# Normalization by Other Means:

## The Failed Techno-diplomacy of Light Water Reactor Export in the North Korean Nuclear Crisis

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"No package of incentives in the past quarter century has worked, and there is no reason to think that new diplomatic efforts could induce them, where so many have others failed." [1] Passages like this are ubiquitous in our deliberation about North Korea's nuclear program. Contemporary nonproliferation analyses often embark from the premise that engagement with North Korea has failed, and then proceed to ask "what now?".[2] We may debate the distribution of blame for that failure, and over which side more egregiously "cheated" on past commitments, but we can generally agree that the workable space of "inducements" has been explored, and proven insufficient to prevent North Korea from acquiring nuclear weapons. Is this an adequate response to history, and is it driven by a reasonable theory of diplomacy under nuclear proliferation crisis? This article examines the campaign of U.S. engagement with North Korea that centered around the 1994 Agreed Framework[3] (AF), and argues that there is still much that we haven't learned from our experience.

The AF is commonly interpreted as an exchange of "carrots" -- the U.S. offered the carrots of energy assistance and security assurances in exchange for North Korea's denuclearization.[4] Central to this arrangement was a "reactor trade", whereby the North agreed to dismantle its proliferation-prone gas-cooled reactors (GCR) in exchange for more proliferation-resistant light water reactors (LWRs) from the West. The accord managed to freeze North Korea's plutonium (Pu) capability, the common story goes, and may have delayed its nuclear pursuits. But U.S. intelligence then discovered that the North was pursuing an alternate route to the bomb: a clandestine uranium enrichment program (UEP). Standard accounts then diverge into two opposing camps. The first argues that the enrichment program "proves" that the regime was

[1] Comments of Michael Auslin, in panel discussion moderated by Alex Shashkevich, "Stanford experts examine options for U.S. in dealing with North Korea", *Stanford News*, Sept. 22, 2017.

[2] Representative example: Shen Ding-li, Chung-in Moon and Andrei Lankov, "Roundtable: North Korea's Nuclear Weapons -- What Now?", *Bulletin of Atomic Scientists*, June 2016.

[3] Agreed Framework of 21 October 194 Between the United States of America and the Democratic People's Republic of Korea, INFCIRC/457.

[4] Academic literature on the AF is scarce. Curtis Martin describes the AF as "shift toward greater proportion of stick to carrot" in "Lessons from the Agreed Framework for Using Engagement as a Nonproliferation Tool", *Nonproliferation Review*, Fall 1999. Similar accounts from nonproliferation literature include Jacques Hymans, "Assessing North Korea's Nuclear Intentions and Capacities: A New Approach", *Journal of East Asian Studies*, 8:259-292 (2008); Michael Mazaar, "Going Just a Little Nuclear: Nonproliferation Lessons for North Korea", *International Security*, 20:2:92-122 (1995); Alex Mansaurov, "The Origins, Evolution and Current Politics of North Korea's Nuclear Program", *Nonproliferation Review*, (Spring/Summer 1995) 25-38; Stephen Haggard and Marcus Noland, "Engaging North Korea: The Efficacy of Sanctions and Inducements", in Etel Solingen (edt.), *Sanctions, Statecraft and Nuclear Proliferation*, (Cambridge University Press, 2012. The carrot formulation also informs test cases for proliferation theory, as in Tristan Volpe, "Atomic Leverage: Compellence with Nuclear Latency", *Security Studies*, 26:3:517-544; and Etel Solingen, *Nuclear Logics*, (Princeton University Press, 2007).

simply "buying time" and planned to cheat all along.[5] The second, more dovish camp, argues that the North did in fact cheat, but that the U.S. had also cheated by not delivering its "carrots" in a timely manner. Hence, the moral force of North Korea's "cheating" may be softened if there is blame to go around.[6]

These debates, and their contesting narratives, are born of a popular conceptual framework that I will call the *inducement paradigm of carrots and sticks*.[7] This is a vision of American diplomacy with North Korea that sees all U.S. policy options as condensed along a one-dimensional axis. On one end we have more sanctions and isolation -- these are the sticks we can use to coerce the regime into giving up nuclear weapons. On the other end we have energy assistance, food aid, security assurances -- rewards we can offer to bribe North Korea into nuclear abstinence. Heated debates may recur over the appropriate "balance" of carrots and sticks,[8] and how to maximize their effectiveness.[9] But there is little consideration of the technical and political realities entailed in implementing of those "inducements", and of what techno-political[10] consequence may be wrought on the ground in Korea. When we do look back on the technical aspects of the AF, and how LWR construction was to be situated within a diplomatic process, a different picture emerges. Rather than a package of carrots to bribe the North, the LWR project looks more like an attempt to build the *physical embodiment* of a normalized[11] political relationship between the U.S. and a denuclearized North Korea. If this was the true shared intention behind the AF -- to "hardwire us all in"[12] and lay down a *physical path* toward denuclearization and normalization -- then the determinants of diplomatic success and failure may have been very different from what the common *inducement* narrative would suggest.

This article presents an alternative interpretation of the AF, which I will call the *techno-diplomacy* model. I begin with a theoretical discussion that draws from rationalist security studies (*SS*) and constructivist science and technology studies (*S&TS*) to help conceptualize the role of nuclear technology in crisis diplomacy. I then outline the *techno-diplomatic* structure of the AF as it is visible from my empirical vantage point. Within that structure, the LWR process



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[5] Example: Jonathan Pollack, *No Exit: North Korea, Nuclear Weapons and International Security* (New York, NY: Routledge, 2011)

[6] Example: David Kang, "Why are we Afraid of Engagement", in Victor Cha and David Kang, *Nuclear North Korea: A Debate on Engagement Strategies*, (Columbia University Press, 2003).

[7] The *inducement paradigm* of nonproliferation diplomacy most explicitly outlined in Etel Solingen, edt., *Sanctions, Statecraft, and Nuclear Proliferation*.

[8] Debate over the appropriate "carrot-stick" balance is exemplified by Victor Cha and David Kang, *Nuclear North Korea, A Debate on Engagement Strategies*.

[9] On improving the effectiveness of inducement see: Solingen, *Sanctions*; and Peter Harrell and Juan Zarate, "How to Successfully Sanction North Korea", *Foreign Affairs*, January 2018.

[10] The phrase *techno-politics* highlights the co-constitution of technological and political realities, and is elaborated in the following section. See: Gabrielle Hecht, *Radiance of France* (Cambridge, MA, MIT Press, 2009); Gabrielle Hecht, edt., *Entangled Geographies: Empire and Technopolitics in the Global Cold War* (Cambridge, MA: MIT Press, 2011); Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London, U.K.: Verso, 2011); Sheila Jasanoff, edt., *States of Knowledge*, Routledge, 2004.

[11] For the purposes of this paper, *normalization* will refer to a wholesale change in relations between the U.S. and North Korea: establishment of a peace treaty and normal diplomatic relations; an end to economic sanctions; and a shifted role for U.S. troops on the peninsula. There is ample evidence that in the late 1980s, normalization became a top priority for the Kim regime. See: Sigal, *Disarming Strangers*, (Princeton University Press, 1998), pp. 24; Don Oberdorfer, *The Two Koreas* (New York NY: Basic Books, 2014), pp. 207; Robert Carlin and John Merrill, "North Korea's Relations with the United States and Japan," *Korea 1991: The Road to Peace*, edt. Michael Mazaar (Washington, DC: Institute for International and Strategic Studies (IISS), 1991), pp. 118-121; For a South Korean perspective, see Lim Dong-won, *Peacemaker: Twenty Years of Inter-Korean Relations and the North Korean Nuclear Issue*, Shorenstein Asia Pacific Research Center, Stanford University, 2012, pp. 124.

[12] Extracted from comments of Amb. Robert Gallucci, head of U.S. Delegation to North Korea, interview with author, Jan. 2018.

offered diplomats an opportunity to incorporate North Korea into an international network of technical collaboration, shared vested interests, and mutual vulnerabilities that is unique to the once-through LWR fuel cycle, and may have obviated the North's perceived need to build nuclear weapons. This prospect emerged in part from the distinctive technical attributes of LWRs -- the brute technological inertia associated with high up-front costs and the internationally-collaborative endeavor of operating them -- and actors' pursuit of that opportunity is borne out in the negotiating history and content of the AF and follow-on LWR supply agreement.[13] Following this, I examine oral accounts of public officials who participated in those negotiations from the U.S. side, and official statements of the North Korean regime. I show that those accounts are more consistent with the *techno-diplomatic* structure outlined here than with common interpretations of the AF that evoke *carrots and sticks*. I then compare the two interpretations side-by-side as alternate *paradigms* in the Kuhnian sense, illustrating several points where they are *incommensurable*, rather than in mere disagreement.[14] I illustrate how prominent aspects of North Korea's nuclear behavior appear mysterious under the *carrot and stick* paradigm -- leading to either convoluted or anti-scientific theories about their motives -- but can seem natural and even expected under a *techno-diplomatic* understanding. I thus hope to leave the reader with little recourse but to abandon the *inducement paradigm* of nuclear crisis diplomacy.

I conclude with implications for future engagements with suspect proliferators, and by outlining a *techno-diplomatic* approach to proliferation-crisis resolution.

## 1. Techno-diplomacy and Nuclear Proliferation Crises



There are two serious difficulties that confront an observer trying to understand the history of nuclear diplomacy with North Korea. The first is lamented often: our empirical access to North Korea's intentions is extremely limited. We can't look at internal documents or interview regime decision makers, and the regime's behavior has often appeared mysterious or downright incomprehensible. But any serious attempt to understand the challenges posed by a suspect proliferator *must* keep a running interpretation of its intentions, even if that interpretation is tentative and regularly updated. Multiple interpretations are often possible, and none can be proven, but some are more reasonable than others. My strategy here will be to suspend disbelief of the regime's stated goals, and examine whether those are consistent with its observed nuclear behaviors.

The other difficulty is that any inquiry into past diplomatic failure requires counterfactual analysis. Other analysts recognize this challenge, and have used it to justify an anti-theoretical stance.[15] But counterfactual consideration is central to any intellectual enterprise, and there are some well-developed guidelines for how to carry it out. Important among those is to ask whether the mutated aspects of an analytical counterfactual are indeed mutable features of reality, and whether they are cotenable with other features of reality that we understand to be less mutable.[16]

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[13] Agreement on Supply of a Light-Water Reactor Project to the Democratic People's Republic of Korea Between the North Korean Peninsula Energy Development Organization and the Government of the Democratic People's Republic of Korea, Dec. 15, 1995.

[14] Thomas Kuhn, *The Structure of Scientific Revolutions*, (Univ. of Chicago Press (UoCP), 1962.

[15] Pollack, in *No Exit*, for instance, dismisses counterfactual analysis as "if only" thinking.

[16] James Fearon, "Counterfactuals and Hypothesis Testing in Political Science", *World Politics*, 43:2:169-195 (1991).

