FALL 2021

The New Space Age: Beyond Global Order

Perry World House is a center for scholarly inquiry, teaching, research, international exchange, policy engagement, and public outreach on pressing global issues.

Perry World House's mission is to bring the academic knowledge of the University of Pennsylvania to bear on some of the world's most pressing global policy challenges, and to foster international policy engagement within and beyond the Penn community.

Located in the heart of campus at 38th Street and Locust Walk, it draws on the expertise of Penn's 12 schools and numerous globally-oriented research centers to educate the Penn community and prepare students to be well-informed, contributing global citizens. At the same time, Perry World House connects Penn with leading policy experts from around the world to develop and advance innovative policy proposals.

Through its rich programming, Perry World House facilitates critical conversations about global policy challenges and fosters interdisciplinary research on these topics. It presents workshops and colloquia, welcomes distinguished visitors, and produces content for global audiences and policy leaders, so that the knowledge developed at Penn can make an immediate impact around the world.


@perryworldhouse


facebook.com/perryworldhouse


@perryworldhouse

The New Space Age workshop and this publication were made possible in part by the generous support of Carnegie Corporation of New York. The statements made and views expressed are solely the responsibility of the authors.

Report Authors

Julia Ciocca, Research Fellow, Perry World House

Rachel Hulvey, Ph.D. Candidate in Political Science, University of Pennsylvania

Christian Ruhl, Global Order Program Manager, Perry World House

Contents

Introduction: The New Space Age

Entering a New Age

In the month leading up to Perry World House's workshop on the New Space Age, it became clear just how quickly state and nonstate activity in the space domain is changing.

China landed a rover on Mars, becoming the second country (after the United States) to operate on the Red Planet; in the United States, a new administrator took NASA's helm, and the Biden administration announced that Vice President Kamala Harris would chair the re-established National Space Council; Russia announced it would leave the International Space Station and build its own; SpaceX successfully landed its Starship SN15 prototype; and the world watched the uncontrolled re-entry of the Chinese Long March 5B rocket, which plunged into the Indian Ocean and reignited a global debate on responsible state behavior in space.

This new space age will bring new challenges and new opportunities. Public-private partnerships have taken off but remain under-exploited and under-regulated. Nations around the world are reorganizing and rebranding their militaries to emphasize space capabilities, and the United States, China, and Russia view space as a key domain for ongoing great-power competition. While some warn of the militarization of space, others see opportunities for its commercialization, including new satellite systems, space ports, space tourism, and even space resource extraction.

International law and global governance, meanwhile, have struggled to keep pace, and Cold War–era treaties governing space increasingly feeling inadequate to manage new challenges. In short, the world has entered a new space age, but academia and the policy and think-tank world are struggling to keep up.

The Workshop

As the new space age evolves, Perry World House convened a two-day virtual workshop on "The New Space Age: Beyond Global Order." Held on May 26 and 27, 2021, the workshop bridged the gap between academia, policy, and industry, and focused debates on four issue areas: (1) public-private cooperation, (2) military and competition, (3) economic opportunities, and (4) international law and global governance. It brought together participants from all over the world to debate the new space age and to try to find innovative policy solutions.

Enabling success and progress in these areas, while simultaneously limiting their potential negative impacts, will be a critical and difficult task for the future of humanity in space and on Earth, where modern life is inextricably bound up with space-based infrastructure. Nearly all the participants who completed a pre-workshop survey agreed that a new space age has arrived (see Figure 1). But that's where the agreements ended. This report summarizes the challenges and opportunities faced by the various actors prevalent in space today and provides an overview of the interdisciplinary workshop debates to explore potential strategies and policy recommendations for this new age in space.

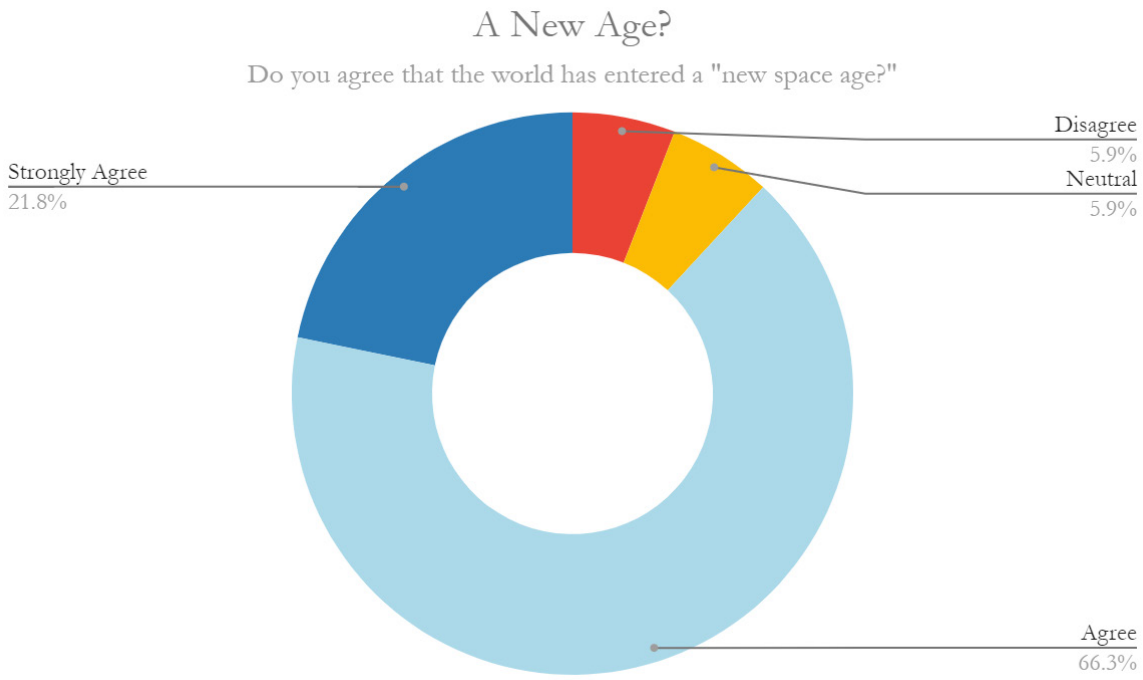

Figure 1: A New Age?

The workshop opened with a public keynote by Naoko Yamazaki, Perry World House Visiting Fellow, Director of the Spaceport Japan Association, and Japan Aerospace Exploration Agency astronaut, on "Launching into the New Space Age." In a webinar conversation with Perry World House Director Professor Michael C. Horowitz, Yamazaki discussed what defines the new space age, how countries can continue to maintain a peaceful and cooperative space, how scientists and engineers can advocate for the protection of the shared commons of space, how spaceports and space tourism are changing the future of transportation, and other critical questions for the future of the domain.

Following the public keynote, experts participated in four panels, which were held under a non-attribution rule to encourage open discussions. Quotations from these parts of the workshop have therefore been anonymized. Any attributed quotations were taken either from written contributions that the panelists submitted for the workshop or from the public event. Additionally, Perry World House fielded a pre-workshop survey to participants. Not all participants at the workshop answered all questions, and results should not be interpreted to attribute beliefs to individual participants.

Before launching into the substance of the workshop's conclusions and debates, this section gives a brief overview of this historical moment in space and of new priorities for space-faring nations.

"We Choose to Go to the Moon" — Again

On September 12, 1962, at the dawn of the last space age, President John F. Kennedy delivered his famous moon speech to a crowd assembled at the Rice University Stadium: "We choose to go to

the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard." Through the Artemis Program, the United States, with a growing group of allies and partners, is once again choosing to go to the moon—and to put the first woman and the first person of color on the lunar surface—and beyond. But in the years since Kennedy's speech, space policy has only become more complex, and by some measures, space has become more dangerous.

Anticipating these dangers, Kennedy outlined a peaceful vision of space in his speech, proclaiming that "space can be explored and mastered without feeding the fires of war." When we asked workshop participants whether they felt this peaceful vision was still realistic 59 years later, many disagreed (see Figure 2).

Seven Priorities for the New Space Age

To understand how to prioritize the many issues facing spacefaring actors in the international system, Perry World House asked participants of the workshop which of the principles in the recently signed Artemis Accords they

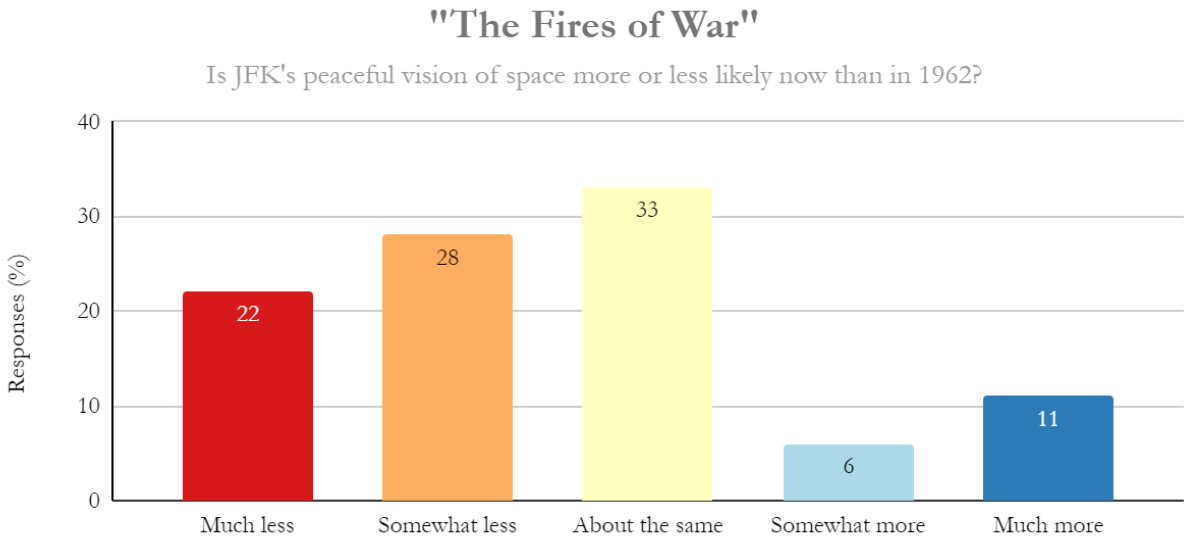

Figure 2: "The Fires of War"

Nonetheless, new international agreements have attempted to outline an updated vision for humanity in space. The Artemis Accords, a set of nonbinding principles for outer space led by the United States, once again used lunar exploration as a backdrop for international cooperation, but the accords also re-emphasized key international norms that have guided human activity in space for the past 60 years. As NASA's acting associate administrator for international and interagency relations put it when the accords were signed in October 2020, "The Artemis journey is to the moon, but the destination of the accords is a peaceful and prosperous future."[1]

viewed as most important. Below are the principles, along with the percentage of respondents who chose that principle as most important.[2] We rearranged their order based on the number of respondents who believed

each principle was most important.

