THE DISPOSITION OF EXCESS WEAPONS PLUTONIUM: A COMPARISON OF THREE NARRATIVE CONTEXTS

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Efforts at long-term management of nuclear materials have been plagued over time by intense public controversy—regarding technical approaches, sites, and schedules. These debates have left policymakers, activists, scientists, and the interested public at considerable odds over how to proceed. The U.S. government's recent decision to undertake a "dual-track" approach to the disposition of excess plutonium (from dismantled nuclear weapons) is no exception. In its Record of Decision of January 1997, the U.S. Department of Energy (DOE) announced its commitment to pursue *simultaneously* the immobilization of plutonium in an inert matrix (such as glass or ceramics) for subsequent disposal as waste, and the use or "burning" of plutonium in commercial nuclear reactors in the form of mixed-oxide (MOX) fuel.

Not unexpectedly, activist groups have expressed significant opposition to the MOX portion of the dual track, arguing that this undertaking would revive what they claim (and hope) is a flagging U.S. nuclear power industry. They also contend that MOX violates U.S. policy against the reprocessing of commercial nuclear fuel, and would thus set a dangerous precedent internationally. Policymakers, on the contrary, have claimed that the MOX option is essential to U.S.-Russian negotiations and that only by exploring MOX in conjunction with immobilization will the United States have any hope of influencing Russian nuclear policy, thus guarding against the possibility that, in a country full of turmoil, plutonium might fall into the wrong hands. Scientists, for their part, have advocated and contested the technical possibilities and challenges of each option, as well as the long-term promises and liabilities of plutonium in general.

This article examines the more prominent positions with regard to plutonium disposition. Rather than evaluating or choosing among them, however, it sets out to discover the underlying logic and assumptions that set them apart so distinctly. This study's basic presupposition is that existing disagreements among policymakers, activists, and other stakeholders cannot be readily understood merely by appealing to the "facts" of the matter. Since we are dealing with the effects of future-oriented policy, the decisions

to be made entail uncertainties and judgments about such things as the effects of U.S. actions on Russian policy, the effects of implementing the MOX option on the domestic and international nuclear power industry, the institutional and political feasibility of various technical processes when taken to full scale, evaluations of environmental and health risks, and even the relationship of future generations to plutonium in general. Furthermore, the actors themselves and their roles are called into question: thus, DOE's public legitimacy becomes an important problem, since it is the institution charged with carrying out any method of disposition. Questions also arise about the legitimacy of the role played by activists, when they take positions that policymakers see as clearly unreasonable. Not only do these participants in the controversy disagree about the policy, but on some points, they find themselves virtually incapable of understanding one another. So complex is plutonium disposition as a policy problem that individuals may disagree on the best course of action despite their otherwise similar views on nuclear affairs, while others are surprised to arrive, on certain points, at the same position as their arch rivals.

This article undertakes a narrative analysis of the dual-track controversy. The term "narrative analysis" describes a systematic inquiry into the context within which the problem of weapons plutonium disposition is perceived and explained: that is, how it fits into a larger chain of related events, as told by those observing or participating in them. From this perspective, the current debate can be viewed within different contextual settings, which yield, in effect, different "stories." Each of these stories is internally coherent with a plot and themes that give meaning to events, creating a plausible conceptual path from the beginning of the nuclear age into a projected future. Of course, each story has its own view of the important events over time and how to interpret them. Thus, the stories express different sets of core values and assumptions, leading to different sets of goals and criteria for determining favorable outcomes. In this way, one can see how these narrative contexts help shape the various positions regarding the dual-track decision.

By articulating the deeper concerns at stake for all those involved and examining how they are reflected in the language of the debate, this article seeks to discover new grounds for a meaningful dialogue among these groups. At present, each side is prone to miscalculate how its own statements and actions will be interpreted by others, while simultaneously viewing actions and statements by other groups with incomprehension and even suspicion. A better understanding of the respective narrative contexts that underlie existing positions should help alleviate the social strain seen currently in the protracted public controversy regarding plutonium disposition policy.

The evidence used to discover the narrative contexts that ground this controversy is drawn from interviews with scientists and engineers at two of the national laboratories involved in researching plutonium disposition options (Lawrence Livermore and Los Alamos), as well as with policy advisors to the president and DOE, activists, and participants in the nuclear industry.[1] In addition, this study draws on a wealth of letters, position papers, graphics, and commentaries available on the World Wide Web that address plutonium disposition and related nuclear issues.[2]

This research has uncovered three archetypal narratives based on different logical and normative themes. These so-called "stories" are reconstructed, ideal-type representations of three basic arguments, stripped of the modifying qualifications that usually accompany them in order to make them "reasonable" within existing societal expectations. As presented below, the stories do not account for real-world differences in the intensity of personal convictions, or the fact that individuals may draw on more than one of these narrative contexts in constructing their own arguments. Therefore, many actual individuals (including some of those interviewed) would not feel adequately represented by any one of these three stories verbatim.[3] However, all accounts examined in this research did echo the main concerns promulgated by the three archetypal narratives and drew upon their interpretations in framing the basic issues at stake in the plutonium controversy.

Decomposing the competing policy perspectives into three archetypal stories allows us to capture and highlight important underlying perceptual differences that are often hidden in today's policy debate. These differences include, among others, assumed models of political and social power, visions of possible and desirable futures, and symbolic interpretations of plutonium itself. By emphasizing and articulating these perceptual factors within sto-

ries that describe particular thematic approaches to nuclear issues, this article attempts to show the internal coherence of each set of views on what should (or should not) happen to the designated excess weapons plutonium. The article then looks for possible grounds for agreement among the three stories. Finally, it provides some guidelines for improving the current policy debate.