The words "agency" and "structure" generally point to those aspects of reality that are more and less mutable, respectively, by the intentional choices of human actors.[17] The distinction helps us interpret the effects of our own choices (given the known structure of reality, could we have chosen differently, and what might the outcome have been?) and the presumable intentions behind the observed choices of others (given the structure within which the other is situated, what can their actions tell us about their interests?). I will thus outline the more inert structural features of the North Korean nuclear crisis, and of the AF that was negotiated by agents who nominally hoped to resolve it. My formulation is consistent with a *structurationist*[18] account, and suggests that key historical actors had an intuitive sense of the *duality of structure*.[19] Along these lines, the AF may be read as a collaborative attempt, by diversely situated actors, to incrementally adjust a structural reality that they had collectively deemed problematic. Physical traces of that attempt -- the desiccated skeletons of half-built reactors on the ground at Yongbyon[20] and Kumho[21] -- attest that they may have begun to succeed.

*a. Bargaining dilemmas, costly signaling, and the arrow of time*

James Fearon has described "a situation in which a mutually preferable bargain is unobtainable because one or more sides would later have an incentive to renege on the terms".[22] This is the canonical *commitment problem* of rationalist *SS*, and it can illuminate the North Korean nuclear crisis. Notice that the crux of Fearon's dilemma is manifest in the dimension of time: it is not the current incentive structure, but its foreseeable *time differential,* that precludes a bargain. We will see that consideration of the time dimension of power has figured prominently in the concerns of U.S. and North Korean decision makers throughout the nuclear crisis, and that both sides attempted to leverage time-irreversible physical processes[23] in order to manage and levy these temporal powers and uncertainties.

The time-directionality of inter-state behavior is implicitly incorporated by *SS* scholarship into the concept of *costly signals*.[24] As states attempt to communicate and observe each others' intentions, the amount of reliable information contained in their signals or observed behaviors is directly related to the irreversible costs visited by those upon the exhibiting state, and to the distribution of those costs over time. Fearon parses out this cost-time landscape by distinguishing between *sunk costs* that are incurred in the act of signaling or making a commitment, and the *tied-hands costs* that are set in place by the signaling or committed act, but which would only be incurred in the event that the signal sender breaks the commitment at some future time. This is congruent with the incentive-time structure of the commitment problem: *sunk costs* speak of the

[17] Alexander Wendt, "The Agent-structure Problem in International Relations Theory", *International Organization* (*IO*), 41:3:335-370 (1987).

[18] See: Wendt, "The Agent-structure Problem"; Anthony Giddens, *Central Problems in Social Theory*, U.C. Press, 1979.

[19] See Giddens **pp. xx**

[20] Yongbyon is North Korea's principle nuclear research complex. See Siegfried Hecker, Chaim Braun, Chris Lawrence, "North Korea's Stockpiles of Fissile Material", *Korea Observer*, 47:4:721-749 (2016).

[21] Kumho was the site selected for building Western LWRs in North Korea.

[22] James Fearon, "Rationalist Explanations for War," *IO*, 49:3:379:414 (1995)

[23] The concept of 'irreversibility' intended here mirrors that associated with thermodynamic processes that result in increased entropy. For a classic illustrations of the connection between time-irreversible processes and the "arrow of time", see: Arthur Eddington, *The Nature of the Physical World*, (Univ. of Michigan Press, 1928); Ilya Prigogine, *From Being to Becoming*: *Time and Complexity in the Physical Sciences*, (Freeman: 1980).

[24] James Fearon, "Signaling Foreign Policy Interests: Tying Hands versus Sinking Costs," *Journal of Conflict Resolution* (*JCR*), 41:1:68-90 (1997); Robert Powell, "War as a Commitment Problem", *IO*, 60:169-203 (2006).

future-oriented commitments by virtue of their time-irreversibility, and a *tied-hands* signal is essentially an act that reaches into the future to irreversibly adjust a foreseen incentive structure in favor of a commitment's durability.

Now consider the structure of the North Korean nuclear crisis at the end of the Cold War. The U.S. and North Korea had been in a technical state of war for over three decades, involving extensive troop buildups along the demilitarized zone, and Trading with the Enemy Act sanctions on North Korea. This is a fairly entrenched mode of interaction between two states. If North Korea -- as it claimed it did -- wanted to change that relationship, that would involve both physical changes on the ground, and long term commitments on the part of the U.S. to maintain those changes in the future. At the same time, North Korea's Pu-production capability was the primary impetus behind U.S. engagement with the North in the first place. So if North Korea were to give that up in exchange for *written* commitments on the part of the U.S. to normalize in the future, why would the regime expect the U.S. to follow through on those commitments, once it had given up its only source of bargaining leverage? Likewise, if the U.S. were to alter the physical (read "military") aspects of the relationship at the DMZ in exchange for the North's denuclearization, how could it then be sure that the North would not invade America's close ally to the South?

This dilemma is structurally equivalent to a commitment problem with endogenous power shifts.[25] If U.S. and North Korean decision makers could envision a mutually-acceptable political future -- comprising a denuclearized Korean Peninsula and normalized relations -- they lacked a credible path toward it. Simple assurances or scraps of paper would not have resolved this problem. Neither would transient inducements with negligible cost to the giving party. Instead, what was needed was a solid framework for costly signals distributed across time; one that could provide a regular stream of credible information between both sides; and incrementally adjust future incentive structures toward ones more compatible with future cooperation.



*b. Do light water reactors have politics?*

Often, "what appear to be nothing more than useful instruments are, from another point of view, enduring frameworks for social and political action."[26] The insight that different technological artifacts entail different modes of social interaction, and hence can function as "politics by other means," is foundational in *S&TS*.[27] Bruno Latour and others even argue that stabilization of social relations is one of the more consequential roles that technology can play in human affairs.[28] Social and political relations are often, by themselves, fleeting and unstable. They require constant regeneration through face-to-face interaction and costless written word. Comparatively, tools are brute and obdurate. Their use can exact costs and rewards on disparate actors who are displaced in space and time. And if use of an alluring tool draws the user into a particular role, or into particular relationships with other users or suppliers, then propagation of that tool can act to spread and solidify those roles and relationships across a human substrate. While the affinities between a given technology and its corresponding social arrangements are not deterministic, they can arise in part from the physical attributes of the technology itself, and

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[25] See James Fearon, "Bargaining Over Objects that Change Future Bargaining Power",

[26] Langdon Winner, *The Whale and the Reactor* (University of Chicago Press, 1985).

[27] Bruno Latour, "Give Me a Laboratory, and I will Raise the World," in Karin Knorr-Cetina and Michael Mulkay, edt., *Science Observed: Perspectives in the Social Study of Science* (Sage, 1993).

[28] Bruno Latour, *Reassembling the Social* (Oxford University Press, 2005), pp. 64-70.

the way it works. For instance, if using steam power to carry out laborious tasks requires that these tasks be tightly coordinated to avoid costly inefficiencies, then disciplined schedules of human work will be partially governed by the "fixed authority of steam."[29] Hence, in order to understand the political and social relevance of a particular technology, we must examine not only how it works and what it can do to empower human actors, but also what it *requires* of humans in order to 'work well'.

Few technologies are more political than those associated with nuclear energy. Scholars, practitioners and activists have argued for decades that nuclear-power infrastructures *require* highly-organized systems of authority and collaboration to ensure the economic and safe operation of reactors.[30] Similarly, the creation of nuclear bomb fuel demands a tightly controlled chain of command to avoid disaster. To some extent, these demands on social fabrics arise from the nature of the strong nuclear force,[31] and the grotesque concentrations of energy and agency that it allows us to condense into small pieces of matter. Consider the Manhattan Project as an illustration. A substantial fraction of the labor and resources of a nation were set to the task of separating out and arranging a few tens of kilograms of highly-enriched uranium (HEU). This involved the coordinated costly efforts of untold numbers of human agents. In turn, the small piece of metal was then transported whole across the globe, and was able to release enough energy to destroy a city. If the signals arising from the labors of populations can be bundled into small bits of metal capable of destroying or powering cities, then broad swaths of human activity can be partially choreographed by matter itself.

Let us use this type of physical and social insight to think about LWR technology, not just as a set of tools that can light homes in order to pacify a suspect proliferator, but as a sophisticated network of signal paths that allow us to communicate and observe nuclear intentions, arrange future incentive structures, and thereby draw actors into more enduring modes of collective action as they seek to make it 'work well'. This amounts to a form of what Gabrielle Hecht has termed *techno-politics*: the manifestation of political visions, identities and strategies in the medium of technological artifact.[32] Here, I adapt Hecht's term to the diplomatic realm: let *nuclear techno-diplomacy* refer to the (re)constitution of international relations in the physical medium of global nuclear infrastructure.[33] I argue that LWR technology can serve as a *techno-diplomatic medium* for forging interdependence between nations, because its 'working well' requires stable international collaboration, mutual leverage, and transparency in the longer term.[34] Consider some of its more exotic attributes:



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[29] Friedrich Engels, "On Authority," *The Marx-Engels Reader* (Norton and Co., 1978).

[30] See, for instance, Russel Ayers, "Policing Plutonium: The Civil Liberties Fallout," *Harvard Civil Rights and Civil Liberties Law Review*, 10:2: 369-443 (1975).

[31] The strong nuclear force between nucleons binds nuclei together. At very small distances (~$10^{-15}$ m) it is hundreds of times more powerful than the electromagnetic force. See Kenneth Krane, *Introductory Nuclear Physics* (Wiley, 1987).

[32] Techno-politics is distinct from politics *about* technology, and from self-empowerment of political actors via the *direct use* of technology. Rather, it highlights cases in which actors seek to bring about a desired social or political order by building technological infrastructures that embody that order, and which draw other actors into it. See Hecht, *Radiance*; Mitchell, *Carbon Democracy*.

[33] To understand what I mean by "in the medium of," consider that an artist may express his/her vision in one or another medium -- for instance, music versus sculpture -- by rearranging the physical constituents of that medium in the image of their vision. One medium may be more or less appropriate than another for a particular project, depending in part on physical properties.

[34] Nuclear power is one of the most highly globalized of all industries, largely for the reasons explained here. See Richard K. Lester and Robert Rosner, "The Growth of Nuclear Power: Drivers and Constraints," *Daedalus* (Fall, 2009), pp. 19-30. See pp. 20-21.

*i. Financial time-structure*. Initial reactor construction accounts for around 70% of the cost of nuclear energy.[35] There are also profound economies-of-scale factors that favor larger reactors. Once constructed, a reactor might return on investment for over a half century, but that relies on comparatively-low operating costs, which in turn require sound operation. Hence, actors who design or finance a reactor will have *sunk* a massive cost, and their *hands will by tied* by a stake in efficient reactor operation for decades to come.

*ii. Fuel-supply requirements*. LWRs require low-enriched uranium (LEU) for fuel. Economically-viable production of LEU at industrial scale has required decades of accumulated research on the part of countless actors, and this capability is concentrated within a small number of states, mostly working in consortia. So fueling requirements can exert a *tying-hands* effect on LWR recipients and exporters who share a common stake in continued reactor operation.

*iii. In-core fuel management*. LWRs run on high-burnup[36] refueling schedules that reduce fuel costs, waste-storage requirements, and losses associated with reactor shutdown. But high-burnup also introduces serious challenges associated with the complex evolution of materials in high-radiation and high-temperature environments. Solutions to these challenges constitute vast stores of intellectual capital accumulated from countless operating hours at LWRs around the world. Safe and efficient reactor-core design is thus an international achievement, and represents a shared vested interest amongst collaborating states.