The new ranking provides surprising insights into the priorities of the new space age. The principle on orbital debris, listed last in the original accords, is the second-most important issue for the Perry World House experts—more important than the principle on peaceful exploration. Some principles, including interoperability, the release of scientific data, and the preservation of heritage, received no votes.

Artemis Priorities:

1. **Deconfliction of Activities (most important for 35% of respondents)**: The Artemis Accords nations commit to preventing harmful interference and supporting the principle of due regard, as required by the Outer Space Treaty.
2. **Orbital Debris (24%):** Artemis Accords countries commit to planning for the safe disposal of debris.
3. **Space Resources (12%):** Extracting and utilizing space resources is key to safe and sustainable exploration, and the Artemis Accords signatories affirm that such activities should be conducted in compliance with the Outer Space Treaty.
4. **Transparency (12%):** Artemis Accords signatories will conduct their activities in a transparent fashion to avoid confusion and conflicts.
5. **Emergency Assistance (6%):** Artemis Accords signatories commit to rendering assistance to personnel in distress.
6. **Peaceful Exploration (6%):** All activities conducted under the Artemis program must be for peaceful purposes.
7. **Registration of Space Objects (6%):** Any nation participating in Artemis must be a signatory to the Registration Convention or become a signatory with alacricity.

In this new space age, these results reflect a shift in priorities since the Cold War. Orbital debris, for example, was once an afterthought of space launches, but it has become one of the most pressing concerns in the new space age. New actors are generating debris at quickly growing rates as the number of space launches and the number of objects in orbit continue to increase. As one survey respondent noted in justification of their choice of orbital debris, "We cannot allow man-made debris to pollute space or to fall uncontrolled into Earth's atmosphere without high confidence that objects will be destroyed prior to any potential impact." Another participant gave a pragmatic reason; orbital debris is a shared challenge that might help create a baseline for cooperation: "Orbital debris presents real risk to space potential while offering a pragmatic basis for cooperation in space on which countries can build." In July 2021, the U.S. Department of Defense issued an unclassified statement underscoring the importance of space debris and—in a first for the United States—outlined normative "tenets for responsible behavior," including one norm to "limit the generation of long-lived debris."[3] The complexity of operations in space, however, has made some observers suspicious of the new statement, suggesting that the norm could be used as "cover" for conducting anti-satellite weapons tests, using the excuse of removing debris to test such weapons. In space, many seemingly innocuous

activities can be militarized, but norms about responsible behavior in space will nonetheless be essential for creating a secure space domain.[4] For related reasons, other survey respondents viewed deconfliction of activities as the most important principle, writing, "Many of the other important components—transparency, debris, registration—arise indirectly from the requirements for deconfliction."

Keynote Conversation: Launching into the New Space Age

Why a New Space Age?

The keynote conversation between Perry World House Visiting Fellow Naoko Yamazaki and Perry World House Director Michael C. Horowitz opened the workshop by drawing attention to changes in space policy and explaining the reasons why the world has entered a new space age. Yamazaki celebrated the International Space Station (ISS) as a symbol and focal point of global collaboration. Even in times of terrestrial tension and conflict, the ISS historically operated above geopolitics to host astronauts from around the world, bringing together allies and strategic competitors to cooperate around space exploration and research.

Despite this collaborative history, however, Yamazaki noted that the world is entering a new space age due to shifts in international collaboration and competition. Recently, Russia expressed its intent to leave the ISS program and develop its own space station. Russia, Yamazaki noted, has been a crucial partner for the ISS because of its manned space vehicle—the Soyuz spacecraft. With Russia's departure, however, Yamazaki predicted that private companies could fill the void: "After Russia leaves, SpaceX has manned spacecraft capabilities, and Boeing will have manned spacecraft capabilities pretty soon. The U.S. has multiple choices, so that means that ISS planning is secured."

China is also considering its own space station and is seeking partners to cooperate with on the launch, compounding the shift away from joint global initiatives. Cooperation around lunar exploration is also fragmenting. The U.S.-led Artemis Accords—signed by the United States, Japan, the United Kingdom, Canada, Australia, the United Arab Emirates, Ukraine, South Korea, New Zealand, and Brazil (as of this writing)—reflect plans for a small coalition of governments to cooperate. As Yamazaki noted, this cooperative framework does not include America's main adversaries: "Russia is not signing it, and Russia and China are planning to create a moon base," she explained, foreshadowing growing global competition between two separate lunar missions operating along existing geopolitical divisions.

In the face of new contestation around space cooperation, public-private partnerships are forming and taking on new significance, and Yamazaki is helping to lead the charge through her work in the private sector. Showing a side-by-side comparison of the manually operated space shuttle cockpit and the SpaceX Dragon automated controls, Yamazaki explained that technological breakthroughs from private companies and their work with governments is opening "up a new era of space travel as well."

Private enterprises now serve as a critical partner for governments to achieve and extend the possibilities for space exploration. Due to public-private models in the United States, the global community enjoyed innovations such as achieving autonomous space-shuttle capacity, which was developed by SpaceX. The SpaceX Dragon had the capacity to dock to the ISS and land. These innovations open up a new era of space travel and create the inspiration for space industries to bring a larger number of individuals to space.

Billionaire entrepreneurs have already launched themselves into space in their respective rockets this summer, and a Japanese businessman plans to fly to the ISS in December of this year, creating the promise of space travel reaching the masses in the near future. Other promising collaborations occur across industries. Yamazaki explained that automobile industries provide valuable functions for navigating the lunar terrain, with existing capabilities from Toyota and Tesla being leveraged for lunar rovers and exploration.

These innovations include point-to-point travel, using spacecraft to connect major global cities. As the representative director of SpacePort Japan, Yamazaki painted a futuristic vision of point-to-point travel by rocket engine. Japan is opening multiple spaceports to create a hub in Asia that leverages Japan's aerospace and manufacturing capabilities—as well as its convenient location surrounded by ocean, which Yamazaki explained is a major benefit for space launch operations. These technologies could be available within the decade, modernizing the way the world travels and dramatically reducing flight times. For example, rather than spending over 14 hours traveling to Philadelphia, the Perry World House fellow could enjoy a two-hour flight time when space ports between the United States and Japan open, holding the promise of further connecting societies through the use of innovative space technologies.

Emerging Dangers and Opportunities

The growing problem of space debris threatens progress in space. Yamazaki underscored that even the smallest space debris has a large amount of energy and the potential to damage investments in satellites and infrastructure, such as the ISS: "When I was on board the space shuttle for 15 days, we got a hit of small space debris into the windows. And it didn't go through, but we had a crack." The ISS and manned spacecraft are designed to withstand small levels of space debris, but as the problem grows, the ability of astronauts to perform their missions safely and securely is threatened. Expensive satellite technology is also threatened by space debris. Large debris can be monitored from the ground, through the U.S. Air Force notifying the ISS or satellites to escape from the path of space debris, Yamazaki explained, but more work needs to be completed to establish a system of global collaboration and international information sharing. The global community must continue innovating around governance solutions to enforce rules on limiting the growing problem of space debris to protect space assets.

> "It's important to secure space assets, because our lives are relying on space assets so much recently, in this current era. Without it, we cannot navigate our own automobile cars, but also the military depends on that GPS navigation so deeply. So, for example, we cannot fly our F-35s, or we cannot fly aircrafts." — *Naoko Yamazaki*

Beyond the geopolitical problems that complicate cooperation on the ISS, several areas emerge as opportunities for exploration and learning. The Artemis Accords expand the frontier from the ISS service of the low-Earth orbit to lunar activities and Mars. The

Gateway Space Station within the lunar orbit plans to send astronauts occasionally to the moon to return samples. This gateway will serve as an outpost to the moon and Mars. There is largely consensus that life does not exist on the moon, but, as Yamazaki explained, special considerations must be taken for the exploration of Mars to protect the planetary environment; for Mars, we have to "consider planetary protection, to protect the Mars environment"—in case there is life.

Yamazaki also underscored the importance of making space more inclusive. "I'm really looking forward to the Artemis program," she explained, "because, you know, we will send the first woman and the first person of color to the moon." As the second Japanese woman to travel to space, Yamazaki advocated for incorporating more women in aerospace industries, as "diversity is power." NASA has made progress in enhancing gender diversity, including in the recent cohort of astronauts. Scholarships should also be used to encourage women to become involved in STEM, as the shortage of women in engineering and aerospace fields is often reflected in the lack of diversity in national space programs. Networking is important and can allow individuals from underrepresented communities to see themselves in space careers and meet role-models. Watching the success of space programs also motivates domestic STEM education, as many students around the world are inspired by the accomplishments of space flight.

"Gender equality, in space areas, in the STEM areas, are vital, because, of course, diversity is power." — *Naoko Yamazaki*

Beyond broadening the diversity of astronauts, the global community should make space more inclusive. Space exploration is concentrated among 11 nations at the time of this writing. Yamazaki's keynote conversation noted the efforts of governments to facilitate greater inclusivity. For example, she explained that "Japan is contributing to the Space4SDGs [sustainable development goals] by providing opportunities for developing countries." Nonetheless, Yamazaki acknowledged work needed to be completed around knowledge sharing and inclusivity—the next frontier in space exploration may well be inclusivity and diversity.

