Scenario Planning, the Interpretation of Uncertainty and Value-Focused Decision Making: A Case Study of a Radioactive Waste Site Remediation

D. Farber

Science, Technology and Society Program
Penn State University
University Park, PA 16802

Abstract—The interpretation of uncertainty is frequently a source of conflict in deciding on an appropriate course of action regarding the remediation of radioactive waste sites. Experts and laypeople may disagree on the uncertainty involving critical driving factors—political, economic, social, and technical (PEST)—of a proposed remediation. Questions such as, what constitutes a plausible stories of the future based upon different interpretations of the uncertainty of critical driving factors. More importantly, experts and laypeople may have different worldviews or "mental models" of how PEST factors interact to create the future. Scenario planning creates internally consistent, plausible stories of the future based upon different interpretations of the uncertainty of critical driving factors. In a case study of a radioactive waste site remediation, it is proposed that scenario planning be used to create a shared language among stakeholders to provide a means for overcoming public suspicions of experts while bringing experts to a greater appreciation of public concerns. The goal is a clearer articulation of the values that inform decision making.

I. INTRODUCTION

Remediating a radioactive waste is a controversial public policy issue. Frequently, stakeholder groups have different interpretations of what the problem is and how it should be solved. In cases that constitute a "major federal action significantly affecting the quality of the human environment," an environmental impact statement (EIS) is required under the National Environmental Policy Act (NEPA) of 1969 (Public Law 91-190, 1970). The environmental impact statement will "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and decisionmaking." The document should provide the basis for reasonable confidence in decisionmaking.

The question of whether the EIS does provide the basis for adequate decisionmaking has been raised [1]. Although much information about the political, economic, social and technical (PEST) variables is gathered for an EIS, the central concern for decisionmaking is the meaning of the information. How do the different stakeholders, especially laypeople, interpret information? Particularly important is the understanding of uncertainty. What is it that is not known? How certain is the information that is obtained? And critically, how are these assessments made?

This paper addresses the means for stakeholder understanding of PEST variables and their uncertainty in the environmental impact statement process for a radioactive waste site remediation. How stakeholders engage in a learning process about PEST variables is essential for decisions that reflect the stakeholders values — simply, what stakeholders care about [2]. Additionally, the extent of stakeholders' understanding of uncertainties can influence their willingness to accept a particular course of action. In this paper scenario planning is considered as a methodology that enables stakeholders to better understand the dynamics of PEST variables and to structure the uncertainty that accompanies them. The Parks Township, Pennsylvania shallow land disposal area (SLDA) radioactive waste site remediation illustrates these points.

II. THE PARKS TOWNSHIP SLDA AND RELATED NUCLEAR ACTIVITY

The Parks Township, Pennsylvania shallow land disposal area is a 40 acre site that has buried radioactive contaminated waste. The Nuclear Regulatory Commission (NRC) has determined that the waste exceeds its' radiological criteria for decommissioning and unrestricted site release so that the site needs remediation. Since some of the wastes are hazardous, but non-radiological, the Pennsylvania Department of Environmental Protection (PaDEP) has jurisdiction and is cooperating with the NRC in the remediation.

The site is located about twenty-three miles east-northeast of Pittsburgh in Armstrong County and sits on a level area of a hillside adjacent to the Kiskiminetas River. Uranium and thorium contaminated wastes from the fabrication of nuclear fuel for the U.S. government are buried in a series of unlined trenches that occupy about 5 of the 40 acres of the site. The surface area of the trenches is about 1.2 acres and the trenches extend between 10 and 20 feet below ground. Below the...
entire site, about 40 to 60 feet below the surface, is a network of abandon underground coal mines. Mine subsidence is a major issue in the remediation.

In addition to the radioactive material, various organic solvents, laboratory equipment, building materials, protective clothing and even a small truck were buried. Although some wastes were buried in various containers most, if not all, have decomposed and the waste exists as a heterogeneous semi-solid slurry. The site is licensed to Babcox and Wilcox (B&W) Inc. although the previous owner Atlantic Richfield Inc. (ARCO) through a corporate agreement has responsibility for remediating the site. Hereafter this corporate collaboration will be refered to as the licensee. Burial operations began in 1961 and continued until 1970 in accordance with NRC regulations in effect at that time. The regulations have since been rescinded.

The SLDA is one site of three within an approximately 10 mile area that have had nuclear activities over the last the last four decades. Fuel fabrication for the U.S. government occurred at a 22 acre facility in nearby Apollo, Pennsylvania facility, infamous for "unaccounted" uranium that was diverted allegedly to Israel's nuclear weapons program [3]. The structures and radioactive material have been removed from this site and decommissioning with unrestricted site release is pending the results of radiological surveys. A 25 acre facility adjacent to the SLDA was also a fuel fabrication facilitation during the 1960s and 1970s and recently has been a facility for the decontamination of power plant tools and equipment. B&W has decided recently to close the facility for business reasons.

