Meltdowns, Cover-Ups and Mutants: Pop Culture's Perversion of Nuclear Energy[1]

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Meltdowns as harbingers of the apocalypse. Nuclear waste causing immediate and horrific mutations. Evil CEOs covering up radioactivity leaks to make a profit. Nuclear energy is often portrayed negatively in movies and television, creating an inaccurate view of the risks associated with nuclear energy. This article will describe the portrayal of nuclear energy in movies and television, compares the perceived and actual risks of nuclear energy, and analyzes how realistic these fears are.

***And Lord, we are especially thankful for nuclear power, the cleanest, safest energy source there is. Except for solar, which is just a pipe dream.* – Homer Simpson**

Throughout the past few decades, nuclear power has been in favor – and then out of favor. Its popularity has cycled through the highs of the 1950s and the lows of the 1970s and 1980s. At the beginning of the 21st century, politicians and policy makers are revisiting the idea of nuclear power as a solution to our current energy and environmental woes – a cleaner, more efficient energy source than coal. Others, however, have expressed concern about long-term storage of spent fuel rods, both from environmental and national security perspectives. Following the recent nuclear disaster in Japan, safety issues have again risen to the forefront of the collective American consciousness.

When faced with these different issue frames, many individuals find themselves to be confused about the benefits and challenges of nuclear energy. How do people create an opinion when faced with conflicting information? Based on a review of the literature, we contend that an individual is influenced by the media he or she has viewed. In the case of nuclear energy, "pop culture" – in this case, films and television programs – has strongly influenced how the general public perceives the pros and cons of nuclear energy. Three questions guide our research: How is nuclear energy portrayed in popular media (movies and television)? How does it compare to the actual arguments against nuclear energy? Finally, how realistic are the fears of nuclear energy?

NUCLEAR ENERGY: A BACKGROUND

The idea of harnessing the power of uranium for power generation was first proposed in 1941 by a British special committee on the uses of uranium. Codenamed MAUD, after one member's former governess, the committee also focused on the wartime use of uranium, specifically the creation of "The Bomb" (Kaku & Trainer, 1983: 18). On the issue of uranium, the committee concluded the controlled fission of uranium could be used to generate energy and had considerable promise for future peaceful uses (Kaku & Trainer, 1983:18). In light of the war, however, it was decided to focus research efforts on the defensive uses of this powerful energy source, namely in the form of the atomic bomb. This effort was organized by the U.S. government under the name "The Manhattan Project" (Cirincione, 2008: 3).

After the war, scientists refocused their efforts on peaceful applications of nuclear technology and in 1946 Congress created the Atomic Energy Commission (AEC) which authorized the construction of Experimental Breeder I in Idaho. In 1951, the reactor generated the first electricity from a nuclear power source (United States Department of Energy, n.d.). Two years later, in 1953, President Eisenhower proposed his "Atoms for Peace" program: a multi-dimensional effort aimed at increasing peaceful utilization of atomic energy (World Nuclear Association, 2009). Soon after, the first commercial electricity-generating nuclear plant was constructed in Shippingport, PA, and the plant reached full design power in 1957 (Kaku & Trainer, 1983, p. 19).

Through the 1960s the nuclear power industry in the United States grew rapidly. Utility companies saw this new form of electricity production as economical and environmentally clean and safe; the public saw nuclear energy as

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the way of the future. By December 1970, there were 19 nuclear plants in the United States and an additional 87 plants were either under construction or in the planning stage (Morris, 2000: 23). During this time the Federal Power Commission predicted that the demand for electricity generated by nuclear power would increase to 41 percent by 1990. This was a gross overestimate; in fact, usage only reached 20.6 percent by that date.

The over prediction of energy demands coupled with the seemingly unprovoked formation of anti-nuclear power groups in the 1970s led to slowed growth through the rest of the 1970s and 1980s. Furthermore, two focusing events also had a negative impact on the development of nuclear energy in the United States: the loss of coolant at Pennsylvania's Three Mile Island plant in 1979 and the chemical explosion at the Chernobyl Nuclear Power Plant in the Ukraine in 1986. Following these events, the Energy Policy Act of 1992 was signed into law. This legislation addressed issues such as safety and design standards, the establishment of an effective high-level nuclear waste disposal program, and the reduction of associated economic risks (United States Department of Energy, n.d.).

