RISK: Health, Safety & Environment (1990-2002)

Volume 12
Number 3 *Issue number 3/4, Fall 2001*

Article 6

September 2001

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Introduction

The purpose of this paper is to analyze claims made about the plutonium on the Cassini-Huygens spacecraft by mission supporters and opponents on the new media terrain of the Internet. Analysis focuses on claims made about the degree of risk involved, citizen control over risk exposure, fairness in the distribution of risks, benefits from the mission, and trust in governmental institutions responsible for risk assessment and management. Variations in framing by gender and by discernible self-interest are also addressed. Of particular interest is the alteration of the relationships among risk assessors, risk managers, and the public by the debut of a new medium, the Internet.

Risk assessment science and risk management policy presumably inform one another in natural and technological hazard situations. Policy toward any given hazard is forged in sometimes contentious debates between risk assessment scientists and risk management decision-makers (who are elected politicians with risks to their own careers possibly riding on these debates). Impinging on these two sets of players are influences from companies and agencies with different interests in the outcome and citizen pressure. Citizen pressure is generated by public interest activists, many of whom are quite sophisticated at educating the public about their takes on issues and adroit in stimulating political activism among the newly-informed.[1]

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1 An elected decision-maker is faced with a set of career risks in deciding what to do in response to public pressure about a given issue, including risk management policy decisions. These risks can be understood in terms of Type I and Type II errors in statistics. Facing constituent pressure concerning a given technological risk, an elected decision-maker may decide the null hypothesis is true and the constituent communications are representative of the

Media plays a crucial role in the social construction of a given hazard. Many of the debates about risks play out in the distorting presence of print and broadcast media. Media portrayal of a hazard affects individual perceptions and agency reactions to the event and influences the meaning people place on it. Unfortunately, the media have goals that may not dovetail with the information needs of society or the communication needs of risk assessment scientists.

Media have been roundly criticized for the sensationalism[2] and biases[3] they display in covering disasters and hazardous situations. Risk assessment scientists, risk management policy makers, and activists do not control the media, nor do they have the resources to produce and distribute their own information about hazards. They are

feelings of most constituents and act accordingly. If the communications are in fact not representative, s/he may alienate the bulk of constituents by doing so, a Type II error. If the communications are representative of the will of the majority and an elected official fails to recognize this, the official faces a Type I error in choosing to ignore the communications. *See* Larry C. Heiman, Acceptable Risks: Politics, Policy, and Risky Technologies (1997).

2 *See e.g.* Thomas A. Birkland, *Natural Disasters as Focusing Events: Policy Communities and Political Response,* 14 (2) Intl. J. of Mass Emergencies and Disasters 221 (1996); Ute J. Dymon & Francis P. Boscoe, *Newspaper Reporting in Wake of the 1995 Spring Floods in Northern California,* 81 Quick Response Report (1996) (available at <http://www.colorado.EDU/hazards/qr/qr81.html>); D. Elliott, *Tales from the Darkside: Ethical Implications of Disaster Coverage,* Bad Tidings: Communication and Catastrophe (Lynne M. Walters, Lee Wilkins, & Tim Walters eds., 1989); Roger E. Kasperson et al., *The Social Amplification of Risk: A Conceptual Framework,* 8 Risk Anal. 177 (1988); Karen Lowrie et al., *Hazards, Risk, and the Press: A Comparative Analysis of Newspaper Coverage of Nuclear and Chemical Weapons Sites,* 11 Risk: Health, Safety & Environment 49 (2000); Allan Mazur, A Hazardous Inquiry: The Rashomon Effect at Love Canal (Harvard Univ. Press 1998); Allan Mazur, *Looking Back: Unneeded X-rays,* 11 Risk: Health, Safety & Environment 1 (2000); Allan Mazur, *Technical Risk in the Mass Media,* 5 Risk: Health, Safety & Environment 189 (1994); Conrad Smith, Media and Apocalypse: News Coverage of the Yellowstone Forest Fires, Exxon Valdez Oil Spill, and Loma Prieta Earthquake (Greenwood Press 1992); Robert A. Stallings, *Hindsight, Organizational Routines and Media Risk Coverage,* 5 Risk: Health, Safety & Environment 223 (1994).

3 *See e.g.* Mike Davis, *The Case for Letting Malibu Burn,* Ecology of Fear: Los Angeles and the Imagination of Disaster (Metropolitan Books 1998); Marla Perez-Lugo, *The Mass Media, Political Fragmentation, and Environmental Injustice in Puerto Rico: A Case Study of the Floods in Barrio Tortugo,* 113 Quick Response Rpt. (1999) (available at <http://www.colorado.EDU/hazards/qr/qr113.html>); Christine M. Rodrigue et al., *Construction of the "Northridge" Earthquake in Los Angeles' English and Spanish Print Media: Damage, Attention, and Skewed Recovery,* Southern California Environment and History Conference (1997) (available at <http://www.csulb.edu/~rodrigue/ scehc97.html>); Eugenie L. Rovai, *The Social Geography of Disaster Recovery: Differential Response to the North Coast Earthquakes,* 56 Y.B. of the Assn. of Pacific Coast Geographers 49 (1994); Eleanor Singer & Phyllis M. Endreny, *Reporting on Risk: How the Mass Media Portray Accidents, Diseases, Disasters and Other Hazards,* 5 Risk: Health, Safety & Environment 241 (1994).

dependent upon traditional print and broadcast media. There is often a disconnect between what risk assessment scientists and policy makers want to communicate to the public and the type of information the media needs to convey to attract audiences and advertiser revenue. Activists are in a slightly better situation, since they can more appropriately generate events, such as demonstrations, that might appeal to the media's need for sensation and human drama.

Of growing importance, however, is the increasing use of Internet media in these discussions to generate awareness and political activism. The Internet allows technical experts and activists to bypass media they do not control and to get messages out in forms they can control to relatively large audiences.

The Internet may alter information acquisition in hazards communication and thereby affect the balance of power among various stakeholders. E-mail, UseNet, listservers, chats, and Web pages have very modest costs of entry. It is difficult for a few powerful media businesses to govern their content, consciously or inadvertantly. More importantly, the Internet also enables the exponential expansion of communication through the forward button. Because of the Internet, ordinary citizens and risk assessment scientists might have the ability to communicate their messages with nearly the efficiency of traditional media. Several questions emerge: Will depolarization of power in communication amplify or attenuate perception of risk? How will it alter the social meaning of a hazard and behavior towards it, including political behavior? How might the Internet affect the interaction between risk assessment science and risk management policy in a democracy?

This paper traces the impact of the Internet on the dialogue between risk assessment and risk policy in the case of the plutonium on board the Cassini-Huygens mission to Saturn and Titan. This technological risk controversy is particularly noteworthy for the degree to which it was carried out on the Internet, spanning as it did the period during which the Internet exploded into a powerful medium competitive with television, radio, and print media in the United States. The next section provides a background on the mission itself, the bases of the National Aeronautical and Space Administration's (NASA's) decision to use plutonium and an Earth gravity-assist, the objections raised by anti-nuclear activists, and the impact of activism in the controversy.

Background on the Controversy over the Cassini-Huygens Mission

The Cassini-Huygens mission to the Saturn planetary system is the largest, most ambitious, and most international project ever undertaken by NASA or its partners, the European Space Agency (ESA) and the Agenzia Spaziale Italiana (ASI). The orbiter and its probe are seven meters high, four meters wide, and weigh more than 5,600 kg. They house eighteen instruments that will be used to conduct twenty seven experiments of Saturn's rings, icy satellites, magnetosphere, and Titan.[4]

NASA dismissed the use of solar power for mission instrumentation and temperature maintenance needs for several reasons. First, the 5,655 kg mass of the orbiter and its navigational fuel, even without massive solar arrays, was already very close to the 5,760 kg launch limits of the largest American expendable launch vehicle, Titan IV/Centaur combination. Second, the duration of the mission to Saturn and extremity of the conditions at Saturn require absolutely dependable and durable power sources. NASA concluded solar panels could not satisfy those conditions. Third, the orbiter will make repeated passes through Saturn's ring system, and solar panels are both highly susceptible to impact damage and provide large targets for such damage. Fourth, NASA put a premium on minimizing the number of moving parts that could fail, after the disastrous deployment failure of the high-gain antenna on the Galileo spacecraft in April 1991. Fifth, Saturn is located about 9.5 astronomical units (AU) or 1.4 billion kilometers from the sun. At that distance, applying the inverse square law, solar energy receipt is about 1% that at Earth. Solar panels in optimum condition would, therefore, have to be about 500 square meters in size to be effective. They would thus be enormously heavy, entail many moving parts to deploy and struts to support, and require heavy batteries.[5]

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4 *See* NASA, Passage to a Ringed World: The Cassini-Huygens Mission to Saturn and Titan (Linda J. Spilker ed., 1997) (available at <http://www.jpl.nasa.gov/cassini/english/teachers/pub/passage/>).

