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REPORT
China's Space Ambitions and the Economics of Space

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Currently worth north of $500 billion, the global space economy is projected to grow to $3 trillion-plus by 2040. With more than eighty nations participating in the global space ecosystem, the US remains a leader in this sector, albeit witnessing a shift from the public to private domains: 80% of the US space industry is now in the private commercial sector.

Technology being developed on Earth is a part of the space economy, from data analytics and energy storage solution to robotics and cybersecurity. Much of that technology is already applicable to solutions on Earth, such as weather prediction that allows better transportation of goods and services, and space technology will continue to be a part of solutions that address issues such as climate change and food security.

A recent US-China series hosted by Shelli Brunswick, Chief Operating Officer at Space Foundation, discussed the business of space and China's ambitions in the sector in the context of overall US-China relations and featured the following experts:

Dr. Shawna Pandya — Scientist, Astronaut Candidate at Project Possum

Malak Trabelsi Loeb — CEO of Vernewell Space Solutions

Ian Christensen — Director of Private Sector Programs, Secure World Foundation

Rob Ronci — Executive Director at Caelus Foundation

Our discussion looks at opportunities, the legal frameworks, and the misconceptions that western observers have about China's space ambitions.

Our big takeaway from dialog with US space stakeholders is that the motivations between private space sector development in China needs to be better understood within the US sector. The Chinese space ecosystem is more complex than widely recognized within US commercial space stakeholders.

America's relations with China on commercial space and scientific inquiry may be fraught with political overtones, but collaboration is possible. The human needs of space exploration can be a promising platform for such collaboration.

By **Paul Krake**, paul@viewfromthepeak.com.hk;
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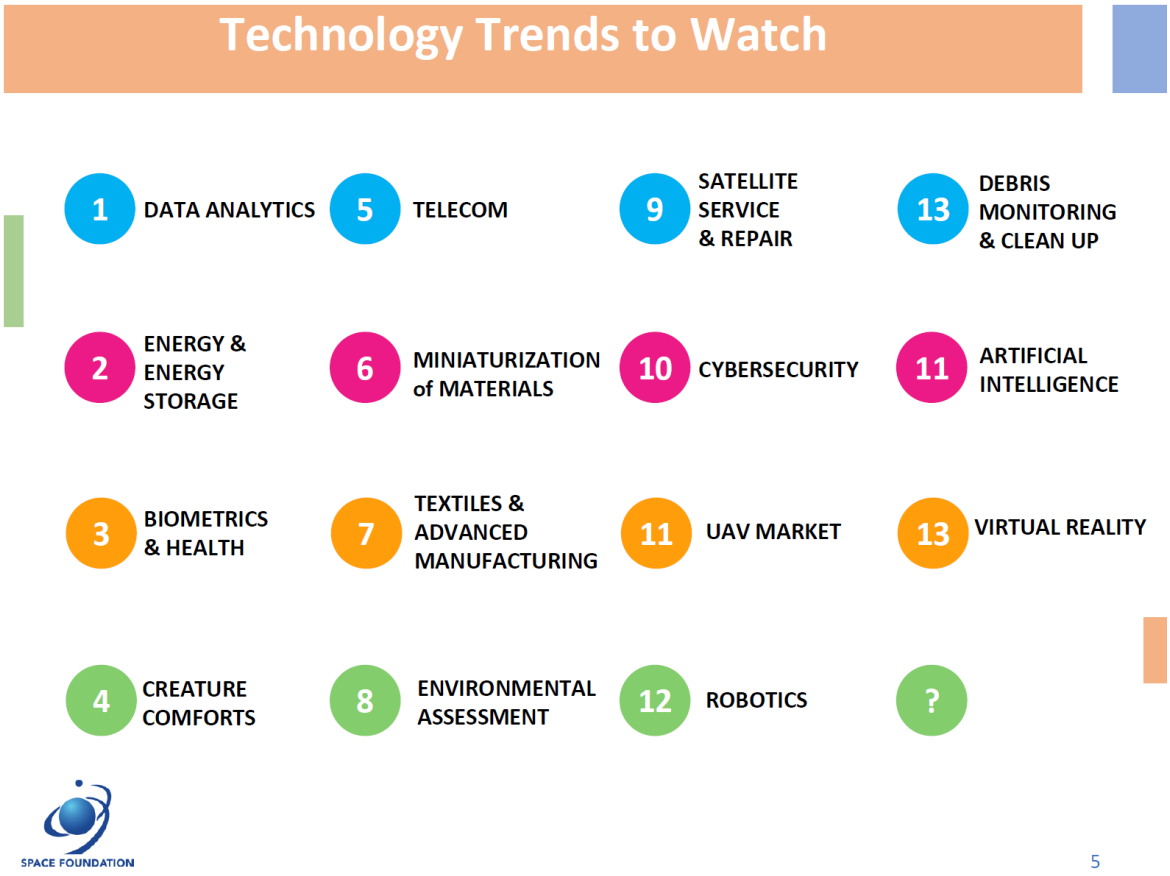
Global Space Economy: An Introduction

