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The co-production of nuclear science and diplomacy: towards a transnational understanding of nuclear things

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ABSTRACT

This paper proposes diplomatic studies of science as a new field of research, which sheds light on actual diplomatic processes as an integral part of knowledge making and presents the notion of nuclear science and diplomacy as co-produced. Science and diplomacy display fundamental similarities: scientists attempt to make knowledge produced locally seem global, thereby achieving universal epistemic order, while diplomats endeavour to maintain political order on a global scale that accommodates the local concerns of their country. In particular, the co-production of nuclear knowledge and political nuclear order has characterised the post-World War Two period. Hence, the making of global political orders includes the emergence of relevant diplomatic actors, which comprise not only sovereign states but also non-state actors, such as international organisations or individual experts. This paper claims that nuclear history provides a suitable ground for cross-fertilisation between the history of science and diplomatic history.

KEYWORDS

Nuclear diplomacy; science diplomacy; nuclear history; The International Atomic Energy Agency (IAEA); the Cold War

Introduction

Knowledge production in science and technology is fundamentally diplomatic. Over the past several decades, scholars in science and technology studies have developed various ways to understand the inevitably collective endeavours to produce seemingly systematic knowledge that people call ‘science’ and/or ‘technology’. Such endeavours involve negotiations, persuasions, compromises, alliances and confrontations, all of which are essential features of diplomacy. Diplomatic activities, in a broad sense of the word, are crucial in uniting individuals and groups, standardising terminologies and measurements, circulating knowledge, materials and personnel and coordinating activities. They are also key to making knowledge produced locally seem global and thereby worthy of the name ‘science’. As diplomats try to maintain a certain political order on a global level, scientists aim for a universal epistemic ordering of their knowledge claims.

This special issue explores how science and technology, being not only modes of knowledge but also human cultural practices that master and explain both natural phenomena and social matters, are inextricable from the diplomatic negotiations that shape them. The essays

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in this issue focus especially on the nuclear realm after World War Two. They bring to the forefront four important features of nuclear science and technology: 1) the growing presence of scientific and technical experts in diplomatic affairs; 2) the central role of international organisations, particularly the International Atomic Energy Agency (IAEA), in regulating and settling nuclear issues; 3) the political cooperation among nations as a precondition for any scientific collaboration; and, 4) the emergence of new actors, such as lawyers and insurers, with a strong say in formal diplomatic practices.

Given their highly international character, nuclear issues are particularly pertinent to diplomatic approaches to science and technology. Discussions about nuclear safeguards and the non-proliferation of nuclear weapons have monopolised international diplomacy for decades, and the effects of nuclear accidents can be global. Radiation risks, which respect no borders, require international regulation.¹ Nuclear materials and devices are trafficked across national borders while nuclear experts move around the world to negotiate foreign policy and uphold international relations.² In numerous ways, nuclear issues have significantly shaped diplomatic history in the post-world war period. This special issue invites us to explore the complexities of nuclear diplomacy and questions the instrumental use of nuclear science and technology in international relations. It further undermines taken-for-granted norms and practices of traditional state-led nuclear diplomacy and sheds light on unexplored diplomatic practices.

National governments and other policy making organizations have recently been intensely interested in science diplomacy. Behind this interest lies the use of science as an avenue for diversifying international dialogue and solving problems that resist traditional diplomatic avenues. Scientists' supposed impartiality – due their commitment to being objective and unbiased – opens doors and unravels Gordian knots that diplomats' negotiating skills often cannot. For example, in *New Frontiers in Science Diplomacy*, published by the Royal Society in 2010, the assumption about the role of science in international affairs is obvious: 'Science provides a non-ideological environment for the participation and free exchange of ideas between people, regardless of cultural, national or religious backgrounds'.³ A positivist understanding of the role of science and technology in settling international affairs exhibited by some policy makers undermines decades of research in the fields of science and technology studies and history of science that have highlighted the co-construction of science and society.⁴ Employing what may be called an 'instrumental model' for understanding science diplomacy, and by extension nuclear diplomacy, national foreign policies assume that science is value-free, neutral and universally rational, while its social, political and cultural aspects are silenced. Valued as a means to an end in an unequal relation to diplomacy – which is approached as a desirable end in and of itself – science works as a handy foreign-policy tool.⁵

The essays in this issue, however, argue that nuclear science and diplomacy have been co-produced throughout their intimate history. The authors provide a historiographical intervention into the understanding of the relationship between nuclear science/technology and diplomacy that undermines the idea of science as innately neutral. Our ambition for this issue is to examine how knowledge-making in the realm of nuclear sciences is incorporated into practices of international order-making and how international diplomacy plays an integral role in the making and use of knowledge. This project is analogous to studies of what Sheila Jasanoff calls the co-production of natural and social orders.⁶

