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More-than-Human Space Diplomacy: Assembling Internationalism in Orbit

William Stewart | ORCID: 0000-0003-1953-6430
Doctoral Student, Department of Geography, University College London, London, UK
william.stewart.19@ucl.ac.uk

Jason Dittmer | ORCID: 0000-0002-1022-4978
Professor of Political Geography, Department head, Department of Geography, University College London, London, UK
j.dittmer@ucl.ac.uk

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Summary

This article explores the role of materiality in space diplomacy through the example of orbital docking technology by tracing its evolution from the early days of the space age to the International Space Station — and beyond. Drawing on the use of assemblage theory in political geography, this article argues for a 'more-than-human' approach to space diplomacy to supplement and provide an alternative to conventional approaches to diplomacy studies. By conceptualising the International Space Station as a *diplomatic assemblage* with which the multinational partners become enmeshed, we investigate how materials, specifically androgynous orbital docking technology, fostered co-operation and peace in the wake of the Cold War and which continues today.

Keywords

space diplomacy – assemblage – materiality – co-operation – International Space Station (ISS)

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1 Introduction

The International Space Station (ISS) has been a remarkable political and diplomatic success — particularly considering past and present terrestrial disagreement between two of the station's main partners: the United States and Russia. The ISS, originally Space Station *Freedom*, was proposed by US President Ronald Reagan in 1984 as the United States' response to the Soviet Union's successful space station programme.[1] Conceived during a tumultuous time in Cold War relations, the eventual partnership represents the continuation of close relations in the space domain — starting with the International Geophysical Year 1957-1958 (IGY) and continuing to this day. While terrestrial diplomacy between the superpowers during and after the Cold War has often been framed in terms of rivalry and competition, in the space domain relations have been remarkably amicable. Successful diplomacy is crucial to keeping outer space a realm of relative peace and co-operation. However, the ISS is nearing the end of its operational life, relations between the station partners are volatile and the number of actors in orbit has increased since the launch of the first ISS module in 1998.

The changing dynamics of the space domain — the 'new space race'[2] — necessitate a re-evaluation of the role of space diplomacy in the 21st century. Notably, as more state and non-state, or NewSpace,[3] actors are operating in orbit and beyond, the possibility of conflict may increase. As noted in the introduction to this special issue, the processes and mechanisms of space diplomacy are important for ensuring orbit and outer space are utilised peacefully. While the fields of International Relations (IR) and diplomacy, space or otherwise, tend to view states as the primary actors,[4] we draw on the use of assemblage theory in political geography to explore the role of the *materials* around which space diplomacy emerges. In doing so, we conceptualise space diplomacy through the framework of a 'more-than-human diplomacy'[5] and trace the forces that shape co-operation and collaboration in the space domain.

Michele Acuto and Simon Curtis argue that thinking IR through assemblage theory can 'help to further destabilize reified meaning and anthropocentric rationalities'.[6] Within IR assemblage, materiality and the more-than-human

1 Lambright 2019.
2 Cross 2019; Cross and Pekkanen 2023.
3 Valentine 2012; see also Shammas and Holen 2019, 10.
4 Riddervold and Newsome 2021.
5 Dittmer 2016.
6 Acuto and Curtis 2014, 9.

have recently been given greater attention through critical security studies,[7] although engagement in diplomacy studies has been limited. Jason Dittmer explicitly joined assemblage thinking with diplomacy studies, trying to reorient the field to consider more-than-human diplomacies.[8] As our collective engagement with the space domain evolves, so too should our academic disciplines adapt. Audra Mitchell critiques IR's ability to adapt to the 'earthly ruptures', such as climate change and other existential threats to humanity, that 'puncture and deflate the globe' on which the discipline is founded — while advocating for a more interdisciplinary approach to IR.[9]

Drawing on the mechanisms from which diplomacy is facilitated, we build on assemblage approaches to diplomacy and boost them into orbit — flattening the otherwise striated and hierarchical relations between the human and non-human in space diplomacy.[10] We conceptualise the development of co-operation and collaboration in outer space as mutually constituted through interactions between materials, diplomacy and state actors such as national space programmes. As noted in the introduction of this special issue, the resilience of mechanisms of space diplomacy may provide greater insight into how likely it is that co-operation in the outer space domain will continue — or that a rupture in co-operative relations is on the horizon.[11] Despite current terrestrial tension between the ISS partners, and bellicose proclamations from Dmitry Rogozin, former Director General of Roscosmos, regarding the future of the station,[12] there remains a tenuous peace in orbit. The mechanisms of space diplomacy — communication, persuasion and bargaining — play a crucial role in the continuing co-operation on the ISS as well as the fostering of relations leading up to the station's inception. That the ISS, and the space domain more broadly, have proven fruitful for international scientific co-operation[13] is a testament to the informal diplomacy and communication channels of the global scientific community.[14] Ongoing terrestrial conflict continues to strain these relationships,[15] but by focusing on the material — and

7 See, for example, Frowd and Sandor 2018; Salter 2015, 2016; Tammi 2021.
8 Dittmer 2015, 2016, 2017.
9 Mitchell 2019, 61; see also Burke et al. 2016.
10 Wille 2016; McConnell and Dittmer 2018.
11 Cross and Pekkanen 2023; for a wider discussion on space as an environment for international co-operation see Johnson-Freese 2007 and Moltz 2019.
12 Yang 2022.
13 Mauduit 2017; Payette 2012; see also Krasnyak 2018.
14 Frehill and Seely-Gant 2016; Stroikos 2018.
15 Witze 2022.

institutional — enmeshing of state actors in a diplomatic assemblage, there exists the possibility for co-operation and peace.

This article explores the historical evolution of American and Soviet/Russian co-operation and interoperability in the space domain, focusing specifically on space diplomacy and orbital docking. We advance the literature on space diplomacy by showing how a focus on materials and interoperability, in this case androgynous orbital docking technology, can supplement orthodox interpretations of diplomatic events. Further, building on the contention that, although IR scholars have recently begun to account for the crucial role of material infrastructures in world politics, 'consideration of space-based infrastructures and technologies has remained largely peripheral',[16] we trace the evolution of orbital docking technology from its Cold War roots to its current iteration on the ISS and its role in fostering co-operation — materially and diplomatically. As we demonstrate in this article, early Cold War co-operation and interoperability between the United States and USSR, and later Russia, on orbital and space-based projects laid the foundation for what would become the ISS. As a result of the cost and complexity of operating in orbital space, the United States and Russia became enmeshed in a *diplomatic assemblage*, one that transcends terrestrial disputes and represents a focal point on which ultimately peaceful negotiations converge.