Shelli Brunswick: The global space economy, currently worth $424 billion, is projected by several analysts from Morgan Stanley and UBS to reach $1 to $1.4 trillion by 2030 and grow $1 to $3 trillion by 2040. With more than 80 nations participating in the global space ecosystem, the US remains a leader in this sector, albeit witnessing a shift from the public to private domains: 80% of the US space industry is now in the private commercial sector. Opportunities abound, moreover, in participating in the commercialization and globalization aspects of the space economy.



Space technology goes beyond high profile technology — such as Mars rovers — to also include technology developed for uses on Earth as part of the space economy. Space technology is already applicable in mobile phones, cordless tools, other everyday applications, and further potential for domains, including data analytics, energy storage solutions, robotics, cybersecurity, and healthcare opportunities. And technology that is already applicable to solutions on Earth will continue to be a part of solutions that address issues such as climate change and food security.

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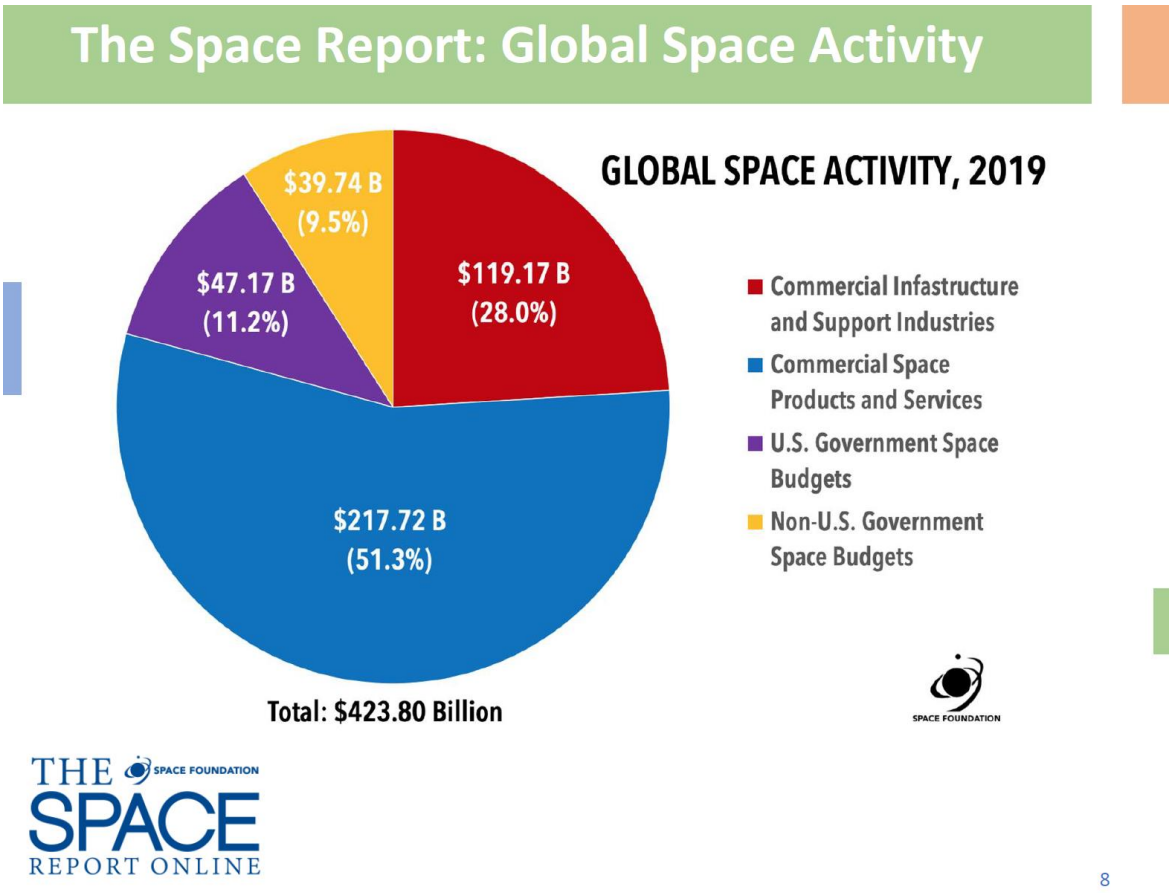

