Whose Shoe Fits Best? Dubious Physics and Power Politics in the TMD Footprint Controversy

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Apparent design breakthroughs in short-range missile defense systems such as Theater High-Altitude Air Defense (THAAD) have prompted questions about the legality of such systems under the 1972 Antiballistic Missile (ABM) Treaty. Prominent physicists have used computer "footprint" methodology to prove that if engineered to specifications, THAAD might exceed ABM Treaty performance limits banning highly effective missile defense systems. In response, missile defense officials commissioned Sparta, Inc. to conduct secret research casting doubt on the validity of such findings. The substantial diplomatic issues at stake and the interesting rhetorical dynamics involved in this dispute warrant close scholarly analysis. Attention to the iterative relationship between the interpenetrating spheres of public argument and scientific practice in this case yields novel insight about the processes in which technical knowledge of defense systems is forged and raises fresh issues for the "closure project" in science and technology controversy studies.

Soon after the Clinton-Gore administration began its aggressive pursuit of Theater High-Altitude Air Defense (THAAD) in the early 1990s, concerns were raised that the new ballistic missile defense system might be illegal. Critics argued that THAAD's high-end design exceeded performance limitations set down in the 1972 Antiballistic Missile (ABM) Treaty. On the surface, such claims strained credulity, given that the ABM Treaty clearly does not cover theater missile defense (TMD) systems such as Patriot and THAAD (it only prohibits widespread testing and deployment of strategic missile defense systems designed to counter long-range rockets fired across whole continents). However, apparent post–Gulf War engineering advances endowed THAAD (on paper, a "theater" system) with potential capability to intercept long-range strategic missiles as well as short-range missiles, blurring the boundary between theater and strategic defenses codified in the ABM Treaty.

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Attempting to find a way to pursue THAAD without undercutting the ABM Treaty, Clinton-Gore administration officials defended THAAD on the grounds that although it would be highly effective against short-range missiles, it was still legal under the ABM Treaty because the system could not stop a long-range rocket attack from Russia or China and therefore would not have "strategic" capability. This argument over the "demarcation" line separating legal theater missile defense systems from illegal strategic missile defense systems has spurred spirited and sometimes contentious debates in Congress and other public spheres. In each of these contexts, TMD demarcation discussions have been arduous as interlocutors have struggled to find common ground at the interface between complex questions of physics[1] and sensitive aspects of international politics.[2] The dispute over THAAD's ABM Treaty legality straddles this interface between physics and politics and raises significant questions regarding the connection between scientific proof and public validation of scientific knowledge.

This article explores the mid-1990s TMD demarcation controversy by focusing on the interplay between public argument and scientific practice. Attention to these interlocking dimensions of the controversy highlights how arguments drew from science, how science was shaped by arguments, and how these insights relate to the substantial political, military, and social stakes in play. This iterative critical approach is well suited for this study, given the historical interpenetration of scientific and political spheres of argument in missile defense debates.

For example, where Reagan-era Star Wars scientists inflated technical assessments to bolster the political case for missile defense (see Broad 1992; Mitchell 1997), scientists in Clinton's THAAD program have been accused of deliberately deflating performance evaluations to portray the system as legal under the ABM Treaty. On another level, while Strategic Defense Initiative (SDI) managers clamped down on scientific dissent as a strategy to stamp out political controversy in the 1980s (see Reiss 1992), critics claimed that THAAD managers stimulated scientific disagreement for political purposes in the 1990s.

More than the mere presence of contradictory scientific beliefs, scientific controversy involves the "clash of opposing opinions; debate; disputation" (Brante 1993, 181). Scientific controversies have become popular subjects of inquiry for scholars who foreground the relationships and feedback between political affairs and scientific practices (see, e.g., Mazur 1981; Martin 1988; McMullin 1987; Nelkin 1984). One branch of "controversy studies" (see Brante 1993) focuses on ways that scientific disputes end. For example, Engelhardt and Caplan's (1987) "closure project" investigates how various actors negotiate, force, or otherwise bring about the termination of scientific controversies (see also Beder 1991; Epstein 1996). Curiously, the symmetrical question of how and why actors stimulate and prolong scientific controversies has received comparatively little scholarly attention. This gap in research deserves attention, given that well-moneyed interests have recently refined the rhetorical strategy of buying controversy as a way to excuse action in the face of the apparent closure of scientific debate. For example, following what has been called the "Tobacco Institute strategy,"[3] a consortium of coal and oil corporations recently launched a major campaign to challenge the findings of the United Nations' (UN's) Intergovernmental Panel on Climate Change (IPCC 1995) study on global warming. By hiring a number of Washington, D.C.-based think tanks to produce dissenting scientific evidence, these threatened corporate interests engineered a "stealth greenhouse spin campaign" that has "managed to convince the public that there is still significant 'debate' on global warming" (Helvarg 1996, 21).

Just as fossil fuel industry spokespersons have pointed to ongoing "scientific debate" surrounding the IPCC report to leverage claims that action to curb warming would be premature (see Christianson 1999, A25), Ballistic Missile Defense Organization (BMDO) Director Malcolm O'Neill has stimulated "healthy scholarly debate" over THAAD's theoretical capability to shield the system from political criticism in the mid-1990s. O'Neill reasoned that headlong pursuit of the system would not flout ABM Treaty limits on strategic defenses, as long as the jury was still out on key scientific questions relating to THAAD's theoretical capabilities. It remains to be seen whether BMDO's rhetorical approach in the TMD footprint controversy will play out successfully in ongoing ABM Treaty compliance negotiations. One thing made clear by strident expression of Russian concerns about U.S. plans for strategic defense, however, is that enormous stakes relating to post–cold war nuclear stability hang in the balance in these missile defense discussions.

Part one of this article provides background on the technical arms control concepts and terminology that elucidates the relevant political claims advanced by Clinton-Gore administration missile defense officials early in the dispute, as well as the process through which dissent arose in opposition to those claims as the issue evolved into a public controversy. In part two, attention shifts to consideration of a particular dispute regarding TMD computer "footprint" methodology used to calculate THAAD's ABM Treaty compliance. Charges of strategic deception, subterfuge, and intimidation pervade the texts of this dispute, and the significant political stakes involved make this "footprint" debate a particularly appropriate case study for this article. With the basic outline of the arguments in the footprint controversy in place, part three moves on to examine the interplay between positions in the controversy, as well as an independent "third-party" review of the dispute. IBM Fellow Richard Garwin (a renowned physicist asked by BMDO to review the facts) has discovered evidence that corroborates critics' public charges of strategic deception on the part of a government-paid contractor in this case, so it is appropriate to consider the possible political ramifications of such findings. In this vein, part four features an analysis that places the TMD "footprint" controversy in the wider political context of ABM Treaty demarcation negotiations and U.S.-Russian relations.

Post–Cold War Missile Defense and the ABM Treaty

The dispute over Reagan's "broad interpretation" of the ABM Treaty can be seen as a precursor to contemporary debates regarding the THAAD system's legality under the treaty. Where Reagan officials argued that Star Wars was treaty compliant because it simply involved research, not deployment (see U.S. Strategic Defense Initiative Organization [SDIO] 1989), Clinton officials contended that as a "theater" system designed only to intercept short- and medium-range missiles, THAAD was legal under the ABM Treaty loophole that allows deployment of such limited systems.[4] This position was advanced publicly by John D. Holum, Clinton's arms control chief,[5] and by BMDO Director Malcolm O'Neill in 1994 testimony before the Senate Foreign Relations Committee.

> The Department is planning to develop and deploy theater/tactical missile defense systems to counter the projected threat to our forces abroad and to our allies. This mission is well within the purposes and objectives of the ABM Treaty. . . . Meanwhile, all of BMDO's testing and development activities remain compliant, *within the narrow interpretation* of the ABM Treaty. (O'Neill 1994, 14-15, emphasis added)

Just as the Reagan-Bush administration's campaign to promote Star Wars as a legal ABM system triggered heated public controversy in the mid-1980s, O'Neill's claim of THAAD's ABM Treaty compliance met with substantial public opposition in the mid-1990s. A group of MIT scientists, including George Lewis and Theodore Postol, were among the critics who challenged the Clinton-Gore administration's position on THAAD most vigorously in public (see Lewis 1994; Postol 1994).

The Gronlund et al. (1994) Footprint Study

In April 1994, a group of physicists, including Lewis and Postol (along with the Union of Concerned Scientists' Lisbeth Gronlund and David Wright), published an article in *Arms Control Today* that used computer footprint methodology to prove that the planned THAAD system would possess dual capability to intercept both theater and strategic ballistic missiles (Gronlund et al. 1994). A theoretical estimate of the capability of ballistic missile defense systems, computer-generated footprints consist of mapped areas demarcating the ground area that defensive systems can reasonably be expected to protect from incoming rocket attack.