By bringing assemblage theory into dialogue with diplomatic studies and IR more broadly, we highlight the critical role that the technical materials of space-based infrastructure play in fostering post-Cold War diplomatic relations between the US and Russia. As global and regional events continue to challenge relations between Russia and the West, the union between the ISS partners necessary to keeping it operational requires communication and interoperability. Examining how peace in outer space has been normalised in recent decades allows for analysis which seeks to replicate those conditions on Earth. Further, by highlighting materials and interoperability, we signal an alternative and additional focus around which co-operation can cohere and develop.

As a crucial technology in the development of space operations, docking mechanisms allow spacecraft to safely link up in orbit. The first successful — but not unproblematic[17] — orbital docking took place on 16 March 1966 between an American Gemini-crewed spacecraft and an uncrewed Gemini Agena target vehicle (GATV) developed to allow the National Aeronautics and

16 Peoples and Stevens 2020, 294.

17 Due to a thruster malfunction the Gemini spacecraft was put into a rapid spin and, once control was regained, the mission was terminated earlier than scheduled.

Space Administration (NASA) to practise orbital rendezvous and docking.[18] Early orbital docking — including Gemini–GATV — primarily used the non-androgynous probe-and-drogue (or probe-and-cone) method with an active 'male' probe and passive 'female' drogue. Prior to the 1975 Apollo–Soyuz Test Project (Apollo–Soyuz), both the Soviet Union and the United States were developing alternative androgynous systems of docking in orbit to allow for spacecraft to dock with another spacecraft more easily. For the Apollo–Soyuz orbital docking, or 'handshake in space', Soviet and American engineers worked together to develop an androgynous docking method that allowed two otherwise incompatible spacecraft to dock on equal terms.[19] This was historic not only because the two Cold War adversaries worked closely and collaboratively to perform the first orbital docking between two nations but also because the co-operation and technology developed during the Apollo–Soyuz became foundational for the construction of the ISS.

This article proceeds by first reviewing the literature on assemblage, diplomacy and interoperability, focusing on the diplomatic and technological relations through which the United States and USSR/Russia became entangled through the space station programme. The ISS represents a noteworthy event in both engineering and political history. It is necessary to incorporate both in a relational and non-hierarchal analysis to think through possible co-operation both terrestrially and in orbit. Following a brief discussion of methods, we then move to our empirical and conceptual contributions.

2 Approaching More-than-Human Space Diplomacy

In this literature review we conceptualise the ISS as a *diplomatic assemblage*, first examining those words individually (in reverse order), with the aim of detailing how the genesis of the ISS, specifically the androgynous docking method and system, is a valuable example of a more material form of diplomacy than is traditionally examined.

By assemblage, we mean that the ISS is produced out of the mutual intra-action of various bodies, objects and procedures,[20] through which the ISS emerges as a piece of infrastructure with certain capabilities,[21] namely the

18 Grimwood, Hacker and Vorzimmer 1969, 235-236.
19 For a more in-depth discussion of the Cold War gender politics of the Apollo — Soyuz see Jenks 2022.
20 Barad 2007.
21 DeLanda 2006.

ability to sustain life beyond the atmosphere and to host scientific research. Colin McFarlane describes assemblage theory as a school of thought that 'seeks to describe the labour through which relations are held together and how novelty emerges through interaction, and aims to identify the potential for those relations to be otherwise'.[22]

While the concept of assemblages remains much debated, Martin Müller outlines five general characteristics.[23] Firstly, assemblages are formed by a constellation of elements coming together with relations of exteriority, with each affected at least slightly by its participation in the assemblage. Because the elements are themselves outward facing, both affecting and being affected, the overall assemblage is likewise enmeshed in relations of exteriority that provide vectors of affect capable of buffeting the assemblage. With regard to the ISS, we might think of its composition via a range of modules that are launched into space and plugged into the existing ISS to bring about new capabilities. We might also think about the balance of heavenly bodies' gravitational fields, which allow for the ISS to remain in orbit, or the solar panels whose material composition allows for the production of energy sufficient for the ISS's needs. These are all examples of relations of exteriority, a hallmark of the ISS despite its crucial function in separating the interior habitat from the extreme environment outside.

The second characteristic of assemblages flows from the first: because assemblages cannot wall themselves off from the external environment completely, they are constantly in flux and generating novel forms. Assemblages are always becoming otherwise, even when they seem stable and coherent. This stability is a function of the thresholds of human perception — both micro and macro — rather than an expression of the actual nature of the assemblage. We might consider the ISS, then, not as a 'thing', but rather as a relational field into which new supplies are territorialised (fresh astronauts, food, replacement parts) and from which waste materials are deterritorialised (carbon dioxide, human waste, worn-out astronauts) in various ways.

The third characteristic of assemblages is that they are material. That is, while discourse is absolutely important to understanding the trajectory of assemblages, they must have at least some material elements, and these material properties are crucial to understanding the way in which the assemblage evolves. For instance, as described earlier, the development of an androgynous docking mechanism allowed for non-hierarchical relations to form between the constituent modules of the ISS. These material elements interact with each

22 McFarlane 2011, 378-379.
23 Müller 2015.

other in specific ways, but because they are embedded in relations of exteriority these material elements are indeterminate in their capacities. An example of this characteristic from the ISS might be the properties of the human body; the living body has evolved to have specific limits of both temperature and pressure that make impossible its unprotected existence outside the Earth's atmospheric embrace. Therefore, the ISS is designed to maintain earthly parameters within its habitat. The human body in assemblage with the ISS habitat module enables new capabilities: ongoing life in a microgravity environment to conduct scientific experiments that would not be possible on Earth.

The fourth characteristic of assemblages is that — because of their relations of exteriority — they are impossible to definitively delimit. Empirical examination can of course indicate moments of relative territorialisation and deterritorialisation, such as when a ship from Earth temporarily coheres to the ISS via the docking mechanism, bringing new elements and taking away old ones; however, it is impossible to say where the ISS 'ends'. If the sun is crucial to the ISS as an energy supply, is it part of the ISS assemblage? What about the earthly apparatus that maintains the flow of supplies? It is not clear how to answer such a question. Where to make 'the cut' between the ISS and the rest of the universe is an act of coding and de-coding,[24] in which various elements are defined as either 'ISS' or 'non-ISS'. Rather, we can see various discursive efforts to delimit the ISS in one way or another as yet another relation of exteriority that shapes the assemblage. As there is no definitive 'outside' to assemblages, there is no place from which to objectively delineate them; rather, that is one of the many subjects of their diplomacy.

The final characteristic of assemblages is that they are marked by desire. That is, they have an internal drive to overcome their current state, what Nietzsche called a 'will to power'. In assemblage theory this is often referred to as self-organisation, with the constant flux of affects causing low-level mutations to the norm, many of which disappear as soon as they arrive but some of which push the assemblage into a 'new normal'. An example of this from the ISS might be the development of social media, which has produced a heightened everyday visibility for the ISS and which has changed the routines for astronauts and other ISS staff as they now produce daily content. Like much of the rest of society, the ISS has been optimised for 'likes', 'hits' and so forth.