*iv. Danger of accident*. Due to the danger of radioactive dispersal, reactors introduce an international safety risk.[37] A leading contributor to reactor safety is the knowledge derived from operating hours accumulated at LWRs worldwide, an international asset to which an ‘indigenous’ reactor program would not have full access. Since the consequence of an accident is too large for market-based insurance, reactor liability requires inclusion in global reactor insurance pools. The resulting *tying-hands* effects would work to bind exporter and recipient into a mutual interest in reactor safety and liability.



*v. Proliferation resistant, but not proliferation proof*. Plutonium isotopics within spent fuel (and hence suitability for weapons) depend on burnup level in a way that places weaponization at cross purposes to energy production in LWRs. Further, the cladding from spent fuel allows time-indefinite storage of unit assemblies that are easily safeguarded. In principle, LWRs could be used to make nuclear weapons, but the technical steps are costly and visible to the international community. So LWR-export recipients acquire a form of nuclear “latency” that may buttress the commitments of patron states,[38] but with a visible and

[35] For the economic peculiarities of nuclear power, see Harold Feiveson, “A Skeptic’s View of Nuclear Energy,” *Daedalus* (Fall, 2009), pp. 60-70. For a more optimistic take, see Lester, “The Growth.” For LWR economics during the 1970s, see: William E. Mooze, *Cost Analysis of Light Water Reactor Plants*, RAND, R-2304-DOE (1978). For these reasons, investments in nuclear power typically require government subsidy.

[36] “Burnup” refers to the amount of energy extracted from fuel during its in-core residence. On the economics of in-core management, see: *Technical and Economic Limits on Fuel Burnup Extension*, IAEA-TECDOC-1299 (2002).

[37] See Lester, “The Growth”; Richard Maserve, “The Global Nuclear Safety Regime,” *Daedalus* (Fall, 2009), pp. 100-111; As of 2009, no private insurer has insured a reactor in the U.S. See: Feiveson, “A Skeptic’s View,” pp. 60.

[38] Example: U.S. extended deterrence is partially motivated by nonproliferation goals. See Francis Gavin, “Strategies of Inhibition”, *International Security*, 40:1:9-46 (2015), and patron states in turn threaten proliferation to reinvigorate those relationships. South Korea, for instance, visibly threatened proliferation to keep U.S. troops on the peninsula. See Volpe, “Atomic Leverage”. **also cite Levite; Kang anf Feiveson on RoK**

costly technical line between latency and active proliferation. This helps resolve the lamented "dual-use" quandary of nuclear technology.

These attributes distinguish the once-through LWR fuel cycle as one of the most globalized technologies in existence,[39] and they are not exhibited by conventional energy sources. They help us understand the strategic importance of LWR export for Cold War superpowers as they attempted to solidify their alliance structures.[40] They also help explain why those LWR complexes have an unblemished non-proliferation record worldwide.[41] May they finally help illuminate the *techno-diplomatic* role of LWRs in the 1994 AF.

## 2. Diplomacy by Other Means

The Cold War's end marked profound shifts in North Korea's strategic and economic environment. Gone were the alternating patronages of China and the Soviet Union, and the North's economy was in steep decline. At this time, Kim Il Sung is said to have made normalization with the U.S. a top foreign policy objective.[42] An improved relationship with the U.S., the regime may have hoped, could make way for a limited economic opening, and balance against a rising China.[43] This objective was communicated in Track II settings as early as 1990,[44] and was a top North Korean demand throughout engagements with the U.S.. While we cannot take regime statements at face value, we can suspend disbelief and examine whether they are consistent with North Korea's observed behavior within its structural environment.

North Korea's nuclear program also came to fruition around this time, and with it a capability to produce WGPu. Its first GCR -- the 5MWe pilot reactor at the Yongbyon nuclear complex -- went critical in 1986, and U.S. satellites observed it running intermittently thereafter.[45] Construction was also underway on the larger 50MWe and 200MWe reactors. Alongside this, North Korea mastered all aspects of the GCR fuel cycle. So by the end of the 1980s, North Korea was producing a small amount of WGPu at the 5MWe -- up to one bomb's worth per year -- and was on the cusp of producing around 30 bombs' worth of material annually, pending completion of their two larger GCRs.[46] This was obviously of grave concern to U.S. decision makers.

If the regime truly wanted to normalize relations with the U.S., it needed a way to incentivize this. There was broad resistance to *any* engagement with North Korea from across the U.S. political spectrum, both in Congress and in the foreign policy establishment.[47] But in 1991, intelligence reports prompted a national security review of U.S. policy toward North Korea. That



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[39] See Lester, *The Growth*; Abraham, *Ambivalence*.

[40] Sonja Schmidt outlines the role of nuclear technology in Eastern Bloc politics and economics in "Nuclear Colonization?: Soviet Technopolitics in the Second World," in Hecht edt., *Entangled Geographies*. For the U.S. side, see John Krige, *Sharing Knowledge, Shaping Europe*, (MIT Press, 2016).

[41] See, for instance, Nicholas Miller, "Why Nuclear Energy Programs Rarely Lead to Proliferation", *International Security*, 42:2:40-77, 2017.

[42] Several authors have made the case elsewhere that North Korea sought normalization and limited economic reform. See footnote **xx**.

[43] See Carlin, "What North Korea Really Wants."

[44] See Sigal, *Disarming,* pp. **xx**. This was also indicated by John Lewis, who had extensive track 1.5 engagements with North Korea, interview with author, Feb. 2016.

[45] See "North Koreas Nuclear Efforts", CIA, 1987, nsarchive2.gwu.edu.

[46] Hecker, et al., "North Korea's Stockpiles of Fissile Material".

[47] See Sigal, *Disarming*.

review recommended engagement with the North as the best way to stop it from building nuclear weapons.[48] Declassified internal documents indicate a mixed sentiment toward engagement within the Bush I and Clinton Administrations, but a consensus is visible on two key issues: that the goal and impetus of diplomacy with North Korea is to stop their nuclear program, and that diplomatic normalization may be acceptable *after* denuclearization.[49]

Here we have the makings of our endogenous commitment problem. Both sides claimed to prefer denuclearization and normalization to their *present* realities of latent proliferation and armistice.[50] If the solution simply amounts to an exchange of self-contained “carrots” that lack internal structure, then there is no dilemma. But denuclearization would also amount to a power shift that, from the North’s perspective, may be incompatible with a stable normalized relationship into the future. And as we will see, many of the physical steps toward denuclearization would constitute time-irreversible processes. It would have been irrational for the North to carry out these steps in exchange for *written* security assurances that could be more easily reversed. For engagement to meaningfully ensue, the North’s disarming steps would need to be reciprocated by similarly-irreversible physical steps on the part of the U.S. that would alter *its own* incentive structure in favor of continued engagement. This is what the ‘reactor trade’ of the AF was all about.

*a. The art of physical commitment*

The regime first proposed to trade its GCRs for Western LWRs during a low-level meeting with the U.S. in June of 1992.[51] The proposal fell under the radar until it was unofficially resurrected during high-level talks in June 1993, during which North Korean Amb. Kang Sok Ju indicated that it was “designed to open up North Korea”.[52] In July of that year, the North Korean delegation formally proposed to dismantle its entire GCR fuel-cycle complex, in a phased approach, in exchange for Western LWRs and normalization with the U.S.[53] This became the centerpiece of a diplomatic approach that would culminate in the AF.

The fact that the AF included LWRs instead of fossil fuel power plants (FFPPs) constitutes one of the perennial mysteries of diplomacy with North Korea, and under the *inducement paradigm* it is indeed mysterious. If the LWRs were simply to function as the *carrot* of energy-generation capacity, then FFPPs would have been far a superior solution. They’d be quicker to build (if you want a carrot, why not get it sooner?); they’d be cheaper, and hence easier to justify to U.S. domestic audiences; and they could be sized to better fit North Korea’s aging energy grid.[54] The U.S. delegation attempted to convince their counterparts to accept FFPPs, but the



[48] National Security Review 28, “United States Policy Toward North Korea’s Nuclear Weapons Program”, 2/6/1991, fas.org.

[49] At nsarchive2.gwu.edu, see: DoD paper, “U.S.-RoK Basic Positions”, ca. 9/1991; Telegram, US-DoS to Tokyo, 9/13/1991; Briefing Book, Deputies Committee Meeting, 12/13/1991;

[50] We can surmise an earnest U.S. preference from declassified internal documents: see **footnote xx**. North Korea’s stated preferences for normalization and a nuclear weapons free zone in Korea are recounted in, for instance, Sigal, *Disarming Strangers*.

[51] Sigal, *Disarming Strangers*, pp. 39.

[52] Recounted by Amb. Thomas Hubbard (Principle Negotiator, U.S. Delegation to North Korea 1993-1996) interview with author, Feb. 2018.

[53] Wit, et al., *Going*, pp. 71-72.

[54] See Peter Hayes, “Should the U.S. Supply LWRs to Pyongyang?”, (Nautilus, 1993).

regime made LWRs an essential demand, and State Department officials recognized that "the idea had merits".[55]

Opening up the technical attributes of LWRs (see *2.b.i-v*) and placing them into the strategic context of the nuclear crisis helps illuminate the *techno-diplomatic* merits of the reactor trade. Throughout the crisis, each side sought to "front load" the other's concessions so as to manage credibility problems.[56] This common diplomatic imperative is mirrored in the financial time structure of LWRs, which is more front-loaded than that of FFPPs (see *2.b.i*) and represents a more profound shared investment in North Korea's energy future.[57] And the international endeavors of reactor fueling[58] (*2.b.ii*), operation[59] (*2.b.iii*), and safety[60] (see *2.b.iv*) could incorporate North Korea into the web of techno-political relationships that make nuclear reactors function. Since these reactors would then be running a substantial fraction of North Korea's industrial economy, that would give the international community strong leverage over the regime's nuclear choices. Altogether, Western LWRs on the ground in North Korea would have constituted a profound shift in shared vested interests, vulnerabilities and risks amongst nations in East Asia. These inert distributions are the physical stuff of international relations.

Building FFPPs in North Korea would represent a much more limited commitment on the part of the international community, and for precisely the same reasons they would be more convenient as a "carrot". The up-front cost and construction time would be much smaller; the fuel-supply would be expensive and more anonymized by market economics; and the operational and safety requirements would be much more straightforward. If nuclear reactors are "not the sort of things a country gives to an enemy,"[61] FFPPs in North Korea would be more consistent with its continued isolation.



The reactor-trade proposal made way for tentative agreement over the content of concessions between U.S. and North Korean delegations.[62] But negotiations then became bogged down over seemingly peripheral issues: the timing of concessions and the national source and identity of the LWRs. These struggles seriously jeopardized the prospect of a deal, and they too are mysterious under the *inducement paradigm*: if the LWRs were simply a carrot, then why would the regime jeopardize the prospect of receiving them over disagreements that seem so petty? But a closer look at these skirmishes reveals a high-stakes struggle over techno-political futures on the Korean peninsula.

There was a crux to the timing issue that went beyond credibility management. The IAEA had demanded special inspections at two sites to resolve uncertainties about North Korea's nuclear past. But North Korean negotiators demanded substantial progress on the LWRs before special inspection could take place. Meanwhile, U.S. nonproliferation law prohibited delivery of

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[55] Comments of Amb. Hubbard, interview Feb. 2018.

[56] This was a persistent theme of negotiations. See: Wit et al., *Going*; and Sigal, *Disarming*. Internal deliberations of the Bush I Administration also obsess over how "forward leaning" U.S. diplomacy should be. See, for instance: Briefing Book 12/13/1991.