Questions for Future Research

- **The Future of Cooperation:** What are the challenges associated with Russia's withdrawal from the ISS and some of China's more independent activities? What do these activities indicate for the future of cooperation in space?
- **How to Limit Space Debris:** What are the best ways to remove space debris and limit future accumulation? What role does international law play in developing clear rules and a process for their enforcement?
- **The Question of Diversity:** How can the global community continue to promote exclusivity in space programs among underrepresented communities and nations?

Panel Discussions

Private-Public Cooperation

Day one began with a panel on public-private cooperation, a defining feature of the new space age. The panelists included Karen L. Jones, Senior Project Leader at the Center for Space Policy and Strategy at the Aerospace Corporation; Sarah Mineiro, Adjunct Senior Defense Fellow at the Center for a New American Security; Troy Thomas, a Partner at Boston Consulting Group; and Matthew Weinzierl, the Joseph and Jacqueline Elbling Professor of Business Administration at Harvard Business School. The panel was moderated by Claire Finkelstein, Algernon Biddle Professor of Law and Professor of Philosophy at the University of Pennsylvania.

Panelists discussed the unrelenting commercialization of space, raising expectations for continued economic progress and growth. During the pandemic, capital continued to flow from private companies and governments around the world, serving as a positive indicator of the inexorable potential for space-industry growth, even in the face of a terrestrial crisis. The space industry is increasingly structured around public-private partnerships, where governments consider trade-offs associated with increasing privatization in the area of national space endeavors with the desire to keep a certain amount of centralized and public-minded control of space missions.

Countries have two overarching roles: making investments in national industries and spurring demand for particular space technologies. Government investments mobilize private industries to respond to public demand. Public officials also incentivize national and local space economies. Some government agencies, such as the Australian Space Agency, enjoy a specific mandate, not to send humans into space, but to stimulate the national space economy. Within the United States, Arizona is analyzing how to better engage local businesses and become a larger participant in the national space industry.

On the private side of the equation, the space industry includes established players and new entrants. The established players are anxious about remaining competitive and are currently critically examining their business models. New entrants, on the other hand, are desperate to close hyperinflated business cases. Space ventures for both players are not without large risks. Panelists noted the problem of space debris and the potential for costly collisions that critically damage investments and underscore the benefit of institutional support. Although there are varying degrees of dependencies on government investment across space-sector economies, a majority of companies are eager to secure large government contracts to fuel costly research and development associated with space industries.

Government collaboration with the private industry is not a new phenomenon, but long-standing questions remain about when public-private partnerships are most fruitfully deployed. In the United States, Operation Warp Speed facilitated the development of two vaccines through

an arrangement where the private industry rapidly produced vaccines that the government was contractually committed to purchase. Funding afforded the private industry the opportunity to leverage the ingenuity of research and development teams, while also working closely with federal agencies on safety requirements to ensure approval and distribution. Some panelists suggested that Operation Warp Speed demonstrates that governments can deploy public-private partnerships to respond rapidly and to effectively address national security demands in space. However, despite some notable and highly prominent successes, other panelists cautioned that public-private partnerships are not always appropriate and demand careful scrutiny from officials.

In a pre-conference survey, participants largely agreed that public-private partnerships constitute a challenging policy area of the space domain. Several areas of the market have yet to realize projected growth potential. Beyond government and national security imperatives, it is unclear what demand the space industry is supplying.[5] Several policy solutions were offered by the panelists for governments seeking to navigate the complexities of the public relationship with the private space industry in order to grow the national space industry to serve clients more broadly beyond government contractors.

Policy Discussion: Identifying and Rewarding Winners

One key debate at the public-private cooperation panel centered on how to encourage governments to "identify and reward winners," in the words of Sarah Mineiro's written contribution to the workshop. The space industry is an exciting and tantalizing market for the private sector, but as with any industry with high rewards, it also comes with high risks. Rewarding winners involves, "holding frequent, fair, and meritocratic competitions to determine the best products on the market and awarding meaningful contracts to the winners of these competitions," as Mineiro writes.[6] Designing and running competitions that are frequent, fair, and meritocratic, will be a key challenge for policymakers as the new space age takes off, especially as perceptions of monopolistic behavior take root in the public imagination.

Panelists discussed best practices for optimizing public-private partnerships. One such best practice that several panelists pointed to is the Commercial Orbital Transportation Services (COTS), where NASA experimented with new ways of contracting with providers. The COTS program identified cargo and crew capabilities but allowed private actors to choose which capabilities to offer. NASA was thus able to shift from paying a margin over costs for custom orders to being, "one customer among many."[7] The competition encouraged private innovation and led to SpaceX Dragon becoming the first commercial spacecraft to deliver cargo to the ISS.[8]

Rewarding winners also requires providing the proper incentives for private players to grow, and panelists discussed the best policies to create such incentives. Some argued that beyond adopting the technologies and investing in industry, governments should allow technologies to be available for uses beyond the service of public contracts. One of the best-case

scenarios, along this line of argument, involves government contracts that lead to spin-off products enjoyed by society.

the private sector accept the risks associated with space, serving as a useful carrot for private-industry

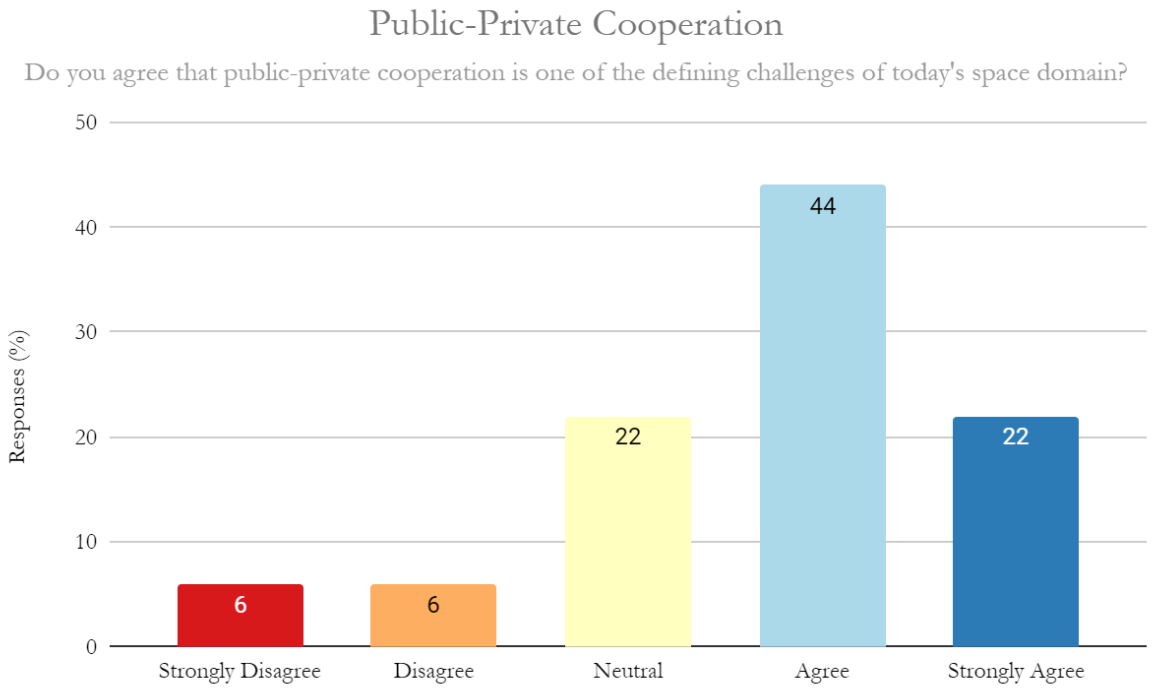

Figure 3: Public-Private Cooperation

Global Positioning System (GPS) technologies originally leveraged by the U.S. Army enjoy a number of critical private-sector uses as society is increasingly reliant on the technology for navigation. Other examples include the National Weather Service allowing AccuWeather to serve private-sector customers. In the space economy, governments might build from these best practices to reward private players. For instance, when the government contracts with a company for a space tug operation, it could also allow the space tug to accept private customers. Several panelists pointed to such operations as one way that the government can act as a customer, not a caretaker, of the space industry.[9] Spin-off products, some panelists argued, help

investment and optimizing public-private partnerships.

Policy Discussion: Adopting a Light Regulatory Approach

Some panelists argued vigorously that governments should adopt a light regulatory strategy and cautioned against over-regulating space industries. In the history of the U.S. space industry, the interagency system began with a bias against approval and a tendency to place the burden of articulating risk on private-industry partners. Over the last 10 years, the U.S. government and National Security Council shifted the paradigm so that bias favors approval. The government also better articulated the risk and safety reliability

requirements associated with competing in security-sensitive areas. These changes and light government regulatory responses were instrumental in helping the commercial remote-sensing industry grow and, some panelists argued, provide a blueprint for future policy.

Other dangers arise when private-industry innovation outpaces the ability of governments to develop regulation that continues to promote national interests. Some panelists warned of over-regulation of national space industries, citing the U.S. National Oceanic and Atmospheric Administration program, which that ultimately discouraged private investment in commercial space-based synthetic aperture radar through a burdensome and inflexible regulatory approach. As a result, investors established programs abroad to avoid the heavy-handed licensing program in the United States, as Sarah Mineiro explained in her written contribution to the workshop.[10] Thus, several panelists argued, governments should carefully choose the appropriate regulatory policy, balancing the needs for safety and security in space, while also avoiding capital flights to more favorable regulatory climates abroad due to cumbersome national rules.

Policy Discussion: Articulating a Comprehensive Vision of the Space Market

Many panelists encouraged governments to set shared goals and promote a vision for what the space market should look like. Government direction is important for setting the vision for what type of industrial base necessary to enable the national security enterprise. Strategic sourcing and acquisition strategies are complemented by the way governments develop talent, carefully consider investments, and spur research and development.

The lack of vision is especially problematic in certain areas of space technology. In the satellite communications market, the fundamental problem is that officials issue requirements without having a vision for the market, leaving the private industry with vague objectives. Space transportation is arguably more successful because of the national security imperative driving a competitive space-launch market. The U.S. government communicates objectives and sources across government institutions, essentially creating the market. Governments must carefully consider how to communicate a vision to achieve the highest likelihood of spurring economic growth.

