Research Paper

Perceptions and the social-political aspects of nuclear power and nuclear waste disposal.

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Introduction

The problems that many nuclear engineers, energy policy makers, industry officials, and risk regulators face when discussing the social and political aspects of their field can be summarized by one word: perception. The public perception of the dangers inherit in the portions of the fuel cycle associated with nuclear power generation and radioactive waste transportation and disposal is vastly different from the perceptions held by those within the nuclear infrastructure (i.e., policy makers, planners, designers, etc.).[1] These perceptual differentials hold the key to any discussion on the social and political aspects of nuclear related activities since they represent the very real, in their consequences, fears that the public has with respect to the industry and especially its related production inputs like nuclear materials and outputs like spent nuclear fuel (SNF).[2]

This article will examine these perceptions and their effects in an effort to offer an atypical perspective, at least from the standard industry viewpoint, on the activities commonly associated with the nuclear power generation infrastructure. To accomplish this goal, the discussion will focus on three interrelated arguments. First, public perceptions have an influence on the ability of the nuclear energy infrastructure to operate within contemporary industrial societies. Secondly, events like those that transpired at the Three Mile Island nuclear power generation facility, the tragedies resulting from the failures of technology and the poor oversight by human caretakers at the Chernobyl site, and even seemingly unrelated events like the terrorist attacks on September 11, 2001, all have the potential to galvanize public perceptions against the nuclear industry and may increase the regulatory and social/political pressures on said infrastructure. Lastly, these same perceptions can exhibit themselves in many ways and could help to unite the various political action groups typically found in a given society and against the nuclear industry.

The conclusion of this essay will address some of the negative aspects of the nuclear infrastructure's resistance to, or in some cases the denial of the legitimacy of, such perceptions and how an understanding of the very real consequences of said perceptions can provide the industry with insights into their social, political and caretaker roles in contemporary society. The object of this argument is to highlight some of the various pressures that face those within the nuclear infrastructure and in the process help illustrate the latent effects of the typical "stonewall" attitude used by industry insiders when faced by the reality of criticisms based on non-technical based perceptions by non-industry social actors.[3]

Public perceptions have influence

While many nuclear industry insiders believe that probabilities and their associate risk calculations have real meaning to the public, the fact remains that these calculations are not what drives the public's view of nuclear power and highly radioactive wastes. One suggestion to overcome the problem that can arise when the general public reacts badly to nuclear power and radioactive wastes is to: 1) conduct an analysis of the perceptions the public has on nuclear related issues and 2) to address their concerns in a non-confrontational and respectful manner.[4] Prior to this being accomplished, it is necessary to understand how the differentials in industry and public perceptions come about and what effects they have on social and political debates surrounding the energy industry. As such this argument will attempt to highlight these issues in a manner that will allow for such understanding.

The social and political consequences of a perceptual differential between the industry and the public can be profound. Just think about the typically response of the nuclear industry to criticisms from outside, what can be termed social or political criticism. For a moment consider the hypothetical situation where the industry, or one of its representatives, contends that the risks of a nuclear power plant have already been studied and for the most part found to be meaningless, in terms of the probability or consequences. This industry reality is in direct opposition to the reality felt by the general public who quickly come to distrust these industry proclamations and find value in the perceptions of alternative experts who use their training in engineering, or risk modeling, to contend that the energy industry is using self serving calculations as the basis of their claims. The tension between these two positions is evident and while it

may be easy for the energy industry to dismiss the very real public fears that result, they should not be discarded so easily.[5]

A more tangible example of the perceptual divide represented herein can be found in the debates on the Yucca Mountain project in America. Recently one industry official testified in the American Congress regarding the chorus of social and political voices opposing the pending program to transport radioactive materials to the proposed Yucca geologic repository.[6] Paraphrasing this testimony, this industry representative referred to the critical voices as a "cottage industry" intent on playing off of the irrational fears of the public and opposing progress by the industry.[7]

The oppositional dialogue represented by such a comment, a distinct "we" verses "them" mentality, easily develops when perceptual differences are so profoundly disjointed. This real world example is not an atypical response when nuclear energy infrastructure proponents face intense questioning of their actions by the public, politicians, non-technical opposition forces, and/or even those within the industry who question choices made by the infrastructure managers regarding safety, security, and transportation.

