance Explorer (SAGE) project
- EPFL Space Center and its associated Space Sustainability Course
- Secure World Foundation (SWF)

Each speaker introduced ongoing initiatives related to capacity-building—ranging from technical standards, regulatory guidelines, and risk mitigation tools to educational programs and ethics-oriented research frameworks.

Our focus during this session was to observe:

- Which types of institutions are taking the lead in defining capacity-building priorities
- Whether coordination and interoperability between initiatives were discussed or left implicit
- How cultural, ethical, and interdisciplinary approaches were positioned within each framework

Following the presentations, participants were invited to collectively reflect on the gaps and challenges identified. This culminated in a collaborative discussion on what a potential “fruition point” might look like: a moment when various efforts—technical, regulatory, normative—converge into a more cohesive and inclusive system. Questions were raised about what would be required for this convergence to happen, and what structural or cultural shifts might make it possible.

3.Outside the formal session, we used the breaks to engage in one-on-one conversations with selected participants. We introduced the draft Near-Earth Space Rights Declaration as a conversation tool—not to promote it, but to observe how rights-based and culturally framed approaches to sustainability were received by actors grounded in legal, technical, or diplomatic traditions.

These private exchanges gave us a chance to explore:

- Whether current institutional frameworks have space for bottom-up or cross-disciplinary contributions
- How different actors react to terms like “rights,” “ethics,” and “public participation”
- What kinds of questions or hesitations surfaced in response to S.T.A.R’s framing

SUMMARY: WHAT EACH ORGANIZATION BRINGS TO THE TABLE

Organizations	Key Contributions
ESA (European Space Agency)	Leading the Zero Debris Charter; coordinating internal sustainability roadmap; developing technical tools like Life Cycle Assessment (LCA) to evaluate environmental impact of missions; working toward public availability of default space-specific datasets by 2027.
ESPI (European Space Policy Institute)	Advancing the diplomatic and institutional framing of space sustainability; engaging with non-space policymakers and foreign ministries; hosted Vienna Space Diplomat Forum to build cross-sector awareness.
WSF (Secure World Foundation)	Published Handbook for New Actors in Space; supports responsible behavior for emerging space actors; shares best practices on international law, national policies, and operator conduct.
EU SST (EU Space Surveillance and Tracking)	Provides operational collision warning services among EU member states; functions as a technical foundation for European Space Traffic Management.
PEFCR (Product Environmental Footprint Category Rules)	Framework developed within the European Commission for harmonized environmental life cycle assessment; applied to space sector through ongoing multi-stakeholder collaboration; aims to finalize validated methodology by 2027.

Table Continued In The Next Page

Organizations	Key Contributions
COST (European Cooperation in Science and Technology)/ EPFL (École Polytechnique Fédérale de Lausanne) /SSR (Space Sustainability Rating)	Supported by COST, the EPFL-led team developed the Space Sustainability Rating (SSR) — a multi-institutional effort aimed at incentivizing responsible behavior in orbit. The project creates a standardized evaluation system that rates satellite missions based on their debris risk, post-mission disposal strategy, and operational transparency. Through this rating, EPFL hopes to embed sustainability not only in engineering but also in regulatory and funding frameworks.
Planet Stewards /Utrecht University	Explores Earth-space governance models from an environmental social science perspective; studies coexistence of top-down, market-based, and community-led frameworks; based at Copernicus Institute; part of the Earth System Governance network.
GreenSpecies Project / Politecnico di Milano	Applies environmental economics to model space debris as environmental externality; develops probabilistic control tools and sustainability indexes; seeks collaboration to integrate legal and regulatory parameters.
Université Laval — SAGE Project	Developed the Space Actors & Governance Explorer (SAGE) database and Governance of Debris in Space (GODS) index. The tools analyze over 1,700 international space arrangements, showing that most agreements still lack debris-related governance measures.

FRICTION POINTS: WHAT WE THINK WE AGREE ON — BUT DON'T

Sustainability Means Different Things To Different Stakeholders

> "We're kind of starting from this assumption that **we all understand what sustainability is**..."
>
> Speaker from Conference

Day2 Workshop with representatives among different organization

While the term "space sustainability" is widely used, its interpretation varies significantly. For some, it refers to measurable environmental impact (e.g., carbon footprints or orbital debris), for others it concerns geopolitical equity, economic viability, or technological feasibility. **The absence of a shared definition weakens coordination and leads to fragmented governance approaches**.

