Distrust and the Nuclear Doctrine

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Abstract.
A generation ago, rampant economic problems and perceived risk of nuclear power brought the industry to a halt on applying for new construction permits. Because of the military history of nuclear technology, development of the existing nuclear power infrastructure during the Cold War, and contemporary discussion about nuclear power offering a reduced carbon footprint, it has emerged as a force within the global climate debate. The amalgam of associated nuclear technologies and activity has created a nuclear doctrine, or a set of conditions about the culture and politics of our energy needs and production options. However, questions remain as to the safety and environmental impact of next generation nuclear technologies, which have yet to be deployed into operation. Economic change with federal incentives along with popular news media describing a renaissance of the industry have sparked renewed questions about the nuclear technology options and impacts. The article uses the wicked problems theme to analyze the nuclear doctrine. The concept of distrust in government and industry managers is applied to understand the primary dilemmas facing the nuclear doctrine in the dynamic context of global climate change.

Introduction

> Can one man derail a train with nothing but his will? Can a few thousand human beings armed with nothing but audacity and purpose bring to a halt the mighty freight train of government, industry, power, war, that overwhelming vision of a future charged by pride and ambition.[1]

Nearly 50 years ago, C. Wright Mills[2] wrote about our inabilities to orient ourselves as part individual and part society. He recognized the effects of trying to reconcile the experience many have of feeling trapped between their own life and what goes on in the rest of the world. Mills prescribed development of '*the sociological imagination*' to deal with the continual and seemingly uncontrolled change within society. With this concept, Mills challenged our failing intellect, not on our achievements, but rather on the ability to grasp the magnitude of our accomplishments and assimilate their meaning into everyday life. Advancements in science and technology compound the need for the sociological imagination Mills recommended.

A year after Mills' academic exploration into the sociological mind, C. P. Snow[3] compellingly argued to the American Association for the Advancement of Science that for some scientific activities we must pay a moral price. Snow made the case that scientists involved in research and discoveries that fundamentally influence and transform the world have more

[1] Edward Abbey, "One Man's Nuclear War" in *Atom's Eve: Ending the Nuclear Age*, ed. Mark Reader with Ron Hardert and Gerald Moulton (New York: McGraw-Hill Company, 1980), 224.

[2] C. Wright Mills, *The Sociological Imagination*, (Oxford: Oxford University Press, 1959), 3-6.

[3] C.P. Snow, *The Physicists*, (Boston: Little, Brown, & Co., 1981), 180-88.

responsibility than non-scientist citizens – they "have a moral imperative to say what they know,"[4] good or bad, precisely because that knowledge has the power to change the world.

With few exceptions, when scientists have told us what they know over the last few centuries at least, it has become increasingly mathematical, often in equations symbolizing a host of other specialized information needed to derive the current matter at hand.[5] Not coincidentally, during the same period we have relied on mathematical models as a way to explain the world, societies have industrialized and technological complexity has become exponential. Snow's principle applies across fields of inquiry, but at the time poignantly focused on physicists, the discovery of atomic fission, and the societal implications that followed since. These phenomena contribute to what Erikson labeled a "new species of trouble"[6] and Beck termed "risk society."[7]

Using the case of what I will call *the nuclear doctrine*, this article expounds on some of the contemporary problems of governing the technological risk we have created. By the term nuclear doctrine, I refer to a set of political, social, and cultural conditions combining several factors. Each of the factors in some form reveals a part to the story that has become our historical legacy and context as well as actions of today and tomorrow related to nuclear technology. The factors are as follows: 1) the transformational science that lead to atomic discoveries in the twentieth century; 2) the tension over nuclear technology development as a military vs. civilian domain; 3) the contemporary re-emergence of the nuclear power industry in a context of global climate change and energy crises facing the governments of tomorrow.

In short, I ask what the appropriate role of government ought to be in the management and regulation of technological risk such as nuclear technology? The core thesis of this article highlights an ongoing political doctrine to support nuclear technologies in the United States. In contrast, many social and cultural indicators do not align to that ongoing nuclear doctrine. Thus, a crisis of trust in government to even greater degrees lies ahead within the pursuit of nuclear technologies. Living with the nuclear doctrine, individuals in modern society face a paradoxical

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[4] Snow, *The Physicists*, 187.

[5] Graham Farmelo, "It Must Be Beautiful" in *It Must Be Beautiful: Great Equations of Modern Science*, ed. Graham Farmelo (London: Granta Books, 2002), xii-xviii.

[6] Kai Erikson, *A New Species of Trouble: Explorations in Disaster, Trauma, and Community*, (New York: W. W. Norton & Co., 1994), 11-23.

[7] Ulrich Beck, *Risk Society: Towards a New Modernity*, trans. Mark Ritter (London: Sage Publications, 1992), 9-50.

future: while we expect, demand, and now rely on the utility and benefits from the complex technological systems we have created, we simultaneously resist, fear, and challenge their associated risks. And, as Perrow's[8] analyses emphasize, the very creation of systems such as nuclear technology court disaster because the risk is inherent to the tightly coupled, interactive complexity that makes them possible.

What is the Nuclear Doctrine?

As indicated above, the nuclear doctrine is a concept I introduce[9] to include several factors elaborated more in this section. Generally, a doctrine refers to a set of principles (political, scientific, or religious) presented within and held as a belief system by a group. Thus, on the surface, the term nuclear doctrine may seem to imply that all adhere to a particular set of beliefs or perceptions about nuclear technology, nuclear energy, or nuclear war, for instance. On the contrary though, the term means to convey the commonality of experience related to various activities while simultaneously maintaining incongruent political, scientific, and cultural positions and perspectives toward nuclear technologies. As author and analyst, use of the term neither conveys support nor opposition to nuclear technology. I employ the term as an observation of transcending phenomena that have evolved from a unique discovery in the science of physics, the culture of warfare, and contemporary claims about nuclear technology filling the void of sustainable energy.