Indeed, some of the articles in her edited volume concern the co-production of science and international or global political orders.⁷ This is the direction that diplomatic studies of science aims at. However, instead of considering co-production of science and diplomacy as a subset of co-productions of natural and social orders and thereby bloating the already problematic category of 'social', we propose a separate field of study that pays a serious attention to diplomatic processes and roles of relevant actors. Accordingly, the contributors to this issue shed light on new actors and new sites of negotiation that became essential in ensuring a 'conceit of controllability and representation' in the nuclear realm.⁸

The papers in this issue decentre the nation-state as the unit of analysis and introduce new institutional players as well as novel methodological concepts, making extensive use of archival materials beyond those in the United States, the nation-state that has been the primary focus of most nuclear historiography. These papers also build bridges between the history of science/technology and a new diplomatic history that departs from formal political and institutional aspects of diplomacy by studying its wider social and cultural dimensions. We further seek to suggest a basis for collaboration between scholars and practitioners in developing '*diplomatic studies of science and technology*', referring to the research into significant features of scientific activity in state and non-state diplomatic settings and by diverse actors where science and technology arise as constituent practices. This newly emerging field embraces a worldwide shift among historians of science to thematise diplomacy and is informed by several ongoing collaborative projects.⁹

Rejecting a programmatic separation between science and diplomacy and the instrumentalist understanding of science in diplomatic practice suggested by government officials, the diplomatic studies of science and technology in this issue raise vital questions. How do science and diplomacy make sense to each other? How does each seek to shape the other, how is each shaped in this process? The power of post-World War Two nuclear history in this case is to expose the complexities of a tangled relationship between two intrinsically valued practices – science and diplomacy. Accomplishing scientific work continually involves articulating what diplomatic multinational and multilateral negotiations consist of, while the art of diplomacy becomes concretely embedded in the epistemic aspect of this work. How is this achieved? How has nuclear diplomacy been performed, by whom and where? What counts as nuclear diplomacy and who counts as a nuclear diplomat? These are the pressing questions that this issue aims to address. The various essays highlight the importance of international diplomatic organisations within the United Nations (UN) system in writing post-World War Two nuclear history, expose the significance of the material world and scientific objects in diplomatic practices, account for the diversity of locations that have served as sites of nuclear diplomacy, and recognise the plurality of state and non-state actors who play key diplomatic roles without belonging to traditional ambassadorial circles.

The essays published here are partly the result of two workshops held in Hayama, Japan in 2018 and in Athens, Greece in 2019. Coming together as historians of science and technology, diplomatic historians, scholars of international relations and representatives of international organisations, we realised that we have much to learn from each other when discussing nuclear history. On the one hand, historians of science and technology had discussed diplomacy and diplomats, applying their disciplinary conceptual tools to analyse nuclear diplomacy. Yet they customarily tended to black-box

diplomacy. On the other hand, diplomatic historians had typically essentialised science and technology, assuming its alleged neutrality. What proved necessary, and what this project supported, was a redefining of nuclear diplomacy and throwing new light on a concept that has evolved to become a catchy term of increasing importance to our world, gaining the attention of scientists and politicians at the highest level.

What is nuclear diplomacy?

In his 1965 book *Atomic Diplomacy: Hiroshima and Potsdam*, historian Gar Alperovitz points to the first instance of what he then called ‘atomic diplomacy’: US President Harry Truman’s disclosure to the Soviet Premier Joseph Stalin of the existence of a weapon of unusual destructive force during the Potsdam Conference in July 1945.¹⁰ Alperovitz was the first to suggest that the decision to use the atomic bomb had nothing to do with putting an end to the war by forcing a Japanese surrender; instead, the United States aimed to intimidate the Soviet Union by demonstrating the destructive power of their new weapon.¹¹ Atomic diplomacy in this case implied a nation’s concern in gaining an advantage in peace negotiations and controlling military power by using nuclear weapons. A two-volume history text used widely in US history survey courses also included an entire chapter on ‘nuclear diplomacy’ as early as 1960, giving attention to the Korean War as well as to the US arms race with the Soviet Union, popularising the concept of nuclear diplomacy within academia.¹²

Throughout the 1960s and 1970s, nuclear diplomacy primarily concerned the ways that sovereign states managed to survive the nuclear Cold War bipolarity through bilateral negotiations, conflicts and/or cooperation. We tend to agree with William Colglazier, editor-in-chief of *Science & Diplomacy* and former advisor to the US Science and Technology Adviser to the Secretary of State, in arguing that ‘science diplomacy really got its start in the modern era after World War Two over the issue of nuclear weapons’.¹³ Science diplomacy was primarily nuclear diplomacy that played an essential role in what happened in international relations. Historians have written volumes on the preoccupation of Cold War nuclear science and technology with state-centred activities, focusing especially on US political strategies. However, just as Paul Sharp complained about the neglect of diplomacy by scholars of international relations and international studies, very few historians of science systematically addressed diplomacy, and if they did, it was always on a macro level of institutional design and political state-based diplomatic norms.¹⁴