Multiple perspectives emerged in the discussion:

- Engineering-oriented participants focused on metrics like reentry toxicity, LCA scores, or orbital congestion.
- Policymakers emphasized alignment with national climate targets and long-term infrastructure planning.
- Social scientists underscored justice and representation, particularly for Global South stakeholders.
- Institutions like EPFL emphasized measurable impact to secure funding and institutional support.

This conceptual divergence highlighted that **many actors are advocating sustainability in good faith**—yet working from different assumptions about what it entails, for whom, and over what time horizon. As one participant noted, "**We are sometimes solving different problems using the same word.**"

Policy And Research Are Not Communicating Effectively

Research projects—especially those employing advanced modeling—**often lack the capacity to interpret or integrate policy requirements** into their tools. Meanwhile, regulators often lack access to technical data or modeling feedback loops. This disconnect results in models that may be robust but policy-irrelevant.

Infrastructure For Collaboration Is Fragmented

Multiple organizations are **building independent tools (databases, workshops, frameworks)**, but few of these platforms interoperate. While they demonstrate commitment, the **lack of coordination reduces efficiency and limits access for underrepresented stakeholders**. Participants called for **shared infrastructure and integration of existing resources**.

> "What we are missing now is... to translate **what's required in terms of policies and regulations**... into modeling purposes."
>
> Speaker from the Green Species Project

> "spaceagenda.com... so there **won't be any scheduled conflicts** between different events."
>
> Speaker from conference

Advocate S.T.A.R Group in the Workshop

IMPLICATIONS

IMPROVEMENTS FOR S.T.A.R GROUP

Don’t Assume Agreement. Help Build It

Although everyone talked about “space sustainability,” what they meant by it was very different. Some focused on environmental metrics, others on social equity, policy, or industry strategy. This reminded us that S.T.A.R’s role is not to push one definition, but to create tools and spaces where people can make sense of their differences — and find common ground.

Young Specialists Can Fill The Missing Link

Several groups — especially technical ones — said they struggle to translate their work into policy terms. Others lacked the ability to connect with researchers or practitioners in other sectors. This gap is exactly where S.T.A.R’s young specialists can help. By being cross-disciplinary and well-trained in communication, they can bridge conversations that normally stay siloed.

The System Is Fragmented. We Need Cultural Infrastructure

The field is full of individual platforms, roadmaps, tools, and projects — but they rarely connect. What’s missing is a shared cultural foundation: common language, shared references, and basic coordination. That’s what S.T.A.R can help prototype. Not by replacing existing efforts, but by helping them work together.


ESP

Group photo in front of EPFL

S.T.A.R IMPACT STRUCTURE

A DISTRIBUTED STRUCTURE FOR COLLECTIVE IMPACT

Through a synthesis of learnings and insights from past attempts, we've begun to shape a preliminary framework for how S.T.A.R. can effectively operate to achieve its three core missions (see Chapter 4 for details).

To achieve its missions, S.T.A.R. operates through a decentralized structure built on collaboration rather than hierarchy. Our coalition is made up of three core departments—**Co-Creation Hub, Promotion Lab, & the Strategic Liaison Unit**—each composed of young specialists from diverse disciplines. This structure enables us to bridge the gaps between **knowledge, storytelling, and policy,** while **allowing individuals to contribute across multiple areas of work**.