THEORY AND METHODS

As noted in the introduction, our research goals are threefold: (1) to analyze how nuclear energy is portrayed in popular culture; (2) to compare Hollywood's vision of nuclear safety with the viewpoints of pundits, policy makers, and scientists; and (3) to determine if the perceived risk as presented through films and television shows matches the reality – that is, does fiction mirror fact? As a starting point, we compiled a list of nuclear energy image frames that appeared in films, books, music and television. [See Appendix A] Please note that the majority of image frames came from films and, unless otherwise noted, the following discussion will review to these images.

To develop our sample, we chose to examine films focusing on issues of nuclear energy; we did not include films about nuclear weapons, unless the weapon was the result of stolen nuclear energy fuel rods. Many of the films were examined first hand; those we could not view were researched for content. The films were catalogued in a spreadsheet and organized by genre, issues addressed, release date, release decade and title. Looking at this dataset, we were able to compare the transformation of fears over time as expressed by popular culture. For example, most films produced in the 1980s focused on a conspiracy or cover-up and waste. As we moved into the new millennium, however, we saw a shift of focus to terrorist plots concerning nuclear plants. We also created a timeline of focusing events, such as Watergate and Three Mile Island; this timeline was used to analyze whether or not the films were reacting to "real world" events.

In developing our theoretical framework, we have relied upon two peer reviewed articles that explicitly examined the issue of how popular media portrayed nuclear energy: "Media Discourse and Public Opinion on Nuclear Power: A Constructionalist Approach" by Gamson and Modigliani (1989) and "Elite Ideology and Risk Perception in Nuclear Energy Policy" by Rotman and Lichter (1987). Both articles suggest that a relationship between media portrayal of nuclear energy and popular opinion exists. For example, popular understanding (or misunderstanding) of nuclear energy through the lens of Ball-Rokeach and DeFleur's "dependency theory" suggests that media's role in constructing meaning varies from issue to issue (Gamson & Modligliani, 1989). For this, popular opinion polls and media portrayals were compared. Evidence was also presented of disconnect between the sentiments of the scientific community regarding nuclear power and that of the media and popular audiences (Rothman & Lichter, 1987). For this, beliefs were gathered and compared from policy makers, members of the media, the scientific community, and the general public. [See Table 1] Based upon the findings by Gamson and Modligliani (1989) and Rothman and Lichter (1987), we contend that the average person frames his or her opinions based on the presentation of the subject in the media.

PORTRAYAL OF NUCLEAR ENERGY IN FILMS AND TELEVISION

Through examining appearances of nuclear energy throughout the decades, one can see a correlation between focusing events, popular debate, and film and television frequencies. The 1980s were the most active decade in terms of nuclear debate and the entertainment industry was not immune. [See Appendix B, Table 1 for a breakdown of nuclear film and television frequencies by decade.]

One can also break down each decade for a road map to core concerns in the contemporaneous debates over nuclear energy. By comparing each decade separately, the trends and changes in opinion can be analyzed. We began by examining the core concerns of the 1960s. [See Appendix B, Table 2] Readers should note how core concerns during this decade center around the mishandling of waste or a machinery malfunction (i.e., human error and the unreliability of the new science) resulting in some type of mutation. The issue of gross mutations as a result of some other realistic issue is a common theme in both the 1960s and 1980s. It can be speculated that these horrid mutations represent the great uncontrollable power of the atom, man's incompetence in controlling it and extreme consequences.

TABLE 1. ARE NUCLEAR PLANTS SAFE?

Sample Groups	Percentage Rating Nuclear Plant Safety at 5 or Higher	Sample Size
Bureaucrats	52	199
Congressional Aides	39.1	132
Lawyers	48.6	149
Media	36.5	156
Journalists at *NY Times* and *Washington Post*	29.4	51
Journalists at TV networks	30.6	49
Military	86	152
Movies	14.3	90
Public Interest	6.4	154
TV, Hollywood	12.5	103
Total Leadership Sample	**36.8**	**1,203**
Energy Experts	75.8	279
Nuclear-Energy Experts	98.7	72
Total Scientists Sample	**60.2**	**925**

Source: Rothman, S. & Lichter, S.R. (1987). Elite ideology and risk perception in nuclear energy policy. *American Political Science Review, 81* (1), 383-404.

The 1970s show more concern about human dishonesty in dealing with such a powerful energy. [See Appendix B, Table 3] The focus was centered on a big business or governmental cover up, putting profits before human lives. This is reflective of the greater sense of skepticism that prevailed in the 1970s, which likely spilled over from the 1960s, the anti-war movement and the loss of trust after the Watergate scandal.