Atomic Fission as a Technological Tempest

"The discovery of atomic fission broke up the world of international physics" which prior, Snow explained, had abounded with transboundary exchange and camaraderie of invention and discovery.[10] Due to the timing and motivation for first application of such a grand discovery as atomic fission, we cannot escape World War II as the context in which decisions about the pursuit of nuclear technology were initially made. While the focus of this article is not to evaluate the ethics of creating or using the atomic bomb(s) to turn the tide of the war, we must recognize that grand philosophical question also relates to the nuclear doctrine of the United States. Regardless of one's moral position use of the bombs, the physical and cultural legacies

[8] Charles Perrow, *Normal Accidents: Living with High-Risk Technologies* (New York: Basic Books, 1984).

[9] Although I have not found the term or concept within academic literature, variation on the term has occurred elsewhere by the Federation of American Scientists (see "United States Nuclear Doctrine and Policy", July 14, 2007, http://www.fas.org/nuke/guide/usa/doctrine/index.html). My explication of the concept here is distinct.

[10] Snow, *The Physicists*, 185.

the discovery of how to generate the energy to make the bomb continues to reverberate in our society today.

Secrecy and the control of nuclear awareness. Over the past few decades, numerous accounts have revealed the atrocities of secret tests, lies, and misinformation that surrounded the government's practices to develop nuclear technology.[11] In addition to more benign elements of the secrecy (such as code words developed to disguise direct discussion of certain materials), intelligence experiments and as well as the implications from physical tests affected many populations, often disproportionately.[12] The pattern of non-disclosure of emerging information originally set by the United States Atomic Energy Commission (AEC) and followed by the subsequent Department of Energy (DOE) first established a false sense of security among much of the American public. Over time, correlating to many of the health impacts on populations from uranium mining and milling, weapons testing, and whistle-blower events, a problematic distrust of government agencies responsible for nuclear activity and information emerged.

The ongoing challenge of nuclear accountability. The nuclear doctrine also now includes communities' attempts to engage themselves in the debates about health, risk, and safety as it applies to their daily lives.[13] With the generations since the discoveries and use of atomic power, the activities of governments in relation to nuclear information and trust of whether safety standards are adequately determined has become part of the rhetoric for public accountability. Returning to the methods of how scientists and experts tell the general public what they know, it has opened the series of social and political interactions within the field of nuclear technology to critique and unprecedented scrutiny. Habermas recognized the dilemma of

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[11] Information on these topics is vast. For several interesting references, see: John Bradley, "Introduction: Invisibility" in *Learning to Glow: A Nuclear Reader* ed. John Bradley (Tucson, AZ: The University of Arizona Press, 2000); Philip L. Fradkin, *Fallout: An American Nuclear Tragedy* (Tucson, AZ: The University of Arizona Press, 1989); Barton C. Hacker, "Setting Radiation Protection Standards: Science, Politics, and Public Attitudes in Historical Perspective," *Physics & Society*, 24, no. 3 (1995): 5-8; Mark Goodman, "Human Radiation Experiments," *Physics & Society*, 24, no. 3 (1995): 3-5; Arjun Makhijani and Scott Saleska, *The Nuclear Power Deception: U.S. Nuclear Mythology from Electricity "Too Cheap to Meter" to "Inherently Safe" Reactors* (New York: The Apex Press, 1999); Eric Pooley, "Nuclear Warriors," *Time*, March 4, 1996, 47-54; Russell Watson, "America's Nuclear Secrets," *Newsweek*, December 27, 1993, 14-18; Eileen Welsome, *The Plutonium Files: America's Secret Medical Experiments in the Cold War*, (New York: Dial Press, 1999).

[12] Goodman, "Human Radiation Experiments," 4; see also Ward Churchill, *Struggle for the Land: Indigenous Resistance to Genocide, Ecocide and Expropriation in Contemporary North America* (Monroe, ME: Common Courage Press, 1993); Winona LaDuke, *All Our Relations: Native Struggles for Land and Life* (Cambridge, MA: South End Press, 1999).

[13] Tim Connor, *Burdens of Proof*, (Columbia, SC: Energy Research Foundation, 1997); Chip Ward, *Canaries on the Rim: Living Downwind in the West* (New York: Verso Press, 2001).

the modern state that lies in conflict with the rise of community demands for accountability. Tasked with protecting a society from social disintegration through policy and control of welfare, states create legitimation structures to attend to such responsibilities.[14] In the category of nuclear accountability and responsibility, the United States government has repeatedly failed to maintain legitimation.

Atoms for War or Peace?

Another problematic emblem of the nuclear doctrine stems from confusing, if not conflicting, perceptions for average citizens as to whether nuclear technology is primarily military or civilian. But the confusion is not unfounded as the schizophrenic reality stands that it is both.

But why would it matter whether someone associates the nuclear doctrine more with the military or civilian activity? From the context of its inception and followed by decades of the Cold War, nuclear technology became culturally associated with fear and paranoia of possible fatal attacks and global destruction at a new scale never imagined among the American public. Although it was a mighty weapon the United States used first in a warfare setting, the Cold War insidiously tainted nuclear technology as the tool the enemy could use for mass destruction on unprecedented scales.[15] The federal government's nuclear weapons testing program further enshrined nuclear activity, technology, and impact as something related to and of, the military. Political dimensions of the doctrine ensured this military identity as such, irrespective of and often at the suppression of disagreement and debate.[16]

On top of this problematic military past for the nuclear doctrine, contemporary discussion on meeting our future energy needs leads proponents of civilian nuclear power to purport the industry to be a solution to curb our heavy dependence on fossil fuels. Since 2000, the claims of a new dawn for nuclear power have been consistent.[17] As a result, rapid exploration and

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[14] Jurgen Habermas, *Communication and the Evolution of Society* (Boston, MA: Beacon Press, 1976), 195.

[15] Fradkin, *Fallout*.

[16] Valerie L. Kuletz, *The Tainted Desert: Environmental and Social Ruin in the American West* (New York: Routledge, 1998), 15-18; also for evidence of early literature on technological risk that suggests concerns about associations of nuclear power and nuclear weapons as well as the perceived technological elitism that controls such systems, see Vincent T. Covello, "The Perception of Technological Risks: A Literature Review" *Technological Forecasting and Social Change* 23 (1983): 285-297.