[57] Reflected in KEDO Supply Agreement, Art. II-III. and Annex 3 and 4.

[58] Reflected in KEDO Supply Agreement, Art. VIII.1.

[59] Reflected in KEDO Supply Agreement, Art. VII-IX.

[60] Reflected in KEDO Supply Agreement, Art. X-XI.

[61] **Amb. Hubbard quoted in Wit, et al. pp. xx.**

[62] Some of these were spelled out in the U.S.-North Korean Joint Statement of June 1993. Others, such as the possibility of IAEA visits at suspect sites to resolve North Korea's past activities were discussed in the July 1994 talks. See Wit, *Going Critical*.

the "nuclear components"[63] of a reactor to countries not in good standing with the IAEA. This impasse forced the U.S. delegation to consult experts in Washington to determine what "percent" of the LWRs could be constructed prior to delivery of nuclear components. Under an *inducement* structure, this detour is utterly bizarre -- if only the carrot of energy generation is at stake, why not bypass the dilemma by going with FFPPs instead? But as a *techno-diplomatic* struggle to shift political realities, it makes more sense. Sinking substantial investment in the "non-nuclear" foundation of a LWR could incentivize two key political changes that had previously been refractory: North Korean acceptance of IAEA demands, and a U.S. nuclear supply agreement with North Korea. The first would bolster the Nonproliferation Treaty regime, and the second would amount to a profound U.S. endorsement of the North Korean regime. This strategy was later dubbed the "percent solution", and written into the AF and follow-on LWR supply agreement.[64]

The second diplomatic roadblock -- the national source of LWRs -- is also instructive. North Korea originally wanted everything to come from the U.S., including financing.[65] That could help produce the bilateral political relationship the regime sought, but might distort the multilateral U.S. alliance structure in East Asia. So the U.S. delegation proposed an international consortium with regional U.S. allies to build the LWRs. South Korea and Japan embraced this opportunity by volunteering large sums of money to pay for the LWRs. But these were dangerous prospects for North Korea: if the U.S. unshouldered the reactor burden to its allies, it might lose interest in the relationship after North Korea disarms. In particular, if the responsibility were shifted to South Korea -- if the reactors became identified as "South Korean" reactors -- then that starts to look like an investment in reunification under the South Korean government, which was the North Korean regime's worst fear. But the consortium became a hardened feature of U.S. demands. From there, North Korea fought to maximize U.S. responsibility for the LWR project by ensuring that the consortium had an "American face". The LWR identity struggle became a defining theme throughout the negotiations, and produced some of its more perplexing artifacts.[66] But if we interpret it as an attempt by North Korea to translate the LWRs' massive sunk costs upon U.S. allies into future audience-cost[67] differentials for the U.S., then the mystery subsides. The relevant audience -- the U.S.-led alliance structure in East Asia -- was after all the major stake for U.S. policy on the peninsula.

The AF was finally signed by the U.S. and North Korea in October of 1994. It called for a U.S.-led international consortium -- the Korean Energy Development Organization (KEDO) as it was called -- to build two 1,000 MWe LWRs in exchange for the freeze and eventual dismantlement of North Korea's GCR complex. The reactors would be of American design, and built by U.S. allies at the North Korean port city of Sinpo. Alongside the LWR project, KEDO would ship U.S.-funded heavy fuel oil (HFO) to Sinpo, and this would function to regularly

[63] The "nuclear components" refer to items on the Nuclear Suppliers Group trigger list. See: **INFCIRC/254, International Atomic Energy Agency, Feb. 1978.**

[64] The "percent solution" and the U.S. strategy behind it were recounted by Amb. Gallucci, interview, Jan. 2018; and Gary Samore (Dir. of Nonproliferation, NSC) interview with author, Feb. 2018. See also, Wit et al., *Going*, pp. 307-310; KEDO Supply Agreement, Annex 4.

[65] Amb. Gallucci, interview, Jan. 2018; Robert Carlin, (Chief, DoS-EAP, 1989-2002), interview with author, Apr. 2016. See also Charles Kartman, Joel Wit, Robert Carlin, "A History of KEDO", CISAC, 2012; Wit et al. *Going*, **pp. xx.**

[66] Among these, we have a "presidential letter of assurance" obligating the Clinton administration to use its "executive powers" to ensure LWR construction (AF, Art. I.1); and a South Korean Standard Reactor design anonymized as the "advanced version of U.S.-origin design" (KEDO Supply Agreement, Art. I.1)

[67] **Cite Fearon on 'audience costs'.**

signal U.S. commitment to the AF. The ultimate stated end goal of the accord was a fundamentally changed relationship between North Korea and the West, culminating in normalization with the U.S. and denuclearization of the peninsula -- precisely the incredible political future articulated by both sides at the outset of the crisis. The accord's main physical prescriptions amounted to an elaborate array of mutual signals and expenditures designed to build the credibility of that envisioned future.

*b. Arrow-of-time diplomacy*

We can now surmise an initial state, and an envisioned end state. In the initial state of affairs, the U.S. is engaging with North Korea primarily because it can produce WGPu at Yongbyon. In the envisioned end state, North Korea has dismantled this capability, but in its place stand two Western LWRs on North Korean soil, constituting the physical embodiment of a changed political relationship. But what about the transition between those two realities? How was credibility to be managed along that path? This was one of the more carefully deliberated issues during negotiations, and the outcome was somewhat paradoxical -- the AF itself was expressly *not* a binding written commitment. Rather, it proposed a strategic choreography of time-irreversible physical processes to service the credibility of a pending political future -- a physical path toward denuclearization and normalization. If commitments to that envisioned future were not credible on paper, then the essential innovation of the AF was to take those commitments *out of juridical space*,[68] and attempt to express them incrementally on the ground at Yongbyon and Kumho.

The proposed sequence of physical commitments was more precisely spelled out in Annex 3 of the KEDO LWR supply agreement (see Fig. 1).[69] North Korea's most irreversible steps toward denuclearization were to be spread out across time, and synchronized with the most costly and irreversible steps in the LWR construction process. While the *carrots* associated with many of these interlocking steps would be reversible -- at any point during the process, KEDO could simply halt construction and the North could restart the 5MWe reactor -- the *costs* entailed in each step would be irreversible without additional costs associated with backtracking. Dollars invested in LWR construction could not be recovered if the LWRs were never operated, and each dismantlement step or freeze-year of the North's GCR complex would sink it further toward unsalvageability. With this careful combination of irreversible costs and reversible pending benefits, each pair of synchronized steps could function as an exchange of costly signals, indicating both sides' willingness to continue down the path, and incrementally shifting the incentive structure in favor of taking the next step. By the time the LWRs were operational, U.S. allies would have invested upwards of $5 billion in North Korea's energy future, and the physical destruction of North Korea's GCR complex would be complete.



[68] Legal counsel to the U.S. Delegation insisted that the AF was "not an agreement, but a framework for action. We do stuff, they do stuff. The stuff we do depends on what they do, but at present (signing of AF) there is no 'agreement'". This passage recounted by Amb. Gallucci, interview Jan. 2018; Carlin, interview Apr. 2016.

[69] KEDO Supply Agreement, Annex 3.

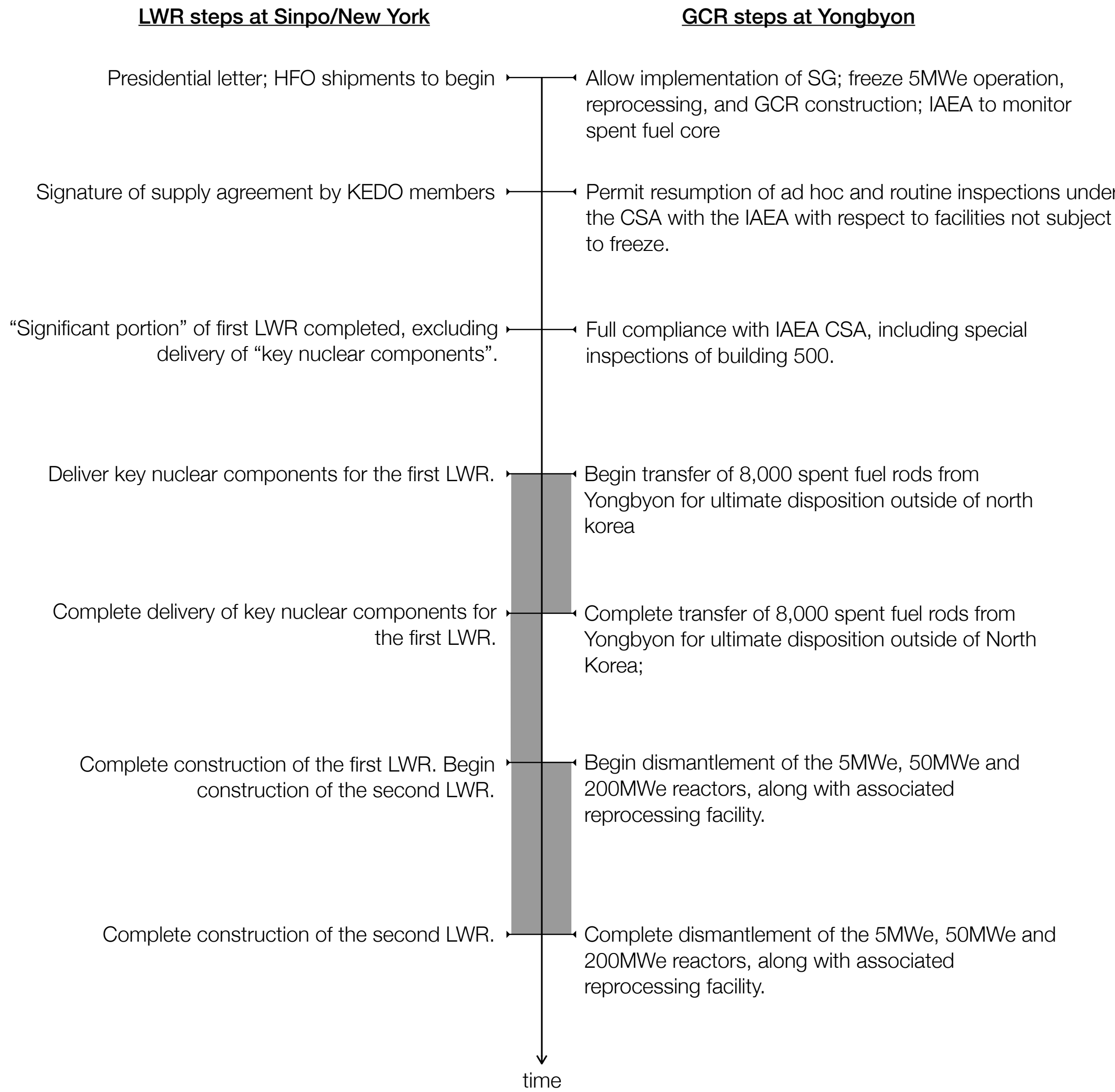


Fig. 1. Timeline of reciprocal time-irreversible physical processes outlined in Annex 3 of the KEDO LWR Supply Agreement.