Entrepreneurs and business leaders have the opportunity to bring space technology to the commercial market by commercializing patents at NASA's Technology Transfer Office and its counterpart at the European Space Agency. As the Space Foundation's quarterly *Space Report* demonstrates, commercial opportunities will grow to become a more significant share of the globalization of space technology even as government investment remains the same, and both heavyweights, including the US, Russia, and China as well as developing countries are embracing space technology. And whereas space was once dominated by governments, scientists, and astronauts, now it is open to entrepreneurs, professionals, trade workers, and artists, among others. It is a great time to be joining and investing in the space industry.

Space: Competition or Cooperation?

Shawna Pandya: US-China relations in the space sector are multi-faceted, requiring an approach from different perspectives; there are promises and perils.

Collaboration-wise, space should be seen as an entity that can melt away some of the prevailing tensions, instead bringing about creative, collaborative, and productive ventures. The 1967 astronaut rescue agreement is one example in which both China and the US are signatories: an astronaut stranded on foreign territory would be rescued and sent back to their country.

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In space education, China is very much open to collaboration, especially with the International Space University, whose summer 2007 session was held in Beijing. The university counts members of the Chinese Space Agency among its alumni and faculty staff.

The future for US-China cooperation on space issues may rest on multilateral relations. Russia recently signed an agreement with China on developing the international lunar research, which is a departure from previous US-Russia partnerships in the era of the International Space Station. Both the US and China are well-connected with other national space agencies in France, Argentina, and the European Union, and opportunities for multilateral collaboration exist. China's strategy — the country's Tiangong Space Station and future space projects such as Mars probes — leave room for collaboration between economic and scientific powers.

In summary, America's relations with China on commercial space and scientific inquiry may be fraught with political overtones, but collaboration is possible. The human needs of space exploration can be a promising platform for such collaboration.

Space as National Security

Malak Trabelsi Loeb: Space activities conducted by nations cannot be separated from the overall international relations context between states. As such, US-China relations in space are an extension of issues that are already at stake surrounding the two countries at large: national policies and their effects on foreign affairs, international political economies, and strategic rivalries that some call a cold war. China's ambition to establish a leading position in the military and economic cues of outer space is met with the US' aims to assert its leading positions within this area, just as the two countries vie for power through military capabilities and economic competition. A quick overview of some milestones that have defined US-China relations and how they provide a context to space competition:

- 2000: Former President Clinton's US-China Relation Act paved the way for a permanent trade relation between the two countries.
- 2007: Former Vice President Dick Cheney stated that China's military build-up was inconsistent with its peaceful rise.
- 2008: the US was increasingly concerned that China was becoming the US's largest creditor while growing on its path to becoming the world's largest economy.
- The 2010s: The Obama administration increased the US's diplomatic and strategic investments in the Asian Pacific region, leading to the Trans-Pacific Partnership. Trade quotas, which were not allowed under international trade laws, created tension between the two nations.
- 2016 – present: Trump administration's hardline policy against China came from tariffs to fight against Chinese economic aggression and military aggression. Accusations of China being a currency manipulator have then been followed by the COVID-19 pandemic.

