Stanton Nuclear Security Fellows Seminar

PANEL 3: Managing Proliferation

1. Edward Cazalas, RAND

Searching for Smuggled Nuclear Materials: Developing New Concepts of Detection

Objective

The objective of the research effort is to develop and analyze innovative operational concepts to detect smuggled nuclear and radiological materials and weapons.

Overview

The threat of nuclear terrorism has loomed over the United States and the international community for decades. While the threat has a history, it is recognized as serious and contemporary by world leaders, U.S. presidents, and politicians spanning time, geography, political rank or party. Nuclear and radiological materials, which may be weaponized into improvised nuclear devices or radiological dispersal devices, can be utilized to attack governmental or financial centers, populace, or critical infrastructure. While nuclear weapons pose the greatest threat through widespread destruction and significant loss of life, radiological-based weapons may still induce disruption to the economy and panic, but on a smaller scale.

International efforts to date, such as the Global Threat Reduction Initiative (GTRI; established within the National Nuclear Security Administration under the Department of Energy) have helped to improve the security of nuclear facilities, processes, and materials. However, the risk remains that nuclear and radiological materials could still be accessed and smuggled. The growth and possible spread of terrorist ideologies, such as those espoused by ISIL, to countries with access to nuclear materials or weapons underscores the significance of this threat.[1]

One of the challenges of this threat is the potential smuggling of nuclear and radiological materials and weapons into the United States. The Global Nuclear Detection Architecture (GNDA; coordinated by the Domestic Nuclear Detection Office of the Department of Homeland Security) recognizes combating nuclear and radiological smuggling as an effective component of preventing nuclear terrorism. The activities to detect and interdict nuclear and radiological materials and weapons include various technical and non-technical activities. Non-technical activities include intelligence gathering and law enforcement response; technical activities include radiation detection and analysis, and forensics. In

[1] W. Stern, E. Baldini, "Global Threat Reduction Initiative Efforts to Prevent Radiological Terrorism," *Federation of American Scientists: Public Interest Reports*, vol. 44, no. 4, Nov. 2013.

addition, activities of programs such as the GTRI and GNDA also act as a deterrence mechanism to smuggling by increasing the chance of material and weapons interdiction as perceived by a smuggler.[2]

The sensing of radiological and nuclear materials, especially nuclear, is difficult due to the lack of knowledge of which entry way or transport mode will be utilized and where threat material may be located within a given inspection volume. Additionally, the signals detected from these materials are relatively weak in the presence of intermediary signal absorbers and signal background. Considerable decline of signal intensity with distance away from the threat material and limited scan time also complicate detection capabilities. Often, the technical difficulties are magnified by operational constraints, such as the demand for speedy cargo throughput at seaports.[3]

The countering of nuclear and radiation smuggling may be enhanced by a paradigm shift of detection applications and operations. Frequently, counter-smuggling efforts have relied on incremental advancements in detection technology, with those technologies typically applied in the same operational manner. Also, the frameworks within which concepts are developed are commonly subject to or restrained by the influence of an institutional perspective or mission. Opportunities exist to develop concepts of detection systems that are outside the current realm of operational thinking or application and which may cut across institutional frameworks. These operational concepts should be developed with existing and current-research detection technologies and may also be fused with non-detection technologies. Research of the nature described may be valuable and policy-relevant in combating the smuggling of nuclear and radiological material.

Expected Results

The proposed research will investigate existing and current-research radiation detector technologies, materials, and systems and scope out gaps in deployed detection operations to identify opportunities that enhance the sensing of nuclear and radiological threats. Opportunities will be exploited by developing operational detection concepts. The concepts will be developed and evaluated for effectiveness and feasibility in terms of operational constraints, technical achievability, and cost. The final product of the proposed research will be a quantitative determination of the most feasible innovative concepts that address the concern of the nuclear and radiological terrorism, specifically the smuggling of nuclear and radiological materials and weapons into the United States.