THREE ARCHETYPAL STORIES

The Diplomacy Story

The first of the three archetypal perspectives on plutonium we can call the "Diplomacy Story." Thematically, it centers on the relationships and interactions among political stakeholders involved in nuclear activities. The Diplomacy Story is one about the United States working to maintain its position among the nuclear nations of the world, about on-going negotiations with the Soviet Union (and now Russia) to reduce the threat of nuclear weapons use, and about satisfying political constituencies along the way.

The unfolding of history that leads up to the current debate on weapons plutonium disposition, as told by the Diplomacy Story, begins with the articulation of U.S. nonproliferation policy after World War II that sought to prevent other nations from acquiring nuclear weapons capability.[4] Important historical events include the announcements and demonstrations of nuclear weapons by other states, signaling the importance of instituting some realistic mechanisms of control; the development and ratification of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), as well as some nations' refusals to ratify or act in its spirit; efforts to ratify arms reduction treaties; the breakup of the Soviet Union and the end of the Cold War; and, finally, negotiations about the bilateral dismantling of nuclear weapons, declaring their plutonium "excess."

Parallel to the history of nuclear weapons are the growth, stagnation, and incipient decline of the nuclear energy industry in the United States; abdication of commercial nuclear fuel reprocessing, concretized in President Carter's policy directive on the grounds of proliferation hazards[5]; and, recently, the emergence of Western European nations and Japan as innovators and leaders in reactor and nuclear fuel reprocessing technologies. Whether these developments are good or bad, or whether commercial reprocessing intrinsically poses a proliferation threat, is not so much at issue here; rather, the Diplomacy Story treats these events as facts of life whose significance varies with the current political climate and economic conditions. The emphasis is instead on establishing and nurturing a nonproliferation "regime,"[6] or a set of social-political arrangements that regulates and verifies the actions of individual nations, whatever their technological preferences. The important *assumption* embedded in this term is that the forces associated with international politics, power, and prestige are universally meaningful and therefore effective at producing the behavior in question.

The history of the United States' interaction with the Soviet Union and Russia on nuclear matters represents here an investment of effort, a sequence of cautiously calculated actions, which can be rendered ineffective if continuity of action is lost. This notion is captured in such figurative expressions as "the Russians falling off the bandwagon," "the train of talks derailing," or "the string of negotiations breaking."[7] In this symbolism, it is clear who is driving the train or pulling the string: the Diplomacy Story features the United States as a paternal character with superior wisdom and means, while Russia in its economic weakness and political disorientation appears like an adolescent who is best managed through consistent guidance and skillful coaxing. Similarly, the history of nuclear energy development signifies an ongoing effort to guide technological progress, specifically, in terms of its instrumental role in supporting international political power and influence. Viewed in this context, the disposition of excess weapons plutonium represents one step in a series of diplomatic efforts to maintain global security, by preserving an authoritative geopolitical position for the United States in general and averting calamity with regard to Russia in particular.

The Energy Story

The second perspective, which we term the "Energy Story," situates plutonium disposition in the more explicit context of nuclear science. Rather than seeing technology ultimately as an instrument of politics, it is technology *per se*, in its physical and scientific aspects, that matters here. Technological progress is in fact the central theme of this story, as a force in its own right that moves humanity along a path determined by scientific rationality and our desire for well-being.

From the Energy perspective, the

history of plutonium begins in Glenn Seaborg's laboratory with its identification as the first man-made element of the Periodic Table, and the realization that its atomic nucleus could be made to fission, releasing vast quantities of energy. Widely described in terms such as "the dawn of a new era" by scientists then and now, this discovery marked man's ability to control nature in a profound way, for the first time achieving mastery over the very constitution of matter itself.[8] Indeed, the transmutation of uranium into plutonium denoted the final success of the mythic alchemical quest, with the "gold" of the nuclear age being even more powerful and valuable than the gold of jewelers and bankers.

Subsequent to—and quite independently of—the discovery of plutonium, applications emerged for putting this new knowledge to practical use: first the atomic bomb, as a rather regrettable occasion; and second, the production of commercial energy in nuclear reactors, as an opportunity to make good on the damage caused by the bomb,[9] benefiting society directly by providing a bounteous fuel for its growth and advancement. On both counts, according to the Energy Story, nuclear technology has been a success: ethical questions about the bomb notwithstanding, its physical functioning certainly represented a triumph of science. And nuclear energy, though its deployment has been hampered and its economic features distorted by political opposition from a poorly educated public, has nonetheless proven itself technically, with reactor designs evolving to meet the increasingly complex challenges entailed by stringent economic and safety standards.