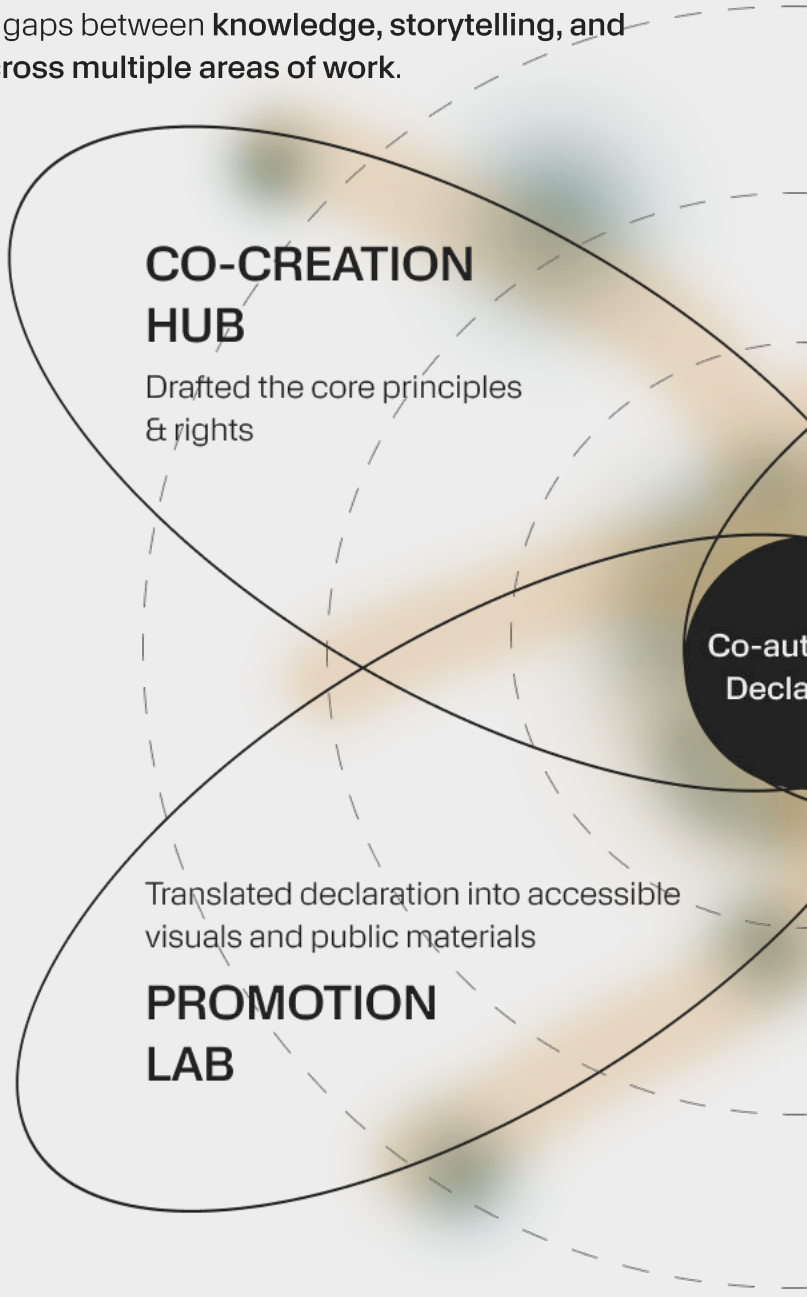
Department I

CO-CREATION HUB

The engine of interdisciplinary innovation

Through collaborative working sessions, this department produces ideas, documents, and interventions that reflect the collective voice of the coalition.

Goal: To bring together young specialists to shift their focus from isolated expertise to shared responsibility.



Department II

PROMOTION LAB

The arm of storytelling and culture-shaping

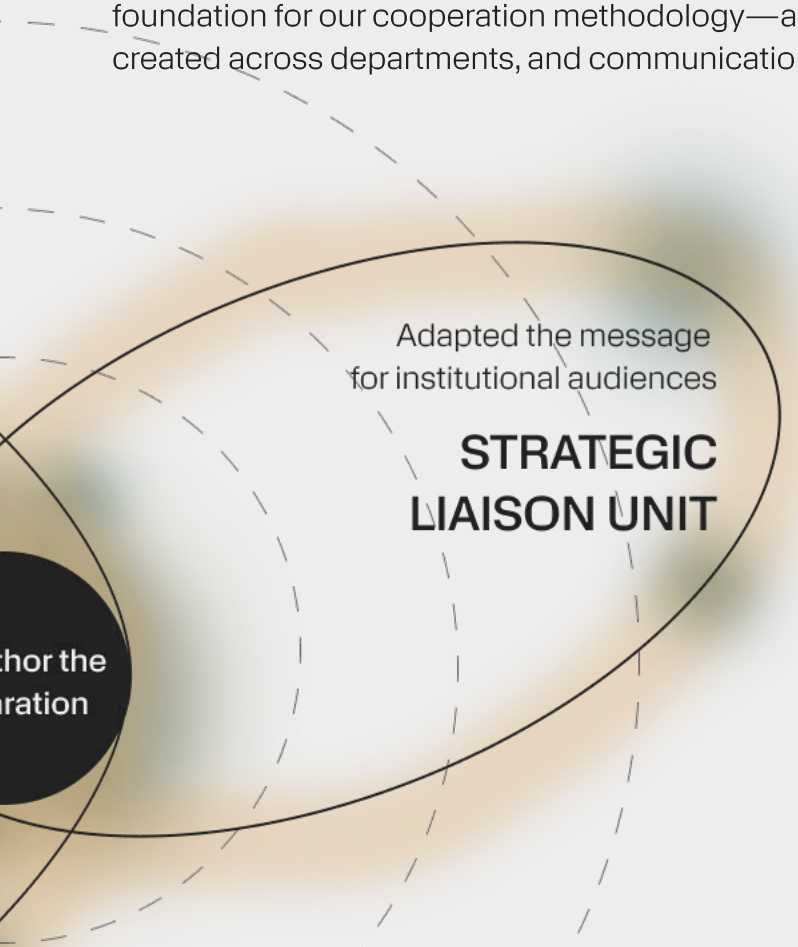
It translates expert knowledge from other departments into public-facing formats—through graphic design, speculative narratives, curation, and social media.