The hottest debate surrounding nuclear energy occurred in the 1980s [See Appendix B, Tables 4] The decade began with fresh fear and hype surrounding Three Mile Island, which led to a several anti-nuclear films. Then, midway through the decade came the Chernobyl disaster which breathed new life into anti-nuclear sentiments. During this time period, the films reflected a diversity of concerns, as well as the gravity of consequences through portraying multiple causes for monstrous mutations and meltdowns.

The 1990s and the new millennium showed an end to the mutations fear and a shift in focus to a new and more pressing issue of terrorism. [See Appendix B, Tables 5 and 6] Changing attitudes also appeared in the transition from fears of cover-ups and conspiracies within the U.S. system to fears of sabotage or thievery from without. The fears of today now focus on acts of God causing structural damage or terrorist plots to either sabotage the plant or steal plutonium for "dirty bombs."

While most of the cases in our analysis associated cover-ups or conspiracies, putting greed over safety, and mutations with nuclear energy, the arguments against nuclear energy do not address these areas as concerns. [See Appendix B, Table 7] Rather, those against nuclear energy identify radiation, waste, meltdowns, terrorism, bomb-proliferation, aging machinery, reactor safety, and energy and fiscal costs as risks associated with nuclear energy. Although some of the actual arguments against nuclear energy are present in the cases observed, such as malfunctioning machinery, radiation, meltdowns, and proliferation, the actual risk is misrepresented.

ARGUMENTS AGAINST NUCLEAR ENERGY

Despite the difference in years between the publish dates of the books against nuclear energy, there is a common thread between the arguments against nuclear energy. These arguments include: (1) radiation; (2) nuclear waste; (3) meltdowns and human error; (4) aging machinery and reactor safety; (5) terrorist attacks and bomb making; (6) the energy used to make nuclear energy; and (7) the high fiscal costs associated with the nuclear process. We have summarized each set of arguments in the section that follows.

Radiation. One safety concern presented by those against nuclear energy is radiation. In her book *Nuclear Power is not the Answer*, Helen Caldicott (2006) describes how radiation is released throughout the nuclear energy process

from the mining, enrichment and fuel fabrication to routine radiation from the fuel cycle. Ralph Nader and John Abbotts (1977: 72) also point out the danger of radiation, pointing out that "Nuclear power plants are also sources of radiation because they release radioactive materials routinely."

There are uncertainties among those in the scientific community in determining an acceptable level of radiation exposure. Dr. Karl Morgan, in an essay on the issue, explained how the standards regarding "acceptable" dosage of radiation had – even only within his career – changed several times. These frequent amendments prompted Dr. Morgan to take a much more cautious stance on the issue of radiation dosages (Kaku & Trainer, 1983).

Nuclear Waste. An additional safety concern stems from the problem of nuclear waste. Much of the concern about nuclear waste stems from the uncertainties surrounding the issue of storage. As noted by Nader and Abbots (1977: 62):

> [P]erhaps the most bothersome problem…is the need to store or dispose of radioactive waste, which can be dangerous for a quarter of a million years or more. There are no demonstrated solutions for dealing with this waste, and the government, which has assumed responsibility for handling the waste, has had difficulties in the past.

Much of the debate surrounding storage concerns unknown variables. For instance, there are many unknowns about Yucca Mountain. We cannot fully take into account geologic characteristics such as fractures, nor can we fully take into account changing aspects of the groundwater because we do not know what will happen to it in the future (Macfarlane & Ewing, 2006: 62). Another unknown variable is the likelihood of specific scenarios, making it difficult to project long-term effects (Macfarlane & Ewing, 2006: 69).

Meltdowns & Human Error. Human error is a part of daily life and leads to many accidents in every area of life. One could argue that human error expands the threat of accidental nuclear meltdowns. As Caldicott (2006: 83) notes, "Human error, compromise, laziness, and greed are implicit in the affairs of men; when these attributes are applied to the generation of atomic energy, the results can be catastrophic." She is not the only one with this concern. Nader and Abbotts mention in their discussion of safety a situation at Browns Ferry in 1975. In this incident, a technician looking for air leaks with a candle accidentally caused a fire that burned for seven hours (Nader & Abbotts, 1977: 61). Human error caused a large scale accident resulting in the close of the reactor for eighteen months.