[17] "A new dawn for nuclear power?" *The Economist*, 359, no 8222 (May 19, 2001): 13, 24-26; Christina Cheddar, "Back in Power" *The Wall Street Journal* (September 17, 2001), R15; Michael Freemantle, "Nuclear Power for the Future" *Chemical & Engineering News* 82, no. 37 (September 13, 2004): 31-35; Jean M. Hoffman,

development of uranium mining has again begun to ravage parts of the landscape in the American West,[18] even though human impacts from the previous uranium mining/milling era linger with little reconciliation.[19]

Because the world has changed with regard to terrorism and threats of nuclear material proliferation to even greater degrees, correlating concerns about attacks on power plants or rogue use of radioactive resources has heightened security and analysis of possible events.[20] President Carter's 1977 executive order to ban the reprocessing of spent fuel wastes in the United States intended to quell concerns about proliferation, and whether founded or not, complicated debates about future technologies. Earlier this year, however, DOE indicated support for preliminary site studies among eleven different community-company consortia to host three large reprocessing-related facilities within its Global Nuclear Energy Partnership (GNEP) program that remains controversial. Congress has only partially funded the program as of 2007.[21] Other leading scientists oppose the push toward reprocessing citing concerns about economic justification[22] as well as proliferation due to the change in how the materials can be handled as spent fuel.[23]

The Greening of Nuclear Power Amidst Climate Change

"Nuclear's New Age" *Machine Design* (September 27, 2001): 93-98; Gail H. Marcus, "Considering the Next Generation of Nuclear Power Plants" *Progress in Nuclear Energy* 37, no. 1-4 (2000): 5-10; Gail H. Marcus and Alan E. Levin, "New Designs for The Nuclear Renaissance" *Physics Today* (April, 2002): 54-60; Douglas S. McGregor, "Rethinking Nuclear Power" *The New American* 17, no. 9 (April 23, 2001) http://www.thenewamerican.com/tna/2001/04-23-2001/vol17no09_nuclear.htm (January 12, 2002).

[18] Petra Bartosiewicz, "Crazy for Yellowcake in Paradox Valley, Colorado" (*MotherJones.com*, July 17, 2007) http://www.motherjones.com/news/outfront/2007/07/crazy_for_yellowcake.html (July 20, 2007); Nancy Lofholm, "New surge, old fallout from nuclear age," *Deseret Morning News*, June 10, 2007, http://deseretnews.com/dn/print/1,1442,660228414,00.html (June 14, 2007); Samuel Western, "The Fourth Wave: Can the West's uranium towns rise once more?" *High Country News* 38, no. 16 (September 4, 2006): 10-14.

[19] Michael A. Amundson, *Yellowcake Towns: Uranium Mining Communities in the American West* (Boulder, CO: University Press of Colorado, 2002); Gary E. Madsen, Susan E. Dawson, and Bryan R. Spykerman, "Perceived Occupational and Environmental Exposures: A Case Study of Former Uranium Millworkers," *Environment and Behavior* 28, no. 5, (September 1996): 571-590.

[20] Carl E. Behrens, Nuclear Powerplants: Vulnerability to Terrorist Attacks (U.S. Library of Congress, Congressional Research Service, Report for Congress, Order Code RS21131, January 31, 2002), 1-4, http://fpc.state.gov/documents/organization/8042.pdf (August 20, 2007); Douglas M. Chapin and others, "Nuclear Power Plants and Their Fuel as Terrorist Targets," *Science* 297 (September 20, 2002): 1997-2000.

[21] J. Johnson, "Reprocessing Key to Nuclear Plan," *Chemical & Engineering News* 85, no. 25 (2007): 48-54.

[22] William C. Sailor, "The Case against Reprocessing" *Forum for Applied Research and Public Policy* (Summer, 1999): 108-112.

[23] Edwin Lyman, "Reprocessing N-waste? Forget it – just store it," *Tooele Transcript-Bulletin* (December 27, 2005), A4.

Even though uncertainty remains about projected long-term impacts, reporting on global climate change continues to increase in frequency as well as offer mounting evidence to make the case of a not-so-distant ecological crisis.[24] The climate change debate raises the specter of a nuclear renaissance because advanced nuclear technologies may provide a substantive and stable energy source while producing very little greenhouse gas emissions, unlike fossil-based fuels.[25] Some analyses, however, suggest the government's communications about energy needs have unnecessarily lead to inflated projections of future demand. The question of adding base power to the current system, rather than merely making current energy production more sustainable, has also spurred discussion about the relationship between climate change and nuclear power.[26]

Interpreting the nuclear boomerang. Even though nuclear news is much more common these days than a decade ago, is there really evidence of a current resurgence, or renaissance, to advance nuclear technology specifically to generate nuclear power within safe operational standards? Without a doubt, several trends are clear over the past decade that provide evidence of an attempt by government and nuclear industry to generate a boomerang effect:[27]

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[24] Elizabeth Kolbert, *Field Notes from a Catastrophe: Man, Nature, and Climate Change* (London: Bloomsbury Publishing, 2006); "Billions face climate change risk" (BBC, April 6, 2007) http://news.bbc.co.uk/1/hi/sci/tech/6532323.stm (May 25, 2007).

[25] Many popular press articles have linked the resurgence of nuclear power to the rising price of oil and increased attention to global climate change. See: David R. Francis, "Suddenly, a light shines on nuclear power" (*The Christian Science Monitor*, May 19, 2005) http://www.csmonitor.com/2005/0519/p16s01-cogn.html (July 1, 2005); Christopher Helman, Chana R. Schoenberger, and Rob Wherry, "The Silence of the Nuke Protesters" (Forbes, January 31, 2005) http://www.forbes.com/free_forbes/2005/0131/084/.html (April 7, 2006); Greg Lavine, "Global warming heats up the nuclear option" (*Salt Lake Tribune*, July 15, 2007) http://www.sltrib.com/portlet/article/html/fragments/print_article.jsp?articleId=6379800&siteId=297 (July 16, 2007).

