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How Do Nuclear Scientists And Engineers Talk Internally Among Themselves About The Fukushima Energy Crisis?

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Abstract

The research question is: How do nuclear scientists and engineers talk internally about the Fukushima accident? This project examines the role that the Fukushima crisis has on the way energy scientists and engineers talk about the future of energy technologies in the context of climate change and the need for new energy policy. Previous research on the interconnection between science and policy has mainly focused on cases in which scientists and engineers communicate with non-scientists in public venues. This project adopts a unique approach by examining how scientists and engineers manage boundaries between science and policy in internal conversations. The innovation of the project is to discover whether engineers and scientists: 1) blend technical and prudential modes of reasoning; and 2) manage science and policy boundaries within their professional and purportedly "technical" communication. The significance of this research is that because sustainable energy policy is an important contemporary sociopolitical topic, it is helpful to see how nuclear scientists talk about nuclear power as a sociopolitical issue in addition to its technical viability. Significantly, the project sought to discover how the Fukushima accident was discussed by nuclear scientists and engineers. Furthermore, this research provides needed empirical research on the internal expert-to-expert rhetoric amongst scientists. This project used both qualitative and rhetorical methods to analyze ethnographic and interview data gathered at professional nuclear science and engineering conferences. Qualitative methods of participant observation and interviewing were used to collect the data about how nuclear scientists and engineers talk among themselves about the non-technical aspects of nuclear power. The data was then coded and analyzed using the Socio-Political Elements of Energy Development (SPEED) framework to uncover the rhetorical strategies used by nuclear scientists and engineers to discuss the sociopolitical aspects of nuclear energy . The initial findings of this research are: first, description of the ways scientists are talking about Fukushima is valuable because it has not been researched before and will add to scholarship in rhetoric of science. Second, there is potential to contribute to our understanding of the role that scientists and engineers have in the development of energy policy.

Key Words: Science and Technology Communication; Nuclear Energy; Risk and Crisis Communication

1. Introduction

This project examines how scientists and engineers researching low-carbon energy technologies talk among themselves about the social, political, and cultural implications of their research. That project examines expert-to-expert discussions among scientists and engineers about low-carbon energy technologies, particularly within two distinct but related energy technology sectors: wind, and nuclear. Using ethnographic and interview methods, the research team collected data at a nuclear science and engineering professional conferences where scientists and engineers gather to discuss their research. This paper presents the initial findings from analysis of one part of the larger

data set focused on the way nuclear scientists and engineers talk among themselves about the Fukushima Daiichi nuclear power plant accident that occurred in Japan in March 2011 following an earthquake and tsunami..

In order to understand how nuclear scientists and engineers talk about the implications of the Fukushima accident on their professional community and the future of energy technologies, the research question for this project is: How do nuclear scientists and engineers talk internally among themselves about the Fukushima accident? More specifically, this project examines the role that the Fukushima accident had on the way energy scientists and engineers talk about not just the technical, but also the sociopolitical implications that Fukushima had for nuclear power such as the future of nuclear energy technologies in the context of climate change and the need for new energy policy. It is important to observe and describe how scientists talk about nuclear energy as a sociopolitical issue and not just a technical issue because it reveals the interconnection between science and politics (e.g., Hart & Victor, 1993; Lahsen, 2005; Shackley & Wynne, 1995, 1996; Yearley, 2008). Past research in rhetoric of science primarily focuses on how scientists use technical reasoning in their internal dialogue and only use sociopolitical (or prudential) reasoning in rhetoric aimed at non-scientist publics (Goodnight, 2005). Yet, Science, Technology & Society (STS) scholars argue that scientists and engineers integrate technical and prudential reasoning, often without conscious recognition (Douglas, 2009; Kincaid, Dupre, & Wylie, 2007; Longino, 1990; Machamer & Wolters, 2004). This research will expand the focus of rhetoric of science research by describing how scientists talk among themselves about the sociopolitical aspects of their research and used both technical and prudential forms of reasoning. In the remainder of this paper, I will discuss the research method, the initial results, and conclude with the importance of this research for scholarship in rhetoric of science.