Aging Machinery and Reactor Safety. David Lochbaum, a nuclear engineer, once stated, "Nuclear power plants are like people: they have numerous problems in their infancy and youth, they operate relatively smoothly in early-to-middle life, and they start to show signs of stress and manifest pathology as they age" (Caldicott, 2006: 83). Some argue that the aging machinery of the nuclear power plants is a cause for concern. Caldicott (2006: 83) points outs eight nuclear power plants were forced to shut down because of potentially serious failures of due to aging mechanical part.

Those against nuclear energy do not hold much faith in the new reactors. They argue the new generation reactors cost less because the makers have "reduced the strength of the containment and other safety-grade features;" the AP-1000 reactor allows "a dangerous amount of pressure to build within the weakened containment structure, which could rupture the vessel and cause a meltdown" and the Pebble Bed Modular Reactor, which operates at 900 degrees, could have an error and "exceed 1,600 degrees centigrade…the carbon coating would fail…initiating the release of massive quantities of radioactive isotopes" (Caldicott, 2006: 118, 120). There is also concern about radiation from reactor damage. Reactor damage would result from an accident sequence known as the Loss of Coolant Accident (LOCA), which would begin with the rupture of one of the pipes carrying water to the reactor, causing it to overheat (Nader & Abbotts, 1977: 97-98).

Terrorist Attacks and Bomb Making. The threat of attack from terrorists is very near to many people, especially those who remember the 9/11 attacks. Some consider a terrorist attack as a very real risk for nuclear power plants. Caldicott (2006: x) sees a terrorist attack on a nuclear energy facility as imminent because "security at U.S. nuclear power plants remains at virtually the same lax levels as prior to the 9/11 attacks."

If the fear of a terrorist attack is not enough, there is the concern of spent fuel from nuclear power plants being used to make nuclear weapons, or more likely than that – a dirty bomb. Spent fuel could be used by terrorists by make a nuclear bomb, bringing about the age of nuclear terrorism, and nations or groups wishing to pursue building nuclear weapons will be able to easily access plutonium because of the nuclear energy byproduct (Caldicott, 2006; Nader & Abbott, 1977).

TABLE 2. RADIATION RECEIVED ANNUALLY FROM VARIOUS SOURCES

Source of Radiation	Dose Received, mrem/year
Average background in U.S.: Cosmic ray's earth and building materials	130
Average, all medical x-rays	95
Cosmic rays at sea level	35
Living in a brick home	30
Food, internal sources	25
Maximum allowable level at fence line of a nuclear plant	10
Fallout from weapons testing	3
3-hour flight in a jet	2
Watching color television	1
All nuclear power plants: emissions over entire U.S.	Less than .02
ONE coal-fired power plant: average within 20 miles	0.1

Source: Page 85 in Morris, R. (2000). *The environmental case for nuclear power: Economic, medical, and political considerations*. St. Paul: Paragon House.

Energy Used to Make Energy. Energy is neither created nor destroyed; rather, it is transferred. Albert Einstein is credited with this conclusion. More specifically, he determined "energy is liberated matter; matter is energy waiting to happen" (Bryson, 2003: 122). This law explains how fission for nuclear energy is possible. It also explains how other energy is created. As such, it requires energy to create nuclear energy. Specifically, it requires energy "to mine uranium ore for fuel, to crush and mill the ore, to enrich the uranium, to create the concrete and steel for the reactor, and to store the thermally and radioactively hot nuclear waste comes from the consumption of fossil fuels, that is, coal or oil" (Caldicott, 2006: 4). This energy used to create nuclear energy releases emissions.

High Fiscal Costs. Some argue the current fiscal cost of nuclear energy is so low because it does not take into account the capital costs associated. As Caldicott (2006: 23) points out, "the 'levelized' cost of electricity generated by a nuclear power plant is about 60 percent higher than the cost of electricity from a coal–fired or combined cycle gas turbine plant, assuming moderate gas prices." Nuclear energy also has additional costs caused by "construction cost overruns, delays, cancellations, premature plant closings, poor operational performance, and an inability to find a permanent storage site" (Caldicott, 2006: 23). A demonstration of the economic burden associated with a nuclear power plant is the industry's canceling or postponement of building about 100 plants in the 1980s and 1990s (Nader & Abbotts, 1977: 65).

RISKY BUSINESS?