Research Design

The course of research will entail: (a) developing an understanding of existing and current-research detection systems and materials in relation to nuclear and radiological materials and weapons smuggling; (b) an investigation of inspection gaps and potential opportunities to deploy detection

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[2] K. Guthe, "The Global Nuclear Detection Architecture and the Deterrence of Nuclear Terrorism," *Comparative Strategy*, vol. 33:5, no. 424-450, Nov. 2014.

[3] A. Lavietes, *et al*., "Technical Review of the Domestic Nuclear Detection Office Transformational and Applied Research Directorate Research and Development Program," *A Report of the APS Panel on Public Affairs and the IEEE*, Sept. 2013.

technologies or fusions of technologies in operationally advantageous concepts; (c) analyze new operational concepts for feasibility and effectiveness.

a) - Develop an understanding of operational limitations of detector systems;

- Survey existing and current-research detection systems and materials.

b) - Identify problematic operational gaps in detection capability;

- Investigate potential opportunities for existing and current-research technologies, materials, and systems to enable new operational concepts;

- Develop new operational concept in sufficient detail to allow analysis.

c) - Perform modeling and simulation to evaluate effectiveness of the new operational concepts;

- Assess the concept's utility for deterrence capability;

- Examine which innovative operational concepts are most promising considering operational limitations, cost, and deterrence utility.

Target Audience and Policy Contribution

The target audience spans a wide-range of stakeholders, including government agencies, public entities, and industrial partners due to the various technologies, applications, and operations that will be researched. Stakeholders may find value in particular sections of the research that align with or affect the stakeholder's mission. The target audience includes those that are involved with program operations and funding including the Department of Homeland Security (DHS), specifically the Domestic Nuclear Detection Office (DNDO), Customs and Border Protection (CBP), and the Coast Guard; Department of Energy (DOE), specifically the National Nuclear Security Administration (NNSA); Department of Defense (DOD) under the purview of the Defense Threat Reduction Agency (DTRA); and the International Atomic Energy Agency (IAEA). The academic and policy communities, and the National Laboratory system (DOE) would find interest in the potential research areas uncovered by the project as well as industrial partners, which also have stock in developing the next generation of sensing systems.

The policy contribution this research will produce is identifying promising operational concepts of existing and current-research detector technologies that reduce the threat of nuclear terrorism.

2. Kalman Robertson, BCSIA

The Evolution of Nuclear Safeguards

Objectives

This project examines contemporary developments in International Atomic Energy Agency (IAEA) safeguards with a focus on mechanisms for ensuring the quality of safeguards findings and the transparency of the IAEA's operation. It will develop theoretical approaches to the allocation of verification resources and the derivation of verification conclusions, and then use them as the basis for an evaluation of the practice of the IAEA. It will produce policy-relevant recommendations for the refinement of the IAEA's emerging state level concept (SLC) and for the resolution of compliance issues that may arise during safeguards implementation.

Overview and Research Design

Nuclear safeguards are measures used to independently verify a state's compliance with its undertakings relating to its nuclear activities. These undertakings are usually obligations to abstain from using nuclear materials to develop nuclear explosive devices. Safeguards are most often applied by the IAEA pursuant to a safeguards agreement between the IAEA and the state.

Until the mid-1990s, IAEA safeguards were primarily designed to verify the "correctness" of state declarations. If a state declared that it was producing, processing, using or storing nuclear material in a facility, then IAEA inspectors and analysts focused on checking the accuracy of the declaration (i.e. detecting any removal of nuclear material from declared holdings or any misuse of declared facilities). By the early 1990s, this approach was proving inadequate to address the risk of non-compliance by non-nuclear-weapon states parties to the *Treaty on the Non-Proliferation of Nuclear Weapons*.