Questions for Future Research

- **Conditions for Partnership:** What is the most effective public-private partnership model for various sectors of the space economy? Under what conditions should particular partnerships be deployed?
- **Resolving the Problems of Space Debris**: Is the protection of space assets a private or public function? How should governments collaborate with firms to address the problem of space debris? Does the private sector need legislation to resolve this issue?
- **Space Market Vision:** What is the best way to elaborate a national industrial policy that would align government buying behavior with the vision for growing an industrial base? Which governments are implementing best practices in this area?

Military and Competition

The second panel of the conference looked at military competition in the space domain. This panel featured Bleddyn Bowen, a Lecturer in International Relations at the University of Leicester; Rudy deLeon, a Senior Fellow at the Center for American Progress and the former U.S. Deputy Secretary of Defense and U.S. Under Secretary of the Air Force; John D. Hill, performing the duties of the Assistant Secretary of Defense for Space Policy; Saadia Pekkanen, Job and Gertrud Tamaki Endowed Professor at the University of Washington Seattle; and Rajeswari Pillai Rajagopalan, the Director of the Centre for Security, Strategy & Technology at the Observer Research Foundation. The panel was moderated by Michael C. Horowitz, Richard Perry Professor and Director of Perry World House.

Throughout the conversation, panelists noted that the concept of a militarized space domain was not new. Militaries have always utilized the space domain for a variety of purposes, including GPS, navigation, communications, and intelligence. However, some of the panelists did note that, as technology advances, the way in which space is utilized as a military domain will also evolve. Rather than serving primarily as a support domain, space is evolving into a domain where fighting could actively occur, with states targeting each other's space assets. Both China and Russia have expressed their willingness to attack other countries' space assets, and more actors are gaining access to the domain, meaning that space operations will become more complex and the difficulties attributing attacks to specific actors may increase as well. This challenge is specifically true given that many space attacks, particularly those that utilize remote cyber activity, can be launched from Earth, and do not require an actor to possess advanced space systems.

Policy Discussion: Strengthening Relationships with Allies and Partners

Another discussion focused on the importance of allies and partners in pursuing a shared vision for space. Space is an inherently international domain, and over the last decade, there has been an influx of actors with access to the domain. However, as competition in the domain has grown, Russia and China have pursued increasingly competitive space policies that will undermine the universal nature of space. Rather than following Russia's and China's examples, the international community should further strengthen its ties with each other, according to many of the panelists. Developing international norms, standards, and dialogue through strong relationships will help to mitigate the uncertainty and challenges present in space. Furthermore, the willingness to have open dialogue with both Russia and China, despite growing tensions, will be critical to avoiding misunderstandings and building effective solutions to global space challenges.

Policy Discussion: Developing Space-Specific Strategies

Several panelists agreed that while the growth of competition within space would not lead to a change in the nature of warfare, it did present several unique challenges that would benefit from more centralized and specialized strategies designed specifically for the space domain. For example,

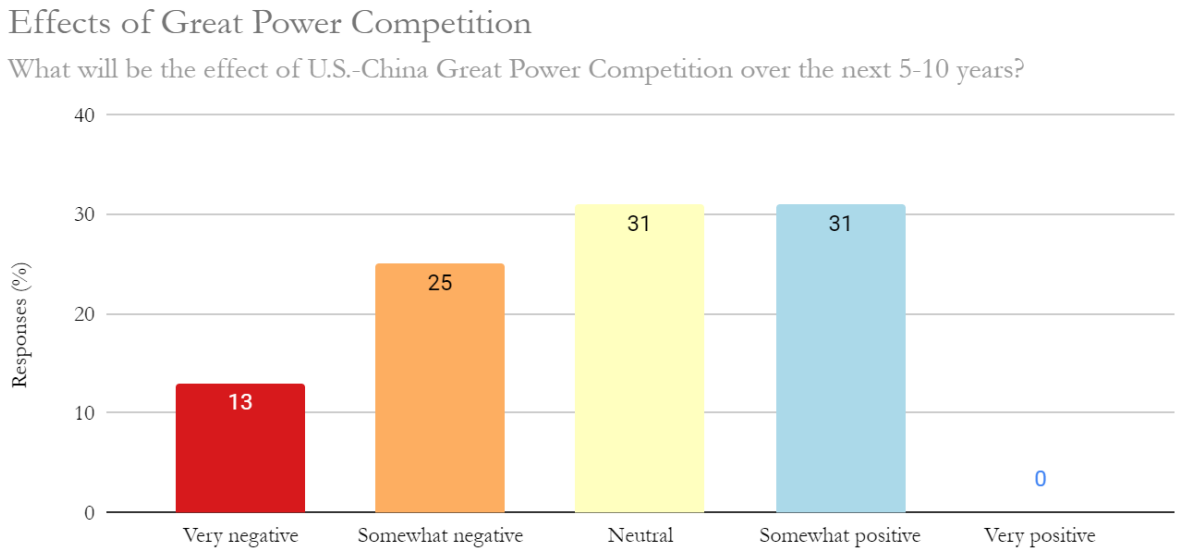

Figure 4: Effects of Great Power Competition

bureaucratic restructuring like the establishment of the U.S. Space Force and the reestablishment of the U.S. Space Command have enabled a more immediate, full-time, and centralized focus on space issues. Similarly, several panelists pointed out that attempts to develop broader strategies, such as deterrence approaches to fit the space domain, will help to ensure their effectiveness by mitigating challenges due to increased uncertainty, attribution complications, and concerns about dual-use technologies. Similarly, creating space-specific strategies will allow for a better understanding of how to best convey messages and signals through space attacks and how space can fit into national and joint operations as it becomes a more "independent" domain. However, some panelists raised concerns that these efforts to develop military strategies may fuel the perception of the space domain's purpose as being primarily military in nature and, therefore, jeopardizing stability in the domain as more countries attempt to develop their space military capabilities to compete, risking accidental escalation and undermining the international nature of the space domain. In spite of these challenges, several panelists said that identifying ways to think about the role of space more explicitly will be critical to avoiding problems like accidental escalation.

Policy Discussion: Increasing Budgets and Funding for Research

Although space has been a quintessential domain for military operations, technological advances have altered how militaries operate in space. Similarly, several panelists noted that the solutions to many of the challenges present in the domain will also rely on advanced technological solutions. While they acknowledged that national security victories do not always require a country to achieve the technology first, due to the technological nature of space, they said that investing in more advanced capabilities and scientific research allows for new and more precise solutions to potential national security problems and also allows for improved quality and efficacy of existing technologies. Additionally, many

panelists said that more subject-matter expertise can help to diversify and inform more effective approaches to space challenges. However, panelists pointed out that though advanced technologies might help to address problems like debris, more advanced technologies may also exacerbate uncertainty, potentially creating an arms race for space technology. Therefore, while many panelists said that funding research into space will be an important part of developing the domain, they also said that this stage could be best served by revamping discussions regarding norms and objectives in space and also finding more ground for cooperation among space actors in order to improve communication that may help to ease tensions.

Questions for Future Research

- **Relationships with Allies and Partners:** What makes relationships with allies and partners more effective? What sectors in space would most benefit from strong allied cooperation and communication? Because of space's inherently international nature, will allied cooperation be more important in the space domain than in other more traditional sectors, or will its importance remain the same?
- **Developing Space Strategies:** How will the uncertainty and ambiguity of the space domain impact the ability to properly attribute attacks to specific adversaries and how will it affect the reliability of traditional military strategies like deterrence? How will tactical and operational plans need to be updated to better address threats in space? What redundancy measures need to be put in place to ensure that forces in other domains can continue to act if space assets are disrupted?
- **Reducing Uncertainty:** Can allies and partners work together to cultivate these operating practices and standardize expectations and strategies in space to reduce uncertainty and the risk of accidental escalation due to misinterpreted intentions? What methods are available to adversaries to improve communication surrounding their space operations to prevent escalation and conflict? What is the role of international organizations in inspiring collaboration and mitigating conflict in space?

Economic Opportunities

The second day of the conference began with a session on the economic opportunities in space. The panel included Henry Hertzfeld, Research Professor at the Space Policy Institute of George Washington University; Johanne Lecomte, Vice President of Sales and Business Development at Thales Alenia Space; Alexander MacDonald, Chief Economist at NASA; and Yamazaki. The panel was moderated by Ellen Chang, Head of H4X Labs and Investors Syndicate 708 and Co-Founder of Wharton Aerospace.

Henry Hertzfeld showed in his written contribution to the workshop, this figure comes to about 6 percent of growth annually—a respectable number, but not astronomical.[12]

However, some panelists also noted that the nature of the privatized space industry, while not a new concept, has changed over the last two decades. Previously, space corporations had centered around research and development with the goal being to sell and contract out technologies to the government. Today, these endeavors continue to thrive and make up a