A number of system parameters and physical variables need to be taken into account to generate a reliable missile defense footprint. The radar detection range of the defensive system is an important factor since longer detection ranges give the tracking and guidance components of a BMD more time to plan and execute intercepts. The speed, reentry angle, and aerodynamic characteristics of incoming missiles are variables that help determine the vulnerability of target missiles and provide important information about the probability that an interceptor can neutralize its target. Furthermore, the performance characteristics of the interceptor missiles themselves need to be factored into footprint calculations, as interceptor lethality, speed, and range play a prominent role in determining the expected proficiency of a defensive system in fending off enemy missile attacks.

Computers can be programmed to incorporate these factors into overall engagement models that generate footprints for particular defensive systems deployed in certain modes and locations. Using computer footprint methodology, Gronlund et al. (1994) demonstrated that if engineered to specifications, THAAD would have the capability to defend against long-range (10,000-kilometer) intercontinental ballistic missiles (see Figure 1). This finding cast doubt on the classification of THAAD as a pure theater missile defense system and directly challenged the Clinton-Gore administration's pursuit of a TMD demarcation threshold to bring THAAD legally within the parameters of the ABM Treaty.[6] By suggesting that the THAAD system exceeded the limitations on acceptable missile defense capability set down in the treaty, Gronlund et al. complicated the administration's demarcation negotiation strategy and presented a perplexing rhetorical quandary to BMDO planners: how does one paint a system that will "walk like a duck and quack like a duck, and will eventually be a duck" as a duckling?[7]

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Figure 1. THAAD footprints constructed by Gronlund et al. (1994).
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Whose Shoe Fits Best? The Debate over THAAD'S Footprint Size

Gronlund et al.'s (1994) footprints came to the attention of BMDO Director Lieutenant General Malcolm O'Neill during a 1994 briefing by government-paid analyst Keith Payne.[8] Startled by the differences he observed when comparing Gronlund et al.'s footprints with the footprints generated by Payne and other official BMDO analysts, Director O'Neill ordered further research into the footprint discrepancy. Director O'Neill's interest in further research on this matter might have been piqued by the fact that Gronlund et al.'s findings directly contradicted O'Neill's own claims regarding the politically sensitive issue of THAAD's ABM Treaty legality that he made in 1993 and 1994 congressional testimony. As director of BMDO from 1993 to 1996, O'Neill was charged with managing a sprawling missile defense bureaucracy that received nearly $3 billion in annual appropriations. O'Neill's key responsibilities in this capacity included overseeing "joint development of BMD systems" and ensuring that "BMD programs are advocated during budget debates" (O'Neill 1996).

Since the official task order for the research commissioned by Director O'Neill has not been released by BMDO, it is difficult to ascertain the precise research objectives laid down in this order. However, internal memos and interviews indicate that BMDO directly commissioned Sparta, Inc., a Rosslyn, Virginia-based think tank to conduct the research.[9] As a recipient of more than $10 million yearly in Department of Defense (DOD) contracts for largely secret research on ballistic missile defense (see Cirincione and von Hippel 1996), Sparta has grown into one of the BMDO's de facto private intelligence agencies, a so-called "SDI boutique" (Isikoff 1986, F1).

To find the Rosslyn, Virginia offices of Sparta, Inc., one needs to know more than the proper street address, 1911 Fort Myer Drive. Since there is no listing for Sparta on the marquee directory in the lobby of the building at this address, first-time visitors must call up from the public pay phone to discover which floor to exit the elevator. Once inside Sparta's eleventh-floor offices, visitors are registered in the receptionist's computer database and issued a black-and-white identification tag for the course of their stay. Visitors lacking security clearance are fenced away from "hot areas" where classified research and discussions take place. Conspicuous signs reminding employees to "refrain from leaving classified information on desks" signal that Sparta is not only concerned with producing knowledge, but it is also deeply entrenched in the business of hiding it as well. Part of a cloistered network of private think tanks, government laboratories, and test ranges that make up the official "BMD community,"[10] Sparta works closely with top officials from BMDO ("bimdo," in Sparta parlance) to analyze key issues of systems architecture for BMD programs. "We've grown as SDI has grown," said Jerry Kinney, the firm's vice president (quoted in Isikoff 1986).[11]

The language used in Sparta's study intimated that the objective of the research, as ordered by BMDO, was to "review" Gronlund et al.'s (1994) paper and "understand why the conclusions they reached were at odds with the BMD community" (Lee et al. 1994). As Laura Lee (1996), Sparta's lead researcher on the project, later recounted, "They [BMDO] gave us the [Gronlund et al.] article and said, 'Could you please explain to the General [Malcolm O'Neill], so he understands, why you get two different footprints?'" As Lee further clarified the approach of the study, "We first tried to reproduce it [Gronlund et al.'s footprints] to understand their assumptions, and then explain to BMDO why we don't make those same assumptions."

The Secret Lee et al. (1994) Counterstudy

To deepen earlier discussion of the technical nuances in the Gronlund et al. (1994) footprint study, it will be helpful to go into a more detailed investigation of the methodology and results of the Sparta counterstudy because later charges of strategic deception on the part of missile defense critics relate directly to several fine points in Lee et al.'s (1994) work. The title of the Sparta study, "The Abuse of 'Footprints' for Theater Missile Defenses and the ABM Treaty," signaled immediately the tone of its conclusion: Gronlund et al. had "abused" footprint methodology in their *Arms Control Today* article. Completed in September 1994, the Sparta study alleged that Gronlund et al. had committed a number of serious technical errors in their research.

To check the validity of Gronlund et al.'s (1994) footprint methodology, the Sparta research team first attempted to replicate Gronlund et al.'s computer model and then ran computer programs to see if the model would yield a strategic defense footprint for THAAD. Initially, the Sparta analysts noted that in order for a defensive system to have a chance against such long-range threats, it would need to track and fly to the incoming missile within a minimum "battle space" time. In the case of TMD versus strategic intercontinental ballistic missile (ICBM), a battle space time of twenty-two seconds was derived by taking into account ICBM velocity, detection time, and minimum intercept altitude (Lee et al. 1994).

Using a radar detection range commonly associated with the proposed THAAD system (202 km for 0.005 m^2 target), the Sparta study then contended that THAAD's long-range detection capabilities would require 30.6 seconds of battlespace time.[12] Because of this battlespace time discrepancy (30.6 to 22 seconds), Lee et al. (1994) concluded that it was not possible for THAAD to generate a footprint when engaged in a strategic context. In concrete terms, the implication was that before the THAAD system could detect, track, and fly to a long-range ICBM, the incoming missile would be on its way down and past the last possible intercept point (see Figure 2).

Lee et al. (1994) concluded that the only way such a footprint could possibly be generated would be if researchers radically simplified the modeling assumptions used in footprint methodology to increase the battle space time available. For example, by ignoring atmosphere and gravity forces during the interceptor burn phase, required battle space time could be shaved to 28.8 seconds (Lee et al. 1994). Furthermore, by assuming infinite acceleration of the interceptor (when only average acceleration would be realistically possible), battle space time could be reduced further, to 20.4 seconds. With these modeling advantages afforded to the defense, the Sparta team concluded that in theory, the THAAD system could lock on and meet an incoming ICBM in less than the battle space time required (20.4 to 22 seconds), yielding a defensive footprint.

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Figure 2. Lee et al.'s failed attempt to reconstruct the Gronlund et al. (1994) THAAD footprint shown in Figure 1.

The Sparta researchers reasoned deductively that the only way Gronlund et al. (1994) could have generated their strategic footprint would have been to adopt these "very, very simple" assumptions in their model (Lee et al. 1994). This was quite a dramatic charge; the Sparta analysts alleged that Gronlund et al. had manufactured a footprint by conveniently ignoring gravity, atmospheric drag, and rocket deceleration. No legitimate physicist could bracket these obvious factors and still claim to offer serious analysis. Lee et al. claimed to have found a specific point where Gronlund et al. had "abused" the footprint process and illegitimately invoked the rhetoric of science to bolster a political argument.

Here was an attempt by defense establishment insiders to "deconstruct" (Jasanoff 1990, 13) scientific facts to prevent potentially troubling tensions from arising between such facts and chosen courses of policy action. Compared to earlier attempts by military officials to stabilize scientific facts (such as propagation of optimistic missile accuracy assessments) (see MacKenzie 1990), Lee et al.'s (1994) strategy was novel in that it sought to downplay THAAD's theoretical capabilities, thereby strengthening political arguments for the system's legality under the ABM Treaty. That the Sparta study was used as a tool of arms control diplomacy is clear from information obtained under the Freedom of Information Act. An internal BMDO memorandum obtained through the Freedom of Information Act confirms that in March and April 1995, BMDO funded and sponsored official briefings where Sparta researchers were permitted to present the findings of their “review” of Gronlund et al. (1994), without rebuttal or opposition, to influential audiences in the arms control community.