2. Research Method

In order to answer the research question, I used two research methods: qualitative and rhetorical. Qualitative research was used to collect the data, which is based on participant observation and interviews with key scientists and engineers at a national nuclear society conference. Other members of the research team collected this data, which includes interviews and transcripts from conference sessions. The data was entered into NVivo qualitative analysis software. This research project analyzed a subset of the data collected by the larger research team. To analyze how nuclear scientists and engineers talked about the Fukushima accident, this project only analyzed the data in which Fukushima was explicitly discussed by nuclear scientists and engineers at a professional conference.

Rhetorical methods were used to analyze the internal expert-to-expert rhetoric of nuclear energy scientists and engineers to discover the forms of technical and prudential reasoning. Our rhetorical analysis followed a codebook based on the Socio-Political Evaluation of Energy Deployment (SPEED) Framework (Stephens, Peterson and Wilson, 2007). The SPEED framework assumes that sociopolitical influences on energy technology include at least six themes: (1) Cultural, (2) Economic, (3) Environmental, (4) Legal, (5) Political, (6) Technical Functions. The research team collapsed the Legal and Political into one code for this study because there were not significant differenced in the data between legal and political functions. According to Stephens, Wilson, and Peterson, "We present three research methods that could be applied within the SPEED framework that could be particularly helpful in understanding the integrated socio-political influences on energy technology deployment: (1) policy review and analysis, (2) media analysis, and (3) focus groups and structured interviews with key stakeholders. By integrating the fields of technology diffusion, environmental policy, comparative analysis of states, and risk perception, future empirical research conducted within this SPEED framework will improve understanding of the interconnected socio-political influences on energy technology deployment to enable energy modelers, policy-makers, energy professionals, state planners and other stakeholders to develop and implement more effective strategies to accelerate the deployment of emerging energy technologies" (Stephens et al., 2007, p.22). This project expands on the SPEED framework by extending it to analysis of ethnographic observation and interviewing data.

The author and an additional researcher on the team conducted sentence-level coding of the data described above using the SPEED framework. To isolate the data pertaining to the Fukushima accident, the researcher conducted word searches using Nvivo software to find the relevant interviews and conference session transcripts that included discussion of the Fukushima disaster. The search query that was used for this project was: Fukushima OR Japan OR Tsunami OR Earthquake OR Meltdown OR Seismic, including stems (so terms like Japanese or earthquakes were also included). This yielded 1 ethnographic interview, 2 long interviews and 8 conference session transcripts, for a total of 275 sentences. Each individual sentence was coded for the six themes in the SPEED framework. If a sentence was coded with one of the six themes, then the coder assessed the tone to indicate whether the speaker gave the theme a negative or positive inflection. The two coders obtained intercoder reliability of 94%.

Some of the SPEED themes were broken down into several different sub-nodes for this particular project to add detail to our analysis. Under cultural, there were three sub-nodes: Nuclear Community Attitudes Towards Risk, Safety Culture and Public Backlash. Nuclear Community Attitudes Towards Risk Negative is used for a sentence in which the Fukushima disaster demonstrates that the scientific community does not take risks seriously. Nuclear Community Attitudes Towards Risk Positive stands for sentences where the Fukushima disaster demonstrates that the scientific community takes risks seriously. Safety Culture Negative is used for a sentence in which the Fukushima is representative of systemic safety culture failures that need reform. Safety Culture Positive is used when the sentence indicates that no sweeping changes are needed because problems were isolated to the Japanese nuclear science community. Public Backlash Negative stands for instances when the general public have and/or will turn against nuclear energy and demand new restrictions. Public Backlash Positive stands for general public has and/or will continue to support nuclear energy in wake of disaster.