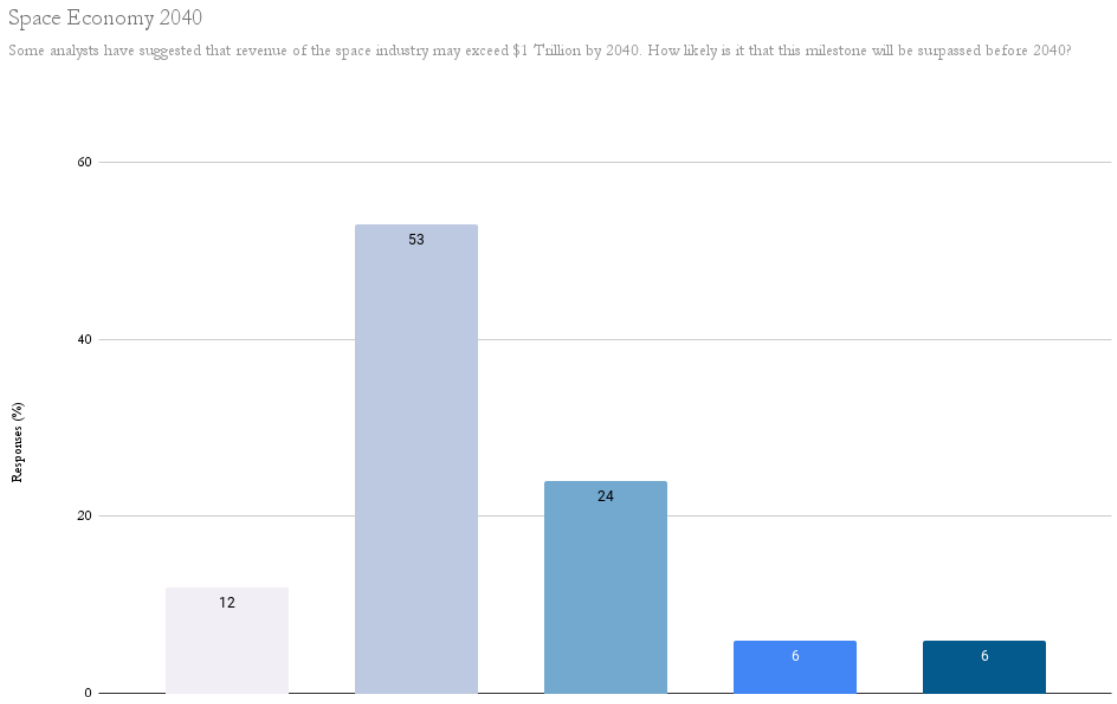

Figure 5: Space Economy 2040

The space economy and expectations for the space economy have grown tremendously. Many panelists pointed out that the value of the space economy, currently estimated to be about $350 billion, is likely to reach $1 trillion before 2040.[11] When this figure is calculated as a compounded interest rate, however, as

significant portion of the interaction between public and private entities, but the efficiency and productivity of space corporations as well as the potential of the domain has expanded to include independent ventures into space. These ventures include independent launches,

private astronauts, space tourism and travel, and asteroid mining.

Policy Discussion: Using Clear Definitions of the Space Economy

Another issue highlighted during the panel's discussion was the variety of definitions for the space economy. Over the last few decades, the types of activities engaged in by private space industries have worked on research and development projects; ground management projects, such as telecommunications, internet access, and water-supply management; as well as almost science-fiction type ventures, such as independent launches and proposed deep-space exploration projects. Because of how vast the types of projects being performed by space corporations are, some panelists pointed out that the term "space economy" often means a variety of things to different people and that these various definitions would likely lead to conflicting conceptions about how the space economy should operate and what regulations, if any, should be established. With the potential to have 10 percent of the world GDP related to a space economy, some panelists argued that using clear definitions for what is encompassed in the space economy and being explicit about which parts of that economy are being discussed and how the subcategories of that sector differ from each other, will be critical to creating clear and accurate policies that work for all of the actors present in space.

Policy Discussion: Investing in Space Debris Research and Prevention

Several panelists highlighted the challenges presented by debris. Most debris in space are exceptionally small, with the majority of debris estimated to be between 1 millimeter and 1 centimeter in size.[13] Despite its small size, it is still detrimental to assets and resources in space. For example, during her keynote address, Yamazaki recounted a story of how a small piece of debris hit a window of the space shuttle during her ISS mission. These damages, a frequent side effect of microscopic debris in outer space, are often expensive and dangerous, jeopardizing the effectiveness of space infrastructure and the safety of astronauts. Furthermore, some panelists emphasized that damages are not the only economic challenge presented by debris. As space becomes more congested, companies will have to invest more money and resources into developing technologies that are able to effectively maneuver around space junk and debris. This strategy requires sufficiently mobile satellites, which would jeopardize stability and breed uncertainty for domain security, and require the development of technology that can better monitor and detect debris prior to an accident.

These challenges will only be exacerbated by the projected increase of debris, due to the influx of actors and mounting security tensions in outer space. Thus, some panelists argued that investing in the prevention of space debris and in the development of technologies and regulations that can help to maneuver around existing debris successfully and securely will be a

critical measure to ensure the long-term stability and usability of the space domain. However, other panelists also pointed out the challenges involved in creating policies for debris. For example, countries may not want to assume responsibility for the space debris problem, as dealing with debris can be extremely expensive and resource intensive and no one country is responsible for the production of debris. Similarly, some panelists highlighted the extreme costs companies face for debris management. Not only could concerns about debris and congestion in space limit or hinder space launches, but companies would need to invest significantly in research and development processes in order to develop solutions that help to limit debris. Therefore, some panelists discussed the potential of governments to provide incentives for companies and organizations engaging in research and development of technology that aids debris prevention.

Policy Discussion: Developing and Strengthening Cross-Sector Partnerships

Another policy discussion among the panelists focused on the importance of developing and strengthening cross-sector partnerships. Some panelists said that as the space economy continues to develop and expand, cultivating and reinforcing existing partnerships with state governments, international institutions, and the scientific community will be an important part of maintaining the future success and usability of the space domain for economic ventures. Therefore, private space industries and corporations should consider partnerships

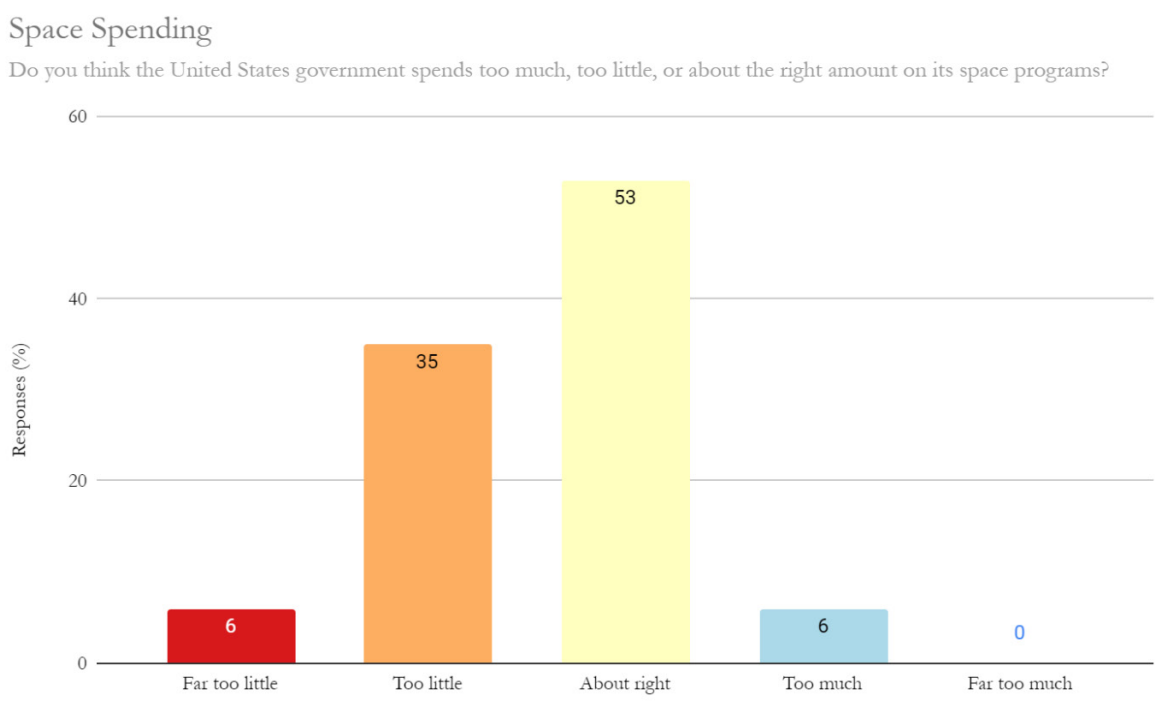

Figure 6: Space Spending

and projects with both government and academic organizations in order to ensure that policies and practices best represent the interests and needs of all actors in space. Additionally, some panelists said that cross-industry partnerships, including with the automotive sector, must also be fostered for success in the new space age. However, others highlighted the challenge of conflicting interests in space, such as between competition among private companies and/or differing objectives and conceptions about the future of space. Thus, while some panelists noted the benefits that could come from such partnerships, they also acknowledged that creating successful partnerships will require more universal classifications of space and open communication of goals and responsibilities for the actors in these partnerships.

Questions for Future Research

- **Defining "Space Economy":** What constitutes a space economy? How can corporations and government agencies work together more effectively to develop a more thorough understanding of the needs, limitations, and realistic opportunities of the space economy?
- **Investment in Debris:** How can developing systems to prevent and/or remove debris from space become more attractive and profitable to private corporations? What kind of technologies and investment would be necessary to support these ventures?
- **Balancing Interests:** Where do economic ventures in space support the interests of the scientific and security communities, and where do they differ? Is there a way to better balance the interests of competing agencies and organizations to preserve the long-term sustainability and usability of space?

International Law and Global Governance

As Lisa Ruth Rand explained in her written contribution to the workshop, the economy of the new space age is also creating a "gilded space age," where the world risks reproducing Earthly problems and inequalities in space, while enriching a handful of billionaire industrialists on Earth.[14]

International law and global governance will be necessary to regulate this gilded age. The conference therefore concluded with a panel on international law and global governance. The panelists included Simonetta Di Pippo, Director of the United Nations Office for Outer Space Affairs; Irmgard Marboe, Professor of International Law at the University of Vienna; Steve Mirmina, Senior Attorney (International Law) at NASA Headquarters, Office of the General Counsel; and Lisa Ruth Rand, then Haas Postdoctoral Fellow at the Science History Institute, now Assistant Professor of History at the California Institute of Technology. The panel was moderated by William Burke-White, Professor of Law at the University of Pennsylvania and Non-Resident Senior Fellow at the Brookings Institution.