The first of these briefings took place at the National Defense University on 6 March 1995 and involved senior members of the Russian State Duma (Lowder 1995, 2). Since a major focus of this meeting was the issue of ABM Treaty demarcation (Lee 1996), the findings of the Sparta study likely addressed some of the most central concerns of the Russian officials regarding U.S. TMD policy. In this briefing, official BMDO resources were used to create a forum where Sparta researchers could amplify their views to high-ranking foreign diplomats. The decision to hold such a briefing and to exclude Gronlund et al. (1994) signaled BMDO’s judgment that the methodology of the Sparta study was sufficiently sound to warrant official amplification of Lee et al.’s (1994) findings. Official support for these briefings also indicated that the BMDO believed that the findings of the Sparta study were relevant to the ongoing Russia-U.S. arms control process.

BMDO sponsored a second major briefing designed to showcase the Sparta study on 3 April 1995, at the State Department in Washington, D.C. This briefing was conducted for a “big, large group” of high-ranking Arms Control and Disarmament Agency (ACDA) personnel (Nacht 1996). Charged with carrying out U.S. arms control negotiations (including the ongoing ABM Treaty talks carried out through the Standing Consultative Committee), ACDA officials often engaged the issue of THAAD’s legality under the ABM Treaty; thus, the TMD footprint controversy was deemed a “very important” issue to the group. One senior official estimated that representatives from as many as eight different ACDA groups attended the briefing.[13]

The Footprint Controversy Ignites

During much of the internal briefing process conducted in late 1994, the Sparta study was not cleared for public release, and therefore it was impossible for authors of the Gronlund et al. (1994) *Arms Control Today* article to learn that their work was being discredited in private meetings conducted by BMDO. However, when BMDO insider Keith Payne made a public reference to the Sparta study in an op-ed piece published in the 15 January 1995 issue of

Defense News, this reference opened up a new layer of the public controversy over ABM Treaty compliance policy.[14]

After obtaining a copy of the Sparta study from Payne, Postol issued a rebuttal claiming that the study was flawed on three levels: it incorrectly calculated Gronlund et al.'s (1994) radar detection ranges, it improperly overlooked early warning radar cueing as a significant aid to strategic defense, and the authors of the Sparta study violated norms of scientific peer review by failing to communicate with the researchers under review to clarify key methodological questions. It will be instructive to consider each of these objections in turn.

First, Postol contended that the Sparta study committed a basic calculation error by determining mistakenly the radar detection range of the THAAD system engaged against long-range (strategic) targets. The Sparta study, Postol argued, overlooked the iterative dimension of footprint calculation. Footprint size and radar search area are correlated; the larger the footprint of a BMD system, the more sky its radar must search. When the radar becomes overtaxed and cannot search all of the area needed to support a given footprint, the system cannot be expected to provide reliable defense. However, this does not mean necessarily that no defense is possible in such scenarios; there still remains the option of consolidating the size of the footprint to lessen radar search demands. By shrinking the footprint, it is possible to reduce the slice of sky that needs to be searched, thus shifting the search area/anticipated footprint equation back into the defense's favor (see Figure 3).[15]

Postol pointed out that by using a "rote scaling" method, the Sparta team ignored the significant search flexibility afforded by this iterative optimization mechanism. Faced with a scenario in which the needed search area exceeded the available radar resources in the strategic context, Sparta's model indicated that there was "no footprint possible." Postol contended that in jumping to this conclusion, the Sparta researchers glossed over another alternative: a smaller footprint might have been generated if the anticipated footprint size would have been adjusted downward to ease the radar's search burden.

Postol's second major objection to the Sparta study was that it failed to take into account the advantages afforded to strategic defense from early warning radar cueing. During the Gulf War, U.S. space satellites provided Patriot missile batteries with data to enable early radar fixes on newly launched Scuds. Postol argued that this same sort of early warning radar cueing (provided by the Defense Support Program [DSP]) would significantly enhance the search capabilities of a THAAD system deployed in strategic defense mode. "Thus by using early warning radars," explained Postol

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Figure 3. Iterative optimization mechanism in the Gronlund et al. (1994) footprint model.
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(1995a), "the composite footprints against strategic targets with varying azimuths and reentry angles could in fact be quite large, even significantly larger than composite footprints against 3,000 km-range theater targets."

In pointing out the iterative optimization mechanism and the radar search savings from early warning cueing, Postol isolated for BMDO Director O'Neill two assumptions of Gronlund et al.'s (1994) model that permitted a footprint for THAAD to be generated in the strategic context. Postol expressed disbelief that Lee et al. (1994) could have overlooked these crucial aspects of the Gronlund et al. methodology, and he contended that their oversight in this regard was symptomatic of a third major shortcoming of the study: failure to conduct legitimate scientific peer review. By attempting to "reconstruct" Gronlund et al.'s footprints using Gronlund et al.'s stated assumptions, Postol contended that the Sparta researchers took on important review burdens. Foremost among these burdens, argued Postol, was the obligation to fully discover and incorporate Gronlund et al.'s modeling assumptions prior to the attempt at footprint reconstruction. Only by duplicating Gronlund et al.'s methodology could a fair attempt to "reproduce" Gronlund et al.'s footprints be undertaken, Postol contended.

However, shortly after public release of the Sparta study, it became evident that not all of Gronlund et al.'s (1994) modeling assumptions were incorporated into the analysis. Although the assumptions of space-based radar cueing[16] and iterative radar search optimization[17] were stated clearly in Gronlund et al.'s original *Arms Control Today* article, these assumptions were omitted in the Sparta study.[18] In place of these assumptions, Lee et al. (1994) included the "very, very simple" assumptions of no gravity, no atmospheric drag, and infinite acceleration. The upshot of this substitution, argued Postol, was that the Sparta study could not be considered a legitimate review of Gronlund et al.'s work.

In addition to the fact that the Sparta study failed to incorporate several of Gronlund et al.'s (1994) key modeling assumptions into its footprint analysis, Postol contended that Lee et al. (1994) showed bad faith in failing to make a significant effort to communicate with the MIT group to gain a more detailed understanding of the modeling assumptions employed in their *Arms Control Today* article. "No attempt was made by the authors of the [Sparta] study or by BMDO contract monitors to contact us to check the accuracy of statements made about our work in the BMDO study," wrote Postol. "There was also no attempt by the BMDO-sponsored authors or BMDO staff to query us about discrepancies between our results and those found by the BMDO-funded analysts" (Postol 1995a).[19]

Postol's reply thus constituted a sweeping and layered rebuttal against Sparta's secret counterstudy. On one level, Postol showed how the Sparta researchers committed basic technical errors that resulted from misreading the *Arms Control Today* article. On another level, Postol challenged the professionalism of the Sparta group by arguing that the misconstruals that led to these basic errors could have been prevented had Sparta researchers contacted the MIT group for clarification prior to completion of their study. This charge reflected a frequent problem that often complicates efforts to use scientific peer review in secretive science projects carrying major political significance. Unless secrecy is explicitly counteracted in these contexts, "peer review is more likely to fall prey to politics than to ensure that impartial standards of quality are maintained in policy-relevant science" (Jasanoff 1985, 24).

Tracking the Twisting Trail of Footprint Arguments

The preceding analysis of back-and-forth argumentation exchanged by principal scientists in the TMD footprint controversy highlighted certain key points of stasis on which the dispute pivoted. The Sparta team claimed that strategic footprints generated by Gronlund et al. (1994) for a THAAD-like BMD system were based on unrealistic and overoptimistic assumptions regarding atmospheric conditions and physical dynamics. On the other hand, Postol claimed in rebuttal that the Sparta team committed basic technical errors in reconstructing the Gronlund et al. footprints and that Sparta researchers also invalidated their study by engaging in practices inimical to professional norms of scientific peer review. This section features examination of key texts that purport to judge these competing claims. Such a focus on judgment will shift attention back to the wider stakes involved in the TMD footprint controversy, with the broader political problematic of ABM Treaty diplomacy coming back into play as a primary theme in the analysis. There are two texts particularly appropriate to frame this discussion: BMDO Director Malcolm O'Neill's 3 May 1995 letter to Theodore Postol and Richard Garwin's 10 October 1995 FILE memorandum. O'Neill's letter has obvious textual significance as the major official statement from BMDO on this matter, while the Garwin FILE memorandum deserves attention because its contents reflect the findings of an expert assessment of the controversy by an independent scientist selected officially by BMDO. The following section considers the O'Neill letter, examines Garwin's FILE memorandum, and then concludes with critical commentary reflecting on the rhetorical implications of these two texts.