As outlined in the previous section, the points of those against nuclear energy do not match the fears created by the movies and television episodes. Rather, those against nuclear energy are concerned about the release of radiation; nuclear waste being stored improperly; a meltdown occurring at any moment; unsafe reactors; terrorists attacking a nuclear power plant or making a bomb from spent fuel; and using an obscene about of energy and money to create nuclear energy. While these are the concerns identified by those against nuclear energy, not all of them are considered to be items of concern.

Radiation. As Allen Brodsky states "[r]adioactivity has always been in the human environment and in the human body … the dangers of radiation have been distorted" (in Kaku & Trainer, 1982: 47, 52). Robert Morris (2000) argues the primary fear of radiation from nuclear power plants stems from memories or stories of the bombings in Japan. It is argued that a nuclear power plant does not expose the public or employees to such levels of radiation. In fact, humans are exposed to more radiation from our own food than we would be at the fence line of a nuclear power plant (Morris, 2000). For example, Table 2 shows a ranking of radiation sources and the average dose that most people receive from them annually.

Nuclear Waste. The topic of nuclear waste is fraught with opinion rather than educated discourse and those against nuclear energy generally do not use scientific reasoning. Caldicott (2006: 107) epitomizes this shortfall in nuclear waste arguments when she mistakenly states, "Never in its sixty-five-year history has the nuclear industry taken

responsibility for the massive amounts of profoundly lethal radioactive waste that it has continued to produce at an every-increasing pace."

Yucca Mountain was expected to be the answer to the problem of storage. In Caldicott's case, prejudices fogged her ability to clearly see the entire picture. In reality, the government assumed control of the waste issue but has been incapable of finding a safe storage solution (Nader & Abbotts, 1977; Macfarlane & Ewing, 2006). This inability of the government to create a safe storage for nuclear waste continues today. Rather than allowing the toxic waste to accumulate in unsafe heaps in the open, the nuclear facilities have had to make arrangements for on-site storage while the government sorts out this situation.

The Nuclear Waste Policy Act of 1982 established clear direction for the federal government's program on nuclear waste management. In 1983, the United States Department of Energy identified nine potentially acceptable sites. In 1986, the list was narrowed down to three sites: a basalt site in Hanford, WA; a tuff site at Yucca Mountain, NV; and a salt site in Deaf Smith County, TX (Macfarlane & Ewing, 2006: 32). Amendments to this act, included in the Nuclear Waste Policy Amendments Act of 1987, ruled out all but the Yucca Mountain site. By eliminating work on potential backup sites, the amendment act increased the uncertainty about when a repository would become available. As it stands, if the Yucca Mountain site is not approved and new legislation will be required to authorize another approach.

Meltdowns & Human Error. Throughout our readings, one fact has become glaringly clear: most people do not truly understand what a meltdown is. Books, articles, and discussions on the topic identify Three Mile Island and Chernobyl as meltdowns (Caldicott, 2006; Greenberg, et al., 2009). In actuality, "[a] meltdown is a nuclear accident in which fuel becomes so overheated that it melts and collapses into the base of the reactor" (Addinall & Ellington, 1982: 200). While Three Mile Island could have resulted in a meltdown, had it not been handled effectively, it did not.

Nuclear power stations are built with various levels of back-up systems; for a meltdown to occur, a string of failures would need to occur in succession. In fact, at the nuclear accidents cited by those against nuclear energy, the safety systems almost completely contained the accident, preventing any serious contamination (Addinall & Ellington, 1982: 158).

Aging Machinery & Reactor Safety. Although aging machinery may have been a foreseeable problem in the 1970s and 1980s, the year 2005 saw the beginning of a push for the use of new generation reactors by the Energy Policy Act as well as the recent development of small reactors (Carroll, 2010: 30). Accidents that have occurred have demonstrated the safety of the reactor design. For example, the accident at Three Mile Island, while resulting in the release of some radioactive material into the atmosphere, released far less than the ash dispersal from the Mount St. Helen volcano eruption (Addinall & Ellington, 1982: 157).

Terrorist Attacks and Bomb Making. If one does not understand the entire story, it would be easy to believe that the lack of change in security systems at nuclear power plants means poor security. However, security at nuclear energy facilities is anything but lax. During a tour of the Bellefonte Plant, Terry Johnson, from the Tennessee Valley Authority, described security at nuclear energy facilities as the highest level of any non-military complex. According to Johnson, this was true prior to the 9/11 attacks and remains true today (T. Johnson, personal communication, March 24, 2010).