[26] For one of the earliest and comprehensive linkages that offers some critique about these relationships, as well as a rather bleak set of implications about projected energy demands, see: Peter Bunyard, "Nuclear Power: Way Forward or Cul-de-Sac?" *The Ecologist* (Agriculture House, Dorset, February 1992); also see Amory B. Lovins, "Competitors to Nuclear: Eat My Dust" (Rocky Mountain Institute, undated) http://www.rmi.org/sitepages/pid1151.php (September 17, 2005); Arjun Makhijani, "Securing the Energy Future of the United States: Oil, Nuclear, and Electricity Vulnerabilities and a post-September 11, 2001 Roadmap for Action," (Takoma Park, MD: Institute for Energy and Environmental Research, 2001).

[27] Evidence exists that these trends of growth, at least the construction plans for new power plants, are global with countries like Russia, China, and India making significant strides for near-future development. For example, see: "China's Nuclear Power Capacity Set to Quadruple by 2020," (Environment News Service, April 22, 2005) http://www.keepmedia.com/pubs/EnvironmentNewsService/2005/04/22/825456 (June 9, 2005); Fred Weir, "Russia plans big nuclear expansion" (*The Christian Science Monitor*, July 17, 2007) http://www.csmonitor.com/2007/0717/p01s04-woeu.html (July 20, 2007). One source claims China may increase its nuclear capacity fivefold by 2020: see, Peter Ford, "China moves to shrink its carbon footprint" (*The Christian Science Monitor*, April 26, 2007) http://www.csmonitor.com/2007/0426/p01s04-woap.html (June 15, 2007).

1. *Financial planning by the industry*. Industrial consolidations[28] and financial actions have been in the works with the anticipation of next-generation technologies planned to come online within 20 years, as reported by the DOE Nuclear Energy Research Initiative (NERI).[29] However, a recent report from a group of researchers associated with the DOE laboratory in Idaho – now the Idaho National Laboratory (INL) – indicated that additional emphases are needed to address social and political concerns about next-generation technologies in order for that platform to meet with success.[30]

2. *Financial and institutional support by the federal government.* Although the U.S. oil industry receives four times more in government subsidies than the nuclear industry,[31] the latter has made significant strides to secure insurance and loan guarantees enabled since the 2005 Energy Bill. These incentives for industry are providing financial security to jump start a new construction era. The incentives include twelve billion dollars in tax breaks and up to an additional "two billion dollars in federal risk insurance for the first six new nuclear-plant projects, protecting them against losses from regulatory or legal delays."[32] More recently, the Nuclear Regulatory Commission (NRC) has increased staff, expecting a flood of applications before the end of 2008 for nearly 30 new reactors.[33]

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[28] Jon Gertner, "Atomic Balm?" *The New York Times Magazine*, July 16, 2006, 36-47, 56, 62, 64; Helman, Schoenberger, and Wherry, "The Silence of the Nuke Protesters".

[29] "Research Areas: New Research Focus" (Department of Energy, Nuclear Energy Research Initiative, undated) http://www.ne.doe.gov/neri/neNERIresearch.html (August 20, 2007).

[30] Steven Piet and others, "Approach for Next Generation Nuclear Plant Public Outreach and Analysis," (Idaho Falls, ID: Idaho National Engineering and Environmental Laboratory Bechtel BWXT Idaho, LLC, 2005) INEEL/EXT-05-02627.

[31] Mark Clayton, "US House takes on Big Oil" (*The Christian Science Monitor*, January 18, 2007) http://www.csmonitor.com/2007/0118/p01s01-usec.html (February 27, 2007).

[32] Mark Clayton, "Nuclear Power Surge Coming" (*The Christian Science Monitor*, September 28, 2007) http://www.csmonitor.com/2007/0928/p01s05-usgn.html (September 28, 2007). The federal government also supports the nuclear industry through its infrastructure of national laboratories that receive substantive annual funding; see John C. Zink, "Administration Supports Nuclear Resurgence" *Power Engineering* June (2002): 26.

[33] Rebecca Smith, "Nuclear Energy's Second Act?," *The Wall Street Journal*, September 25, 2007 B1; see also Clayton, "Nuclear Power Surge Coming."

3. *Land acquisition, applications, and permit requests.* In September 2007, a U.S.-based company filed the first full application in over 25 years to build two new nuclear power plants in the state of Texas.[34] Two years prior to that, a consortium of eleven nuclear power companies called NuStart Energy Development LLC that operates 58 percent of the nation's reactors began a licensing process with DOE and the NRC to complete new reactor designs.[35] And a Virginia company (Alternate Energy Holdings, Inc.) that purchased property in Idaho to build a new nuclear power plant has investors willing to loan three and one-half billion dollars to the project.[36] Other state legislatures have also held discussions on adding incentives to potentially lure nuclear utilities.

4. *Technological development.* Recent reports indicate nuclear engineers' claims to have developed simpler and more standardized designs, which will translate to increased safety of operating future reactors.[37] Although timelines exist for Generation III and Generation IV reactors analyses are ongoing to determine optimal designs for safety, efficiency, and managing waste streams.[38]

Even given this ramp of activity, however, skeptics remain. Moreover, the first line of skepticism and caution comes not from those who necessarily oppose nuclear technology on philosophical grounds, but are evaluating the still-daunting financial realities despite the recent subsidies.[39]

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[34] Steven Mufson, "U.S. Nuclear Power Revival Grows," *The Washington Post*, September 25, 2007, D1.

[35] "Sites Chosen for First U.S. Nuclear Plants in 30 Years," (Environment New Service, September 23, 2005) http://www.mywire.com/pubs/EnvironmentNewsService/2005/09/23/1024673?&pbl=82 (October 5, 2005); "NuStart Signs DOE Agreement in Support of Advanced Nuclear Plants," (NuStart Energy, May 9, 2005) http://www.nustartenergy.com/DisplayArticle.aspx?ID=20050509-1 (May 21, 2005).

[36] Ken Dey, "Developer says investors will loan $3.5 billion for proposed nuke plant in Southwest Idaho," (*Idaho Statesman*, June 27, 2007) http://www.idahostatesman.com/newsupdates/v-print/story/91781.html (July 1, 2007).

[37] "Atomic Renaissance" *The Economist* 384, no. 8545 (September 8, 2007): 81-83; Gertner, "Atomic Balm?"