An early exception was John Beatty’s work on the Atomic Bomb Casualty Commission (ABCC), the joint Japanese–American effort to study the effects of atomic bombs, written in the mid-1990s. As Beatty makes clear, the ABCC was more than a scientific collaboration on an international level; it was a deeply diplomatic and strategic move to assist the United States in affecting Cold War geopolitics. To analyse the diplomatic aims of the ABCC comprehensively, Beatty scrutinised concepts such as the transnationality of science and international scientific collaboration. He moved beyond the macro level of sovereign-state diplomacy and focused on the micro level of the social practices of those scientists who implemented the United States–Japan Cooperative Science Program.¹⁵

Since Beatty's work, the body of literature relevant to nuclear diplomacy has grown enormously. However, most studies are framed by issues of international relations, transnational history and foreign policy on nuclear power or armament without thematising diplomacy. Roughly, the studies fall into the following two categories: 1) historical studies on the geopolitics and circulation of nuclear materials and devices as well as the international/transnational aspects of relevant scientific knowledge in the post-World War Two world; and 2) nuclear weapons' history and the historical formation of today's nuclear order.¹⁶ Generally, efforts to understand knowledge production in nuclear science and technology sideline or even ignore the importance of diplomacy, especially non-state diplomacy and the countless diplomatic practices associated with science and technology. The concept of diplomacy frequently appears as a designation of a certain foreign policy or associated with the end product of diplomatic negotiations rather than actual diplomatic practices.

Critiques of Alperovitz's aforementioned thesis on the diplomatic nature of the US 'decision' to use the atomic bomb in Hiroshima help to illustrate one possibility of future diplomatic studies of science and technology. Alex Wellerstein challenges the thesis by questioning whether there was a single decision to drop a bomb at all. Drawing on Michael Gordin's work, he suggests that the bomb was not dropped according to a grand plan based on future prospects but that it happened through many small, sometimes local, determinations without a long-term prospect.¹⁷ Our point in highlighting these contrasting arguments is that there is an asymmetry in the granularity of the narratives: while Alperovitz gives a detailed account of US diplomatic manoeuvrings toward the Potsdam Conference, Wellerstein and Gordin illuminate the process of choosing to use the bombs. Historians of science and technology today are accustomed to studying the day-to-day scientific practices of relevant actors. We should be able to apply similar analytical strategies to diplomatic practices and observe how scientific knowledge emerges through them. Rather than examining how the foreign policies and diplomatic considerations of a country shape nuclear knowledge, we are interested in studying how diplomatic processes and knowledge productions in nuclear matters happens together and/or shape each other.

The following essays propose a new conceptual framework that advances *nuclear diplomacy as emergent processes* by which state and non-state actors build and manage relationships on multinational and multidisciplinary levels, shaping themselves and nuclear knowledge at the same time. Such actors include scientific and technical experts, European Union administrators, international diplomatic organisations, scientific communities, lawyers and insurers and formal ambassadors, to mention a few. As Gabriela Soto Laveaga suggests, microhistorical studies on such non-conventional arrays of figures open up possibilities for reconfiguring spatio-temporal boundaries and uncover new dimensions of global knowledge circulation.¹⁸ Nuclear diplomacy shapes and is shaped by political and economic interests, geostrategic contexts, epistemic claims, technological products and materials and even the nitty-gritty details of knowledge production. The conceptual framework outlined in this issue, characterised by the co-production of science and diplomacy, is intended to suggest what might constitute a new academic field – diplomatic studies of science – on the crossings of the history of science/technology, international relations and diplomatic history.

Bridging the history of science/technology and diplomatic studies

Political scientist Brigitte Schroeder-Gudehus was among the first of her peers to argue that ‘in the arsenal of foreign policy, science and technology thus dominate the whole range of instruments from coercion to peaceful penetration, from domination to persuasion, from intimidation to elusive gestures of rapprochement and conciliation’.¹⁹ Surprised that, with only a few exceptions, the systematic study of foreign policies and international relations ignored the role of science and technology, Schroeder-Gudehus recognised as early as the late 1970s that science had been used as ‘a privileged tool of unobstrusive [sic] communication’.²⁰

Although this special issue endeavours to address audiences in the history of science and technology and science and technology studies more than diplomatic studies, it also attempts to rethink familiar disciplinary distinctions bridge disciplines. As science and technology increase their presence in diplomacy, historians of science and technology have much to offer to diplomatic studies. They can historically unpack technical aspects of science diplomacy that constitute a crucial part of key diplomatic issues and illuminate complex processes of international negotiations about nuclear knowledge and its materiality. In short, historians of science can provide an account of science diplomacy in action.