Typically those who work within the energy infrastructure feel that such animosity towards social and political criticism is their only response given the emotionality, or even what they may term irrationality, of the opposition. Thus, such responses by the industry are seen by those within this infrastructure as self-protective and their proclamation is almost demanded given the antagonist claims and arguments of opponents.

Another way of seeing this is that such an industry response is not productive to the health and welfare of the industry and its workers; it will inevitably foster increased criticism by the opposition and can even engender amplified regulatory oversight since the public and non-sympathetic regulators and government officials see this attitude as a prime example of industrial arrogance. It is possible that such forms of corporate arrogance will just add fuel to the firestorm of public debates. They also show a clear disjunction between the perceptions expressed by the nuclear industry and those held by the public.

What may be difficult for many in the industry to comprehend, and perhaps this lack of understanding is one motive for these types of self-destructive attacks against social and political critics of the nuclear infrastructure, is that perceptions are socially and politically relative. They are *not and never will be* reducible to scientifically derived probabilities and typically industry risk assessment methodologies. Such profound perceptional differences as these can not be overcome by these forms of instrumental logic alone, they must be understood as to their point of origin, as to why they persist in the face of what the energy infrastructure considers valid evidence, and most importantly, a process must be engaged wherein the criticisms can be addressed by dialogue, not hostility.

In social scientific terms, the social construction of reality the social and political opponents of the energy industry engage in is a very powerful process. This construction of reality is a social process based on an internalized assessment of how people interact on the basis of symbols and signs. Such symbolic interactions help people assign meaning to their everyday experiences and perceptions. They shape how we view the

world and everything within that world, even those things we fear and dread, like radioactivity. Thus our life world, the everyday social world we inhabit, includes the social and political routines, rituals, and experiences that shape how we see the world and how we as social beings react to threats like those posed by nuclear power and radioactivity.[8]

For many in the body politic, radioactivity is a part of the life world where they do not wish to delve. The have been socialized to believe that nuclear power is equated to nuclear war and the outcomes of a nuclear power plant (NPP) accident, or terrorist attack on a spent fuel pool or radioactive waste shipment, would be equated to the attacks on Hiroshima or Nagasaki.[9] The bottom line is that due to such characterizations from popular culture and the internalization of such a normative structure, they seek out and value an alternative scientific literature. Due to these factors the public has horrific images attached to nuclear power. These images are difficult to mitigate by typical industry logic alone, or even worse by an industry insistence on using such seemingly normalized engineering presentations of risk calculations replete with references to 10^{-8} probabilities.[10]

This social reality is in direct opposition to those within the nuclear infrastructure and their everyday world of handling radioactive materials. To these industry insiders, the normalized rituals of their everyday experience and their intimate working knowledge of the materials and safety procedures therein, make any outside criticism seem less than creditable, especially if the critics use the public dialog of imminent annihilation that could become attached to nuclear power during an accident or hazardous incident.

To summarize what is a perceptual disjunction, to the general public, the common and everyday yellow placards and safety equipment used to protect health and safety in nuclear facilities are signs fraught with a vastly different symbolic meaning than those held within the energy infrastructure. The common everyday meanings associated with nuclear power escape those within the industry, at least with respect to risk perceptions, because of this perceptual disjunction.[11]

While the non-industry perceptions may have been learned from movies and other non-technical sources, they hold a valued place in the everyday social and political culture of advanced technological societies. What is critical to understand is that the perceptual disjunction is very real in there consequences for the energy industry. Clearly, the disjunction between industry and public perceptions may be the result of differentials in education, training, risk knowledge, everyday experiences, and/or perceived "troubling" history publicly associated with all things nuclear.

Clearly, for those within the nuclear industry the world of working with radioactivity is very different than what the public feels about these materials. The industry insider typically sees risk, but not what is considered overt danger. The public sees risk and considers it a fatal danger just waiting to happen. Therein lays the rub, one perspective that sees all things nuclear as a tool of progress and social success and one that sees all things nuclear as a threat to health, safety, and security.

This type of perceptual disjunction may well be the origin of the social and political problems faced by the energy industry as an entity. When certain events transpire in the course of social life, these events galvanize public opinion and focus scrutiny on the normalized activities that transpire in the nuclear infrastructure. The next

section of this essay will examine these social pressures in an effort to show how perceptual differences can impact society and the nuclear power industry.