But the Energy Story also has an important twist. The decision not to reprocess nuclear fuel in the United States marks a radical departure from the systemic fuel management concept envisioned by nuclear engineers, designers, and planners. In fact, there are two story lines here: how things were supposed to turn out, and how they actually did. Based on the assumptions that growth in energy consumption is vital for societal progress and that the most efficient utilization of uranium fuel is definitely desired, the notion of recycling fissionable plutonium from spent reactor fuel (where it has been created or "bred" as an inevitable by-product of exposing uranium to neutrons in the reactor milieu) is clearly the logical path. Followed through at full scale, the operation of "closing the fuel cycle" would provide vast quantities of commercial electricity at low marginal cost—a theme immortalized in the 1950s slogan "too cheap to meter."[10] Given how well this approach fits the bill of addressing anticipated resource and environmental constraints in the future, the Energy Story predicts the closed fuel cycle as an inescapable choice in the end. From this perspective, the decision to abdicate reprocessing for security reasons, along with the national decline in nuclear generating capacity, represents an anomaly: a diversion, occasioned by political contingencies, from what is essentially a well-determined technological path. At some future point, then, the story line of what happened is bound to converge with the line of what must be. As one engineer put it, the Carter policy ultimately "just expanded the timeline" of the inevitable progress toward the closed fuel cycle.[11]

In this context, the disposition of excess weapons plutonium represents a choice to delay or accelerate progress, by either wasting an energy resource via immobilization—a prospect one scientist described as "unethical"[12]—or utilizing it as it was meant to be in reactor fuel. Moreover, the MOX option represents a unique symbolic, as well as practical, opportunity to turn swords into plowshares. By abjuring its martial function, using it as fuel will perhap even reinstate the good name of plutonium.

The Nature Story

The third perspective, which we call the "Nature Story," sees no such possibility of vindication. This is a story about failure and corruption so deep that the only way out is to abdicate our involvement with nuclear materials altogether.

The Nature Story also begins with the quest for knowledge and mastery over nature, but here this quest is at its core an illegitimate one, driven essentially by greed and a reckless desire to manipulate the world according to our appetites. Because the forces of Nature are so incalculably powerful, man's mastery over the atom is ultimately a delusion, his controlling grasp much more tenuous than he realizes, and the harnessed power always threatening to break out and overcome human civilization. This tension and lack of control manifests in the plot as a relentless succession of adverse events involving things nuclear, from the detonation of the Bomb to all sorts of inadvertent or even deliberate releases of radiation in power plant accidents and other nuclear-industrial processes.

The history of nuclear energy here reads basically as a fiasco—a string

of failures in design, management and operation, usually followed by officials' attempts to cover them up.[13] The Three Mile Island and Chernobyl accidents are not anomalies here, but rather the logical consequence of playing with the nuclear fire. The economic struggles of the nuclear industry appear to further corroborate the notion that nuclear technology is not viable without heavy subsidies, and was simply not meant to exist. Its main justification, energy scarcity, does not exist here, either, because the availability of renewable resources such as solar and wind energy is estimated to match society's future needs quite adequately—indeed, it dictates what these needs ought to be.

The alchemical metaphor is significant in this story, too, but here one sees its dark side. Power, if pursued for the wrong reasons, always extracts its price, and the acquisition of plutonium was essentially a Faustian bargain: man received the ability he desired to master the ultimate power source, but at the cost of life itself. Unless mankind can still renounce the deal, the Nature Story holds, present and future generations will all have to pay up. The radioactive half-life of plutonium, 24,000 years, becomes an ominous figure that signifies the endurance of this bargain with the devil, and almost seems to forebode the inevitable restitution in the future. It seems hardly coincidental that the Latin name "Pluto" refers to the god of the dead and ruler of the underworld, from the Greek *ploutos*, wealth. This sinister origin of plutonium is what imbues it with those supernatural powers that inspire its popular characterization as "the most poisonous substance known to man," despite scientists' objections that other substances are lethal in even smaller concentrations. So deep is the alchemical symbolism that the chemical element cannot divest itself of its mythic role, for better or for worse.

Weapons and peaceful uses of plutonium are functionally bound here, that is, not merely by association.[14] Where, in the Energy Story, applications for technology are seen as arising independently or contingent upon external events, and their ethical merit can be judged individually, the Nature Story views all functions of nuclear energy as inextricably linked to the deliberate act of creating the capability in the first place: there is no such thing as value-free science, or discovery without purpose. Thus, any use of nuclear technology, regardless of its justification, represents a reaffirmation of the nuclear bargain. "Peaceful use" of nuclear energy becomes an oxymoron, an attempt to distract from the fundamental ethical flaw of the whole endeavor of breaking atoms. In this context, the disposition of excess weapons plutonium represents an opportunity to either renounce or reaffirm the Faustian bargain, by demonstratively pulling the material out of circulation and putting it to rest, or by continuing to manipulate it in the pursuit of profit.

DIFFERENCES OF INTERPRETATION

In comparing these three archetypal stories, we immediately note a difference in tone, which can be characterized in terms of the setting of each story. Figuratively speaking, in the Energy Story, we are climbing a long, upward road toward progress; in the Nature Story, we are situated at the edge of an abyss; finally, in the Diplomacy Story, we find ourselves in a landscape of rolling hills where the future is never foreseeable and we must continually negotiate our path by referring to nearby peaks and valleys.

These settings are related to the methods of navigation, or orientation toward doing what is right. In the Energy Story, the direction is obvious: "follow the road marked by indicators of technological sophistication and efficiency." In the Nature Story, the guiding principle is to minimize human impact on the planet: "look out for the abyss, and stay away from the edge!" In the Diplomacy Story, navigation is more challenging but possible through rational and judicious analysis of political and economic factors: "at each turn, assess your options carefully and cool-headedly."

Plutonium plays an important symbolic role in each story, but of course with different significance in each case. In the Nature Story, plutonium is evil, unnatural, and represents death by wrongful cause. In the Energy Story, plutonium is akin to gold, holding material value and the promise of well-being. In the Diplomacy Story, plutonium is like stock, possessing value not intrinsically as a physical substance, but by virtue of social contract: the trick is to know when to buy and when to sell.