The IAEA underwent a process of strengthening safeguards during the 1990s, which introduced a greater focus on the verification of the "completeness" of state declarations (i.e. the absence of undeclared nuclear materials, activities, or facilities).[4] The IAEA first introduced the term state level concept (SLC) in 2005 as a means of describing an emerging approach to evaluating the state as a whole, as opposed to the traditional approach of implementing safeguards purely on a facility-by-facility basis.[5] The SLC embraces the expanded sources of information available to the IAEA following the reforms of the 1990s. It also seeks to improve the efficiency of safeguards by developing bases for differentiating between states in safeguards implementation. Although the SLC does not extend the rights or responsibilities of the IAEA (or those of states parties to safeguards agreements), it has produced considerable controversy among states in part because of the perception that it could have a discriminatory impact on safeguards implementation. In 2013 and 2014, the Director General of the

[4] In the terminology of IAEA safeguards, the adjective "undeclared" describes an object or location that the state has not declared and placed under safeguards but is required to declare pursuant to its safeguards agreement, see paragraphs 2.5 and 2.6 of IAEA, *International Atomic Energy Agency Safeguards Glossary: 2001 Edition* (Vienna: 3rd ed, 2002).

[5] Laura Rockwood, 'The IAEA's State-Level Concept and the Law of Unintended Consequences' (September 2014) 44(7) *Arms Control Today* 25-30.

IAEA released reports on the development of the SLC, seeking to clarify its scope and cast it in objective terms.[6]

The last 25 years have also seen several findings of non-compliance with safeguards, as well as numerous other cases of detected anomalies and breaches. Despite this experience, the IAEA has not articulated a substantive definition of non-compliance or a well-defined procedure for exposing non-compliance.

Safeguards experts acknowledge that the identification and clarification of principles for determining safeguards priorities and for deriving safeguards conclusions will be an important step toward strengthening the nonproliferation regime.[7] In order to help elucidate the options available for developing these missing principles, this project draws on the existing literature on nuclear materials accountancy, game theory, and the determinants of proliferation to develop contrasting theoretical approaches to both the allocation of verification resources and the selection of standards for drawing verification conclusions. Each approach strikes a different balance between the competing objectives of verification in seeking to manage the risks of international agreement. The project then evaluates the current and historical practice of the IAEA against the theoretical approaches and recommends reforms to the safeguards regime.

On the issue of resource allocation and priorities, the project will put forward two broad approaches. The first is based on the object of verification (i.e. the nuclear material) and leads to narrow, mechanistic and quantitative criteria. The second is based on the subject of verification (i.e. the state), which better reflects the fact that the risk of proliferation and the likelihood of detection vary between states. However, some of the state-specific factors that come out of this latter approach have an ambiguous relationship with the likelihood of undetected proliferation or involve evaluating evidence that is far-removed from the IAEA's traditional information sources. This project will then examine the evolution of the IAEA's practice on safeguards resource allocation, showing where it has embraced aspects of each of the theoretical approaches and where it remains ambiguous. It will recommend refinements to the SLC to ensure that it provides demonstrably objective criteria for differentiating between states in safeguards implementation in order to assist the IAEA to fulfil its responsibilities with a limited budget.

On the issue of drawing verification conclusions, the project advances two basic types of approaches, one based on a legalistic definition of non-compliance and one based on a substantive definition. The former applies a strict interpretation of some or all of the terms of the safeguards agreement, while the

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[6] See IAEA, 'Supplementary Document to the Report on the Conceptualization and Development of Safeguards Implementation at the State Level (GOV/2013/38): Report by the Director General' IAEA Board of Governors Doc GOV/2014/41 (13 August 2014).

[7] Pierre Goldschmidt, 'Exposing Nuclear Non-Compliance' (2009) 51 *Survival* 143-164; John Carlson, 'Defining Non-Compliance: NPT Safeguards Agreements' (2009) 39(4) *Arms Control Today* 21-27; Peter Jenkins, 'Staying Credible: How Precedents Can Help the IAEA Get Noncompliance Calls Right' (September 2010) 41(7) *Arms Control Today* 19-23; Gareth Evans and Yoriko Kawaguchi (Co-Chairs), *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers*, Report of the International Commission on Nuclear Non-Proliferation and Disarmament (Canberra: ICNND, 2009) 87, paras 9.14, 9.15; Trevor Findlay, *Nuclear Energy and Global Governance: Ensuring Safety, Security and Non-Proliferation* (Abingdon: Routledge, 2011) 205.