5 *See* NASA, Final Environmental Impact Statement for the Cassini Mission (Solar

For these reasons, NASA decided on the compact radioisotope thermoelectric generator (RTG) and radioisotope thermal unit (RHU) design as the orbiter's power sources. These generate heat and, in the case of the RTGs, electrical power through the alpha radiation emitted by ceramicized plutonium-238 dioxide. Pu-238 is non-fissile and cannot sustain chain reactions the way Pu-239 and Pu-241 can.[6] The collisional energy of the large alpha particles striking the ceramic in which the Pu-238 is embedded generates heat. The heat maintains the instruments at operating temperature in the extreme cold and is converted into electricity to power their operation. The RTGs and RHUs became the center of controversy in 1995, due to their incorporation of 33 kg of plutonium dioxide. Plutonium was characterized by John Gofman "the most fiendishly toxic substance ever known" in 1974[7] and subsequently popularized by Ralph Nader "the most toxic substance known" in 1975.[8]

Adding to the controversy, NASA further opted for a Venus-Venus-Earth-Jupiter Gravity Assist (VVEJGA) trajectory.[9] Gravity assist entails exchanging angular momentum with a planet by swinging a spacecraft past it in the direction of the planet's revolution. Gravity assist would boost Cassini-Huygens to the velocity it needed to reach the Saturn system during the careers of its science teams. The gravity assist element led to accusations that Cassini could strike Earth or otherwise break up and explode in the Earth's atmosphere, distributing its plutonium throughout the Earth's atmosphere.[10] If the plutonium

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Exploration Division, Office of Space Science, 1995); NASA, **Final Supplemental Environmental Impact Statement for the Cassini Mission** (Solar Exploration Division, Office of Space Science, 1997) (available at <http://www.jpl.nasa.gov/cassini/english/msnsafe/>).

6 Norman Holden, *Table of the Isotopes (Revised 1998)*, CRC Handbook of Chemistry and Physics (David R. Lides ed., 2000).

7 Testimony provided by John Gofman in *Comm. v. Sam Lovejoy* (excerpted at <http://www.ecn.cz/temelin/Lovejoy.htm#Gofman>).

8 This Ralph Nader quotation is frequently cited and often unattributed. It was made in a debate between Nader and Ralph Lapp in 1975, in which Nader stated that one pound of plutonium could kill every human being on Earth. The debate is discussed in Theodore Rockwell, *Discussions of Nuclear Power Should Be Based in Reality*, 12 The Scientist (March 16, 1998) and in Bernard L. Cohen, *The Myth of Plutonium Toxicity,* Nuclear Energy 355-365 (Karl O. Ott & Bernard I. Spinard eds., Plenum Press 1985).

9 *See* NASA (1995), *supra* n. 5, at 1, 3-4, 2-74; NASA (1997), *supra* n. 5, at Sec. 2.

10 *See e.g.* Daniel Chong, *Nukes in Space: The Final Frontier? NASA To Launch Nuclear-Powered Space Probe*, Awareness Mag. (Sept./Oct. 1997) (available at

were thereby vaporized into particles small enough to be inhaled but large enough not to be exhaled, the radiation from an embedded particle could indeed induce cancer through the concentration of its energy within the very small penetration radius of alpha radiation.[11]

The risk management questions raised included: How likely is such an accident scenario? What would happen to the RTGs and RHUs in such an accident? What would be the number and size distribution of plutonium dioxide particles released by an explosion? Where would fine particles fall? What is the probability of a person being at that location to inhale the appropriately sized particles in that distribution?

Risk assessment performed for NASA as part of the mission's Environmental Impact Statement characterized the risk of plutonium release on launch or a swingby accident as negligible and acceptable at levels that would not be statistically observable over a five decade timeframe.[12]

By 1995, opposition to the mission had begun to organize.[13] Anti-Cassini activists were skeptical of any risk assessment performed for NASA, and questioned the independence of the outside agencies and individuals consulted by NASA. The activists came up with their own

<http://www.awarenessmag.com/sepoct7.html/so7_nuke.html>); Karl Grossman, *Risking the World: Nuclear Proliferation in Space*, Covert Action Q. (Summer 1996) (available at <http://www.projectcensored.org/c1997.htm#1>); Russell D. Hoffman, *Cassini: An In-Depth Look* (Jan. 30, 1997) (available at <http://www.animatedsoftware.com/cassini/cassiplu.htm>); Michio Kaku, *A Scientific Critique of the Accident Risks from the Cassini Space Mission*, The Real News Page (Aug. 1997) (available at <http://www.americanreview.net/kaku1.htm>).

11 *See* J. C. Nenot & J. W. Stather, The Toxicity of Plutonium, Americium, and Curium (Pergamon Press 1979).

12 All estimates for any of the launch phases for expectation and maximum scenarios were below one health effect, *i.e.*, surplus cancer death. *See* NASA (1995), *supra* n. 5, at 4.57-4.58. For an inadvertant entry during the Earth swingby, depending on the angle of re-entry, the estimate ranged from 1,910 to 3,480 excess deaths developing over five decades, a level that would not be statistically observable among the 1 billion or so deaths normally expected in that time frame. *Id.* at 4.59. This estimate was calculated without the controversial *de minimis* assumption of an allegedly harmless dose of 0.001 rem. These estimates were revised downward in the Final Supplemental EIS of 1997 after application of new probabilistic safety analyses and more detailed descriptions of accident and environment scenarios. For pre-launch and launch accidents, expected surplus deaths again remained below one for all phases, and worst case scenarios resulted in less than 1% probabilities of from 0.55 to 1.50 surplus deaths being exceeded, depending on the time of failure. *See* NASA (1997), *supra* n. 5, at 2.20-2.22. For inadvertant entry failures, there was a substantial drop in expected excess deaths, to 120, with a 1% probability of 450 surplus deaths being exceeded. *Id.* at 2.22-2.23.

13 Signaled by the publication of Karl Grossman & Judith Long, *Apollo Outtakes*, The Nation (Sept. 11, 1995) (available at <http://www.animatedsoftware.com/cassini/kg9509na.htm>).

risk estimates, ranging from over 200,000 deaths[14] to 1 million deaths (attributed to John Gofman by Grossman)[15] and 4.6 million to 9.2 million deaths (Ernest J. Sternglass quoted on the NoFlyBy web site)[16] to as many as 40 million deaths (attributed to Sternglass by Grossman).[17] The timeframe of these predicted surplus deaths is not specified. The opponents further claimed that NASA was imposing an unnecessary risk, in light of improvements in solar technology. They argued that solar power would have been an option, even at Saturn, where incoming solar radiation is one percent that at Earth.[18] They openly wondered if Cassini were part of some military conspiracy to acclimate Americans to "nukes in space" so that space could be “weaponized.”[19]

From 1995 through October 1997, the opposition movement concentrated its efforts on creating pressure to abort the October 1997 launch of Cassini.[20] The launch went forward, so the movement then focused on aborting the flyby, scheduled for August 1999.[21] The movement was unsuccessful in stopping either of these events, but it did generate enormous controversy and put a lot of pressure on Congress, the White House, and the courts.[22] Several senators and

14 Kaku, *supra* n. 10, at top of document.

15 Karl Grossman, *The Risk of Cassini Probe Plutonium, Christian Science Monitor* (October 10, 1997) (available at <http://www.csmonitor.com/durable/1997/10/10/opin/opin.1.html>).

16 *See* NoFlyBy <http://www.flybynews.com/> (accessed November 7, 2001).

17 *See* Grossman, *supra* n. 15.

18 J. Turner, *Nuking the Final Frontier*, 5 (4) Shift (1997).

19 *See e.g.* Helen Caldicott, *Nukes in Space Are a Serious Threat to Us All*, Sydney Morning Herald (August 18, 1999) (available at <http://www.gn.apc.org/cndyorks/yspace/articles/caldicott.htm>); Karl Grossman & Jonathan Mark, *The FORCE behind Cassini* (Press Release, July 21, 1999) (available at <http://www.flybynews.com/archives/alerts/18n.htm>); Karl Grossman, Address, *Space Use and Ethics* (Darmstadt, Germany, Mar. 4, 1999) (available at <http://www.flybynews.com/archives/karl/ethics.htm>); Al Decker, *Hey NASA: Send It Up Uranus! — Opposition to Cassini Heats Up*, EarthFirst! J. (available at <http://www.enviro web.org/ef/old/Lughnasadh97/Cassini.html>).

20 *See e.g.* Stop Cassini Newsletter index (available at <http://www.animatedsoftware.com /cassini/nltrs/index.htm>). This claim is at least partly based on statements by the American military about its mandate to assure American military control of space. *See e.g.* United States Space Command, *Long Range Plan: Implementing USSPACECOM Vision for 2020* (available at <http://www.peterson.af.mil/ usspace/LRP/cover.htm>).