The stories also differ in their basic values, or that which one strives to acquire, and fears, or that which must be avoided at all cost. The Diplomacy Story values influence in the social-political environment, particularly on the big international playing field. The outcome that is dreaded here is a breakdown of the structures that provide for socialization, potentially leading to war but also threatening each nation (or its

representatives) with eventual isolation and insignificance. The Energy Story values the notion of progress, while the potential adversity that looms largest in the future is poverty and restriction of society's growth. Finally, the Nature Story values nature, viewed here not only as a composite of living things and their physical environments but as an entity with a purpose (Gaia or Mother Earth). This entity possesses its own code of ethics that predates and transcends any human claims. The fear, from this perspective, is of a disaster precipitated by man's arrogance and folly for having violated this code.

Proliferation Hazards

Articulating these basic fears offers some insight into how the hazards of plutonium disposition—and particularly the proliferation hazards that have figured so prominently in the debate—are constructed differently in each of the three stories. In the Diplomacy context, nuclear proliferation refers primarily to the spread of nuclear capability among those not considered authorized to possess it. Besides its eventual connotation of physical harm, the most immediate meaning of proliferation here is a loss of influence over what happens to the means of supreme political potency. This story makes an important distinction, then, between government entities that are players at the table (particularly the five nuclear weapons states recognized by the NPT) and which are bound by established rules of the political game, and "rogue nations,"[15] which have little to lose in terms of status or credibility and whose judgment in handling nuclear technology cannot be trusted. Evaluating the hazard of plutonium management from this perspective, the operative question is: "How can we prevent the material from falling into the wrong hands,"[16] where the "wrong hands" could mean either rogue nations or subnational terrorist groups.

In the Nature Story, the distinction between responsible and irresponsible parties handling nuclear materials is at best one of degree, but is ultimately meaningless. The assumption here is that because social contracts are impermanent, artificial structures, they cannot be relied upon to keep these dangerous forces in check; rather, nuclear capability, if it exists anywhere, will inherently tend to spread out among all those desiring it. If some people believe they can control whether and how others use the technology, this perspective holds, they are deluding themselves. Moreover, the notion of any "responsible" parties is in itself questionable. Given their track records as interpreted by the Nature Story, none of the governments or corporate entities administering nuclear materials so far has proven itself worthy of being trusted with this task. The hazard of plutonium, then, is largely independent of who happens to be in charge of it. Proliferation, in this context, means simply that there is more material in circulation, and thus more that will eventually escape to inflict harm.

In the Energy Story, proliferation is somewhat removed as an issue from the main theme: it is like an adverse side effect of the means for dealing with a completely different and more immediate problem, energy supply. In the conceptual frame of engineering, nuclear proliferation is like one of many external constraints: one over which the engineer has little or no leverage, which will be duly considered in design, but which does not continue to haunt the engineer as a responsibility. Thus, the emphasis in this technology-centered view is on physical safeguards, or designing the handling process for nuclear materials in such a way as to render their removal by unauthorized parties very difficult (this might be thought of as a "technological regime" against proliferation). Once this has been done, it is basically up to the politicians to support and uphold these safeguards with appropriate measures. Nuclear materials are considered here to be fundamentally controllable, and, by extension, the dangers of proliferation manageable. Indeed, *not* pursuing nuclear development represents the greater threat to peoples' well-being, in that future energy supply options may be foreclosed.

Goals for the Future

By combining these interpretations of proliferation risks with their respective definitions of core values, we can readily deduce each story's favored policy option for the disposition of excess weapons plutonium. In the Diplomacy Story, the goal is to manage current international affairs and to strengthen the nonproliferation "regime." The means to accomplish this objective lie in crafting a policy that offers all important parties a stake in the negotiations. Both MOX and immobilization, in this context, represent political acts to satisfy certain constituents. The dual-track decision, aimed at simultaneously appeasing international negotiating partners via MOX and domestic constituencies via immobilization, fits this bill perfectly. The

definition of "success," therefore, is the crafting of an agreement among all the players to handle nuclear materials and technology in a manner that complies with an international regime. In doing so, the goal is to reinforce the social-political mechanisms and incentives for controlling nuclear proliferation.[17] The choice of technical options for plutonium disposition is viewed as much less important than the *process* of cooperative involvement under established rules,[18] which is seen as affording the greatest protection against any harmful use of nuclear materials.

In the Energy Story, the goal is to move society onto the proper technological trajectory for expanding the supply of energy. Developing MOX technology is an important means to this end, and the presence of excess weapons plutonium a fortuitous occasion to launch this process in the United States. The MOX option here signifies progress, while immobilization represents stagnation and loss. Looking toward the future, a successful operation would be one that leads to all plutonium, including that contained in spent commercial reactor fuel, eventually being used for energy production, with no material being diverted for weapons. Because the focus is on the technical properties of materials, MOX also appears as the superior option here with respect to nonproliferation, since the isotopic conversion that MOX fuel undergoes inside a reactor somewhat degrades the quality of the plutonium for weapons applications, while immobilization alters only its chemical properties and, in that sense, appears more reversible.