latter requires judgments of the actual or potential significance of individual anomalies or breaches. This project will then examine the practice of the IAEA Secretariat and the Board of Governors with respect to past cases of anomalies, breaches, and findings of non-compliance. I expect to conclude that both organs of the IAEA are applying a loose or flexible combination of the two theoretical approaches. Even if it is not possible to develop an exhaustive definition of non-compliance by reference to past cases, the analysis may point to opportunities to introduce procedures and principles that would more clearly distinguish the roles of the Secretariat and the Board in drawing conclusions, thereby enhancing the transparency of the IAEA's operation and the credibility of the verification assurance. This could help avoid unnecessary politicization of the IAEA (and the Secretariat in particular) when compliance issues arise.

This project relies primarily on documentary sources of information, including IAEA reports and resolutions on safeguards implementation, cases of non-compliance, and the conceptualization of safeguards implementation at the state level. I obtained most of the relevant documentation during my Ph.D. research. Although I made significant progress on obtaining interview sources during my Ph.D. research, I intend to continue to explore some aspects of the inner workings of the IAEA Secretariat and its use of state evaluation teams through interviews, primarily with former officials from the IAEA Department of Safeguards. In particular, it would be worthwhile investigating the use of specific mechanisms, such as "red team" analysis, to reduce the potential for narrow, biased or criteria-driven thinking among inspectors and analysts.

Expected final products

The main products of this project will be a book manuscript and a journal article.

The book manuscript will cover the entire verification process, from planning verification activities and allocating verification resources to analyzing collected data and drawing conclusions. It will examine both the theoretical approaches and the practice of the IAEA in the manner outlined above.

The journal article will cover the IAEA's capability to verify completeness with particular emphasis on the foreseeable effects of verification activities conducted in connection with the Joint Comprehensive Plan of Action (JCPOA). The text of the JCPOA and current debates surrounding its implementation represent a previously unrecognized degree of convergence among scholars and practitioners on the subject of the IAEA's rights and responsibilities to verify completeness, particularly where third party sources of information point to the existence of undeclared nuclear activities. This has important implications for the management of the risk of safeguards violations, particularly those that may occur outside of declared facilities. This component of the project may also produce an op-ed in the lead up to the December 15 deadline for the Director General to submit his final assessment to the Board of Governors on the resolution of past and present outstanding issues regarding Iran's nuclear program.

Target audience and contribution to policy process

The products of this project will be targeted toward both academic and policy audiences. The findings should interest scholars of international relations, particularly those examining the issue of resolving the

tension between the technical and political components of verification. For national regulatory bodies, government departments, the nuclear industry and other stakeholders in nuclear governance, the products will provide insights into the operation of an international institution that may often seem like an unnecessarily complex bureaucracy. The findings should also provide a basis for nonproliferation policy makers to engage constructively with the IAEA on the subject of ongoing evolution of IAEA safeguards.

The challenges of implementing international verification across states with diverse nuclear industries are not likely to end with existing IAEA safeguards agreements. The results of this project will also be relevant to the design of future verification regimes in nuclear nonproliferation, arms control and disarmament, such as a fissile material cut-off treaty. In particular, the issues of allocating safeguards resources and resolving safeguards violations are likely to become more complicated as states go beyond traditional nuclear cooperation agreements to establish more sophisticated multilateral approaches to the nuclear fuel cycle. Compliance with safety, security and safeguards obligations is often cited as a logical condition for a state's continuing participation in such an arrangement. Such arrangements may run into difficulties due to the absence of an agreed standard of compliance with these obligations. My book manuscript will canvass possible multilateral approaches to fuel cycle facilities and explain the extent to which they may modify existing safeguards resource requirements. I will also recommend procedures that may be written into future nuclear cooperation agreements for managing allegations of safeguards violations involving states participating in such approaches.