One might raise the argument that Johnson's statement is one-sided and is what the nuclear energy industry wants one to believe. Such an argument might have some sway if his statements were not supported by independent sources. Other sources agree that security is tighter at nuclear energy plants than ever before, making the overall of a terrorist risk less (Greenberg, et al., 2009: 82). In fact, the nuclear energy industry has become a leader in monitoring, surveillance, and worker training (Greenberg, et al., 2009: 82).

If the fear of a terrorist attack is not enough, there is the concern of spent fuel from nuclear power plants being used to make nuclear weapons. One could counter argue that nuclear bombs were being made before nuclear energy was being utilized, so the making of nuclear bombs will continue without the assistance of nuclear energy.

Energy Used to Make Energy. The concern about the amount of energy used to create nuclear energy has a foundation; however, as this has not been formally assessed at a national or global level, it is impossible to compare the amount of fossil fuels used in the set-up of nuclear energy to the actual use of fossil fuels for electricity. While

Caldicott (2006: 6) states "very few studies are yet available that analyze the total life cycle of nuclear power and its final energy input versus output," she uses a single source to reach her conclusion.

High Fiscal Costs. While the amount put forward by Caldicott (2006) seems like an enormous difference in cost, it does not indicate if the comparison cost of coal-fired or combined cycle gas is levelized, meaning the costs equals the total cost of electrical energy produced divided by the total cost of construction and maintenance. Construction cost overruns, delays, cancellations, premature plant closings, poor operational performance, and an inability to find a permanent storage are very real problems. Still, there is no mention from those against nuclear energy of the role litigation and bureaucracy implemented by the anti-nuclear faction to slow-down to the point of halting the nuclear energy expansion. Morris (2000) explains in his book how anti-nuclear activist have stalled almost indefinitely the nuclear energy production through frivolous lawsuits. It would be interesting to see how the costs would change if these roadblocks were removed.

While a building slow-down did occur, Nader does not mention the overestimation of energy demand and subsequent realization of the overestimation. In 1970, there were 19 nuclear plants in United States with 53 under construction and 34 being planned; six months later, 63 more were ordered when the Federal Power Commission predicted the nuclear share of nation's electricity would grow to 24 percent in 1980 and 41 percent by 1990, but usage fell short and rose by only 20.6 percent in 1990 (Morris, 2000: 23).

NUCLEAR ENERGY TODAY AND TOMORROW

In recent years there have been suggestions of a nuclear renaissance. As energy costs continue to increase, the recession continues, global warming fears raise and the vast majority of the world's oil is controlled by a few countries, the public and policymakers alike are reassessing the use of nuclear power. The change of tone in the popular media cases from the 2000s shows a general change of opinion put forth.

Environmentalists, previously vehemently opposed to nuclear power, are now seeing it as the lesser of energy evils. Countries are working together to explore multi-lateral solutions to issues that still surround nuclear energy. Ideas that were thrown out by previous leaders are being discussed anew, such as ideas of reprocessing and recycling spent fuel. The world can expect to see a continued and expanded effort in this area in the near future.

CONCLUSION

Initially the idea of nuclear energy was embraced by American society. It was seen as the key to a productive future and electricity was predicted to become "too cheap to meter" (Kaku & Trainer, 1983: 27). Robert Morris (2000) blames uninformed anti-nuclear activists for so severely damaging the nuclear process, particularly those who began the movements in the 1960s and 1970s. He goes on to show through a series of studies that nuclear power is in fact "best" for the environment (Morris, 2000).

In looking at the cases of nuclear energy in popular media, it is clear that nuclear energy is portrayed negatively. The message created and sustained through the decades is that nuclear energy is dangerous; furthermore, the greed of nuclear energy executives will lead to cover-ups of the dangers around us, resulting in mutations. Compared to the actual arguments of nuclear energy, those presented by popular media are wildly off target, yet serve to strengthen the argument against nuclear energy. As demonstrated in our article, some arguments against nuclear are based on emotion and hearsay rather than scientific evidence. Although some of the arguments against nuclear energy do have merit, they do not warrant abandoning nuclear energy.

While the concern surrounding radiation is difficult to ascertain as it seems to be heavily influenced by perspective, there are concerns easy to see. What to do with nuclear waste is one of the main concerns. The disposal of nuclear waste has been in the policy and planning stages for more than thirty years. Action must be taken. Another very real concern is of bomb proliferation, maybe not as much by terrorist, but rather from rogue nations. The current debate in this area is relevant and will have much impact on the global future of nuclear energy.