The economic theme used Cost of Industry Negative for sentences in which Fukushima has and/or will create cost burdens to industry in the form of cleanup, new regulations, and/or stalling of new projects. Cost of Industry Positive was used for instances when Fukushima will not lead to cost burdens for the industry; economic fallout for industry as a whole is minimal.

Under the environmental theme, there were three sub-nodes: Natural Disasters, Environmental Fallout, and Human Impact. Natural Disasters Negative is used when the Fukushima disaster shows current standards are not good enough to protect against natural disaster. Natural Disasters Positive indicates that current standards good enough to withstand natural disasters; Fukushima was an anomaly. Environmental Fallout Negative is used when the sentence indicates that the Fukushima disaster has and/or will have negative impact on the surrounding environment in Japan. Environmental Fallout Positive, on the other hand, indicates that Fukushima hasn't and/or will have little impact on the surrounding environment in Japan. Human Impact Negative is used when the sentence indicated that the Fukushima disaster has and/or will have negative effects on local human populations (e.g. radiation, displacement). Human Impact Positive indicates that the Fukushima disaster has and/or will not have negative effects on local human population; and fears of such effects are overblown.

Under Political/Legal, there are two sub-titles: Governments Reaction on Fukushima and New Standards Post-Fukushima. We used Government Reaction to Fukushima Negative when sentences indicated that government leaders have and/or will turn against nuclear because of disaster. Government Reaction to Fukushima Positive indicates that government leaders are and/or will continue to be supportive of nuclear in spite of disaster. New Standards Post-Fukushima Negative is used for sentences that talk about governments creating new regulations; and that these new regulations will be burdensome. New Standards Post-Fukushima Positive was used for sentences that indicate that governments will not enact new reforms and/or new reforms will not be burdensome.

Under the technical node, Technological Safety Negative is used for instances when the Fukushima disaster shows technological changes are needed; current technology not safe enough. Technological Safety Positive is used for sentences that indicate that current technology is safe; and that the disaster was result of using outdated or "bad" technology.

3. Results

The following bullets list the frequency of each of the codes within the 275-sentence data set for this project.

- Community Attitudes Towards Risk Negative - 23 times.
- Safety Cultural Negative - 31 times.
- Public backlash Negative - 27 times.
- Community Attitudes Towards Risk Positive - 31times.
- Safety Culture Positive -19 times.
- Public Backlash Positive - 18 times.
- Cost of Industry Negative - 22 times.
- Cost of Industry Positive - 6 times.
- Natural Disaster Negative - 29 times.
- Environmental fall out Negative - 6 times.
- Human Impact Negative - 10 times.
- Natural Disaster Positive - 4 times.

- Environmental Fall Out Positive - 1 time.
- Human Impact Positive - 15 times.
- Governments Reaction Negative - 12 times.
- New Standards Negative - 15 times.
- Governments Reaction Positive - 3 times.
- New Standard Positive - 1 time.
- Tech Safety Negative - 7 times.
- Tech Safety Positive - 10 times.

The top three topics coded are: Nuclear Community Attitudes Towards Risk Positive, Safety Culture Negative and Natural Disasters Negative. The three topics that were coded the least are: Governments Reaction Positive, New Standard Positive and Environmental Fall Out. Also, there are two really strong correlations: 1) a correlation between Nuclear Community Attitudes Towards Risk Negative and Public Backlash Negative and, 2) a correlation between Public Backlash Negative and Cost to Industry Negative. Based on the frequency of the codes, our intial findings reveal that scientists and engineers have some debates within their field about cultural factors especially on Safety Culture and Community Attitudes Towards Risk.

4. Discussion of Results

The results confirm our general hypothesis and previous research that suggests that when nuclear scientists and engineers talk internally among themselves, they are talking about both technological and sociopolitical aspects of their technologies and they use both technical reasoning and prudential reasoning (Goodnight, 2005). Indeed, the results indicate that the discussion of the Fukushima disaster often invoked sociopolitical issues more than technical issues. Based on the results, specifically comparing the frequency of the technology category and cultural category, nuclear scientists and engineers' discussions of Fukushima were heavily influenced by sociopolitical and prudential topics. The Fukushima disaster will play an important role in future policy discussions surrounding nuclear safety. Our results suggest scientists vigorously discussed the implications of the Fukushima disaster for continued used of this technology.