Some panelists argued that the existing body of law is insufficiently developed to address the unprecedented, fast-paced progress of global space activity, echoing disillusionment from private actors and government officials in the existing regime.[15] In the pre-conference survey, those participants who completed the survey overwhelmingly believed that global governance and international law have not kept up with recent developments in space (see Figure 5). This sentiment is further

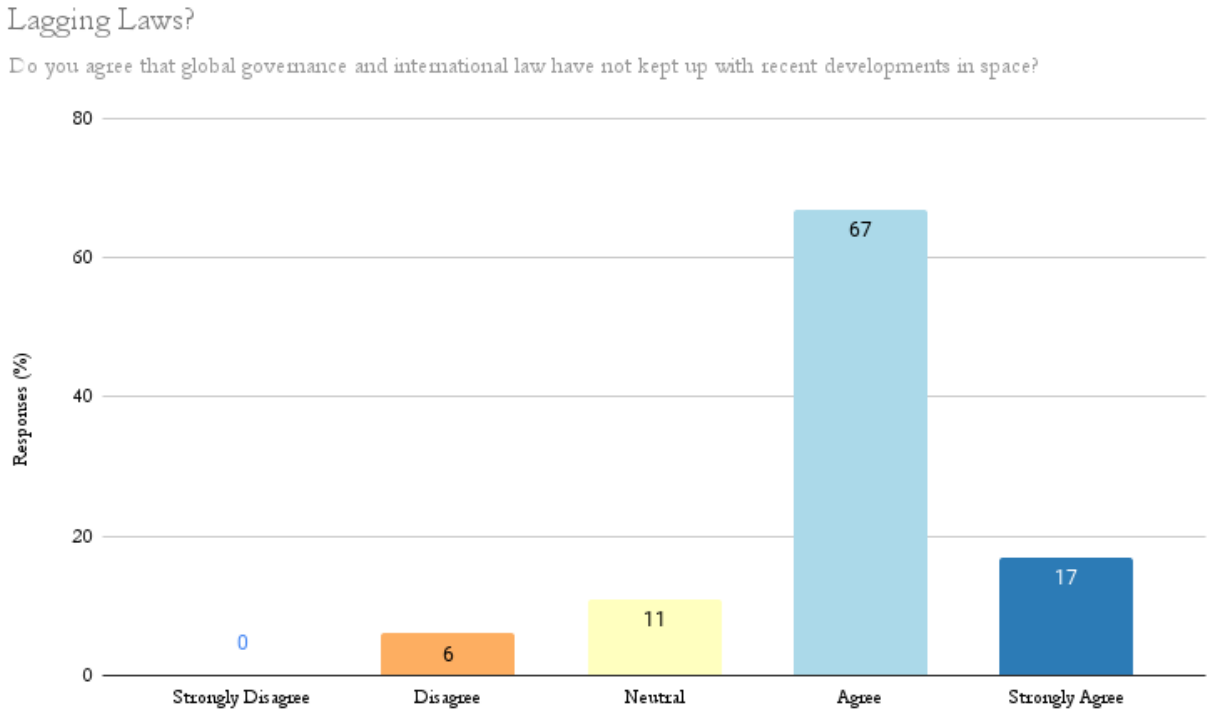

Figure 7: Lagging Laws?

reflected in the views of many public officials and the policy positions of nation-states that refuse to ratify existing accords. In a 2020 executive order,[16] the United States explicitly argued that it "does not consider the Moon Agreement to be an effective or necessary instrument to guide nation states regarding the promotion of commercial participation in the long-term exploration, scientific discovery, and use of the Moon, Mars, or other celestial bodies."

Policy Discussion: The Benefits of the Moon Agreement

Some panelists specifically explored the relevance of the Moon Agreement to govern modern lunar activities and space exploration. The "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies" was adopted by consensus by the UN General Assembly in its Resolution 34/68 of December 5, 1979, but it only enjoys ratification by 18 state parties. Although recent ratifications include Armenia in 2018 and Kuwait in 2014, most notably, none of the most active space-faring nations, such as the United States, Russia, China, Japan, or India, have ratified the agreement. Thus, as Henry Hertzfeld explained in his written contribution to this workshop, the Moon Agreement "is considered by many a failed treaty."[17]

Developing a new legal instrument is challenging; hence, some of the participants argued that non-signatories should reconsider ratification of the Moon Agreement as a useful legal instrument to enable collaboration around lunar resource exploitation and utilization. Contrary to common misunderstandings, the Moon Agreement does not establish a moratorium on mining or preclude the exploitation of resources for scientific investigation and sustaining space missions, and it might provide a foundation for greater cooperation in space.

Some of the reasons for the United States to remain a non-signatory are unsatisfactory and based on historical political fluctuations, which Irmgard Marboe explored in her written contribution to the workshop. Controversy surrounding the Moon Agreement arises from terminology in Article 11 and the provision that, "the Moon and its natural resources are the common heritage of mankind." Historically, Article 11 enjoyed greater consensus during the process of drafting the text, than in the modern era. During the negotiations, the United States was supportive of the "common heritage" principle, whereas the Soviet Union opposed. Changing political tides led officials in the United States to later denounce Article 11 as a "socialist concept" hostile to entrepreneurship and private investment.[18] Some panelists stressed that it is important to remember that the United States originally supported Article 11 and "common heritage" is not used in the same way as the controversial provision in the UN Convention on the Law of the Sea, limiting the reasons for continued skepticism and political resistance from Washington.

Space mining is likely to look different from traditional terrestrial conceptions and requires thoughtful—and no doubt contentious—legal design to account for the unique context associated with lunar resource extraction. For now, space resource extraction is not a priority, according to many panelists at the workshop, but engaging with the complex issues regarding property in space now will help pave the way for greater cooperation in the next space age. Four industries are likely to be involved: (1) companies associated with

searching and locating resources, (2) companies extracting the resources, (3) the beneficiation industry that extracts useful materials out of the regolith, and (4) an industry that processes and purifies the minerals. Some panelists stressed that no company is going to make the investments to undertake these risky ventures if international legal guarantees are absent. Without such guarantees, the next space age will stop before it can even begin.

Some panelists suggested that ratifying the Moon Agreement could satisfy the global appetite for legal parameters surrounding space resource activities as private companies and national agencies develop plans to mine space resources. The drafters of the Moon Agreement were mindful that the rules surrounding the exploitation of natural resources should be established once governments have a clearer sense of the technologies and intricacies associated with capturing resources, leaving some portions to be elaborated. Paragraph 5 of Article 11 provides that an international regime will be created once technology develops and "exploitation is about to become feasible."[19] Governments could renegotiate portions of the Moon Agreement to provide guidance around the use of lunar resources in a manner that preserves the lunar environment and limits the potential for conflict.

Some portions of the Moon Agreement even mirror modern legal efforts to preserve lunar resources. For instance, the 2020 Artemis Accords share many similarities with the Moon Agreement. Instead of banning the use of space resources, Section 10 of the Artemis Accords elaborates that governments could capture resources, especially when capture "would benefit humankind by providing critical support for safe and sustainable operations." Section 9 calls for the preservation of "outer space heritage," including historically significant human or robotic landing sites, artifacts, spacecraft, and other evidence of activity on celestial bodies. The Moon Agreement complements the Artemis Accords understandings.[20] Article 6(2) provides that state parties may "use mineral and other substances of the Moon in quantities appropriate for the support of their missions." Likewise, Article 7 of the Moon Agreement specifies efforts to preserve resources "concerning areas of the Moon having special scientific interest."

Policy Discussion: Effective Governance Models for the Growing Problem of Space Debris

Space debris is a problem panelists discussed, adding that multilateralism is necessary to overcome the risk to the safety, sustainability, and security of near-Earth space. Over 11,000 objects have been launched into space, but the rate of launches has rapidly grown in recent years. In 2012, the global community launched 200 objects, but expanded to over 1,000 objects in 2020.[21] The rapid expansion leads to problems of space debris and the potential for problematic collisions. Demand is growing for a governance system to address the disposal of nonfunctional objects that remain in orbit even after their project lifespan and to enforce space traffic-management systems to mitigate collisions. As the Director of the UN Office of Outer Space Affairs Simonetta Di Pippo explained in her written contribution to this workshop, "rules of the orbit" developed at the United Nations and elsewhere must

address this growing problem.

The valuable functions that international organizations perform are part of the demand for a global system dedicated to the management of space debris. Existing collision alerts are challenging and undertaken via decentralized means. The slow speed at which notifications are received limits the viable options for moving investments before a collision. Opportunities for coordination are compounded by the large technical investments required to implement a monitoring and notification system. Thus far, collaboration on the topic of space debris has largely occurred through the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), which has convened member and observer states since the late 1950s and recently worked to expand membership. The COPUOS-led adoption of the Space Debris Mitigation Guidelines and the Guidelines for the Long-term Sustainability of Outer Space Activities was the first step in developing norms around managing space debris.

Given the differing viewpoints and geopolitics of space, however, even voluntary agreements are hard to negotiate. The COPUOS Sustainability Guidelines took over a decade to reach only a shallow consensus. Likewise, consensus is frustrated by the diversity of viewpoints and interests. Some panelists pointed to recent innovations that overcame some of these challenges. Similar to other issue areas in world politics that involve a large number of private actors, the UN Office for Outer Space Activities launched the World Space Forum in 2019 as a multistakeholder conference that brings together governments, academia, research centers, firms, and the public to build a sustainable space sector.[22] Private actors are increasingly attempting to have their voices reflected in multilateral deliberations, and the global community of nation-states would be remiss not to include technical and private representatives in discussions for expertise and coordination.

Promise in space coordination involves drawing from other issue areas incorporating a variety of viewpoints. UN processes such as the Group of Governmental Experts and Open-Ended Working Groups could be leveraged, similar to the initial success achieved in developing agreements in cyberspace, which was inclusive of industry voices. Rather than attempting to define space debris in a multilateral treaty, some panelists instead recommended that governments work with industry to develop technical measures where space-faring nations make voluntary commitments to take particular types of actions, including standards for draining batteries and taking spacecraft out of orbit. In short, governments should remain pragmatic in aspirations for legal consensus, while working to incorporate a rich and diverse array of voices to overcome the growing issue of space debris.

Questions for Future Research

- **International Rules for Resource Extraction:** How can international law best facilitate practices from the off-Earth mining of celestial bodies and space resource-extraction industry in a way that best protects the space environment? Are current agreements the most appropriate texts to govern international relations surrounding resource extraction?
- **Best Practices:** When new norms

are developed to guide space activity, are there existing issue areas that could inform the development of rules in outer space? For example, when developing rules to guide the management of the space debris problems, should governments look to the lessons from the climate change regime?