Had they been fully constructed, however, the KEDO LWRs alone wouldn't have been enough to ensure expanded relations between North Korea and the outside world. Rather, their *techno-diplomatic* potential was seen as fractal or nested. As a self-contained entity, the LWR export itself was described as a possible "lynch pin" to set the stage for further *techno-diplomatic* engagements.[70] Toward this end, physical changes on the ground were intended to precede and hopefully *catalyze* important juridical changes within KEDO-member states. Bilateral nuclear cooperation agreements, labor protections, and lifts on communication and travel bans were

[70] Joel Wit (senior advisor to U.S. delegation during AF negotiations) outlined the extraneous effects of the KEDO project that DoS officials envisioned in "The Korean Peninsula Energy Development Organization: Achievements and Challenges," *Nonproliferation Review*, vol. 6, no. 2 (1999), pp. 59-69. See pp. 62-63. Reiterated to the author by Wit (interview Feb. 2017) by Carlin (interview Apr. 2016). The phrase "lynch pin" was used by Thomas Fingar (Dir., DoS-EAP, 1989-1994), interview with author, Apr. 2016. Mitchell Reiss (lead negotiator of KEDO 1995-1999) articulated these prospects as follows: "we'd be all over that country"; interview with author Feb. 2018.

previously unthinkable in respective capitals, but with the first large-scale Western-style construction project in North Korea hanging in the balance, they might suddenly become imperative for both sides. Connecting the LWRs to North Korea's energy grid would be another avenue for precipitated cooperation. The grid upgrades needed would require North Korea to obtain financing from international institutions, which would in turn require changes in U.S. laws that opposed international loans to North Korea. They would also entail further exposure of the regime to international-finance norms and western civil-engineering practices. Since the fate of KEDO's own loans would be tied to extracting electricity from the LWRs, KEDO members would face new incentive to facilitate these changes. Again, FFPPs sized to fit the existing grid did not offer the prospect of catalyzing any of these further investments or changes.

*c. Cross correlations and financial hysteresis of the KEDO process*

If the AF articulates a physical path between two disparate political realities, then significant actualized progress along that path is evident in the partially-constructed power reactors at Yongbyon and Kumho. But most of the steps outlined in the KEDO supply agreement were never carried out. Construction steps and HFO delivery were both chronically delayed, leading North Korea to protest that the U.S. was not committed to the process. And shortly after the Bush Administration entered office in 2002, it reevaluated the available intelligence on North Korea's procurement activities, and accused North Korea of "cheating" on the AF by pursuing a clandestine enrichment program.[71] The U.S. then ordered KEDO to halt HFO shipments and LWR construction, and North Korea responded by restarting the 5MWe reactor and reprocessing the spent fuel from its initial core. This was effectively the end of the AF. All told, U.S. allies had invested nearly $2 billion in the first LWR; the U.S. had contributed $405 million to create KEDO and facilitate HFO shipments; and North Korea had essentially gutted its GCR complex, leaving its 50MWe and 200MWe reactors in ruins, and only a meager Pu-production capability intact. What to make of this partially-realized political vision?

Common appraisals of the AF hinge on how successfully it is seen to have "delayed" North Korea's nuclear program. This interpretation stems from the *inducement paradigm* which sees AF implementation as a stream of "carrots" to continually "buy" a Pu freeze at Yongbyon, and evaluates success based on the intrinsic security value of the freeze. Under this framing, any non-violent nonproliferation policy is simply a stop-gap measure. But if we consider the time-directionality of diplomacy and the *physicality* of commitment, we can learn much more from this history. Figure **xx** shows a timeline of engagement under the AF, with North Korea's major steps arrayed along the top, and KEDO steps arrayed along the bottom. Behind the discrete events, I have plotted North Korea's projected Pu-production forfeit (resulting from the freeze) as a waterfall graph along the top, and KEDO's financial status along the bottom.[72]



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[71] See Mike Chinoy, *Meltdown: The Inside Story of the North Korean Nuclear Crisis*, (St. Martins Griffin, 2008), ch. 5, "The Scrub".

[72] KEDO financial data drawn from "KEDO Annual Report, 2005", appx. 1: "Financial Support". Projected Pu-production deficit is estimated in Hecker, et al, "North Korea's Stockpiles". Perry Process and missile-related events chronicled in Chinoy, *Meltdown*. North-South engagement events outlined in Lim Dong-won, *Peacemaker: Twenty Years of Inter-Korean Relations and the North Korean Nuclear Issue*, (Brookings, 2012), ch. 10. For outline of what is known about North Korea's clandestine enrichment efforts, see David Albright and Paul Brannan, "Taking Stock: North Korea's Uranium Enrichment Program," ISIS (2010); and Hecker, et al., "North Korea's Stockpiles". Projected Pu-production absent AF based on projected completion of the 50MWe in 1996 and 200MWe in 1998.

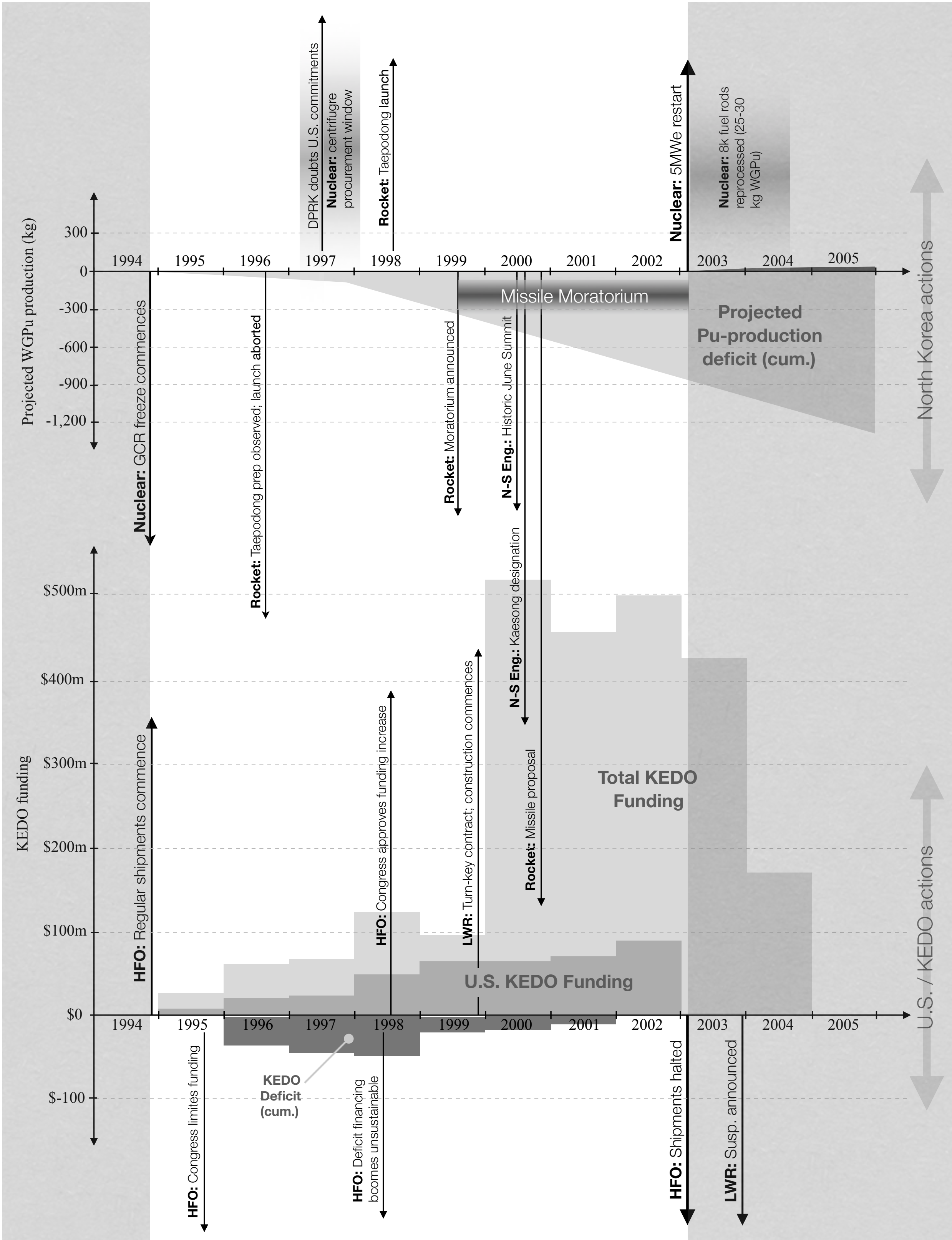


Fig. 2. The Agreed Framework era of engagement with North Korea. Select North Korean and U.S. actions (top and bottom, respectively) are overlaid with KEDO financial status. Inward-pointing arrows represent steps toward better relations; outward pointing arrows represent steps away from better relations.

**(Note: Pu absolute numbers need to be adjusted, but the observations regarding irreversibility will still hold.)**

The first aspect of to notice from Fig. 2 is that prominent features of North Korean behavior mirror the trajectory of KEDO's financial status. The actions plotted are selected based on three areas of U.S. diplomatic concern: the clandestine enrichment program, the missile track, and North-South engagement. Difficulties in the KEDO process -- deficit financing resulting from lack of U.S. funding for HFO shipments, delays in LWR construction, etc. -- are well outlined in other venues.[73] What we notice here is that North Korea's initial centrifuge procurements and long-range rocket test fall at the height of KEDO's financial insolvency (1997-1998), whereas the major breakthroughs on the missile track and North-South engagement are aligned with commencement of the LWR construction process. I do not intend to suggest a linear causal relationship between these observables -- the Clinton Administration's "Perry Process" and Kim Dae-jung's Sunshine Policy were crucial parts of the later diplomatic breakthroughs -- but rather to highlight the traces of hybrid[74] techno-diplomatic steps in what are otherwise considered distinct technical and diplomatic realms.

The second important observation is that both cost curves (Pu-production forfeit and KEDO expenses) extend well beyond the political collapse of the AF in early 2003. This time-lag -- between agents' political choices and the consequent shifts in structural reality -- is *precisely* the physical effect that the AF was collaboratively *designed* to harness. KEDO's activities had accumulated pending cost differentials that were then visited upon its members when the AF collapsed. On one side, U.S. allies vigorously resisted the suspension of KEDO's activities, having already invested heavily in the first LWR. Construction was not suspended until December 2003, and significant expenditures were then required to preserve the LWR structure, which would otherwise remain open to the entropic elements of weather. These inertial consequences even reverberated off-sight, at the Doosan heavy industrial manufacturing plant where construction of the massive nuclear components was underway. The parts of the steam generator, for instance, were already constructed, and would corrode quickly if left un-assembled. Engineers had to insist that it be assembled and closed air tight before a suspension could begin. Special mechanisms were then constructed to store those massive components without further corrosion. Altogether, these costs added up to roughly $600m spent by U.S. allies *after* the collapse of the AF.[75]



On the North Korean side, most of the Pu-production forfeiture entailed in the freeze was irreversible at the end of the AF. It is well-known that steel and concrete structural components of unfinished construction projects will degenerate quickly when left exposed to the weather. So while the 5MWe and reprocessing could be unfrozen, each freeze-year of the half-built 50MWe and 200MWe GCRs amounts to an irreversible physical process. It is also instructive to note that North Korea took no steps to preserve these structures.[76] And after eight years of freeze, the two

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[73] See Wit., "The Korean Peninsula"; Kartman, et al., "History of KEDO", ch. 7.