Goal: To spark public curiosity, raise awareness, and embed space sustainability into everyday consciousness.

HOW THE STRUCTURE WORK?

Each initiative is led **by one discipline**—whether legal, artistic, technical, or scientific—and then co-developed through a shared medium. Over time, leadership will **rotate across sectors**, fostering a dynamic and inclusive model of collective authorship.

First major test: co-authorship of the Declaration of the Rights of Near-Earth Space. Specialists from all three departments contributed to the declaration: **the Co-Creation Hub drafted the core principles, the Promotion Lab translated them into accessible visuals and public materials, and the Strategic Liaison Unit adapted the message for institutional audiences.** This project set the foundation for our cooperation methodology—a process where leadership rotates, outputs are co-created across departments, and communication flows both horizontally and vertically.



Department III

STRATEGIC LIAISON UNIT

The bridge of grassroots work with institutional action

It connects with national and international policy-making bodies, translating the coalition's outputs into formats that resonate with decision-makers. It also channels insights from those institutions back into the coalition's thinking.

Goal: To equip young specialists to become future policy influencers—offering them toolkits, governance fluency, and engagement opportunities.

ROTATIONAL LEADERSHIP & FLUID PARTICIPATION

Specialists are encouraged to move fluidly between departments, joining multiple projects based on their interests and strengths. This flexibility supports creativity, mutual learning, and long-term ownership across the coalition.

Together, this structure and methodology allow S.T.A.R. to remain nimble, inclusive, and impactful, creating a model for how youth-led coalitions can respond to complex global challenges through shared action.

STEPS

06.

NEXT & APPENDIX

FUTURE PLAN(2025)

To expand our impact and invite more young specialists to join, we've drawn from past experiences and will launch the following activities this year.

DEC
2025

SPACE TRASH EDUCATIONAL EXHIBITION

SEP
2025

PANEL DISCUSSION

Partner: Columbia University Public Outreach

SEP
2025

DECLARATION WORKSHOP 2

Partner: NYU Law Society

JUN-JUL

Develop A Toolkit For Cultivating Young Specialists

Space Duo in Trash Bags

REFERENCE

Baker, D. (2023). Tragedy of the commons in space: Scientists call for action to prevent an orbital debris crisis. Space.com. https://www.space.com/tragedy-of-the-commons-in-space

Space Safety Magazine. (2023). Kessler Syndrome: The space debris cascade effect. Retrieved April 21, 2025, from https://www.spacesafetymagazine.com/space-debris/kessler-syndrome/

Space Trash Signs. (n.d.). Editorial: Space trash signs. Retrieved April 21, 2025, from https://spacetrashsigns.org/editorial/

Wikipedia contributors. (2024). Tragedy of the commons. Wikipedia. https://en.wikipedia.org/wiki/Tragedy_of_the_commons

Wikipedia contributors. (2024). 2009 satellite collision. Wikipedia. https://en.wikipedia.org/wiki/2009_satellite_collision

2025 EFPL Space Sustainability Workshop

Chapter1: reference

Boley, A. C., & Byers, M. (2021). Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth. Scientific Reports, 11(1), 10642. https://doi.org/10.1038/s41598-021-89909-7

Davenport, C. (2023). The space barons: Elon Musk, Jeff Bezos, and the quest to colonize the cosmos. PublicAffairs.

Deudney, D. (2020). Dark skies: Space expansionism, planetary geopolitics, and the ends of humanity. Oxford University Press.

Harrison, T., Johnson, K., & Young, M. (2021). Space as a domain of great power competition. Center for Strategic and International Studies (CSIS). https://www.csis.org/analysis/space-domain-great-power-competition

Pekkanen, S. M. (2022). Governing the new space race. American Journal of International Law, 116(1), 131-137. https://doi.org/10.1017/ajil.2021.48

Shen, Y., Hong, J., Luo, H., Liang, M., & Zeng, Z. (2022). Research on national space competitiveness and geopolitical interactions. *Geography and Geo-Information Science, 38*(5), 47-56.