In the Nature Story, finally, the goal is to eliminate plutonium and shut down the nuclear industry altogether, because the only way ultimately to prevent nuclear proliferation is to remove all fissionable materials from the biosphere. The question then becomes, how can we make the plutonium safely go away? Ultimately, the Nature Story holds suspect any technological process that might be chosen for this purpose, because it will necessarily do an imperfect job of renouncing the nuclear past (the knowledge itself cannot be erased, nor can all material traces) and will in itself represent an industrial activity involving plutonium. Translated into political discourse, the most consistent response is to oppose any such process. In a more pragmatic stance, some adherents of the Nature Story advocate that mankind defer the decision and guard the plutonium carefully until greater knowledge or better technologies are obtained. Others, still more prepared to take the risk of some action, embrace immobilization (with subsequent geologic disposal) as the most realistic option: though not perfect, it is at least faithful to the intent of permanently removing the material from circulation. By contrast, the MOX option represents a strong, renewed commitment to a vicious cycle in which more is invested in nuclear facilities, and ever more nuclear materials will continue to circulate.

DEADLOCK IN THE DEBATE

MOX and Reprocessing

Having characterized these basic perspectives, we can now examine some of the main arguments advanced in the current policy debate, and recognize why they often fail to persuade other players. One contentious issue is the question of whether the fabrication and burning of MOX fuel made from the currently designated 50 metric tons of excess weapons plutonium in the United States is linked at all to the notion of reprocessing commercial spent fuel in the near future, and might therefore conflict with U.S. nonproliferation policy. From the Diplomacy perspective, the two actions are easy to separate: Physically, a MOX fabrication facility could be designed for the express and limited purpose of converting the excess weapons plutonium, and not serve to support a closed fuel cycle.[19] Politically, weapons plutonium disposition and commercial reprocessing are governed by different policy decisions that can be made at different times by different office holders. Indeed, considering the explicit objectives in each case—rendering accessible plutonium inaccessible by burning it as MOX, versus separating previously inaccessible plutonium out of spent fuel and thus making it accessible and available for use—MOX from weapons plutonium and reprocessing are literally *opposite* endeavors.

Not so, according to both the Energy and the Nature Stories—and here, for once, they agree. This unexpected consensus comes about because neither story views the declared intent of current policies as an essential element of the plot. Rather, they both refer to long-term developments or trajectories in which events are connected by a deeper logic than short-term political decisions.

This attitude is reflected in part within the symbolic connotation of plutonium. The Energy and Nature

Stories regard plutonium from both dismantled weapons and commercial reactors as basically the same substance—albeit gold in one story, and the essence of death in the other. So unique and important by its intrinsic nature, plutonium acquires in these stories a status as an indivisible entity, almost a character in its own right. Thus, engaging with any bit of it invokes the notion of engaging the whole entity, and strategies for manipulating any amount of plutonium derive their meaning by extrapolation to *all* the plutonium there is. What mankind does with 50 tons of weapons plutonium, then, can only make sense in the context of the entire (much larger) inventory of commercial spent fuel. In the Diplomacy Story, on the other hand, plutonium is merely an instrument. Here, weapons and reactor plutonium represent stock—of different kinds. While both are currency for potential new weapons, the stuff from each source has a distinct political significance. Thus, making a transaction with one in no way implies making a similar transaction with the other.

More concretely, the long-term outlook of both the Energy and Nature Stories is reflected in their emphasis on the development of MOX technology as a future-oriented process. This process entails financial investment, acquisition of expertise, collaboration with the Europeans and Japanese, and perhaps a degree of desensitization. These factors would all contribute to create a climate in which a return to commercial nuclear reprocessing in the United States is more feasible or encourages commercial reprocessing in other countries. The key here is that both the Energy and the Nature Story view the move to the closed fuel cycle as a pre-existing path—a good path in one case, and a bad one in the other. From the Energy perspective, the hope is that by getting involved and developing the technological capabilities for MOX, mankind will acquire confidence and a renewed, rational evaluation for recognizing the benefits of the closed fuel cycle. From the Nature perspective, this scenario is all too plausible and menacing. In a sense, it appears analogous to the notion of becoming addicted to drugs: powerful forces are at play that some people mistakenly believe they can control. Taking the first steps to succumb to the temptation will affect our very judgement and tend to pull us irretrievably down the slippery slope. Seen in this light, a promise to make just this one batch of MOX and then stop is patently incredible, and the only prudent choice is to "just say no."

From the Diplomacy viewpoint, this argument against MOX sounds like an illogical extension, if not an irrational fear: if we as policymakers do not want the nuclear industry to reprocess commercial spent fuel once the weapons plutonium has been burned, then we can tell them not to, or simply withhold financial subsidy, and they will not embark on such a program without our mandate. The perceptual shift is that, in the Diplomacy story, the protagonists are viewed as capable of exerting such control. Thus, it assumes that the executive branch can effectively regulate the activities of research scientists, the success of industry lobbyists, and even the energy policies of foreign governments through some combination of political pressure and rational advice. From the Nature perspective, on the other hand, mankind is subject to forces beyond its control, natural or otherwise. Thus, it might readily fall prey to a group of privileged political and economic stakeholders such as those embodied in the term "military-industrial-utility complex,"[20] which captures the sense of a remote and intractable entity against which the public has no recourse. The eager positive response by nuclear industry representatives to the MOX-portion of the dual track[21] here serves as evidence that these groups are already rejoicing in their freshly empowered status. This picture is only intensified by the prospect of increasing international collaboration, which seems to remove corporate entities one step further from political accountability.