[74] For technical-political hybridity, see Bruno Latour, *We Have Never Been Modern*, (HUP, 1993).

[75] See comments of Choi Han Kwon (KEDO secretariat) and Jack Mulligan (Dir. of Proj. Relations, KEDO), recounted in ch. 13-14 in Kartman et al., "History of KEDO".

[76] Visual observations of Stanford Track II Delegation (2004), and conversation with Yongbyon Dir. Ri Hong Sop, (2004-2006), recounted to author by Siegfried Hecker and John Lewis, Fall 2015. See also: Siegfried Hecker testimony to Senate Foreign Relations Committee, "Visit to the Yongbyon Nuclear Scientific Research Center in North Korea", Jan. 21, 2004; Siegfried Hecker, "Report on North Korean Nuclear Program", CISAC, Nov. 2006.

larger reactors had disintegrated to “heaps of scrap metal”. While the North was able to quickly resurrect a token Pu-production capability at the 5MWe after the AF’s demise, the opportunity costs of nearly 200 (need to fix numbers, but my point will remain valid) bombs-worth of WGPu, and 30-bombs worth of continuing production capacity, were not recoverable.

Meanwhile, the U.S. was free to abandon the AF with little consequence to the incumbent administration. This was precisely the stated fear of the North Korean regime during the AF negotiations -- that if the U.S. offset its responsibilities, it might “lose interest” in engaging North Korea once the bulk of the nuclear threat had subsided. In this sense, the low cost to U.S. tax payers of KEDO may have been one of the fatal defects in the AF. A more pronounced “American face” to the KEDO project may have mended this defect by translating Japan’s and South Korea’s sunk costs into audience costs for the U.S. vis-a-vis its allies in the region. But American responsibility for KEDO had been whittled away to mere window dressing by 2001. And while North Korea’s clandestine centrifuge procurements are fairly uninteresting as a “cheat” on the AF -- all states will “cheat” on a commitment if they perceive their security to be at stake -- their timing as a “hedge” in response to the signals entailed in KEDO’s financial insolvency is precisely what a *techno-diplomatic* understanding would predict.

## 3. Subjective Accounts of Agency within a Techno-diplomatic Structure

My description of the AF is thus-far supported by a diverse array of empirical sources, ranging from the negotiating history and content of the AF and follow-on supply agreement, to observable physical steps on the ground at Kumho and Yongbyon. But this begs the question: did the actors themselves actually see it in the way I describe? (Add comment on **Eddington and intuitiveness here?)** This section seeks to answer that question in the affirmative, and explore some interesting caveats to the answer. For the U.S. side, I have conducted a series of semi-structured interviews with key U.S. public officials who participated in the negotiations and implementation of the KEDO process. For the North Korean side, without direct access to documents or interview subjects, I will instead examine its official statements, and address popular interpretations of the possible motives behind its observable behavior that run counter to my account.



### *a. “An instrument to manage the relationship”*

“We didn’t think of the KEDO LWRs as a carrot, but as an instrument to manage the relationship over time”.[77] While this was the chosen language of one interview subject, it is representative of the overwhelming theme. Amb. Robert Gallucci,[78] head of the U.S. delegation that negotiated the AF, spells it out more explicitly when discussing the reactor identity issue (see *Sec. 2.a*).:

> The LWR project was a manifestation of a changing relationship, because it would take quite a long time to build, and substantial financial investment...the North Koreans wanted the U.S. to be the ones who were on the hook...that is what the LWR project was a manifestation of. It wasn’t that they’d just get 2,000 MWe of electricity, but that the LWR project would have meant that the U.S. was hardwired in. And we would have gone further if there were a way for us to finance it, but there wasn’t.

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[77] Fingar, interview Apr. 2016.

[78] Amb. Gallucci, int. Jan. 2018.

This passage explicitly foregrounds the financial time structure of an LWR project, while relegating its intrinsic utility to North Korea -- 2,000 MWe of energy generation -- to the periphery. The LWRs were "a manifestation of a changing relationship" *because* of their high up-front costs and lengthy construction process. This is precisely the opposite of an *inducement account*, which would base the prospect of *inducement* success on the "carrot's" intrinsic value to the regime, and treat the cost and duration of its delivery as a regrettable, if necessary, tradeoff.

Other accounts tell a similar story -- all interview subjects either explicitly or implicitly describe the KEDO process as an attempt to change the relationship between North Korea and the outside world. While no single account offers a full outline of the technical attributes of LWRs (*Sec. 1.b.i-v*) as they pertain to their *techno-diplomatic* function within the AF, those attributes emerge piecemeal and implicitly, as in Gallucci's account above.

There is, however, an illuminating caveat. Two interview subjects -- Mitchell Reiss and Gary Samore -- explicitly dismissed the role of LWRs, and interpret them as simply an idiosyncratic demand on the part of the regime. At first glance, these two exceptions appear to conflict with my *techno-diplomatic* account of the AF. But on closer examination, they articulate the *techno-diplomatic* prospects of LWR export with high fidelity, if only from a more U.S.-centric point of view.

Reiss begins his account by sidelining the LWR choice, and black-boxing North Korean motives behind the demand.[79]

> The North Koreans wanted LWRs, they didn't want anything else. So the technology itself was not an option for us.
>
> It was the shiny new toy, it was status...the heart wants what the heart wants.



But when he distinguishes between LWRs and FFPPs from a U.S. strategic perspective, the *techno-diplomatic* strategy comes to the forefront of Mitchell's account.

> LWRs would require much more extensive training; they'd be harder for them to manage; they'd take longer to bring online. LWRs are much harder than FFPPs to operate and repair. And then there's are safety and liability issues that require long-term interaction. I don't want to call it a Trojan horse, but we were gonna be in there for a really long time.

It opens up further when Reiss highlights the grid upgrades that the LWRs would required.

> We talked about World Bank or IMF loans (to finance the grid upgrade)...and the Japanese were quietly talking about tens of billions of dollars of infrastructure. So yeah, we'd be all over that country (if the LWRs had materialized). People were thinking that there is an upside to us being so intimately involved with some of their fundamental national decisions.

Samore's account follows a similar trajectory. When asked about the possible North Korean intent behind the LWR preference, he says:

> God knows (why they insisted on LWRs). When pressed, their explanation was something along the lines of 'Kim Il Sung said so'.

But when discussing Annex 3 of the supply agreement from a U.S.-strategic perspective, he recounts the "percent solution" (described above in **Sec. xx**), whereby a maximal non-nuclear

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[79] Reiss, interview Feb. 2018.

investment was to be made on the ground at Kumho so as to incentivize North Korea to allow IAEA special inspections.

> The theory behind the LWR project (from a U.S. perspective) was that it would create an incentive for the North Koreans to come into compliance with their safeguards agreement, because the project would halt if they didn't. And it was deliberately set up that way.

These accounts align with our *structurationist* analysis. When discussing the AF from a global or wholistic perspective, Reiss and Samore attribute the LWR choice to North Korean idiosyncrasy. But when situated within a U.S. strategic perspective at the negotiating table with North Korea, both actors expertly navigate and mobilize the unique constraints and opportunities within that strategic locale. That negotiating environment was, in turn, shaped in part by a larger structural reality of which the prospect of LWR export was a defining feature.

*b. "A physical guarantee of confidence building"*

Throughout the history of diplomatic engagement between the U.S. and North Korea, Western LWRs remained one of the regime's central demands. When the proposal surfaced in 1993, Amb. Kang Sok Ju indicated that it was "designed to open up North Korea". As late as 2005, track II diplomats relayed to Washington an unequivocal message from Amb. Kim Gye Guan: "no reactor, no deal".[80] Reference to LWRs was a defining feature of the breakthrough Sept. 19, 2006 joint statement of the six party talks.[81] But shortly after that breakthrough, the U.S. delegation unilaterally announced the dissolution of KEDO, effectively dashing the prospect of LWR export. The response from the North Korean Foreign Ministry might be the most explicit articulation of the desired *techno-diplomatic* function of Western LWRs in North Korea[82]:

> The U.S. should not even dream of the...DPRK's dismantlement of its nuclear deterrent before providing LWRs -- a *physical guarantee of confidence building* (emphasis added). One should wait and see how the U.S. will move in actuality at the phase of 'action for action' in the future."

By explicitly referring to the LWRs as "a physical guarantee for confidence building", and saying nothing about energy generation, this statement diverges sharply from an *inducement* account of U.S.-North Korean engagement. Other regime statements along these lines are listed in Appx. **xx**. Previous sections have outlined a parsimonious model of U.S.-North Korean engagement in which prominent features of North Korean nuclear behavior -- willfully forfeiting most of their WGPu-production capability, while hedging with clandestine centrifuge research -- are consistent with these statements.

But there are alternative interpretations that are widely held in the West. North Korea is believed to have prioritized nuclear weapons above other goals, and used engagement to extract "carrots" from the West while buying time for its weapons program. While it is impossible to rule out any of these interpretations, there are several anomalies that arise in each, making them needlessly convoluted theories of North Korean strategy. I will consider two popular theories here.

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[80] Recounted Hecker and Lewis, Fall 2015.

[81] See Chinoy, *Meltdown*, **pp. xx.** Also recounted to author by Kathleen Stephens (Dep. Ass. Sec. of State for East Asia and Pacific), int. by author spring 2016, spring 2017; and Yang Xiyu (Dir. of Korean Affairs, Chinese Foreign Ministry, drafter of Sept. 19 statement), int. by author spring 2016.

[82] Statement of the North Korean Ministry of Foreign Affairs, Sept. 20, 2006.

The first popular interpretation is the "have their cake and eat it too" narrative, which suggests that North Korea hoped to use LWRs to produce energy and plutonium for bombs at the same time. Proponents of this interpretation point out -- correctly -- that the refueling schedule for LWRs can be shortened to produce WGPu. But this theory disregards the global interdependencies that LWR operation depends on (*Sec. 1.b.v*). Shortening the refueling schedule would be visible to the international community, which could then withhold fuel and technical support. Then, the North would be left with two cores of fuel -- perhaps enough Pu for a handful of nuclear weapons -- and no reliable prospect of running those reactors further. They would have no reliable implosion device; no test data; no delivery vehicle; no experience reprocessing spent LWR fuel, and the LWRs themselves would be sitting ducks for a preemptive strike. Some analysts argue that the clandestine enrichment program might enable them to independently run the reactors. But industrial-scale enrichment for large power reactors is a profoundly different technical challenge than a fledgeling HEU program sized for nuclear weapons. At the time the AF was signed, North Korea was nowhere near able to enrich uranium at all, and even today it is doubtful they can enrich on the industrial scale required for large power reactors.[83] It is difficult imagine how such a plan could be justified in 1994 from a technical perspective, when the major parts of a sure and timely route to nuclear weapons were already in place at that time.