United Nations. (2021). The role of UNOOSA in promoting space sustainability. United Nations Office for Outer Space Affairs. https://www.unoosa.org

Weeden, B., & Chow, T. (2012). Taking a common-pool resources approach to space sustainability: A framework and potential policies. Space Policy, 28(3), 166-172. https://doi.org/10.1016/j.spacepol.2012.06.004

Zheng, Y., & Peng, J. (2022). The privatization of space and its implications for global security. Astropolitics, 20(1), 1-18. https://doi.org/10.1080/14777622.2022.203868

Grossman, R. (1968, December 6). Race for the moon [Magazine cover]. TIME. https://content.time.com/time/covers/0,16641,19681206,00.html

OECD. (2022). The space economy in figures. https://doi.org/10.1787/8bfef437-en

Chapter2:

Liou, J.-C., et al. (2022). The Kessler Syndrome: Implications to future space operations. Acta Astronautica, 193, 254–258. https://doi.org/10.1016/j.actaastro.2021.12.025

Jakhu, R. S., & Pelton, J. N. (n.d.). Space law and hazardous space debris. Oxford Research Encyclopedia of Planetary Science. Retrieved May 3, 2025, from https://oxfordre.com/planetaryscience/display/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-70

China National Space Administration. (2021). China's Space Program: A 2021 Perspective. https://www.cnsa.gov.cn/english/n6465645/n6465648/c6813088/content.html

European Space Agency. (n.d.). What is space debris? https://www.esa.int/Space_Safety/Clean_Space/What_is_space_debris

NASA. (n.d.). Orbital Debris - Office of Safety and Mission Assurance. https://sma.nasa.gov/sma-disciplines/orbital-debris

United Nations Office for Outer Space Affairs. (2002). Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space. https://www.unoosa.org/pdf/publications/st_space_49E.pdf

United Nations Office for Outer Space Affairs. (n.d.-a). Russian Federation (Added on 18 February 2019). https://www.unoosa.org/documents/pdf/spacelaw/sd/RF.pdf

European Space Agency. (n.d.). Mitigating space debris generation. https://www.esa.int/Space_Safety/Space_Debris/Mitigating_space_debris_generation
NASA. (2011). Engineering and Technology Challenges for Active Debris Removal. https://ntrs.nasa.gov/api/citations/20110013011/downloads/20110013011.pdf
Space Generation Advisory Council. (2024). Progress and Challenges of Orbital Debris Remediation. https://spacegeneration.org/beyond-mitigation-progress-and-challenges-of-orbital-debris-remediation
Viva Technology. (2025). Space Debris: The Numbers, Challenges and Solutions. https://vivatechnology.com/news/space-debris-the-numbers-challenges-and-solutions
European Space Agency. (2025). ESA's Annual Space Environment Report. https://www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf
Wikipedia contributors. (2025). Space debris. In Wikipedia. https://en.wikipedia.org/wiki/Space_debris
Wikipedia contributors. (2025). ClearSpace-1. In Wikipedia. https://en.wikipedia.org/wiki/ClearSpace-1
Wikipedia contributors. (2025). Collision avoidance (spacecraft). In Wikipedia. https://en.wikipedia.org/wiki/Collision_avoidance_(spacecraft)
Henry, C. (2023, October 18). Major changes approved for ClearSpace-1 mission. SpaceNews. https://spacenews.com/major-changes-approved-for-clearspace-1-mission/
ClearSpace. (n.d.). An artistic impression of ClearSpace-1 approaching its target, the upper part of a Vespa (Vega Secondary Payload Adapter) left after a 2013 launch [Illustration]. SpaceNews. Retrieved from https://spacenews.com/major-changes-approved-for-clearspace-1-mission/
Drmola, J., & Hubik, S. (2018). System dynamics model of orbital space debris. Acta Astronautica, 146, 409–416. https://doi.org/10.1016/j.actaastro.2018.02.019
Kessler, D. J., Johnson, N. L., Liou, J.-C., & Matney, M. (2010). The Kessler Syndrome: Implications to future space operations. 6th European Conference on Space Debris, ESA SP-672, 1–14. https://www.researchgate.net/publication/358632375
NASA. (2021). Orbital Debris Quarterly News, 25(4). https://orbitaldebris.jsc.nasa.gov/quarterly-news/
European Space Agency. (2023). Space debris by the numbers. https://www.esa.int/Safety_Security/Space_Debris/Space_debris_by_the_numbers
Hardin, G. (1968). The tragedy of the commons. Science, 162(3859), 1243–1248conference.sdo.esoc.esa.int. https://doi.org/10.1126/science.162.3859.1243
Moltz, J. C. (2014). Crowded orbits: Conflict and cooperation in space. Columbia University Press.
Berger, P. L., & Luckmann, T. (1966). The social construction of reality: A treatise in the sociology of knowledge. Anchor Books.
Bourdieu, P. (1991). Language and symbolic power (J. B. Thompson, Ed.; G. Raymond & M. Adamson, Trans.). Harvard University Press.
DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. American Sociological Review, 48(2), 147–160.
Harding, S. (1998). Is science multicultural? Postcolonialisms, feminisms, and epistemologies. Indiana University Press.
Jones, M. D., McBeth, M. K., & Shanahan, E. A. (2014). The science of stories: Applications of the Narrative Policy Framework in public policy analysis. Palgrave Macmillan.
Latour, B. (2005). Reassembling the social: An introduction to actor-network-theory. Oxford University Press.
Light, A. (2022). Planetary responsibility and the rhetoric of outer space: From the frontier to the commons. In The Oxford handbook of climate change and society (2nd ed.). Oxford University Press.
Roe, E. (1994). Narrative policy analysis: Theory and practice. Duke University Press.
Schön, D. A., & Rein, M. (1994). Frame reflection: Toward the resolution of intractable policy controversies. Basic Books.
Stone, D. (2002). Policy paradox: The art of political decision making (Rev. ed.). W. W. Norton & Company.