Throughout the course of our article, we have tried to remain objective and present an unbiased finding. As such, we have presented arguments from both sides. Although pro and anti-nuclear scientists draw the same data, they interpret the information differently, leading to controversy. Still, much of what was read in opposition to nuclear energy was not based in fact or scientific reasoning; rather, they were sensationalized statements to scare.

The cause for nuclear energy's anti-popularity spiral may be due to rumor mongering. As shown in this article, many of the arguments against nuclear energy are unfounded. Only through open dialogue, cross-discipline communication, and education can citizens obtain the tools and perspective to make well informed decisions

regarding nuclear energy policies. No longer is it acceptable to be swayed by Hollywood and the media sensationalist ideas of nuclear energy. We have an obligation to ourselves and to future generations to approach these issues with a spirit of scientific inquiry and with willingness to cross-disciplines in order to finally allow the most significant scientific discovery in the modern era its chance to flourish peacefully and to better living conditions for human beings in every region.

Future Research. One area of future research is the energy costs of creating nuclear energy. This area is weak in data and lacks adequate information; a full investigation such as thesis-sized project would be of great benefit. Only after such a comprehensive study could a real cost-analysis study be completed. Second, it would also be interesting if those who wrote against nuclear energy in the 1970s reviewed their positions and previous arguments to see how their personal views remained intact or changed. This interest is based on the change of stance exhibited by some environmental and science groups such as the Union of Concerned Scientists. Originally against nuclear energy, the Union of Concern Scientists now works to improving the safety of nuclear energy (Nuclear Power, 2010). How have other opinions against nuclear energy changed?

Third, Caldicott (2006) has argued that the safety and operations of nuclear power plant can be affected by changing weather patterns and global warming. These topics were not mentioned in any of the other books we read for this project. The lack of additional information in these areas means one of two things: the threat of weather and global warming has no bearing on nuclear power plants or Caldicott is a pioneer in recognizing these problems. Additional investigation into these areas is necessary to determine the meaning. Finally, a comparison of the portrayal of nuclear energy in popular culture in countries where nuclear energy is more accepted and expected, such as France, could be enlightening. Is nuclear energy over the past fifty years portrayed in the same negative light? Are the storylines as unlikely as in the movies found in the United States? This comparison would give more indication if popular opinion is driven by popular media.

EPILOGUE

Our hearts are with the people of Japan as they work to move forward in the aftermath of one of the most devastating earthquakes and tsunamis in recorded history. In the wake of this devastation, concerns about Japan's nuclear stability have dominated headlines in news sources across the globe. Some have been matter of fact, but sadly others have been more sensationalist than informative. In keeping with our urging throughout this article for a more informed, intelligent discussion on nuclear energy, so too do we urge the international community to foster intelligent, productive discussion on the issue so as not to use this great tragedy as a means for boosting ratings and exaggerate fear.

Some news sources, especially the BBC, have been more effective than others at focusing on a factual account of the situation in Japan. However, it did not take long for sources, such as Fox News, to move the discussion away from Japan towards a story of gloom and doom about how a similar accident might happen in the United States, noting that the majority of Americans are fearful of a similar accident at home. That being said, they did provide illuminating details as to the age- breakdown, noting that younger voters had more faith in nuclear energy (Blanton, 2011).

We, the authors, still believe that nuclear energy is a clean, viable source for energy production and that the media and popular culture tend to twist it into something that boost ratings, makes headlines, and does nothing to help meet future energy needs. The reactors in Japan were built too close to the coastline in an earthquake and tsunami prone area and were built too close to one another. That being said, Fukushima Daiichi was designed to withstand a six-meter tsunami, and when the 15-meter tsunami hit after the earthquake, it led to a loss of electric and cooling water running to the oldest reactors (Grimston, 2011). Had the reactors been as up to date as the others, it is likely that they too would have been brought to a 'cold shutdown' like the others. We feel that this situation can and will be prevented in the future so long as proper planning and spacing of nuclear facilities occurs and so long as the public and policy makers learn to approach the situation with facts rather than fancy.