21 *See e.g.* NoFlyBy site, *supra* n. 16.

22 *See e.g.* Dave Weldon, *NASA's Cassini Mission Is Safe*, Space News (September 22-28, 1997)(available at <http://www.reston.com/nasa/congress/09.05.97.weldon.cassini.html>).

representatives signed a public petition against the mission, and California Senator Barbara Boxer commissioned a study by the U.S. Government Accounting Office entitled, "Space exploration — power sources for deep space problems." [23] State and local government representatives were pressured to declare their jurisdictions in opposition to the launch or flyby. Several responded, including the Massachusetts House of Representatives, which passed a resolution to abort the launch, as did the Newton, Massachusetts City Council; the Santa Cruz, California City Council; and the Marin County Board of Supervisors.[24] The movement may not have achieved its original goals, but it was highly effective in making RTG and RHU use controversial, which may, in turn, affect the design, authorization, and funding of future missions.[25]

Besides a number of print media and television pieces on the controversy,[26] most of the day-to-day activism took place on E-mail and listservers, the Web, and on UseNet.[27] Indeed, many of the

[23] *See* U.S. Government Accounting Office, *Space Exploration — Power Sources for Deep Space Problems*, GAO/NSIAD-98-102 (1998) (available at <http://www.gao.gov/archive/1998/ns98102.pdf>).

[24] *See* Grossman, *supra* n. 15; City of Santa Cruz, *City Council Minutes of 9/9/97* (available at <http://www.ci.santa-cruz.ca.us/cc/archives/97/9-9m.html>); and *Marin County Resolution No. 97-26* (available at <http://www-1.marinorg.net/mc/bos/bosagmn/a970325.txt>).

[25] *See e.g.* Regina Hagen, *Nuclear Powered Space Missions - Past and Future* (Aug. 11, 1998)(available at <http://www.globenet.free-online.co.uk/ianus/npsmindex.htm>). Controversy over RTGs has encouraged innovation within NASA concerning alternative power sources for deep space missions, including efforts to develop solar concentrators and more efficient thermoelectric conversion devices for RTGs to minimize the amount of Pu-238 required. *See* Glenn Research Center & NASA, *Deep Space Solar Stirling* (Jan. 4, 2000) (available at < http://www.lerc.nasa.gov/WWW/tmsb/dynamicpower/doc/stirling_deepsolar.html>). The Discovery Program of smaller missions explicitly forbids designs dependent on RTGs although the smaller RHUs are permissible. *See* NASA, *DRAFT for Community Comment, Announcement of Opportunity, Discovery Program* (Jan. 9, 1998) (available at <http://spacescience.nasa.gov/aodraft/discovery/discdrft.txt>).

[26] For examples of print media pieces on the controversy, *see* William J. Broad, *Powered by Plutonium, Saturn Mission Provokes Warnings of Danger*, N.Y. Times (Sept. 8, 1997) (available at <http://www.flybynews.com/archives/ref/nyt98.htm>); Karl Grossman, *Nuclear Menace in Outer Space*, Baltimore Sun (Dec. 8, 1996) (available at <http://www.flybynews.com/archives/ref/kg9612ba.htm>); Robyn Suriano & Tony Boylan, *Demonstration ends with 27 arrested*, Florida Today (Oct. 5, 1997) (available at <http://www.flybynews.com/archives/ref/flt105.htm>). For examples of broadcast media pieces, *see* Cassini Segment, 60 Minutes (CBS News Co., Oct. 5, 1997) (transcript available at <http://www.prop1.org/2000/cassini/971005fl.htm>); Karl Grossman, *Nukes in Space: The Nuclearization and Weaponization of the Heavens* (1995); *Nukes in Space II: Unacceptable Risks* (1998), EnviroVideo, Box 311, Ft. Tilden NY 11695; Interview by Art Bell Coast to Coast Radio Show with Michio Kaku (Sept. 24, 1997).

traditional media pieces germane to the subject wound up as E-mails and Web pages. Internet activism resulted in demonstrations that were then covered by conventional media.

The dense and rapidly increasing network of connections among people in cyberspace clearly offered a way for the politically active to bypass the constraints of conventional print and broadcast media to get their messages directly into the hands of readers. Readers could easily propagate the messages themselves, so that, ultimately, a handful of activists communicated with hundreds of thousands of people indirectly through the power of the forward button. The Cassini controversy exemplifies the power of the Internet in information propagation and activist recruitment.

Hazard Perception

My purpose in examining this controversy included testing several hypotheses from the hazards perception literature. One of the most common statements in the literature is that there is a marked difference in hazard perception on the part of risk assessment experts and the lay public. The lay public is often described as being ill-informed and, therefore, as offering little valuable input in risk management policy decisions.[28] A variant on this vision of the public as poorly informed is expressed in statements that suggest that, lacking the time and training to evaluate certain risks, people will form their opinions about risks by

[27] For examples of web pages, *see* <http://www.flybynews.com>, <http://www.animatedsoftware.com/cassini/>; <http://www.rain.org/~openmind/cassini.htm>,<http://www.jpl.nasa.gov/cassini/>; <http://www.jpl.nasa.gov/cassini/english/ msnsafe/>.

[28] For statements expressing reservations about raw public input, *see e.g.* Norman Augustine, *What We Don't Know Does Hurt Us: How Scientific Illiteracy Hobbles Society*, 279 Science 5357 (1998); Baruch Fischhoff, *Acceptable Risk: A Conceptual Proposal*, 5 Risk: Health, Safety & Environment 1 (1994); Sharon M. Friedman, *The Media, Risk Assessment and Numbers: They Don't Add Up*, 5 Risk: Health, Safety & Environment 203 (1994). For statements that public input is seen as limited in value by risk assessors and managers, *see e.g.* Branden Johnson, *Advancing Understanding of Knowledge's Role in Lay Risk Perception*, 4 Risk: Health & Safety 189 (1993); Frances M. Lynn, *Public Participation in Risk Management Decisions: The Right to Define, the Right to Know, and the Right to Act*, 1 Risk: Health & Safety 95 (1990); Thomas O. McGarity, *Public Participation in Risk Regulation*, 1 Risk: Health & Safety 103 (1990); Kristin S. Shrader-Frechette, *Perceived Risks versus Actual Risks: Managing Hazards through Negotiation*, 1 Risk: Health & Safety 341 (1990); Paul Slovic, *Beyond Numbers: A Broader Perspective on Risk Perception and Risk Communication* in Acceptable Evidence: Science and Values in Risk Management (Deborah G. Mayo & Rachelle D. Hollander eds., Oxford University Press 1991).

deferring to the opinions of reference groups they trust. Once these opinions are formed, they become very resistant to contrary evidence.[29]

Douglas and Wildavsky have proposed a model based on cultural predispositions toward risk assessment and tolerance.[30] They describe a "center" approach characteristic of people at, or near, the core of political power. These people demonstrate respect for rational risk assessment, acceptance of the hierarchical structure of modern society that privileges them, and willingness to tolerate a certain degree of risk if it is offset by greater benefits enabled by assumption of that risk. Douglas and Wildavsky also define a "border" approach, associated with people peripheral to social power who are suspicious of the center, fearful of pollution of the natural environment by the self-serving power elite, and unimpressed by a rationality seen as serving central interests. They are generally described as possessing egalitarian social values and being politically oppositional. Basically, this model describes expert opinion as "centrist" and lay opposition to technology as "borderer." This model, an extension of the ill-informed public hypothesis, has generated an enduring debate between those who would dismiss the public and those who value lay hazard perception in a democratic society.

Many critics of the Douglas and Wildavsky model argue that lay hazard perception may reflect a more nuanced and multifaceted consideration of risk than do the narrowly focused mortality and morbidity calculations of risk assessment experts.[31] The concern of this literature is that the public will overestimate risks, and perhaps even

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29 *See e.g.* Vincent T. Covello et al., *Guidelines for Communicating Information about Chemical Risks Effectively and Responsibly* in Mayo & Hollander, *supra* n. 28; Johnson, *supra* n. 28; Howard Margolis, Dealing with Risk: Why the Public and the Experts Disagree on Environmental Issues (The Univ. of Chicago Press 1996); Slovic, *supra* n. 28; Paul Slovic et al., *Rating the Risks: The Structure of Expert and Lay Opinions*, Risk in the Technological Society (Christoph Hohenemser & Jeanne X. Kasperson eds., Westview Press 1982).

30 *See* Mary Douglas & Aaron Wildavsky, Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers (Univ. of Cal. Press 1982).