Galvanizing events

Advanced technologies have drawn opposition from social and political groups in the modern era, perhaps none more readily than nuclear power plants (NPP).[12] The relatively few instances of serious problems with NPP and the potential for tragic consequences that may result from a failure of controls and/or that may be the result of outside forces are legitimate social and political concerns expressed by a variety of groups and movements in many places around the globe.[13]

The perceptions within the energy industry that such instances are either isolated problems or unrelated to the operations of most NPP also represent a similar dimension of the perceptual dialectic the industry has from public perceptions. This dichotomy is hard for energy insiders to grasp and as such makes it difficult to understand why the public has such fear and dread of normal everyday operations of NPP's. A quick review of three significant galvanizing events may help situate the link between such common public fears and the nuclear infrastructure.

The events surrounding the failure of controls at the Three Mile Island (TMI) nuclear power facility have had a powerful influence on the public and have had a significant impact on how the general public sees nuclear power generation.[14] On March 28, 1979, Unit 2 at TMI was beset by an incident that ended as the most serious commercial power plant operation accident in United States history. Adding to the problems this accident burdened the industry with was the fact that at the exact same time this accident transpired, the movie the *Chain Syndrome* was in theaters. The social and

political fusion of fact and fiction was instantaneous and the result is difficult for the public and energy industry to untwine, even 20 plus years *ex-post-facto*.

The intertwining of these two events was fortuitous for the moviemakers whose product popularity was more than enhanced as a result. What is important is that the images from this movie have had a significant impact on how the public views nuclear power in the post-TMI era. To illustrate, the perceived reality held by the public is not easily moderated when decades after the actual accident at TMI, the Nuclear Regulator Commission (NRC) notes that the "causes of the accident continue to be debated to this day ... (relevant) factors appear to have been a combination of personnel error, design deficiencies, and component failures" (NRC 2002).

After over twenty years of study, this regulatory body clearly states that no clear-cut answers are available as to why this accident transpired. The systematic failure of the human, regulatory, and technological controls in this particular instance are illustrative of why a profound distrust exists between the public and the nuclear infrastructure. As part of their function in society, regulatory bodies like the NRC must assure the public that such accidents are rare and that they are not worth the continuing fear of the body politic. Such claims are common when regulatory agencies are advocating for nuclear technologies to be used and/or expanded, yet this particular accident did transpire and the public somehow remembers the same agency and its pre-incident claims of low probability and downplayed fears of the consequences of such accidents. Such instances of perceptual disjunctions hold the potential to transform the debates on nuclear power and failure to recognize such a perceptual perspective is one factor in the divide between the industry and the public.

Similarly, the Soviet nuclear industry accident on April 26, 1986 at the Chernobyl power plant site is generally characterized as the worst accident in the history of nuclear energy. Similar to TMI, the social and political results of this event are difficult to overcome by probabilistic logic and again point out the disjunction between perceptions held by the public and those articulated within the industry.

While immediate fatalities at Chernobyl were relatively low (31 deaths), the worldwide body public was exposed to other facts: the need to establish a central contamination zone surrounding the damaged plant (~ 30 km); the results of a massive transfer of local residents with perhaps 100,000 permanently dislocated; details on the enrollment of hundreds of thousands into a medical registration system to track the health effects of this exposure; and particulars on the many other post-incident remediation efforts reported on by the world press.[15] These developments present a symbolic picture that is difficult to purge from the public memory and equally arduous to overcome when discussing the role of NPP in contemporary society. One result faced by many industry insiders, despite their proclamations that this was an anomaly, is that the "benefits" of nuclear energy are ever increasingly more difficult to advocate when the results of an accident at an NPP are so evident, so dramatic, and potentially so socially and politically devastating.

The third galvanizing event discussed herein was the tragic events of September 11, 2001. The details are startling: terrorists used large commercial airliners to attack a highly symbolic target, the coordinated and suicidal efforts of a large group of attackers were successful, and the profound socio-economic effects evident in the aftermath were

socially and politically significant. These are troubling facts when one considers the fate of NPP.