3. Todd Robinson, RAND

An Analysis of the Strategic Logic of Proliferation Prevention

Although efforts to halt or slow Iranian proliferation have been at the forefront of both policy-making and public discourse in recent years, it is only the most recent case where states have acted to prevent the acquisition of nuclear weapons by intervening at various points in the weapons-development process of states to affect their ability and/or willingness to proliferate.[8] The decisions of whether, how, and at what point in the process to intervene and what effect they have on the success or failure of proliferation prevention efforts are questions that have received relatively little attention in the academic literature. This project will therefore seek to develop such an understanding by analyzing, in detail, the proliferation intervention decision-making process, with the aim of coming to lessons for future policymakers.

Originating almost concurrently with atomic/nuclear weapons themselves has been efforts to curtail their spread. Even before the creation of the nonproliferation regime, states considered acting to prevent the acquisition of nuclear weapons and weapons-related technologies. While the presence of the regime certainly makes proliferation more difficult, states, either acting individually or in concert with others, still have, at times, intervened to prevent or deter the acquisition/development of nuclear weapons-related technologies by other states. Examples such intervention include the United States' use of diplomatic measures to curtail the development of enrichment facilities in the 1970s and Israel's use of military strikes against Iraqi nuclear facilities in 1981 and again against Libya in 2007. Why those states that do elect to intervene to prevent the proliferation of nuclear weapons-related technologies decide to do so is a question that is largely unexplored in the academic literature, as is why those that do choose to intervene adopt the intervention strategy that they do. Instead, the focus has been on particular forms of intervention in isolation, e.g., the use of military strikes against suspected nuclear facilities,[9] or on individual cases, e.g. Israel's conduct of Operation Opera in 1981.[10] This has led to a lack in our understanding of the range of options available to policy-makers when choosing to intervene to prevent proliferation, what fails to reflect what Most and Morgan refer to as "foreign policy substitutability." In addition, focusing on individual forms of intervention ignores the critical question of whether there is a strategic logic to the timing and sequencing of the adoption of those mechanisms; i.e. why one state would, for example, begin by imposing sanctions and threatening military action only if sanctions fail, while another might forego economic or diplomatic means of intervention entirely and instead adopt a military-only intervention strategy.

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[8] I use the term proliferation intervention to include counter-proliferation activities (acts taken to directly affect a state's ability to proliferate, such as the imposition of economic sanctions) as well as also those designed to affect a state's willingness to proliferate, such as the offering of security assurances

[9] See Fuhrmann, Matthew and Sarah Kreps, "Targeting Nuclear Programs in War and Peace: A Quantitative Empirical Analysis, 1941-2000," Journal of Conflict Resolution 54, no. 6 (2010) pp. 831-859 and Kreps, Sarah and Matthew Fuhrmann, "Attacking the Atom: Does Bombing Nuclear Facilities Affect Proliferation?" Journal of Strategic Studies 34, no. 2 (2011) pp. 161-187.

[10] For an example, see Feldman, Shai, "The Bombing of Osiraq-Revisited." International Security, Vol. 7, No. 2 (Autumn, 1982), 114-142.

Equally unclear in the literature is why states choose not to intervene in situations where states are seeking to acquire proliferation-related capabilities or are suspected of doing so. South Africa, China, and Sweden, are examples of cases where states are known to have engaged in the process of seeking to acquire nuclear weapons and, more significantly, were suspected of doing so at the time, yet were largely allowed to proceed without outside state intervention. Why the decision to intervene is made in some cases, but not others, is a question that has also received relatively little attention.

To fill these gaps, this project will thus endeavor to answer the following interrelated questions:

1. Why do states intervene to prevent the acquisition of nuclear weapons and weapons-related technologies by some states, but not others even when we might have expected them to?
2. Why do those that choose to intervene adopt the intervention mechanism(s) or strategy that they do?

Possible Explanation(s) & Expected Result(s)

Unless a suspected proliferator has somehow signaled to a potential intervener or interveners what it might take for them to abandon their nuclear pursuits (such as an offer of a security guarantee), which makes intervention relatively straightforward, states are largely left to decide, either on their own or in concert with other actors (states, international organizations, etc.), if, how, and when to intervene.