Over the years citizen opposition to the nuclear activities has grown with two citizens groups active in environmental issues. A focus for the groups are claims of increased cancer incidence in the area, however, epidemiological studies have not supported these claims. The demise of the steel and nuclear industries have left the area economically depressed and the legacy of the area's nuclear past is frequently discussed as a barrier to future economic development.

III. DEFINING THE ENVIRONMENTAL IMPACT

On April 16, 1992, the NRC issued an action plan to ensure the timely decommissioning of radiologically contaminated sites and the SLDA was identified as a site that required decommissioning action (Federal Register 57(249):13389). NRC's rule for decommissioning requires that the site be returned to unrestricted use and in accordance with the NRC action plan, the licensee had submitted a proposal for remediation. The NRC next determined that the licensee's proposed decommissioning would constitute a major federal action and would require an EIS under NEPA.

The Alternatives

The licensee had examined three possible remediation alternatives — stabilization in place (SIP), stabilization on site (SOS) and disposal off site (DOS). The SIP plan calls for an in situ engineered barrier that encapsulates the waste. The SOS plan requires removing the waste from the trenches and constructing an above ground containment structure. The DOS plan requires removing the wastes and shipping it off-site to an approved waste repository. In addition, the no action alternative would be evaluated.

According to the licensee, "technologies and remediation scenarios that represent technically sound and cost-effective ways to remediate the site and provide long-term protection of human health and safety and environment were identified and evaluated. The remediation scenario that best protects human health and the environment is stabilization in place (SIP) (my emphasis). It is considered to be the most effective remediation solution. The evaluation shows that SIP meets NRC radiation protection standards and is in full accord with the principle that the dose be As Low As Reasonably Achievable (ALARA)" [4]. The SIP proposal, however, will require long-term institutional controls, which is not permitted under the present regulations. The licensee would need to apply for an exemption.

Public Participation

In order "to fulfill NRC's responsibilities under NEPA, the NRC [must] prepare an EIS that will analyze the environmental impacts of the proposed action, as well as environmental impacts of alternatives to the proposed action and the costs associated with both the proposed action and the alternatives" (Federal Register 59(249):67344, December 29, 1994). To identify the scope of the issues addressed in the EIS, a public scoping process is required. Public participation is important for three main reasons [5]. "First, the competence of the final decision is higher when local knowledge is included and when expert knowledge is publicly examined. Second, the legitimacy of the final outcome is higher when potentially affected parties can state their own case before their peers and have equal chances to influence the outcome (ie., the process was fair). Third, public participation is identified with the proper conduct of democratic government in public decision making activities" [5].

Two public meetings were held previously to the scoping meeting so that the licensee could explain the SIP plan and...
why it would best protect the public's health and safety. Additionally, the NRC explained their radiological decommissioning criteria. From the perspective of the licensee and the NRC, these meetings were informational. From the perspective of some citizens, the intent of the meetings was to "sell" the community on the SIP option. The SIP option was viewed as the cheapest option and therefore the licensee's preferred option. Economics, not health and safety was viewed as the driving force behind the remediation proposal.

The intent of the scoping meeting was to determine the issues to be included in the EIS and the impacts of all the identified alternatives. However, most of the public's comments were somehow related to potential problems with the licensee's preferred option, SIP. As one commenter stated bluntly, "We have stated time and again that the burial dump must be removed. Stop wasting our money (the taxpayers) on all of the travelling expenses incurred, etc. to set up these fiascos. Use this money to get it out of there."

Instead of the scoping meeting being a collaborative discussion about the values of the community and how the proposed options achieve those values, the meeting could be interpreted as a confrontational interaction where the community was on the defensive. From the community's view, it needed to make clear as strongly as possible that any option other than waste removal, DOS, would be unacceptable.

Social Learning

Although there was public participation in each of the three meetings described, a critical question is whether social learning occurred. "Social learning means more than merely individuals learning in a social situation. [Envisioned is] a community of people with diverse personal interests, but also common interests who must come together to reach agreement on collective action to solve a mutual problem. Social learning refers to the process by which changes in the social condition occur — particularly changes in popular awareness and changes in how individuals see their private interests linked with the shared interests of their fellow citizens. This is a product of individuals learning how to solve their shared problems in a manner that is responsible to both factual correctness and normative consent (meaning legal and social responsibilities)" [5]

Webler et. al. distinguish two general components of social learning: cognitive enhancement and moral development [5]. Succinctly, cognitive enhancement can be thought of as developing an understanding for the causal relations of a focal issue and an awareness of the learning process itself among group members. Moral development in public participation can be thought of developing clarity on the values that effect judgment in evaluating a focal issue.

Although many PEST issues were raised in the scoping meeting, the question of how they would be evaluated was not. Not made evident were the causal relations the experts use to evaluate an alternative. The assessment of uncertainty among these relations was also not questioned. In other words, questions about model validity and verifiability were not addressed but yet are central to the evaluation of remediation alternatives [6]. It should be noted that the licensee had made several technical presentations of the SIP alternative after the scoping meeting to the NRC in Rockville, Maryland. Even though the public was notified, community members from Parks Township have not attended.