[38] Steven Piet and others, "Current Comparison of Advanced Nuclear Fuel Cycles," paper presented the Annual Symposium of the Idaho Academy of Science, Idaho Falls, ID (April 20, 2007).

[39] "Atomic Renaissance," *The Economist*; Gertner, "Atomic Balm?", 45-47, 56; Matthew L. Wald, "Slow Start for Revival of Nuclear Reactors," *The New York Times* (August 22, 2006) http://www.nytimes.com/2006/08/22/business/22nukes.html (September 30, 2006).

Is nuclear power as green as industry says it is? Modern critics still write about the nuclear industry's checkered past of operational safety, usually citing the two major cases of accident, risk, and near-catastrophe known world-wide: Three Mile Island in Pennsylvania in 1979, and five years later in the Ukranian town of Chernobyl.[40] Recently, in response to the groundswell of nuclear energy promotion among the industry and proponents, a coalition of "nearly 300 international, national, regional, and local environmental, consumer, and safe energy groups have issued a declaration rejecting nuclear power as a solution to Earth's warming climate."[41] Yet, some noteworthy exceptions to that broader environmental stance have also begun to creep forward:

> In his presentation at the Institutional Investor Summit on Climate Risk in May, Harvard University Professor and National Commission on Energy Policy Co-Chair John Holdren stated that nuclear power might be a valid energy alternative to mitigate climate change. Greenpeace founder Patrick Moore said the same thing in testimony before the Congressional Subcommittee on Energy and Resources. So did Whole Earth Catalog founder Stewart Brand in an article in the May edition of *Technology Review* from Massachusetts Institute of Technology, and Gaia theorist James Lovelock in a May op-ed in *The Independent*.[42]

Although many still screen out nuclear utilities, socially responsible investment firms (i.e., Sierra Club Mutual Funds) now also grapple with the complexity of nuclear costs and benefits.[43]

Even though the central mantra of the environmental opposition to nuclear power occasionally concedes to the weight of global climate change as a large enough long-term risk that could force the option of nuclear power,[44] the lower expected levels of carbon emissions from nuclear utilities may be a function of how the carbon footprint is measured. A recent German analysis of the full nuclear fuel-cycle, including "upstream" and "downstream" costs,

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[40] Jonathan Thompson, "Reborn: The West casts a wary eye on the latest nuclear craze" *High Country News* 38, no. 16 (September 4, 2006): 9.

[41] "300 Groups Reject Nuclear Power as Global Warming Solution" (Environment News Service, June 17, 2005), http://www.keepmedia.com/pubs/EnvironmentNewsService/2005/06/17/903050 (June 29, 2005).

[42] William Baue, "Nuclear Power: Still an Environmental Scourge or Now a Climate Change Mitigator?" (SocialFunds.com, June 9, 2005) http://www.socialfunds.com/news/article.cgi/article1729.html (June 12, 2005).

[43] Baue, "Nuclear Power: Still an Environmental Scourge or Now a Climate Change Mitigator?"

[44] Lavine, "Global warming heats up the nuclear option".

indicates that if we take into account the true range of human and environmental health impacts, the carbon footprint of nuclear power is much greater than recent industry claims and media reports have indicated.[45] In light of President George W. Bush's failed leadership to reconcile a national commitment to reducing carbon emissions from the United States, not having nuclear power as a silver bullet complicates the federal government position even more so.

To summarize, I have labeled these observations collectively as the nuclear doctrine. In this case, the doctrine constitutes more of a set of conditions we live with rather than principles we live by. We live with nuclear energy, the ongoing presence of nuclear weaponry, and the threat, however perceived or real, that the technology has costs and benefits, which remain difficult to sort out within our dynamic and changing culture.

Nuclear Risk as a Wicked Problem

Above, I described my use of the nuclear doctrine concept. This section elaborates the larger context of how the nuclear doctrine relates to the problem at hand – ailing trust in the governing of technological risk. The important, but not yet fully developed theme of *wicked problems* is helpful to this end beginning with a review of its core premises.

First articulated by Rittel and Weber[46] several decades ago, the wicked problems theme refers to the intersection of societal and resource management problems of extreme intractability. Or, in fact, wicked problems may have no solution at all which might challenge the beliefs of those predisposed to technological fixes. Rittel and Webber first described the characteristics of wicked problems with other terms like malignant, vicious, and tricky to indicate the dynamic and problematic magnitude of this form. Allen and Gould[47] distinguished the notion of complexity from wicked problems in their analysis of rampant problems found in forest planning and policy, stating complex problems can still be addressed with calculated, routine scientific procedures. They posited that wicked problems include degrees of unpredictability, the inability to test for the validity of solutions, and that each concerns a unique combination of factors. Following this

[45] Uwe R. Fritsche, Comparison of Greenhouse-Gas Emissions and Abatement Cost of Nuclear and Alternative Energy Options from a Life-Cycle Perspective (Darmstadt: Institute for Applied Ecology, 2006), 2-9, http://www.precaution.org/lib/nuke_ghg_emissions.060224.pdf (September 1, 2007); see also Mark Clayton, "How Green is Nuclear Power?" (*The Christian Science Monitor*, March 7, 2007) http://www.csmonitor.com/2007/0307/p01s04-sten.html (June 27, 2007).

[46] H. W. J. Rittel and M. M. Webber, "Dilemmas in a General Theory of Planning" *Policy Sciences* 4, no. 2 (1973): 155-169. In a different context, the term "wicked problems" was also used earlier (see: C. Churchmann, "Wicked Problems" *Management Science* 4, no. 14 (1967): B141-142.

[47] Gerald M. Allen and Ernest M. Gould, Jr., "Complexity, Wickedness, *and* Public Forests" *Journal of Forestry* 84, no. 4 (1986): 20-24.

discussion, Patterson and Williams included the theme in their argument for a deeper understanding of the philosophy of science[48] in order to develop new paradigms to address issues of grand scale and wickedness.