Nonproliferation: Common Goal, Different Means

The question of influence and control also arises in the global context of nonproliferation. Most, if not all, participants in the discussion would agree that an important criterion for selecting a plutonium disposition method in the United States is how effectively this approach can help reduce the threat of nuclear weapons worldwide. But different assumptions are made vis-a-vis the mechanism by which this might occur.

The Diplomacy Story holds that active involvement in nuclear technology will place the United States in a better position to exert any influence over nuclear activities internationally and continue to muster respect in its leadership role. Undertaking the MOX option implies contributing technology and advice to Russia, where plutonium is seen to be at the greatest risk of being diverted. The MOX option also car-

ries political currency because, by changing the isotopic composition, it offers another degree of assurance (if only symbolic) to Russian skeptics that the United States does not intend to re-use the material in weapons. Foregoing MOX in the United States, on the other hand, would lessen its credibility with Russia and the G-7 and thus compromise its ability to help prevent any plutonium (especially Russian plutonium) from turning up in the wrong place.

The Energy Story has no contradiction with this account, though its notion of leadership as afforded by the MOX option refers in more general terms to scientific and technological advancement. As one scientist articulated most succinctly, "if we [the United States] fall behind the rest of the world in nuclear technology, how will we even know what to tell them [other countries] to do?"[22]

The Nature Story, on the contrary, sees the United States not as a technological but as a moral ambassador. Here the operative model is that of the Carter policy: in order to credibly beseech other nations to manage nuclear materials in a responsible manner, the United States must set an unmistakable example. If the goal is to dissuade others from commercial reprocessing, then, while it may not be sufficient, it is certainly necessary for it to abstain from any activity that could be interpreted as being related to or symbiotic with a closed fuel cycle approach. Fabricating even 50 tons of weapons plutonium into MOX, this story holds, would send a mixed message and serve to encourage the international plutonium industry. Again, the long-term view is crucial, since an individual facility like a MOX fabrication plant cannot be evaluated as a single, self-contained project within this story, but only in terms of its projected systemic context. In this vein, it is argued that helping Russia build a MOX plant would provide a crucial piece of infrastructure and thus, even if this is contrary to the explicit intent of the policy, accelerate its move toward closing the fuel cycle.

Legacy for Future Generations

Ultimately, all sides would tend to agree that plutonium disposition must be evaluated ethically in terms of the legacy current policymakers will leave for future generations. Yet, again, each story offers a different interpretation of this challenge. The Energy Story suggests as a happy ending a world in which a safe, secure, efficient, and sustainable energy supply system is in place. Sustainability requires recycling, and like the recycling of household materials, nuclear reprocessing is seen here as having the dual virtue of generating new value and reducing waste. Indeed, burning weapons plutonium in the form of MOX signifies its removal from the waste inventory; the term "burning" itself suggests that a substantive conversion takes place because the original fuel is eliminated. Therefore, the MOX option is the one that represents the responsible act of cleaning up after ourselves, while immobilization implies leaving the material around for people in the future to worry about.

The Nature Story argues just the opposite. By its accounting, recycling nuclear waste does not reduce but instead increases its quantity and danger. Here the argument relies on an explicit technical rationale: while the amount of original plutonium in MOX fuel is cut when it leaves the reactor, more plutonium has been bred in the meantime by irradiating uranium in the same fuel, generating additional waste (contaminated equipment) and a host of radioactive fission products. Metaphorically, the emphasis in "burning" here is on combustion products and pollution. This analysis confirms what the Nature Story suspected on principle: that as long as people manipulate nuclear materials at all, they can never get ahead of their negative emanations; the more they do to the waste, the more of a mess they make. MOX and reprocessing thus imply a legacy of future waste production and worry. Immobilization, by comparison, conveys a sense of finality, if not abolishing then at least containing its mess, and appears here as a responsible first step toward leaving future generations in a tidier situation.

From the Diplomacy perspective, these arguments are of limited consequence, because what is good or bad for future generations cannot be readily foreseen. The best that can be done, according to this story, is to provide for global peace and political structures that promise to avert war and nuclear terrorism for as long as possible. The ramifications of radiation exposure from processing or burying nuclear waste pale in comparison with the "clear and present danger"[23] of plutonium waiting to be bought by a terrorist from an underpaid Russian official. From this point of view, the worst that current policymakers can do for the future is to hesitate now and fail to take some action that will lessen the most certain, immediate threat.

COMBINING NARRATIVES

In this triangle of views, alliances are found on different aspects of the problem. As discussed above, the Energy and Nature perspectives, though most at odds in terms of their policy preferences, agree in their emphasis on the long-term fate of nuclear technology as a context for evaluating weapons plutonium disposition. The Diplomacy perspective can be consistent with either position regarding the merits of the closed fuel cycle and the pursuit of nuclear energy in general. Thus, its adherents may borrow from the Energy Story and treat MOX as the desirable option, but recognize that immobilization is a politically necessary component of the dual track; or they may sympathize with the Nature Story and prefer immobilization on principle, but accept an obligatory MOX portion in the deal.

Indeed, a considerable number of those interviewed drew on the Diplomacy Story with respect to the near term and either the Nature or Energy Story for the long term. These individuals would generally approve of the dual-track decision and agree with the imperative to move along with the Russians. Thus, they agreed that, for the near future, actions ought to be directed in good part by political considerations. The longer the time frame, however, the weaker and less certain predictions of political circumstances (and thus prudent courses of action) inevitably become. For these individuals, beliefs in more fundamental and permanent principles of how the world works took the place of diplomatic speculation in suggesting likely and advisable paths for the future. Accordingly, these informants proposed long-term scenarios in which the political dust settles and projected decisionmaking over nuclear activities is based on technical criteria, not on factors in the social world.