In addition, other aspects not addressed in the scoping process, such as environmental justice, would be addressed in the EIS. According to the scoping process summary report socio-economics section, citizens' values will be integrated in the EIS as follows, "The EIS will evaluate the effects of the proposed action and other alternatives on property values and the projected future economic development of the region" [7]. Although environmental justice concerns and cultural resources are listed in the preliminary outline of the EIS, these issues have no clear meaning [7].

To the citizens the development of the EIS can be seen as a black box process. Admittedly, creating an environment for social learning is difficult and perhaps outside the scope of a regulatory agency's legal mandate. What minimum level of understanding must the public have and can the collective stakeholder group really expect collaborative decisionmaking?

IV. SCENARIO PLANNING
AND ENVIRONMENTAL LEARNING

Scenario planning is a method of strategic planning pioneered at Royal Dutch/Shell group in the early 1970s. The core concept of scenario planning is the re-perception of reality. "To operate in an uncertain world, people need to be able to reperceive — to question their assumptions about the way the world works, so that they could see the world more clearly" [8]. Scenarios are a set of plausible stories about how the future may unfold.

It is a common belief that serious information should appear in tables, graphs, numbers, or at least sober scholarly language. But important questions about the future are usually too complex or imprecise for the
conventional languages of business and science. Instead, we use the languages of stories and myths. Stories have a psychological impact that graphs and equations lack. Stories are about meaning; they help explain why things could happen in a certain way. They give order and meaning to events—a crucial aspect of understanding future possibilities [8].

Scenarios, however, are supported with quantitative information and sober scholarly language.

Scenarios derive from mental models. A mental model is a mapping of the main elements and relations of a domain that is used to make inferences about possible future states of the domain [9]. "The mental model is not a scenario; it is the representation of the major variables and relations in the area of interest. Scenarios are inherent in the model, however, if we define them as possible combinations of values taken by the variables" [9].

Bostrom et al. [10] have used mental models, represented as influence diagrams, to address the problem of communicating substantive knowledge about hazards of radon. The influence diagram shows the relations among the variables. Influence diagrams can be very complex but at a rudimentary level they could be useful tools in enabling the public to better understand the relations among PEST variables. They could help serve to bridge the gap between technical experts and the public. How questions of uncertainty are addressed is a difficult issue. As noted in [lo], "when completely specified, an influence would be defined in terms of conditional probabilities...obviously, this is a considerable challenge even for the technical experts most knowledgeable about the environmental hazard."

Scenario planning is not a method for establishing probabilities of socio-technical systems. "Probabilistic and scenario planning address different domains of the decisionmaking process. Probabilistic planning helps in making choices between well-defined alternative options in well-structured choice situations. Scenario planning helps in defining these situations in the first place, it does not have a one-to-one mapping with a particular decisionmaking situation. It infiltrates the overall strategy discussion and affects the shape of the strategic options considered" [11]. For example, a critical uncertainty that appears important to the future of the Parks community is the role of social trauma [12]. That is, can the community overcome its nuclear past which currently divides the citizens even if the waste remains? Assigning a probability to this variable and its influences could distract from the main meaning of a scenario. Indeed, if an EIS process that promotes social learning is pursued one can imagine the easing of tensions between the stakeholders, so that community members can examine remediation alternatives in light of the values they reflect. On the other hand, if the EIS process is seen as an illegitimate expression of community values, then it is plausible that continued suspicions would remain as well as generating the associated negative impacts for all stakeholders. Scenarios are not about determining which future is more probable. As Schwartz states, "the end result, however, is not an accurate picture of tomorrow, but better decisions about the future" [8].

V. CONCLUSION

Scenario planning can open up the EIS process to address issues not currently addressed, such as response to the worst case scenario [1]. The strength of scenario planning is not in the determination of probabilities of outcomes for socio-technical systems, but rather in addressing larger uncertainties, such as the course of action to pursue if a low probability-large consequence event unfolds. In this sense, scenario planning could play an integral role in designing socio-technical systems.

Importantly, scenarios can provide a way for articulating possible future visions of an environment in which a decision can unfold. It provides a means for individual and group reflection on the meaning of actions serving to enhance social learning and effective public participation.

VI. ACKNOWLEDGEMENT

I gratefully acknowledge the support of the Science, Technology, and Society Program and the Department of Nuclear Engineering at Penn State University, and the U.S. Nuclear Regulatory Commission.

VII. REFERENCES


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Darryl Farber is a Ph.D. candidate in Technology Management and Policy and a teaching assistant in the Science, Technology, and Society Program at Penn State University. He received a B.S. with Honors in Plant Science from Cornell University in 1984 and an M.S. in Agricultural Economics from Penn State in 1989.