For historians of science, it is important to recognise that diplomacy is as much of an expertise as science and, therefore, requires as much unpacking, historical investigation and theorisation. For example, James Der Derian’s 1987 book *On Diplomacy* illustrates how much historians of science and diplomatic scholars have in common (and to what extent they differ).²¹ To understand what diplomacy is, Der Derian draws on both Karl Marx’s theory of estrangement and alienation and Michel Foucault’s genealogical approach. According to Der Derian, the genealogy of diplomacy goes back to what he calls ‘mytho-diplomacy’, and he identifies six consequent ‘interpenetrating paradigms’ that finally lead to ‘techno-diplomacy’. Key to his argument is that sovereign states are not a prerequisite for diplomacy but are co-constitutive, with both developing through estrangements from the original solidarity (the papal and suzerain systems).²² Historians of science are familiar with genealogical approaches because instead of setting a birthdate for ‘science’ (or any specific part of it) and initiating a historical narrative from that point onwards, they tend to begin with genealogical precedents of science or other related matters. While historians of science for the most part no longer employ grand intellectual historical (and Eurocentric) narratives, as Der Derian does regarding diplomacy, they consider it important to understand how an entity emerges, whether a technical object or a human individual; this approach bears some resemblance to Der Derian’s understanding of the emergence of sovereign states.²³ At least historians of science remain highly concerned with the co-production of science and social order, which shares many features with Der Derian’s notion of the co-evolution of diplomacy and sovereign states.

Given the parallelism of diplomacy and science, it is only natural that histories of both fields use similar theoretical concepts, such as practices, performativity, agency, actors, interest and (political) representation. For example, some international relations scholars draw on Bruno Latour’s recent writings to reconsider certain theoretical concepts in diplomacy.²⁴ Investigation of the co-production of science and diplomacy will further feed such cross-fertilisation.

The aforementioned comments by Schroeder-Gudehus, whose main concern was scientific internationalism and international scientific organisations, highlight another possibility of cross-fertilisation. Traditionally, diplomacy has been categorically concerned with negotiations between sovereign states, with classic textbooks on diplomacy generally focusing on diplomacy between states, though some mention international conferences and public diplomacy.²⁵ Only in the past few decades has more attention been given to diplomacy by non-state actors, dubbed as the New Diplomacy. In the New Diplomacy, non-government organisations and international organisations are recognised as prominent diplomatic actors.²⁶ However, mainstream diplomatic history continues to focus on state actors, though Schroeder-Gudehus's work has already suggested that science diplomacy is an area in which non-state actors have played important roles.

Regarding nuclear diplomacy, in parallel to the state-centred approach to the history of nuclear knowledge, international relations scholars and political scientists have analysed international affairs as the sum of activities of nations as they try to advance their position in the global geopolitical order using nuclear science and technology. The nation has remained the basic unit of analysis, with science viewed as a facilitator in diplomatic affairs and a promoter of national interests, although multi-national aspects of nuclear diplomacy and emergence of international organizations were already pointed out in the 1960s.²⁷ It is increasingly apparent that non-state actors play important roles in nuclear diplomacy. Recently, several historians of science and technology have incorporated non-governmental actors into nuclear diplomacy. For example, in her extended work, Gabrielle Hecht shows that to understand global Cold War technoscience, including nuclear knowledge, one needs to engage with it beyond the confines of national borders and study unusual actors in unexpected places.²⁸ Although not specifically related to nuclear diplomacy, John Krige's most recent work similarly aims at a transnational history of knowledge circulation and focuses on non-governmental actors when international exchange of knowledge is discussed.²⁹ The works of Hecht and Krige are part of a growing body of literature shedding light on the important roles played by non-governmental actors, for example scientists with international standing, private scientific or political organisations, such as the Pugwash Conference, or intergovernmental organisations, such as the UN and the IAEA.³⁰ Thus, nuclear diplomacy can provide fertile ground for studying the diplomacy of non-state actors.

Research directions

As historians of science, we are accustomed to addressing science and technology systematically, but we lack analytical rigour when approaching diplomacy. Similarly, diplomatic historians are able to elaborate on complex diplomatic processes but may feel uneasy analysing the role of nuclear science and technology in those processes. Eventually, all the authors in this volume took off their disciplinary shoes and analysed nuclear diplomacy as a political instrument employed by certain historical actors to influence nuclear world order and pursue particular interests.