- **Formal or Informal Lawmaking:** What are the trade-offs between formal treaties, versus informal commitments, nonbinding commitments and domestic law in governing space relations? What is the role of state practice and custom in navigating around the limited number of multilateral rules in the space regime?

Next Steps

Space-based assets structure modern human life. They facilitate the information and communications technology infrastructure and play a pivotal role in the networks that keep the global economy running smoothly and that have kept humanity connected during the isolation of the COVID-19 pandemic. Modern militaries rely on satellites for navigation, surveillance, high-tech weapons systems, arms-control verification, and even the command, control, and communications systems of nuclear weapons. The future of humanity lies in space, too, whether through scientific exploration, economic expansion, or to help tackle some of the world's most challenging problems, like climate change on Earth.

Despite its importance, space policy remains a neglected field, both by academics and policymakers. When we asked participants whether space policy receives the right amount of attention from think tanks and academia, 39 percent of those who completed the survey said it receives somewhat too little attention, and 22 percent said that it receives far too little attention. The situation looks even worse in the policy world; 67 percent of these experts said it receives somewhat or far too little attention from policymakers.

Policy and Research Recommendations

Given this lack of attention, in a field like space policy, it is even more important to bridge the gap between academia and the policy world, to create new connections, shape research in productive ways, and translate that research into creative policy solutions. This section builds on the policy discussions throughout the report and expands to three general recommendations:

1. **Recognize the dangers of space hype**—exaggerated claims and mischaracterizations of space are holding back productive discussions on pressing policy issues.
2. **Use space debris as a Trojan horse to strengthen global "rules of the orbit"**—only a global multistakeholder initiative can help address this cross-cutting threat, which can become a foundation for further support.
3. **Leverage public-private partnerships to fuel the new space age**—these partnerships provide a tried and tested model for innovation in the new space age.

Additionally, we asked workshop participants, "What problem or issue should be scholars' and policymakers' greatest priority with regard to space policy?" Their answers, below, should shape the approach to space policy for years to come.

- "Ensuring peaceful use of space, with eye toward ensuring no militaristic escalation."
- "Rethinking outer space as an explicitly environmental regime in need of more comprehensive regulation."
- "Avoiding the spoliation of Outer Space."
- "Public-private partnership growth, including talent development programs."

- "Debris, militarization of space."
- "Ensuring that international politics does not overshadow science."
- "Coping with space debris and [developing] international space traffic-management rules."
- "Protecting assets in space without creating significant debris or international conflicts."
- "Global Governance."

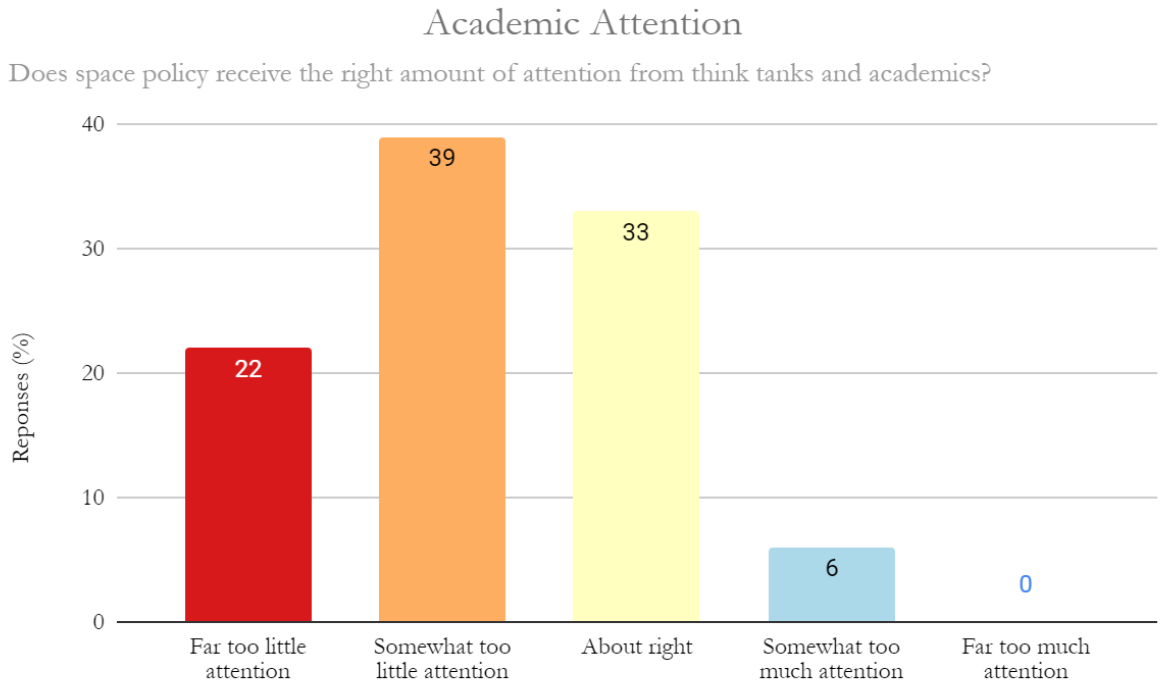

Figure 8: Academic Attention

Recognize the Dangers of Space Hype

A $1 trillion space economy by 2040 sounds impressive—until one does the math, as Henry Hertzfeld did in his written contribution to this workshop: $1 trillion comes out to about 6 percent growth per year, before inflation. Previous research by Perry World House scholars has emphasized the perils of overhyping emerging technologies.[23]

In artificial intelligence, for example, a "hype cycle" of overpromising and over-selling the technology has caused backsliding to "AI winters." Other cutting-edge fields face the same problem—as a quantum-computing expert recently explained, the public and policymakers mistakenly view quantum computers as "magical uber-machines that will soon cure cancer and global warming by trying all possible answers in different parallel universes."[24]

Space, too, is prone to hype. More than once, participants in the workshop described the global space market and venture capital scene as "frothy" and suffering from a culture of fake-it-until-you-make-it. The title of Sarah Mineiro's

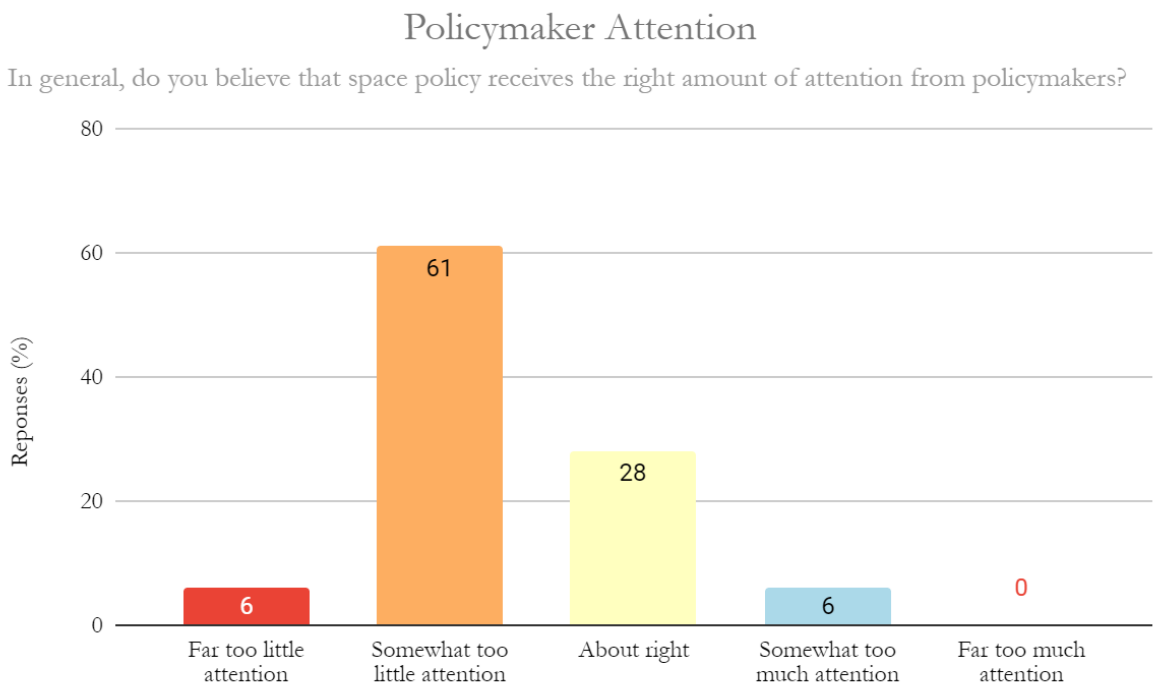

Figure 9: Policymaker Attention

written contribution to the workshop—"A Boring Space Innovation Paper"—also alludes to the need for arguments that are both figuratively and literally more grounded. Making space boring might have side effects—in recruitment and retention for new space-focused military organizations, for example—but it is crucial for the future of the domain.

Public communications campaigns, both from national governments and from international organizations, can make space seem more relatable and the need for protecting space feel more tangible. In the "gilded space age," to use the phrase of Lisa Ruth Rand's written contribution to the workshop, space seems ripe for a populist backlash if it continues to appear as the domain of the ultra-wealthy or of costly sci-fi wars. Over-regulation, underinvestment, and rash actions might cripple humanity's future in space. To avoid this, set realistic expectations, and create stable support for government investment in space, a public communications campaign should emphasize the role of small businesses and scrappy start-ups in the new space age, the importance of space for national security, and the manifold ways that the sustainability of space underpins the lives of everyday people around the world. In the words of one participant from the workshop, the future of space relies on "making it less about Star Trek jokes and more about your ability to access the money from your ATM."

Use Space Debris as a Trojan Horse to Strengthen Global "Rules of the Orbit"

The real issue, therefore, is not with much-hyped projects like terraforming Mars, but with more mundane problems, like keeping low-Earth orbit sustainable and free of space debris. Space debris

was one issue that cut across all panels, with each highlighting its potential problems. Some space debris is too small to be tracked, but large enough to damage important systems, providing a serious challenge for national and international governments. More research is needed on multistakeholder approaches to space debris and how to better leverage standard-setting bodies and nonbinding norms (for example, at the UN's space bodies) to create what UN Office of Outer Space Affairs Director Simonetta Di Pippo called "rules of the orbit" in her written contribution to the workshop.