In the aftermath of September 11, 2001, the possibility of similar attacks on NPP and/or the nefarious use of waste products (in transit or in spent fuel pools) as the source material for a radiological dispersal event have unfortunately become much more of a commonly held form of tactical knowledge. Couple this knowledge with the subsequent revelations that terrorist groups were already, and still are, considering the use of radiological dispersion devices and it is easier to see how such potentialities have dominated the popular media in the last several years and how such images came to be associated with nuclear power generation and the energy industry.[16]

The tactical progression of some violent groups towards strategies that threaten nuclear facilities and the energy industry, have started to reveal a deeply entrenched social and political reality behind the public's fearful perceptions of all things radioactive. Given the accidents noted above and the as yet to be known aftermaths of these same instances, what would happen if a large dedicated suicidal group of fanatics tried and succeeded in an attack against an NPP, or the SNF storage pools therein, and/or were successful in attacking a shipment of highly radioactive waste destined for a reprocessing plant and/or geologic storage facility? The questions reveals an uncertainly quotient that is part of the everyday operation of a nuclear facility, an unknown risk factor that is highlighted by such events.

The social distance the public feels from such risks is lessened during such galvanizing events, perhaps to a point of intolerance for the nuclear industry, but not always to this point of no return. So why are such fears important to understand?

Perhaps most importantly, they have the potential to act as a catalyst to action against nuclear power and the energy infrastructure. The next section of this essay will examine this opposition coalesce potential.

Uniting factors

The perceptual differences between the energy industry and the public are highlighted at those times when the public and politicians focus intensely on the safety of nuclear power or the various parts of fuel cycle that are related to energy production. Galvanizing events like those noted above are just the lens that helps to focus unwanted attention on the industry, but they will persist in the future. The reactions of the industry to criticisms resulting from such events are equally as sure to persist in the future. Both the reactions to galvanizing events by the public and the response to criticisms by energy insiders during times of crisis are evidence of the perceptual divide between the public and the energy infrastructure.[17]

This divide may be the most predictive aspect of the social and political barriers that are faced by the energy industry. These represent disconnect moments between the energy industry and the public and they are indicative of what can be termed bureaucratic anomie, a term used to describe how out of touch formal organizations can become with the reality commonly experienced by the pubic. The debates that transpire at these times show how the nuclear industry reify their own risk modeling and internalize a unshakable belief in their engineering prowess, while forgetting that the vast majority of the citizens do not understand their calculations and in fact mistrust their proclamations of low probability events, sufficient safety, and adequate security.

Thus, the social and political factors that result from such perceptual fracturing can produce significant resistance to nuclear power and the energy infrastructure behind its production. The technology that seems so trustworthy to industry insiders is not seen as reasonable or viable in light of such risks. The regulatory processes that oversee the nuclear industries everyday operations, generally without significant incidences, are quickly subject to being questioned because they cannot be trusted to assure absolute safety and freedom from problems during NPP operations.

The government and regulatory oversight of the energy infrastructure is almost instantly examined to insure that special energy industry interests are not given priority over public safety, and to insure that such bodies place a higher value on protection on human health and life than on industrial production. In short, the public recalculates the economics of the industry and the role of regulatory bodies during such times.

Thus, factors associated with the technology, regulation, oversight, and risk modeling come into question. The public distrust for sophisticated science is heightened and the standards of scientific proof that will be necessary for future projects will most likely be raised. The types of resistance factors noted above are further strengthened when industry representatives relegate the risks to the realm of impossible and demote public fears to characterizations of the opponents as ill-informed, delusional, and as the ranting of radicals and environmental crackpots. The conclusion of this essay will address the conflict between such a hypothesized inspired body public and the energy industry, in an attempt to offer some suggestions to overcome this oppositional dynamic.

Conclusions

Several conclusions can be drawn from the discussion herein. First, a perceptual differential exists between those within the energy infrastructure and the public. Based just on these differences in interpretations, but enhanced by galvanizing events, the results of perceptual differences can profoundly affect the short-term operations and the long-term viability of the nuclear energy industry. Failure to understand these existing and potential differences in perceptions can alter the social and political landscape, perhaps to the ultimate determent of the nuclear industry. What are some of the specific social and political circumstances that can be affected by such differentials?