31 *See e.g.* Kristin S. Shrader-Frechette, *Evaluating the Expertise of Experts*, 6 Risk: Health, Safety & Environment 115 (1995); Margolis, *supra* n. 29; Andrew F. Fritsche, *The Moral Dilemma in the Social Management of Risks*, 7 Risk: Health, Safety & Environment 291 (1996); Slovic, *supra* n. 28; Slovic et al., *supra* n. 29; Eeva K. Berglund, Knowing Nature, Knowing Science: An Ethnography of Local Environmental Activism (The White Horse Press 1998); Lennart Sjöberg, *World Views, Political Attitudes, and Risk Perception*, 9 Risk: Health, Safety & Environment 137 (1998).

be aroused into political activism against risks, if any of the following dimensions are present: lack of control, lack of familiarity, unfairness, dread, or mistrust.

People will accept quite high levels of risk if they perceive themselves as controlling their own risk exposure but will become very upset at even the most trivial risk if they feel it is being imposed on them.[32] People are also more tolerant of risks that are familiar to them, e.g., cars versus planes.[33] The public will accept higher risk in a situation they see as benefiting them, but they will become agitated if they perceive that they are assuming the risk and someone else is gaining the benefit.[34] Dread attaches to any hazard, no matter how tiny its probability, if the hazard's imaginable consequences include sheer horror, particularly frightening diseases, or transmission of harm to future generations. The horror of Hiroshima, and the slowly growing realization that even minute exposures to radioactive substances can result in mutation and cancer, ensures that any potentially nuclear hazard evokes dread.[35] Social concern over hazards may become amplified far beyond the risk assessed by experts if the institutions responsible for assessing risk and protecting the public are themselves under suspicion. Public trust of governmental institutions in general seems to have hit a decades-long slide in the wake of revelations of gross government misconduct, conspiracy theorizing from both left and right, and a pervasive "X-Files" mentality.[36] Lastly, many studies have found differences in risk perception or tolerance along ethnic, age, and gender lines. These differences perhaps reflect the relative situatedness of these aspects of identity along the fairness, control, familiarity, and trust axes of this and many other social issues.[37]

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32 *See* Slovic, *supra* n. 28; Slovic et al., *supra* n. 29.

33 Slovic et al., *supra* n. 29.

34 *See e.g.* Berglund, *supra* n. 31; Margolis, *supra* n. 29; Kristin S. Shrader-Frechette, *First Things First: Balancing Scientific and Ethical Values in Environmental Science*, 88 (2) Annals of the Assn. of Am. Geographers (1998).

35 *See e.g.* Slovic, *supra* n. 28; Vincent Covello, *Risk Comparisons and Risk Communication, Communicating* Risk to the Public (Roger E. Kasperson & Pieter Jan M. Stallen eds., Kluwer 1991).

36 *See e.g.* Douglas & Wildavsky, *supra* n. 30; Berglund, *supra* n. 31; Fritsche, *supra* n. 31; Margolis, *supra* n. 29; Sheila Jasonoff, *Acceptable Evidence in a Pluralistic Society*, in Mayo & Hollander, *supra* n. 28; Howard Kunreuther et al., *Risk Perception and Trust: Challenges for Facility Siting*, 7 Risk: Health, Safety & Environment 109 (1996).

As stated earlier, the purpose of this paper is to analyze the claims made about the plutonium on board the Cassini-Huygens spacecraft, as expressed on the Internet. Many questions derive from this literature:

1. Do Internet debates on Cassini raise the issue of perceived control over plutonium?
2. Are issues of fairness in the social distribution of the mission's risks and benefits raised by the mission's opponents and proponents in their debates online?
3. Do Cassini opponents focus on expressing or eliciting dread?
4. If so, since dread is a more compelling emotion than the scientific curiosity and romance of space-exploration motivating mission proponents, are opponents more numerous and more vocal than proponents?
5. Is suspicion of governmental institutions generally, or of NASA specifically, used by opponents to discredit the risk assessment performed by or under contract to NASA?
6. Can demographic variations be discerned among the people contributing to this debate online? If so, are these demographic differences associated with different percentages of authors in opponent and proponent stances?
7. Does self-interest affect the propensity to contribute to this debate? Does the removal of identifiably self-interested individuals significantly change the balance of authors and messages between support and opposition to the Cassini-Huygens mission?
8. Is there evidence for the claim that people rely on trusted reference groups to form political opinions on issues beyond their technical training? Does this vary between mission opponents and proponents?
9. Can Douglas and Wildavsky's center/border dichotomy be discerned in the values and concerns raised in the content of the messages themselves? Do mission proponents express more confidence

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[37] *See e.g.* Denise Blanchard-Boehm, *Risk Communication in Southern California: Ethnic and Gender Response to 1995 Revised, Upgraded Earthquake Probabilities*, 94 Quick Response Report (1997) (available at <http://www.colorado.EDU/hazards/qr/qr94.html>); John-Paul Mulilis, Gender and Earthquake Preparedness, 14 (1) Australian J. of Emergency Mgt. (1999) (available at <http://www.ema.gov.au/5virtuallibrary/pdfs/vol14no1/mulilis.pdf>); Robert T. Bolin, Martina Jackson, & Allison Crist, *Gender Inequality, Vulnerability and Disasters: Issues in Theory and Research*, Through Women's Eyes: The Gendered Terrain of Natural Disaster (Elaine Enarson & Betty Hearn Morrow eds., Praeger 1998).

in science and mission opponents express more counter-cultural perspectives?
10. Does the use of the Internet for political communication create an effective alternative channel for risk management agenda-setting to the traditional print and broadcast media and lobbying?

Data and Methods

The Internet varies in the degree to which it can be investigated for research purposes. For example, the Web contains a huge population of sites devoted to one aspect or another of this controversy, but this population is quite unstable through time, as people change their websites and discard materials no longer of immediate interest. Listservers number in the dozens, if not hundreds, of thousands,[38] but, while the lists themselves can be located through several search services, postings on them are archived (or not) by the individuals running each list. Chats are by their nature ephemeral. UseNet news groups became the focus of this analysis, because they were archived by Déja.com in a fully searchable form.[39] Messages can be searched by keyword, author, date, and newsgroup.

Using Déja.com's search engine, I searched for the keyword "Cassini" from April 1995 to August 1999. This resulted in a population of 19,853 messages that had been posted from April 1995 through March 1999 which contained the word "Cassini" anywhere (e.g., in the posted message, subject line, or author name). Since the debate unfolded over four years, I ensured longitudinal representativeness of messages by using "Cassini" as the keyword and specifying dates by month, working backwards from the end of March 1999 to the beginning of April 1995. The number of postings varied from a low of three comments in April 1995 to a high of 4,385 in October 1997, the month of the spacecraft's launch.

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38 CataList reports nearly 180,000 lists conducted through LISTSERV software alone <http://www.lsoft.com/catalist.html>. List, now Topica.com, provides access to 80,000 lists moderated through LISTSERV, ListProc, and Majordomo list management packages; over 35,000 IRC chat channels; and 30,000 UseNet news groups <http://www.liszt.com/>. PAML catalogues over 7,000 publically available mailing lists, as well <http://paml.net/>.

39 Google, the search engine company, acquired the Déja.com UseNet search engine in February 2001. Thus, <http://www.deja.com/home_ps.shtml> now transfers to <http://groups.google.com/googlegroups/deja_announcement.html>.

I then sampled the discussion by viewing up to 250 messages in each month, working backwards. Déja.com sorted messages by "relevance," basically the number of times the keyword turns up in a message. From this maximum of 250 messages per month, I extracted only those written in English on the subject of the spacecraft, saving the author's name and E-mail address and an abstract of the message in a word processor. Excluded were postings on "Cassini" topics unrelated to the mission.[40] Furthermore, I saved only the most recent posting by a given author and then categorized the author's stance on the basis of this comment as "proponent," "opponent," or "neutral." If authors' stances were not decipherable from these comments, I would then search on these authors' names and "Cassini" to read their other messages on the subject, until I could classify their stances. Additionally, I did searches on all author names and "Cassini" to identify numbers of postings on the subject per author as a crude indicator of interest level. If people are highly interested in a debate, chances are greater that they will contribute to it repeatedly.

This sampling process yielded comments by 937 authors who had posted 8,020 messages on the subject, 40% of the "Cassini" messages dating from the four-year study period. The authors were classified by stance, central concerns raised, gender (the only detectable demographic variable), affiliation with NASA and related institutions or with opposition organizations, and whether their messages were largely original compositions or forwards of another person's message. Classification was done solely by myself, as funding did not allow the training and hiring of a team of coding assistants. Single coder content analysis may suffer from reduced reliability because it lacks a mechanism for soliciting possibly divergent interpretations of a message and then democratically deciding among such interpretations. On the other hand, single coder content analysis does guarantee consistency in

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[40] There were many messages about Oleg Cassini, the fashion designer; Nadia Cassini, an actress; and Jean-Dominique Cassini, the seventeenth century astronomer and discoverer of Saturn, for whom the orbiter is named. There were also amateur astronomers' postings on the Cassini Division or gap between Saturn's A and B rings; *The Cassini Division*, a science fiction novel by Ken MacLeod; and a number of postings by authors surnamed Cassini.

coding as one person applies a single approach to all messages rather than training others who may apply that approach with varying levels of motivation and understanding.