As a starting point towards developing an explanation of why states do or not intervene, and subsequently adopt or not adopt an intervention strategy, it is assumed that the adoption of an intervention strategy, including the form and timing of intervention mechanism(s), is endogenous to the decision to intervene. As such, they share a similar and interrelated logic. The decision of whether, how, and at what point in the proliferation process to intervene is, informed by three factors:

1) whether the potential intervener judges that the suspected proliferator is more or less likely to succeed in producing nuclear weapons, given both their indigenous resources and access to sensitive nuclear weapons-related technologies,
2) whether and to what extent the potential intervener believes the suspected proliferator is willing to incur the costs of engaging in nuclear proliferation, and
3) whether and to what extent the perceived motivation(s) of the suspected proliferator directly or indirectly affect(s) the potential intervener's interests.

It would thus be expected, for example, that states that judge proliferation to be likely and to have a direct effect on their own security or those of their allies would 1) be much more likely to intervene, 2) do so in ways that are generally more costly (such as the conduct of military strikes), and 3) intervene much earlier in the proliferation process than states that would only be marginally affected by the successful production of nuclear weapons by the suspected proliferator.

Research Design

My proposed research design is comprised of two complementary approaches. The first is to employ comparative historical analysis on cases of proliferation chosen for their utility in the evaluation of the proposed theoretical framework. The analysis will focus not on the proliferating state, per se, but on the set of states most likely to be affected by said state's acquisition and/or development of weapons-related capabilities. A possible method of delimitation, as an example, would be to look at states that are directly contiguous. Thus, for a country like North Korea in the late 1990s and early 2000s, the set of states would be South Korea and China. An alternate method would be to look at politically relevant or politically active dyads, which would then include states such as Japan, Russia, the United States, etc. For these cases, using archival research on publicly available sources, I will seek to determine whether the leadership of the potentially affected state(s) considered acting in some way to prevent the development of nuclear weapons by the suspected proliferating state and why the decision to intervene was or was not ultimately made. For cases where intervention occurred, I will then explore the decision-making process with an eye towards discovering the range of policy responses or intervention mechanisms that were considered and the logic behind the choice of intervention strategy ultimately adopted (including the timing of the implementation of those mechanisms).

The second approach will be to use formal modeling to describe, in more detail, the logic of the presented theoretical framework. This will also aid in the production of hypotheses which can be tested using statistical analysis, if appropriate. As I am somewhat constrained by the population size, I will employ techniques designed to correct and/or deal with small numbers of cases, including, but not limited to, matching techniques.

Relevance to the Policy Process

This project is particularly policy-relevant for two reasons. First, it allows us to predict the future behavior of other states and whether and how they may react if and when proliferation occurs. Second, by incorporating foreign-policy substitutability, which is the range of foreign policy tools that a policy-maker can employ for a particular circumstance, this study should, ideally, better explain the policy-making process than studies that focus only on individual forms of intervention.

Targeted Publication(s)

The proposed project will ideally result in two interrelated products. The first is a book manuscript that will be submitted to the major security studies publishers for consideration (Cambridge, Stanford, etc.). The second is a few op-eds or policy-relevant pieces designed to shed light on how future decisions to intervene to prevent the spread of nuclear weapons can draw on what has happened in the past.

4. William Spaniel, CISAC

The Perverse Incentives of Proliferation Mitigation

Description and Objectives

My project investigates the value of "proliferation mitigation," defined as measures designed to minimize the negative consequences of nuclear proliferation. The research will generate a framework for understanding the effects of international negotiations to terminate nuclear weapons programs and the fallback measures to curb the side effects if such negotiations fail. The goal is to produce relevant policy implications about how the United States and its allies can best respond to problems associated with proliferation.

Expected Results

I want to investigate the tradeoff that countries face between (a) limiting the spread of nuclear weapons technology through negotiations with potential nuclear weapons states and (b) deploying strategies to minimize the damage once a state has proliferated. The goal is to show that strong damage-mitigation strategies can perversely lead to more bargaining breakdown, which can surprisingly lead to more problems overall than if damage-mitigation strategies were nonexistent.