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The US has imposed various protective measures, from blacklisting dozens of Chinese companies to imposing sanctions against individuals for alleged abuse in Hong Kong. These measures come from the Committee on Foreign Investments in the United States, which reviews investments in US companies and operations in light of national security considerations. CIFUS' pilot program involving regulations concerning critical technologies, especially its illicit transfer, is an example showing that space-faring nations will be especially aware of future space strategy security. The ecosystem responds to the massive security issue involved in space activities, and from a national security standpoint, governments seek advantages in preventing espionage. China's successful launch of satellites in 2016 was an example of a first in intercontinental cryptology.

For private actors in space, the economic interests between national interests and states' rights and imperatives to control its space activity are at stake; they will want to be diligent in ensuring successful ventures and avoiding disappointments. This is the current business climate in the global space economy, lacking legal certainty, the rule of law, and long-term predictability.

Understanding China's Space Industry

Rob Ronci: The US-China relationship is a highly sensitive subject in general, but even more so in the space sector. Space is a high-security domain, and the US' concerns with China have already had an enormous impact on how business is conducted in the industry. Strict export controls cover satellite equipment and manufacturing; legislation limits NASA's ability to engage directly with Chinese government entities, and the establishment of the US Space Force have all led to a primarily a hands-off relationship with very direct engagement between the two countries regarding the space sector.

The Caelus Foundation and Secure World Foundation established a dialogue with the Chinese Society of Astronautics in 2019 to discuss how the US and China approach space commercialization. Moreover, the foundations have understood the perspectives of American commercial stakeholders, comparing them to the current space sector in China.

Ian Christensen: The US and China have arguably the two most comprehensive national space programs across all dimensions. Some key comparisons:

- The US remains the most capable and advanced space-faring state, where the government budget is 4 to 5 times that of the government space budget in China — though China's exact budget is hard to ascertain.
- America's space industry is more robust and innovative, yet China's public and private investments in the space industry are rapidly increasing. The US Institute of Defense Analyses recently identified 78 commercial space companies in China, in comparison to the US, which has hundreds of space start-ups and a much larger number of companies.
- Both the US and China are pursuing sustained lunar exploration programs as well as human space life programs in lower orbit at the International Space Station and the Tiangong Space Station.

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- China is the second-largest private space investment destination after the US. Consulting firm Bryce Space and Technology identified $314 million in private investment in China in 2019, compared to $4.8 billion in the US.
- One caveat is that more information on US space activities is available compared to China, creating an asymmetrical understanding of the two countries' industries that is exacerbated by geopolitical considerations.

In summary, American stakeholders in the commercial space industry are interested in and concerned about China's space activities, as China is expected to be a critical competitive player. Yet, it is difficult to view China's space program without the underlying geopolitical context of perceiving the nation's industry as a monolith dictated mainly by the government and SOEs.

The State of China's Space Industry

Rob Ronci: China's space industry, contrary to being a monolith, is defined by internal competition, division, and friction.

One example is the use of the phrase 'national team,' which refers to entities, stakeholders, and individuals with a strong attachment to the central government. The term is also often used by tech start-ups, for instance, to otherize those that receive support from the state. The dynamic is such that little direct competition exists between private firms and SOEs which belong to the national team. These frictions manifest, for instance, in the sharing of the workforce, where SOEs have objected to their employees working in the private sector and where leaked documents have shown the much lower compensation that employees receive at SOEs.

In another instance, a government document that was made public encouraged SOEs to cooperate and work with the commercial sector, and the latter expected to be able to do business and purchase from SOEs. The SOEs, however, decided that there was no obligation to supply equipment such as rocket engines to private firms.

Space in China: Long-Term Advantage?

Ian Christensen: US stakeholders perceive Chinese funders, both public and private, take a more patient and long-term approach to return on investment and expectations of outcomes than their US counterparts. This is apparent in that Chinese government investment would take place over more extended periods, that SOEs transfer technology to commercial companies, and that the state supports foreign acquisitions.