BMDO's Official Response

On 3 May 1995, Lieutenant General O'Neill issued a two-page letter to Postol that outlined BMDO's official stance on the TMD footprint dispute and attempted to address Postol's criticisms of the Sparta study. In the letter, O'Neill offered three major arguments: (1) the findings of the Sparta study did not represent official BMDO policy, so Postol's dispute should be with Sparta, not BMDO; (2) the divergence between Sparta and MIT's findings was not due to technical errors by Sparta but instead was the natural outgrowth of a legitimate scientific disagreement; and (3) Postol's attacks on Sparta were unjustified because Lee et al. (1994) worked in good faith to produce their study.

Occupying a seat of judgment invested with considerable institutional power and addressed by Sparta and Postol as the primary audience for their scientific dispute, BMDO Director O'Neill was situated at the locus of the controversy over THAAD's legal status under the ABM Treaty. It is interesting to sift through his statement on the TMD footprint controversy for insight regarding the official reaction to the scientists' argumentation and to look for more general evidence of BMDO's assumptions regarding the role of scientific inquiry in the overall BMD enterprise. A critical assessment of O'Neill's letter will provide a useful occasion to work through these issues and to begin framing larger lessons from the experience of the Sparta-MIT footprint dispute.

In pursuing a strategy of disassociation, O'Neill sought to deflect Postol's criticisms of the Sparta study by pointing out that Lee et al.'s (1994) findings had not received official BMDO sanction. Although O'Neill (1995) admitted that his organization commissioned the Sparta study, he added that "BMDO has not adopted the findings of the Sparta study" and that "[the Sparta study] neither states nor reflects U.S. or BMDO policy." By opening up this distance between BMDO and Sparta, O'Neill cleared a space to pursue a rhetoric of deniability. By eschewing accountability for the specific findings of Sparta's work, O'Neill positioned himself to transcend the dispute and react to it as an interested but detached observer.

So positioned, O'Neill then proceeded to defuse the rhetorical exigence created by Postol's strident criticisms by removing himself from the seat of judgment. Because the findings of the Sparta study lacked official status, there was no pressing need for O'Neill to provide authoritative adjudication of the controversy. Freed from this burden to issue a definitive resolution of the dispute, O'Neill then proceeded to frame the TMD footprint controversy as a non-zero-sum game where all sides could benefit from the open airing of scientific disagreement. "After a thorough review of your paper, your letter and the Sparta footprint analysis slides," O'Neill wrote to Postol, "I conclude that the difference of opinion between you and Dr. Lee is reasonable and reflective of healthy scholarly debate" (O'Neill 1995). In this same vein, O'Neill invoked the marketplace-of-ideas metaphor to illustrate his point that the arguments of both sides might usefully coexist. "True enough," O'Neill wrote to Postol, "your article and the Sparta study do not agree. That doesn't surprise me. In the marketplace for ideas there is room for vigorous and honest debate."

One of the most basic insights of science and technology studies (STS) is that in scientific controversies, actors' arguments are colored by their political interests (see, e.g., Epstein 1997; Garrety 1997). Although a thoroughly "symmetrical" political interests analysis of the TMD footprint controversy would likely illuminate interesting aspects of the political dimensions on both sides of the dispute, space limitations prevent such dual-focus examination in this article. Nevertheless, a brief consideration of BMDO's political interest in perpetuating prolonged controversy on the TMD footprint matter still promises to shed light on similar, recent episodes in which institutions and organizations have used power and money to defer closure of scientific controversies through so-called "Tobacco Institute strategies."

BMDO Director O'Neill's interests were clearly tied to continued political support for THAAD, one of BMDO's most promising weapons systems. Because THAAD's political future would have been severely clouded if the scientific claims advanced by Gronlund et al. (1994) had stabilized quickly, O'Neill's political interests were well served by the prospect of a long, drawn-out, and inconclusive scientific controversy over TMD footprint methodology. Uncertainty about THAAD's theoretical capability as a strategic BMD system resulting from such a protracted row promised to reduce the authority and credibility of computer footprint modeling as a scientific method of settling ABM Treaty compliance issues, thereby insulating THAAD from political criticism based on Gronlund et al.'s findings. Such controversy also promised to insulate O'Neill personally from political peril, by absolving him of the need to stand by the Sparta study or issue a definitive judgment on scientific dimensions of the dispute. "To the extent that science can be represented as indeterminate," explains Jasanoff (1987, 198), "political decision-makers absolve themselves of the need to toe the line on any particular scientific orthodoxy."

These dynamics parallel those found in other scientific controversies, where conflict among scientific experts reduces the experts' potential impact as authoritative arbiters of policy disputes (Nelkin 1975; Shackley and Wynne 1996). Deliberate attempts to foment scientific disagreement to achieve such effects have been dubbed Tobacco Institute strategies (Helvarg 1996, 21), in honor of the now-defunct trade group that kept debate about cigarette smoking's health harms going for years by churning out endless scientific studies of dubious merit. A Florida jury recently returned a landmark verdict against the Tobacco Institute and other defendants for using what victorious attorney Stanley Rosenblatt called "diversionary tactics to keep alive a nonexistent scientific controversy about smoking and health" (quoted in Meier 1999, A18).

Other similar "debates about closure" (Epstein 1996, 29) have unfolded over the issue of climate change. On one hand, a large group of scientists have argued that a definitive and robust scientific consensus has emerged in support of the theory that greenhouse gas emissions from human sources is causing rapid global warming. Essentially declaring the global warming debate over, this group of scientists argued that the emergence of a scientific consensus marked the end of an intense period of controversy and that immediate and aggressive action to cut greenhouse gas emissions was warranted (IPCC 1995). On the other hand, scientists skeptical of the global warming hypothesis resisted the move toward closure of the controversy and challenged the notion that a legitimate scientific consensus had emerged. Calling for more debate and additional research, this group of "warming skeptics" attempted to prolong the controversy to postpone judgment and action (e.g., Seitz 1996). So far, the strategy has been relatively effective in reducing the efficacy of climatologists as authoritative experts on global warming policy. History professor Gale Christianson (1999, A25) recently noted that in this context, the Tobacco Institute strategy of prolonging scientific controversy has turned a "scientific discovery [global warming] into an ideological, spiritual, or political debate" (see also Shackley and Wynne 1996).[20]

An Independent Voice

Shortly after BMDO Director O'Neill provided an official response to the THAAD footprint controversy in his 3 May 1995 letter to Postol, renowned physicist Richard L. Garwin visited the Sparta offices for the purpose of conducting a review of the arguments in the case (see Lowder 1995). Garwin was uniquely qualified as a reviewer, given his sterling credentials as an independent physicist having great familiarity with missile defense issues.[21] After interviewing Sparta analysts Laura Lee, Robert Bulk, and J. E. Lowder during his 28 September 1995 visit to Sparta's Rosslyn, Virginia offices, Garwin drafted a FILE memorandum that summarized his conclusions. Initially, the document was released privately to Sparta analysts on 8 October 1995 for advance review. After receiving the Sparta team's reply, Garwin attached it to his own memorandum and circulated both widely on 10 October 1995. Although Garwin's visit to Sparta did not bring closure to the TMD demarcation controversy, it did lead to some startling rhetorical judgments about BMDO's lack of credibility as a source of reliable scientific information.

Garwin's investigation yielded the finding that basic technical errors in the Sparta study invalidated Lee et al.'s (1994) crucial claim that Gronlund et al. (1994) had used "very, very simple assumptions" in generating a footprint for a THAAD-like system against long-range ballistic missiles. Specifically, Garwin noted that the Sparta team ignored the "iterative optimization mechanism" included in the Gronlund et al. footprint model as an assumption that cuts radar search demands and gives a THAAD-like interceptor enough battle space time to defend (theoretically) against long-range intercontinental ballistic missiles. This conclusion directly undermined the key claims made by Foil 104a/04 in the Lee et al. study, which stated that "the footprint shown (Figure 2) is impossible unless one assumes infinite acceleration, no gravity and no atmosphere" (Lee et al. 1994). In his review, Garwin concluded that

> this statement is incorrect, according to what SPARTA told me. Foil/010 permits these results to be obtained without invoking not all, but one or more of

> these “very, very simple assumptions” and now adds another assumption (tailoring of the search area) that would do it also. (Garwin 1995, 4)

Since the Sparta team’s stated methodology involved a commitment to “replicate” the Gronlund et al. (1994) model to check its validity, Garwin’s finding that Lee et al. (1994) had omitted a key element of the model casts serious doubt on the credibility of the Sparta study. In fact, Garwin reported that during conversation, Sparta analysts conceded both that they had excluded the iterative optimization mechanism for “radar search area tailoring” (the Gronlund et al. iterative optimization mechanism) as an assumption in their attempts at footprint reconstruction and that such an exclusion had a definite effect on their conclusions. As Garwin recounted, the Sparta analysts agreed that incorporation of the iterative optimization mechanism as an assumption in the Gronlund et al. footprint model would have enabled the model to generate a valid footprint for THAAD-like systems defending against strategic missiles.