The first dimension may well be technology. The industry has faith in its engineering and the technological controls that embody that faith. The everyday operation of so many plants across the world, generally without incidence, is testimony to that faith and the power of a belief in the industrial prowess of nuclear technology. The flip side of this is that when an incident occurs, the pre-exiting claims of safety and security come into question and defending technology during these times is problematic at best, and can be severely damaging to the industry's social and political image if not addressed with a critical assessment of where the critiques come from, what they represent, and why they persist over time.

The second dimension is that surrounding politics. In general, political structures are supportive of energy production; it is after all the fuel that drives financial expansion and provides for economic viability. The loss of faith by the body politic in nuclear energy can significantly affect the structures of power that are normally very supportive of the nuclear industry. The result may be a temporary or even permanent loss of such

structural support. The growth of a perceptual divide between industry and governments would be potentially devastating to one (energy industry) of these institutions and failure to address such perceptual disjunctions could damage the other.

The third dimension, social factors like alterations in the economics of power generation, loss of tourist revenue due to contamination perceptions, and many other socio-economic factors are equally troubling since they can inauspiciously impact the energy industry. Failure to recognize the reality of public fears about such factors, as well as the dismissal of those fears due to industrial/corporate arrogance, may be equally as ruinous for the long-term health of the energy industry.

Additionally several suggestions emerge from the analysis of public and industry perceptions. First, the industry should acknowledge that a perceptual difference exists and that it matters. This acknowledgement would start to allow for a more productive dialogue between the parties and about the very real issues that arise from such differences in perceptions. One social scientific based research methodology to assess the extent of the differences would be to conduct a survey of industry insiders on their perceptions of the nuclear industry and its importance to society. Comparison of these results to existing survey data on the public perceptions of the industry may yield critical one or more nexus of discussion between the two sides and suggest ways to bridge the gaps between the two perceptual endpoints they seem to represent. Once such disjunctions are identified by means of research, the industry and critical stakeholders from the critics of the industry could then shape public and industry awareness campaigns to educate both on the reasons for such disjunctions. Perhaps in this more inclusive way the two could shape a new and productive dialogue dynamic.

Nuclear power is a mature technology and its vital place is assured in many societies, unless the fears and perceptual divides noted above are neglected, forgotten, or plain ignored.[18] These offer serious challenges to the energy industry if its representatives foster disbelief in the industry, fail to take cautions from criticisms, and in general act with arrogant aforethought. Social perceptions are genuine and have very real social and political power when harnessed. The question is which side of this divide will harness them to their advantage during times of crisis. The nuclear power industry has some successes over the years, but the potential for failure is just a misperception away.

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[1] This essay will intertwine nuclear power production with its by-product issues: nuclear waste storage and disposal. The author's own work has advocated that the risks of terrorism against plants are equal to a potential attack on SNF storage facilities and/or an attack on in-transit radioactive waste shipments.

[2] The author of this essay has almost ten years experience writing about the sociological and political aspects of security for nuclear waste transportation. His work has focused primarily on potential terrorism attacks against SNF transportation efforts to Yucca Mountain, Nevada, USA. The discussion herein is not technical in nature, rather it is more impressionistic and the arguments are social science based, at least the social interpretive variant. This argument is deliberately not based on probabilistic risk assessment or other typical communication means used within the nuclear infrastructure.

[3] "Stonewalling" is the term used to denote a persistent refusal to grant critics legitimacy with respect to their arguments; a persistence in beliefs about the strength of existing safety and security arrangements in light of changing terrorist threats; and/or a political technique to outwait the opposition until the immediate crisis of legitimation passes and normalized energy production activities can be reestablished.

[4] Risk perception is a field often associated with economics, insurance, and engineering and has specific meanings in each of these areas of scholarship. Risk in the sense used herein refers to social, economic, and cultural risk or what Graham, Weiner, and Sunstein (1997) refer to as the chances of adverse outcomes: to humans, to their lives and the quality thereof, and to the environment. The perception of risk is generally thought to be associated with: 1) the probability of something happening and 2) the consequences of that action if and when it does happen. In many cases these two factors produce disagreement (Margolis 1997), especially when discussing complex systems and complex technologies (Perrow 1999) like those surrounding nuclear materials and radioactive waste products.