In the first essay in this collection, Alexandros Kyrtis and Maria Rentetzi address the question of who – in addition to state diplomats – gained international diplomatic standing, and how through their study of third-party nuclear liability, which responded

to the excessive environmental risks that the nuclear industry introduced in the mid-1950s. Insurance policies quantify some crucial issues of nuclear power, including its long-term risk and economic viability. While insurance provides a focal point where all nuclear issues converge, it is also a greatly understudied subject in nuclear history. Hence, by tackling the topic, Kyrtsis and Rentetzi open many avenues for further research and bridge nuclear and insurance history. They introduce new actors, a group they call '*backstage nuclear diplomats*' – insurers and insurance lawyers, as well as the nuclear insurance pools they created – arguing that the nuclear diplomatic practices of the 1950s and 1960s have been strongly defined by the attempt to formulate third-party nuclear liability.

Since the mid-1950s, diplomatic conferences have treated the topic of insurance of liability for nuclear damage. The 1960 Paris Convention and the 1963 Vienna Convention, and their amendments, are characteristic results of the efforts to establish legal standards to cope with the following three major issues: a) the financial burden that might be caused in the event of major nuclear catastrophes; b) the damage to both private and public property; and c) the impact on the environment. Inevitably, nuclear insurance became international because of the nature of its coverage. A nuclear accident, from which national governments were expected to protect their populations, could affect large areas that crossed national borders. Nuclear materials, which were often insured, were transported internationally. Regulations that affected nuclear insurance involved various kinds of international agreement negotiated through international organisations such as the IAEA. Overall, the insurability of nuclear risks as a prerequisite for licensing nuclear installations, and especially nuclear energy power plants, shaped both national and international legislation and the plans driving peaceful uses of atomic energy.

However, Kyrtsis and Rentetzi argue that governments of signatory states of the conventions on third-party nuclear liability and international organisations, such as the Organization for Economic Co-operation and Development, the IAEA and the EU, were not the only key players in this process. Pooling financial resources through complex financial operations and related instruments, insurers, reinsurers and banking institutions involved in insurance pools played crucial roles in shaping standards and rules of conduct. To achieve these goals, insurers went well beyond lobbying governments. Expanding their activities to multilateral nuclear diplomacy, they transformed their identities from lobbyists to nuclear diplomats who, from backstage, influenced formal diplomats, shaped international legislation and twisted knowledge on nuclear issues to their benefit.

Kyrtsis and Rentetzi bring forward new archival sources as well. Most of the original information was found in the corporate history archives of the Swiss Reinsurance Company. A thorough study of unclassified official documents and white papers circulated by primary insurers, reinsurers and governmental/trans-governmental organisations reveals invaluable information about the evolution of the nuclear industry and its dependence on insurance-driven safety features as a result of multi-track diplomatic negotiations leading to pertinent legislation.

Bringing another perspective on nuclear diplomacy, Fintan Hoey's paper stands as an example of how diplomatic historians have started to draw on the insights of science studies, opening up a new venue of analysis to discuss traditional issues in diplomatic

history. Hoey sees nuclear diplomacy as a form of the ‘*conceit of controllability*’, a disposition which promises the absolute controllability of nuclear weapons and power, the neutrality of related scientific inquiries and the absence of any adverse effects thereof. Examining the diplomatic negotiations between Japan and the United States in the 1970s over plutonium reprocessing, Hoey demonstrates how these countries negotiated not only nuclear science and technology but also, and principally, the international prestige of nuclear power and its technological advancements. By doing so, he shows how science and technology served not as a neutral ground to unite countries with different opinions. Rather, in making reasonable the projects of controlling the use and risks of nuclear materials and technologies, Japan and the US divided the world into nuclear ‘haves’ and ‘have-nots’ or perhaps we might say, ‘should-nots’.

The United States-Japanese nuclear diplomacy that Hoey examines was the means by which both parties attempted to assert their own conceptions of control in proximity to nuclear technologies along lines that served their national interests. In Japan’s case, this conception meant control over its future energy and the status associated with advanced nuclear power technology. Japan had recently emerged as a global economic giant but had diminished in status through its permanent disavowal of nuclear weapons in adhering to the Non-Proliferation Treaty. In light of these factors, the Japanese government was determined not to have its access to cutting-edge nuclear power technology curtailed. For its part, the United States sought to control the spread of a technology, which, it felt, would lead to an unacceptable increase in global plutonium stocks and therefore presented a weapons’ proliferation risk. Washington’s diplomatic gambit, the International Nuclear Fuel Cycle Evaluation (INFCE), attempted to press into service ‘neutral’ science for a particular political end. However, Tokyo was able to ally with like-minded partners and engage in multilateral nuclear diplomacy, frustrating Washington’s ambitions. In the long term, however, Japan was not successful, and may never be, in realising its hopes of reprocessing nuclear fuels. Ultimately, neither Washington nor Tokyo was able to assert control.