Those individuals who gravitate strongly toward one of the three perspectives arrive at their own policy recommendations with relative ease, seeing the challenge of the plutonium disposition problem as residing primarily in the political opposition to the "correct" solution, not in the substantive difficulty of determining the best course of action. They can readily respond to the question, "If you were 'king' for a day and could simply decree what should be done with this plutonium, what would you say?" Those, on the other hand, who consider this an agonizing choice tend to draw on more than one story in their own conceptualization of the problem and admit to being vexed by the conflicting requirements of each.

CONCLUSION

Conflicts among the stories persist because they cannot be resolved by testing the truth or falsehood of any factual information. All available empirical evidence concerning plutonium disposition can be integrated into each of the three narratives. Certainly, this reconciliation involves assigning different weight to various pieces of information, dismissing some as irrelevant and embracing others as cornerstones of the plot. However, none of the stories at its core relies on any claims contrary to proven science or empirical observation. Thus, while individual adherents may be naïve or stubborn and incorporate demonstrably counterfactual elements into their own personal accounts (for example, fictitious events or inaccurate physical data), the archetypal stories themselves do not depend on these elements for their integrity as coherent, meaningful interpretations. Therefore, it is not possible to "refute" any of the stories or their conclusions by appealing to facts. Because their function is not to generate testable hypotheses, but to assign *meaning* to events, it is impossible to "falsify" any of the narratives. Trying to decide which of the three is the "correct" view of plutonium would be like trying to determine the correct interpretation of a Rorschach ink blot. While the blot on the paper has measurable dimensions that can readily be agreed upon, who is to say what it really represents?

These findings do not lead to any specific policy recommendations as far as handling the excess weapons plutonium. They do instead suggest that disagreement about nuclear materials management strategies is here to stay, because the different narrative frameworks can readily assimilate even seemingly contradictory factual information. Thus, searching for practical ways to cope with this conflict may represent a more promising avenue than attempting to settle it by appealing to "rationality."

Based on the findings presented here, one important element lacking in the current debate is mutual recognition of the sincerity of all sides to do good, a quality obscured by perceptions of the misguided, unreasonable, or disagreeable conclusions of other perspectives. Absent such recognition, it is only logical for participants to surmise hidden agendas. Indeed, among the allegations uncovered in the course of the inter-

views was the claim that scientists researching plutonium disposition are doing so only to distract from their zeal to build more weapons, that policy advisors have sold out to the nuclear industry, and that anti-nuclear activists are working mostly for personal gain or ego aggrandizement.

Short of such severe indictments, more general misunderstandings on all sides pervade the public discourse. Adherents to the Energy Story tend to presume that those opposing nuclear technology do so because they are uneducated and therefore afraid of things nuclear. Of course, this presumption misses the point because the Nature Story's critique is fundamentally based on moral principle and a different vision of the future, not quantitative measures of danger. Similarly, adherents of the Diplomacy Story may attribute disagreement with their proposed objectives and means to ignorance of the intricate dynamics of politics and international relations. Yet others in the nuclear debate disregard such political objectives because, as transient artifacts of human interaction and imagination, they seem irrelevant in relation to more fundamental questions about man's relationship to science and nature. Finally, Nature Story adherents have difficulty believing that anyone involved in the nuclear establishment could be ethically motivated, seeing instead a game of deception driven by misguided interests and delusions of grandeur. Operating within different reference frames, those accused find themselves unable to respond by proving their own ethics and credibility in meaningful and convincing terms to the others.

The irony is that all three sides may see themselves as victims in this situation. Proponents and opponents of MOX alike express their sense that their own perspective is being marginalized in the decisionmaking process. Adherents of all three stories feel that their arguments have not been heard and their moral integrity has not been recognized by others. These misunderstandings are clearly detrimental to efforts at building a constructive dialogue.

What is needed, then, is a framework for discussion that allows explicit room for diverse interpretations, to make it possible to recognize common goals where they exist, acknowledge the internal consistency of other positions, and articulate clearly those areas where participants can agree to disagree. In principle, this would allow each side to feel that its position has at least been understood and is respected for its views and beliefs. Accepting such diverse interpretations as a legitimate basis for conflicting positions would help foster good will in policy discourse and permit a clearer and more deliberate focus on goals, values, and solution approaches.

[1] The authors conducted 22 focused interviews in person, by telephone, and via e-mail. In addition, the research for this project involved numerous meetings with scientists as well as activists. Funding for this research was provided by the Campus Laboratory Collaboration Program, Office of the President, University of California.

[2] The most prolific websites on this topic include http://www.nci.org/nci/index.htm (the Nuclear Control Institute); http://www.ieer.org (the Institute for Energy and Environmental Research); http://www.nirs.org (the Nuclear Information and Resource Service); http://www.nei.org/pressrm/briefs (the Nuclear Energy Institute); http://www.pbs.org/wgbh/pages/frontline/shows/reaction (a response forum for the PBS Television show *Frontline: Nuclear Reaction* that aired in April 1997 that also features interviews with Glenn Seaborg and Richard Stallings, among others). See also http://www.greenpeaceusa.org/campaigns/nuclear and http://www.ccnr.org (the Canadian Coalition for Nuclear Responsibility) on the activist perspective, and http://www.bullatomsci.org/issues/1997/ma97 featuring perspectives on plutonium disposition by Richard Garwin, John P. Holdren, and Edwin S. Lyman (*Bulletin of the Atomic Scientists* 53 (March/April 1997).