Later, the text database became the basis of a spreadsheet database that included fields for author name, login nickname, E-mail address, gender, basic stance, central concerns raised, and number of postings by the author. I also noted whether the message had been originally composed by the author or was basically a forward of someone else's writing. Most of these fields are straightforward but, in light of the one-coder methodology, it is appropriate to show a few of the messages, randomly chosen, and how their author's stances and central concerns were classified.

To that end, a handful of representative posts were extracted from this database and listed in Figure 1, which is found at the following Web address: <http://www.csulb.edu/~rodrigue/cassini/risk01figure.html>. To extract them, I used a random number generator and found the message corresponding to a given random record number in the spreadsheet. I then found the corresponding message in the text database of UseNet messages and pasted them onto the web page. In some of these, more than one concern is found in the message. I classified them by the concern that the author wrote about most.

The database developed was then sorted on various fields to yield the results summarized in the following tables. Significance levels are generated from difference of proportions Z tests, with prob-values < 0.05 considered significant.

Findings

The great majority of UseNet authors were supportive of the mission: 60% were supporters; 21% were opponents; and 19% were neutral (Table 1). Given the emotional power of nuclear dread, this result was surprising. The opponents were, however, considerably more vocal than the proponents or neutrals. The 21% of authors who were opponents posted 31% of the messages (prob<0.001). The 19% of neutral authors posted 13% of messages, significantly less than their numbers (prob<0.001). The 60% of pro-Cassini authors posted 56% of messages, which is signficantly less than expected (prob=0.005).

Table 1
Stance by Gender

Stance	*Gender*	*Individuals* #	%	*Posts* #	%
Neutral	female	7	3.9	10	0.9
	male	139	78.1	930	87.5
	organization	4	2.2	14	1.3
	unknown	28	15.7	109	10.3
19.0% of authors 13.3% of posts		178	100.0	1063	100.0
Opponent	female	16	8.2	103	4.1
	male	132	68.0	2067	82.4
	organization	6	3.1	121	4.8
	unknown	40	20.6	217	8.7
20.7% of authors 31.3% of posts		194	100.0	2508	100.0
Proponent	female	19	3.4	154	3.5
	male	468	82.8	3946	88.7
	organization	3	0.5	24	0.5
	unknown	75	13.3	325	7.3
60.3% of authors 55.5% of posts		565	100.0	4449	100.0

937=n (authors)
8020=n (posts made by these authors)

The only demographic difference discernible among the authors was gender (Table 2). The debate was an overwhelmingly male preserve. Fewer than 5% of authors were female; they contributed only three percent of the posts. The Internet has been perceived as a largely male domain, but the disparities between the percentages of women contributing to this discussion are drastically greater than those of women using the Internet itself, according to the statistically representative telephone survey series by CommerceNet/Nielsen Media Research Internet Demographic Study.[41] In 1995, at the beginning of the study period, women made up 33% of Internet users in the United States and Canada versus 7% of identifiable participants in the Cassini debate from April 1995 through March 1996. In 1999, at the end of the study period, women constituted 46% of Internet uses

[41] *See* Gail L. Grant, *Internet Users Top 92 Million in the U.S. and Canada*, CommerceNet Research Note #99-26 (June 23, 1999) (available at <http://www.commerce.net/research/reports/1999/99_26_n/99_26_n.html>).

in the United States and Canada, versus 5% of Cassini discussion participants from April 1998 through March 1999. While gender disparities in user numbers are disappearing online, there remain differences in the interests women and men pursue in online shopping and purchasing activities, with men likelier than women to pursue technological interests. This difference may account for the greater likelihood of men to participate in an online technological risk debate.[42]

Both genders in this debate were likelier to support Cassini than to oppose it. Even so, there was a gender gap. Only 45% of the women were mission-supporters, compared to 63% of the men (prob=0.019); whereas 38% of the women were opponents, only 18% of the men were (prob=0.002). Even if the genders had been equally represented among the authors, proponents would still have been in the majority (54% of the eighty one gender-identified authors, had they been equally male and female), but the disparity would not have been so extreme (opponents would have been 28% and neutrals, 18%).

The authors' stated concerns and stances suggest what activated them to contribute to the social debate over Cassini (Table 3). Opponents were dominated by three subtypes: 24% simply passed on messages originating from about half a dozen people or organizations, often without comment; another 24% wrote messages consisting of independent expressions of concern about the risks of plutonium in general or during the launch and flyby phases of this mission in particular; and 21% were people interested in Nostradamus and astrology, who expressed great fear that Cassini was the "King of Terror" that Nostradamus had predicted would come from the skies and destroy Earth in summer 1999 (the Earth flyby took place on August 17-18, 1999).

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42 *Id.*

Table 2
Gender by Stance

Gender	*Stance*	Individuals #	Individuals %	Posts #	Posts %
Female	neutral	7	16.7	10	3.7
	opponent	16	38.1	103	38.6
	proponent	19	45.2	154	57.7
4.5% of authors		42	100.0	267	100.0
3.3% of posts					
Male	neutral	139	18.8	930	13.4
	opponent	132	17.9	2067	29.8
	proponent	468	63.3	3946	56.8
78.0% of authors		739	100.0	6943	100.0
86.6% of posts					
Organization	neutral	4	30.8	14	8.8
	opponent	6	46.2	121	76.1
	proponent	3	23.1	24	15.1
1.5% of authors		13	100.0	159	100.0
2.0% of posts					
Unknown	neutral	28	19.6	109	16.7
	opponent	40	28.0	217	33.3
	proponent	75	52.4	325	49.9
16.0% of authors		143	100.0	651	100.0
8.1% of posts					

937=n (authors)
8020=n (posts made by these authors)

Proponents, given their much larger numbers, discussed a wider range of issues and concerns, with no one issue concerning as many as a fifth of the authors. The most common statement, made by 17 % of proponents, was that the opposition, though vocal, was very small and unqualified to comment. Sixteen percent opined that the risk of the mission or of RTGs was being grossly overstated. Thirteen percent simply enthused about the mission and its goals. Another ten percent engaged in rather nasty "flaming" of the opponents (slang for *ad hominem* attacks). Only six percent forwarded other people's or organizations' messages, usually something from a NASA publicity office. The content of proponents' postings, then, emanated from people enthusiastic about science and technology and comfortable with conventional risk assessment analyses and results. That is, they seem more centrist in point of view, to use Douglas and Wildavsky's phraseology.

Neutral messages fell into two categories. The most common of these were questions or answers about very technical issues related to the spacecraft's design, instrumentation, and objectives (40%). A distant second were very elementary questions and answers, such as which planet was Cassini's destination or why it takes so long for a spacecraft to get there (11%). Another 8% were forwarded messages, and another 7% were basic questions from Nostradamus fans or queries about the risk involved in the mission. Thus, the balance of the concerns expressed emerges as more centrist than borderer.

Opponents were significantly more likely simply to pass on others' messages (24 %) than were the other two groups (seven-percent of the pooled 743), with a prob-value of <0.001. Forwarding others' opinions reflects the tendency for time-pressed citizens to rely on trusted reference groups' opinions in forming their own opinions on complex issues unfamiliar to them. That opponents were likelier to resort to this form of political communication than proponents may speak to the center/border dichotomy as it applies to access to, and trust in, conventional technological risk assessment information. Proponents were far likelier to engage in individually-targeted flames (10%) than were either opponents (2%) or neutrals (4%). The difference between the proponents and the other two stances is significant at a prob-value well below 0.001 and carries a whiff of center snobbery towards the border.

Within the Nostradamus debate, opponents and neutrals were fans of the sixteenth century astrologer-poet, while proponents were his critic. Of those who commented on Nostradamus, 21% of the opponents discussed him in connection with Cassini, as did 7% of the neutrals and 4% of the Cassini proponents. Thus, opponents are significantly more likely to come to this technological risk debate from an ascientific and countercultural (border) perspective than the neutrals and the proponents (prob<0.001).

The sample may not be representative of all those on the Internet with an opinion on Cassini. It is likely that people who bestir themselves to contribute to the debate are in some way self-interested in its outcome. For example, they may be employees of NASA, the ESA, the ASI, or their subcontractors, or perhaps committed and activism-prone members of opposition organizations.