5. Conclusion

This study is an exploratory study that offers a description of the types of technical and sociopolitical themes that came up in scientists' discussions among themselves about the Fukushima disaster. These findings contribute to knowledge about how scientists and engineers employ both technical and prudential reasoning and engage with sociopolitical issues in conversation amongst themselves. Continued research in this project has the potential to enhance our understanding of the rhetorical and argumentation patterns of interdisciplinary dialogue among scientists and engineers, both with regard to Fukushima and in relation to other issues discussed by the community. The larger research project of which this is a part also has the potential to benefit society by addressing how policy implications are composed within a societal context that includes both technical and prudential forms of reasoning. It is especially timely given heightened societal awareness of climate change, nuclear energy, and our energy system. This project will lend way to future research on shrinking the gap between society and scientists.

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7. References

1. Stephens, Jennie C., Tarla Rai Peterson, and Elizabeth J. Wilson. "Socio-Political Evaluation of Energy Deployment (SPEED): An Integrated Research Framework Analyzing Energy Technology Deployment." Technological Forecasting and Social Change. 75, no. 8 (n.d.): 1224–46. doi:10.1016/j.techfore.2007.12.003.
2. Hart, D. M., & Victor, D. G. (1993). Scientific elites and the making of US policy for climate change research, 1957-74. Social Studies of Science, 23(4), 643-680. doi:10.1177/030631293023004002
3. Lahsen, M. (2005). Technocracy, democracy, and U.S. climate politics: The need for demarcations. Science, Technology & Human Values, 30(1), 137 -169. doi:10.1177/0162243904270710
4. Shackley, S., & Wynne, B. E. (1995). Global climate change: the mutual construction of an emergent science-policy domain. Science and Public Policy, 22(4), 218-230.
5. Shackley, S., & Wynne, B. (1996). Representing uncertainty in global climate change science and policy: Boundary-ordering devices and authority. Science, Technology, & Human Values, 21(3), 275-302. doi:10.1177/016224399602100302
6. Yearley, S. (2008). Nature and the environment in science and technology studies. In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), The handbook of science and technology studies (3rd ed., pp. 921-947). Cambridge, MA: MIT Press.
7. Douglas, H. (2009). Science, policy and the value-free ideal. Pittsburgh, PA: University of Pittsburgh Press.
8. Kincaid, H., Dupre, J. & Wylie, A. (Eds.). (2007). Value-free science? Ideals and illusions. Oxford: Oxford University Press.
9. Longino, H. (1990). Science as social knowledge: Values and objectivity in scientific inquiry. Princeton, NJ: Princeton University Press.
10. Machamer, P., & Wolters, G. (Eds.). (2004). Science, values, and objectivity. Pittsburgh, PA: University of Pittsburgh Press.
11. Sismondo, S. (2008). Science and technology studies and an engaged program. In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), The Handbook of Science and Technology Studies (3rd ed., pp. 13-31). Cambridge, MA: MIT Press.