Yet questions of whether US firms are at a disadvantage because of the perceived long-term strategic approach in China need to be addressed according to China's broader goals as a nation. China has very ambitious domestic economic growth goals under the next five-year period, doubling its GDP by 2035, reaching high-income status by 2025, and emphasizing initiatives regarding urbanization, climate change, and technological independence. Space needs to be understood within the context of these goals.

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When it comes to funding, provincial governments play a larger role in Chinese commercial space companies than the national government. Local authorities respond to policy signals and programs at the national level while also pursuing their own regional economic development or technology goals.

In April last year, China's National Development Reform Commission's decision called for satellite internet to be added to a list of strategic new infrastructures. As a result, several provincial governments announced plans to develop satellite manufacturing hubs in the form of technology parks built to develop these capabilities. Private space companies also raised money from these announcements, though the demand, in this case, is from a domestic consumer base. And while this may not directly compete with US companies, there are secondary effects on the overall US-China space race.

Challenges for China's Private Firms

Rob Ronci: Private and commercial Chinese firms have access to substantial amounts of capital in the form of private venture capital and provincial government sources instead of support from the national government. Yet there are several disadvantages to this system:

- There's a predominant struggle for Chinese private firms in establishing a customer base and revenue. In contrast to the US, there is no equivalent of a Chinese NASA that serves as a large government customer.
- The lack of regulatory support means that private firms are not guaranteed market access in the same way that SOEs are.
- Chinese venture capital tends to have a shorter return on investment timeframe than their US counterparts. It is quite common to see smaller Chinese firms engage in revenue-generating activities outside of their business model entirely, such as education and marketing rather than launch, just to pay back investors and stay open.
- Chinese commercial space firms struggle on the global marketplace, as they do not yet have a clear role in initiatives such as Belt and Road. There also exists a lack of business acumen that prevents them from effectively engaging in the global marketplace compared to other national competitors.

Ian Christensen: Our big takeaway from dialog with US space stakeholders is that the motivations between private space sector development in China needs to be better understood within the US sector. The Chinese space ecosystem is more complex than widely recognized within US commercial space stakeholders.

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US-China Space Competition (Q&A)

China's Space Vision

What is China's grand vision for its space ambitions, and are there proposed timetables of those significant achievements?

Ian Christensen: At the government level, China has ambitious and well-articulated plans to develop its modular Tiangong space station over the next decade. The country also has a lunar exploration plan that will run through the 2030s, beginning with robotic missions and leading up to more complex robotic missions, finally culminating in human and crew presence, as well as scientific activities planned for Mars. Some government initiatives will also be included in the Belt and Road Initiative, which will leverage satellite infrastructure as part of development.

The US has ambitious long-term plans, including the Artemis program, which aims to bring the US and international partners back to the moon in the 2030s. As both countries have these long-term plans, the divergence begins in the different political and economic systems related to implementation.

Shawna Pandya: One could perceive space development as a form of economic advancement. Infrastructure development for nations — whether it is launching observational satellites or more advanced initiatives — is an essential form of investment. Yet these programs involve trust, and space exploration can turn competitive: a satellite, for instance, can be said to be used for disaster response or other, more strategic reasons. This is an area that remains to be understood and which is nervously being navigated between the US, China, and other parties. The Cold War and space race were historical lessons demonstrating that behind the achievements of humanity, there are fraught questions of security, intelligence, and interests that need to be addressed.

Malak Trabelsi Loeb: China is also developing its capabilities in the constellation satellite sector as well as quantum-based satellites. The race to gain these competitive advantages is already there, and between China, Russia, and the US, the country that implements quantum technology in satellites will hold a key advantage. This tension will continue in the future, and while the US will try to be the first in gaining this competitive advantage, China and Russia are working together as healthy competition to the US.

Space Development and Security Interests

As a quantum technology race in the name of national security interests takes place, what are ongoing concerns regarding China's development of quantum technology that may be weaponized in connection to their planned satellite constellation, as well as their plans to build an international lunar base that could assist in their interplanetary exploratory ambitions?