> I asked in particular about the assumption that was actually made by TAP [Gronlund et al.] and others—that it made no sense to scan an area larger than the footprint could be defended, so that for the small RCS [radar cross section] case the scan solid angle would be reduced, compatible with the defended footprint to be obtained; launch-point cueing from DSP would make this possible. *Sparta stated that they had not considered this in their response to O’Neill (“Abuses . . . ”)* and they agreed that that *could have been listed as among the “assumptions” that would make the difference. I pointed out that I did not believe this was appropriately termed “very, very, simple assumptions.*” (Garwin 1995, 4, emphasis added)

When Garwin asked why the Sparta researchers excluded Gronlund et al.’s (1994) iterative optimization mechanism in their attempt to reconstruct the footprints published in Gronlund et al.’s *Arms Control Today* article, he got the following reply: “SPARTA suggests that they did not have enough information on the methods used by the MIT group” (Garwin 1995, 4). This is a particularly problematic explanation, given that a crucial dimension of sound scientific peer review in attempts to “reconstruct” or “replicate” experiments entails necessarily a commitment to seek out and acquire sufficient information about the original work under scrutiny to enable valid experimental replication. It would not have been difficult for the Sparta team to acquire the necessary information in this case, given that the iterative optimization mechanism for radar search area tailoring was an explicit modeling assumption stated in Gronlund et al.’s published work (see Gronlund et al.

1994, 6). Garwin's investigation appeared to support the conclusion that in this case, the Sparta analysts did not make a sufficient effort to gather information about the details of the Gronlund et al. footprint model to support a credible scientific review.

A more general conclusion regarding the reluctance of the Sparta team to engage in healthy dialogue on this matter can be drawn from the Sparta researchers' treatment of Garwin himself. Even though Garwin held top-secret clearances (that were transferred for his visit to Sparta), Lee "declined to give . . . a copy" of foils describing the origin of the Sparta study, "to avoid the charts being criticized 'out of context'" (Garwin 1995, 1). This excuse is particularly curious in light of the fact that the meeting came "at the suggestion of BMDO" (Lowder 1995, 2) and was called presumably to provide Garwin with the necessary information required to reach an informed and independent judgment on the Sparta-MIT footprint controversy. Lee exhibited a similar lack of willingness to share research results when she denied permission to reprint a key viewgraph from the Sparta study for this article, justifying her decision to block publication of such material with the explanation that the study "is so old and probably no longer matters to anyone" (Lee 1999).

Two years after completion of this review, Garwin published a chapter in a book on defense issues put out by the National Research Council (Garwin 1997). In this chapter, Garwin reflected on the Sparta-MIT footprint controversy and reiterated emphatically his FILE memorandum conclusion that the Sparta findings were wrong. Furthermore, Garwin argued that official BMDO support for such "technical misinformation," as well as the willingness of top-level missile defense officials to convey such misinformation to Russia through diplomatic channels, had done substantial diplomatic damage to U.S.-Russian relations.

> Unfortunately, there is much misinformation, and even technical misinformation, provided to the Russian legislature, that could lead to substantial missteps by the United States and by Russia. For instance, a study paid for by the BMDO and released publicly in February 1995 has been claimed to counter the analysis of Professor T. A. Postol of the Massachusetts Institute of Technology and his colleagues that argues that THAAD has significant effectiveness against strategic ballistic missiles, *if* it is effective against missiles of 3,000-km range. Unfortunately, this BMDO-sponsored study has no "study" behind it—just the briefing charts, as explained to me by BMDO staff and the contractor. Furthermore, the results are wrong, although it is more difficult to determine that they are wrong if there is no written analysis that can be evaluated. (Garwin 1997, 192-93)

Garwin's ultimate conclusion was that the Sparta-MIT footprint controversy episode so thoroughly undermined BMDO's credibility as a source of technical information that in future debates in this area, "one should not trust the material published by BMDO, on which BMDO policy, that of the Department of Defense (DOD), and presumably U.S. national security policy are based" (Garwin 1997, 193).

Sizing Up the Footprint Controversy

As Trevor Pinch (1994, 88) noted in his analysis of the cold fusion dispute, during a controversy, "social processes not normally visible within science can become unusually explicit. . . . Under the lens of a scientific controversy, the good, the bad and the ugly within science come into focus as never before." One illuminating way to shed light on these typically submerged dimensions of scientific practice is to approach controversy from a rhetorical perspective. This vantage point yields particular insight about how different audiences enable and constrain opportunities for actors to advance scientific claims, as well as the manner in which the relative credibility of actors competing in controversies affects the course of events. Such a theoretical orientation can also help unpack the dynamics involved in "controversies about controversies," such as so-called "closure debates" (Epstein 1996, 29), where topics of discussion relate to the appropriateness of suspending argumentation. Closure debates often unfold in multiple tracks as interlocutors carry arguments to different forums and audiences. For example, even though Tobacco Institute researchers conceded that smoking caused cancer in "constitutive forums" such as corporate boardrooms, they maintained simultaneously that such facts were not proven in the "contingent forums" of the public sphere.[22]

The audience dependence of argumentation in scientific controversies can create heterogeneous layers of rhetorical performance. The resulting textual layering of argumentation poses serious problems for methods of critical analysis that presuppose essentialized models of scientific controversy, but such complexity also opens up opportunities for critique that take the interplay between tracks of argumentation as key points of departure. When significant cleavages between tracks are identified, vistas of critique open up. For example, in the recent Florida verdict against cigarette industry representatives, "jurors found that cigarette makers committed fraud, concealment and negligence by privately acknowledging the health risks of smoking and the addictiveness of nicotine while publicly playing down those concerns" (Geyelin 1999, A3). Brian Martin (1991, 101) noted similar dynamics in the controversy over water fluoridation, where interlocutors on both sides of the dispute highlighted “discrepancies between the stated norms of scientific behavior and the actual behavior of certain scientists.”

Accordingly, scientific arguments that claim the mantle of objectivity, on one hand, but subvert validating dialogue strategically, on the other, could be described accurately as “performative contradictions.” A central tool of criticism for Jürgen Habermas, the performative contradiction involves a speech act that is frustrated by some aspect of the speaker’s performance (see Habermas 1990; Jay 1992). In J. L. Austin’s (1975, 16) terminology, the performative contradiction involves a “misfire” of an attempted speech act (e.g., when speakers make verbal promises with fingers crossed behind their backs). In search of grounds for critique of institutional argumentation based on these concepts, Erik Doxtader (1995, 186) observes that “institutions use the contingency of public discussion to tactically disarm the force of criticism that would offer contravening norms of political development” and that “critique that calls into question the terms of such methods reveals how bureaucratic rule-makers presuppose forms of deliberation that have not yet occurred.” With these thoughts in mind, it would be appropriate to revisit the text of O’Neill’s intervention on the TMD footprint controversy since the previous theoretical discussion presents valuable avenues for pursuing understanding of this text’s rhetorical dynamics.

Although Garwin’s primary motivation for reviewing the controversy between Lee et al. (1994) and Gronlund et al. (1994) was to examine the technical aspects of TMD footprint modeling, his most hard-hitting conclusions were rhetorical in nature. Garwin raised deep questions about the seriousness of Sparta’s commitment to legitimate scientific peer review and expressed grim reservations about BMDO’s credibility in the eyes of world audiences. In this section, I explore further implications of Garwin’s rhetorical judgments, returning to O’Neill’s 1995 letter to shed more light on how in this case, missile defense advocates used a variant of the Tobacco Institute strategy to defer closure of the TMD footprint controversy. Then I turn to the broader political stakes involved, with correspondence by Alexei Arbatov, member of the Russian State Duma, serving as a text to bring the wider political significance of the rhetorical fallout from this episode into perspective.

Is This “Healthy, Scholarly Debate”?