By diplomatic assemblage, we mean the ISS does not fall under the jurisdiction or control of any single state but is rather a relational field produced by a range of state actors and the legal instruments they produce, and therefore it

24 The act of coding an assemblage 'refers to the role played by special expressive components in an assemblage in fixing the identity of a whole' (DeLanda 2016, 22).

can be understood as a diplomatic entity. The extent to which state actors and legal instruments become increasingly enmeshed in the ISS, and are considered the 'ISS', speaks to the extent that components are coded as international as opposed to distinctly national. For example, Russia detaching its section from the ISS can be seen as an attempt at decoding from ISS and recoding to Russian. Most obviously, the ISS is the result of ongoing diplomacy by not only the United States and Russia, but also the other states who have latterly joined the collective enterprise. The history of this diplomacy is relatively well documented, at least regarding the origins of the ISS,[25] and it is intertwined with the geopolitical history of the Cold War's denouement and the era of globalisation. This is a diplomacy that locates agency in humans, either in the form of states or in individual diplomats' rhetorical or discursive performances.

However, our vision of diplomacy — augmented by assemblage theory — points in new directions. The 'communication, persuasion and bargaining' cited in this special issue's introduction here take new forms, not replacing the anthropocentric mechanisms but existing alongside them. Our notion of diplomacy is not limited to human action but includes all infrastructural or material connections between states. Communication here refers to the establishment of a field of relations through which both messages and affects can circulate. This necessarily requires a medium for communication, the materiality and technical form of which are central to the specific circulation of messages and affects. Think, for instance, of diplomacy on Twitter and how it differs from a private meeting in an embassy. Persuasion and bargaining refer not to tactics in negotiation, but rather to the ways in which political subjectivities are remade through their enrolment and participation in diplomatic assemblages. The 'I' of negotiation is replaced by the 'we' of becoming otherwise together. Here, communication, persuasion and bargaining indicate not two (or more) separate interlocutors engaged in negotiation or collaboration (although there can be that too). Rather, they refer to the making of a collective subject via the material infrastructure underpinning the assemblage. In short, thinking about the space diplomacy of the ISS requires thinking about materials and how they shape the field of relations.

Central to these material infrastructures is the development of interoperability. As states became connected through denser networks of relations, Andrew Barry noted the pressures on states to harmonise their technical practices.[26] In traditional diplomacy there emerged, for example, the concept of 'protocol', which established common procedures and expectations for

25 McCurdy 1990; see also Payette 2012; Krige, Callahan and Maharaj 2013; Jenks 2022.
26 Barry 2001.

diplomatic encounters.[27] These common procedures and expectations evolved into norms out of many unscripted encounters, before eventually being codified in international law. It is clear that the production of interoperability is necessary to facilitate diplomatic relations, whether between two states, two pieces of space equipment or two pieces of space equipment produced by different states.[28] For this reason, our analysis focuses on the androgynous docking system that underpins the modular politics of assemblage on the ISS.

The insights of assemblage theory also point us to deeper understandings about interoperability. Brian Massumi has, following Spinoza, described affect as 'the capacity to affect and be affected', further elaborating that '[t]o affect and to be affected is to be open to the world, to be active in it and to be patient for its return activity. This openness is also taken as primary. It is the cutting edge of change'.[29] Therefore, to create a protocol — to negotiate interoperability — is to lay yourself open, in some way, to the political affect of your partner. When two (or more) things/states/people are oriented towards one another in this way, they become something different, what John Protevi has dubbed a 'body politic'.[30] Neither element remains untouched by the relation, with processes of political cognition altered in all participants. Nevertheless, efforts can be made to modulate affect through either technical design or the bureaucratic governance of bodies. For instance, many foreign ministries attempt to protect their diplomats from 'going native' at a foreign posting by rotating them from one location to another after a set number of years, at great cost in terms of loss of local expertise, language skills and so forth. This is deemed an acceptable price to pay to maintain the perceived integrity of the foreign ministry's body politic. However, one of the benefits of Protevi's reframing of the body politic from Hobbes's more functionalist formulation is that it enables conceptualising bodies politic that are not congruent with the nation state but instead transcend framing by a single sovereignty that directs its activities. The ISS provides just such a scenario.

To be clear, we are not dismissing the agency of humans in our analysis. Even though they are not fully autonomous subjects, humans are the only parts of the assemblage that are capable of reflexive action, attempting to direct assemblages towards different ends. This a crucial difference between the human and the non-human. Nevertheless, human agency must be understood as enabled and conditioned by non-human elements of the assemblages

27 Sowerby 2016.
28 See Dittmer 2017, 2021.
29 Massumi 2015, ix.
30 Protevi 2009.

in which they are enmeshed, and so it is sensible to discuss agency as distributed through assemblages, with certain elements becoming more 'agentic' than others at particular moments. For example, following the Russian invasion of Ukraine in February 2022, the arrival of Russian cosmonauts wearing yellow and blue flight suits in March, intentional or not, suggested their opposition to the invasion, thus highlighting the circumvention of terrestrial tensions aboard the ISS.[31] In contrast, the controversial decision to display of the flags of the Luhansk People's Republic and the Donetsk People's Republic in July aboard the ISS led to a rare rebuke of the Russian Space Agency by NASA.[32] These incidents take on greater meaning as a result of their entanglement in the ISS assemblage and accentuate both the role of human agency and the relational and distributed nature of agency overall.

To summarise our perspective, we intend to trace out the diplomacy required to assemble — and maintain — the ISS as an international project. Whereas some have argued that outer space is a zone of peaceful co-operation as a result of the extreme environment, others have argued that the politics of outer space is an extension of terrestrial politics, with the same tensions and mistrust playing out in zero gravity. Our argument is rather different; we argue that the diplomacy of interoperability in outer space is unfolding in synchronic emergence with the wider diplomatic field, shaping actors' sense of their interests and capabilities. However, whereas past work on interoperability has tended to focus on the 'affective push toward solidarity and harmonization'[33] sparked when this work begins, this article crucially argues that this harmonisation is always partial and incomplete, with difference retained even within the critical infrastructures of space survival.

3 Methods

This research presents an account of interoperability and materiality in space diplomacy, specifically through the example of an orbital docking mechanism, the Androgynous Peripheral Attach System (APAS), developed to allow the Soviet Soyuz and American Apollo spacecraft to rendezvous in orbit. This research traces the evolution of APAS from its Cold War roots to its use on the ISS. Drawing on assemblage theory, the qualitative methodology used in

31 *Associated Press* 2022.
32 Davenport 2022.
33 Dittmer 2017, 84.

this research traces the human and non-human relations from which the ISS emerges as a diplomatic assemblage.