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APPENDIX A. LISTING NUCLEAR ENERGY FRAMES IN SAMPLE

Title	Decade	Type	Core Concerns
The Horror of Party Beach (1964)	1960s	Movie	Mishandling Waste Mutations
"Production and Decay of Strange Particles" (1964)*	1960s	TV	Machinery Malfunction Mutations
Red Alert (1977)	1970s	Movie	Machinery Malfunction Meltdown/Explosion
China Syndrome (1979)	1970s	Movie	Greed v. Safety Cover up/Conspiracy Meltdown/Explosion
Island Claws (1980)	1980s	Movie	Radioactive Emissions Mutations
The Children (1980)	1980s	Movie	Radioactive Emissions Mutations
Chain Reaction (1980)	1980s	Movie	Natural Disaster Damaged Infrastructure Contamination Cover-up/Conspiracy
Stronger than the Sun (1980)	1980s	Movie	Cover-up/ Conspiracy Greed v. Safety

APPENDIX A, CONTINUED

Title	Decade	Type	Core Concerns
Silkwood (1983)	1980s	Movie	Cover-up/ Conspiracy Greed v. Safety
Toxic Avenger (1985)	1980s	Movie	Mishandling Waste Mutations
The Nuclear Conspiracy (1985)	1980s	Movie	Cover-up/ Conspiracy Greed v. Safety
Choke Canyon (1986)	1980s	Movie	Cover-up/ Conspiracy Greed v. Safety Mishandling Waste
Class of Nuke 'Em High (1986)	1980s	Movie	Mishandling Waste Mutations
Final Warning (1990)	1990s	Movie	Meltdown/ Explosion
Class of Nuke 'Em High 2: Subhumanoid Meltdown (1991)	1990s	Movie	Mishandling Waste Mutations Greed v. Safety
Naked Gun 2 1/2 (1991)	1990s	Movie	Cover-up/ Conspiracy Greed v. Safety
Touch and Die (1991)	1990s	Movie	Cover-up/ Conspiracy Greed v. Safety
Dirty Games (1993)	1990s	Movie	Terrorism
Atomic Twister (2002)	2000s	Movie	Natural Disaster Damaged Infrastructure Meltdown/Explosion
American Meltdown (2004)	2000s	Movie	Terrorism Nuclear Fuel for Bombs
"Homer Pushes the Button" (1990s)**	1990s	TV	Human Error
24 (2000s)	2000s	TV	Terrorism Nuclear Fuel for Bombs Contamination

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APPENDIX B. NUCLEAR ISSUES IN POPULAR CULTURE

TABLE 1. OVERVIEW OF SAMPLE, DECADE BREAKDOWN

Decade	Number of Films
1960s	2
1970s	2
1980s	9
1990s	6
2000s	3

TABLE 2. CORE CONCERNS IN THE 1960s

Concern	Frequency of Issue Frame
Machinery Malfunction	1
Mishandling Waste	1
Mutations	2

Number of Films = 2

TABLE 3. CORE CONCERNS IN THE 1970s

Concern	Frequency of Issue Frame
Cover-up/Conspiracy	1
Greed v. Safety	1
Machinery Malfunction	1
Meltdown/Explosion	2

Number of Films = 2

TABLE 4. CORE CONCERNS IN THE 1980s

Concern	Frequency of Issue Frame
Contamination	1
Cover-up/Conspiracy	5
Damaged Infrastructure	1
Greed v. Safety	4
Mishandling Waste	3
Mutations	4
Natural Disaster	1
Radioactive Emissions	2

Number of Films = 9

TABLE 5. CORE CONCERNS IN THE 1990s

Concern	Frequency of Issue Frame
Cover-up/Conspiracy	2
Greed v. Safety	3
Human Error	1
Meltdown/Explosion	1
Mishandling Waste	1
Mutations	1
Terrorism	1

Number of Films = 6

TABLE 6. CORE CONCERNS IN THE 2000s

Concern	Frequency of Issue Frame
Contamination	1
Damaged Infrastructure	1
Meltdown/Explosion	1
Natural Disaster	1
Nuclear Fuel for Bombs	2
Terrorism	2

Number of Films = 3

TABLE 7. SUMMARY OVERVIEW OF CORE CONCERNS

Concern	Number
Contamination	2
Cover-up/Conspiracy	8
Damaged Infrastructure	2
Greed v. Safety	8
Human Error	1
Machinery Malfunction	2
Meltdown/Explosion	4
Mishandling Waste	5
Mutations	7
Natural Disaster	2
Nuclear Fuel for Bombs	2
Radioactive Emissions	2
Terrorism	3

Number of Films = 22