Rob Ronci: While the security implications of a quantum satellite range remain unclear, one could argue that the establishment of China's lunar base should is not the most worrisome

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threat. Concerns over China's lunar ambitions reflect the US's current lack of long-term strategic space ambitions. It is unrealistic to suggest that presence on the moon would be hugely lucrative; on the contrary, it is an expensive and challenging endeavor. As of right now, China's plans to establish an international lunar base are not an immediate threat.

Ian Christensen: The strategic advantage of military installations on the moon is questionable. From a legal and treaty standpoint, a military installation on the moon is a clear violation of international law, and many nations, including the US, would be opposed to such developments. Moreover, the rhetoric surrounding the US Space Force and other discussions on long-term ambitions tend to remain on the dramatic side and not necessarily reflecting their true missions. It is likely that competition and friction will take place in "boring areas." that only specialists will find fascinating.

Shawna Pandya: Presence on the moon — and beyond — is generally understood as a matter of pride rather than economic benefits. It's able to say, "We did this first. We're ahead of the game". Despite the resources that could be at stake — whether helium, precious metals, or others — space exploration is a show of superiority even in the absence of immediate economic return.

Rob Ronci: Yet there is the risk that focusing on these types of discussion distracts from a more near-term economic competition that exists in the terrestrial aspects of the space economy. Some of these include supply chain interactions and the development of these large global constellations where geospatial competition does not exist and several markets involve national security interests. This near-term competition will, directly and indirectly, affect economic development.

Shawna Pandya: Indeed, this competition will be defined by subtle boundary-pushing. As opposed to overt moves such as establishing military bases on the moon, strategies could be more in the form of maneuvers that are non-military in nature, yet which subtly push the boundaries. A way to achieve détente in this space competition will also be needed. The tensions and near escalations that defined the 20th-century risk playing out once more in the 21st century, and we must look for collaboration and to work towards the world which we would like to see in the long-term future.

Where does this information asymmetry regarding space development in China and the US come from? Is it primarily about China's choices around transparency?

Rob Ronci: There are several reasons. Firstly, unlike the US in many regards, China does not publish figures. Secondly, language plays a role, whereby Mandarin-only sources are inaccessible to many who are not proficient in the language. Finally, the great firewall and China's information ecosystem means that information is difficult to access outside the country.

American companies tend to be more transparent about their plans and long-term goals, whereas Chinese companies may not be. In general, the asymmetrical understanding of China is

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a complicated problem, but it is essential to try and access information on the Chinese space industry.

Malak Trabelsi Loeb: The business culture plays a role too, where a newcomer in the space industry in China and elsewhere finds it challenging to understand the landscape. There is a lot of discrepancy and issues in the national intake of data, for instance. Fake satellite accounts data now appear in the US, and it is important that numbers and data within space reports are reviewed and ensured for accuracy.

What are the differences in ambition between the United States and China, and do both nations have long-term strategies?

Ian Christensen: Both countries have long-term ambitions, yet the actors, the viability of their plans, and the criteria by which their success is judged are different. The US government has long-term space exploration plans, including the Artemis program, long-term cooperation with the International Space Station, and commercial initiatives such as SpaceX and Boeing, both of which are done with a view towards long-term planning. The titans of the American commercial space industry, including Elon Musk and Jeff Bezos, are thinking with hundreds of years in mind, and such long-term views are driving the sector at large. And the initial success of companies such as SpaceX is apparent.

China also has long-term ambitions, which should be evaluated from technical standpoints along with assumptions as to their motivations. I believe some of China's space activities' goals are understood, but other goals remain unclear.

Competition in the Space Sector

Will the new presidential administration in the US benefit space activities, placing the country on a long-term trajectory?

Shawna Pandya: The US wants to create a safe world for their citizens' economic interests, and the Biden-Harris administration is seeking to return the US's status as a world leader and global peace broker. Though very different compared to the US, China's approach also seems to be conducted in an attempt to secure its place in the world. Both nations seek security, and both have dreams – the American dream versus Xin Jinping's China dream. Though they're going about this in very different ways, where one is more supportive of autonomy and democracy than the other, the end goal appears to be the same: security.

What could the future of US-China competition look like in the production of satellites, satellite components, as well as services such as launchers, observation data, and internet service? How will the future of supply chains for the US and its allies look like?