This research was conducted between August 2021 and March 2022. The research method for this article approaches space diplomacy from a subset of materials whose interoperability is crucial to orbital operations, specifically in-orbit docking, and how they became important to diplomatic negotiations from the Apollo–Soyuz Test Project through to the Artemis Plan. In consulting the NASA Technical Reports archive and NASA Headquarters History Division Collections Management database, we searched for references to orbital docking, androgynous docking mechanisms, interoperability and diplomacy. We consulted John Logsdon's two-volume reference work *Exploring the Unknown* for key documents related to NASA and human spaceflight.[34] We also drew on select memoirs, historical accounts and oral interviews by NASA historians, and secondary resources on NASA's human spaceflight programme and relations with the Soviet Union and Russian space programmes. The breadth of documents, from technical reports to oral interviews, attends to the essential role of a diverse array of actors and actants in a more-than-human approach to diplomacy.

NASA, and the US federal government more broadly, has a long history of preserving historical records.[35] Enshrined in the National Aeronautics and Space Act of 1958, which created NASA, is the mandate to make available 'the widest practicable and appropriate dissemination of information concerning its activities and the results thereof'.[36] Moreover, NASA played an important part in the development, growth and modernisation of archives and specialised libraries. Brett Spencer and Nancy H. Dewald write that the reconceptualisation of the library by early NASA leaders — such as Wernher von Braun and Melvin Day — 'would provide a launch pad for efforts to invent spaceships, satellites, and all the other technologies needed to reach the stars' and serve as 'a blueprint for the twenty-first century library, a library based more on bits and bytes and less on bricks and books'.[37] Thanks to their prescient efforts, archival research on outer space is freely and publicly available for researchers from across the globe. The NASA historical records, in conjunction with the digital archives of the Presidential Libraries, the US Department of State and the National Security Archive of the George Washington University, are the primary archives drawn upon for this research.

34 Logsdon 1995, 1996.
35 Launius 1999.
36 Logsdon 1996, 337.
37 Spencer and Dewald 2015, 310.

Researching diplomacy and technology is not without obstacles. NASA was famously reticent to part with technology and intellectual property,[38] and activity in, and the technology of, space has often been shrouded in secrecy, often due to their proximity to the military (a provision for which the National Aeronautics and Space Act accounts).[39] Further, the role of private contractors in triumph and failure is neglected in historical accounts despite their extensive contributions.[40] Finally, despite the role of freedom of information acts in making available otherwise closed-off archives and historical documents, these accounts are always partial and produced 'through the inclusion and exclusion of certain materials' and, as a result, control 'fact and fiction, truth and falsity, visibility and invisibility'.[41]

4 US–Soviet Outer Space Relations: Cold War Co-operation and Interoperability

In this section we narrate a historical oscillation between co-operation and competition in the space realm, which sets up our larger argument about technological interoperability and affects of co-operation in the section to follow.

International co-operation at the outset of the space age, notably between the United States and USSR, while at once 'enmeshed in the Cold War rivalry between the two superpowers', was at the same time 'a remarkable international scientific event and a global science endeavour' and can be seen as a form of scientific internationalism that carries on to the present day.[42] The October 1957 launch of *Sputnik*, while often understood as having ignited a combative 'Space Race', was 'formally a collective, international endeavor and some of the science needed to achieve it was being widely shared across countries'.[43] During a 1953 meeting of the Committee for the International Geophysical Year 1957-1958, the prospect of launching satellites into orbit was proposed and later announced simultaneously across the capitals of the participating countries.[44] The American National Academy of Sciences wrote that, as opposed to *Sputnik* ushering in a 'space race', the launch of orbital satellites

38 Krige, Callahan and Maharaj 2013; see also Sadeh 2004.

39 Gould 1986; David 2015; Jenks 2020; see Sections 102(b), 304 and 305 of the National Aeronautics and Space Act of 1958 (Logsdon 1995, 334-345).

40 Kay 1999.

41 Müller 2012, 14.

42 Stroikos 2018, 74.

43 Cross 2021, 391; for a more in-depth analysis of the Soviet Union's decision to launch *Sputnik* as part of the IGY see Siddiqi 2000.

44 Nicolet 1984, 316.

was a demonstratively co-operative part of the IGY, with interoperability of radio signals pre-negotiated.[45] Following the successful launch, US President Dwight Eisenhower publicly congratulated the Soviet Union on its successful launch, repeatedly emphasising that there was no space race with the Soviet Union.[46]

Kim McQuaid argues that the 'symbiosis between space races and arms races was more an elite than mass phenomenon'. The attendant *Sputnik* panic 'caused a political furore within portions of Congress and the executive branch after secret panels of national security advisers wildly overestimated Russia's current and potential rocket strength at the time'.[47] The 'space race' was arguably socially constructed by both politicians and the media.[48] Mai'a Cross argues that competition between the United States and USSR is subject to hawkish interpretation:

> even the most in-depth descriptions rarely mention the fact that as early as 1958, a US–Russian joint moon landing was a US bipartisan policy; or the fact that, as late as 1962, 47 per cent of Americans were in favour of space cooperation with the Soviet Union.[49]

Eisenhower noted that the launch of *Sputnik* was a known and planned part of the IGY, but the capability to launch an object into orbit became equated to long-range Soviet missiles in the minds of politicians and the media.

Following Yuri Gagarin's historic spaceflight on 12 April 1961, in a congratulatory telegram to Soviet Premier Nikita Khrushchev, US President John F. Kennedy expressed his 'sincere desire that in the continuing quest for knowledge of outer space our nations can work together to obtain the greatest benefit to mankind'.[50] Despite the Bay of Pigs invasion only days later, and the subsequent diplomatic fallout between the United States and USSR, the following year Kennedy proposed a partnership for lunar and solar system exploration, including crewed spaceflight.[51] Kennedy's message, however, was mixed: Congress rejected funding for any outer space partnerships in 1963 and, through the discursive creation of a missile gap and the space programme falling behind as a result of *Sputnik*, Kennedy 'precipitated a sense of threat

45 National Academy of Sciences 1957.
46 Eisenhower 1957.
47 McQuaid 2007, 376.
48 Cross 2019; see also McDougall 1985. Alternatively, for a history of the Soviet Union's human spaceflight programme and the space race see Siddiqi 2000.
49 Cross 2019, 1404.
50 Kennedy 1961.
51 Kennedy 1962.

that had not previously existed'.[52] That is, assemblages of space co-operation became coded by enmity, and new territorialisations of the national space programmes worked to exclude outside programmes and secure technological capabilities. The Cold War framing of hierarchical power relations came to dominate the previously horizontal coding of outer space co-operation.

4.1 *Apollo–Soyuz Test Project*

This coding of outer space as a realm of competition over hierarchy gradually came into question during the détente of the 1960s and early 1970s, culminating in the 1975 Apollo–Soyuz Test Project. Apollo–Soyuz was a high-profile attempt at demonstrating a 'space brotherhood'[53] between American astronauts and Soviet cosmonauts and saw the ideological rivals collaborate on a docking mechanism that allowed the two nations to link spacecraft together in orbit. This docking mechanism, APAS-75, was jointly designed by the Soviet and American space programmes.