[5] Generally the risk literature reflects three perceptual paradigms (Slovic 2000). The first paradigm is characterized as *absolute rationality* where the industry experts are considered most appropriate in making the calculations since they have the most relevant information on the subject of nuclear related risks. In this perspective the general public and those not inside the industry are considered irrational and thus their suggestions untrustworthy. The second, *limited rationality*, acknowledges that human ability to know every variable that may impact risk is not a realistic expectation. What is more pragmatic is to educate laypersons to understand the consequences of risky decisions with respect to key variables, thus this paradigm would seek to educate the populace as to the reasonableness of accepting the risks associated with nuclear power. The last paradigm is *social/cultural rationality* that refers to the perception wherein the public is not considered teachable on such highly technical matters. This then is considered a public good since to do so may reveal critical safety and security information. As an example, the United states department of Energy (DOE) recently conducted a shipment of nuclear waste from New York to Idaho (a 2300 plus mile trip) under a shroud of secrecy, or at least the public perceived the shipments thusly (Farquhar 2003; Tetreault 2003; Struglinski 2003). The original shipments of these fuel assemblies and their delivery was delayed by the events of September 11, 2003.

[6] The opposition to the Yucca Mountain geological repository project has lasted decades and involved environmentalists, nuclear power opponents, local governments, and many other stakeholder groups. The best documentation of alternative perspectives on the Yucca Mountain project can be found at http://www.state.nevada.us/nucwaste/. This website offers various critiques of the project including those related to policy issues, legal issues, transportation related issues, socio-economic issues, health effects, and technical issues. Clearly, the State of Nevada's arguments do not rest merely on a single issue with the repository; this local government entity has fought the placement of the repository within its geographic boundaries on a variety of grounds and from many different perspectives over the course of the last few decades.

[7] See testimonial record from the hearings before the *Committee on Energy and Natural Resources*, One-Hundredth Seventh United States Congress. "Testimony regarding S. J. Res.34 Approving the Site at Yucca Mountain, Nevada, for the Development of a Repository for the Disposal of High-level Radioactive Waste and Spent Nuclear Fuel, Pursuant to the Nuclear Waste Policy Act of 1982*"*. May 2002.

[8] The idea of a social construction of reality comes from the work of Albert Schutz and others working in the tradition he helped to found. This tradition is commonly known as phenomenological sociology (Schutz 1967; Berger and Luckmann 1967; Schutz and Luckmann 1974). See the referenced literature for additional details on this theory and the 'life-world' concept discussion used herein.

[9] The characterization that opponents to nuclear power use that equates nuclear power generation activities to the use of nuclear weapons is commonplace and subject to much negative dialogue from energy industry insiders. This negativity may be a common perception by nuclear industry insiders, at least when they fail to understand the perceptional differences this characterization represents. The same insiders may see that any opposition to their industry, by environmentalists and others, is based on this "misperception" and thus not worthy of their time and energy. When faced with long term and intense debates/criticisms on the social viability of nuclear power, the attitudes they posit can also become based on frustration. When this happens the attacks on the opposition can become polemical. It is as if the argument against nuclear power is so far removed from the nuclear industry experience, so detached from the insiders realities, that what many industry supporters feel at these times is articulated thusly: The (insert opposition – e.g., environmentalists) are against (insert characterization - e.g., progress) and they are (insert invective here – e.g., radicals). If you are interested in the history of Hiroshima see the essays of the Japanese writer Kentzaburo Oe (Oe 1995). To better understand a source of pop culture images associated with nuclear devastation see (Goldstein, Wegner, Dillon, and Goldstein 1999).

[10] For an example see the DOE's draft or final *Environmental Impact Statement* for the Yucca Mountain project. Details are available at http://www.state.nevada.us/nucwaste/.

[11] One personnel example may help illustrate this point. When talking about the safety and security of nuclear waste transportation from Savannah River, Georgia (USA) to a DOE facility in Idaho, a safety expert directly involved in the shipment engaged in an intense debate and assured this author the safety and security of such shipments was paramount to him and his agency. The debate concluded with a definitive comment, at least for the security expert, to the effect that if he was not worried for the health and safety of his family, then the criticisms must be moot/irrelevant. This is illustrative of the disjunction in risk perception between those within the infrastructure and those held by outsiders. It may also be a good example of what has been termed total institutional socialization – where those within the industry have been so socialized by their employers and social relations within their job environments that nothing else can become a reality.