As a shared challenge that has not yet been politicized the way other transnational problems (like climate change) have, space debris can become a "trojan horse" for international cooperation. As one workshop participant argued in the anonymous survey, "Orbital debris presents real risk to space potential while offering a pragmatic basis for cooperation in space on which countries can build." It's not just countries—the workshop showed that private actors, too, have strong incentives to support international rules to mitigate the challenge of space debris. Such "rules of the orbit" can follow other regulations of quickly changing fields like cybersecurity, where the recent 2021 consensus report of the Group of Governmental Experts working on cyber issues at the United Nations showed that limited cooperation on contested domains is still within reach. The United Nations has Space Debris Mitigation Guidelines and Guidelines for Long-term Sustainability of Outer Space Activities. The United States and its allies, too, must prioritize finding multilateral solutions to space debris—both the U.S. economy and the long-term sustainability of space depend on it.

Leverage Public-Private Partnerships to Fuel the New Space Age

Public-private partnerships, too, can provide one avenue for dealing with space debris. Some experts discussed how orbital "trash-removal" services—powered by the combined force of the private market with the incentives of governments—might help to solve the space debris problem. Moreover, as outlined above, public-private partnerships have been the fuel that is powering many of the most important developments of the new space age. More research is needed, however, to solve space-specific issues for public-private cooperation. One of these is the dual-use nature of many space-based assets, where debris-removal technology can easily be seen as anti-satellite weapons technology. Another is the public perception that space is the domain of billionaires funded by taxpayer dollars—the case for public private partnership will need to be a public case.

In short, researchers can help to strengthen innovation by studying and identifying the most effective models of public-private cooperation that could be applied to the space domain. Industry collaboration with governments, therefore, is not the only kind of public-private partnership that matters for space. Academic-policy partnerships, like those fostered at Perry World House with the support of Carnegie Corporation of New York, will also be crucial for the new space age. Policymakers who are literate in the realities of space, and academics who understand the needs of the policy world, will help drive forward the promise of the new space age. The next section suggests further reading.

Conclusion and Further Reading

The problems of the new space age may not be that new, and may be literally more mundane than often supposed, but the world relies on space, and any hopeful vision for the future of humanity will require a sustainable and secure space domain. The space domain is growing more dangerous—as Saadia Pekkanen explained in her written contribution to the workshop: "We have moved well beyond the characterization of space as contested, congested, and competitive. Today, we see and talk openly about kinetic and non-kinetic weaponization and arms races in space, and the possibility of conflict involving the space domain."[25]

Even without militarization, the growing problem of space debris threatens to make the domain unusable, and the proliferation of both public and private actors in space is making the domain more complicated than it ever was during the Cold War. Perry World House will continue to pursue work in this area to identify new paths forward for the most pressing global issues. In the meantime, you can dive deeper into space policy through experts' reading recommendations, below. Or follow the advice of one of the participants: "watch For All Mankind and read more science fiction, comics, and engineering books."

What the Experts are Reading

Natalie Borman and Michael Sheehan. *Securing Outer Space*. Routledge, 2009.

Namrata Goswami. *Scramble for the Skies: The Great Power Competition to Control the Resources of Outer Space*. Lexington Books, 2020.

Roger Handberg. *Reinventing NASA: Human Spaceflight, Bureaucracy, and Politics*. Praeger, 2003.

Todd Harrison, Kaitlyn Johnson, Makena Young, and Joe Moye. *Space Threat Assessment 2021*. Center for Strategic and International Studies, 2021. https://www.csis.org/analysis/space-threat-assessment-2021.

Joan Johnson-Freese. *Space Warfare in the 21st Century: Arming the Heavens*. Routledge, 2016.

Bruce McClintock, Katie Feistel, Douglas C. Ligor, and Kathryn O'Connor. "Responsible Space Behavior for the New Space Era." RAND, 2021. https://www.rand.org/pubs/perspectives/PEA887-2.html.

Walter McDougall. *...the Heavens and the Earth: A Political History of the Space Age*. Johns Hopkins University Press, 1985.

James Clay Moltz. *Asia's Space Race*. New York: Columbia University Press, 2018.

Morgan Stanley. "A New Space Economy on the Edge of Liftoff." MorganStanley.com. Last modified February 17, 2021. https://www.morganstanley.com/Themes/global-space-economy.

National Aeronautics and Space Act (1958). https://history.nasa.gov/spaceact.html.

Saadia Pekkanen. "Governing the New Space Race." In: *Introduction to the Symposium on the New Space Race, American Journal of International Law Unbound*, 113, 2019.

Rajeswari Pillai Rajagopalan and Narayan Prasad, eds. Space India 2.0: Commerce, Policy, Security, and Governance Perspectives. Observer Research Foundation, 2017. https://www.orfonline.org/wp-content/uploads/2017/02/ORF_Space-India-2.0_NEW-21Nov.pdf.

Lisa Ruth Rand. "Falling Cosmos: Nuclear Reentry and the Environmental History of Earth Orbit." *Environmental History*, 24(1): 78–103, 2019.

Asif A. Siddiqi. "Competing Technologies, National(ist) Narratives, and Universal Claims: Toward a Global History of Space Exploration." *Technology and Culture* 51, 2: 425–43, 2010.

Clementine G. Starling, Mark J. Massa, Christopher P. Mulder, and Julia T. Siegel. *The Future of Security in Space: A Thirty-Year U.S. Strategy*. Atlantic Council Strategy Papers, 2021. https://www.atlanticcouncil.org/wp-content/uploads/2021/04/TheFutureofSecurityinSpace.pdf.

Brian Weeden and Victoria Samson, eds. *Global Counterspace Capabilities: An Open Source Assessment*. Secure World Foundation, 2021. https://swfound.org/news/all-news/2021/04/swf-releases-2021-global-counterspace-capabilities-report.

Endnotes

1 NASA, "NASA, International Partners Advance Cooperation with First Signings of Artemis Accords," NASA.gov, last modified October 13, 2020, https://www.nasa.gov/press-release/nasa-international-partners-advance-cooperation-with-first-signings-of-artemis-accords.

2 Summaries of Artemis Accords principles from NASA, "NASA, International Partners Advance Cooperation with First Signings of Artemis Accords," NASA.gov, last modified October 13, 2020, https://www.nasa.gov/press-release/nasa-international-partners-advance-cooperation-with-first-signings-of-artemis-accords.

3 Theresa Hitchens, "In a First, SecDef Pledges DoD to Space Norms," Breaking Defense, July 19, 2021, https://breakingdefense.com/2021/07/exclusive-in-a-first-secdef-pledges-dod-to-space-norms/.

4 Philip Potter, George W. Foresman, and Michael Horowitz, "Space Norms and U.S. National Security: Leading on Space Debris," *War on the Rocks*, August 2, 2021, https://warontherocks.com/2021/08/space-norms-and-u-s-national-security-leading-on-space-debris/.

5 Matthew Weinzierl, "Encouraging the Space-for-Space Economy," *The New Space Age: Beyond Global Order* (Perry World House, May 21, 2021).

6 Sarah Mineiro, "A Boring Space Innovation Paper," *The New Space Age: Beyond Global Order* (Perry World House, May 21, 2021).

7 Weinzierl, "Encouraging the Space-for-Space Economy," 2.

8 Mineiro, "A Boring Space Innovation Paper."

9 Weinzierl, "Encouraging the Space-for-Space Economy," 3.

10 Mineiro, "A Boring Space Innovation Paper."

11 "Space: Investing in the Final Frontier," Morgan Stanley, July 24, 2020, https://www.morganstanley.com/ideas/investing-in-space.

12 Henry Hertzfeld, "Space Economics and Law," *The New Space Age: Beyond Global Order* (Perry World House, May 21, 2021).

13 Mark Garica, "Space Debris and Human Spacecraft," NASA, May 27, 2021, https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.

14 Lisa Ruth Rand, "Global Roots of a Gilded Space Age," *The New Space Age: Beyond Global Order* (Perry World House, May 21, 2021).

15 Simonetta Di Pippo, "Space Realities in the 21st Century," *The New Space Age: Beyond Global Order* (Perry World House, May 21, 2021).

16 U.S. Executive Order 13914 of the President, April 6, 2020.

17 Hertzfeld, "Space Economics and Law."

18 Irmgard Marboe, "The Relevance of the Moon Agreement," *The New Space Age: Beyond Global Order* (Perry World House, May 21, 2021), Note, President Reagan argued that the Moon Agreement represented a redistribution of the world's wealth, referring to the text as global collectivism and international management.

19 Marboe, "The Relevance of the Moon Agreement," 2.

20 Marboe, "The Relevance of the Moon Agreement."

21 Di Pippo, "Space Realities in the 21st Century."

22 Di Pippo, "Space Realities in the 21st Century."

23 Julia Ciocca, Michael C. Horowitz, and Lauren Kahn, "The Perils of Overhyping Artificial Intelligence," Foreign Affairs, April 6, 2021, https://www.foreignaffairs.com/articles/united-states/2021-04-06/perils-overhyping-artificial-intelligence.

24 Scott Aaronson, "What Makes Quantum Computing So Hard to Explain?" WIRED, June 13, 2021, https://www.wired.com/story/what-makes-quantum-computing-so-hard-to-explain/#:~:text=Quantum%20computers%2C%20you%20might%20have,answers%20in%20different%20parallel%20universes.&text=And%20just%20as%20in%20cryptocurrency,with%20money%20have%20come%20hucksters.

25 Saadia M. Pekkanen, "Cautionary Remarks on the Emerging Bipolarity of Space Alliances: A Japanese Perspective," *The New Space Age: Beyond Global Order* (Perry World House, May 21, 2021).

PERRY
WORLD
HOUSE
University of Pennsylvania

UNIVERSITY OF PENNSYLVANIA
PERRY WORLD HOUSE

3803 LOCUST WALK, PHILADELPHIA,
PA 19104

215.573.5730