The design of the androgynous docking mechanism served two roles. Firstly, it allowed the two space programmes to dock otherwise incompatible systems. Secondly, it offered an alternative to the non-androgynous docking mechanisms that materialised the period of hierarchy and competition in outer space design. The Gemini–Agena docking of 1966 was of the probe-and-drogue variety, which was problematic because of how it coded the docking in ways that embedded (gendered) hierarchy. Although the use of 'androgynous' is meant to sidestep the hierarchy of discretely gendered language, it keeps visible the overtones of sex and gender in space infrastructure design. APAS prevented disagreement about male–female coupling between the two spacecraft as neither side wanted to be seen as feminine.[54] Soviet engineer Vladimir Syromiatnikov, one of the main designers of the APAS system, recalled the complexity of using an androgynous docking mechanism:

> APAS turned out to be a hard nut to crack for us, its 'parents'. Indeed, there had to be good reasons, or again, as the Americans like to say, one had to feel strongly enough to take this kind of a long and difficult road. Even more so, since in both countries well-developed docking mechanisms had already been built and tested in space by that time.[55]

52 Cross 2019, 1416; see also Buono 2019.

53 For a discussion on 'space brotherhood' and the symbolism of Apollo — Soyuz see Ellis 2019.

54 Jenks 2022; see also Syromiatnikov 2005.

55 Syromiatnikov 2005, 395.

Syromiatnikov also hinted at the role machismo played in the decision, writing that his NASA counterpart Caldwell Johnson, perhaps jokingly, suggested the reason that engineers resisted the non-androgynous probe-and-drogue system: 'none of the countries wanted to play a female role in space before the eyes of the world'.[56] The probe-and-drogue method was problematic for two reasons: firstly, neither wanted to be seen as the feminine, penetrated, side, reflecting the patriarchal and aggressively masculine mentalities that shaped Cold War politics;[57] and secondly, adapting the spacecraft was technically and economically challenging.[58] The docking system and accompanying terminology were seen as possibly presenting a threat to the 'heterosexual vitality of the nation'.[59] The affective presence of machismo, or fear of being both materially and discursively penetrated and seen as subservient, was ever present during the Apollo–Soyuz negotiations. Fortunately, a different method was being developed by both nations' scientists: an androgynous interlocking capture system. The Apollo–Soyuz mission, and the APAS method developed as a result, however, ends up being both a first step towards interoperability and adaptation as well as a catalyst for enmeshing both sides in what became the ISS.

Apollo–Soyuz and the APAS that it produced ushered in new possibilities in space diplomacy and technological co-operation. Upon the successful docking of the two spacecraft, a message from Soviet General Secretary Leonid Brezhnev was broadcast to the crews stating that '[o]ne can say that the Soyuz Apollo is a forerunner of future international orbital stations'.[60] The non-hierarchical docking design enabled affects of trust and co-operation to circulate between the two spacecraft and also, crucially, between the two nations' space administrations. This new flat relation between them unlocked the possibility of further interoperabilities in future space collaboration.[61] Moreover, as Andrew Jenks writes, 'Apollo–Soyuz involved both the design of a docking interface between the Soviet and American space programs and, simultaneously, the building of an alternative, less adversarial, less militaristic, and safer relationship between the Soviet Union and the United States'.[62] Apollo–Soyuz, while not a wholly

56 Syromiatnikov 2005, 395.
57 See May 2008.
58 Ezell and Ezell 1978; see also Jenks 2022.
59 Jenks 2022, 90-91.
60 Ezell and Ezell 1978, 329.
61 Krasnyak 2018.
62 Jenks 2022, 17; see also Jenks 2021.

successful domestic political project for either side,[63] laid the foundation for future co-operation and interoperability while simultaneously countering the Cold War perception of a competitive and combative space race.

This affective push towards co-operation was not, however, overdetermined. Following the 1979 invasion of Afghanistan, US President Ronald Reagan ended the period of détente with the Soviet Union, exemplified by the phrasing of the 1982 National Security Strategy objectives: 'To contain and reverse the [Soviet Union's] expansion and military presence throughout the world' and 'To limit Soviet military capabilities by strengthening the U.S. military … and by preventing the flow of militarily significant technologies and resources to the Soviet Union'.[64] The re-territorialisation of technology and resources around state competition over hierarchy would come to play an important role in preventing early co-operation — and stand out as a testament to post-Cold War co-operation.

4.2 *Space Station* Freedom

Reagan deterritorialised the NASA space programme vis-à-vis the Soviet programme and instead re-territorialised it with the United States' traditional Western allies. This re-territorialisation also entailed a recoding of US space projects to be oriented around discourses of Western exceptionalism ('Freedom') while embedding a new hierarchy within the assemblage between the United States and its non-superpower allies.

In his 1984 address to Congress, President Reagan, having declared the Soviet Union an 'Evil Empire' the year before,[65] asked NASA 'to develop a permanently manned space station' and 'invite other countries to participate so we can strengthen peace, build prosperity, and expand freedom for all who share our goals'.[66] Christened Space Station *Freedom* in 1988,[67] the space station project represented a US-led collaboration of 'free world' partners and was driven by Reagan's fascination 'with big technology as a projection of national power, especially against the Soviet Union'.[68] The USSR at the time was itself projecting national power and prestige through the success of its human spaceflight

63 On the American side there was concern that the USSR would take advantage of the close co-operation on Apollo — Soyuz to acquire sensitive space technologies (Jenks 2020; see also Ellis 2019; Krige, Callahan and Maharaj 2013; Volf 2021).

64 Reagan 1982.

65 Reagan 1983.

66 Reagan 1984.

67 Fitzwater 1988.

68 Lambright 2019, 86.

and *Salyut* space station programmes as well as the development of the *Mir* space station, set to be launched in 1986. However, instead of a demonstration of American prestige, *Freedom* showed that large technical projects — especially in outer space — demand a high level of international co-operation and compromise. The possibility of assemblage to produce new capabilities greater than the sum of its parts was made clear to the US government.

During the *Freedom* phase, NASA and the United States were apprehensive about the transfer of sensitive technology, the protection of intellectual property and remaining in control of critical path development of the project.[69] The determination to impose a hierarchy on the project limited the role of international partners to merely supporting the *Freedom* project, a phase Eligar Sadeh terms 'augmentation'.[70] The US policy at the time was to restrict any activity that could be thought of as transferring NASA technology, and the other ISS partners were prevented from contributing to critical path technologies for the station. The United States was resistant to other parties becoming integral to the success of the mission — including pushing against interoperability and equal partnerships and maintaining hierarchical relations with its partners.