Rather than adopting a one-state point of view, Hoey masters both US and Japanese archives, emphasising the importance of multinational diplomacy through his focus on international institutions, such as the INFCE and IAEA, and the landscape of international nuclear commerce and non-proliferation. Yet the actors in Hoey’s case are not circumscribed to the involved states and international institutions. Science policy advisors such as Imai Ryukichi and Gerard Smith prove to be important nuclear ambassadors, who were able to manoeuvre between nuclear science and diplomacy under strenuous conditions.

Keeping Japan in focus, Kenji Ito attempts to capture the detailed processes by which nuclearity shapes diplomacy. Although we are accustomed to equating diplomatic processes to literal negotiations, Ito highlights the importance of material culture to nuclear diplomacy. He introduces the concept of *diplomatic object*, referring to an object whose mode of existence depends primarily on diplomatic activities, that is used by involved members to advance their foreign policy interests and that deeply affects nuclear diplomacy. A promising analytical category, the diplomatic object turns our attention to non-literal modes of diplomacy, weaving its diverse aspects into a single story. Drawing on Japan’s direct negotiations with the IAEA and several backchannel exchanges with an array of other countries, Ito demonstrates how three tons of uranium – originally

perceived as a precious scientific object – are transformed to a diplomatic object that redirects the course of diplomacy.

During their meetings from 1958 to 1959, the IAEA Board of Governors, one of the most powerful policy-making bodies of the IAEA, addressed what seemed to be a trivial request in the era of the rapid development of the nuclear industry. Japan was soliciting the IAEA's assistance to obtain three tons of natural uranium. Yet addressing that request proved to be important to the IAEA's history and a watershed moment for the development of its nuclear safeguards. Using the extensive records of the Board of Governors meetings as well as letters and telegrams, Ito unfolds how two distinct diplomatic agendas converged – the establishment and strengthening of the IAEA safeguard system and Japan's purchasing of three tons of uranium. He shows how during the negotiations, uranium became a 'diplomatic object' that was neither merely a scientific object used in a highly technical nuclear procedure nor ordinary merchandise priced and traded in a financial market. Rather, it facilitated intense, complex and multilateral negotiations at the highest level within the IAEA hierarchy over its safeguard system. The diplomats from the countries involved did not share a context in which to interpret the uranium. Instead, they enacted what the uranium was through diplomacy, where assumptions were contested and the final decision was made by a majority rule rather than a consensus.

Taking advantage of methodological concepts introduced by Science Studies scholars, Gisela Mateos and Edna Suárez-Díaz use *paper technologies* to explore the working practices of nuclear diplomacy developed by the IAEA. The authors argue that the IAEA's nuclear diplomacy in its early days, was embodied in the Preliminary Assistance Missions (PAMs). In the PAMs, teams of IAEA staff members and scientific experts were sent abroad to collect information, advise and assist IAEA member states. They worked, however, as diplomatic instruments, targeting underdeveloped countries with the aim of shaping, controlling and redirecting national nuclear programmes. Attending to the aspirations of the recipient countries and focusing on the PAM to Latin America in 1958, Mateos and Suárez-Díaz remind us that diplomacy was at the heart of the IAEA's function. In the form of secular missions designed to promote atomic energy, assist local efforts to develop nuclear power and gather regional nuclear information, the IAEA's missions served the agency's dual role of regulating and promoting nuclear energy.³¹ The IAEA's diplomacy was initially conducted through face-to-face negotiations by 'go-betweens,' or what historical actors called 'atomic ambassadors'. As Mateos and Suárez-Díaz explain, Glenn Craig, who directed the Economic Development Section of the Fund for Peaceful Atomic Development, coined the term to describe the function of the Fund's 'missionaries', which was very similar to those of the IAEA. Despite and because of the apparent success of the missions, a fundamental asymmetry between the United States and the Latin American countries on the matter of nuclear development was eventually maintained and possibly reinforced.

Mateos and Suárez-Díaz also shed light on the material aspects of the IAEA's nuclear diplomacy by revealing the numerous paper technologies involved in it. Before the introduction of digital technology, diplomacy generated large number of papers,

including letters, telegrams, memoranda, reports and position papers. The technical nature of the nuclear information exchanged through the PAM missions generated an enormous number of questionnaires, final reports and policy drafts in paper. Along with multilateral, inter- or intra-entity memos, these questionnaires functioned as diplomatic tools and outlined a global network of nuclear diplomatic activities.