[12] During the dawn of the industrial revolution groups formed that opposed technology and the progress it brought to humanity. The Luddite movement in England was one example of such a movement. In the early years of the 19th century opposition to technological advancement, the Luddites attacked especially that which displaced industrial workers who were flocking to cities for jobs. These technological advancements were targeted, both physically and intellectually. Some of the basic tenants of this movement were/are that technologies are never neutral and in many cases they represent harmful advancements for society; the nation state is intertwined with industrialism and can not be overthrown by revolt; and lastly, resistance to industrialization is not only possible, but desirable to offset this march of progress (Sale 1996). Contemporary articulations of this philosophy are known as neo-Luddite thought and in the computer dominated workplace of today the arguments have morphed to include the idea that society has become too reliant on technology and that we need to remember that technology is a servant of mankind, not its master. For examples of contemporary Ludditism inspired texts and arguments see (Abbey 2000; Noble 1993).

[13] The globalize operation of NPP are mostly incidence free and do not offer the level of threats most laypersons associate with this source of energy. That argument aside, the few high profile problems that arise, the problems associated with nuclear waste reprocessing and/or disposal, social movements advocating a progress away form nuclear power, and the unanswered question of safety and security in light of creditable terrorist threats against NPP, spent fuel pools, and waste shipments are problematic. Such threats, in some cases not yet a reality, are on the edges of the social radar since intelligence agencies have found some evidence of potential attacks and regulators such as the International Atomic Energy Agency (IAEA), Northern Atlantic Treaty Organization (NATO), and United States Nuclear Regulator Agency (NRC) have started to give such threats serious consideration. The security debates on NPP in the post-September 11, 2001 era are illustrative of these concerns (discussed elsewhere in this essay).

[14] For some written reflections on the TMI accident see recent memoirs from one reporter at the scene (Pawelski 1999) and some of the many books on the subject (Goldstein and Schorr 1991; Wood and Shultz 1988).

[15] For more details on this accident see (NRC 2000; Mould 2000; Medvedev 1992; Marples 1988; Flavin 1987).

[16] The aftermath of these attacks were global and potentially profound as to nuclear power security and safety. In Australia the headlines read "Bomb scare at nuclear reactor" (*The Australian*, October 9, 2001); In Bulgaria "Bulgarian nuclear officials dismiss doubts about security at plants" (*BBC Monitoring Service*, October 1, 2001) while a few days later the headlines read "Additional security measures adopted at nuclear station" (*BBC Monitoring Service*, October 8, 2001); In Canada the headlines read "Security tightened at Canadian nuclear plants" (*The Star*, September 26, 2001); In Finland the story read "Finns consider possibility of terrorist attack on nuclear power plants" (*BBC Monitoring Service*, September 27, 2001); France may have had the most dramatic headlines: "France positions missiles to protect nuclear plant" (*The Guardian*, October 20, 2001); while in Germany the reports were equally dramatic "Nuclear reactors not made to withstand airborne terrorist attacks" (Schwobel and Thielbeer, *Allgemeine Zeitung*, Sept 27, 2001). Discussions along the same lines could be found in media coverage in Japan, Romania, Slovakia, Sweden, Switzerland, the United Kingdom, the United States, and other locations where NPP are located.

[17] The post-September 11, 2001 debates on nuclear waste and Yucca Mountain transportation security help illustrate this perceptual divide. On one side industry representatives downplayed the threats to NPP and waste shipments (see a *Science* article by Chapman et al 2002). This article was written by a large group of industry insiders and dismisses the possibility of an attack on a NPP and downplays the potential consequences of an attack against both NPP and waste shipments. The other side of the debate is embodied in the State of Nevada's long standing positions on transportation safety and security which suggest that prior to this attack severe security issues existed with SNF transportation planning and safety and that in the aftermath of the attacks on September 11, 2001 reconsideration would be prudent (see http://www.state.nv.us/nucwaste).

[18] The DOE's *International Energy Outlook* (2003) shows that as of 2002, 441 NPP were in operation around the world. In some geographic regions a decline in production can be seen, for example in many more developed nations like the United States and certain parts of Europe. Likewise in other regions of the globe an increase in production is noted, particularly in the developing world and Asia. See http://www.eia.doe.gov.