BMDO Director O’Neill’s 3 May 1995 letter to Postol announced BMDO’s official stance on the Sparta-MIT controversy for the first time. Previous analysis highlighted the three main arguments in O’Neill’s correspondence: (1) the findings of the Sparta study did not represent official BMDO policy, so Postol's dispute should be with Sparta, not BMDO; (2) the divergence between Sparta and MIT's findings was not due to technical errors by Sparta but instead was the natural outgrowth of a legitimate scientific disagreement; and (3) Postol's attacks on Sparta were unjustified because Lee et al. (1994) worked in good faith to produce their study.

Although BMDO may not have explicitly adopted the findings of the Sparta study as official policy, the circumstances and character of official briefings indicate clearly that BMDO used its official status to create forums where Sparta researchers could present their views in an unopposed fashion to high-ranking audiences. Thus, while O'Neill forswore any official responsibility for the contents of the Sparta study in his letter to Postol, in practice, it was official BMDO policy that provided the institutional support for the study, and it was official BMDO policy that arranged for the unimpeded amplification of the study's findings to key official audiences. The tension between O'Neill's rhetorical strategy of disassociation and BMDO's on-the-ground practice thus becomes manifest: BMDO appeared to have no reservations about promoting the Sparta study through official briefings, yet its director showed no interest in defending the study as a legitimate review in the face of vigorous external challenge.

Furthermore, Sparta researchers were able to use their close association with BMDO to gain direct access to defense officials throughout the official BMD community. As Sparta's Lee explained, this access translated into an exclusive right of first reply in cases when officials got wind of the Sparta-MIT controversy. "[After public release], we had to go through a lot," Lee said. "Every time Ted [Postol] flared it up, somebody somewhere would say, 'I want to see this.' And people would want to know the details. And so we'd show the charts, go through the diagrams and equations, approximations, and they'd go 'Oh, okay.'" Intimating that this was a frequent occurrence, Lee went on to say, "I can't tell you the number of times I've dealt with this" (Lee 1996).

The tension between O'Neill's strategy of deniability and BMDO's practical role in promoting Sparta's findings can be localized in two significant omissions in the text of O'Neill's letter to Postol. While O'Neill reiterated that BMDO's charge to Sparta was to "review" Gronlund et al.'s (1994) article, O'Neill ignored Postol's claim that the Sparta study did not even qualify as a legitimate scientific peer review because it did not replicate Gronlund et al.'s modeling assumptions when attempting to reconstruct Gronlund et al.'s footprints.

In addition, O'Neill failed to respond to Postol's charge that Lee et al. (1994) deviated from fundamental norms of scientific peer review by failing to contact Gronlund et al. prior to the completion of the Sparta study. This silence is deafening in light of Garwin's findings that the Sparta team made fundamental and careless errors in replicating the Gronlund et al. (1994) footprint model, such as ignoring key theoretical assumptions (e.g., the iterative optimization mechanism) built into the Gronlund et al. model that were disclosed clearly in published work.

O'Neill's second move, deferring judgment on the Sparta-MIT controversy by bracketing the dispute as a "healthy scholarly debate," takes on new light when assessed against the backdrop of Garwin's independent findings. By naming the MIT-Sparta footprint controversy as a "healthy scholarly debate," O'Neill suggested that it was the interplay between the opposing positions that afforded him valuable insight into aspects of U.S. TMD policy vis-à-vis the ABM Treaty. "In the marketplace of ideas," wrote O'Neill, "there is room for vigorous and honest debate" (O'Neill 1995). It was precisely this dynamic of debate that O'Neill claimed to find most illuminating about the Sparta-MIT exchange, and that was also used to excuse him from any obligation to judge one side or the other as correct.

However, O'Neill chose not to reply to Postol's charge that Lee et al. (1994) sought to foreclose scientific debate by refusing to share information and by failing to make even minimal communicative attempts to clarify crucial aspects of the Gronlund et al. (1994) computer model. This silence takes on a more disturbing quality in light of Garwin's findings that this case was hardly a model of "open, honest" scientific debate carried on in the "marketplace of ideas." In fact, there was no debate in the first six months after completion of the Sparta study because its contents were shrouded in secrecy. During this time, Gronlund et al. were not even aware of the fact that a major challenger had enjoined them in debate. Presumably, O'Neill would have never permitted this time period to elapse if he was genuinely seeking to spur robust debate in the open marketplace of ideas. This tension is yet another manifestation of the contradictory dynamic latent in O'Neill's reply to Postol.

O'Neill's characterization of the controversy as an honest scholarly debate thus appears highly questionable when assessed in the context of the charges, countercharges, and third-party findings of systematic distortion in the peer review process of the TMD footprint controversy. Yet O'Neill relied heavily on the classification of the controversy as a healthy scholarly debate to support his aloof rhetorical posture. In the internal "BMD community," a classic "constitutive forum" (Collins and Pinch 1979), BMDO commissioned a secret study by a private SDI boutique and then amplified the findings of the study in official briefings. This internal strategy provided grounds for official missile defense advocates to discredit the contents of a threatening public article and help shore up political support for THAAD. However, when the study drew intense criticism after its public release, BMDO denied sanctioning the study and declined to defend its findings in the "constitutive forums" (Collins and Pinch 1979) of the public sphere. The inconsistencies found between these two tracks of rhetorical performance appear to support the conclusion that in Habermas's (1990) terminology, O'Neill's strategy of prolonging the TMD footprint controversy involved a performative contradiction.

Finding a similar contradictory dynamic to be latent in institutional arguments advanced on behalf of the contingent valuation method (CVM) of environmental risk assessment, Doxtader (1995) argued that members of the public need to critique such tensions if they are to protect the environment from being despoiled by unconstrained institutional logics hell-bent on profit maximization. There is a related bottom line connected to the TMD footprint controversy since one cost of BMDO's Tobacco Institute strategy for manufacturing and prolonging disagreement over computer footprint methodology appears to have been forfeiture of another public good, international trust and cooperation.

Diplomatic Missteps and Superpower Suspicions

According to senior Russian arms control official Alexei Arbatov (1995), in the mid-1990s, the Gronlund et al. (1994) article became "widely known in Russia," and its results were "extensively used in the discussion about the problems associated with ABM Treaty modification." It is easy to appreciate why Gronlund et al.'s argument would find such a wide Russian audience. Russians worried that headlong American pursuit of missile defense would nullify the deterrent value of their offensive nuclear forces and make them vulnerable to U.S. nuclear blackmail. The Gronlund et al. *Arms Control Today* article spoke directly to this concern because its contents constituted the scientific basis for many public claims that BMDO sneaks strategic defense in through the backdoor, by cloaking truly strategic missile defense systems in the garb of pure theater defense.

In the case of TMD footprints, Russian perception that American negotiators employed methodology that understated the capability of U.S. TMD systems against strategic targets worked to chill the negotiating climate and bolster the hand of arms control opponents in the Russian Duma. As chair of the Subcommittee on International Security and Arms Control in the Russian Duma, Arbatov exercised significant control over the fate of superpower arms control at the height of the TMD demarcation debate. "There is a considerable number of Duma members concerned about possible strategic capabilities of advanced theater defenses and this issue is very likely to be raised in connection with ratification of the START II Treaty," Arbatov stated in 1995. "It is therefore very important for us to have *clear* and *unambiguous* understanding of the issues associated with discrimination of theater and strategic defenses" (emphasis added).

A popular argument advanced by U.S. TMD advocates in response to these concerns was that on questions of ABM Treaty compliance, capability, not intention, was key to determining a given system's legality. While such an approach might have been technically correct, it may not necessarily have been politically prudent, especially given the concerns voiced by Arbatov. Even if a TMD is technically legal under the ABM Treaty, Russian perception that such a system was being packaged to circumvent treaty limits could be as damaging to strategic stability as outright abrogation of the treaty.[23] It was precisely this dynamic that led Russia to link its ratification of the START II arms control agreement not only to continued U.S. observance of the ABM Treaty but also to satisfactory resolution of outstanding TMD demarcation issues. Vladimir Lukin, head of the International Relations Committee, was the floor manager of the START II bill in mid-1990 deliberations held in the Russian Duma. Lukin said, in effect, "that the development of these [TMD] defenses could torpedo ratification [of START II]" (quoted in Mendelsohn 1996).

Lukin's statements suggested that Russian linkage of START II to U.S. ABM Treaty compliance was more than a technical issue; it was also a rhetorical issue. Russian officials have made it abundantly clear that their assessment of American intentions regarding missile defense deployment may have been as important as their determination of extant American capabilities as a factor determining whether to ratify START II. For instance, Pavel Povdig (1995, S19210), arms control expert at the Moscow Centre for Disarmament, Energy, and Ecology, argued that THAAD "will lay down a basis for the country's [United States'] anti-missile defense system." In a similar vein, Anton Surikov (1996, 1), general director of Russia's Institute of Defense Studies, contended that "these [TMD] plans are essentially another attempt at dragging the SDI idea in through the back door and they present a significant threat to strategic stability in the world."