7.1 Work Consulted

1. Aristotle. (1991). On rhetoric: A theory of civic discourse. (G. A. Kennedy, Trans.). New York: Oxford University Press.
2. Banning, M. E. (2009). When poststructural theory and contemporary politics collide: The vexed case of global warming. Communication and Critical/Cultural Studies, 6(3), 285–304.
3. Bitzer, L. F. (1992). The rhetorical situation. Philosophy & Rhetoric, 25, 1-14.
4. Bucci, M. & Neresini, F. (2008). Science and public participation. . In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), The handbook of science and technology studies (3rd ed., pp. 449-472). Cambridge, MA: MIT Press.
5. Burke, K. (1966). Language as symbolic action: Essays on life, literature, and method. Berkeley: University of California Press.
6. Ceccarelli, L. (2011). Manufactured scientific controversy: Science, rhetoric, and public debate. Rhetoric & Public Affairs, 14(2), 195-228.
7. Couldry, N. (2008). Form and power in an age of continuous spectacle. In D. Hesmondhalgh & J. Toynbee (Eds.), The media and social theory (pp. 161-176). New York, NY: Routledge.
8. Coleman, S., & von Hellerman, P. (Eds.). (2011). Multi-sited ethnography: Problems and possibilities in the translocation of research methods. New York, NY: Routledge.
9. Crate, S. A. (2011). Climate and culture: Anthropology in the era of contemporary climate change. Annual Review of Anthropology, 40, 175-194.
10. Depoe, S. P., Delicath, J. W., & Elsenbeer, M.-f. (Eds.). (2004). Communication and public participation in environmental decision making. Albany, NY: SUNY Press.
11. Douglas, H. (2000). Inductive risk and values in science. Philosophy of Science, 67(4), 559-579.
12. Endres, D., Sprain, L., & Peterson, T.R. (2008). The necessity of praxis in environmental communication research: A case study of the Step It Up 2007 national research project, Environmental Communication: Journal of Nature and Culture, 2(2), 237-245.

13. Endres, D. (2009a). Expanding our notions of scientific argument: A case study in the use of scientific argument by Native Americans in public hearings. In L. Kahlor & P. Stout (Eds.), Communicating science: New agendas in communication (pp. 187-208). New York, NY: Routledge.
14. Endres, D. (2009b). From wasteland to waste site: The role of discourse in nuclear power's environmental injustices. Local Environment, 14(10), 917-937.
15. Endres, D. (2009c). Science and public participation: An analysis of public scientific argument in the Yucca Mountain controversy. Environmental Communication: A Journal of Nature and Culture, 3(1), 49-75.
16. Endres, D. (2009d). The rhetoric of nuclear colonialism: Rhetorical exclusion of American Indian arguments in the Yucca Mountain nuclear waste siting decision. Communication and Critical/Cultural Studies, 6(1), 39-60.
17. Endres, D., Sprain, L., & Peterson, T. R. (Eds.). (2009). Social movement to address climate change: Local steps for global action. Amherst, NY: Cambria Press.
18. Endres, D. (2012) Sacred land or national sacrifice zone: The role of values in the Yucca Mountain participation process. Environmental Communication: A Journal of Nature and Culture 6(3), 328–345.
19. Endres, D. (in press). Animist intersubjectivity as argumentation: Western Shoshone and Southern Paiute arguments against a nuclear waste site at Yucca Mountain. Argumentation.
20. Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). Writing ethnographic fieldnotes. Chicago, IL: University of Chicago Press.
21. Falzon, M. (Ed.). (2009). Multi-sited ethnography: Theory, praxis and locality in contemporary research. Abingdon, UK: Ashgate.
22. Farrell, T. B., & Goodnight, G. T. (1981). Accidental rhetoric: The root metaphors of Three Mile Island. Communication Monographs, 48(4), 270-300.
23. Feldpausch-Parker, A. M., Chaudhry, R., Stephens, J. C., Fischlein, M., Hall, D. M., Melnick, L. L., & Wilson, E. J. (2011). A comparative state-level analysis of carbon capture and storage (CCS) discourse among U.S. energy stakeholders and the public. Energy Procedia, 4: 7378-6375.
24. Fischlein, M., Larson, J., Hall, D. M., Chaudhry, R., Peterson, T. R., Stephens, J. C. & Wilson, E. J. (2010). Policy stakeholders and deployment of wind power in the sub-national context: A comparison of four U.S. states. Energy Policy, 38: 4429-4439.
25. Foss, S. K. (2009). Rhetorical criticism: Exploration and practice (4th ed.). Long Grove, IL: Waveland Press.
26. Franklin, S. (1995). Science as culture, cultures of science. Annual Review of Anthropology, 24, 163-184.
27. Fuller, S. (1993). Philosophy, rhetoric, and the end of knowledge: The coming of science and technology studies. Madison, WI: University of Wisconsin Press.
28. Gad, C., & Jensen, C. B. (2010). On the consequences of post-ANT. Science, Technology & Human Values, 35, 55-80.
29. Geels, F. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Research Policy, 39, 495-510.
30. Geels, F., & Schot, J. (2007). Typology of sociotechnical transition pathways. Research Policy, 36, 399-417.
31. Goodnight, G. T. (1982). The personal, technical, and public spheres of argument: A speculative inquiry into the art of public deliberation. Journal of the American Forensic Association, 18(4), 214-227.
32. Goodnight, G. T. (2005). Science and technology controversy: A rationale for inquiry. Argumentation and Advocacy 42(1), 26-29.
33. Gross, A. (2006). Starring the text: The place of rhetoric in science studies. Carbondale, IL: Southern Illinois University Press.
34. Haack, S. (1996). Science as social: Yes and no. In L. Hankinson Nelson and J. Nelson (Eds.), Feminism, science, and the philosophy of science (pp. 79-94). Dordrecht, Holland: Kluwer Academic Publishers.
35. Habermas, J. (1991). The structural transformation of the public sphere: An inquiry into a category of bourgeois society. (T. Burger & F. Lawrence, Trans.). Cambridge, MA: MIT Press. (Original work published 1962).
36. Habermas, J. (1989). Theory of communicative action: Lifeworld and system: A Critique of Functionalist Reason (volume 2). (T. McCarthy, Trans.). Cambridge, U.K.: Polity Press. (Original work published 1981).
37. Hackett, E. J., Amsterdamska, O., Lynch, M., & Wajcman, J. (Eds.). (2008). The handbook of science and technology studies (3rd ed.). Cambridge, MA: MIT Press.
38. Heath, D. (1998). Locating genetic knowledge: Picturing Marfan Syndrome and its traveling constituencies. Science, Technology, & Human Values, 23(1), 71-97.
39. Henke, C. R., & Gieryn, T. F. (2008). Sites of scientific practice: The enduring importance of place. In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), The handbook of science and technology studies (3rd ed., pp. 353-376). Cambridge, MA: MIT Press.