The American desire to control the territorialisation of the assemblage, including materials and technology essential to the project, prevented integration of partners into the space station, meaning *Freedom* remained merely an idea.[71] Instead of demonstrating American prestige and capability in outer space, *Freedom* ran into domestic political obstacles due to lack of progress, rising costs and funding reductions, multiple redesigns with decreased capabilities, and increasing delays.[72] The hierarchical and asymmetrical partnership of 'free world' countries on *Freedom* underlined the limitations of imposing strict control. The collapse of the Soviet Union and Russia's subsequent embrace of capitalism, as well as increasing American scepticism about *Freedom* and a new administration, then combined to open the space station assemblage to re-territorialisation and recoding, which allowed it to actualise in a new formation.

69 Lambright and Schaefer 2004.
70 Sadeh 2004, 175.
71 Sadeh 2004.
72 Kay 1994; Nixon 2016.

5 Post-Cold War Space Diplomacy: Co-operation Heats Up

On 17 June 1992 in Washington, DC, US President George H. W. Bush and Russian President Boris Yeltsin signed an agreement proposing, among other things, a docking mission between the American Shuttle and the Russian *Mir* space station, to take place in 1995.[73] The resulting project, popularly known as Shuttle–*Mir* or, alternatively, within NASA as the Phase 1 Program, was the first official step in re-territorialising the space station project around Russia. Shuttle–*Mir* 'represents the building block to create the experience and technical expertise for an International Space Station. The program will bring together the United States and Russia in a major cooperative and contractual program that takes advantage of both countries' capabilities'.[74] In conjunction with the Gore–Chernomyrdin Commission developed in the wake of US President Bill Clinton and Russian President Yeltsin's April 1993 Vancouver Summit, this agreement was the official diplomatic enmeshing of the two states in the newest iteration of the space station assemblage. The space station was always becoming in relation to, and reliant on interoperability with, Russia and its space-based technology — which started with APAS and Apollo–Soyuz.

The Gore–Chernomyrdin Commission formalised the partnership between the United States and Russia on the space station. This step can be seen as the actualisation of the ISS as a diplomatic assemblage, rather than the US-dominated *Freedom*. Further, changing the name to emphasise the 'international' as opposed to the propagandistic *Freedom* created conditions in which the partners became discursively encoded into the assemblage and challenged the hierarchal nature of the Reagan-era proposal. Previous co-operation on the space station programme, notably in the early stages of *Freedom*, was characterised by diplomacy via agreements and memoranda of understanding. Bringing Russia in advanced the project via an injection of expertise, as well as the material absorption of Russia's *Mir 2* project into the assemblage — a key step in the actualisation of the ISS and in building trust between the two states. As John Krige, Angelina Long Callahan and Ashok Maharaj note, '[t]he architecture of the ISS was accommodated to incorporate Russian elements into technologies that were critical to mission success'.[75] This module, originally intended for a future Russian space station, today serves as the heart of the ISS.

73 National Aeronautics and Space Administration 1993, 105-107.
74 Nield and Vorobiev 1999, 3.
75 Krige, Callahan and Maharaj 2013, 249.

The Gore–Chernomyrdin Commission paid homage to the success of Apollo–Soyuz, highlighting the affects of co-operation unleashed by the development of APAS, with US Vice President Al Gore remarking:

> the agreements that we signed here today, as much as they owe to the accomplishments of that competitive era, most clearly have their roots in the Apollo–Soyuz rendezvous and docking in July 1975. It was through this project that Russian and American space scientists and engineers, astronauts and cosmonauts first began to work together.[76]

In attendance at the signing were the two commanders of the 1975 Apollo–Soyuz mission, Russian cosmonaut General Alexei Leonov and American astronaut General Tom Stafford. Apollo–Soyuz and the development of the docking mechanism showed that co-ordination on space-based projects was possible between the two rivals. In a later statement by the Commission the process of co-ordinating the two programmes was laid out more specifically:

> All planned U.S.–Russian space cooperation programs are interconnected and have the common goal of creating an effective space-based scientific research complex earlier and with less cost than if undertaken separately. The United States and Russia are convinced that a unified Space Station can offer significant advantages to all concerned, including current U.S. partners — Canada, Europe and Japan. The U.S. and Russia will jointly develop a detailed plan of activities for such a Space Station.[77]

In a December 1994 Space Committee meeting, Gore remarked that the United States and Russia 'had demonstrated an ability to work together productively and that as a result US and Russian industry are also cooperating closely'.[78] In the same report, then-NASA Administrator Daniel Goldin stated that the two countries and their space programme experts were 'working as one unit', with several notable co-operative achievements, including joint astronaut — cosmonaut training and hardware incorporation. This highlights the depth of, and the necessity for, interoperability being imagined in the future.

Russian involvement in the ISS brought expertise in human spaceflight and orbital space stations as well as related technologies. Further, while the United States and NASA had partnerships with other nations and space programmes,

76 National Aeronautics and Space Administration 1994, 103.
77 National Aeronautics and Space Administration 1994, 105.
78 National Security Council and NSC Cables 2013, 115.

no other country had the depth and breadth of experience that Russia had — and that the United States wanted to keep contained. The involvement of Russia in the ISS, specifically the expertise of Russian rocket engineers, helped prevent the selling of knowledge and technology that could be used to develop missiles and other technology to states the United States considered adversarial.[79] Importantly, no other partner had successfully collaborated with the United States on as complex a project as Apollo–Soyuz. Prior to Russian involvement, the space station project was *real* but not *actual*,[80] and at times its virtual existence was in peril. The project, much like APAS itself, was subject to adjustments and adaptation.

5.1 *Shuttle*–Mir

In October 1995, several months after the signing of the initial agreement, the heads of NASA and the newly formed Russian Space Agency (RSA) signed an agreement detailing closer co-operation between RSA and NASA, including the use of a derivative of the original docking mechanism developed for the Apollo–Soyuz on the American-made Shuttle for docking with *Mir*.[81] The agreement also suggested that, if the use of APAS were feasible, the newly privatised Russian space industry (NPO Energia) would 'enter into a separate contract with an American company to provide, modify or integrate this device or its derivatives with the Shuttle'.[82] The Soviet Union already had two APAS-89 androgynous docking ports on *Mir*, but now that the US Shuttle was frequently docking with *Mir*, it was decided that a new docking module would be installed and would utilise APAS-95 for the Shuttle. The APAS-89 docking port was designed for purely Soviet use, whereas the APAS-95 was designed to work with Russian or American partners. This highlights how the materials of the space station assemblage were adapted to enable greater interoperability and facilitate a wider array of partners and configurations.

John J. Uri, co-chair of Phase One Mission Science Working Group, notes the role Shuttle–*Mir* played (despite, and as a result of, near-disaster) in integrating the two space programmes:

> Some of the unfortunate events we had, such as the fire and the collision, made us become even more aware of how the Mir systems operate, and, of course, we became much more integrated into the Russian system on

79 See Moltz 2019; Krige, Callahan and Maharaj 2013.
80 DeLanda 2006, 2016.
81 Logsdon 1996, 222-228.
82 Logsdon 1996, 224.