Finally, Anna Åberg brings us to a more recent history of nuclear diplomacy by focusing on the negotiations around the establishment of the International Thermonuclear Experimental Reactor (ITER), a controlled thermonuclear fusion reactor currently being built in Cadarache, in southern France. As one of the world's largest technoscientific collaborations, ITER stands as a unique example of highly complex technological diplomacy in the post-World War Two period. Thirty-five nations are collaborating to produce the first fusion device to produce net energy, which will be used as the prototype device for the commercial production of fusion-based electricity. Åberg's paper traces the history of fusion collaboration leading up to ITER and focuses on the early period of ITER negotiations, showing the importance of reciprocity and compromise in the conception of the project during the 1990s.

Throughout the project's history, reciprocity and compromise have been enacted by an array of actors and organisations that have strived to keep ITER together. From politicians, formal diplomats and EU administrators to scientists, engineers, material scientists, economists and hands-on workers, all actors involved have been struggling for thirty-five years to manage and complete a project that seems to be a Sisyphean task. While *reciprocity* comes as a key promise of the frontstage diplomacy performed by national ministries of foreign affairs, *compromise* is what ITER partners achieve through uniquely complex backstage diplomacy. Åberg examines how backstage diplomatic practices over ITER shaped, and continue to shape, the scientific organisations involved, decision-making processes, the procurements of materials and the sites where the reactor's material components are produced. She further shows how backstage diplomacy affects the very design of the device and the project's technological choices. Nuclear diplomacy, in Åberg's case, is projected on ITER, an ongoing organisational, bureaucratic and technical entanglement, which holds together the states involved with innumerable compromises that involve people, materials, engineering principles and physical space.

As a whole, this special issue ambitiously reshapes the post-World War Two nuclear history of science by analysing a broad range of practices that are clustered together under the umbrella of nuclear diplomacy. But it is not only this. We are also bold enough to claim that we offer a different publishing form and contribute to what has been called 'slow scholarship'.³² Given the current problematic patterns of science publishing, as guest editors, we wanted to provide an encouraging, highly interdisciplinary and supportive environment to the scholars involved. Our aim was to work both up- and downstream from the peer review process to develop as collaborative an intellectual project as possible, rather than accept the often-isolating procedures of academic publication. During the two workshops that shaped this collection and provided coherence among the essays, we experimented with editorial sponsorship, a notion that Amy Slaton, co-editor of *History and Technology*, and Maria Rentetzi coined over a coffee and under palm trees during an international conference in Rio de Janeiro. The editors of *History and Technology* accepted our invitation to act as editorial sponsors – that is, to provide on-site support and

guidance regarding how we could sharpen our arguments and care about young scholars, to discuss one-on-one how ideas become published words, to help us challenge the safety of traditional narratives and to expose their own standpoints on the issues at hand. In Hayama, Japan, we were fortunate to be joined by Amy Slaton and Jesse Smith, deputy editor of *History and Technology*, who generously offered ideas, comments and suggestions for three days. Amy joined us for a second time in Athens, Greece. Acting as ‘on-site editors’, as if they were on-site engineers who spend their days on the construction site to ensure that the developments would be long lasting, the editors left a strong imprint on this collection. It took us two years, two workshops and long enjoyable trips to meet each other, share expertise and experiences, shape and reshape our arguments before peer-review and publication. As guest editors, we made particular efforts to meet in person and collaborate on every word of this introduction. We look forward to the paths that this effort will lead us on.

Notes

1. For a recent study on global environmental effects of nuclear tests, see Higuchi, *Political Fallout*.
2. See, for example, Rentetzi, *Trafficking Materials*.
3. The Royal Society, *New Frontiers*, 15.
4. For a textbook account of the literature on this development, see Sismondo, *An Introduction*.
5. The instrumental model of science diplomacy has been discussed in Rentetzi, “Diplomatic Studies.”
6. Jasanoff, “The Idiom of Co-Production”; and Jasanoff, “Ordering Knowledge, Ordering Society.”
7. Miller, “Climate Science”; Thompson, “Co-Producing CITES”; Waterton and Wynne, “Knowledge and Political Order”; and Storey, “Plants, Power and Development.”
8. “2018 Nuclear Diplomacy: Past, Present and Future”; <http://www.inssci.de/news-media/articles/article/nuclear-diplomacy-past-present-and-future>.
9. The notion of diplomatic studies of science has been introduced by Rentetzi, “Diplomatic Studies” and extensively discussed during the Nuclear Diplomacy workshop co-organized by Kenji Ito and Maria Rentetzi in Hayama, Japan in 2018. We would like to thank all the participants for their contributions in further developing this notion. Rentetzi, “Diplomatic Turn”; and Rentetzi, “Diplomatic Studies.” Maria Rentetzi runs a European Research Council consolidator grant on the history of radiation protection and the role of the IAEA. The project advocates a diplomatic turn in the history of science in which diplomacy becomes central to analysing post-World War Two science (HRP-IAEA, ERC-2017-CoG, 770548). Pascal Griset coordinates InsSciDE, a Horizon 2020 funded project, which is centred on the development of a shared science diplomacy across Europe and explores its history through highly interdisciplinary research. A strong indication of this trend is the establishment of the Commission on Science and Technology of the International Union of History and Philosophy of Science and Technology/Division of Science and Technology in 2017 by a number of scholars. The Commission’s first meeting in 2019 featured diplomats in science diplomacy (<https://diplomacy.science.blog/2019/06/05/schedule-for-copenhagen-meeting/>).
10. Alperovitz, *Atomic Diplomacy*, 204. Originally, Truman, *Year of Decisions*, 416.
11. Alperovitz, *Atomic Diplomacy*, 64; It is known that P. M. S. Blackett argued a point similar to Alperovitz’s. See Wellerstein, “What Journalists Should Know.”
12. Carman, Syrett, and Wishy, *History*.