40. Hine, C. (2007). Multi-sited ethnography as a middle range methodology for contemporary STS. Science, Technology, & Human Values, 32(6), 652-671.
41. Irwin, A. (2008). STS perspectives and scientific governance. In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), The handbook of science and technology studies (3rd ed., pp. 583-607). Cambridge, MA: MIT Press.
42. Isoard, S. & Soria, A. (2001). Technical change dynamics: Evidence from the emerging renewable energy technologies. Energy Economics, 23(6), 619-636.
43. Jackson, Jr., J. P. (2006). Argumentum ad hominem in the science of race. Argumentation and Advocacy, 43, 14-28.
44. Jasanoff, S. (1990). The fifth branch: Science advisors as policy makers. Cambridge, MA: Harvard University Press.
45. Keränen, L. (2005). Mapping misconduct: Demarcating legitimate science from 'fraud' in the B-06 lumpectomy controversy. Argumentation and Advocacy, 42(2), 94-113.
46. Keith, W., & Rehg, W. (2008). Argumentation in science: The cross fertilization of argumentation theory and science studies. In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), The handbook of science and technology studies (3rd ed., pp. 211-239). Cambridge, MA: MIT Press.
47. Kemp, R., Parto, S., Gibson, R. B. (2005). Governance for sustainable development: Moving from theory to practice. The International Journal of Sustainable Development, 8(1/2), 12-30.
48. Kinsella, W. J. (2001). Nuclear boundaries: Material and discursive containment at the Hanford Nuclear Reservation. Science as Culture, 10(2), 163-194.
49. , W. J. (2004). Public expertise: A foundation for citizen participation in energy and environmental decisions. In S. P. Depoe, J. W. Delicath, & M.-F. Aepli Elsenbeer (Eds.), Communication and public participation in environmental decision making (pp. 83-98). Albany: SUNY Press.
50. Kinsella, W. J. (2005). Rhetoric, action, and agency in institutionalized science and technology. Technical Communication Quarterly, 14(3), 303-310.
51. Knorr Cetina, K., & Merz, M. (1997). Floundering or frolicking—How does ethnography fare in theoretical physics? (And what sort of ethnography?): A reply to Gale and Pinnick. Social Studies of Science, 27(1), 123-131.
52. Krauss, W. (2009). Localizing climate change: A multi-sited approach. In M.-A. Falzon (Ed.), Multi-sited ethnography: Theory, praxis and locality in contemporary research (pp. 149-164). Abingdon, UK: Ashgate.
53. Krauss, W. (2011). Migratory birds, migratory scientists, and shifting fields: The political ecology of a northern coastline. In S. Coleman & P. von Hellerman (Eds.), Multi-sited ethnography: Problems and possibilities in the translocation of research methods (pp. 146-160). New York, NY: Routledge.
54. Latour, B. (1987). Science in action: How to follow scientists and engineers through society. Cambridge, MA: Harvard University Press.
55. Latour, B. (2004a). Politics of nature: How to bring sciences into democracy. Cambridge, MA: Harvard University Press.
56. Latour, B. (2004b). Why has critique run out of steam?: From matters of fact to matters of concern. Critical Inquiry, 30. 225-248.
57. Latour, B. (2005). Reassembling the social: An introduction to Actor-Network Theory. Oxford, UK: Oxford University Press.
58. Latour, B. (2010). An attempt at a 'compositionist manifesto', New Literary History, 41, 471-490.
59. Latour, B., & Woolgar, S. (1986). Laboratory life. Princeton, NJ: Princeton University Press.
60. Leff, M. (1980). Interpretation and the art of the rhetorical critic. Western Journal of Speech Communication, 44, 337-349.
61. Lindlof, T. R., & Taylor, B. C. (2011). Qualitative communication research methods (3rd ed.). Thousand Oaks, CA: Sage Publications.
62. Lofland, J., & Lofland, L. L. (1984). Analyzing social settings: A guide to qualitative observation and analysis (2nd ed.). Belmont, CA: Wadsworth Publishing.
63. Loorbach, D. (2007). Transition management: New mode of governance for sustainable development. Utrecht, The Netherlands: International Books.
64. Lorenz-Meyer, D. (2012). Locating excellence and enacting locality. Science, Technology, & Human Values, 37(2), 241-263.
65. Luhmann, N. (1992). What is communication? Communication Theory, 2, 251-259.
66. Macfarlane. A. (2003). Underlying Yucca Mountain: The interplay of geology and politics in nuclear waste disposal. Social Studies of Science, 33(5), 783-807.