The gulf between American assurances of ABM Treaty compliance and Russian perceptions of covert U.S. ABM Treaty breakout represented a rhetorical chasm that threatened to swallow up prospects for superpower arms control. This chasm was widened by Russian perceptions of U.S. strategic deception on TMD demarcation issues. Surikov's "backdoor" SDI hypothesis was strengthened each time the U.S. deliberately underrepresented TMD capabilities to Russian demarcation negotiators. Although O'Neill's use of the Tobacco Institute strategy in this case may have been politically expedient for him personally, the resulting loss of credibility for BMDO as an organization was very damaging. Recent evidence suggests that Russian suspicion about the potential capability of proposed U.S. BMD systems continues to hamper arms control diplomacy designed to achieve reciprocal “deep cuts” of offensive strategic missiles (see Tanner 1999; Hoffman 1999). As Arbatov (1999, 316) explains, Russian concerns about the U.S. TMD program have “also deadlocked the U.S.-Russian talks at the Standing Consultative Commission on the delineation of strategic and tactical defenses.”

Robert McFarlane (1992) touted the advantages of cold war deception on SDI by arguing that it misled the Soviet Union to take on bloated military budgets, speeding up the collapse of the Soviet economy by five years. Ironically, U.S. strategic deception may turn out to have similar effects in the present context. As in the cold war, Russian suspicion of U.S. military intentions translates into significant argumentative ammunition for Kremlin hawks calling for boosts in defense spending. Where such massive enemy expenditures allegedly served U.S. interests in the late stages of the cold war, by smothering the Soviet Union’s economy and supposedly hastening the fall of communism, today similar spending patterns waste precious economic fortunes and subvert efforts by those in both Russia and the United States to move beyond debilitating superpower cold war antagonisms. This is no trivial concern, given that in the present milieu, a revival of unbridled cold war passions on the part of major nuclear powers could trigger another Cuban missile crisis gone wrong. The world came uncomfortably close to outright nuclear war during the cold war, and the next time a harsh diplomatic stalemate such as the Cuban missile crisis confronts hostile nuclear superpowers, there is no guarantee that the deterrence dice will come up lucky again. Should superpower antagonisms escalate to the level of a nuclear exchange, life on planet earth would be in grave jeopardy. Therefore, extraordinary efforts to stave off unnecessary superpower friction in the present milieu are prudent, if not imperative.

The zero-sum framework of cold war competition provided incentives for superpower adversaries to wreak havoc on each other’s economies. Now, the stakes are different as the superpowers attempt to navigate a transition toward a more cooperative and sustainable post–cold war posture. The success of such a transition depends in large part on mutual trust since suspicion strengthens the hands of those in each country calling for a return to cold war–style military confrontation. In this context, corrosive fallout from American strategic deception can be located on a rhetorical level. Should Russians begin to join Garwin in doubting fundamentally the credibility of BMDO promises and assurances, U.S. Deputy Secretary of State Strobe Talbott suggested that we could expect them to begin translating our discourse in a more hostile manner, filtering ostensibly amicable American proposals for post–cold war partnership and cooperation through an adversarial zero-sum lens.

> If the Russians overindulge their misplaced suspicions that we want to keep them down, then words like partnership and cooperation, translated into Russian, will become synonyms for appeasement, subservience, and humiliation at the hands of the West. The result then could be that we will indeed cooperate less, and compete more, on precisely those issues where it is in our common interest to cooperate more and compete less: arms control, environmental degradation, terrorism, regional conflict, and proliferation of weapons of mass destruction. . . . Russian policymakers—especially those still inclined to see their country's relationship with the United States as intrinsically a rivalry—may fall into the trap of defining what is in their national interest as pretty much anything that annoys, or causes problems, for us. If that reflex for scoring points against us in a zero-sum game becomes a kind of default feature in the software of Russian policy, it will only generate mistrust on our side. Suspicions of each other's motives could prove self-justifying, and pessimistic prophecies about the future of the relationship may be self-fulfilling. (Talbott 1996)

Mutual trust and cooperation are especially crucial in the context of nuclear stability since "American security, like that of all other nations, depends on political pressures and constructive diplomacy, imperfect though these tools are" (Garwin 1998, A15). It is reasonable to expect such diplomacy to falter when Russian suspicions about the structure of the current U.S. missile defense program are allowed to fester.

Conclusion

Laura Lee continues to perform research for Sparta, but she recently set aside the TMD footprint issue and moved on to other projects. "There's nobody here [at Sparta] working in [the footprint] area anymore," she said in a recent telephone conversation. "We answered all the questions to our satisfaction, and any problems with the work have been resolved" (Lee 1997). How have the problems been resolved and the questions been answered? BMDO insiders may be the only ones who ultimately receive a full and fair accounting on these points. Until the entire missile defense enterprise is made more transparent, those in the public realm will continue to remain largely uninformed and essentially dependent on official sources of information. Under these conditions, there is every reason to expect that those in the missile defense bureaucracy will continue to resort to strategic deception as a routine strategy for the promotion of missile defense systems (Mitchell 1997, 23).

Exploration of the mid-1990s public controversy over the ABM Treaty demarcation reveals that new strategies of deception have been developed to bolster missile defense advocacy in the post–cold war milieu. Specifically, in the case of the TMD footprint issue, renowned physicist Richard Garwin found that BMDO worked with Sparta to propagate “technical misinformation” as a way to influence official judgments on matters of U.S. ABM Treaty compliance. The novel element of such a strategy is that it was employed to stimulate controversy over THAAD’s intercept effectiveness to make the system more politically palatable. As a maneuver to defend BMDO’s political interests in the “closure debate” regarding TMD footprints, this strategy bore a resemblance to institutional argumentation advanced by advocates with deep pockets in recent scientific controversies over health harms of tobacco smoking and anthropogenic climate change. These cases point to an opening for STS controversy studies that would complement Englehardt and Caplan’s (1987) “closure project” by steering critical attention not only to the ways that scientific controversies end but also how they are stimulated and prolonged to serve political interests.

Are there other new forms of strategic deception that pervade the missile defense enterprise? Is the Sparta study just the tip of the iceberg? For Garwin, the lesson of the Sparta-MIT controversy is that in future missile defense debates, “one should not trust the material published by BMDO, on which BMDO policy, that of the Department of Defense (DOD), and presumably U.S. national security policy are based” (Garwin 1997, 193). If his conclusion is correct, then it is unlikely that members of the public will receive satisfactory answers to the tough questions that continue to dog BMDO while it remains a scientific island, ringed by a moat of secrecy and cut off from the wider physics community.

Technical breakdown and cover-up in the BMD community not only invite erosion of democratic decision-making processes. Such trends also undercut arms control diplomacy and frustrate superpower efforts to move beyond cold war antagonisms. Unnecessary secrecy always spawns mistrust, and in the present political context, the United States can ill afford needless superpower friction. Public statements of Russian officials suggest that the BMDO’s position on TMD footprint analysis may have sapped U.S. arms control credibility in ABM Treaty demarcation negotiations while also undermining support for the ratification of START II in the Russian Duma. The success of the U.S. arms control agenda depends in large part on rhetorical persuasion, and persuasion depends on credibility. One challenge for U.S.

diplomats in the new millennium will be to recover the lost credibility squandered during the mid-1990s TMD footprint controversy.

Appendix
Chart of Acronyms and Abbreviations

ABM Treaty. Antiballistic Missile Treaty. Arms control agreement signed by the United States and Soviet Union in 1972 to limit deployment of missile defense systems.

ACDA. Arms Control and Disarmament Agency. Branch of the U.S. Department of State in charge of U.S. arms control negotiations.

ATBM. Antitactical ballistic missile system. Type of missile defense designed primarily to protect allied troops and civilians from missile attack in foreign combat theaters. Also called TMD.

BMD. Ballistic missile defense. Weapon system designed to intercept incoming ballistic missile attacks.

BMDO. Ballistic Missile Defense Organization. Branch of the U.S. Department of Defense in charge of missile defense since 1993.

CVM. Contingent valuation method. Approach to risk assessment most often used in environmental regulation.

DSP. Defense Support Program. Pentagon space surveillance program designed primarily to detect and track enemy missile launches.

DOD. Department of Defense.

ICBM. Intercontinental ballistic missile.

IPCC. Intergovernmental Panel on Climate Change. Group of scientists studying global warming.

RCS. Radar cross section. Characteristics of a ballistic missile as detected by radar.