To examine self-selection bias on the basis of self-interest, I removed all 165 people with E-mails originating from the space agencies, their contractors, and academic institutions having sizable grants with them. I also removed seven people who posted from activist organization addresses. I may have failed to cull individuals working or volunteering in these organizations who maintain private E-mail accounts not associated with their organizational affiliations. This is especially likely to be true of opponents, who are less likely to have E-mail accounts on their organization's domains (many Internet service providers offering domain-hosting services for small businesses and organizations limit the associated E-mail accounts to about twenty). With these caveats, the easily-identifiable affiliates made up 18% of the authors. Interestingly, they contributed 26% of the messages, a disproportion (prob=0.022) suggestive of their passion on the subject (Table 4).

By removing them, the database dropped to 765 authors and 5,912 messages originating from people with no discernible ties to Cassini and the organizations that oppose it. Of these remaining authors, 20% are neutral, slightly more than was the case with the full database (prob=0.469). However, they posted 16% of messages, a somewhat greater percentage than did the neutrals in the original database (prob<0.001). Twenty three percent of the authors in the reduced database are opponents, a slightly greater percentage than in the original (prob=0.319), but they posted fully 38% of the messages, which is quite a bit higher than was seen in the full database (prob<0.001). The public left in the database who oppose the mission, then, emerge as more likely to communicate their feelings. The percentage of proponents in the revised database dropped insignificantly, from 60% to 57% (prob=0.156), but these authors were less communicative about their sentiments than was true when identifiable employees of NASA and related institutions were left in. That is, the percentage of posts from non-self-interested proponents dropped to 46% from the 56% seen in the original database (prob<0.001).

Table 3
Central Concerns Raised by Stance

	#	%
Neutral Issues	#	%
Technical questions/answers	72	40.4
Asking/providing basic information	20	11.2
Passing on others' messages	14	7.9
Nostradamus fan asking basic question	13	7.3
Risk question	12	6.7
Flames	7	3.9
Costs, taxes	6	3.4
Politics/bureaucratization	5	2.8
Privatization of space	4	2.2
Vulnerabilty of big mission	2	1.1
Other	23	12.9
Sum	178	100.0
Opponent Issues	#	%
Passing on others' messages	46	23.7
Risk	46	23.7
Nostradamus/astrology/666 fears	41	21.1
Calls to action	11	5.7
Costs, scale, opportunity costs	9	4.6
Censorship by media	7	3.6
Conspiracy/militarization of space	6	3.1
Flames	4	2.1
Privatization of space better than NASA	3	1.5
Other	21	10.8
Sum	194	100.0
Proponent Issues	#	%
Opponents a small # unqualified Luddites	95	16.8
Risk overstated, disproproportionate	91	16.1
Enthusiasm for the mission and space	73	12.9
Flames	59	10.4
Orbit/trajectory aimid to be safe	36	6.4
Passing on others's messages	36	6.4
Past nuke/RTG failures didn't kill life on earth	27	4.8
Solar not feasible	22	3.9
Big missions=big results	20	3.5
Nostradamus critiques	23	4.1
Cass budget doesn't allow for cruise science	16	2.8
Opportunity costs of opponent activism	11	1.9
Media consorship/bias against science	9	1.6
Calls to action	8	1.4
Privatization critique for large-scale missions	4	0.7
Other	35	6.2
Sum	565	100.0
937=n (authors)		

In all, the public left in the database were basically indistinguishable from the full database in terms of the proportions of individuals adhering to the three positions. Mission opponents left in the database, however, were more communicative about their views, which offers support to the expectation that the emotional basis of opposition, dread of nuclear contamination, is more compelling than that of support for the mission. This is particularly evident when people whose livelihoods may depend on the mission or on the space program (a potent emotional driver!) are removed. Indeed, though proponents left in the database dominated as individuals, their support was considerably more tepid emotionally than when identifiably self-interested persons remained in the database, at least as judged from the number of posts they offered on the subject.

The result created by analysis of the non-self-interested public is strengthened by comparison of those persons working for NASA and its affiliated institutions with those with E-mail addresses in opponent organization domains. Of the 165 people employed at NASA or affiliated institutions, fully 79% were proponents, and 86% of their 1,965 messages were supportive of the mission. In contrast, all seven people with E-mail accounts on the opponent organization domains were mission opponents, and they posted 162 messages. Where, on average, the 765 unaffiliated authors posted 7.7 messages on the topic of Cassini, the 165 NASA-affiliated authors averaged 11.9 messages, and the seven people identifiably in opponent organizations averaged 23.1 messages. Again, the disparity in numbers of messages in this debate suggests the difference in intensity of motivation. Self-interest and, especially, nuclear dread produce greater frequency of communication.

Particularly striking with respect to the nature of UseNet communication was the great influence of a very small number of individuals in this debate. Some 24 % of opponents were passing along messages from others. I traced these back and found that they originated from about half a dozen individuals!

Table 4
Stance by Gender

Stance	*Individuals* #	%	*Posts* #	%
Those with no traceable affiliation				
Neutral	156	20.4	968	16.4
Opponent	174	22.7	2233	37.8
Proponent	435	56.9	2711	45.9
765=n (authors)				
5912=n (posts made by these authors)				
Those affiliated with NASA				
Neutral	22	13.3	138	7.0
Opponent	13	7.9	136	6.9
Proponent	130	78.8	1695	86.1
165=n (authors)				
1969=n (posts made by these authors)				
Those affiliated with opponent organizations				
Neutral	0	0.0	0	0.0
Opponent	7	100.0	162	100.0
Proponent	0	0.0	0	0.0
7=n (authors)				
162=n (posts made by these authors)				

The whole controversy began in print media articles by Karl Grossman starting in 1995 that highlighted the amount of plutonium on board Cassini-Huygens, questioned NASA's safety record, implied a military connection to get Americans used to "nukes in space," and drew attention to the large corporations, including NASA contractors, with stakes in nuclear power.[43] Grossman was continuing a line of articles he had written on the Galileo mission to Jupiter. His articles were posted widely online, which he encouraged.[44] His writings would

43 *See* Grossman, *supra* n. 10, 13, 15, 19 & 26; Grossman & Mark, *supra* n. 19; Karl Grossman, *U.S. Slinging Plutonium into Space*, The Cleveland Plain Dealer (May 22, 1996) (available at <http://www.animatedsoftware.com/cassini/kg9605pl.htm>).

44 *See e.g.* Karl Grossman, *Nuclear Space Missions Break Down Political Barriers*, 28 Just Peace, Florida's Peace & Justice Newsp. (1993) (available at <http://www.animatedsoftware.com/cassini/ kg9328jp.htm>); Karl Grossman, *Kiss Florida Goodbye?*, N.Y. Times (Oct. 17, 1989) (available at <http://www.animatedsoftware.com/ cassini/kg8910ny.htm>); Karl Grossman, *We Don't Need Reactors in Space: Ignoring Safe Solar Power, We Send Plutonium-Laden Probes into Orbit*, Newsday: The Long Island

be credible to many environmental and peace organizations, which themselves serve as reference groups, because his work has often been cited in the progressive Project Censored's[45] annual list of news stories that receive insufficient coverage.

In March 1997, Russell Hoffman, a very energetic individual who owns a software company, became concerned by Grossman's arguments and began to push them online vigorously in a series of Web-based newsletters (Stop Cassini Newsletter).[46] Many UseNet postings were forwards of this newsletter. Jane Wardlow Prettyman, editor of The Real News Page, now called American Review, began a web page devoted to Cassini, called Disingenuous Digest: Analysis of News Media Handling of Cassini.[47]

Three organizations became champions of the opposition: the Florida Peace and Justice Center (Bruce Gagnon),[48] the Lovearth environmentalist network,[49] and the NoFlyBy group (Jonathan Mark).[50] These early activists then recruited individuals with credentials in areas including physics, such as Michio Kaku,[51] John Gofman,[52] Ross McCluney;[53] medicine or health physics, such as Helen Caldicott,[54] Earl Budin,[55] Ernest Sternglass,[56] and Horst A.

Newsp. (May 31, 1991) (available at <http://www.animatedsoftware.com/cassini/kg9105we.htm>); Karl Grossman, *Plutonium Shuttle: The Space Probe's Lethal Cargo*, The Nation (Jan. 23, 1988) (available at <http://www.animatedsoftware.com/cassini/kg8801tn.htm>).

45 *See* Project Censored web page <http://www.projectcensored.org/intro.htm>.

46 *See* <http://www.animatedsoftware.com/cassini>.

47 *See* <http://www.americanreview.net/cassini.htm>.

48 *See* Bruce Gagnon, *Cassini Is a Bad Seed*, Rat Haus Reality (July 1997) (available at <http://www.ratical.org/radiation/cassini.html>).

49 See <http://www.lovearth.net/> to get a sense of the Lovearth network, but their Cassini materials had been removed at this writing.

50 *See* Jonathan Mark & Earl Budin, *NASA Misleads the World on the Dangers of the Cassini Space Ship's Fly-by of Earth*, Global Network Against Weapons and Nuclear Power in Space web site <http://www.globenet.free-online.co.uk/cassini/stopcass.htm>; Grossman & Mark, *supra* n. 19; and the NoFlyBy web site, *supra* n. 16.