67. Marcus, G. E. (1995). Ethnography in/of the world system: The emergence of multi-sited ethnography. Annual Review of Anthropology, 24, 95-117.
68. Marcus, G. E. (1998). Ethnography through thick and thin. Princeton: Princeton University Press.
69. Marcus, G. E. (2011). Multi-sited ethnography: Five or six things I know about it now. In S. Coleman & P. von Hellerman (Eds.), Multi-sited ethnography: Problems and possibilities in the translocation of research methods (pp. 16-32). New York, NY: Routledge.
70. Mayo, D., & Hollander, R. (Eds.). (1991). Acceptable evidence: Science and values in risk management. New York, NY: Oxford University Press.
71. Middleton, M. K., Senda-Cook, S., & Endres, D. (2011). Articulating rhetorical field methods: Challenges and tensions. Western Journal of Communication, 75(4), 386-406.
72. Pataki, D. E., Emmi, P. C., Forster, C. B., Mills, J. I., Pardyjak, E. R., Peterson, T. R., … Dudley-Murphey, E. (2009). An integrated approach to improving fossil fuel emissions scenarios with urban ecosystem studies. Ecological Complexity, 6, 1-14.
73. Perelman, C., & Olbrechts-Tyteca, L. (1969). The new rhetoric: A treatise on argumentation. University of Notre Dame Press.
74. Peters, J. D. (1999). Speaking into the air: A history of the idea of communication. Chicago: University of Chicago Press.
75. Peterson, M. N., Peterson, M. J., & Peterson, T. R. (2007). Environmental communication: Why this crisis discipline should facilitate environmental democracy. Environmental Communication: A Journal of Nature and Culture, 1, 74-86.
76. Peterson, T. R., Peterson, M. J., & Grant, W. E. (2004). Social practice and biophysical process. Environmental Communication Yearbook, 1, 15–32.
77. Peterson, T. R., Peterson, M. N., Peterson, M. J., Allison, S. A., & Gore, D. C. (2006). To play the fool: Can environmental conservation and democracy survive social capital? Communication and Critical/Cultural Studies, 3, 116–140.
78. Ragland, C. J., Feldpausch-Parker, A., Peterson, T. R., Stephens, J. C., & Wilson, E. J. (2011). Socio-political dimensions of CCS deployment through the lens of social network analysis. Energy Procedia, 4, 6210-6217.
79. Rouse, J. (1987). Knowledge and power: Toward a political philosophy of science. Ithaca, NY: Cornell University Press.
80. Rowland, R. C. (1986). The relationship between the public and the technical spheres of argument: A case study of the Challenger Seven disaster. Central States Speech Journal, 37(3), 136-146.
81. Sismondo, S. (2009). An Introduction to science and technology studies. Malden MA: Wiley-Blackwell.
82. Stephens, J. C., Rand, G. M., & Melnick, L. L. (2009). Wind energy in US media: A comparative state-level analysis of a critical climate change mitigation technology. Environmental Communication: A Journal of Nature and Culture, 3(2), 168-190.
83. Stephens, J. C., & van der Zwaan, B. (2005). The case for carbon capture and storage. Issues in Science and Technology, 22(1), 69-76.
84. Stephens, J. C., Wilson, E. J., & Peterson, T. R. (2008). Socio-political evaluation of energy deployment (SPEED): An integrated research framework for analysis of energy technology deployment. Technological Forecasting and Social Change, 75, 1224-1246.
85. Thompson, J. L., Forster, C. B., Mills, J. I., Werner, C., & Peterson, T. R. (2010). Mediated modeling: Using collaborative processes to integrate scientist and stakeholder knowledge about greenhouse gas emissions in an urban ecosystem. Society & Natural Resources, 23(8), 742-757.
86. Turner, S. (2001). What is the problem with experts? Social Studies of Science, 31, 123-49.
87. Turner, S. (2003). Liberal democracy 3.0: Civil society in an age of experts. London, UK: Sage.
US Energy Information Administration: Independent Statistics and Analysis, 2009. Annual Energy Review 2008. Retrieved 13 March 2010 from http://www.eia.doe.gov/aer/pdf/aer.pdf.
88. Verbong, G., & Geels, F. (2007). The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960-2004). Energy Policy, 35, 1025-1037.
89. Waddell, C. (1990). The role of pathos in the decision-making process: A study in the rhetoric of science policy. Quarterly Journal of Speech, 76(4), 381-400.
90. Wander, P. C. (1976). The rhetoric of science. Western Speech Communication, 40(4), 226-235.
91. Wilson, E. J., & Stephens, J. C. (2009). Wind deployment in the United States: States, resources, policy, and discourse. Environmental Science & Technology, 43, 9063-9070.
92. Woolgar, S. (1982). Laboratory studies: A comment on the state of the art. Social Studies of Science, 12(4), 481-498.

93. Wynne, B. (2002). Risk and environment as legitimatory discourses of technology: Reflexivity inside out? Current Sociology, 50(3), 459-77.