> the ground, in terms of working these problems and other issues. The shuttles became very integral in maintaining the Mir, in terms of resupplying it with new hardware for hardware that had broken, resupplying water. We also tend to refill them with air during the docking phases.[83]

This demonstrates not only that the production of interoperability via androgynous docking technology was necessary to overcome challenges, but also that unexpected events (such as the *Mir* fire) can erupt within diplomatic assemblages, providing affective boosts to co-operation (or, of course, to deterritorialisation).

5.2 *ISS: Adapters and Overcoming Incompatibility*

The historic 1998 International Space Station Intergovernmental Agreement (IGA) brought together the ISS partners and set forth the terms for co-operation and collaboration on the station, its construction, management and operation.[84] The IGA does two important things which both enmesh the partners in the ISS assemblage and formalise channels through which space diplomacy continues amicably. Firstly, it establishes the responsibilities and norms for operating a multinational space station and, as a result, affectively recodes relations not only between the space programmes but also between the states themselves. Secondly, it encodes a significant level of trust and dependence between the partners. For example, the material and infrastructural responsibilities of the partners are clearly laid out in the annex of the IGA.[85] Notably, eschewing the development of a means to re-boost the ISS, the United States is reliant on Russian Progress automated spacecraft to boost the orbit of the station — leaving the station vulnerable to deorbiting if Russia chooses to withdraw its participation in the station.[86]

The diplomatic negotiations of the 1993 Gore–Chernomyrdin Commission reverberate in the 1998 agreement through the determination to have Russia provide crucial initial infrastructure for the ISS — a decision which was not entirely popular:

> The Russians have consistently failed to fund and construct their elements of the Space Station. Consequently, construction of the Space Station has

83 Uri 1998.
84 Department of State 1998.
85 Department of State 1998, unpaginated.
86 A vulnerability former Roscosmos Director Rogozin has alluded to exploiting on social media; see Yang 2022.

> been delayed by one year and delivery of the Russian Service Module on time is highly questionable. NASA has sent the Russian Space Agency $60 million in 1998 and intends to send another $40 million before the end of the year. These funds are ostensibly for the purchase of Russian crew time and stowage space, but the funds are ultimately intended for further work on the Service Module. Although not yet approved by the Office of Management and Budget, NASA is currently entertaining the notion of paying the Russian Space Agency $150 million per year for the next four years to help pay for Russia's commitments to the Space Station.[87]

The decision to have Russia perform an enabling as opposed to an enhancing role on the ISS was as much a political as it was as a technical decision, alluding to the persuasion mechanism of space diplomacy. This hints at the notion of spillover,[88] or the hope that co-operation on the ISS might translate to 'generalized mutual trust'.[89] The ISS played a crucial role in communicating the importance of diplomacy in space, and its translation to terrestrial politics, by establishing a common task from which co-operation emerged. While the annex clearly and succinctly sets forth the material responsibilities of the partners, it is vague on specifics. As the US–Russian relationship, including their literal material relationships, had been previously established, the docking technology used to link their infrastructural elements drew on previous co-operation.

The androgynous docking method of APAS continued with the construction of the ISS. An APAS-95 on the initial module, *Zarya*, interfaces with a Pressurised Mating Adapter (PMA), PMA-1, that links the US Orbital Segment with the Russian Orbital Segment — in other words, the historical link to Apollo–Soyuz and androgynous docking is at the heart of the ISS. However, as the ISS, and the space domain more broadly, evolve beyond the initial big two — Russian and US — space programmes, so too does the materiality of orbital infrastructure. Although the use of androgynous docking does not make the leap from its US–Russia bipolar space legacy to the rest of the ISS partners,[90] the legacy of material co-operation for space diplomacy — tenuously — lives on. The legacy of the APAS design transmits to the Chinese

87 House of Representatives 1999.
88 Cross and Pekkanen 2023.
89 Su and Mayer 2018, 2.
90 The non-human spaceflight capable ISS partners use unpressurised berthing mechanisms as opposed to pressurised docking. For a comprehensive history of attaching mechanisms on the ISS see Cook et al. 2011.

space programme and the Chinese Docking Mechanism.[91] Further, the berthing technology in use on the ISS relies on the non-androgynous Common Berthing Mechanism (CBM)[92] developed specifically for the station while the ISS continued to use docking hardware procured from Russia,[93] distancing these decisions from the Apollo–Soyuz-era politics of symbolic hierarchy. This reflects the degree to which state and non-state actors become territorialised with the ISS and their material decisions shift from political importance to technical expediency. For example, the commitment to androgynous mechanisms was discarded, due to their 'unnecessary complexity, weight, development time, and expense', in favour of the 'male/female-type configuration' of the CBM.[94] The gendered designation of male/female thus still reflects the gendered and heteronormative discourse and politics of outer space.[95]

However, it would be a mistake to think that interoperability is achieved through a single technology. Rather, the development of one interoperable standard unleashes the need to make a range of other systems interoperable.[96] The complexity of the ISS necessitated the development of an array of docking (and berthing) mechanisms, some androgynous and some non-androgynous, in order to accommodate not only the different ISS partners but also the possibility of a new generation of state and non-state actors. Importantly, the growing number of stakeholders in the space domain has led to the need to develop standards that allow material interoperability and harmonisation among private actors as well as state-based space agencies.

5.3 *International Docking System Standard and Artemis*

In October 2010 the ISS Multilateral Coordination Board approved the International Docking System Standard (IDSS), 'a standard docking interface to enable on-orbit crew rescue operations and joint collaborative endeavors utilizing different spacecraft'.[97] The IDSS represents the most recent generation of space-based connection, while APAS has become a legacy system (still to be accommodated). The push for standardisation and interoperability via IDSS saw NASA develop the first US-built docking system since Apollo–Soyuz, the NASA Docking System. Justin McFatter, Karl Keiser and Timothy W. Rupp note

91 Pelton, Sgobba and Trujillo 2020.
92 Berthing, as opposed to docking, is done via external guidance by, for example, a robotic arm.
93 McFatter, Keiser and Rupp 2018.
94 Illi 1992, 282.
95 Griffin 2009; see also Casper and Moore 1995.
96 Dittmer 2017.
97 International Space Station Multilateral Control Board 2016, i.

that 'requirements of the new International Docking System Standard trace much of their heritage to the APAS',[98] while John Cook et al. observe that '[t]he common ancestor of most of these [docking and berthing] mechanisms is the APAS, which has roots in the Apollo/Soyuz program'.[99] The reverberations of Apollo–Soyuz and APAS live on in the design and development of docking standards today, linking Cold War-era space diplomacy to the present.