13. Colglazier, "Science Diplomacy."
14. Sharp, "For Diplomacy."
15. Beatty, "Scientific Collaboration."
16. The relevant literature is vast. A few indicative examples include Sherwin, *A World Destroyed*; Helmreich, *Gathering Rare Ores*; Walker, *Utter and Prompt Destruction*; Maddock, *Nuclear Apartheid*; Hecht, *Being Nuclear*; Creager, *Life Atomic*; Gavin, *Nuclear Statecraft*; Hunt, "Birth of an International Community"; Drogan, "Nuclear Imperative"; Holloway, "Soviet Union"; Schmid, "Nuclear Colonization?"; Twigge, "Atomic Marshall Plan"; Popp, Horovitz, and Wenger, eds., *Negotiating the Nuclear*; Wolfe, *Freedom's Laboratory*, Chap. 6; Holloway and Nuti, eds., "Aspects"; and Rentetzi, "Determining Nuclear Fingerprints." In particular, John Krige's work has been highly relevant and influential in shaping nuclear history. He and his collaborators have produced a series of massive studies on the international aspects of science in the post-World War Two world (Krige, *American Hegemony*; Krige, *Sharing Knowledge*; Krige, ed., *How Knowledge Moves*; Krige and Barth, eds., *Global Power Knowledge*; Oreskes and Krige, eds. *Science and Technology*). Some studies in their collected volumes are directly relevant to this special issue. It should also be pointed out that relevant literature exists in languages other than English, as some of the papers in this issue indicate.
17. Wellerstein, "Decision to Use the Bomb"; Wellerstein, "What Journalists Should Know"; and Gordin, *Five Days*.
18. Soto Laveaga, "*Largo Dislocare*."
19. Schroeder-Gudehus, "Science, Technology and Foreign Policy," 479.
20. Schroeder-Gudehus, "Science, Technology and Foreign Policy," 496. Since the 1960s, Schroeder-Gudehus has been publishing her studies on scientific internationalism primarily in French. For another English article, see Schroeder-Gudehus, "Nationalism and Internationalism." See also Fox, *Science without Frontiers*, especially, 'Introduction' and 'Bibliographical Essay.'
21. Der Derian, *On Diplomacy*.
22. *Ibid.*, 4–5.
23. For theories of individualisation, see Simondon, *On the Mode of Existence*; Barad, *Meeting the Universe Halfway*.
24. Wille, "Representation and Agency"; and Braun, Schindler, and Wille, "Rethinking Agency."
25. For classical textbooks on diplomacy, see Nicolson, *Diplomacy*; and Berridge, *Diplomacy: Theory and Practice*.
26. On the New Diplomacy, see Kelly, "New Diplomacy."
27. Wadsworth, "Modern Diplomacy."
28. Hecht ed., *Entangled Geographies*; Hecht, *Being Nuclear*.
29. Krige ed., *How Knowledge Moves?* For an earlier critique on the state-centred approach, see Abraham, "Ambivalence."
30. For both the IAEA and the Pugwash conference, see, for example, Holloway, "Soviet Union"; Mallard, *Fallout*; Brown, *Nuclear Authority*; Wolfe, *Freedom's Laboratory*; Kraft and Sachse, eds., *Science, (Anti-)Communism and Diplomacy*; and Creager and Rentetzi, "Dual Use."
31. For concepts related to 'paper technology,' see Klein, *Experiments*; and Bittel, Leung, and von Oertzen, *Working with Paper*.
32. Higgitt, "Science Publishing 2035"; and Petterson, "Rescaling Communication."

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