More recently, Freeman[49] applied the wicked problems theme to water resources policy dilemmas, and Carroll and others[50] incorporated it into the ongoing debate over forest policy on public lands in the Inland Northwest region. Yet, the wicked problems theme has yet to be applied to the range of issues associated with the nuclear doctrine I have described here, including managing high-level nuclear wastes, although that sub-topic, important as it is, does not constitute the focus of this article.[51] One reason for this gap could be the span of time in which the nuclear doctrine has emerged. In addition, the sheer magnitude of the topic does not lend itself easily to a full analysis. Thus, the duration of decades might have the effect of lessening its appearance as a wicked problem at any given point. Nonetheless, from the literature, we can derive several core characteristics common to wicked problems in order to evaluate a thematic application to the nuclear doctrine. Thus, wicked problems include the following characteristics, especially as they apply to a natural resources management context:

1. *Socially constructed realities.* This element suggests that wicked problems have no objective definition of the problem but are subject to different perspectives negotiating an ongoing reality as described by Berger and Luckmann.[52]

2. *Unique* and *multi-faceted aspects*. The literature on wicked problems stresses that wicked extends beyond normal meanings conveyed by complexity to indicate

[48] Michael E. Patterson and Daniel R. Williams, "Paradigms and Problems: The Practice of Social Science in Natural Resource Management" *Society and Natural Resources* 11, no. 3 (1998): 279-295. For a more recent article on applying the philosophy of science to interdisciplinary problems, see Sanford D. Eigenbrode and others, "Employing Philosophical Dialogue in Collaborative Science" *BioScience* 57, no. 1, (January 2007): 55-64.

[49] David M. Freeman, "Wicked Water Problems: Sociology and Local Water Organizations in Addressing Water Resources Policy" *Journal of the American Water Resources Association* 36, no. 3 (June 2000): 483-491.

[50] Matthew S. Carroll and others, "Managing Fire Danger in the Forests of the US Inland Northwest: A Classic 'Wicked Problem' in Public Land Policy" *Journal of Forestry* 105, no. 5 (July/August 2007): 239-244.

[51] My search did not reveal a linkage of the wicked problems theme with the nuclear doctrine. However, a recent and important manuscript focuses on the dilemmas of the high-level nuclear waste policy in the United States (see: Robert Vandenbosch and Susanne E. Vandenbosch, *Nuclear Waste Stalemate: Political and Scientific Controversies* (Salt Lake City, UT: The University of Utah Press, 2007) .

[52] Peter L. Berger and Thomas Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge* (Garden City, NY: Anchor Books, 1966), 51-61.

multiple dimensions, issues, or factors shaping a problem, but also how that combination may have no precedent or repeat occurrence.[53]

3. *Social and political conflict exceeding structures of institutional control*. As per the two points above, wicked problems manifest as social conflict levels that threaten normal institutional procedures of resource management.[54]

My analysis asserts that wicked problems may be irreconcilable, at least within a democratic government.

Given these three characteristics, does the theme of wicked problems apply to the technological risk of the nuclear doctrine? Unequivocally, the answer is yes, it does apply. Each of the three characteristics appears as part of the often seen and described pattern of expert vs. layperson opinions, perspectives, or (mis)understanding of situations such as risk. This, after all, is why we as social scientists must be linguistically sensitive to phenomena within the nuclear doctrine as perceived risk rather than simply calling it risk. Aptly described as "the fallacy of dismissing the layperson"[55] this phenomenon often sets the public at odds with the professionals, or technical experts, despite Snow's call to arms for scientists to tell us what they know.[56] Wicked problems highlight the dilemmas of a socially constructed reality among multiple groups or stakeholders and fluid levels of conflict operating amidst the legal, political, and resource management agencies of the government. Nuclear technology is a premier example of gaps understanding others' perspectives may plague the discourse within a wicked problem.

The central feature of nuclear technology often identified as the problem could be described as *the perceived threat of radiation exposure*. Slovic's analysis demonstrated the lack of "a uniform or consistent perception of radiation risks"[57] among the public. Still, professionals

[53] Allen and Gould, "Paradigms and Problems," 21-22; Freeman, "Wicked Water Problems," 483-484.

[54] Carroll and others, "Managing Fire Danger in the Forests of the US Inland Northwest," 239-242; Freeman, "Wicked Water Problems," 483-484.

[55] Kristin Shrader-Frechette, "Producer Risk, Consumer Risk, and Assessing Technological Impacts" *Impact Assessment Bulletin* 6, no. 3-4 (1988): 155-164.

[56] See footnote 4. Also, this point appears to equate all professionals with "scientists" which is an obvious over-generalization in an attempt to make a larger point.

[57] Paul Slovic, "Perception of Risk from Radiation" *Radiation Protection Dosimetry* 68, no. 3-4 (1996): 165-180.

often make assumptions that laypersons are ignorant about probabilities and/or that fears are irrational,[58] both of which conflict with the social continuum of perceptions about radiation exposure. In this vein, well-meaning scientists with good intentions have tried, perhaps taking Snow's advice as a moral imperative, to tell us what they know and explain in rational terms how risk is negligible or of little concern compared to what laypersons may perceive. As an example, the accident at Three Mile Island is argued by some as worse than public perceptions,[59] and by others that it was not at all the risk many commonly attribute to the historical event.[60]

Freudenburg pointed out the conundrum of a "declining public deference toward science and technology" [61] amidst the technological advancement of industrialization. In truth, this paradox highlights Mill's observation of our lacking sociological imagination within society. Such a collective tool could enable shared understanding about the uncertainties associated with complex technologies, rather than individualistic anxieties of the complexities themselves.[62] Here though, I make the case that nuclear technology is not just complex, but also or more so, wicked. This is so because with technological risk we usually lack the full evidence needed sociologically at any given time or place to know whether real risk, or inversely if uncertainty, is chronic or acute. This point is vital, as wicked problems constitute social constructions, even if one just perceives risk, it is real in the consequences and actions one may take. Early analytical literature on nuclear power demonstrated concerns of nuclear risk as involuntary, unfamiliar, uncontrollable, inequitable, and potentially catastrophic as well as suffering from a technological elitism borne out of the expert / layperson divide.[63] Erikson's description of the technological risk era we have created claims the level of dread evoked by fear of radiation exposure extends to a range of invisible, stealthily acting toxic poisons now embedded within our natural

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[58] Shrader-Frechette, "Producer Risk, Consumer Risk, and Assessing Technological Impacts," 156.