SDI. Strategic Defense Initiative. So-called “Star Wars” missile defense system proposed by Ronald Reagan in 1983.

SDIO. Strategic Defense Initiative Organization. Branch of the U.S. Department of Defense in charge of missile defense before 1993.

START II. Strategic Arms Reduction Talks II. Pending arms control agreement limiting U.S. and Russian ballistic missile deployments.

STS. Science and technology studies. Branch of academic scholarship.

THAAD. Theater High-Altitude Air Defense. Missile defense system currently being developed by Lockheed Martin, Inc.

TMD. Theater missile defense. Type of missile defense designed primarily to protect allied troops and civilians from missile attack in foreign combat theaters. Also called ATBM.

Notes

1. These questions relate to competing theoretical estimates of missile defense system performance capabilities, including radar search power, battle management, intercept effectiveness, and other measures of system proficiency.

2. Technical discussion of Theater High-Altitude Air Defense's (THAAD's) theoretical capability as a strategic defense system has direct ramifications for policy in the areas of international treaty compliance, diplomacy, and arms control.

3. The reference to the tobacco industry is due to the tendency of that industry to fund private think tanks such as the Tobacco Institute to produce dubious scientific evidence challenging the well-established hypothesis that smoking causes health harms. The primary aim of such industry research was not to prove definitively that smoking was safe but rather to propagate the illusion of scientific debate to heighten uncertainty regarding claims that smoking was dangerous (see Helvarg 1996, 21).

4. The treaty prohibits ballistic missile defense (BMD) testing "in an ABM mode," clarified in 1978 to mean "with the flight trajectory characteristics of strategic ballistic missiles . . . over the portions of the flight trajectory involved in testing" (quoted in Bunn 1990, 106).

5. In an op-ed piece for the *New York Times,* Holum (1994, A21) claimed that "[a] theater missile defense system could protect against such threats [as North Korea]—but not against a Russian strategic missile attack. Missiles in a theater defense might theoretically shoot down one or another incoming long-range missile, but the multiple missiles in a theater could not shoot down significant numbers of enemy missiles during a real attack. The theater missile defense would not and could not be used to protect the United States."

6. Gronlund et al. (1994) argued that the Clinton-Gore administration's proposed TMD demarcation threshold was untenable because THAAD-like theater missile defenses (TMDs) exceed the maximum capabilities allowed for missile defense systems under the Antiballistic Missile (ABM) Treaty: "As our analysis indicates, it is far from obvious that it will be possible to deploy highly capable ATBMs without seriously undermining the ABM Treaty. It also casts serious doubts on statements by Administration officials that the proposed changes are only minor 'clarifications' to the Treaty" (Gronlund et al. 1994, 8).

7. Arms Control Association Director Jack Mendelsohn (1995) offered the duck/duckling, strategic/tactical metaphor to highlight the argumentative contortions that Clinton-Gore administration officials went through to contend that on paper, the THAAD system would have no realistic strategic capability.

8. The briefing was related to a paper Keith Payne had prepared for General O'Neill on the topic of "Proliferation, Potential TMD Roles, Demarcation and the ABM Treaty," and the briefing took place in Ballistic Missile Defense Organization (BMDO) front offices (Lee 1996).

9. The footprint research was covered under two ongoing BMDO contracts: (1) BMDO Super SETA Extension, SDIO84-93-C-0018/J-700D-93014/Task Order 44, Work Area 1, and Task Order 65, Work Area 6 and (2) SETA for the BMDO Technology Readiness/Strategic Relations Deputate, HQ0006-95-0006/06S5000834, Task Order 10 (Lowder 1995, 2). The estimated time spent "in support of the footprint analyses and briefings is less than 100 hours with a cost to the Government of less than $8,500" (Lowder 1995, 2).

10. From the perspective of insiders, the "BMD community" includes those security clearance holders directly and indirectly connected to the intelligence, planning, and procurement infrastructure of BMDO (Lee 1996).

11. This experience was not unique to Sparta, Inc. Burgeoning Strategic Defense Initiative (SDI) budgets sprouted an entire cottage industry of missile defense contracting in the mid-1980s (see Carrington 1985; Tirman 1995).

12. The time for the track and intercept calculation was assumed to be 5 seconds, while the interceptor flight time (using the shortest possible path) was assumed to be 25.6 seconds. Added together, these estimates made up Sparta's total calculated battle space time of 30.6 seconds (Lee 1996).

13. Nacht (1996) suggested that members of the following Arms Control and Disarmament Agency (ACDA) groups would have taken an interest in the Sparta briefing: Director's Office, Bureau of Strategic and Eurasian Affairs, Special Weapons Division, SCC Commission, Intelligence, General Counsel's Office, and Operations.

14. In an editorial by Sidney Graybeal and Keith Payne (1995, 20), the following reference was made to the Sparta study: "[Gronlund et al.'s] analysis is based on a calculation of the area that a THAAD-like system could theoretically defend—called a 'defensive footprint.' However, more recent and complete computer simulations of a THAAD-like defensive footprint demonstrate that such a system has little or no significant capability against any realistic strategic missile attack." Shortly after, Wright and Postol(1995) issued a brief reply in the same publication.

15. As Postol (1995a, Appendix A) explained, "In order to find the optimal defended footprint, a balance must be struck between three related quantities: the detection range; the size of the area of the sky that can be searched by the radar; and the size of the defended footprint, which is in part determined by the distance versus time flyout characteristics of the interceptor. . . . Thus, the defended footprint is the result of a tradeoff between the search area detection range that can be achieved by the radar, and the size of the defended footprint, which depends on the time available for the interceptor flyout."

16. "The approximate launch point of an attacking missile is assumed to be provided by DSP satellites, which reduces the angular search required" (Gronlund et al. 1994, 6).

17. "The search area in each case depends not only on the anticipated detection range, but also on the size of the footprint to be defended, and is determined iteratively" (Gronlund et al. 1994, 6).

18. In BMDO parlance, Gronlund et al.'s (1994) iterative radar search optimization mechanism is called "goaltending," and goaltending was not an assumption included in the Sparta study. As Lee (1996) explained, "What we were trying to do here, is perform it the way they [Gronlund et al.] did it, but we used the characteristics they told us about, using the concepts and the way that we employ radar, which is not goaltending. . . . Initially, they didn't tell us anything about goaltending."

19. As Postol (1995b, 1) further explained in a letter to Deputy Assistant Secretary of Defense for Forces Policy John R. Harvey, "I first spoke with Ms. Lee on the morning of 19 January 1995. During that conversation, all Ms. Lee was willing to tell me about her study was its name. She asked me for information about our interceptor model and we gave her that information on the afternoon of the same day. I again spoke with Ms. Lee on 20 January and she complained that she could not obtain reference three in our *Arms Control Today* article and suggested that perhaps this was because the reference did not exist. I asked her why she had not requested the reference five months earlier, before she published her study of our work, and she could offer no explanation. I sent her a copy of reference three that day and I have not talked to her since."

20. In addition to discussing the tobacco research example as a case in which prolonged scientific controversy worked to defer the necessity of definitive judgment by policy-making authorities, Dickson (1998, 194-95) shows this same phenomenon at work in disputes over the regulation of formaldehyde and the environmental effects of acid rain.

21. In addition to his position at IBM, Garwin is also an adjunct professor of physics at Columbia University, as well as a member of the National Academy of Sciences and the National Academy of Engineering, and he sits on the Advisory Committee to the ACDA. After completing his Ph.D. in physics under Enrico Fermi at the University of Chicago in 1949, Garwin went on to make fundamental contributions to the U.S. government air defense program in the 1950s. With the advent of long-range missile technology during the peak of the cold war, Garwin shifted his focus to missile defense, and he has made numerous public interventions on this subject since

that time (see "The Garwin Archive—1990s, housed at the Federation of American Scientists Web site, online at http://www.fas.org/rlg/90-96.htm).

22. For discussion of the distinction between "constitutive" and "contingent" forums in scientific controversies, see Collins and Pinch (1979).

23. As Mendelsohn (1996, 28) explained, "Large numbers of high-performance missile defense systems, even if disingenuously defined as 'theater' systems to circumvent ABM Treaty constraints, are likely to be perceived as the first step toward preparing a 'base' for national defense. In turn, that perception will chill efforts to shrink the strategic arsenals of Russia and the United States. In the worst-case scenario, large numbers of highly capable TMD deployments might actually reinvigorate the strategic arms race." When combined with space-based sensors, Pike (1996, 14) wrote that TMD will work "well enough to provoke offsetting buildups of offensive missiles by potential adversaries—a prescription for a new and spiraling arms race of offenses versus the defenses such as those now envisioned."

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