The second popular interpretation is that the HEU program proves the regime intended to build nuclear weapons all along, and was simply "buying time". Again, we have to put ourselves in the hypothetical shoes of a bomb-determined regime in the early 1990s. While the emerging GCR complex was the surest and quickest route to massive stockpiles of bomb fuel, an HEU capability was a distant and extremely unsure prospect, especially with the super-critical centrifuge model available on black markets at the time. On top of this, HEU bomb designs are more difficult to miniaturize (and hence deploy) than Pu-based designs because the neutronics management often requires the extra step of boosting with fusionable material.[84] A technologist trying to persuade the regime to give up GCRs in favor of the distant prospect of an HEU capability would at least need to make the case for confidence in such a route. This would require a much more substantial centrifuge R&D effort than appears to have been in place at the time. Even when centrifuge parts were finally obtained from the A.Q. Kahn network circa 1997, these were sufficient for R&D with a single cascade. The HEU program does not appear to have constituted a major national effort until around 2001. And the "buying time" function could have been achieved more easily with FFPPs, which could have been constructed in full before IAEA compliance.

If the intended end goal was to acquire nuclear weapons, with perhaps the carrot energy generation along the way, trading GCRs for LWRs or an uncertain HEU program represent radical detours that are difficult to explain. While we can never rule out bizarre strategies on the part of North Korean decision makers, we should not embrace anomaly simply to preserve a belief in North Korea's determination to build nuclear weapons. Meanwhile, the distant nuclear latencies afforded by LWRs and clandestine centrifuge development fit quite seamlessly into our *techno-diplomatic* model of the AF, as a "hedge" to preserve nuclear leverage in case the nominally-preferred path toward normalization fails.



[83] Hecker et al. "North Korea's Fissile Material Stocks".

[84] Carey Subblette, "Engineering and Design of Nuclear Weapons", 1999, http://nuclearweaponarchive.org. **Not sure if true but can make a variant of that argument.**

This understanding is congruent with that of KEDO officials engaging in *techno-diplomacy* at Kumho. KEDO's first director, Amb. Bosworth is on record indicating that "many of us at KEDO *assumed* (my emphasis) that they were hedging...that they had something going someplace that they could rely on if we did not follow through on what they viewed to be our commitment".[85] The pertinent observation for our purposes is that the expectation of hedging did not overturn the conviction held by KEDO employees that their activities represented positive steps. Rather it enhanced their subjective appraisal of the importance of their endeavor, because LWRs on the ground in North Korea would likely create steep incentive for North Korea to refrain from actually building nuclear weapons.

## 4. Two Paradigms of Diplomacy Under Nuclear Proliferation Crisis

This section argues that the *inducement* and *techno-diplomacy* interpretations of the AF flow from competing *paradigms* of proliferation-crisis diplomacy that are mutually *incommensurate* in the Kuhnian sense.[86] In other words, interpretive contributions from the two paradigms do not combine additively into a coherent understanding of the AF, but instead interfere destructively with one another, leading to persistent cognitive dissonance and mis-communication. In fact, the two framings often suggest precisely the opposite prescriptions for nonproliferation policy. I first consolidate and clarify the points of incommensurability we have encountered so far, and then comment on the operation of both paradigms in foreign policy discourse.

The main thread of distinction is that the *inducement paradigm* focuses on the content of inducements -- their intrinsic utility to the target state -- and on linking those to the moral content of *previous* target-state behavior. To the extent that credibility is at issue under *inducement*, it relates to the moral accounting of previous target-state behaviors, and whether the utility of appropriate inducements themselves will actually be received by the target state. In contrast, the major stake for the *techno-diplomacy* paradigm is the future political relationship, and concessions in the present are relevant to the extent that they *speak credibly* about the relative plausibilities of distinct political futures. Since action and structure often speak more credibly than written word, focus shifts to the physicality of commitment. In short, *inducement* diplomacy is backward looking, moralistic, and bound in juridical norms; *techno-diplomacy* is forward looking, co-intentional, and beholden to physical law.

Shifting between these two paradigms entails a direct inversion in the relevance of several consequential dimensions of crisis diplomacy. As Kuhn famously illustrated, cognitive inversions of this type are similar to a *gestalt switch* in visual perception where, for instance, the ears of a hand-drawn rabbit suddenly re-appear as a duck's beak.[87] The observational contents of one gestalt simply cannot combine with those of the other, and instead the visual apparatus flips back and forth erratically. Here are some of the more striking points of incommensurability between the *inducement* and *techno-diplomacy* interpretations of the AF:

> *i. Pro-con inversion -- LWRs versus FFPPs*. When LWRs and FFPPs are compared as candidates for export to North Korea, the very same LWR attributes figure as cons under *inducement* and pros under *techno-diplomacy*. For instance, the necessity of rebuilding North

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[85] Comments of Amb. Bosworth, "Reflections on KEDO, Part III", https://www.38north.org/2012/07/kedointvw/. 17:30.

[86] Kuhn, *Structure*, ch. 6.

[87] See Kuhn, *Structure*, pp. 62.

Korea's electrical grid, in order to connect the LWRs, severely complicates the role of LWRs as an *inducement*, yet could function positively as a *techno-diplomatic signal* to suggest and incentivize profound new forms of engagement and transparency between North Korea and the outside world.

*ii. Time-structure inversion -- appropriate order of concessions.* Positive *inducements* are designed to reward good behavior, and hence must come *after* North Korean denuclearization, which in turn should be preceded only by negative inducements. Under *techno-diplomacy*, the appropriate order is reversed -- credible signals need to be exchanged for a duration before it becomes rational for North Korea to denuclearize, and hence coercive measures prior to denuclearization steps can often be counterproductive.

*iii. Figure-ground inversion -- source versus content of concession.* Under the *inducement* paradigm, intrinsic value of inducements is central, and their source and cost are of peripheral importance. Under *techno-diplomacy*, concessions figure as costly signals, and the bearer of the cost is the actor about whose intention the signal speaks. Thus, as we saw in *Sec.2.a*, the source and identity of the reactors became a central issue of negotiations, and the 2,000 MWe of energy generation became peripheral.

*iv. Inversion of cost-credibility correlation.* Under *inducement,* the cost of concessions is primarily relevant to the domestic audiences of the states that pay for them. Costly concessions are more difficult to justify to domestic audiences, so lowering costs adds to the credibility that they will be given. Under *techno-diplomacy*, the cost *is* the signal about future intent, and the credibility of the signal increases monotonically with cost.

*v. Final vs. open-ended solutions.* If the content of *inducements* and cessation of nuclear activities are the primary stakes, then a final solution to "the nuclear problem" is preferable to open-ended solutions that can be framed as "stop-gap measures". But if the future relationship and nuclear status are the primary stakes, as in *techno-diplomacy*, then open-ended arrangements are crucial, as they indicate endurance of political changes indefinitely.

*vi. Juridically- vs. entropically-binding commitments.* If the realization of *inducements* themselves is at stake, then legally binding written commitments should be sought to enhance credibility that they will be realized. But if an envisioned future is at stake, then irreversible physical changes on the ground constitute much more binding commitments than politically-reversible written agreements. And since verification and interpretation of written agreements is one of the most challenging aspects of arms control, binding written agreements can be counterproductive and distract from what would otherwise be more durable physical changes.

*vii. Clandestine nuclear latency -- cheating vs. hedging.* Under *inducement*, a clandestine latent nuclear capability is morally incompatible with concurrent positive inducements, and hence is considered "cheating". Under nuclear *techno-diplomacy*, a clandestine latent capability figures as "hedging". Rational actors will hedge against the possible failure of nonproliferation agreements, and may feel empowered by the hedge to take further denuclearization steps.

An independent article could be written to demonstrate the dominance of *inducement* tropes over U.S. nonproliferation discourse on engagement with North Korea. The alert scholar could draw amply from news media,[88] nonproliferation academic[89] and grey literature,[90] public policy statements and declassified government documents[91] to make the case. Here I take a snapshot from a moment that was both representative and consequential -- a 1995 congressional hearing on the "Joint U.S.-DPRK Agreed Framework on Nuclear Issues".[92] During that hearing, proponents and critics of the AF alike seemed baffled by basic elements of the AF that relate to points *3.i-vii* listed above, and generally debate the adequacy of the AF as a least-worst stop-gap measure. However, a *techno-diplomatic* sensibility is not entirely absent. What is interesting is that the two paradigms do not map neatly onto proponents and critics. Rather, both sides lapse periodically in and out of each paradigm, and often speak past one another when they do.

Chairman Murkowski opens the hearing by outlining the AF as a list of "what we get" versus "what they get," -- the central features of *inducement* diplomacy. He then points to what an *inducement* lens would see as the AF's three major "oddities": the choice of LWRs rather than FFPPs (*4.i*); the timing of concessions (*4.ii*); and its non-binding nature in legal space (*4.vi*). From here, these anomalies are interwoven into the questions of both proponents and critics of the AF, which are mostly concerned with the propriety of "what they get". There is little discussion of what the AF's steps would mean for North Korea's relationship with the outside world, and how that might shift the incentive structure in favor of nonproliferation.

Bewilderment at the LWR choice is exemplified in the testimony of nonproliferation expert Gary Milholin:

> Why does North Korea want LWRs? Nobody outside the country seems to know. It is agreed...even by the (Clinton) Administration...that the U.S. could provide coal-fired plants much faster and cheaper.



These questions were a common theme throughout the hearing, leaving AF proponents to concede that FFPPs "would have been better", but that North Korea simply would not have accepted them. With little discussion of the political interdependencies associated with LWR construction and operation (*1.b.ii-v*), senators are left to conclude that North Korea secretly wants energy *and* plutonium, and that the LWR demand is some sort of ruse.

Anomalies associated with the time structure (*4.ii*) and non-bindingness (*4.vi*) come together to inform the basis of other major protests, such as that of Senator John McCain:

> There is nothing in that agreement that forces North Korea to account for (previous) diversion...it places no obligation on North Korea to come in compliance with the Nonproliferation treaty...dismantlement of the...nuclear facilities will not begin until (North Korea has) received one fully operational $2 billion LWR...and they do not have to complete dismantlement...until the second LWR is completed...

The defect highlighted is that North Korea receives benefits before correcting past transgressions, and hence is being rewarded for bad behavior (see *4.ii*). And in the absence of "contractual agreement" for both sides to follow through on their respective *inducements*, the AF becomes merely a "best effort" arrangement. Proponents of the AF generally responded by

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[88] For example, see: David Sanger, "Clinton approves plan to give North Korea aid," *The New York Times*, Oct. 19, 1994, pp. A1.

[89] See footnote **xx**.

[90] For example, see: Henry Sokolski, "There is No Way to Curb the North Korean Nuclear Threat," *The Washington Post* (29 Oct., 2000), pp. B1.

[91] For instance, the Bush II Administration approach, dubbed CVID, is informed primarily by *inducement-model* tropes, as is evident in declassified internal documents. See: Donald Rumsfeld, "Remaining Firm on North Korea," Dec. 26, 2002, Department of Defense FOIA, 09-M-2474.

[92] "U.S.-North Korea Nuclear Issues," hearing before the Senate Committee on Energy and Natural Resources (Jan. 19, 1995).

highlighting the intrinsic value, to U.S. security, of "freezing the program in its tracks" and buying several years before North Korea reaches a nuclear weapons capability, rather than outlining the potential shifts in incentive structure associated with LWR construction steps. Consider the following exchange between Sen. Murkowski and Gary Samore:

> Sen. Murkowski: Why did you negotiate (immediate special inspections) away?
>
> Samore: We focused our attention on the biggest immediate problem..the 25 to 30 kg of Pu we know the North Korean's have (from the first reactor core)...(and on stopping) their ability to complete their larger reactors. (Those priorities) are addressed in the agreement. The AF calls for North Korea (to allow special inspections) before any nuclear components arrive...we would not have been able to achieve immediate compliance...as an immediate issue.
>
> Sen. Murkowski: Well, immediate or five years...
>
> Samore: ...what we get in return...is very attractive to us.