[59] Albert J. Fritsch, Arthur H. Purcell, and Mary Byrd Davis, "Critical Hour: Three Mile Island, The Nuclear Legacy, and National Security" (Yggdrasil Institute, 2006) http://www.earthhealing.info/CH.pdf (December 30, 2006).

[60] Theodore Rockwell, "Discussions of Nuclear Power Should Be Based in Reality" *The Scientist* 12, no. 6 (March 16, 1998): 7.

[61] William R. Freudenburg, "Risky Thinking: Irrational Fears About Risk and Society" *The Annals of The American Academy of Political and Social Science* 545 (May, 1996): 46; for additional theoretical discussion of this point, see also: Anthony Giddens, "Living in a Post-Traditional Society" in *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order* eds. Ulrich Beck, Anthony Giddens, and Scott Lash (Stanford, CA: Stanford University Press, 1994).

[62] Charles Perrow, "Risky Systems: The Habit of Courting Disaster" *The Nation* (October 11, 1986), 347-355.

[63] Covello, "The Perception of Technological Risks: A Literature Review," 290.

environment from chemical uses.[64] Yet in everyday life, do we act more as though we have greater perceived fear for a new nuclear power plant in our community or the pesticides and preservatives we ingest from the food we purchase to eat?

Trust, Distrust, and the Crisis of High Technology

Having established the nuclear doctrine, and why it constitutes a wicked problem, this final section of the article seeks to explore how and why this looms as such a crisis of technology and trust. While the focus remains on the national problem within the United States, I also note the international implications of this dilemma, as nuclear risk analyses have appropriately broadened to include transboundary risk management.[65]

Sociometric analyses of the dominant images associated with nuclear waste emphasize that the crisis, which appears so technical, is actually more one of failed confidence in those tasked with the management of highly radioactive materials.[66] In the words of Slovic, Flynn, and Layman, it is "a profound breakdown of trust in the scientific, governmental, and industrial managers of nuclear technologies."[67] To be clear, that is not to say a distrust of individuals (perhaps with high-profile exceptions that symbolize the problem), but rather of the management *systems* of which they are a part. As it aligns to my focus here, the system not only includes, but also largely is, the government in its role as the institution that sets operational standards to regulate risk and ensure safety. Although some studies cited here pertain more specifically to the case of nuclear waste and related policy, the nuclear doctrine concept I employ here suggests no functional differentiation by the public given the apparent tendency to focus on values and images. And, as Albrecht noted: "A workable solution to the nuclear-waste problem is essential to shape a future for the commercial nuclear-power industry."[68]

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[64] Erikson, *A New Species of Trouble*, 19-20. Work by others (see: Joe Thornton, *Pandora's Poison: Chlorine, Health, and a New Environmental Strategy*, Cambridge, MA: MIT Press, 2000) has provided extensive evidence about chemical contamination effects.

[65] Ragnar E. Lofstedt and Vidmantas Jankauskas, "Swedish Aid and the Ignalina Nuclear Power Plant" in *Transboundary Risk Management* eds. Joanne Linnerooth-Bayer, Ragnar E. Lofstedt, and Gunnar Sjostedt (London: Earthscan, 2001), 33-58.

[66] Paul Slovic, James H. Flynn, and Mark Layman, "Perceived Risk, Trust, and the Politics of Nuclear Waste" *Science* 254 (1991): 1603-1607.

[67] Slovic, Flynn, and Layman, "Perceived Risk, Trust, and the Politics of Nuclear Waste," 1606. See also: Covello, "The Perception of Technological Risks," 290. For a related policy analysis that makes similar points see: Stan L. Albrecht, "Nuclear Gridlock" *Forum for Applied Research and Public Policy* (Summer, 1999): 96-102.

[68] Stan L. Albrecht, "Nuclear Gridlock" *Forum for Applied Research and Public Policy* (Summer, 1999): 96-102.

To claim trust is vital to this dilemma, we must evaluate the dimensions of trust the nuclear managers have violated. Trettin and Musham's analysis of trust and environmental risk communication indicated needed elements of trust and credibility as: an emotional sense of security; a perceived basis for honesty; an emotional basis for faith and confidence (believability); and, reliability, the latter being judged by whether "a person or institution is predictable, adheres to procedures, and shows fiduciary responsibility."[69] The above description of the nuclear doctrine and compounding issues of confidence within its legacies demonstrate not only a failure to achieve, but in some cases, undermining these elements of trust and credibility. The penultimate example of lacking believability, reliability, and trustworthiness is the decades-old debacle of the planned Yucca Mountain geologic repository[70], symbolizing both the largesse of the contemporary nuclear military-industrial complex as well as the mix of technical and social dilemmas that weave into the nuclear wicked problem.

While there may be latent functions of a lack of trust such as healthy skepticism and critical thinking,[71] it raises the theoretical question of whether there is a difference between *distrust* and a lack of trust. I suggest there is a difference, namely that distrust occurs when a pattern of questioned, ambiguous, or inconsistent trust (each of which could be described as a lack of trust) fundamentally turns so that it no longer sustains or supports the social relationships built upon it.[72] Unfortunately, therefore, distrust seems eminently symptomatic of wicked problems.

To further elaborate the implications of distrust for technological risk, I rely heavily on Luhmann's work related to both risk[73] and trust.[74] Luhmann argued our everyday interactions remain predicated on trust. In other words, the social order that guides daily life is not chaos and paralyzing fear, even if we have a rhetoric of distrust for a system or its components. Distrust, therefore, can only be constructed relative to the expectation and norm of trust. Yet that balance

[69] Lillian Trettin and Catherine Musham, "Is Trust a Realistic Goal of Environmental Risk Communication?" *Environment and Behavior* 32, no. 3 (May 2000): 410-426.

[70] Vandenbosch and Vandenbosch, *Nuclear Waste Stalemate*, 2007.

[71] Trettin and Musham, "Is Trust a Realistic Goal of Environmental Risk Communication?", 423.

[72] For an important sociological perspective on trust and its implications to interaction and relationships, see: J. David Lewis and Andrew Weigert, "Trust as a Social Reality" *Social Forces* 63, no. 4 (June, 1985): 967-985.