Rob Ronci: The Biden administration is looking to recreate the US's supply chain and reinvigorating the manufacturing sector. COVID-19 has exposed several weaknesses, and the

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goal of technological independence and supply chain independence is being pursued by both the US and China.

Our research has concluded that much of the innovation and production in this industry have shifted from the US to China. And as the US diversifies its supply chains, some have expressed concern that competition in these sectors and supply chains may decrease prices for all space services and technology. In other words, diversifying supply chains away from China may result in less desirable outcomes for everyone.

Shawna Pandya: Current trends in geopolitical relationships may mean that tensions will escalate before a détente is possible. This is true even with the new US administration. In the current state of affairs, the neutral ground will be vital, and the example of the International Space University — where international cooperation has been very successful and shows the potential of education as serving such a neutral purpose.

In the case of supply chains, it may be the case that countries become more insular, with greater reliance on homegrown supply chains as well as restrictions on critical technologies, intellectual property, and know-how to maintain national security interests.

With the changing nature of US-China relations, how can American space institutions — both government and commercial — change to remain competitive with China's space industry?

Shawna Pandya: Seemingly innocuous collaboration, even in the educational realm, could become involved in the competition. Project Possum, as a bioastronautics nonprofit organization which I am a part of, is one example. Despite the international and collaborative nature, the organization has not had a Chinese participant yet; and in moving forward, we will have to learn how to break down initial barriers as well as realizing that innocuous collaboration opportunities have to be viewed with every possible scenario in mind.

Ian Christensen: The space community should be more open to engagement with Chinese entities. Engagement is an opportunity to learn more, to understand better, to build personal cultural connections. While cooperation may not be the appropriate step right now, there is value in building better understanding, better communication lengths, and better interpersonal links.

Are China's space ambitions a source of pride for Chinese citizens in the same way that NASA is a source of pride for Americans?

Rob Ronci: In China, research has shown that the Chinese citizenry is more excited about space than US citizens are now towards their program. More children wish to be astronauts, and culturally, space ambitions form a very significant part of the rejuvenation of the Chinese identity. There are many similarities in their views of the long-term direction, ambitions, and desired outcomes regarding the two countries' longer-term space ambitions. Both the US and China wish for space expansion to benefit their national endeavors, but both are pursuing their goals in entirely different ways.

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The US is often concerned that frequent switches in presidential administrations weaken long-term visions: in other words, the political system does not necessarily encourage long-term thinking, whereas China is perceived as having long-term stability in its strategy. Yet, the private sector plays a large role in the US, and entrepreneurs think on a long-term basis. There is an underlying instinctual goal to make the space industry grow and expand while becoming profitable.

Closing Thoughts

Shawna Pandya: A rather realist view has been taken in regards to both the US-China relationship as well as relations between US partners and Chinese allies at large. These relations are shifting, and it is essential to cautiously approach this and the future of these relations. We should ask ourselves about the desirable future for all parties in the next few decades and 100 years. How will the US-China relationship be like, and how do we avoid the next tense geopolitical standoff?

Malak Trabelsi Loeb: In the space industry, private actors should have a bottom-up approach to find a consensus for how to conduct competition without deteriorating the future use of space. The long-term sustainability of space is one significant aspect. Firstly, much environmental protection is needed. In addition, an ultimate goal of achieving space economy sustainability is essential: in other words, keeping space for peaceful purposes and development without deteriorating the environment. Private commercial actors can try to achieve this goal while balancing national interests and the competition between nations.

Rob Ronci: Current considerations on space and competition between the US and China often draw comparisons to the Cold War. That era demonstrated that the most significant events and troublesome parts were misunderstandings and a lack of communication. During the Cold War, many of the most effective episodes came about due to communication — even during conflict or tension — to better understand the situation. This is our mission in trying to understand the other side through increased efforts of direct engagement.

Ian Christensen: The future of the space economy in the next decades will be defined by decisions made by China and the US, either together or separately. Even in the midst of values competition, economic competition, strategic competition, it is possible and beneficial to find shared understanding and even some errors of shared interests. It behooves our global community to be open to that possibility and to have these conversations.

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