51 *See* Kaku, *supra* n. 10.

52 *See* Gofman, *supra* n. 7; PBS Forum, *Risks vs. Returns: Is the Cassini Mission Safe?* (Oct. 21, 1997)(available at <http://www.pbs.org/newshour/forum/october97/ cassini4.html>).

53 *See* Ross McCluney, *Solar Solutions For Cassini*, *The Cassini Debate and Beyond* (Jane W. Prettyman, ed.), American Review (Aug. 14, 1997) (available at <http://www.americanreview.net/cassolar.htm>).

54 *See* Caldicott, *supra* n. 19; Helen Caldicott, Speech, *NASA Ames Research Center*, 125

Poehler;[57] and a former employee at Cape Canaveral, Alan Kohn.[58] Each was willing to make public statements or speeches at demonstrations encouraging opposition to Cassini, which then were sent around UseNet and other Internet venues. Kaku, McCluney, Budin, and Poehler were willing to write and post materials for the cause, while Gofman, Caldicott, Sternglass, and Kohn permitted themselves to be quoted on activist web sites. Many of these individuals are well-known and widely respected in progressive political and environmental circles, making their statements on this issue credible among people who admire and trust them in other situations. Thus, this whole controversy started with from one to eleven people, depending on how far back one looks.

On the proponent side, nearly 6% of UseNet authors simply forwarded others' messages. These were generally posts from NASA publicity office personnel, notably Ron Baalke[59] and Mary Beth Murrill.[60] Eight percent of neutrals also forwarded others' messages. The influence of key individuals, thus, was both proportionately and absolutely less in the case of neutrals and proponents. Only the Cassini opponents were able to make effective use of the power of chain-letters forwarding. The success of chain-letters depends upon catching the attention of readers and then motivating them to forward the message to others. The dread elicited by opponent postings substituted for the "bad things will happen to you if you do not immediately send this to

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Stop Cassini Newsltr. (available at <http://www.animatedsoftware.com/cassini/nltrs/nltr0125.htm>).

55 *See* Mark & Budin, *supra* n. 50; Earl Budin, *Letters to the UN* (April 2, 1999) (available at <http://www.flybynews.com/archives/ref/budin2.htm>); Budin (March 12, 1999) (available at <http://www.flybynews.com/archives/ref/budin3.htm>).

56 *See* Russell D. Hoffman, *Dr. Sternglass and Me*, Stop Cassini (April 8, 1997) (available at <http://www.animatedsoftware.com/cassini/ster9704.htm>).

57 *See* Horst A. Poehler, *Cassini Cancers ("The Plutonium Story")*, Stop Cassini (August 1997) (available at <http://www.animatedsoftware.com/cassini/hp9708ps.htm>.)

58 *See* Alan Kohn, Speech, *Cape Canaveral Air Force Station Main Gates* (July 26, 1997) (available at <http://www.prop1.org/2000/cassini/9707kohn.htm>). Mr. Kohn was the Emergency Preparedness Operations Officer at Cape Canaveral during the Galileo and Ulysses launches.

59 Ron Baalke is a webmaster for JPL missions and publicizes mission events on UseNet newsgroups.

60 Mary Beth Murrill is the News Chief for JPL and handles publicity concerning space nuclear power and institutional environmental issues.

ten of your friends" curse that typically accompanies other contemporary E-mail chain-letters.

Discussion

In this section, findings are related back to the hypotheses generated from hazards perception literature. Table 5 organizes the research questions and their outcomes.

First, contrary to the expectations of hazards literature, this technological risk debate does not seem driven by the issue of control over the plutonium exposure, not even among the opponents. Fairness questions are often raised as an explanation for public activism over technological risk, but only two percent of authors in this debate on UseNet brought up the issue of fairness, and they did so in a manner tangential to the risk of plutonium exposure.

Table 5
Summary of Findings

Research Questions	*Outcomes*
1. Perceived control over exposure	Not a focus
2. Fairness of risks and benefits	Not a focus
3. Dread	Central axis of debate
4. Opponents more numerous and vocal	Less numerous, more vocal
5. Suspicion of government	Some evidence both sides
6. Demographic variations (gender)	Few women, plurality does support mission, gender gap: fewer women support mission than men do
7. Self-interest	Public supports mission, self-interest is evident
8. Reliance on reference groups	Opponents forward others' messages more than proponents and neutrals do
9. Center/border dichotomy	Opponents more counter-cultural (Nostradamus), more reliant on reference groups
10. Internet as effective political medium	Half dozen people started impressive movement that made Cassini very controversial at national and local levels

Second, there was a significant gender gap, which has emerged in other hazards perception studies, with women more doubtful about the assumption of this technological risk. Even so, a greater percentage of women supported the Cassini mission than were neutral or opposed to it. The most striking manifestation of gender in this debate, however, was the near invisibility of women among the 937 authors (only 42). Online space-related technological risk discussion remains a male preserve.

Third, and perfectly in accordance with prior literature, dread is the central axis in this hazards debate. Two thirds of opponents expressed dread of nuclear contamination, and the Nostradamus discussants seemed quite terrified that Cassini would bring about the predicted end of the world. Over a quarter of the proponents addressed the dread factor, too, mainly by trivializing the probability of an accident and the consequences of an accident should one occur.

Another factor mentioned in hazards literature is mistrust of public institutions, and it is a secondary theme in this debate. Six opponents said that there is a NASA conspiracy to militarize space and the plutonium on Cassini is merely the camel's nose in the tent, while another seven stated that the media were censoring the plutonium risks of Cassini. Both of these arguments are often cited in the forty six messages forwarded by opponents. Even a few proponents (nine) said they thought the media were biased towards the opponents and were not allowing NASA the chance to defend the mission and its goals. So, mistrust of national government and of media is present among opponents of the mission and, in the case of the media, this mistrust is shared by a few proponents, too.

Fourth, surprisingly, given the level of dread attached to plutonium, more UseNet contributors supported the mission than opposed it, even when self-interested people were removed. Self interest did affect the authors' propensity to communicate in this controversy, however. When discernibly self-interested persons were removed from the database, there was no significant change in the balance of authors among the opponent, proponent, and neutral stances towards Cassini-Huygens, but there was a very significant shift in the volume of communications coming from each stance. The more loquacious proponents in the original database seem to have been those in Douglas and Wildavsky's center, people involved in the mission or in the space program, closer to the center of political power in this issue, and obviously much more comfortable with conventional risk assessment and trade-offs between risk and gain. When these more "central" people are removed, a more communicative and passionate periphery is seen, one skeptical of risk assessment science, mistrustful of government, and oppositional in communication style.

Fifth, suggestions of the center/border dichotomy also show up in this debate in the form of Nostradamus. Nostradamus' predictions appeal to some non-scientists, especially those inclined to New Age and other classically counter-cultural movements. These movements explicitly question scientific logic and method, denigrating science as merely a privileged, but not an epistemologically superior way of knowing the world and making decisions.[61] The New Age and Nostradamus fit the counter-cultural quality of Douglas and Wildavsky's border. It is not surprising that fans of Nostradamus were prominent among the opponents to Cassini-Huygens[62] and that all but 2 of the 13 proponents who addressed Nostradamus' "King of Terror" were debunkers of astrology and the New Age.

The tendency to forward others' messages is indicative of both the center/border split and the tendency for time-pressed people to rely on the judgments of reference groups they trust. The amount of research necessary to understand the details of the plutonium controversy is beyond most people's time and energy, and yet in a democratic society it is an important social issue. Few people outside the borders of the space program and its contributing institutions are familiar with the technology, while those more central to the program may be both familiar with it and self-interested in the outcome of the debate. Those persons on the outside necessarily depend on other people's opinions, judgments, and analyses; hence, the opposition more strikingly used the

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61 *See e.g.* Robert Anton Wilson, The New Inquisition: Irrational Rationalism and the Citadel of Science (Falcon Press 1987).

62 The main organizers of the anti-Cassini movement were conflicted over this Nostradamus angle that had descended on them. Russell Hoffman was appalled at the development, fearing for the credibility of the movement. He wrote "Right now, I think the BIGGEST problem facing the movement is that NASA/JPL is trying to make it look like there is no scientific objection to Cassini — instead, pretending that there is only Nostradamus-related confusion." *See* Stop Cassini Newsltr. 93 (Feb. 9, 1999) (available at <http://www.animatedsoftware.com/cassini/nltrs/nltr0093.htm>). The NoFlyBy people decided to encourage the Nostradamus fans in an "enemy of my enemy is my friend" strategy, expressed in their response to "an appeal for information on Nostradamus or other possible pathways to lead to the interest of the media, even including the tabloids. It is not the time to be fussy." *See* NoFlyby Newsltr. 9 (Dec. 23, 1998) (available at: http://www.flybynews.com/archives/alerts/9.htm>).

forwarding of other people's messages to communicate its concerns and suspicions.