The development of the IDSS can be seen as establishing a set of technical and material norms to overcome potential incompatibility and foster interoperability. In a European Space Agency press release regarding the signing of the IDSS agreement, then-Director of Human Spaceflight Simonetta di Pippo is quoted as saying '[t]he IDSS is an outstanding example of international collaboration. We have developed a common language for docking systems to use the same "words" in space when it comes to work together',[100] echoing the communication mechanism of space diplomacy. Here, the development of a 'common language', whose roots can be traced back to APAS and Apollo–Soyuz, anticipates the need for a universal techno-material vernacular that both expects interoperability and allows 'the flexibility to design and build docking mechanisms to their unique program needs and requirements'.[101]

The assembly of the ISS was possible in spite of the incompatibility of systems (both docking and berthing). 'These systems have been developed by either the U.S. or Russia for their space programs and are not compatible, in spite of the fact that the basic technical drivers are the [*sic*] common'.[102] The evolution of in-orbit docking, beginning with Apollo–Soyuz and continuing with the ISS, led designers and ISS partners to realise that standardising and harmonising docking was crucial for future co-operative outer space plans. 'Many of the potential human space flight nations have docking systems and therefore creating a standard could ease integration of spacecraft from different nations — and the emerging commercial spaceflight companies'.[103] The IDSS shows the importance of materials, interoperability and the mechanisms of space diplomacy — here persuasion and arguing — in fostering closer co-operation and collaboration in the space domain.[104]

Reflecting the future of interoperability and co-operation in space, IDSS accounts for the design philosophy and policy goal differences of the partners

98 McFatter, Keiser and Rupp 2018, 4.
99 Cook et al. 2011, 56.
100 European Space Agency 2010.
101 International Space Station Multilateral Control Board 2016, 1-1.
102 Hatfield 2012.
103 Hatfield 2012, unpaginated.
104 Kerr 2010.

while keeping in mind the legacy of the original androgynous docking designs. The material designs of the IDSS are a political and technological achievement, allowing for the 'borderless' realm of space to be populated by a range of public and private actors in a co-operative fashion. The post-Cold War vision of outer space co-operation has become materially ensconced at the heart of the ISS, at least for now. With the ISS set to be retired in 2030, NASA is currently pursuing the Artemis Plan for lunar and Martian exploration, which includes the development of the Lunar Gateway space station. The Artemis Plan, and the accompanying diplomatic component the Artemis Accords, identifies interoperability as a core tenet, reflecting 'established practice in the field of international cooperation in outer space' that dates to Apollo–Soyuz.[105]

The enmeshing of the partners, legally and technically, in the ISS gives an affective push or imperative to ensure that the diplomatic assemblage succeeds. The legacy of APAS speaks to a historic moment that reverberates to this day. While the political optics of orbital docking are a remnant of the Cold War era, new challenges have arisen in its stead. The number and variety of spacecraft have increased in subsequent decades and orbit is becoming increasingly crowded.[106] For now, we rely on formal and informal diplomatic mechanisms to keep outer space peaceful. Further, as we have argued, foregrounding materiality, for instance through material institutionalisation and enmeshing of states in a diplomatic assemblage in the case of the ISS, sheds light on how co-operation continues despite contentious terrestrial politics.[107]

6 Conclusion

In an early assessment of post-Cold War US–Russian co-operation in outer space, John Logsdon and Ray A. Williamson found that the United States and Russia had 'considerable incentives to avoid linking political or military behavior to co-operative space work. They also want to use the International Space Station as a continuing symbol of cooperation between former adversaries'.[108] Since this assessment was made, the relationship between the United States and Russia has been increasingly contentious — both on and off Earth. Keeping co-operative space work independent from terrestrial military and

105 Deplano 2021, 803.
106 Moltz 2014.
107 Although co-operation on the ISS is currently threatened by Russia's assertion that they might withdraw support after 2024 (Ilyushina and Davenport 2022).
108 Logsdon and Williamson 1995, 44.

political behaviour has, at times, proven difficult. However, the United States and Russia, much like this article, have focused on the material and technological aspects of outer space and diplomacy to remain relatively hospitable. As Jean-Christophe Mauduit notes, '[t]here is therefore a growing need to further understand space diplomacy and how collaborating in space can help foster stable and long-lasting diplomatic relationships'.[109] Given the dual-use nature of space technology and increasingly crowded orbit,[110] fostering closer collaboration and co-operation in orbit through space diplomacy is a matter of urgent concern.

Understanding this space diplomacy as purely the product of agreements and commissions is to understate the role of materials as diplomatic actors in the wider inter-state assemblage. This account has foregrounded the role of material design from Apollo–Soyuz to the ISS, from APAS-75 to IDSS, to address the diplomatic affects of co-operation circulating through both the tight, enclosed and highly vulnerable spaces of the ISS and also the broader networks of US–Russian space co-operation from Star City, Moscow and Baikonur Cosmodrome, Kazakhstan to Space City, Houston and Kennedy Space Center, Florida. While US–Russian co-operation in space looks less likely in the near future, this does not diminish the diplomatic achievements of several decades past. All assemblages, after all, deterritorialise in the end.

What does this narrative say about the role of materials, interoperability and assemblage theory in space diplomacy? Firstly, a 'more-than-human' approach to space diplomacy highlights the role of materials in fostering co-operation and peaceful negotiations — specifically in the wake of the Cold War. Secondly, interoperability emerged from co-operation and, while rooted in the early IGY days of the space age, was solidified during Apollo–Soyuz and continued with the ISS. The story of orbital docking tells a wider story of working around problems and coming up with material solutions to political problems. Foregrounding the materials around which space diplomacy assembles tells a different story than that of a more 'people-centred' focus. Thinking of the ISS as a diplomatic assemblage opens up new ways of seeing how international partnerships, particularly those in the outer space domain and attentive to tangible material issues, form in spite of terrestrial conflict and where future peaceful co-operation might be productive.

109 Mauduit 2017, 4.

110 At the intersection of these issues is anti-satellite weapons testing and the accompanying debris that threatens not only orbital bodies such as satellites and the ISS but also the use of orbit in general as increasing debris and density of activity in orbit threatens potential cascading collisions in orbit called the Kessler syndrome (see for example Moltz 2014).

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William Stewart

is a doctoral student in the Department of Geography, University College London. His current research on the geopolitics of the International Space Station focuses on the diplomacy and politics of microgravity and life in orbit. His research interests include the politics of materials, outer space and popular culture. Before coming to academia, he was a military intelligence language analyst and Non-Commissioned Officer in the US Air Force. He has previously worked with the State Department Mission to the United Nations and the Department of Homeland Security.

Jason Dittmer
is a Professor of Political Geography and the Head of Department at University College London. His current research explores the role of materiality in geopolitics, diplomacy and heritage. He is the author of *Diplomatic Material: Affect, Assemblage, and Foreign Policy* (2017) and *Popular Culture, Geopolitics, and Identity*, 2nd edition (2019). His most recent work explores Gibraltar and its shifting role in empire.