[73] Niklas Luhmann, *Risk: A Sociological Theory* (Piscataway, NJ: Aldine Transaction, 2002).

[74] Niklas Luhmann, *Trust and Power* (Chichester: John Wiley & Sons, 1979).

of trust is delicate, fragile, and tenuous as a social contract. After much effort to build trust, it can be quickly lost.

Further, trust is only possible in a familiar world. This premise immediately conflicts with what little the average person may know about the objective realities of nuclear technology despite the nuclear doctrine. And although "trust increases the tolerance of uncertainty", its primary function in social systems is to reduce complexity.[75] Related, Luhmann later wrote about "the special case of high technology":

> What has been realized in the shape of 'high technology' or what presents itself for potential realization in this category appears to transcend the boundaries of the technical regulation of technology – even when, and especially when, it works . . . Other circumstances arise when newer and newer techniques are massively deployed without knowing enough about the ways in which they interfere with existing or simultaneously introduced new causalities.[76]

Although abstract, this passage describes the effects for many within the nuclear doctrine – an experienced reality of deployed high technology[77] but an increasing feeling and sense of reliance on these systems structured as pre-conditions rather than individual choices.[78] Once again, this point returns us to how the lack of a sociological imagination compounds the perceptions of risk associated with nuclear technology. Observing nuclear technology as a system foisted upon us at a societal level over the course of decades, we do not know where to place ourselves individually within the maze of risk, uncertainty, or alleged safety of the systems. Scientific assurances do not bridge the gaps we perceive in an attempt to socially understand

> systems that operate in unforgiving environments or with toxic or explosive materials . . . [and that demand] . . . tight coupling, that is there are few unplanned substitutes available; there are short-time sequences, irreversible sequences, the

[75] Luhmann, *Trust and Power*, 15.

[76] Luhmann, *Risk: A Sociological Theory*, 89.

[77] I define "high technology" as that which increased complexity of parts, interconnections, or couplings with respect to systems to which the technology may or may not connect. For elaboration on this concept, see: Perrow, *Normal Accidents*, 1984.

[78] Luhmann, *Risk: A Sociological Theory*, 99.

> inability to stop or pause once it starts, and only one way for the goal of the system to be met.[79]

In addition to this case about the inherent physical coupling of technological systems, Bradbury's work, recognized different physical and social perspectives on risk and noted that simply improving technical analyses does not solve the need for fundamentally new institutional procedures to address risk.[80]

The pervasive quality of nuclear risk perceptions is also germane to Beck's broader notion of *risk society.*[81] Risk society assumes the following: previously unknown degrees of hazards or threats; unprecedented technological innovations that produce unanticipated consequences; and political-economic policy focused more on technological management than evaluation of deployment. And as Wynne added, "risk has become the form of public discourse through which public meaning is given to technology and innovation."[82] As a matter of public discourse though, risk relies on trust rather than distrust. Beck also described the wicked problem dimension of this paradox:

> Consequently, we face the paradox that at the very time when threats and hazards are seen to become more dangerous and more obvious, they become increasingly inaccessible to attempts to establish proof, attributions and compensation by scientific, legal and political means.[83]

In this way, a social pattern of distrust from pervasive risk, the perceived failure of government to manage that risk, and a technology that operates autonomously[84] compounds the crisis of a loss of social capital now prevalent within the literature. While examples exist of revitalized community cohesion (bonding social capital) as well as networks that keep communities and

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[79] Charles B. Perrow, "Accidents in High-Risk Systems" *Technology Studies* 1, no. 1 (1994): 1-20.

[80] Judith A. Bradbury, "The Policy Implications of Differing Concepts of Risk" *Science, Technology, & Human Values* 14, no. 4 (Autumn, 1989): 380-399.

[81] Beck, *Risk Society*, 1992.

[82] Brian Wynne, "Risk and Environment as Legitimatory Discourses of Technology: Reflexivity Inside Out?" *Current Sociology* 50, no. 3 (2002): 459-477.

[83] Ulrich Beck, "Risk Society Revisited: Theory, Politics, and Research Programmes" in *The Risk Society and Beyond: Critical Issues for Social Theory* eds. Barbara Adam, Ulrich Beck, and Joost Van Loon, 211-229 (London: Sage, 2000).

[84] For extensive explanation of this reasoning, see: Langdon Winner, *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought*, 8th ed. (Cambridge, MA: MIT Press, 1992,).

organizations connected (bridging social capital) amidst resource management and change,[85] practices within the nuclear doctrine fail to meet these social requisites, and thus fail to garner trust except in isolated areas. In effect, within this wicked problem, we are bound to distrust.

Conclusion

Nuclear technology and the associated cultural and political doctrines we have created to fight and support that technology, suffer from the status of a wicked problem. The conflict over perceived risk from things nuclear stems from issues that are both highly technical and socially volatile. While it seems we cannot underestimate the culturally disruptive power inherent in such a wicked problem, the United States Executive leadership, the Department of Energy, and nuclear utility owners and managers appear to underestimate that power, in turn leading to distrust in relation to the nuclear doctrine. Presumably, those supporting the nuclear doctrine believe the American public will eventually succumb to a perspective of perceived benefits from additional nuclear power outweighing the perceived costs.

As we enter an age of intensified debate and overdue action to curb global climate change, the nuclear doctrine looms stronger than ever. Our sociological imagination to grasp implications from more than two generations of a nuclear doctrine eludes us still. As such, many of the not-to-be dismissed citizens in the United States remain unknowing of the recent institutional reform to allow a renaissance of the nuclear power industry in part justified by the global climate crisis. This is the mode of today, no matter the future risk; no matter the nuclear atrocities of the past. Thus, prior to the onset of the full ecological impact of global warming, we face a political crisis from failing to address social concerns of nuclear technology and giving the impression of prescribing the same engineering fix for the future that led to the original problem.

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[85] Mary Emery and Cornelia Flora, "Spiraling-up: Mapping Community Transformation with Community Capitals Framework" *Journal of the Community Development Society* 37, no. 1 (Spring, 2006): 19-35; Mark Granovetter, "Economic action, social structure, and embeddedness" *American Journal of Sociology* 91 (1985): 481-510.

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