For example, suppose that U.S. negotiators had good reason to believe that North Korea's development of a nuclear weapon would have led to a significant spread of nuclear weapons technology to rogue third-party actors. Then the U.S. would have increased its effort to halt North Korea's path to the bomb so as to avoid those consequences. In reality, though, the U.S. could take countermeasures. The Proliferation Security Initiative, for instance, coordinates international efforts to hinder transport of nuclear weapons materials, while U.N. Security Council Resolution 1540 mandates that countries adopt domestic laws to criminalize non-state WMD transfer, manufacturing, and possession. Given these "insurance" policies, the U.S. had less incentive to offer North Korea deals it was more likely to accept. Strangely, this means these proliferation side effects are potentially more pervasive when the international community is better able to limit the damage.

Overview

For the last few decades, the United States, the United Nations, and the International Atomic Energy Agency (IAEA) have sought to limit the spread of nuclear weapons technology in two ways. The preemptive tool is negotiations. Opponents of would-be nuclear weapons powers can offer policy or economic concessions in exchange for compliance to nonproliferation obligations. There are many historical examples of this, including agreements with Ukraine, Belarus, and Kazakhstan after the end of the Cold War, Libya in 2003, and the current plan for Iran. In many ways, this is the ideal outcome: since the states in question do not develop nuclear weapons technology under these agreements, said technology cannot spread to third parties or cause environmental damage. Put simply, there cannot be negative side effects of nuclear proliferation if no proliferation occurs.

Nevertheless, negotiations may fail. In these cases, the international community has incentive to work to mitigate the damage afterward. One central component of this is tracking existing nuclear weapons materials, lest they fall into rogue hands. This was a major problem in 1990s and early 2000s. A.Q. Khan, a Pakistani nuclear scientist, used his knowledge and connections during the development of Pakistan's bomb to form a nuclear black market, leading to exchanges with Libya, North Korea, and Iran. After an intelligence breakthrough, the U.S. and IAEA shut down the network in 2003. However, these concerns recently reentered the news with the discovery of an organized crime ring in Moldova trying to sell Russian materials to ISIS operatives.

My project intends to identify how these two strategies interact. At present, most studies of proliferation side effects only analyze how institutions alter outcomes once the institution is already taking action. Meanwhile, most studies of negotiations fail to consider how mitigation strategies affect the bargaining process. Yet the mitigation efforts begin if bargaining breaks down. Negotiators know this ahead of time. Thus, the expected mitigation influences bargaining strategies. For example, the more worried the United States is of an Iranian A.Q. Khan, the more effort Washington will (or should) exert to end Iran's program. In turn, it is unclear exactly how much value mitigation efforts bring to the table.

Overall, I intend to show that mitigation can be counterproductive. That is, because mitigation provides some relief, countries have less incentive to negotiate agreements to terminate nuclear programs and stop the problems before they start. Thus, a hypothetical world where networks like that of A.Q. Khan could operate with impunity might have fewer problems overall. In turn, international investments in mitigation may not be as valuable as they appear.

Research Design

I plan to use a combination of formal theory and qualitative methods (process tracing in case studies) to expand the argument. The purpose of the formal theory is to produce empirical implications and verify that the above logic is valid. I will then use case study work to illustrate the mechanism. For now, I plan to focus on the efforts to end the A.Q. Khan network and the coordination efforts of Resolution 1540 and the Proliferation Security Initiative, though I am hoping to find additional historical examples in my time as a Stanton Fellow at CISAC. I would especially like to study how such mitigation efforts influenced non-proliferation negotiations with Iran.

Target Audience

These results should be interesting to both researchers and policymakers. The perverse incentives of the bargaining logic are novel to the international relations literature, so I believe there is a real contribution to be made. I may ultimately split the findings into two pieces, one focusing on mitigation of security concerns (such as by developing missile defense) and another on black market concerns.

The project also has important policy implications, namely that the utility of mitigation strategies might be overestimated. As such, I will work the results into an op-ed or post a highly accessible statement on a website such as the Monkey Cage or Foreign Policy online.