ACKNOWLEDGE

This project was never just ours. It was built with the help of many people who listened, encouraged, challenged, and stood beside us—especially when we weren't sure where it was going. We are profoundly grateful for the guidance, generosity, and solidarity that made this thesis possible.

Miya Osaki

Thank you for your quiet trust and support. You gave us the space to take risks, ask hard questions, and explore freely—reminding us that it's possible to work within systems while imagining beyond them.

Kara Meyor

Thank you, Kara Meyer, for always trusting that we were doing meaningful work—even when others had doubts. You helped us refine our thinking, strengthen our logic, and offered us more feedback than we can count. Every step of the way, you were there—reading our drafts, asking sharp questions, helping us improve. This project didn't just grow under your supervision; it grew because of your steady encouragement, your belief in us, and your constant presence behind

Kara Meyor

Thank you for connecting us to Earth Day and giving us a platform to share our work with the public.

Mari Nakano

Thank you for encouraging us from the very beginning and offering thoughtful guidance throughout the journey. Your expertise in storytelling helped us sharpen our narrative and stay true to our message.

Karen Proctor

Thank you for being our spiritual mentor throughout this journey. Thank you for helping us navigate the emotional and personal complexities of working in a team, for reminding us to stay grounded while reaching for something larger. Your wisdom, clarity, and questions helped us move through self-doubt, conflict, and uncertainty—and toward growth. We carry your words with us.

Huiming Cheng

Thank you, Huiming, for the conversation that first set us on this path. Thank you for continuing to support us—by sharing resources and helping us spread our message on the school platform. This project would not have existed without you.

Tara Maurice

Every time we saw you, you asked how things were going—and you meant it. Thank you for regularly sharing articles, resources, and insights that helped us think more deeply. Your supports always make us feel warm and care.

The DSI Community

To all the faculty, classmates, and friends—thank you for your ideas, introductions, and encouragement. Your love, wisdom supported us to go this far.

The DSI Community

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All the people we interviewed

Thank you to Aaron Boley, AJ Link, Nicole Nir, Thomas Gooch, R. Sharma, Mari Margil, Minghao Song, Mahhad Nayyer. Your generosity and trust gave us momentum.Your selfless sharing and passion for the universe has always inspired us to keep going!

Our families and friends

Thank you to our families and friends, for your patience, encouragement, and constant belief in us. Thank you for standing behind us through long nights, unpredictable schedules, and ideas that didn't always make sense at first. Your love gave us the strength to keep going.

Space Duo Group Photo at Earth Day Booth

SVA NYC DSI
MFA Design For Social Innovation

S.T.A.R
SPACE TRASH AWARENESS & RECOVERY

SCHOOL OF VISUAL ART
DESIGN FOR SOCIAL INNOVATION

2023/2025
136 W 21ST ST,
NEW YORK, NY 10011