[3] For these reasons, we deliberately refrain from associating stories with specific groups of adherents.

[4] See, for example, John H. Barton and Lawrence D. Weiler, eds., *International Arms Control—Issues and Agreements* (Stanford, CA: Stanford University Press, 1976) and United States Congress, Office of Technology Assessment, *Nuclear Proliferation and Safeguards* (New York: Praeger Publishers, 1977).

[5] For a retrospective on the Carter policy, see, for example, Spurgeon M. Keeny, Jr., "Plutonium Reprocessing: 20 Years Experience (1977-1997)" (http://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/keeny.html).

[6] This notion of "regime" is emphasized in a key policy document, the report to the DOE by the National Academy of Sciences, Committee on International Security and Arms Control, *Management and Disposition of Excess Weapons Plutonium* (Washington, D.C.: National Academy Press, 1994).

[7] These are quotes from three individuals who have been involved in official negotiations or scientific consultations with Russians about arms control or plutonium disposition; personal communication, May-July 1997.

[8] See, for example, Glenn T. Seaborg and William R. Corliss, *Man and Atom: Shaping a New World Through Nuclear Technology* (New York: E.P. Dutton, 1971).

[9] We refer here not only to the destruction of Hiroshima and Nagasaki, but also the 1954 incident in which fallout from a U.S. nuclear test contaminated several inhabited atolls and a Japanese fishing boat, the Lucky Dragon, stirring up great international concern (Ralph E. Lapp, *The Voyage of the Lucky Dragon* (New York: Harper, 1958)) and arguably strengthening commitment to the Atoms-for-Peace program, just announced by President Eisenhower in December 1953.

[10] The expression was coined by the Chairman of the Atomic Energy Commission, Lewis L. Strauss ("Remarks Prepared for Delivery at the Founders' Day Dinner, National Association of Science Writers," September 16, 1954; cited in A. Makhijani and S. Saleska, *The Nuclear Power Deception* (Takoma Park, MD: Institute for Energy and Environmental Research, April 1996)).

[11] Member of the research staff on mixed-oxide

fuel, General Electric Co., personal communication, March 31, 1997. See also, for example, A. David Rossin, "U.S. Policy on Spent Fuel Reprocessing: The Issues" (http://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/rossin.html).

[12] Research scientist from Los Alamos National Laboratory, during an academic presentation about plutonium management, October 1997. Though we heard only one individual actually say the word "unethical" in this context, the notion that it is somehow profoundly wrong to waste such a concentrated energy resource—much like it is simply wrong to waste food—was implicit in many other accounts. For example, several scientists made remarks like, "of course, it hurts me to see this stuff go to waste...."

[13] See, for example, the department "Nuclear Notes" in *The Nuclear Monitor*, Nuclear Information and Resource Service (http://www.nirs.org/mononline/notes).

[14] For example, the caption under an illustration titled "The Two-Headed Monster of Poison Fire" in *Safe Energy Handbook* (Berkeley: Plutonium Free Future, 1997) begins: "The nuclear weapons and nuclear power industries are two aspects of the same beast. Each exists in the presence of and as a result of the other."

[15] The term "rogue nations" in this sense appears, for example, in the DOE document "Surplus Plutonium Disposition and the U.S. Policy of Reprocessing" (http://web.fie.com/htdoc/fed/doe/fsl/pub/text/any/fis033.htm).

[16] The first key security objective for weapons plutonium disposition listed by the National Academy Report is "to minimize the risk that either weapons or fissile materials could be obtained by unauthorized parties" (National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium*, Executive Summary, p. 3).

[17] The National Academy Report states as another key security objective "to strengthen the national and international arms control mechanisms and incentives designed to ensure continued arms reductions and prevent the spread of nuclear weapons" (*Ibid*.).

[18] One argument we came across, however, holds that the MOX process is preferable to immobilization because it will more readily submit to verification and control under the existing regime of international safeguards as instituted by the International Atomic Energy Agency; see K.K.S. Pillay, "Safeguardability of the Vitrification Option for Disposal of Plutonium," presented at Plutonium Stabilization and Immobilization Workshop, Los Alamos National Laboratory, December 12-14, 1995 (LA-UR-95-4191).

[19] For example, U.S. Department of Energy, "Surplus Plutonium Disposition and the U.S. Policy of Reprocessing" (http://wwb.fie.com/htdoc/fed/doe/fsl/pub/text/any/fis033.htm).

[20] Expanding on the term "military-industrial complex" coined by President Eisenhower, the "new military-industrial-utility complex" is referred to on the Nuclear Information and Resource Service website (http://www.nirs.org/moxtritium/moxtrit.htm and http://www.nirs.org/mononline/MOXUPDATEJuly97.html).

[21] See, for example, "Nuclear Industry Urges Swift Action on MOX Implementation," *Nuclear Materials Monitor* (Washington, D.C.: Exchange/Monitor Publications, Inc., April 25, 1997).

[22] Research scientist, Los Alamos National Laboratory, personal communication, May 15, 1997.

[23] This term is used in the National Academy Report (National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium*, Executive Summary, p. 1), apparently in reference to its specific legal meaning as an actual or imminent harm to an interest of compelling importance that warrants an abridgement of Constitutional rights (in this case, justifying expeditious executive action).