This exchange does little to address why IAEA compliance might be more likely once the foundation of the first LWR is in place in North Korea. And by focusing on the intrinsic value of the freeze itself, Samore and other AF proponents say little about why North Korea might be less likely to resume Pu production after the LWRs are in place. Under this framing, the AF is nothing more than a stop-gap solution.

Other questions arose about who will pay for the reactors, with any cost to U.S. tax payers seen as a serious flaw in the agreement. In order to diminish this flaw, Secretary of State Warren Christopher (AF proponent) guaranteed to Congress that the total U.S. financial contribution to KEDO would be limited to $30 million per year. As noted above (*4.iv*), if KEDO's activities are simply a package of "carrots", then offsetting their cost would not interfere with their function as such. But if KEDO's activities are a sequence of signals bearing information about U.S. commitment, then diminishing their cost severely attenuates the signal. This set the stage for the massive shortfalls in KEDO funding plotted in **Fig. xx** above, because even U.S. allies were reluctant to contribute large sums of money to KEDO if the U.S. financial stake was so small.

At various points of the hearing, however, both sides lapse into a more *techno-diplomatic* sensibility. For instance, Ash Carter describes the "essence" of the AF as a sequence of reciprocal signals and incentive-structure adjustments, and speaks of the prospect of "opening up" North Korea. And Victor Galinski, one of the AF's most outspoken critics, testifies to the irreversabilities associated with reactor construction investments:

> A nuclear power plant of even modest size needs an infrastructure of people and equipment and a sizable and secure electrical grid...To develop these, to train large numbers of North Koreans and to build a plant would take most of a decade...the project is likely to develop strong constituencies (in the U.S., South Korea and Japan) and to take on a life of its own. Do we really want to do this?

Galinski's testimony here aligns almost perfectly with the North Korean statement recounted above, which refers to the reactor project as a "physical guarantee". While nominally in opposition, the two passages are in perfect conversation with one another, and yet inaudible to the *inducement* ear. Both ask the fundamental question that a *techno-diplomatic* lens would force us to ask: 'does the U.S. really want the envisioned future that the AF articulates?' A not-too-outlandish interpretation of KEDO's slow death might suggest that in the end, the answer was 'no'.

## 4. A Theory of Engagement Under Nuclear-proliferation Crisis (*This conclusion will be re-written based on feedback from the CISAC Nuclear Reading Group*)

In their chapter on the history of diplomacy with North Korea, Stephen Haggard and Marcus Noland define "engagement" as a "willingness to consider positive inducements".[93] Under this definition, the AF represents an earnest attempt at nonproliferation engagement with North Korea. At high cost to its allies, and steep moral hazard to the nonproliferation regime, the U.S. offered North Korea a package of inducements whose intrinsic value bordered on the extravagant. But the regime's desire for nuclear weapons must have eclipsed its momentary taste for carrots. This historical verdict seems so cut and dry that few scholars have ever attempted serious study of AF or the KEDO project, which together represent the principle episode of U.S. engagement with North Korea. Yet the common, under-theorized reading of the "North Korea case" informs endless case studies and data sets in nuclear proliferation scholarship, and shapes our interpretation of other proliferation crises and diplomatic campaigns.

I have attempted to provide a new model of engagement in the North Korean nuclear crisis. It begins by acknowledging the legitimate bargaining dilemma that arose between North Korea and the West at the end of the cold war, and the reciprocal credibility challenges that stood in the way of normalization and denuclearization. It then examines nuclear technology to outline the role that physical steps toward LWR export played in charting a resolution to those credibility dilemmas. The KEDO reactors were not a 'carrot' offered to bribe the North, and the AF was no contract. Normalization and denuclearization would require that two nations suddenly end decades of hostility and isolation, disintegrate their physical commitments to that hostility and isolation, and durably pursue a peaceful and mutually-acceptable interaction. Had these deep muscle-memory erasures been simply written into contract, then the sheer historical discontinuity proclaimed therein would have been laughably implausible. Normalization and denuclearization were just not credibly expressible in the usual languages of diplomacy and international law. Instead, North Korean and American negotiators sought to express them in an alternate medium, by building the physical embodiment of normalization in the form of a technological infrastructure that was understood to be proliferation-resistant, stubbornly inert, and deeply international. The AF and associated KEDO project were an attempt at diplomacy by other means; diplomacy by more credible and durable means. And if in the end that endeavor had a fatal shortcoming, it was that the U.S. managed to offset its physical costs to allies, leaving a U.S. stake in normalization that was constituted more in name than in flesh.

Today we need a more serious theory of engagement under nuclear proliferation crisis. It is beyond the scope of this article to analyze the current nuclear challenges posed by North Korea and Iran, and how they compare with the first North Korean nuclear crisis. But the history recounted here offers a straightforward lesson: North Korea's nuclear behavior has been most responsive to U.S. moves that speak credibly about North Korea's place in a political future; it has been relatively immune to sanctions and transient rewards. This suggests that nonproliferation diplomacy is not really about inducement at all. Rather, the goal of engagement under nuclear proliferation crisis is to identify and articulate a space of mutually-acceptable political futures, and then to underwrite the credibility of that envisioned future via a graduated sequence of visible, physical steps that inch us in its discernible direction.



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[93] Haggard, et al., "Engaging North Korea".

## Appendix I: Oral Accounts of the Role of the KEDO Project in the Agreed Framework.

| Name | Role | Comments | Source |
|---|---|---|---|
| **Robert Carlin** | Chief, DoS-EAP 1989-2002 | The North Koreans saw the LWR construction process as a way to ensure U.S. involvement with the DPRK over a long period, thus improving the prospect of normalizing political relations. | 2016 interview with author |
| **Amb. Robert Gallucci** | Head of U.S. delegation to North Korea | The LWR project was a manifestation of that changing relationship, because it was gonna take quite a long time to build these things, and a substantial financial investment...the North Koreans wanted the U.S. to be the ones who were on the hook, and that is what the LWR project was to be a manifestation of. It wasn't just that they were gonna get 2,000 MWe of electricity, but that the LWR project would have meant that the U.S. was hardwired in. And we would have gone further if there was a way for us to finance it, but there wasn't. | 2018 interview with author |
| **Amb. Charles Kartman** | DoS-EAP, 1992-2001<br>Special Envoy for Korean Peace Talks 1997-1999<br>Dir. of KEDO 2001-2005 | The KEDO's activities were essentially designed to provide a better basis for sustained and substantive contacts (with North Korea).<br><br>Imagine if we had rebuilt that grid (in order to run the LWRs). We'd be able to see into every square foot of that country, and they'd be able to see first hand what western-style construction and energy infrastructure looks like. And the North Koreans probed us over and over about the prospect of rebuilding the grid. | 2012 Written comment; verif. by author 2017<br><br>2017 interview with author |
| **Thomas Fingar** | Dir. Analysis; DoS-EAP 1989-1994 | We didn't think of the KEDO LWRs as a carrot so much as an instrument to manage the relationship over time. | 2015 interview with author |
| **Joel Wit** | Senior Advisor to U.S. Delegation (DoS) | KEDO has two broad functions: encouraging systematic change through modernization in the DPRK; and increasing ties between the DPRK, its regional neighbors, and the international community, in the hope that such ties would help ease tensions and build peace on the Korean peninsula.<br><br>As a result of the (KEDO) project, the North will have to strengthen its regional and international ties to ensure the completion and effective operation of the two nuclear reactors. | 1999 written comment; verif. by author 2017.<br><br>1999 written comment; verif. by author 2017. |
| **Mitchell Reiss** | Lead Negotiator for KEDO 1995-1999 | LWRs would require much more extensive training, they'd be harder for them to manage, they'd take longer to bring online. A LWR is hard to operate, and really hard to repair, much harder than FFPPs. So we (were) gonna be in there for a really long time.<br><br>(On the grid): we talked about World Bank or IMF loans, the Japanese were quietly talking about tens of billions of dollars of infrastructure development. So yeah, we'd be all over that country (if the LWRs had materialized). People were thinking that there is an upside to us being so intimately involved with some of their fundamental national decisions.<br><br>Bob and I used to argue that the AF didn't guarantee anything. What it did was to provide an opportunity that didn't previously exist for North Korea and the outside world to have a fundamentally different relationship. That's not to minimize what Bob did, he created a new reality. But he didn't guarantee the outcome. It was up to the players to fill that role, and we did for a while, but ultimately we (the U.S. and North Koreans) failed, collectively | 2018 interview with author |

| Name | Role | Comments | Source |
|---|---|---|---|
| **Amb. Thomas Hubbard** | Princ. Neg, U.S. Delegation to North Korea 1993-1996. | I think they saw it less from the perspective of the electrical power that would derive from it, and more from the perspective that our willingness to provide these reactors would be a sign that we could be a reliable partner out in the world. | 2018 interview with author |
| **Gary Samore** | DoS Nonproliferation (1993-1996) NSC Dir. of Nonproliferation (1996-1998) | We should (design the LWR supply agreement) in a way that makes it possible that they'll stick to the Agreement, that they won't back out of it once the balance of power shifts. | 2012 interview, KEDO History Project. |
| | | ...are you sure I didn't say 'balance of plant? | 2017 interview with author |
| **Amb. Chang Sun Sup (RoK)** | Exec. Board Chair, KEDO | KEDO was not a purpose itself; it was sort of a vehicle to reach North Korea…(Kim Young Sam) was excited to use this project to promote his own objectives to improve relations with North Korea. | 2012 interview, KEDO History Project. |
| **Amb. Cho Khy-hyung (RoK)** | | I think there was no serious disagreement among the government agencies in that it should be implemented, not only for the solution of the nuclear problem but also for the sake of national reconciliation between South and North Korea. | 2012 interview, KEDO History Project. |
| **Kim Young-mok (RoK)** | Advisor; Gyeonggi Gov. | North Korea opposed KEDO at the beginning and hoped that everything would be done by the US government or US companies. | 2012 interview, KEDO History Project. |
| **Amb. Choy Young-jin (RoK)** | | To my mind, KEDO represented the first example of Koreans, Americans and Japanese working together in our entire history. | 2012 interview, KEDO History Project. |
| **Amb. Yanai Shunji (Japan)** | | …nuclear power generation is a business from which we could expect returns in the future. So against this background, we got the idea of borrowing money from the (Japanese) ExIm Bank. | 2012 interview, KEDO History Project. |
| **Amb. Kang Sok Ju (DPRK)** | | The LWR proposal is "backed by Kim Il Sung and is designed to open up North Korea. | 1993 June negotiations |
| **Amb. Kim Gye-guan** | | No LWR no deal. | 2005 (to Siegfried Hecker during track II visit) |
| **DPRK FM statement** | | The U.S. should not even dream of the...DPRK's dismantlement of its nuclear deterrent before providing LWRs -- a *physical guarantee of confidence building* (emphasis added). One should wait and see how the U.S. will move in actuality at the phase of 'action for action' in the future. | 2006 DPRK FM statement after KEDO dissolution announced |
| **Amb. Kim Gye-guan** | | We are taking very good care of your LWR project. | 2009 (to Amb. Bosworth) |