Finally, the vanguard of this movement utilized border themes and complaints to recruit others to spread the message. The forwarded messages appealed to suspicions of NASA and the military-industrial complex: bodily pollution being imposed by greedy powers; perceptions of science as the corrupt servant of insane elites; astrological concerns about the "grand cross" of 18 August 1999; and claims that the "Ancients" had detailed knowledge of plutonium. The messages, thus, were embedded in a matrix of pre-existing border beliefs that made them credible to many of their recipients. Incorporated in that matrix were elements shown to bear on perception of technological risk and arouse concern. Dread, above all, and mistrust of public institutions responsible for informing the public about and protecting the public from hazardous technologies.

Conclusions

Risk assessment is a probabilistic, statistical science, not a deterministic, experimental one. Its conclusions inescapably carry the hazards of Type I and Type II errors, and the minimization of one of these errors generally raises the probability of the other. We assume a hazard exists or a technology is dangerous unless shown otherwise by tests with very low prob-values. However, high confidence in the name of human safety may exact opportunity costs in knowledge or economic benefits foregone, while minimizing opportunity costs may increase danger.

Standards in hazard assessment science are inherently political choices. It is a policy decision to manage a hazard to promote human safety and accept opportunity costs or to manage it so as to minimize the opportunity costs of regulation and accept lower levels of human safety. Assessment science and management policy must inform one another, but the relationship is unavoidably controversial. Media can create, enhance, or obscure controversy on any given hazard assessment and decision-making process through coverage of the interaction between experts and activists, which may in turn result in activist recruitment among the public to apply pressure to risk management policy-makers.

Traditional print and broadcast media, which wring out the sensation and drama in a disastrous event or hazardous situation and then move on to other, more "newsworthy" stories, sometimes leave information needs unmet. Risk assessment scientists and risk-management policy-makers cannot control such media. Activists are only marginally more capable of reliably hooking coverage.

The Internet is an emerging way to get information past the control of traditional media decision-makers. The Internet requires a vanishingly small price of entry compared with the entry price required in the highly oligopolistic conventional media. It is also growing explosively into a densely interacting global community. The Cassini controversy demonstrates the power the Internet offers to political activists to affect the agendas of policy decision-makers, particularly if the channels chosen include those not dependent on an audience actively looking for information on a given topic as does the Web. Using E-mail, listservers, newsgroups, or chats, a handful of people can alert others to an issue of concern and enlist them to spread the news. The population passively receiving these notices expands exponentially. Even if just a small percentage of those exposed to the idea responds politically, the result can be tremendous political pressure.

This kind of audience-passive Internet communication offers a counterweight to the political influence of great corporations and wealthy individuals, which normally dominate the traditional print and broadcast media because of the cost of entry. It is potentially very empowering to ordinary citizens. Democratization is the great strength of the Internet in the sense that it allows a wider cross-section of society to generate effective political pressure.

The demagogic use of the Internet, however, remains the shadow of democratic empowerment. Sensationalism, conspiracies, *ad hominem* attacks, exaggeration, and other emotionally-manipulative devices are abundant in the Cassini debate, particularly among the opponents but also among flame-prone proponents.

The technological hazard case of Cassini raises issues of expert qualification, the acceptability of risk, and the tension between democracy and demagoguery in cyberspace. Independent risk assessment of the plutonium on board Cassini deemed the hazard tiny in probability and trivial in consequence. This assessment did not comfort those who deeply dread nuclear technology in any form whatsoever or who profoundly mistrust government. They found experts to claim high probabilities of disaster and extremely serious consequences, some of whom spoke out on topics outside their expertise without benefit of peer review.

As this battle raged on in the listservers, chat rooms, and UseNet groups, it had all the appearance of dueling risk assessment experts. Thus, expertise was delegitimated. People encountering the messages over the issue were on their own to decide if Cassini was a mortal danger or not, with an array of experts among whom to cherry-pick in support of their decision after the fact.

The complex nature of Cassini and of many other technological and natural hazard controversies makes them baffling to the average citizen. The citizen yet must decide whether to act politically about such controversies or, worse for a democratic society, remain uninformed and apathetic.

This is a dilemma we all face as citizens, scientists or not. We have to make political judgments, and we simply do not have the time to research issues far from our training and everyday concerns. So we take shortcuts to form our opinions — we tend to defer to the opinions of people and organizations we trust. New media make it possible for a handful of people to tap this mechanism of trust and by using their computer's forward button, mobilize a politically potent movement over a socially-amplified hazard. This powerful new phenomenon perhaps deflects us from taking effective political action on more significant hazards. Hazard misperception exacts an opportunity cost in civic organizing time and energy.

What does this controversy teach about risk assessment and risk management decision-making as this new medium emerges to shape hazard perceptions on the part of the public? For risk assessment scientists, the advent of the Internet means more effective opposition to the technology being proposed. This puts the onus on scientists to clearly state and justify all assumptions, procedures, and logic used to assess a risk. Among those assumptions must be a statement of the policy informing assessment: How has the proper balance between human safety costs and scientific or economic opportunity costs been chosen?

There is now an urgent need to make this transparent in documents written specifically and clearly for the lay public and placed online. This public communication in many ways is harder than the original risk assessment. It would help if risk communicators became very familiar with the axes most likely to trigger public credibility and anticipate how they will play out in a given situation. This may entail hiring outside consultants, as most risk assessment scientists do not have the communications background or inclination for such a project.

The alternative is to have that process explained to the public by a hostile party. JPL did put its various environmental impact statements online,[63] and effort was made to justify the risks involved at a very elementary level.[64] The intermediate level of explanation was dominated by the critics who were able to situate their explanations and criticisms within the larger suspicions of an alienated public.

Risk management decision-makers, particularly politicians, will be hearing more frequently from a larger sample of the public as the Internet becomes more and more ubiquitous. In this sense, Internet communications may better represent the feelings of the general electorate by dint of reducing small sample effects. As the effort involved in constituent communication becomes ever smaller, however, it is becoming harder to discern just how much political commitment constituents have on an issue. Traditionally, elected officials assumed that one paper letter, because it took so much effort to write, might represent the feelings of a much larger number of constituents without the time to write. A swarm of E-mail, however, might come from a sample of people to whom the issue means just barely enough to cause them to hit a forward button.

In the case of a given technological or natural hazard debate, this sample, whatever it represents, may be responding to demagoguery, self-interest, or the well-informed consideration of risks and benefits.

63 *See e.g.* <http://www.jpl.nasa.gov/cassini/english/msnsafe/introlinks.html>.

64 *See e.g.* <http://www.jpl.nasa.gov/cassini/english/msnsafe/>, although this was updated and substantially improved in May 2000.

Note: All links given here were verified as working as of 11/07/01. As time goes on, however, their accuracy will degrade as web authors change their sites or close them.

The source of political pressure may not be too apparent when decision-makers consider hazard policy management. While one would hope that decision-makers rely on risk assessment science in framing their responses, they do so in an atmosphere of political risk and uncertainty, with Type I and Type II hazards to their own careers.

For activists, the Cassini controversy illuminates the possibility of tremendous empowerment of individuals. In this case, a handful of people became an effective vanguard for a mass movement that might just have been able to shut this mission down. The movement might have been successful had Internet organizing been available when the mission was most vulnerable to cancellation, during the 1992 economic crisis and the ensuing congressional cost-cutting frenzy. On the other hand, the electronic frontier does not guarantee success. Cassini-Huygens was launched and the Earth gravity-assist went forward, both safely. Despite the exponential transmission of a handful of people's oppositional messages, the majority online remained unconvinced of the risk despite appeals to the end of the world. Apparently, there are limits to success in online organizing. It is in the interest of activists to find out just what those limits are and to respect them.

The Internet clearly can confer a measure of political agenda-setting power on a wide cross-section of society. Individuals highly placed in corporate management and major political contributors may find their own power more often and more effectively contested and diffused among "Netizens." In its ability to diffuse agenda-setting power, Internet organizing promotes democratization. Demagoguery, however, remains the shadow of empowerment, and its hallmarks are in this debate. However the dance of empowerment and demagoguery may play out in the hazard debates of the future, it is well to remember the remark of Thomas Jefferson in a letter to William C. Jarvis, Monticello, September 28, 1821:[65]

> I know no safe depository of the ultimate powers of society but the people themselves; and if we think them not enlightened enough to exercise their control

65 Letter from Thomas Jefferson to William C. Jarvis (Sept. 28, 1821), in Writings of Thomas Jefferson in Twelve Volumes vol. 10 (G.P. Putnam's Sons 1904) (available at <http://memory.loc.gov/mss/mtj/mtj1/052/0200/0276.jpg>).

with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion.