CONSTRUCTING EXPERT-LAY COLLABORATIONS WITHIN ENVIRONMENTAL SCIENCE

ENACTING MODE 2 WORK:

CONSTRUCTING EXPERT-LAY COLLABORATIONS WITHIN ENVIRONMENTAL SCIENCE

By

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ABSTRACT

This dissertation consists of three essays each of which revolves around a group of environmental engineers/scientists who have a different vision of how science should be done and who are seeking to work side-by-side with non-scientific partners to find alternative pollution prevention strategies and technologies. Their goal is to address environmental and social problems by "democratizing" science and redefining expert-lay collaboration so as to involve all participants in the design and application of ecologically friendly technologies and pollution prevention strategies. These scientists and engineers, who call themselves the "Learning Alliance," reflect a trend that researchers in the area of the social study of science and technology call a shift from Mode 1 to Mode 2 science.

The first essay focuses on how the Learning Alliance attempts to enact Mode 2 science. I present an ethnographic study that analyzes how the Learning Alliance goes about establishing the kind of collaboration with end-users on which their vision of science depends. I show that successful negotiations between the Learning Alliance and a particular corporate group of end-users with whom they were working took place only after a series of failed attempts. I argue that both the failures and the successful project they were finally able to establish, can be explained in terms of what Learning Alliance learned about the prerequisites for successful collaborations. More specifically, using social worlds theory and the concept of boundary objects, I make the case that only once effective boundary objects are found can lines of action between social actors in different social worlds be fit together.

In the second essay I draw parallels between the emergence of a Mode 2 model of science and debates within sociology about the need to move towards a public sociology,

that is, a sociology that is more socially engaged. I discuss how the demands of a more publicly oriented sociology presented itself as a dilemma in my own research and how this ultimately led to both a repositioning of myself as an analyst and a re-negotiated relationship with the Learning Alliance I was studying.

The third essay serves as an example of the kind of product that can result when sociologists step outside of their role as detached observers of the groups they study and instead, collaborate with those groups in promoting their collective agendas. The essay is a paper I wrote together with a member of the Learning Alliance. The paper deals with the question of how to involve end-users in all phases of technological development within water and sanitation sectors. The paper builds on the *trading zone* metaphor frequently used in the sociology of science to explain expert-lay collaborative ventures.

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For Barbara Dixon.
We miss you so very much.
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CHAPTER 1 – INTRODUCTION

This dissertation centers around a group of scientists and engineers involved in an initiative to create alternative forms of knowledge production as a means of solving issues related to environmental sustainability. The scientists and engineers reflect a growing movement in science, the goals of which are to democratize science, bringing in end-users and making space for lay expertise in an effort to more effectively address the world's problems.

The particular group of scientists and engineers that I studied called themselves the "Learning Alliance." The group has dedicated itself specifically to the development of ecologically friendly technologies and pollution prevention strategies. They also advocate for social, economic and environmental change. Driven by what they see as systemic failures inherent in conventional "top down" models of knowledge production, the group sought to become involved in projects that took them outside of the university and away from "pure science," where they would be working instead with people in industry and government on "real" problems. Questions I was interested in exploring in relation to the Learning Alliance were the following: How do these academic scientists, trained in conventional disciplinary fields, manage to construct a more "democratic" vision of science with end-users, who traditionally are rarely ever involved in the beginning phases of research? How do these scientists pursue their goals and achieve interdisciplinary collaboration with other disciplines to serve the "public good"? In examining these questions, the goal of the dissertation was to explore the various ways in which a select group of engineers and scientists construct their alternative vision of environmental science and how they go about collaborating with non-scientific partners.

While these goals were ultimately met, the dissertation also took an unanticipated turn. I began the research taking the point of view of a detached and neutral observer and treating the Learning Alliance as a case study in a new scientific movement. However, over the course of the

research my stance shifted and I became a collaborator in the activities in which the Learning Alliance is involved. As a consequence, the dissertation evolved. Rather than producing a conventional dissertation focused exclusively on an ethnography of the Learning Alliance, I opted instead to produce a sandwich thesis that in addition to offering an ethnography that contributes to a better understanding of the Alliance and scientific movements more generally, documents my trajectory toward what is commonly referred to in the discipline as "public sociology." While I discuss public sociology at greater length later in the dissertation, public sociology can be briefly described here as a more activist oriented sociology that aims to use the insights and tools of sociology to address the world's problems and to advance the public good.

The dissertation is organized in the following manner: The first essay focuses on the activities of the Learning Alliance and reflects the perspective of a sociologist seeking to understand the social processes at work in the setting observed. The essay takes the form of a classic ethnography. While my goal was to capture the lived experiences of Alliance members, I did so from the vantage point of an outside observer.

The second essay addresses the shift in my perspective. The essay has elements of an auto-ethnography to it in the sense that it is based on my personal experience. In discussing the factors that contributed to the shift, however, the essay also offers a reflection on the move towards public sociology and the parallels between these new directions in sociology and new ways of producing scientific knowledge that prompted my interest in the Learning Alliance.

The third essay is a paper that was generated out of my collaboration with the Learning Alliance. In other words, I wrote the paper not about the Learning Alliance but about how best to achieve their goal of working collaboratively towards greater environmental sustainability. The paper serves as an example of what a public sociology might look like.

In the remainder of this introduction I provide a more detailed description of the Learning Alliance, when and where it emerged, who its members are and its underlying philosophy toward expert-lay collaborations within environmental science. I also want to situate the group's views within similar trends in science and discuss the literature in the area of Science and Technology Studies (STS) that both tracks and advocates for the democratization of science.

The Learning Alliance

The Learning Alliance is the brainchild of an environmental engineer I refer to using the pseudonym Jared. Prior to earning a PhD in engineering, Jared had been a consultant at a large firm in waste management. For fifteen years he assisted major industrial partners in finding affordable ways to reduce energy costs, limit waste, prevent pollution, develop technological patents and save money. Although he found this line of work stimulating, he did not feel he was making much of an impact in reducing humanity's overall ecological footprint. Looking for a more authentic experience, he decided to pursue an advanced degree and an academic career as he believed this avenue would allow him to make a greater contribution to science, society and the environment. However, once he found himself in an academic position he discovered that even in this role he felt limited in what he could accomplish. With regard to the problems of traditional academic research, he stated, " I want to avoid *empire building* and establish a true sense of collaboration. It is unjust to have one university with only a few scientists who get all the funding. We need to cultivate a number of local research environments in which the meeting of diverse minds can flourish. We can't allow one project to get overly large…only by decentralizing the process can we reach out to those in need. " [Field Notes 2007] Disillusioned with what he called "empire building" within the sciences, Jared sought out a number of scholars who shared his desire to move beyond what he suggested is the exclusionary "expert mono

culture" of academia and find ways to work together to achieve practical results [Field Notes 2007] Jared further explained his discontent with the lack of collaboration and application within universities:

> Aside from a few workshops, a majority of so called collaborative work has nothing of value to show. Sure, when the grant is over, everyone has something to display, a publication or two and a fancy chart. But no knowledge transfer in relation to those who could have benefited from bottom up research...the Learning Alliance model allows different stakeholders to come together and achieve so much more than an academic paper. [Interview #16, 2007]

Having attended many departmental meetings and conferences, Jared met a number of like minded scholars who shared his disappointment with traditional research. Through emails, phones calls and in person conversations, Jared managed to convince nine environmental engineers and scientists at Halo University to assist him in redefining environmental science (6 men and 3 women).[1] These core members held many meetings to clarify their new vision for establishing a more democratic research paradigm regarding pollution prevention, sustainability and knowledge translation. Jared and his core group of scholars gave themselves the responsibility of recruiting, managing and organizing the different stakeholders who would come together under various pollution prevention, environmental and water conservation projects.

In addition to this core group of academic scientists, there were 15 peripheral members (nine men and six women). Depending on the research activity and the problems that core members encountered, these peripheral members were brought in to consult on issues related to problems the core team encountered. These issues ranged from problems with technology to miscommunication with government officials regarding environmental policy design. This peripheral portion of the group was made up of academics from other departments and nearby

[1] In order to maintain anonymity, I provide my participants and the university they work and meet at with pseudonyms.

universities as well as environmental consultants whose interests and goals were compatible with Jared's and those of his core team.

In establishing itself, the group was guided by a model that had its origins in organization and management studies. In fact, the model itself bears the name "learning alliance perspective" or "learning alliance method." [2] The method was designed to explore the dynamic tension that exists between co-operation and competition among groups embedded within market systems. Those who developed the learning approach were aiming to reconceptualize management processes within organizations by developing models that facilitated learning relationships based on common values and easier access to diverse forms of knowledge. Advocates for a learning alliance approach stress that an organization can dominate its competition by establishing strategical learning alliances in which members placed importance on cultivating long term trusting environments that in turn ultimately result in more effective open transfer of knowledge between groups and departments (Crossan and Inkpen 1995; Khanna et al. 1998; Morrison & Mezentseff 1997). Although the learning alliance model first appeared in organizational studies, it has since been adapted in fields as diverse as health, education, international development, agriculture and has just recently been endorsed by urban water management research as a means to address water conservation in heavily populated areas (Laban and Moriarty 2005).

In the case of the Learning Alliance I studied, the learning alliance model is being used to democratize scientific research within pollution prevention arenas. The goal of the Learning Alliance is to make research more relevant and practical by progressively engaging stakeholders in the process of innovation and to ensure rapid uptake of newly developed technologies and processes. Unlike traditional research and development projects, the Learning Alliance tries to

[2] Throughout this introduction I will capitalize the term Learning Alliance when referring to the group I am studying so as to distinguish the group from the learning alliance method. Depending on the context, the scientists in my study use the terms interchangeably.

enlist all participants within any given project in the design, modification and review of research objectives and methodologies. Alliance members argue that wide-scale uptake of solutions is much more probable if those expected to apply solutions are involved in their development.

Alliance members are committed to the idea that local end-users should be viewed as active partners in the research process rather than treated as passive consumers of pure esoteric scientific knowledge. They believe that taking such an approach allows the many barriers to knowledge translation and transfer to be overcome. [3] The Learning Alliance claims that they have a vision and an approach that can counterbalance risk and ineffective knowledge translation and can help environmental research break free from the barriers that deny end-user participation. They argue that a learning alliance approach can facilitate widespread replication and sustainability as a means to prepare for the economic and environmental stresses that will impact the public in the near future.

The Learning Alliance argues that a pitfall of many research and development projects has been their inability to translate research outcomes into practical solutions that are readily taken up by end-users. They suggest that this failure stems in part from relegating knowledge translation to a minor role in the research and development process, resulting in the alienation of stakeholders and end-users. The Learning Alliance promotes sustainable innovation in a number of ways. They claim their methods ensure that research and development problems are appropriately identified and that the real needs of end-users and stakeholders will be addressed. Knowledge translation is inherent in a learning alliance process as the engaged stakeholders quickly adopt the ideas and communicate them within their "community of practice."

[3] Knowledge translation is the practical application of research knowledge to solve problems. Knowledge transfer addresses the problems inherent in moving information from one group or department to another within organizations and how this process impacts individuals and their professional activities (Argote & Ingram 2000).

Implementation of ideas and innovations become the responsibility of all stakeholders, ensuring that risks and rewards are appropriately shared.

In order to achieve their goals, the Learning Alliance is currently bringing together individual and institutional agents in government, industry, and the public sector, including academic colleagues, local businesses, advocates, funding agencies, regulatory bodies, media, consultants and municipal officials to create a team of "green champions" who are willing to break away from conventional modes of knowledge production. Specific examples of their efforts in this regard are described in two of the dissertation's essays.

The Learning Alliance faces a number of challenges in its attempt to empower end-users and enact its vision of sustainability, innovation and pollution prevention. These challenges include how to deliver their alternative environmental science; how to encourage and manage end-users in the collaborative process; how to achieve adequate knowledge translation between themselves and diverse non-scientific partners and most importantly; how to best serve the public good by effectively integrating the multiple discourses of environmental advocacy, scientific research and lay expertise. How the Learning Alliance attempts to overcome these barriers was the core question that originally guided my study.

Mode 2 Science and the Reconstructivist Agenda

The Learning Alliance is by no means the only group working towards an alternative way of doing science. The Alliance is in fact part of a much larger trend towards the democratization of science and technology. Social scientists working in the area of Science and Technology Studies (STS) have described this trend as a shift from Mode 1 to Mode 2 science. For most of the 20th century, the majority of scientists practised "Mode 1 science" (Gibbons et al. 1994; Nowotny et al. 2001) or "normal science" (Funtowicz and Ravetz 1993; Kuhn 1962; Ravetz

1999). Mode 1 science is characterized by the theoretical and experimental activities of experts operating in isolation within monolithic and centralized institutions with little regard for broader social concerns. Over the last several decades, however, conventional Mode 1 science is slowly being displaced by a new way of producing scientific knowledge known as "Mode 2" (Nowotny et al. (2001) or post-normal (Ravetz 1999). Hessels and van Lente (2008: 740) further summarize the trend from Mode 1 to Mode 2 science as a research system that

> ...used to be located primarily in scientific institutions and structured by scientific disciplines, its locations, practices and principles are now much more heterogenous. Mode 2 knowledge is produced 'in the context of application' by so-called transdisciplinary collaborations. Moreover, scientists are more reflexive and they operate according to different quality criteria when compared with the traditional disciplinary mode.

Mode 2 knowledge is what Nowotny et al. (2001) call 'socially robust'. This type of knowledge is different from Mode 1 knowledge in three ways. First, the validity of this knowledge is not dependent on the laboratory. Although it has legitimacy in the laboratory context, it also has value outside the laboratory. Second, the legitimacy of Mode 2 knowledge is achieved by an 'extended group of experts'. This includes lay expertise as well. Third, due to its origins, such knowledge is more likely to weather the storm of intense critique (Gibbons 1999:13). Mode 2 science is best characterized by its diversity and inclusivity. Gibbons states,

> Since expertise now has to bring together knowledge that is itself distributed, contextualized and heterogeneous, it cannot arise at one specific site, or out of the views of one scientific discipline or group of highly respected researchers. Rather it must emerge from bringing together the many different 'knowledge dimensions' involved (Gibbons 1999:15).

Rather than overlooking more traditional and experiential knowledge, a democratically minded science is not beyond exploring alternative epistemological and methodological approaches as a means of solving local problems. Scientists working within a Mode 2 paradigm

acknowledge that conventional scientific methods are on their own, not up to the task of dealing with the problems that face contemporary society. They recognize the need to accommodate knowledge gained through experience as well as from other areas of academic study. A democratic science requires information and facts that go beyond disciplines and conventional methods (Ravetz 1999). Mode 2 science and post normal science are both a concept and project, prescription and description capturing processes that are taking place in science and society in which the traditional paradigms of science (Mode 1/normal) are being eroded and modified by more progressive and inclusive scientific cultures (Mode 2/post-normal).

Many of those within the STS area interested in Mode 2 science are not merely exploring the shift from Mode 1 to Mode 2 science, but are actively promoting it. They argue that beyond simply explaining or describing technoscience and its relationship to society, their task as academics is to offer their sociological skill-set and findings to the scientists they study in the service of solving technological and scientific problems. Furthermore, they assert that such sociological knowledge should inform scientific governance, influence policy and ultimately be used to steer science toward serving the "public good". Woodhouse et al. (2002) term this position the *reconstructivist* agenda. The term reconstructivist is used to "denote a wide domain of scholarship that is normative in orientation and activist in sympathies...helping to inform and deepen public inquiries, deliberations, and negotiations concerning the democratic shaping and reshaping of technologies" (Woodhouse et al. 2002: 299). Researchers in this area "tackle the problems of how to reconstruct technoscience to promote a more democratic, environmentally sustainable, socially just, or otherwise preferable civilization" (Woodhouse et al. 2002: 298). Patrick Hamlett (2003: 115) claims that "it seems only a small step from asserting that technologies are socially constructed (or that technology and society are mutually and

reciprocally constructed) to asking more normative questions: How should technologies be constructed? Which 'relevant social groups' ought to be included in the process? Are there morally preferable ways for the creation of technological frames?" Woodhouse at al. (2002) suggest that first generation scholars in STS prided themselves on their impartiality and neutrality, but their descendants are now gravitating more toward solving social problems as they embed themselves in the political and economic issues that surround their participants' activism.

Empirical Studies

For those adopting a reconstructivist agenda, effective solutions can only come from a scholarship that is engaged in holistic, integrated, and collaborative thinking. To approach knowledge production in any other way can have drastic ramifications. An example offered in the literature is the collapse of the cod fishery off the coast of Newfoundland in 1992. According to Dean Bavington (2009), the near decimation of fish can be attributed to experts' false sense of confidence in their models of sampling, prediction and control regarding the management of cod populations. Scientists, government officials and industry refused to recognize the concerns and incorporate the knowledge of local fishermen who had for many years been issuing warnings about the dangers inherent in offshore commercial fishing. In this case indigenous knowledge was viewed as merely "subjective," "experiential" and "difficult to validate."

The literature also offers examples of the benefits of taking a Mode 2 approach. Whereas the cod fishery disaster is an example of expert failure, Epstein's (1995) study of AIDS activists and their influence in the reformation of clinical drug trials provides insight into the progress science can make when it is prepared to acknowledge experiential knowledge. Epstein discusses four key tactics which "treatment activists" within the AIDS community used to generate the

kind of credibility they needed to have scientists consult them on the transformation of experimental drug tests. "The acquisition of cultural competence, the establishment of political representation, the yoking together of epistemological and ethical claims making, and the taking of sides in pre-existing methodological disputes" all contributed to a situation where the activists were taken seriously and their potential contributions acknowledged with the result that the process of testing new AIDS treatment was greatly improved (Epstein 1995: 410).

While some social scientists have embraced and advocated for Mode 2 science, there are others who have reservations. Denying the shift from Mode 1 to Mode 2 all together, Magnus Gulbrandsen and Liv Langfeldt (2004) have found no evidence indicating a movement towards Mode 2 knowledge production in Norway. Marlee van de Kerkhof and Pieter Leroy (2000) similarly, have found little to suggest that science is being done any differently in the Netherlands. They argue that Holland's National Research Programme "cannot be typified as a post-normal research activity, but that it undoubtedly contains post-normal aspects" (2000:899). Weingart (1997) goes even further and argues that Mode 2 or post normal science are merely catchy metaphors to describe more "politically correct" ways of transforming science. Suggesting that research agendas characterized as Mode 2 are just 'old wine in new bottles,' Weingart argues "there is no fundamental change in epistemology" and the Mode 2 label becomes an excuse to "dramatize" issues and avoid "theoretical depth" resulting in the exploration of "phenomena on the surface" (1997: 592). He goes on to state that alternative science "stands for an epistemological revolution whose more detailed description is unfortunately not provided" (1997:594).

Weingart (1997:594) also claims that researchers who investigate and promote Mode 2 and post-normal science are vague as to what these new paradigms of science actually look like

in practice. Those researchers who do in fact provide evidence for the formation of alternative knowledge production in the sciences demonstrate that these practices are complex and reflect the fact that "not all calls for the democratization of science and expertise are the same" (Michael Carolan 2008: 508). Steven Fuller (1999; 2000:108) suggests that advocates of Mode 2 science have developed a "*stereoscopic* view of history" in which they erroneously separate science into two distinct developments. Mode 1 beginning in the seventeenth-century with the Scientific Revolution and Mode 2 having its origins during the Cold War. Fuller argues that had the "modists" focused on the history of chemistry rather than physics they would have found that the two modes of knowledge production do not suffer from a generational gap but were actually institutionalized simultaneously during the late nineteenth century. Another matter of contention in debates about the direction of Mode 2 science is whether its benefits will be evenly distributed. Hebe Vessuri (2000) has argued, for example, that universities in the developing world may be disadvantaged and marginalized. Rather than participating in knowledge production, he suggests, they may be reduced to passively purchasing "canned virtual courses...and research 'solutions' through the redefined schemes of international cooperation" (2000: 206). Vessuri fears that Latin American research centres in particular will be forced into the role of an "empty cage for new commercial endeavours of the knowledge institutions from the North, ready to explore the last market frontier, that of knowledge" (2000: 206). This isomorphic trend in the globalization of Mode 2 science is speculative as it has yet to be tested.

To summarize, much of the literature on Mode 2 science is concerned with the degree to which a shift in the direction of Mode 2 knowledge production has occurred, whether Mode 2 science represents a fundamental or useful change in how science is done and its attendant problems. These are not issues that my dissertation addresses. My concern was to analyze

ethnographically an attempt to enact Mode 2 science. I was interested in the question of process. My goal, at least initially, was to produce an empirically based micro study of experts attempting to problematize conventional science as a solution to issues in sustainability. Further, in contrast to the literature, this study is unique in that the Learning Alliance is a "professionally initiated participatory science" (Moore 2006). There are only a few 'democratizing science movements' led by experts rather than lay or consumer groups (McCormick 2007).

Conceptual Framework: Social Worlds Theory

In studying the Learning Alliance, I drew on social worlds theory (Clark & Star 2008; Strauss 1993) Social worlds theory has its roots in symbolic interactionism and the interpretive tradition in sociology which seeks to understand the meaning-making activity of social actors. The concept of social worlds was first coined by Anslum Strauss. As a conceptual framework, social worlds theory focuses on how new social groupings emerge with novel ways of understanding themselves in relation to extant social groupings and pressing social problems. Social worlds are distinct communities with similar responsibilities, obligations and goals, creating interactions of reciprocity with each other to realize their goals, and building up overlapping "ideologies" that signal to others how the group accomplishes their activities (Clarke 1991:131).

It was during their study of psychiatric hospitals that Strauss first described how social worlds come together to create social order through negotiation (Strauss et al. 1964). Strauss and his colleagues found that each professional segment within the hospitals they were studying had different perspectives on how patients should be treated and how the hospital should conduct itself. The ongoing negotiation among members eventually brought about various levels of coordinated action despite the many conflicting definitions of health care services. Nurses, social

workers, psychiatrists and hospital administration with divergent perspectives managed to accomplish a working consensus and a common understanding. This negotiated order among distinct social worlds was temporary and often required renewal, yet it was the underlying mechanism that made collective action possible and was the very reason for successful everyday hospital operations. On the basis of these findings Strauss argued that social organization is a collective negotiated experience among many different actors. Social order is not the outcome of prefixed processes acting on individuals. Rather social order comes out of a negotiation context in which problem solving activities take place through actors' reflective adjustments to various obstacles.

Clarke and Star (2008:113) define the concerns of social worlds theory in this way: "This framework thus assumes multiple collective actors-social worlds-in all kinds of negotiations and conflicts, committed to usually on-going participation in broad substantive arenas." The social worlds/arenas perspective acknowledges the situational and dialectical nature of constraint and agency. "In arenas, 'various issues are debated, negotiated, fought out, forced and manipulated by representatives' of the participating worlds and subworlds" (Clarke and Star 2008: 133 [Strauss 1978:124]). "Social worlds/arenas theory focuses on how people organize themselves, and addresses how they do this in the face of others trying to organize them and/or broader structural situations in which they find themselves" (Clarke and Star 2008:135).

As a framework social worlds theory has been applied to various situations, but has proven to be particularly appealing to those who are interested in science as a social world. A common theme that has emerged in studies that have taken a social worlds approach to science is how "going concerns" are managed in light of various constraints (Hughes 1971). Influenced by Hughes work, other interactionist such as Jaber Gubrium and James Holstein argue that

> ....going concerns could be as massive and formally structured as government bureaucracies or as modest and loosely organized as a group of friends... Large or small, formal or informal, each represents on ongoing commitment to a particular moral order, a way of bringing who and what we are in relation to the immediate scheme of things (Gubrium & Holstein 2000:102).

Star's (1989) study of British neurophysiologists during the nineteenth century was one of the first applications of the social worlds theory and the "science as work" approach. Star (1989) uncovered a number of rhetorical strategies used by brain researchers who promoted the theory of 'localization of function' to outmaneuver colleagues who supported a "diffusionist" model to explain the mind-body problem. As a result of strategies that "devoured" anomalies and "managed" uncertainties, scientists who promoted the "localizationist" model overcame the theory's inherent contradictions and achieved an authoritative status that to this day dominates the conceptual organization of neurophysiology. The social worlds framework also played a prominent role in Clarke's (1998) historical analysis of how reproductive sciences, originally a unorganized heterogeneous mishmash of actors, managed to achieve "coalescence" in the 20th century. Clarke argues that the new field of reproductive science could have taken a number of different paths. Yet, her focus on specific "arenas of action," and complex locales of negotiations, demonstrated the path the discipline took to achieve institutionalization. Despite its success, Clarke (1989: 264) suggests that reproductive sciences, because of its "association with sexuality and reproduction...clinical quackery and problematic treatments...and controversial social movements...continues to be viewed as illegitimate." Miall and Miall's (2002) exploration of the role of "reputational capital" in the legitimation of scientific ideas and models despite an absence of data or independent proof is another influential study within the social worlds tradition.

The social worlds approach to studying science as group life acknowledges how actors with diverse backgrounds deal with conflict and acquire mutually shared perspectives or achieve certain levels of collaboration without necessarily acquiring total consensus. In exploring the Learning Alliance's efforts to enact Mode 2 science, I am conceptualizing the group's organization and interactions as a social world seeking to manage and promote its concerns in the face of numerous constraints. Using the social worlds framework in the first essay, I asked, how do new social worlds within the scientific community like the Learning Alliance emerge and take shape? How do those new worlds negotiate the tensions and conflicts inherent in creating new patterns and relationships? My main concern was to investigate the process by which the Learning Alliance attempted to shift from Mode 1 to a Mode 2 science. This dissertation offers an opportunity to study these democratizing processes and the challenges they present as an "intersubjective accomplishment" (Prus 1996; 1997). Prus defines this type of process in terms that resonate with social worlds theory.

> Intersubjective accomplishments are the meanings that are negotiated and shared among members of a community or group. These practices are not static but ongoing and dynamic social processes. Group life and shared meanings are made possible because people "attend to one another", "convey understandings to the other", "acknowledge the view point of the other", "make indications [of things] to self and others and...achieve a mutuality of focus" (Prus 1997: 38).

A social worlds perspective and a focus on the Learning Alliance as intersubjective accomplishment allowed me to keep my analytical focus on member's meaning making activity within a wider negotiation context in which actors are forced to navigate a number of social constraints. Sandstrom et al. (2006:144) define the negotiation order within a context that is informed by a "set of structural conditions and past negotiations that surround and directly affect their content, process, and consequences." A social worlds approach to the study of group life

acknowledges the tension between members' subjective processes and the objective conditions in which they are embedded. In addition to exploring the gradient that exists between autonomy and constraint as it is experienced by the Learning Alliance in their negotiations with non scientific others, I also reflect on this dynamic as it relates to my own involvement with the Learning Alliance.

Not only is this dissertation concerned with the development of the Learning Alliance, but on another level, the dissertation is about my own evolution as a sociologist. I started as a researcher who wanted to take a detached look at how the Learning Alliance organized themselves into a distinct social world and engaged in activism to both change how science is done and to do something about the environment. But through the course of my study I underwent a change of perspective in terms of my understanding of my role as an analyst and how I wanted to approach my research. This trajectory is reflected in the different essays that make up the organization of the "sandwich thesis."

CHAPTER 2- MODE 2 SCIENCE AND INDUSTRY

Mode 2 Science and Industry: Redefining the "Payback Period"

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Running Head = REDEFINING THE "PAYBACK PERIOD"

Word Count= 9 616

ABSTRACT

Using the social worlds perspective, I explore the efforts of a group of academic environmental engineers to involve local industrial partners in projects concerned with long-term sustainability and pollution prevention technologies. Ethnographic data show that the major sources of conflict during early interactions was based on the different perspective that each group brought to their mutual goal of introducing environmentally sound practices into industrial operations. The Alliance scientists were oriented towards projects that had a meaningful environmental impact while their business partners gravitated towards projects that allowed them to demonstrate their sense of environmental responsibility without impacting their financial bottom line. The business partners were also concerned with quick "payback periods". These are projects that deliver quick returns on their investments. These differing perspectives resulted in two failed efforts at collaboration. Ultimately, however, the two groups were successful in finding a project on which they could collaborate. I explain both their failures and their success in terms of the need for effective boundary objects in situations where different social worlds come together in the pursuit of common goals. Within a negotiation context I describe as asymmetrical, the Learning Alliance and their business partners fit their lines of action together so as to allow for collaboration.

This paper explores the activities of a group of academic environmental engineers and scientists in Southern Ontario, Canada, who, starting in 2006, have been organizing themselves around a newly emerging model of knowledge production in science to advocate for social and environmental change within pollution prevention and water sanitation sectors. These scientists have committed themselves to incorporating local end-users and community stakeholders in scientific work they do, which in this particular case involves the development and maintenance of ecological sustainable technologies and strategies. By recognizing the value of the knowledge and experiences these groups have, the scientists in the Learning Alliance claim that they can more adequately address the lack of knowledge translation between end-users and researchers within environmental science. Although there are many initiatives designed to tackle the problems associated with pollution prevention, the engineers and scientists I have been following stand out for their determination to bring together, at the ground level and in their local context, various individual and institutional stakeholders such as scientists, engineers, local businesses and municipal officials into the process. They are striving for, in their words, a "paradigm shift" in environmental science. Persuaded by what they see as the failures inherent in conventional "top down" models of knowledge production and translation, they have created a group they call a "Learning Alliance."

The Learning Alliance can be characterized as being engaged in Mode 2 knowledge production (see Gibbons et al.1994). Scholars who have studied how science is done argue that traditional science (Mode 1 knowledge production) with its strict adherence to disciplinary agendas rooted in the orthodoxy of detachment and objectivity is being replaced by a new way of doing science (Mode 2 knowledge production). Mode 2 science is sensitive to non-academic contexts and addresses not only technical issues but economic and social concerns. Mode 2

science is oriented to developing practical applications and solutions to technical social problems. Practitioners of Mode 2 science seek to move beyond the confines of their universities and disciplines to integrate into their network. Both experts and those with lay knowledge, creating "extended peer communities" (see Funtowicz and Ravetz 1993; Ravetz 1999). The purpose of these "extended peer communities" is to bring a range of perspectives and approaches to bear on those problems. Recognizing the complex nature of most of the social problems that science seeks to address, Healy (1999: 658) describes the purpose of extended peer communities" in this way:

> The aim of this process is the development of a shared meaning of uncertainty, and the knowledge to which it attaches, rather than the imposition of one particular view. This negotiated approach thus enables a shared agreement or understanding conducive to effective and resilient outcomes resulting from the input and support of a broad range of stakeholders.

Understood in Mode 2 science terms, the goal of the Learning Alliance is to create 'extended peer communities' with a view to solving complex environmental problems.

However, while the literature on Mode 2 knowledge production assumes and even promotes a more collaborative approach in science, it offers little in the way of analysis of the actual lived experience of groups, like the Learning Alliance, that are involved in the process of creating "extended peer communities." This paper fills that gap by examining precisely how the Learning Alliance attempts to enact a more democratic science. In general analytical terms, my central questions have to do with how scientists are translating the idea of Mode 2 science into practice. More specifically, I am interested in a key practical problem that the Learning Alliance faces, namely that the end-users with whom the group seeks collaboration are embedded in a social world very different from their own.

In many ways the interaction between the Learning Alliance and its business partners resembles a clash of social worlds or cultures. The notion of social worlds is a central concept in the social worlds framework which is concerned with meaning-making between groups and actors "doing things together" with shared technologies and tools (Becker 1986; Clarke and Star 2008:113). Clarke and Star (2008: 113) define the social worlds theory within an ecological context: "Over time, social worlds typically segment into multiple worlds, intersect with other worlds with which they share substantive/topical interests and commitments, and merge." While industry and the Learning Alliance intersect and share similar goals regarding environmental responsibility, each social world operates within a different field, influenced by its own logic. Tensions between the two social worlds resulted from a clash of perspectives, one rooted in academic science while the other is industry oriented. As a result the two groups did not always see eye-to-eye on how best to come together to be environmentally responsible. No matter how "green" those in industry seek to be, they are constrained by certain institutional values and norms that academics do not necessarily share. Another way to capture the differences is to say that business has to orient itself to the competitive nature of the arena in which it operates, making profits, keeping shareholders satisfied, and ensuring the long term viability of their company's key concerns. Scientists on the other hand, are free to pursue their goal of environmental stewardship in relatively unencumbered ways.

While industry competes for monetary capital, those in science are more concerned with symbolic capital (i.e. grants, publications, prestige and status, Bourdieu 2001). It was not until the Learning Alliance failed in several of its efforts to establish collaborative projects that Alliance members began to appreciate the diverse logics that operate within the two different social worlds. Coming together around environmentally sensitive questions and a common desire

to do things differently, both members of the Learning Alliance and their industry partners had to manoeuvre around a range of complicated political, moral and economic issues. The paper demonstrates just how delicate the collaboration process can be when an alternative vision of environmental science as it relates to big business takes centre stage. Given these competing orientations, I am interested in how the Learning Alliance and the business partners they need to create their extended peer community find common ground.

I begin by describing the methods I used to gather the data for this paper. I then explain how members of the Learning Alliance understand their goals and why they see collaboration with big business as central to their efforts. In the next section, I turn to the efforts on the part of the Learning Alliance to establish these collaborations with a specific company, Steel Inc. I explain how the Learning Alliance came to be involved with the company and how it carefully orchestrated its approach so as to facilitate collaboration. I go on to explain how, in spite of this carefulness, the Learning Alliance faced significant challenges in getting successful projects off the ground with Steel Inc. More specifically, I organize this discussion around three proposals. Two of these proposals resulted in failure. Finally, on their third attempt, the Learning Alliance was successful in finding a project on which Steel Inc. was willing and prepared to collaborate. After presenting the details of the three cases, I analyze them and attempt to explain the outcomes. I use the experiences of the Learning Alliance to make a more general argument regarding the challenges that exist in bringing Mode 2 knowledge production about and strategies that may be employed to deal with these challenges.

Methodology

Rooted in symbolic interaction, social worlds theory consists of both a theoretical approach and a preferred methodology. The interpretive tradition from which social worlds

theory was derived is premised on the idea of human behaviour as inherently social, negotiated and in constant flux. The focus is on how individuals acquire perspectives within their communities and orient their interactions toward the social objects that have meaning for them (Blumer 1969; Prus 1996; 1997). The methodological approach that best lends itself to capturing the perspectives and lived experience of social actors is participant observation or what Cooley (1902) calls "sympathetic introspection." In order to understand the perspectives of social actors, it becomes necessary for researchers to situate themselves within the social networks of those they seek to study. Participant observation demands that researchers commit themselves to the "social roles that fit into the worlds they are studying" (Adler & Adler 1987:8). Attempting to experience what their participants experience, feel what they feel and behave in a similar fashion gives researchers insight into how those they study perceive the world around them. To be *in situ* is to find out what is important to participants and how they define and manage situations that are both constraining and enabling through the course of their everyday activity. It is the management and negotiation of these social perspectives and the consequences that follow the clash of multiple definitions among and between groups that are most important in understanding social phenomena.

Following this methodological approach, my goal became to immerse myself within the Learning Alliance. My first contact with the Learning Alliance was through Jared, the originator of the group. I met Jared when we both became involved in a community-based initiative to develop a multi-faith curriculum for children in the area in which we both lived. I noticed that Jared brought a unique approach to our lesson plans, one that put an emphasis on getting parents more involved in school activities. When I asked him in casual conversations about his strong commitment to inclusiveness, he told me he was using a similar model in his scientific research

as an environmental engineer on getting end-users to buy into his environmental technology and pollution prevention strategies.

At that point the Learning Alliance consisted of a core group of nine engineers and scientists, including Jared who frequently met on their own, and a larger peripheral group of students, business and government representatives who were brought into discussions of specific projects. The group had first started in 2006, when Jared, an environmental engineering professor, became involved in a project, the goal of which was to investigate the feasibility of large scale rainwater harvesting in Canadian cities. In developing the project, Jared had consulted with an environmental biologist (William) and an environmental engineering consultant (Edward). The three colleague were aiming to assist industry and homeowners in designing and installing rainwater technology. However, their efforts were repeatedly stalled by end-users' frustration with managing their equipment and by what the group saw as antiquated water regulations and standards that made it next to impossible to implement their vision of water quality and conservation. Disillusioned with their experiences and hoping to avoid future disappointment, the three scientists began to think about a better process for bringing scientists, end-users and government together to effect change. They began to gather like-minded individuals around them and to make overtures to those in government and the business sector. As the group began to take shape they began to call themselves the Learning Alliance.

When I showed interest in his academic research, Jared invited me to sit in on a few Learning Alliance meetings at Halo University. Taking Jared up on his offer I began attending meetings of the Learning Alliance. It did not take long to recognise the possibilities for an interesting study, though I did not know at that stage what particular conceptual direction such a study might take. I asked Jared if he was comfortable with my conducting a sociological study of

the Learning Alliance. Jared consulted with the group. Within a week I had an answer. Alliance members agreed to have me sit in on their meetings and take notes with the understanding that I share my findings with the group. I prepared a proposal for ethics review. Once my protocol was cleared my involvement with the group became more regular and my note taking more systematic.

During my study, the Learning Alliance consisted of an expanding membership of environmental engineering professors, their graduate students, private environmental consultants, industrial engineers and private and public representation such as corporate industry and government officials respectively. My participant observation with the Learning Alliance began in the summer of 2006, I essentially "hung out" with members of the Alliance one to two days a week, for one to five hours a day at various locations where the group met. Usually these meetings occurred at Halo university at least one a month. Members of the group would meet with industry or the Ministry of Environment (MOE) officials. Meetings of the core group typically involved discussions about flawed conventional approaches to solving environmental problems within science and engineering circles and ideas about projects that could bring a broader range of key players together to do things differently. As Alliance members followed through on some of these ideas. I would accompany the group when they visited various "green champions" they had identified in governance and industry.

The majority of my data comes from notes taken in the field. I was able to take notes openly and did not appear out of place in doing so as everyone at these meetings took notes themselves. Some of the best data I obtained was gathered while travelling with Alliance members back and forth between meetings. I typically sat in the back of a van while the members of the Learning Alliance would sit up front engaged in strategizing or in intense

discussions about how their meetings had gone, seemingly oblivious to my presence. At other times they actively involved me in their conversations, eager to hear my reactions.

Although field notes were my primary source of data, I also conducted 21 qualitative interviews. Nineteen of these interviews were with members of the Alliance; the remaining two were with company managers with whom the Alliance became involved. Interviews occurred at Halo university and local coffee shops. They were digitally recorded and consisted of open-ended questions aimed at getting at the perspective of the engineers and scientists.

I analyzed my data using a grounded theory approach (Charmez 2006; Glaser & Strauss 1967). [4] Grounded theorists endorse an inductive approach that allows for the emergence of theory or analytical concepts from observation of participants' activities. The main conceptual and methodological tenents of grounded theory are derived from an interactionist view of human social conduct and thus guide my study of individuals interacting with the context of group life. Herbert Blumer (1969:2) succinctly addresses this perspective and approach to meaningful group life with the following three premises:

> The first premise is that human beings act toward things on the basis of the meanings they have for them...The second premise is that the meaning of such things is derived from, or arises out of, the social interaction that one has with one's fellows. The third premise is that these meanings are handled in, and modified through, an interpretative process used by the person in dealing with things he encounters.

The grounded theory commitment to the sense-making and world-defining accomplishments of participants, make for a robust qualitative methodological approach to studying human group life. Guided by Blumer's three premises of group life, the researcher studies participants within their own natural setting, and through observation and participating in their worlds, theory or

[4] There is no consensus as to what makes a grounded theorist, even among the founders themselves. Glaser (1992) argues that Strauss and his student's style of grounded theory "force data and analysis into preconceived categories and, thus, contradicts fundamental tenets of grounded theory" (Charmaz 2006:8).

conceptual analytical frameworks grounded in participant's own experience are constructed. The researcher is ever cognizant never to stray too far from their participant's common sense knowledge of the everyday world and how that knowledge is used to construct and make sense of reality.

Furthermore, researchers do not assume that an objective social world exists independently of the interpretations and perceptions of those who operate within it. The meaning-making process is a fundamental object of study and can only be uncovered by an intimate understanding of the life experience of those who are being investigated rather than pushing a foreign theory or explanation on their meaning making activity. Unlike natural science and its emphasis on reliability and validity, the grounded theory approach suggests that the researcher be constantly reflective, open to the continual revision of their ideas by going back and forth between their participant's empirical world and their own concepts that represent that world (Glaser and Strauss 1967:31). This analytical exercise helps the researcher "avoid importing and imposing packaged images and automatic answers" (Charmaz 2006:135). External theory and models are not imported into the study to be deductively tested; rather, theory is grounded in the data and emerges through inductive analysis.

In relation to my study, taking a grounded theory approach meant that I was engaged in a continual process of interpreting the data as I collected it and generating at first broad, and then continually more refined categories as I proceeded. As themes and generalizations began to emerge I consistently returned to the field to gather more data, using theoretical sampling as a way to compare and redefine previous categories. Charmaz (2006:189) defines theoretical sampling as a process by which the researcher

> ...aims to develop the properties of his or her developing categories or theory, not to sample randomly selected populations or to sample representative distributions of a

> particular population. When engaging in theoretical sampling, the researcher seeks people, events, or information to illuminate and define the boundaries and relevance of the categories.

A grounded theorist does not study the individual, but the analytical categories of action that emerge from the data.

Why Industry Matters

According to the Learning Alliance, industry is essential to achieving many of their environmental goals because 1) like it or not, industry sets the pace for change and 2) it is the problems outside university walls that require their attention. The Learning Alliance feels strongly that the environmental problems the world is currently facing are particularly complex and that in this area, perhaps more than anywhere else, scientists ought to be working closely with any group that has something to contribute. Although big business is often seen as a major contributor to pollution, the Learning Alliance acknowledges that change is not possible unless industry not only takes responsibility for current conditions, but leads the way in developing innovative technology and strategies to reduce and eliminate waste. An Alliance member makes this clear: "Government is lost and turning to industry to help figure it all out. Don't kid yourself. Business is first and then government follows." [Field Notes 2008] Another member expresses the same sentiment regarding the importance of the private sector: "When it comes to climate change, government is useless...they are turning to industry to figure out innovative ways to reduce emissions... and so you see the carrot more than the stick..." [Interview #14, 2007] He continues to elaborate on the eventual stress that will be placed on business and the need for them to change their ways,

> But they (business) know they have to eventually figure it out. One day it will be too costly for them to ignore the problem... So, this is our window to get on board. You know, help industry lead the way. [Interview #14, 2007]

The quote above is a good example of how the Learning Alliance recognizes the logic of profit as their wedge into the social world of business. A strategy they know they can use is the argument that if companies do not co-operate in the pursuit of a common environmental goal, their business will suffer.

The members of the Learning Alliance also see business partners as necessary to their efforts in that they provide practical real life opportunities for applying their innovative ideas and technologies to actual problems outside academia. Alliance members often justified their eagerness to embrace industry as partners by comparing the vitality of big business with the stagnation and isolation of university research. One Alliance member argued that conventional research is too far removed from *real* problems and that it is scientists' obligation to collaborate with industry.

> Universities seem to just wait around and expect them (business) to come to us. Well, it does not happen that way. We have to go to them. It's about solving problems and monitoring how solutions work in the REAL world. We often complain that our ideas and models work in the lab but they don't apply to real world conditions. I realize you need to fund traditional research but can you imagine if a funding agency said 'most of the funding is now going to go toward research that is dedicated to solving real world problems. Not just some abstract solution devised on paper never to be carried out. This forces us to meet with industry. There are plenty of problems to solve on their end. [Field Notes 2008]

Although the Learning Alliance recognizes the culpability of industry in the degradation of the environment and in the generation of so many of the problems for which solutions are now being sought, members of the Alliance are reluctant to demonize industry. Rather, members suggest that the entrepreneurial spirit is often at the forefront of innovative change. They also understand that partnerships with business are essential if their vision of Mode 2 research is to move beyond academia and assist in the solution to 'real world' problems.

Collaborating With Industry

If the Learning Alliance's new vision of science is to be realized, one can understand the significance its members attach to seeking out potential partners. To create these partnerships, the Learning Alliance started by targeting eight large businesses within an industrial park located within a fifteen minute drive from the University where the Alliance is centred. Alliance members made calls to several of these local businesses, offering to consult with them on potential pollution prevention projects. Although many companies appeared interested, ultimately the majority of them were not willing to follow up. The one company that actually agreed to meet with the Learning Alliance was a large manufacturing plant called Steel Inc. The prospect of creating a partnership with Steel Inc.- a corporate end-user- was one that excited the members of the Learning Alliance. In the following quote, a member expressed his relief, "This is fantastic, we now have a partner (Steel Inc.) that has taken an interest in the Learning Alliance philosophy. It should be interesting to see where this leads us." [Field Notes 2008]

Alliance members carefully planned their first meeting with Steel Inc. They were well aware of the pivotal importance of the meeting. Previous experiences that some Alliance members had with non-scientists had taught them that such encounters could be difficult and that mistrust of scientists might be a problem. One Alliance member provides some insight on the issue of trust, pointing out that business often assumes that scientists are interested only in getting data or remuneration for their consulting services.

> On many occasions you'll find they [industry] do not trust consultants and researchers. They feel our main goal is just to expand the project. You know, prolong it so we can achieve more fees or get enough data just to publish a paper. Right out of the gate it is going to be an *uphill battle* with them (Steel Inc.)... you must be patient and go the extra distance to earn their trust. Thanks to some bad apples, we certainly will not have it [trust] when we approach them... [Field Notes 2008]

Another member pointed out: "When it comes to researchers; we find most clients are once bitten twice shy." [Interview # 8, 2008] Recalling a previous experience with industry, another Alliance member made the point that it was imperative for the Learning Alliance not to present itself as a group interested merely in the research opportunities the partnership represented for them. The key he suggested was to highlight the benefits of the partnership for industry.

> When we first visited them (manufacturing plant), we were met and received with great enthusiasm. They seemed keen to benefit from a project with so many partners. We explained, as you do, why we were there. At a certain moment one of the managers said 'I am not interested in research'. This was obviously not very encouraging, given that's exactly what we had to offer. But he went on to say that he was looking for innovation, and technological solutions to meet plants pollution problems. He reeled off the problems as he saw them.

He continues,

> Pressed to clarify, he [company manager] explained that the kind of research he got from academics, from Universities, was not given to him in forms he could understand nor at the right time. He wanted something he could use. Clearly there is a challenge here. Influencing implementers, who are often hungry for research findings and have problems to solve, is rarely going to be done through a refereed paper at the end of a project (Internal Memo).

Members of the Learning Alliance were frustrated by the reputation other scientists and researchers earned for themselves in the local community. Going into their encounters with Steel Inc. they were determined to rebuild trust and change the image of researchers as academically ambitious and selfish.

In anticipation of the meeting with Steel Inc. the Learning Alliance were careful in their strategyzing. The members of the Learning Alliance stressed among themselves that the trust based relationship they hoped to build with Steel Inc. would emerge gradually and would be reflected in the extent to which Steel Inc. allowed the Learning Alliance to become a part of their decision making processes. An Alliance member explained it this way: "We may not get them (Steel Inc.) to make sudden and drastic change, but we can first show them some benefits

associated with small incremental changes, you know, gain their sense of trust and then they will allow us to do much more within day-to-day operations." [Field Notes 2009] Despite the advance work that the Learning Alliance engaged in, just how challenging the task of building a partnership with their business partner became immediately apparent once the two groups began to discuss the details of their partnership.

Face-to-face interaction between the Learning Alliance and Steel Inc. started with Alliance members requesting a tour of the plant's daily operations. As representatives of the company and Alliance members walked through Steel Inc.'s facilities, there was a tentative discussion of the potential each location had for immediate and sustainable alterations. It was during this first walk through that the Learning Alliance tentatively identified for itself a number of possibilities for collaboration.

Steel Inc. did not play an active role in selecting areas they deemed important for the Learning Alliance to address. Rather, they took a hands-off approach, leaving it up to Alliance members to identify areas that they felt required the most attention. Steel Inc.'s lack of involvement generated a mixed reaction among Alliance members. On a number of occasions, Alliance members asked to meet with a manager from one of Steel Inc.'s facilities. Despite their many requests, the manager continually made excuses as to why he was unavailable. The quotes below demonstrate that some members of the Alliance found this apparent indifference frustrating, while others enjoyed Steel Inc.'s *laissez-faire* attitude. In the following quote, one member expressed his irritation with the situation: "Why did he agree to work with us when he is unable to even meet with us for longer than five minutes... I refuse to make another appointment with his secretary." [Field Notes 2008] Meanwhile, another member saw no problem with the manager's lack of involvement: "It's great, I don't want him looking over my shoulders anyway.

[Field Notes 2008] Alliance members began to get the sense that the managers at Steel Inc. wanted them come up with a simple pollution prevention plan with the least amount of disruption possible with respect to the factory's daily operations and routines.

A sore point that emerged between the two groups was the issue of the accessibility of data from the company. In order to put together a specific proposal the Learning Alliance needed data from the managers of various facilities at Steel Inc. Without this data they could not properly analyze the "trouble spots." The Alliance had stressed during early negotiations with Steel Inc., that this data was key to identifying areas that required improvement and to making recommendations. Despite this fact, the managers dragged their feet. Any data that was passed on to the Alliance, its members found to be outdated or cryptic. Reacting, an Alliance member showed his frustration:

> They do not see data as vital...we are trying to measure things they would never consider. Projects are always broad at the beginning. Access to the proper data allows us to make connections and narrow down the problems. This is next to impossible when they take forever to get us the specs...what we do have is outdated and useless...a few of the charts we got are veiled in a mess of mumbo jumbo. [Interview #9, 2008]

Undeterred, the Alliance began to focus on the fact that Steel Inc. was wasting a great deal of electrical energy in its day-to-day operations. The Learning Alliance hoped to devise a plan that would allow Steel Inc. to operate at full capacity while at the same time consuming 1/3 less the energy.

Arranging a meeting, Alliance members presented their idea to a number of departmental managers at Steel Inc. Managers knew how much they spent on energy within their own departments but were unaware of the expense the manufacturing plant as a whole was incurring, a fact that surprised Alliance members. One engineer commented, "You would think a big

company like Steel Inc. would be on the ball...constantly updating and recording this kind of information" [Field Notes 2008] Another member commented:

> It seems like we not only have to get these guys to be more efficient with technology in the way they use up energy, but they need assistance in being more efficient with information sharing...they truly have no idea how much water and energy they consume. Industry is in desperate need of improving managerial procedures...Steel Inc.'s whole operation is inefficient, not well monitored and certainly poorly maintained. [Field Notes 2008]

Since Steel Inc. did not have the data that the Learning Alliance needed to take the next step, the Alliance decided that they themselves would need to obtain accurate data measurements. To do so, however, required that the factory cease operations for a short period of time. Alliance members contacted Steel Inc., asking if the company could stop production for a few hours so Alliance members could run a number of diagnostic tests on key processing units in each major facility simultaneously. Steel Inc. denied the request, arguing that a pause or even a slowing down of production would result in a loss of revenues. This left the Learning Alliance at a dead end and unable to move forward.

In debriefing about the incident, Alliance members began to recognize that the unrelenting stress on productivity and profits might become a problem. They found it difficult to understand why Steel Inc. would not be willing to make what they viewed as a minor compromise to achieve the greater energy efficiency the Learning Alliance believed they could deliver. One Alliance member commented: "...in the big picture, what's a few minutes really cost...come on." [Field Notes 2008] Another Alliance member made the same point in saying:

> We are being pulled from one department to another...all the managers want us to think about their 'bottom line' but none of them want to take on the time and responsibility required for the development of efficient pollution prevention strategies. [Field Notes 2008]

Proposal 1: Common Lighting

Despite Steel Inc.'s lack of cooperation, the Learning Alliance worked with the little "usable" data they had to come up with a concrete proposal. The proposal involved reducing the factory's lighting costs. From the perspective of the Learning Alliance, the project was not ideal in that it did not constitute what the Learning Alliance considered a priority item. But with so little to work with the Alliance had no choice. From their perspective, the key was to keep the collaborative process going. Moreover, it was the sense of Alliance members that their chances of keeping Steel Inc. on board were greater if they started with modest projects and with projects that fit in with problems that the company itself was interested in solving. An Alliance members observed:

> Most times we are dealing with businesses that already have a solution in mind (i.e. warehouse lighting) and so they hire us to achieve their goals. This can be frustrating when we find more severe problems that need to be addressed but they would rather us ignore because that was not their original concern. If we continue pressing for alternative solutions they will just hire someone else who will commit to their profit driven model. [Interview #7, 2008]

The lighting project did not require a shut down of the company's operation, but it did require the installation of mechanisms to record essential data and assist in more sensitive readings of energy loss. The Learning Alliance understood the need to keep costs down, but this was a minimal expense that was key to the completion of the project. Steel Inc. responded by rejecting the proposal. The company was not willing to incur the expense of energy monitors. The company's response generated more frustration for Alliance members:

> You want us to fiddle with the lights? Fine! But at least let us get the data we need...When we suggested that we place electric meters on the equipment to get more accurate readings, they looked at us like we were crazy and they laughed...they understood the necessity, but the cost would be an enormous burden for the company to carry...I am not sure how long we can be involved in all this... being 'nickle and dimed' bears its own cost...we are losing patience and tired of being under appreciated. [Field

Notes 2008]

Keen to maintain their relationship with Steel Inc., the Learning Alliance compromised and generated an alternative and even more modest proposal. The Learning Alliance proposed that Steel Inc. could save money on lighting by replacing their old light bulbs with more energy efficient halogen lamps. The Learning Alliance stressed that the company would see a return on its investment in as little as five years. But Steel Inc. balked even at this proposal. From Steel Inc.'s perspective, the time frame on the return on their investment was too long.

> We spent a lot of time researching energy efficient industrial halogen lights. These lights are amazing but they (Steel Inc.) refuse to purchase them...I really wish we could tell them that they would see profits within a matter of months, but it just isn't in the cards. A payback period of five years is out of the question for them.

The outcome of these discussions was that the idea of focusing on a lighting project was shelved. The Learning Alliance responded to Steel Inc.'s refusals by suggesting that there was little point in continuing to focus on lighting and suggested moving on to something "broader in scope". Summing up how the Learning Alliance felt about how the process had unfolded, one of the Alliance members said:

> I didn't come here to consult with this business on saving energy by merely drawing up plans to keep the doors shut and turning down the lights. This isn't environmental engineering… I know our job is not just to save money, but to look at alternatives, see what makes sense and what is feasible and how we can direct others to implement sustainable environmental changes…we need to get them to think more globally… [Field Notes 2008]

Proposal 2: In-house vs. Outsourcing Chemical Treatment

The second proposal that the Learning Alliance made involved the point assembly line. During the initial walk through the factory, a member of the Learning Alliance had noticed that the chemical treatment of toxic waste generated by the company's paint assembly line did not

meet environmental standards. In following up on this observation, the Learning Alliance learned that Steel Inc. did not treat its own chemical waste but outsourced the process to another company. The Alliance's second proposal involved a recommendation that Steel Inc. manage its own waste rather than passing it on to a company which might not be processing the waste properly. The Learning Alliance argued that it was important for Steel Inc. to maintain control over the process to ensure the minimal environmental standards were met. The Learning Alliance proposed a plan that would have Steel Inc. refurbish a large abandoned room within the factory. This room would be modified to house the necessary machinery needed to chemically treat the company's hazardous materials.

This proposal too ran into trouble. The in-house treatment versus outsourcing of waste became a bone of contention between the two groups. Steel Inc. rejected the idea of in-house treatment because the company had expended considerable time and resources selecting an appropriate company to handle their waste. They had replaced one company with another one that was more more committed to efficient waste treatment processes. The argument that the Learning Alliance made, that Steel Inc. had no formal way to track where their waste went, what the outsourced company did with it, and whether appropriate environmental safety standards were being met, fell on deaf ears. Steel Inc. felt that it had gone as far as it was prepared to go in acting in an environmentally responsible manner in seeking out a new waste elimination partner and considered discussion on this matter closed.

This response too disappointed and frustrated members of the Learning Alliance who felt that Steel Inc. was more concerned with being perceived to be environmentally conscious than in actually ensuring that this was the case:

> Just because they switched chemical treatment partners we are expected to honor their moral integrity. They can't just dismiss our concerns and suggestions on in-house

> treatment because they feel they have already took responsibility for the mistreatment of industrial waste…choices they say have cost them money… but they are proud to have done it…they are just covering their butts and making excuses to protect their bottom line…they don't seem to want to take that extra step forward. [Field Notes 2008]

Another Alliance member complained:

> …its like we were on different planets when talking about the same problem…at times you think they are just going through the motions and could care less about our concerns about waste management. [Field Notes 2008]

She continued,

> They are reluctant to have us fix it, they think the disposal costs in the future will be financially devastating …just ridiculous. [Field Notes 2008]

The waste management proposal, like the lighting proposal failed. However, both experiences proved to be valuable learning lessons for the Learning Alliance. Building on these failed experiences and the lessons learned, the Learning Alliance made a third proposal.

Proposal 3: Greywater Harvesting

The third project that the Learning Alliance proposed was a water-based project. The project involved taking Steel Inc.'s used water and recycling it instead of letting it go down the drain. Basically, the Learning Alliance proposed the construction of a feedback system that redistributed water from facilities that no longer needed it or were wasting it to areas of the factory that could use the water to cool its pipes. This reuse strategy would drastically reduce the consumption of water and energy use at Steel Inc.

The greywater harvesting [5] idea was one that had come up early in the Learning Alliance's discussions about possible projects, but had been put aside because some members felt it was too simple in that it did not dramatically reduce pollution prevention. However, after its first two failed efforts the Learning Alliance was prepared to reconsider this option.

[5] Greywater is the wastewater that comes from baths, faucets, showers, laundry, and the kitchen.

Commenting on the dynamics of the decision within the Learning Alliance, one member noted: "We judge other researchers for not thinking outside the box, but we ourselves are not beyond reproach. Glad to see we can practice what we preach. This technology (greywater harvesting) is simple, but make no mistake, it is not simplistic." [Interview #10, 2008]

As members of the Learning Alliance discussed the possibility of a greywater harvesting proposal, there was a growing sense that the idea would appeal to Steel Inc. because while it was environmentally friendly, it was also economically feasible. By this stage the Learning Alliance was determined not to "scare them away." [Field Notes 2008]. Alliance members knew that the environmental merits of the proposal would not be enough to bring Steel Inc. on board. In preparing themselves to present the proposal, they knew they would need to emphasize to Steel Inc. that investing in greywater harvesting technology would be in the company's best financial interest. During a brief meeting at a local coffee shop, just before the Learning Alliance met with Steel Inc. to present the proposal, one member cautioned the group to exercise care in the language they used, to downplay talk about "changing the world" and to present the idea instead as a relatively minor, cost-effective adjustment of the company's usual practices.

> We have to reduce the talk about changing processes, they (Steel Inc.) seem to see this as drastic and expensive change, we can minimize it more into a language that alludes to it as merely tweaking the procedures they are already familiar with…[Field Notes 2008]

Another member of the Learning Alliance emphasized the need to meet Steel Inc. halfway:

> We must get them (Steel Inc.) to think more long term…our end goal, and theirs, is to develop a pollution prevention program that is not dependent on such a volatile market… they have an idea of security and so do we… it's a balancing act to make them happy, so we need to work within our own area of competence but at the same time we need to step out of our comfort zone, speak their language and provide them with what they need to feel secure to move forward…[Interview #5, 2008]

In presenting the proposal to Steel Inc., Alliance members argued that the company could invest in water conservation technologies, thereby generating a reputation for itself in the community as responsible stewards of the environment while at the same time saving money.

This time Steel Inc. responded positively. The company agreed with the Learning Alliance that the project resonated with their needs and was realistic from a cost perspective. In other words, the greywater project was seen by Steel Inc. as a win-win proposition: The water reuse technologies would be visible to the public, signalling the company's commitment to the environment while at the same time saving the company money. Further, the time frame or "payback" period was reasonable. A return of investment would have occurred within nine months. This is three months more than Steel Inc.'s acceptable six month window. The "green" factor allowed the temporal extension but it appears that another month would have been a 'deal breaker.' The Learning Alliance, operating within the constraints of the market, found a creative way to extend the payback period.

The reduction in water and energy costs alone was not enough to cover the cost of the technology. But the positive public exposure Steel Inc. would gain as a "green" company became the catalyst that carried negotiations forward. The Learning Alliance recognized that the secret to the success in this instance was presenting the proposal to Steel Inc. in way that aligned with the company's priorities while simultaneously getting them to "think outside the box." [Field Notes 2008] The lead scientist involved in the project expressed this idea in terms of convincing business to link revenue with the ability to advertise ecological accountability:

> Often, businesses don't know what they want to do…in the final analysis we have to move them from the payback consumer philosophy to a more sustainable efficient technical one…we gently steered them (Steel Inc.) in an alternative direction…greywater harvesting technologies are a win-win situation. We gave them something that the public will recognize--a visible technology for all to see… people will think about the company

> as one that cares about water resources…what a great advertisement…I'm telling you, environmental sensitivity can be profitable…[Interview #4, 2008]

Alliance members were particularly proud of their victory. From the perspective of the Learning Alliance this was their first real win with the company. As one Alliance member pointed out:

> We managed to demonstrate to them that there are different ways to look at payback. We convinced them of the many direct and indirect incentives and that their definition of payback doesn't acknowledge… the many future benefits…it's not just solely about dollars and cents but public perception... publicity is worth something. We used this to our advantage and convinced them to transcend their idea of monetary value. [Field Notes 2008]
>
> He continued,
>
> You see, governments and people are starting to be more concerned with the environment, these issues are starting to emerge as extremely important—we simply used this as our pitch. [Field Notes 2008]

Another Alliance member commented:

> The key is striking a balance between what they think is important and what we know is best for the environment…it comes down to short term profit and long term sustainability… it's a tug of war...once we understood this we began to work things out. [Field Notes 2008]

The greywater harvesting project itself did not significantly alter the company's environmental footprint. As a project, the proposal was unimpressive. However, as a symbol of what the Learning Alliance could accomplish in getting Steel Inc. to think about its responsibility to take environmental concerns into account, the project represented a major success.

Discussion

This account of the Learning Alliance's encounter with Steel Inc. offers an opportunity to better understand how Mode 2 science is enacted and more specifically how a group of scientists committed to the idea of Mode 2 knowledge production and transfer negotiate the "extended peer communities" that are so central to their vision of how science *should* be done. The case shows that collaborations are complicated because those who pursue them are trying to bring together members from different social worlds. They are especially difficult when these collaborative efforts take place with partners who are constrained by a profit motive.

Although both Steel Inc. and the Learning Alliance shared the same goal- to reduce waste, conserve energy and prevent pollution-they brought different interests to the pursuit of these goals. The Learning Alliance was focused primarily on environmental responsibility and demonstrating that science could be done more democratically. For Steel Inc., a commitment to environmental responsibility was mediated by the need for fiscal responsibility. Industry's demand for quick profits on investments acted at least initially, as a constraint for Learning Alliance in efforts to enact Mode 2 science. Unless the Alliance could show that a profit could be generated in a time frame that was acceptable to Steel Inc., the company refused to look at the Alliance's proposals. Alliance members referred to this constraint as the "payback period". Such a short term planning frame was something that Alliance members were not used to and found difficult to work within. They were accustomed to a university environment where financial payoffs are less important or indirect, making themselves apparent over a much longer period of time. Alliance members eventually came to the realization that any pollution

prevention solutions they proposed also had to be economically feasible from the company's perspective.

The fate of the three proposals that the Learning Alliance and Steel Inc. discussed can be explained in terms of how successfully the two groups were able to find a project that satisfied their mutual interests. A boundary object is a useful concept for understanding the dynamics of the interaction between the Learning Alliance and Steel Inc. Sociologists of science were the first to explore the complex intersection between distinct social worlds through boundary objects. Star and Griesemer (1989) developed the concept of a boundary object while investigating negotiations amongst various social worlds in the development and maintenance of a museum. They used the concept to explain how successful collaborations took root without stockholders necessarily agreeing on the meaning and purpose of museum specimens (i.e. curators, scientists, amateur collectors, trappers, philanthropists and administrators). The University of Berkley viewed specimens and the museum as a status marker, a signal to the more prestigious east coast universities that they were conducting state of the art research. The trappers viewed the animals they hunted for the museum as a way to earn a livelihood. The lead scientist collected specimens to conduct research in the hopes of contributing to evolutionary theory, while the philanthropist who funded the museum viewed the collection as a means to promote the conservation of Western American flora and fauna. Although specimens carried different meanings depending on the social location and specific interests of those within each social world, they still provided a focal point in which collective action was organized, thus contributing towards the operational success of the museum.

The construction of effective boundary objects - a critical factor in any type of successful co-operation between groups that come from different social worlds- is especially important in

situations where those social worlds are as diverse as science and business, two spheres of activity that function according to entirely different and in many cases, competing logics. Applied to the case of the Learning Alliance and Steel Inc., it was the failure of the two groups to find a workable boundary object that inhibited their collaboration. The lighting project failed because the Learning Alliance did not see it as sufficiently significant a project from the point of view of advancing sustainability. Steel Inc.'s refusal to invest in data monitors and alternative halogen lighting reduced the potential impact that the Learning Alliance felt it might have had in terms of improving the efficiency of the warehouse lighting situation.The in-house chemical treatment proposal was rejected by Steel Inc. because the company did not see it as a wise investment.

The idea the Learning Alliance proposed as to how Steel Inc. could manage its waste was environmentally sound but produced no where near the profit margins that Steel Inc. expected to make it a viable project. The position of Steel Inc. was that the company had done enough to make its waste process treatment more environmentally friendly and that without additional financial payoffs, further steps were simply not feasible. As with the proposed lighting project, failure resulted because the proposal did not work as a boundary object. In other words, it was not a project that satisfied both the Learning Alliance's need for a project that met its environmental goals and Steel Inc.'s need for a project that justified the investment. The two failed proposals can be described as constituting ineffective boundary objects. The Learning Alliance's fundamental failure was its inability to achieve what Strauss called a "matching of reciprocities." The failure to find a project that could bring together the two social worlds, each committed to the principle of environmental sustainability, but each with its own objectives and logics, stalled their collaboration. However, the two failures were valuable in the sense that the

Learning Alliance learned important lessons about the need to establish a common boundary object in order to make the kind of collaboration they sought possible. Though Alliance members were frustrated with Steel Inc., they also came to appreciate that any steps the company made in the direction of greater sustainability had to make sense not only from a scientific point of view but also from a business point of view.

The lessons learned were reflected in the Alliance's third proposal. The greywater harvesting proposal was based on a recognition and acknowledgment of market constraints. Alliance members took Steel Inc.'s needs and perspectives into account. They looked for a project that they felt would work as a boundary object. The greywater havesting project worked for the Learning Alliance because the project would contribute to a more environmentally sound way of operating. At the same time the project worked for Steel Inc. because it both demonstrated the company's commitment to being environmentally responsible thereby generating the green capital of public recognition - while also satisfying the company's need to pay attention to its bottom line.

Through failure, Alliance members learned how to construct the kind of boundary objects that made cooperation possible. They learned as well how to navigate social pathways around contested and complicated situations. Once they were able to factor into their own thinking the notion of "return on investment," a notion central to how Steel Inc. approached their collaborative effort, it became possible to find boundary objects to bring the two groups together. Using greywater harvesting technology, Alliance members managed to translate the "payback period" in a way that spoke to the needs of Steel Inc. while at the same time satisfying their need to partner with business in addressing an environmental issue.

Bowker and Star (1999:296-297) have observed that boundary objects are "plastic

enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use and become strongly structured in individual-site use." The fact that the Learning Alliance succeeded in accomplishing joint action with their industry partners by finding an effective boundary object, affirmed for Alliance members the possibility of doing science differently. Within the context of this study, 'weakly structured in common use' refers to how the two groups did not spend a lot of time talking about what environmental sustainability meant to each of them and how it fit into their basic goals. The idea existed loosely as something that they were both interested in. The key was coming up with a project that they each understood within the confines of their own social worlds, as a path to their respective ends. For the Learning Alliance, the project affirmed for members that partnering with end-users in an effort to address pressing social problems is possible. For Steel Inc., the project was an opportunity to reap business payoffs by paying attention to environmental sustainability.

Of course not all negotiations are symmetrical. Maines (1982:270) defines a negotiation context as "the relevant features of the setting which directly enter into negotiations and affect their course." In this case study, the relevant negotiation context was the Learning Alliance's reliance on Steel Inc. Hall (1987:7) observes that the social processes involved in interaction and negotiation between social worlds are not without their difficulties. "The analysis of negotiative activity is markedly processual and dynamic, yet grounded in the political realities of social life." Among other things, the negotiation context must be taken into account.

In this case, the Learning Alliance was at a disadvantage. This set the stage for tensions between the Learning Alliance and industry, ultimately drawing out the ideological differences between the parties. If they wanted Steel Inc. to participate in an ecologically responsible

collaborative venture, they had little choice but to find a way to accommodate the company's demands for a quick payback period. The Learning Alliance stood to lose more from failure than Steel Inc. Once the Learning Alliance recognized the saliency of market constraints, they began to acquire a perspective that was responsive to Steel Inc.'s perspective. Alliance members were forced to make more accommodations and compromises than Steel Inc. Nevertheless, the Learning Alliance ultimately achieved its goal. They found a creative way to modify their approach, to fit their lines of action together with those of their business partners, thereby changing business practices in the direction they were seeking and showing that science/business collaborations were possible.

Clarke (2005:52) has argued that, "the study of boundary objects can be an important pathway into often complicated situations, allowing the analyst to study the different participants through their distinctive relations with and discourses about the specific boundary objects in question." The tensions that arose out of the failed proposals made the difference in perspectives between the Learning Alliance and Steel Inc. obvious and eventually culminated in a change in approach and a successful venture. At the same time, studying these tensions and their ultimate resolution serves usefully to illuminate the differences in perspectives between these two social worlds.

Reflecting more generally on the contributions of this case study to our understanding of Mode 2 science, a number of observations become possible. Moving away from conventional science and embracing the idea of genuine collaboration and a recognition of diverse knowledge systems is possible only if scientists are aware of the barriers they may face in realizing this alternative vision of knowledge production. Key among these barriers are the difficulties inherent in any situation where different social worlds must come together in order for

collaboration to occur.

References

Becker, H. 1986. *Doing Things Together.* Evanston, IL: Northwestern University Press.

Blumer, H. 1969. *Symbolic Interactionism.* Berkeley: University of California Press.

Bourdieu, P. 2001. *Science of Science and Reflexivity.* Chicago: University of Chicago Press.

Bowker, G. and S. Star. 1999. *Sorting Things Out: Classification and its Consequences.* Cambridge: The MIT Press

Clarke, A. 2005. *Situational Analysis: Grounded Theory After the Postmodern Turn.* London: Sage Publications.

Clarke, A. and S. Star. 2003. "Science, Technology, and Medicine Studies". Pp.539-574 in *Handbook of Symbolic Interactionism*, edited by L. Reynolds & N. Herman-Kinney. New York: AltaMira Press.

------. "The Social Worlds Framework: A Theory/Methods Package." Pp.113-138 in *The Handbook of Science and Technology Studies*, Edited by E. Hackett, O. Amsterdamska, M. Lynch and J. Wajcman. Cambridge: MIT Press.

Funtowicz, S. and R. Ravetz. 1993. "Science for the Post-Normal Age." *Futures*. 25:735-755.

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow. 1994. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

Gorman, M. and M. Mehalik. 2002. "Turing Good into Gold: A Comparative Study of Two Environmental Invention Networks." *Science, Technology and Human Values.* 27: 499-529.

Hall, P. 1987. "Interactionism and the Study of Social Organization." *Sociological Quarterly.* 28:1-22.

Healy, S. 1999. "Extended Peer Communities and the Ascendance of Post Normal Politics." *Futures.* 31:655-669.

Maines, D. 1982. "In Search of Mesostructure: Studies in the Negotiated Order." *Urban Life* 11:267-79.

Ravetz, J. 1999. "What is Post-Normal Science." *Futures* 31:647-653.

Star, L. and J. Griesemer. 1989. "Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science* 19: 387-420

Strauss, A. [1959] 1969. *Mirrors and Masks.* San Francisco: Sociology Press.

----------. 1993. *Continual Permutations of Action.* New York: Aldine de Gruyter.

CHAPTER 3- MODE 2 PUBLIC SOCIOLOGY

Mode 2 Public Sociology: Accomplishing Interdisciplinary Collaboration

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Running Head: ACCOMPLISHING INTERDISCIPLINARY COLLABORATION

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ABSTRACT

The paper looks at the interface between two segmenting disciplines both of which are committed to producing knowledge that is more relevant to current social problems and to a knowledge production process that is collaborative and democratic in the sense that it brings together a broad range of stakeholders. The first of these segments is a movement among scientists towards what is called a Mode 2 model of knowledge production. The second segment is represented in the movement within sociology that is called public sociology. After drawing out the parallels between the two movements, I reflect on their impact on my own research on a group of environmental Mode 2 scientists. More specifically, I discuss the pressures I experienced from the group I studied to become engaged as a collaborator in their initiatives. I discuss as well the pressure I experienced as a result of debates within my own discipline to rethink my role as a sociological analyst. The paper ends with a discussion of the challenges involved in negotiating a collaborative relationship with non-sociologists in the production of knowledge.

Bucher and Strauss pointed out many years ago that professions are not homogeneous monoliths, but rather consist of a loose amalgamation of complicated "segments" that have distinctive values, goals, and their own identities that at times come into conflict with other groups within their occupation or fields of work (Bucher and Strauss 1961; Pawluch 1996; Podomore 1980). The same can be said of academic disciplines, including science, engineering (Schnaiberg 1977) and even sociology itself. Academic departments are comprised of segments that may share certain goals, values and identities, but also diverge in terms of interests, approaches, and theoretical underpinnings (Hermanowicz 1998; Star 1989; Tuunainen 2005). This tension can result in disciplines "fragmenting into pieces" (Galison and Stump 1996:2), but the segmentation process can also create new opportunities for collaboration and growth within a profession.

We are seeing just such innovative opportunities with the emergence both in science and in sociology of segments that are reimagining the fundamental tasks of their discipline. A number of segments within science and engineering are making the transition from conventional research models to interdisciplinary and transdisciplinary collaborations that make room for input from, and are more responsive to, the experiences and needs of the lay public. These shifts in science are described as a move from Mode 1 towards Mode 2 knowledge production (Gibbons et al. 1994; Nowonty et al. 2001). While conventional scientific research generates pure scientific knowledge that is generally divorced from its context, Mode 2 science strives to contextualize knowledge in ways that acknowledge the real world problems that science should ultimately be seeking to solve. In a highly technical and uncertain world, advocates for Mode 2 science believe that science needs to move away from a model that compartmentalizes knowledge production according to disciplines working in isolation from each other and revolves

around a "star" system where only established researchers obtain funding for their work. Instead, Mode 2 advocates promote a way of doing science that encourages scientists to work democratically with others and to consider the broader goals towards which humanity is striving.

Similarly, in sociology there has been a movement over the last decade towards not only observing and explaining social phenomena, but using the sociological knowledge and insights gleaned to serve the very people sociologists are studying and the public at large. The trend has been described as a move in the direction of a public sociology. Public sociology rejects the notion of sociology as a "value free" science of society and promotes instead the idea of an activist, engaged, problem oriented sociology (Burawoy 2004; Messer-Davidow 1993). The work of a public sociologist is guided in large part by the "interests of humanity" and a belief in "keeping at bay both state despotism and market tyranny" (Burawoy 2005:24). In an attempt to improve as well as understand the lives of others and solve social problems, a public sociologist downplays "elite" theory driven research and focuses more on alternative ways to generate knowledge and to ensure both public engagement in, and public payoffs from, sociological research.

The shifts in disciplinary knowledge production in both the natural sciences and sociology and how they intersect came together for me in a personal way in the context of a study I have been conducting of a group of scientists called the Learning Alliance. The Learning Alliance is a local group of academic environmental engineers who are struggling to find ways to integrate end-users in all phases of their research. Alliance members are attempting to remove barriers between disciplines, stressing collaboration and a problem oriented approach that advocates for social and environmental issues. The Learning Alliance's unique alternative vision of science and engineering brings it into contact with other professions, academic departments

and end-users in the hopes of establishing collaborative circles that are committed more to the process of serving the public good rather than advancing their own professional interests. The Learning Alliance is attempting to persuade their engineering colleagues, the government and industry to make a greater effort to address environmental issues and to do so by getting all stakeholders to come together in a democratic effort to solve concrete problems.

In 2006 I began a study of the Learning Alliance. My goal was to track ethnographically what efforts to enact a democratically oriented science looked like on the ground. My initial interactions and involvement with the Learning Alliance involved my observing them at their work places, and attending meetings and conferences with the group. While I kept detailed notes, these notes were for my own purposes. Over time, however, members of the Alliance came to look to me for advice and input into what the group was doing. More specifically they wanted me to systematically observe how interactions with their industry partners were going and to offer suggestions as to how these discussions could go more smoothly. In response to the increasing pressures on me to play a more involved role in the Learning Alliance and its activities as a contributor to their efforts, I was led to re-examine my positioning as a sociologist.

This reflexive exercise on my part was fueled as well by recent debates that I was following within the sociological literature about the goals of the discipline and the need for a more public sociology. The social sciences have always had scholars involved in what has been called "participatory action research" (McIntyre 2008). Recently, however, debates about the ultimate goal of sociology, where "social engineering" fits into this goal and how members of the social groups that sociologists study figure in our efforts have all become more intensified (see Helmes-Hayes and McLaughlin 2009). In his 2004 American Sociological Association presidential address, Michael Burawoy (2005: 10-11) asked two fundamental questions: 1) who

is sociological knowledge for? "Are we just talking to ourselves (an academic audience) or are we also addressing others?" and 2) "Should we be concerned with the ends of society or only with the means to reach those ends?" As scholars are we merely required to generate instrumental knowledge with the intention of solving social puzzles or do we have an obligation to disseminate and use our findings to promote the public good?

My reading of the literature on public sociology led me to wonder what public sociology would look like within the context of my own study of the Learning Alliance. Would a decision on my part to participate in the Alliance's activities in the way its members wanted also serve the purpose of pushing me in the direction of a public sociology? If so, what impact would this have on my ethnography? The outcome of these reflections was a decision to shed my detached stance or my role as a sociological observer and instead to engage with the Learning Alliance in their efforts. The purpose of this paper is to explain this decision within the context of disciplinary segmentation. On one level, this paper documents my transformation as a sociologist. On another level the paper can be read as an example of shifting disciplinary and professional segments and their convergence in a new approach to knowledge production.

The paper is organized as follows. I start by describing more fully the changes in science that I referred to earlier as a shift from Mode 1 to Mode 2 science. In the next section of the paper I discuss in greater detail how changes in the natural/physical sciences and in the social study of science and technology have been paralleled by similar developments in sociology in the form of the recent debates about public sociology. I then discuss the convergence of these trends in terms of their impact on my research. I describe the tensions between involvement and detachment that I experienced in conducting an ethnography of the Learning Alliance. I focus on the questions these tensions led me to consider and concerning my traditional sociological

training, my decision ultimately to join, rather than simply study the Learning Alliance. I discuss my transition from a conventional ethnographer to public sociologist. I make the case that as a result of the transition, I was able to engage in an ethnographic public sociology that served both me and the Learning Alliance in our mutual goal of forging a new way to produce knowledge in our respective disciplines and to contribute in a more meaningful way to environmental efforts in the process.

Shifts in Science

The concept of Mode 1 and Mode 2 science was first proposed by Gibbons et al. (1994) and Nowotny et al. (2001) who argue that a new mode of scientific knowledge is slowly supplanting more traditional scientific research. They describe conventional knowledge within the sciences as Mode 1, a process of knowledge development that is based strictly on the norms of the scientific method. While the alternative form of research, Mode 2, is not devoid of the scientific method, Gibbons et al. (1994: 3) suggest that it possesses its own "distinct set of cognitive and social practices...different from those that govern Mode 1." Rather than solving problems based on "codes of practice relevant to a particular discipline", problems are handled "around a particular application" (Gibbons et al. 1994: 3). Mode 2 seeks to achieve solutions that usually transcend specific disciplines. Therefore, interdisciplinary collaboration often takes shape around a number of concerns that Mode 1, less accountable and rarely reflexive, is often ill equipped to handle.

The Learning Alliance can be described as a Mode 2 initiative in that it is continually seeking to generate an 'extended group of experts' dedicated to solving particular problems and willing to do things differently. The Learning Alliance believes that scientific knowledge cannot be separated from how it is used and what consequences it brings about. A Mode 2 model of

knowledge production is situated along many "knowledge dimensions" (Gibbons 1999:15). These dimensions are both scientific and moral. As far as Alliance members are concerned, facts are not developed in a vacuum as they are inextricably linked with values (Shalin 1986). Alliance members believe that all researchers have a responsibility to consider the moral dimensions of their work because all research has moral consequences. The specific problems that are of concern to the Alliance are those that connected to sustainability. Alliance members make it clear that they do not want to separate knowledge production from the problems they feel that science should be dedicated to solving. Alliance members feel strongly that the fate of the world depends on learning how to think differently about environmental science and how to practice it.

Shifts in Sociology

The theme of public service and the integration of multiple "knowledge dimensions" that is so central to the move towards Mode 2 science is also at the heart of changes occurring within sociology. Burawoy divides the discipline of sociology into four interrelated types of knowledge acquisition and dissemination: Policy, professional, critical and public sociology. Policy sociology is associated with sociological knowledge used " in the service of a goal defined by a client" (Burawoy 2005: 9). Here, the public defines the problem and invites sociology to assist in its solution or have sociology "legitimate solutions that have already been reached" (Burawoy 2005: 9). Professional sociology "supplies true and tested methods, accumulated bodies of knowledge, orienting questions, and conceptual frameworks" (Burawoy 2005: 10) Burawoy (2005:10) defines critical sociology as the watchdog of the discipline- making it "aware of its biases." Critical knowledge is used to "examine the foundations- both the explicit and the implicit, both normative and descriptive- of the research programs of professional sociology"

(Burawoy 2005: 10). Public sociology takes place when scholars are directly involved in open and reflexive dialogue with local communities (Burawoy 2005: 7). Depending on their own interests and goals, all four types of knowledge overlap but ultimately each practitioner emphasizes one over all others.

Burawoy (2005: 8) makes a distinction between a more authentic and relevant sociology that is engaged with the public and a conventional sociology that at first glance appears amendable to public issues but is in fact more in line with professional interests. He calls the former public sociology "organic" and the later "traditional." Burawoy (2004; 2005) describes "traditional" public sociology as unidirectional. It tends to take place within newspapers and interviews with scholars expressing their authoritative voice rather than truly representing the needs of others. Furthermore, an "organic" sociology possesses a certain humility. It is open to other ways of knowing and thus able to evolve through "mutual education" between sociological expertise and the public.

Diane Vaughn's collaboration with NASA offers an example of traditional public sociology. In a paper entitled, "On the relevance of ethnography for the production of public sociology and policy", Vaughn (2005) suggests that the media attention her findings on NASA's "organizational failings" received during the Space Shuttle Columbia disaster, moved her from the position of professional sociologist to public sociologist. Commenting on the value of ethnographies from the public's perspective, she writes:

> Ethnographic thick description presents details that convince, enabling readers to recognize patterns and make that important connection between personal problems and public issues...ethnography is particularly suited for showing complex social relations, exposing the intersection of history, institutional forces, culture, and structure as they affect everyday interaction and the meanings of social life to individuals (Vaughn 2005: 413).

Vaughn states that after the Space Shuttle Columbia tragedy, NASA and the media immediately placed her in the spotlight and as a result she made the transition from the "usual routine as a professional sociologist" to a public sociologist. Although Vaughn and others embrace the idea of a public sociology, there are just as many who do not see this democratic movement as beneficial to the sociological enterprise. A majority of these scholars are more concerned with what they see as the survival of the discipline rather than what it has to offer the public. Steven Brint (2007: 239) represents such a stance. He writes: "To the extent that it succeeds in shifting attention away from 'professional sociology', it will reduce the achievements and legitimacy of the field rather than increase its influence." There are also concerns about sacrificing detachment and compromising objectivity. Jonathan Turner (2007:273) writes: "Sociologists who are advocates soon lose their professional detachment to analyze conditions accurately; they are pulled by emotion and ideology into the cause, and almost always, they lose their sociological imagination in the process."

Burawoy (2005) has argued that an organic public sociology need not necessarily jeopardize the legitimacy of professional sociology nor be blinded by ideology. Rather, he (2005: 8) insists, an organic sociology engages the public in a "dialogue, a process of mutual education." Buroway explains the difference between traditional and organic styles of public sociology in this way:

> Public sociology...strikes up a dialogical relation between sociologists and the public in which the agenda of each is brought to the table, in which each adjusts to the other...In the...genre of what I call traditional public sociology...are (books and articles) read beyond the academy and (which) become the vehicle of public discussion about the nature of U.S. society...(A)nother type of public sociology (is) organic public sociology in which the sociologist work in close connection with a visible, thick, active, local, and often counter-public (Brint 2007: 239; Burawoy 2005:9, 7)

However, Buroway is not clear on what he means by public sociology as dialogue or about how this plays out in everyday interaction between researcher and participant. Perhaps this is why his work is so vulnerable to a number of moral and ideological critiques (Brint 2007, Turner 2007).

If we want to better understand how the public and the discipline generate meaningful dialogue then we must problematize mutual education as intersubjective accomplishment. In the case of my ethnographic research, the mutual influence or 'dialogue' that took place between myself and the Learning Alliance had its beginnings in my participants' demands for reciprocity. Those demands created tensions in that they raised for me the kinds of questions about legitimacy, detachment, and objectivity with which critics of public sociology are grappling. In dealing with these tensions I was led to consider more carefully the possibility of "dialogue as mutual education" and how it might be accomplished.

At the heart of this dialogue is the unfolding of an effective translation of expertise between two different social worlds. Elaborating on the role of translators, Collins and Evans suggest that "some people have a special ability to take on the position of the 'other', and to alternate between different social worlds and translate between them. The translator will have to have at least interactional expertise in both areas"(Collins and Evans 2002: 258). Translators have the ability to bring diverse groups together by drawing on different perspectives to construct a narrative that both parties can appreciate and thus bring about a shared understanding so that projects can be completed. Like Diane Vaughn, I became a translator between social worlds. In the next section I go into more detail about my transition from professional to public sociologist and the process of "mutual education" I became engaged in with members of the Learning Alliance.

Experiencing Tension in the Field

In hindsight, it should have been possible for me to anticipate that the kind of traditional ethnography I envisioned would not be possible. After all, as scientists concerned with opening up the boundaries of science and working side-by-side with a much broader range of players, it was natural for Alliance members to see me not as someone "on the side," but as an academic with a potential contribution to make to their cause. In fact there must have been an implicit expectation on their part by bringing me into their inner circle they would incorporate my insights into the social aspects of their research.

For my part, I understood that I was going to be collecting data on the negotiation process between themselves and their end-users. I understood as well that this was data that I would be sharing with the group and that the data could be potentially useful to them. To the extent that the data shed light on the interactions with end-users, Alliance members could use it to facilitate and improve those interactions. However, I saw myself as using the data for a different purpose, that is, to advance sociological knowledge about Mode 2 science. At that stage, while I was certainly sympathetic to their environmental goals, I did not see myself as a member of the group pursuing those goals.

At a meeting during which members were writing up a grant application for a collaborative project on waste-water management and conservation, without much discussion the assumption was made that my name would be involved in the application. Not recognizing at the moment the significance of the decision, I went along with the plan. I did not want to jeopardize my access to the group. My sense was that this was one way for me to reciprocate.

Environmental Engineer: "With a Sociologist on board, we have an even greater chance of getting funding for this project. It will signal to the board that our Alliance has grown beyond disciplinary borders."

Author: "Sounds exciting. What will my role be?"

Environmental Engineer: "You can monitor and evaluate the negotiations and tell us what we are doing wrong." [Field Notes 2008]

Another occasion when an Alliance member blurred the line between me as a researcher and me as a member of the group was in an interview. Discussing the role of academics in the Alliance, an interviewee said:

> You have to understand where we are coming from. Of course we want to work with not only end-users but also other academic disciplines. But we can't help but be wary. We want to avoid just sitting around and talking about ideas. It is important that we invite like minded individuals that are willing to engage the real world. [Interview #11, 2008]

The comment had the effect of making me feel as though I too, as an academic, was being put to the test. I felt myself challenged to consider whether it was enough for me to limit myself to producing scholarly knowledge or whether I too needed to be willing, as the interviewee suggested, to "engage the real world."

The questions that my involvement with the Learning Alliance began to raise for me were jarring, given that I believed I had already worked through my role as a sociologist. I knew that there were sociologists committed to serving the public good, but most of these were critical sociologists concerned with structural inequalities and ways to address these inequalities. In the sociological tradition in which I had situated myself, that is, the interpretive tradition, sociologists are more interested in how their participants makes sense of their world. Rooted in the pragmatist tradition, interactionist approaches are concerned not with whether the meanings that social actors create are right or wrong, but with how these meanings are created and what consequences these meanings have. In fact, at the heart of these approaches is W.I. Thomas

famous dictum: "If men define situations as real, they are real in their consequences" (Thomas and Thomas 1928: 571-72).

Connected with the interactionist tradition, there is a concomitant understanding of where the sociologist sits with respect to the meanings constructed by the social actors he or she studies. While it is the task of the sociologist to capture the perspectives of social actors through a process of sympathetic introspection, the purpose of such introspection is to understand the meanings created since they are the basis for social action. The sociologist does not judge those meanings as correct or incorrect, worthy or unworthy, legitmate or illegtimate. The sociologist stands "on the side."

The dilemma that I found myself facing in connection with the Learning Alliance was the following: On the one hand I wanted to remain detached and to focus on how the Learning Alliance understood science and their role as scientists. On the other hand, I was tempted by the role into which they were casting me, as "one of them," working as a member of the Alliance. What would it mean to my analysis if I did in fact cross the line and became a member of the Alliance? Would I be able to produce anything that would be useful sociologically speaking? Turner (1969: 95) discusses the "liminal" tension of being "betwixt and between" two worlds. I experienced just such a tension. Was I going to use my sociological skills to study the Learning Alliance or, as an Alliance member, advance the cause of the Alliance? The imperative to "stand on the side" is drilled into those trained in interpretive or interactionist traditions. Academics in this tradition frown on and are warned against the dangers of "going native." Guevarra (2006: 530) for example, cautions ethnographers that they are always "vulnerable to participants who define the researcher's place in their social worlds based on the researcher's usefulness to them

or in ways that may support their belief systems or political agendas." Fuller (1999:226) suggests that "going native" is connected with

> ...the apparent loss of validity, integrity, criticality, necessary distance, formality and, ultimately, reputation. In this context, the integrated position is one of anxiety, in which the researcher is faced with the realization that, by being incorporated into the research community that (s)he was supposed to be studying, (s)he has effectively failed.

Collectively Constructing Mode 2 Science: The End-User as Boundary Object

The decision to become an Alliance member eased the tension surrounding my role and clarified the stance I was bringing to my research. In this sense it solved one problem. In doing so, however, it generated another problem. In what ways could I, as a sociologist, contribute to the Alliance's goals? How could I engage with my fellow Alliance members in a process of "mutual education?" Would I and my fellow Alliance members be able to reconcile our different academic backgrounds, ways of thinking about scholarly research and methodological training to work together towards our goals?

The challenge for us paralleled the challenge I discussed in my paper on the encounter between the Learning Alliance and its industry partner (Steel Inc.). Our goal and commitment to the environment were shared, but the realization of those goals hinged on learning how to communicate with and understand each other, on finding common ground that made sense to all of us. In other words, the Learning Alliance and I faced the challenge of negotiating a "transaction space" and finding a common "boundary object." Transaction spaces, according to Howotny et al. (2001), are inclusive interdisciplinary communities that consist of both experts of various types and lay people. These Mode 2 transaction spaces tend to generate innovative knowledge production that consists of intersecting social worlds in which "individual scientists are now much freer to co-operate with individuals from other groups and to transgress

established institutional and group boundaries" (2001:103). They further describe these transaction spaces as an open invitation to a number of diverse stakeholders:

> Individuals from other social groups, whether members of other scientific communities, industrial partners or lay people, are now actively sought, valued and welcomed in the new game of knowledge production characterized by much more individualistic rules of engagement and potential for developing novel relationships with those who are in the rising category of the ubiquitous 'user'(2001:1003).

Within these social groups, experiential alternative forms of knowledge are considered valuable. "Transaction spaces" provide a climate within which 'users' can feel comfortable sharing their knowledge, skills, and expressing their opinions and values with experts regarding the design and implementation of technologies that may impact their communities and businesses.A transaction space helps these segments achieve effective collaboration but still retain their distinct identity. When professional segments intersect, collaboration may take place resulting in transaction spaces built up around specific boundary objects. "The idea of 'transaction' implies...that all partners bring something that can be exchanged or negotiated...Of course, the meanings attributed to exchanged objects may greatly differ for different participants. But the success of these exchanges depends on each participant bringing something that is considered valuable by someone else..." (Nowotny 2001:145).

Boundary objects, according to Clarke (2005: 50-51) are "things that exist at junctures where varied social worlds meet in an arena of mutual concern...Here the basic social process is 'translating the object' to address the multiple specific needs or demands placed upon it by the different worlds involved." These objects are difficult to predict because they are emergent entities that manifest during negotiation and are specifically adapted to the groups involved and the environment in which they are constructed. "Something is necessary to align diverse and often divergent interests if work is to get started, but it is not a planned process." (Howotny

2001: 149). Howotny et al. (2001) provide the UK Human Genome Mapping Project (HGMP) as an example of a boundary object's emergent qualities. Despite the conflicting demands that existed between the various administrative and scientific social worlds involved in the project and the policy that was being the constructed, the "gene mapping community" managed to align diverse interests and successfully achieve cooperation around the common goal of mapping the genome.

The boundary object that allowed me to work together with the Learning Alliance and to contribute to the group's goal of creating collaborative environmental ventures was the notion of "end-users." Critical to the Alliance's success was the active involvement of end-users (i.e. industry partners, government officials, home owners, technological designers). The whole idea of Mode 2 science hinges crucially on bringing end-users in as fully present and agentic players. This explains why from the point of my earliest involvement with the Learning Alliance so much of the group's discussions centered on end-users. While the Alliance was clear about its dependence on end-users, as natural scientists most members of the group did not feel confident about what it might take to establish effective working relationships with end-users. In fact, as I explain in another paper, the group ran into difficulties in their initial encounters with end-users.

These difficulties may account for the group's eagerness to have me involved in their efforts. They saw in me and in my social science training, the opportunity to potentially benefit from knowledge I had to contribute. As my own hesitation about involving myself in the group's activities in this way dissipated and as I more whole heartedly took on the role of colleague and partner, in more focused ways I began to think about how my sociological training could be used to realize the group's goals. I began discussing with the group the tenets of symbolic interaction and its method of qualitative analysis (Blumer 1969; Prus 1993). I suggested it was an approach

that we could utilize to better grasp the perspective of their end-users and how end-users understand the implementation of technologies. My end of the "mutual education" process was to explain how from a symbolic interactionist perspective, the researcher studies participants within their own natural setting and builds an understanding of what is happening in that setting through observation and participating in the social milieu of social actors. The researcher is careful never to stray too far from the participant's common sense knowledge of the everyday world and how that knowledge is used to construct and make sense of reality.

The discussions we began to have about symbolic interaction were both abstract and specific as together we worked out the implications of symbolic interaction for the work we were doing. At one meeting for example, I was given an opportunity to explain how I perceived social action. In explicitly academic terms I talked about Becker's (1967) interpretation of Mead's (1934) social psychology. I shared with the group a specific Becker quotation that I thought would serve as a useful point of communication between us:

> We must always look at the matter from someone's point of view. The scientist who proposes to understand society must as Mead long ago pointed out, get into the situation enough to have a perspective on it. And it is likely that his perspective will be greatly affected by whatever positions are taken by any or all of the other participants in that varied situation (1967:245).

I went on to describe how this approach is distinct from the more popular hypothetico-deductive method, a paradigm with which the natural scientists in the group would have been more familiar. I then related the ideas back to the group's activities which initiated a discussion about the directions from which end-users might be coming and the need to take their perspectives always into account in attempting to forge relationships with them.

There were also discussions in the group about qualitative approaches to research questions and the value of proceeding inductively, that is, taking stock of and analyzing new data

as it comes in, and allowing one's on-going analysis to direct next steps. This approach was, in fact, adopted by the group as it reflexively assessed in a back and forth fashion its efforts to incorporate stakeholders in developing user-led design approaches. The outcome of these discussions were two co-authored papers by the lead engineer and myself. We presented these papers at conferences on engineering and innovation in two different provinces (see Appendix A and Appendix B).

While learning to work together, as I have described it, may appear to have been a smooth path, this was not always the case. The process involved endless hours of talk and time spent together. It also involved getting used to our differing ways to talking and thinking about problems. While others in the Alliance talked about 'end-users' , 'drivers' and 'green champions' I tended to use such terms as 'participants' and 'joint action.' Nevertheless, we eventually generated what Galison (2007) calls an 'inter-language' or 'Creole.' As a boundary object, end-users and the need to make them central to the work we were doing, served usefully to bring all of us who were members of the group together. End-users allowed me to bring my sociological knowledge to bear on the work of the Alliance and its goals. Moreover, by contributing to a better understanding of end-users and their role in the process. I was able to derive the benefits of this understanding in relation to knowledge about fundamental social processes, while the scientists in the group were successful in moving themselves closer to the Mode 2 science they were seeking to enact.

Discussion: Reflecting on Detachment and Involvement

In closing, I want to briefly address the question of the implications of "going native." I learned early in my professional socialization the importance to interpretive sociologists of keeping one's analytical distance, that is, to grasp but not adopt the perspective of the social

actors we study. Hammersley and Atkinson (1983:102) argue that in adopting the perspectives of social actors, we render our analysis into mere personal accounts. They state,

> There can be no question of total commitment, 'surrender,' or 'becoming.' There must always remain some part held back, some social and intellectual 'distance.' For it is in the 'space' created by this distance that the analytic work of the ethnographer gets done. Without that distance, without such analytic space, the ethnography can be little more than the autobiographical account of a personal conversion.

Along with the caution to avoid "personal conversion" in the field is the claim that one must be morally disengaged when studying others problems. Gusfield (1984:46) advocates for a "sociology of detachment" that is

> ...a sociology whose ironic scepticism about the factual basis of social problems places the sociologists in an Olympian position. Not action but understanding is the aspiration of interpretive sociologies...the sociologist disputes, implicitly, the claim of sociology to effect a rational base to social problems policy...Asked whose side are we on, the answer is: On the side.

He goes on to argue that

> ...sociology cannot offer the society a technology, a method for discovering or solving public problems, not a science, a body of knowledge whose indisputable character resolves moral and political conflict. Its social value lies in widening our understanding of self and others and in revealing the many alternatives from which to make choices and interpret events. Its aesthetic value lies in the joy of knowledge and interpretation that is neither science nor art, but yet both (Gusfield 1984: 48).

Both Hammersley and Atkinson and Gusfield's positions are limiting and seem to force a choice that I do not believe needs to be made. In other words, understanding the perspective of social actors on one hand, and moral engaging those we study on the other, need not be an either or proposition. That these positions have been constructed by so many interpretive sociologists as a binary or as mutually exclusive positions may be why I and probably many others

experience their relationships with their study participants as complicated, ambiguous and fraught with dilemmas.

In a paper that deals with the myths that qualitative researchers tend to perpetuate, Gary Alan Fine (1993) suggests that among these myths is the unobtrusive ethnographer. Even if unobtrusiveness is possible, he insists it may not be an ideal worth striving toward. Fine writes, "...the degree to which one is an 'active member' affects the extent to which this sympathetic understanding is possible, and this is a function of one's social location...as a consequence, the presence of an observer should not be too worrisome..." (1993:282) The real concern over participant observation is not *if* the ethnographer influences his participants or *if* they influence him, but *how much* influence is allowable given this unavoidable dialectic? Fine (1993:281) states that we need not worry about the role of the observer "as long as the impact is not excessively directive or substantive."

While Fine is discussing obtrusiveness rather than identification with participants and their perspectives, his point about the impossibility of doing research without some level of engagement with participants is significant. In essence, Fine is conceding that as sociologists we can never be completely on the side, uninfluenced by our participants and not in a position to influence them. The line he draws at influences not being "excessive" is curious. At what point do these influences become excessive? Moreover, what are the consequences of going too far? Fine does not address this question.

The possibility of a public sociology within fieldwork settings forces us to consider these questions and to revisit the assumptions we make about the dangers of going native. To conduct my study of the Learning Alliance as I wanted to do it, I had to relinquish the pretence of being an unobtrusive ethnographer. As Fine argues, I would not have been unobtrusive in any case.

More critically, I found myself not wanting to be unobtrusive. On the contrary, I wanted to be fully engaged with the Learning Alliance and its efforts. I found the pull of, and rationale for, a public sociology more compelling than the traditional arguments for maintaining professional distance. I wanted my analysis both to further knowledge in sociology and advance the environmental and science related goals of the Learning Alliance. In the end I believed I achieved this without compromising the value of the sociological contributions I have made.

Going even further, one can argue that being influenced by participants, to the point of adopting their viewpoints and causes as our own, and influencing them to the point where we may be directing the actions they take or directions they move in, makes for better and more valuable sociology. Writing about the tensions, but also the benefits associated with different social worlds colliding, Longino (2002) writes:

> Membership in multiple communities may be a source of internal conflict, but it is also an epistemological resource. It permits an individual to compare standards and to assess (purported) knowledge produced and accepted in one community in reference to standards proper to another. It confers on individuals the ability to see things from more than one point of view or at least to understand that there could be more than one point of view...(2002:155).

Allowing my perspective as a sociologist interested in scientists to co-mingle with the perspectives of the scientists I studied led to a situation wherein they shaped me to produce an account that contributed more levels than it would have otherwise. In addition to what I learned about the enactment of Mode 2 science and acquired knowledge about certain technical issues in water reuse technology, environmental challenges, and the importance of end-users my participants/co-activists learned how valuable an understanding of interactional processes and a qualitative approach can be in the pursuit of a more "democratic science."

The interdisciplinary collaboration that took place between myself and the Learning Alliance demonstrated "mutual education" within an ethnographic public sociology. Together,

Alliance members and myself, using end-users as our boundary object, each acquired a working knowledge of the other's expertise and in the process pushed ourselves further in the pursuit of our own individual goals than we would otherwise have gone.

My collaboration with the Learning Alliance proved to me that my membership in the world of the group I was at the same time studying could in fact be seen as a methodological strength. The successful construction of end-users as boundary object and the sociological insights it gleaned for me were made possible as a result of my own expertise in studying my own understanding of social interaction and my participant's visions of scientific activism. This resulted in a much more nuanced research experience than is captured in Hammersley and Atkinson's typification of an engaged sociological analysis as an "autobiographical account of a personal conversion"

Any research involving participant observation demands a combination of rapport and objectivity. The successful balance of these two positions is difficult to achieve at the best of times. Ultimately the problem is not developing rapport but rather what "kind and quality of rapport" has been achieved? And "...at what point does closeness to the subject limit the research role (Miller 1952: 98-99)? These are questions that demand personal reflexivity on the part of ethnographers as only they can answer the question of "over-rapport" for themselves. Miller (1952) argues that complete detachment (i.e. Martian) or fully integrated participant (i.e. convert) are stereotypes that in reality do not exist. Perhaps it is best to view participant observation along a continuum ranging from complete participant to neutral observer, each position having its own epistemological advantages and disadvantages (Gold 1958; Miller 1952). The 'Martian' will err on the side of producing a strangely lifeless account that does not include the participant's subject world, whereas 'converts' must question if in becoming 'the other,' they are presenting

only their own point of view rather than an accurate reflection of their participant's life-world (Miller 1952:341-2). Regardless of where the ethnographer falls along the Martian-convert continuum, it is important to reflect on one's place in the research process. Most ethnographers will at some point in the research process ask themselves, "Who are the participants to me?" I would argue that we should also be asking ourselves, "Who am I to them (Tedlock 1991) and how can my sociological work be useful to them?" There are certainly many epistemological and methodological issues to address in raising these questions. Nonetheless, grappling with difficult questions in this regard is better than perpetuating the myth of the 'unobtrusive observer' and representing the "researcher (and research itself) as inert, detached and neutral" (Fuller 1999: 224).

There are a number of overlapping themes running through this paper: segmentation within science and sociology, interdisciplinary collaboration, reciprocity in fieldwork settings, and the positioning of sociologists in relation to the groups they study. I explored these themes in the context of my own ethnographic experiences with a newly emerging segment in science-a group of environmental engineers seeking to do science differently. I explained how I was pushed into a re-examination of my place and task as a sociologist by the insistence on the part of my research participants to join them and take up their cause rather than simply studying them. The debates within sociology itself about the need for a more relevant, problem-oriented public sociology fuelled that re-examination. The push/pull forces and the role crisis they precipitated led me ultimately to drop the pretence of being a detached observer of social phenomena and to become instead an ethnographer committed to both understanding social phenomena and using that understanding to contribute to social change. In doing so, I became a player in both the segmentation process in science (towards Mode 2 science) but also within my

own discipline where at least some sociologists are fashioning a different way of doing sociology. In this sense my paper can be seen as an autoethnography- an analysis of a larger social process or trend refracted through the lens of personal experience.

References

Abbott, A. 2001. *Chaos of Disciplines*. Chicago: University of Chicago Press.

Adler, P.A. and P. Adler. 1987. *Membership Roles in Field Research.* New York: Sage Publications.

Becker, H. 1967. "Whose Side Are We On?" *Social Problems.* 14:239-427.

Blomley, N. 1994. "Activism and the Academy." *Society and Space* 12: 383-5.

Blumer, H. 1969. *Symbolic Interactionism*. Berkeley: University of California Press.

Bucher, R. and A. Strauss. 1961. "Professions in Process." *American Journal of Sociology.* 66: 325-334.

Burawoy, M. 2004. "Public Sociologies. A Symposium from Boston College." *Social Problems* 51(1):103-30.

Burawoy, M. 2005. "For Public Sociology." *American Sociological Review.* 70:4-28.

Burawoy, M. 2005. "Public Sociology:Populist Fad or Path to Renewal?" *The British Journal of Sociology.* 56: 417-432.

Charmaz, K. 2006. *Constructing Grounded Theory.* London: Sage Publications

Clarke, A. and S. Star. 2003. "Science, Technology, and Medicine Studies." Pp.539-574. in *The Handbook of Symbolic Interactionism*, Edited by L Reynolds and N. Herman-Kinney. Toronto: AltaMira Press.

Clarke, A. 2005. *Situational Analysis: Grounded Theory After the Postmodern Turn.* London: Sage Publications.

Clarke, A.and S. Star. 2008. "The Social Worlds Framework: A Theory/Methods Package." Pp.113-138 in *The Handbook of Science and Technology Studies*, Edited by E. Hackett, O. Amsterdamska, M. Lynch and J. Wajcman. Cambridge: MIT Press.

Collins, H.M. and R.J. Evans. 2002. "The Third Wave of Science Studies: Studies of Expertise and Experience."*Social Studies of Sciences*. 32:235-296.

------. 2007. *Rethinking Expertise*. Chicago: The University of Chicago Press.

Cooley, C. 1902: *Human Nature and the Social Order.* New York: Charles Scribner's Sons

------. 1926. "The Roots of Social Knowledge." *American Journal of Sociology* 32:59-79.

Davis, F. 1973. "The Martian and the Convert: Ontological Polarities in Social Research." *Urban Life* 2: 333-343.

Dewey, J. 1897. "My Pedagogic Creed." *The School Journal.* LIV(3):77-80.

Fine, G. 1993. "Ten Lies of Ethnography: Moral Dilemmas of Field Research." *Journal of Contemporary Ethnography.* 22(3): 267-294.

Fuller, D. 1999. "Part of the Action, or 'Going Native'? Learning to Cope with the 'Politics of Integration'" *Area.* 31(3) 221-227.

Galison, P. 1997. *Image & logic: A Material Culture of Microphysics*. Chicago: The University of Chicago Press.

Galison, P. and D. Stump. 1996. *The Disunity of Science: Boundaries, Contexts and Power.* Stanford: Stanford University Press.

Gibbons, M. 1999. "Science's New Social Contract." *Nature*. 402: 81-84.

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow. 1994. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

Geertz, C. 1973. *The Interpretation of Cultures: Selected Essays*. New York: Basic Books.

Glaser, B. & A. Strauss. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research.* New York: Aldine.

Goffman, E. 1959. *The Presentation of Self in Everyday Life.* New York: Double Day Anchor.

----------. 1967. *Interaction Ritual.* New York: Double Day Anchor

Gold, R. 1958. "Roles in Sociological Field Observations." *Social Forces* 36(3) 217-223

Gubrium, J. and J. Holstein. 1997. *The New Language of Qualitative Methods.* Oxford:University Press.

Guevarra, A. 2006. "The Balikbayan Researcher: Negotiating Vulnerability in Fieldwork with Filipino Labor Brokers." *Journal of Contemporary Ethnography*. 35: 526-551.

Hammersley, M. and P. Atkinson. 1983. *Ethnography: Principles in Practice.* New York: Tavistock.

Helmes-Hayes, R. and N. McLaughlin. 2009. "Public Sociology in Canada: Debates, Research and Historical Contexts." *Canadian Journal of Sociology* 34: 573-600.

Hermanowicz, J. 1998. "The Presentation of Occupational Self in Science." *Qualitative Sociology.* 21:129-148.

Hughes, E. 1971. *The Sociological Eye.* New York: Aldine Publishing Company.

Jasanoff, S. 2003. "Breaking the Waves in Science Studies." *Social Studies of Science.* 33:389-400.

Latour, B. 1987. *Science in Action: How to Follow Scientists and Engineers Through Society.* Cambridge: Harvard University Press

Lofland, J. 1971. *Analysing Social Settings.* Belmont, CA: Wadsworth.

Longino , H. 2002. *The Fate of Knowledge.* Princeton: Princeton University Press.

McIntyre, A. 2008. *Participatory Action Research.* Los Angeles: Sage Publications

McTaggart, R. 1997. *Participatory Action Research: International Contexts and Consequences.* Albany: State University of New York Press.

Mead, G. 1934. *Mind, Self and Society.* Chicago: University of Chicago Press.

Messer-Davidow, E. 1993. "Manufacturing the Attack on Liberalized Higher Education." *Social Text* 36: 40-80

Miall, C. and A. Miall. 2002. "The Exxon Factor: The Roles of Academic and Corporate Science in the Emergence and Success of a New Global Model of Sequence Stratigraphy." *Sociological Quarterly*, 43: 307-334.

Miller, G. 1952. "The Participant Observer and 'Over-rapport'" *American Sociological Review* 17:97-99.

Nowotny, N., P. Scott and M. Gibbons. 2001. *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty.* Cambridge: Polity Press.

Pawluch, D. 1996. *The New Pediatrics.* New York: Aldine de Gruyter.

Podmore, D. 1980. "Bucher and Strauss Revisited: The Case of the Solicitors' Profession." *British Journal of Law and Society.* 7(1): 1-21

Pollner, M. and R. Emerson. 1983. "The Dynamics of Inclusion and Distance in Fieldwork Relations" Pp. 235-252 in *Contemporary Field Research*, Edited by R. Emerson. Boston: Little, Brown

Prus, R. 1997. *Subcultural Mosaics and Intersubjective Realities.* Albany: State University of New York Press.

Schnaiberg, A. 1977. "Obstacles to Environmental Research by Scientists and Technologists." *Social Problems* 24:500-520.

Shalin, D. 1986. "Pragmatism and Social Interactionism." *American Sociological Review* 51: 9-29.

Star, L. & J. Griesemer 1989. Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* 19: 387-420

Strauss, A. 1978. "A Social Worlds Perspective." *Studies in Symbolic Interaction* 1:119-128.

----------.1982. "Social Worlds and Legitimation Processes." *Studies in Symbolic Interaction* 4:171-190

----------. 1993. *Continual Permutations of Action*. New York: Aldine de Gruyter.

Tedlock, B. 1991. "From Participant Observation to the Observation of Participation: The Emergence of Narrative Ethnography." *Journal of Anthropological Research* 47(1) 69-94

Thomas, W.I. and D.S. Thomas. 1928. *The Child in America: Behavior Problems and Programs.* New York: Knopf.

Turner, V. 1969. *The Ritual Process.* New York: Aldine De Gruyter

Tuunainen, J. 2005. "When Disciplinary Worlds Collide: The Organizational Ecology of Disciplines in a University Department." *Symbolic Interaction*, 28: 205-228.

Vaughn, D. 2005. "On the Relevance of Ethnography for the Production of Public Sociology and Policy." *The British Journal of Sociology.* 56:411-416.

Wynne, B. 2003. "Seasick on the Third Wave? Subverting the Hegemony of Propositionalism." *Social Studies of Science.* 33: 401–17.

CHAPTER 4 - INNOVATIVE KNOWLEDGE TRANSLATION IN URBAN WATER MANAGEMENT

Innovative Knowledge Translation in Urban Water Management: An Attempt at Democratizing Science

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Running Head: AN ATTEMPT AT DEMOCRATIZING SCIENCE

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ABSTRACT

Some engineers are beginning to recognize that local end-user's knowledge and experience are vital for long-term sustainability and development of technologies. As a result of such insights, they are looking for ways to involve these end-users in all phases, from project development to implementation and upkeep. Within the water and sanitation sector, environmental engineers are constructing a series of "connected multi-stakeholder platforms" known as "learning alliances". These flexible networks involve relevant institutional and individual levels in the process of innovation. Rather than view end-users as passive receptacles, emphasis is placed on their active involvement in the shared learning experience of innovation. One goal of a learning alliance is to develop capacity among all stakeholders through a cyclic and incremental knowledge development process that incorporates technical and scientific expertise as well as lay expertise and localized knowledge. Similar patterns of practice were uncovered by certain social scientists while studying various collaborative ventures in science and technology. They noted that trading zones emerged within some of the more successful projects, allowing various experts to house competing interests while simultaneously agreeing upon other pertinent issues. We extend the trading zone metaphor to include expert-lay collaborative ventures. Our programmatic model further democratizes science and draws out some of the more salient knowledge transfer processes that constitute an ideal capacity building situation for all stakeholders.

The credibility of science in Western society is not immune to public anxiety and the perceived fear of a modern world spiraling out of control. Technoscience, for example, is no longer viewed as the key ingredient in solving the ills of humanity. Not necessarily jaded about the failed promises of technoscience, but less naive, we struggle now over the ambivalence of what 'progress' means for our species as a whole and the role science plays in our lives. Further, debates surrounding climate change, the safety of genetically modified organisms (GMOs), the threat of bovine spongiform encephalopathy (BSE) and vaccination have contributed to an emerging contested arena in which public deference toward science in general has eroded (Nowotny 2005). It is therefore imperative that we take stock of this waning in legitimacy and establish a democratic landscape that redefines, without succumbing to a putative 'culture of fear', the way science is done. In this paper, we address this issue by focusing on a small group of engineers within the water urban management sciences who are calling for alternative methodologies that address the complexity of knowledge transfer in sustainability projects.

First, we problematize science by suggesting that if it is to flourish in the 21st century it must move beyond the stringent traditional 'expert' knowledge production that is so isolationist in terms of involvement with end-users and become more democratic and open to alternative views and methods that respect all participants and public transparency (Funtowicz & Ravetz 1993; Gibbons et al. 1994; Nowotny et al. 2001; Ravetz 2006). Second, we argue that certain sustainability-style- projects emerging within integrated urban water management, despite their embryonic form, may provide innovative mechanisms for understanding and implementing knowledge transfer and thus promote more democratic conditions in science.[6]

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[6] Rather than describe a concrete case study, we offer the reader a programmatic approach. By advocating for our particular vision of urban water management, we are suggesting that members orient themselves to these

Fuller (1999) has suggested, science as an "authoritative" system of knowledge has the potential to be transformed into a "republican" mandate for knowledge governance. This vision challenges science to make more room for dissent, diversity, unorthodoxy and democratizing processes in order to further the "public good". Given that a majority of claims that challenge conventional science take the form of external critiques, and are thus powerless to promote change, in this paper we focus on change emerging from within environmental engineering around issues of water sustainability.

Environmental Engineering and a Learning Alliance Model

A global movement in environmental engineering is beginning to recognize that many unresolved and inevitable future problems in water sustainability are replete with a level of risk and uncertainty that traditional models of science cannot and will not accommodate.[7] In essence, they acknowledge the need for what Funtowicz and Ravetz (1993) term 'post-normal science'. It is likely that any expert commitment to a 'post-normal science' will guide engineers and scientists beyond their comfort zone and orient their members toward creative pathways that cultivate a more reflexive attitude toward claims of professional scientific knowledge. Indeed, frustrated with their 'silos' of exclusion and isolation, many experts are no longer willing to

mechanisms of innovative knowledge transfer as a working hypothesis, and 'in the field', adapt accordingly. We look forward to confirmation, modification or refutation of the theoretical underpinnings found in this paper.

[7] This type of risk narrative is implicitly derived from Ulrich Beck's (1992) popular 'risk society' thesis. "Risk may be defined as a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself" (Beck 1992:21) Industrial society manages and organizes itself around a perceived increase in risk. However, due to the very nature of modernization and its rational instrumentation, this containment is never fully realized. It is recognized that scientific, social and political systems are unable to fully address the immense complexity associated with the very risks they construct. Both expert and lay are struggling with this uncomfortable ambivalence and the numerous insecurities that have emerged within the modern era. These issues are especially salient within health, crime and the environment.

neglect lay local knowledge in the design and implementation of technology.[8] Some environmental engineers understand that if they are to contribute to an enduring sustainability in urban water management, they must allow for a flexible and reflexive science which local users can adapt, and modify according to their own values and perceived needs. [9]

This egalitarian- minded context sets the stage for the analysis of a newly constructed knowledge transfer model within urban water management sciences known as a "learning alliance" (hereafter LA). The LA is derived from engineers and scientists who are unhappy with failures in knowledge translation and capacity building in water management. We see this movement as a unique expert- led initiative in further democratizing science; one based on improving collaboration with lay end-users as a means to generate sustainable solutions.[10]

In order to address the issues discussed above, this paper is divided into three related sections. First, we discuss the concept of a *trading zone*, used as an analytical tool to understand cooperation without consensus within and between scientific worlds (Galison 1997). Second, we will advocate on behalf of lay expertise and argue for a more egalitarian science, introducing the concept of the LA as a collaborative network of diverse stakeholders advancing a democratizing agenda within the science of urban water management. Finally, we will suggest that researchers

[8] Further empirical work may indicate that expert initiated collaborative projects with end-users are more rooted in a professional survival strategy rather than altruistic values. However, the two are not necessarily mutually exclusive.

[9] In particular we are referring to a multinational effort named SWITCH (Sustainable Water Management Improves Tomorrow's Cities' Health). This diverse group of environmental researchers consists of a five-year (2006-2010) international EU funded project (25 million) with over 30 partners. The overall goal of the SWITCH project is to address future water issues through the establishment of a more sustainable open-ended water management system, one that is fundamentally different in form and content from previous efforts. In essence, what they strive for, in their terms, is a "paradigm shift" in urban water management science.

[10] We take issues of sustainability and ecological damage for granted rather than as on-going interpretive realty. See Fine (1997) and Hannigan (2006) for insight on how individuals and groups socially construct the environment. Those who seek a more subjectivist standpoint may wish to consult the constructionist perspective to social problems (see Spector & Kitsuse ([1977] 2001)

extend the trading zone metaphor beyond expert-expert negotiations within scientific subcultures to include expert-lay collaborative projects. We argue that an exploratory analysis of knowledge transfer practices within LAs may provide researchers the necessary tools to build capacity and also construct open forums committed to empowering end-users.

Trading Zones: Expert - Stakeholder Arenas of Collaboration

Over the past decade, a clear trend has emerged within science and engineering in which funding agencies are strongly encouraging collaboration between experts. Terms such as interdisciplinary or transdisciplinary research have been extensively used as requirements for successful funding and most researchers in science and engineering have been forced to seek academic partnership with other colleagues. The emphasis on expert-expert collaboration has stemmed from the recognition that much of the research conducted in academic institutions finds little translation in real world. The hope has been that, for example, collaborative efforts among biologists and engineers would lead to more useful application of biological sciences to society. More recently, the concept of "knowledge translation" has been promoted for example, by the Canadian Institute of Health Research (CIHR) to facilitate uptake of health-related research findings by the greater public. CIHR characterizes knowledge translation as defining research questions and methodologies (often conducted by experts), conducting research (participatory research is encouraged), publishing findings in plain language, context-based research communication, decision-making and action informed by research and influencing future directions of research (CIHR, 2008). The driver for knowledge translation in health care funding in Canada has been the lack of measurable impact of past health research on the overall health of the public.

In his study of various collaborative ventures in science and technology in general, Peter

Galison (1997) observed that some of the more successful projects allowed various stakeholders to accommodate competing interests while simultaneously agreeing on other pertinent issues. This dynamic process reflected what he conceptualized as *trading zones*, or spaces within arenas in which technologies and strategies could be coordinated among participants at the local level despite the clash of distinct identities and cultures.

The trading zone metaphor is akin to anthropological descriptions of distinct cultures interacting with one another for purposes of trade.

> Like two cultures, distinct but living near enough to trade, they share some activities while diverging on many others. In particular, the two cultures may bring…objects that carry radically different significance for the donor and recipient. What is crucial is that in the highly local context of the trading zone, despite the differences in classification, significance, and standards of demarcation, the two groups can collaborate (Galison 1999: 146).

Galison (1999) also characterized the interaction among differing subcultures within the Physics community as an exchange of ideas that acknowledged both the differences in perspectives and the possibility of cooperation. Focusing on the boundaries between the subcultures of physics (i.e. instrumentation, experiment, and theory), Galison argued that trading zones become the means by which cooperation is accomplished despite multiple perspectives, and that this co-operation is facilitated by the development of *Inter-language* and the presence of *Boundary Objects*.

Specifically, given the lack of a shared conceptual vocabulary, Galison argues that in order for disciplines in science to collaborate with each other, they must first co-construct an inter-language or working language that links them. This simple inter-language is formulated so parties can come together for a short duration to trade ideas and resources, and as such, it makes transactions possible.

In terms of *boundary objects*, Star & Griesemer (1989) also recognize that even though science is a heterogeneous activity, its actors are always involved at some level in seeking collaboration and mutual understanding. Total agreement is not always required for successful interdisciplinary work in the sciences. However, members who come from diverse scientific social worlds must find the necessary common ground to reach agreement and to find solutions to scientific problems. Boundary objects provide a link or shared understanding among diverse collaborating members but do not encroach on each member's unique vision of scientific work.

Star and Griesemer (1989) developed the concept of boundary object while studying the collaborative nature of museum operations. They recognized that displayed dead bird specimens had very different meanings for the many stakeholders involved in the museum. (i.e. curators, scientists, amateurs). Yet these specimens acted as shared mutual points of focus among the social actors involved and thus facilitated collaboration between them and the overall successful daily operations of the museum. Stuffed animals as objects of importance in the museum were agreed on while their function was interpreted differently according to the actors' own position within the negotiated order. This example demonstrates that cooperation can be built up despite conflicting perspectives. Although the objects are the same, they carry different meanings. At the same time, all groups agree on their value and importance within the interaction.

Thus, in addition to inter-languages, Galison argues that boundary objects characterize cooperation within trading zones and are also fashioned for local use when distinct needs emerge between two different social worlds (Clarke and Star 2003; Star 1989). As Bowker and Star (1999:296-297) have observed, boundary objects are "plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common

identity across sites. They are weakly structured in common use and become strongly structured in individual-site use."

Scientists and engineers who seek to empower non-experts may "translate" boundary objects in innovative ways to meet the needs or demands of multiple different worlds involved in collaborative work. Indeed, Clarke (2005:52) has argued that, "the study of boundary objects can be an important pathway into often complicated situations, allowing the analyst to study the different participants through their distinctive relations with and discourses about the specific boundary objects in question."

In terms of the focus of this paper, given the LA's philosophical commitment to include all stakeholders in the collaborative effort to solve scientific problems, researchers should be sensitive to the novel methods by which members cooperate and navigate social pathways around contested and complicated situations. In particular, attention should be given to the inter-language and boundary objects that arise within trading zones. Moreover, studying these inclusive circles may offer insight into the formation of novel trading zones, not only among experts, as they are conventionally conceived, but also between lay end-users. But before we clarify an expert-lay trading zone, it is necessary to explore the various ways lay-expertise is acknowledged.

Contesting Science and Empowering Lay-Expertise

There are a number of social movements that organize themselves around the contestation of science (Frickel & Moore 2006). Many of these groups attest to the importance of lay-expertise. For example, AIDS patients and activists have challenged, modified and supplemented the research protocols of experts, and in doing so, managed to contribute to a better understanding of the illness and its treatment (Epstein 1996). A major research center in

France is widely known for its collaborative work in muscular dystrophy, facilitating interaction between scientists and laypeople and as a result co-producing a more robust knowledge (Callon 1999). Collective action of this nature consists of diverse stakeholders, from individuals involved in grass-roots politics and business entrepreneurs to lay end-users of technology, all claiming they are resisting and transforming the institutionalization of science through a number of democratizing ventures.

Brian Wynne's (1989; 1992; 1996) classic study of sheep farmers in Cumberland, England demonstrates that lay members' knowledge can be far more reflexive, rigorous and practical than government endorsed scientists. In this case, experts were commissioned to evaluate radioactive contamination following the Chernobyl nuclear disaster. Scientists downplayed the risk and paid little attention to farmers' everyday tacit knowledge of the surrounding flora and fauna. Government officials, entrenched in a laboratory mindset, could not relate to the localized farming practices, thus neglecting nonlinear factors that could have assisted in their investigations.

Wynne tells us that the Cumbrian sheep farmers were certain of contamination long before expert analysis determined that the soil and plant life absorbed radioactivity and passed it on to the livestock at dangerously high levels. When experts did eventually incorporate the farmers' methodology and indigenous knowledge, their flawed research model benefited greatly and they had to admit that the level of contamination was more consequential than originally suggested. Wynne argues that despite the contribution of farmers' lay-expertise, they were still not fully recognized for their skill set and as a result, developed mistrust for the government and scientific community. This is not to say that scientific expertise should be abolished, but that diversity of opinion and creativity requires an attentive ear and an open forum. Advances in

knowledge transfer require deference to both theoretical and experiential knowledge. While the farmers in the Cumberland study were open to the possibility that expert knowledge could supercede their understanding of the situation, scientists on the other hand clung tenaciously to their dogmatic perspective. Had they been more open, to a different knowledge system, Wynne argues, farmers would have been spared a great deal of financial and psychological frustration.

Defining science as elitist and unapproachable, people are questioning the vision of science as free and open, arguing instead that the mode of knowledge production is in need of drastic change due to the incapability of "normal science" to cope with modernity's increased uncertainty, complexity, risk and high stake situations (Ravetz 1999). Moving away from conventional science, embracing genuine collaboration and recognizing diverse knowledge systems is made possible when specialists are realistically aware of their own epistemological limitations and willing to entertain alternatives that bring them out of their comfort zone. A preventive science of this magnitude is dependent on a professional body of experts who humbly perceive themselves as not having all the answers and avoiding the conventional one size fits all 'silver bullet' solution to controversial and complex environmental issues (Vanderburg 2000). Not antiscientific in their contestation of science, but egalitarian at all levels of human innovation, concerned citizens and sympathetic experts seek out like-minded individuals who are willing to redefine the scientific process and its potential to make room for lay involvement and uncertainty.

One method in which to refashion science and empower end-users is through the promotion of 'extended peer communities' (Funtowicz and Ravetz 1993). Extended peer communities invite both expert and lay members to consult, and thus "positively enrich the processes of scientific investigation" (Funtowicz and Ravetz 1993:753). This open-ended

structure allows the flexibility necessary to accommodate local indigenous knowledge systems and provide external checks and balances that may be needed when experts dismiss lay-expertise or downplay potential environmental harm.

It is not just "citizen science" that has become reflexive (Irwin 1995). Experts themselves are sensitive to their neglect of lay end-users' knowledge and have established their own variety of "professionally initiated participatory science" (see Moore 2006).[11] We are in the midst of witnessing such an innovation within urban water management. A few environmental engineers are currently designing their own version of an 'extended peer community.' Led by professionals, this form of extended peer community may prove to be highly successful as it organizes itself further along the *hierarchy of credibility* than initiatives run by lay members (see Becker 1967). These professionals are committed to the idea that local end-users should not be viewed simply as passive consumers of knowledge, but as active partners in the search for long-term sustainability and development of technologies. Working specifically in the water and sanitation sector, these engineers are constructing a series of "connected stakeholder platforms" to involve all institutional and individual levels in the process of solution identification and implementation. These processes are germane with the post-normal science suggestion of 'extended peer communities.' This group is bringing together various individual and institutional stakeholders such as scientists, engineers, local businesses and municipal officials into a process

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[11] It seems dubious that scientists would be willing to cede their authority to lay-people. Yet, one can think of several explanations for why scientists would be willing to cede their authority 1) They value good science over their authority as experts. They are willing to recognize that science requires certain conditions for it to flourish, and democratization of science improves the conditions of science (see Fuller 2000). 2) As previously stated, this strategy is a survival strategy in the face of the corporate colonization of the lifeworld. Corporate interests are increasingly trying to deskill and disempower scientists (subordinate them to economic capital), and new strategies are emerging to combat the colonization of the lifeworld. Democratization processes may be one of them. One can speculate that there is a battle going on between authoritarian, technocratic modes of science and democratic science. It is problematic to assume that undemocratic science flourishes simply due to inertia.

aimed at identifying and implementing solutions to the problem of water resource management.

Persuaded by what they see as the failures inherent in conventional "top down" models of knowledge development, environmental engineers are creating the Learning Alliance as a means to construct integrative, transparent, and open-ended scientific approaches to eco-friendly innovation. They are concerned with developing capacity among all stakeholders through dissemination and sharing of ideas and technologies before and during development rather than only after the research projects have concluded. Rather than view end-users as passive receptacles, emphasis is placed on their active involvement in the shared learning experience of innovation. The LA is a rare development among environmental activist movements because it was not created by frustrated 'lay' members of the public, but rather experts who view end-users as important contributors to knowledge production and technological design. These environmental engineers seek to empower lay members of the public by recruiting and encouraging their involvement in knowledge production and overall scientific processes as a means to achieve greater success in integrated water resources management. They do more than just describe collaborative practices with end-users; they are attempting to co-construct a processual model of knowledge translation. We view this as a trading zone that empowers lay-expertise and brings about a more robust democratic scientific practice.

Although a majority of studies that invoke the metaphor of trading zones and boundary objects are concerned with expert-expert scientific collaboration, we wish to push this model toward a LA context in which studies in knowledge translation can focus more on expert-lay interactions and the democratization of science (adapted from Nowotny et al. 2001:146). The notion of a trading zone does not work in the long run since it aims at creating an artificial environment so collaboration among participants can take place temporarily without attempting

to create a long-term process of knowledge development and translation. Additional insight into collaboration among lay and experts within urban water management will help scholars further explicate the underlying processes in which trading zones and their boundary objects emerge and are sustained over the long term. We argue that researchers who are interested in understanding not only the social processes involved in constructing and establishing trans-disciplinary cooperation but also lay-expert negotiations within democratizing science movements would do well to pay more attention to the development of LA and the metaphor of trading zones as heuristic tools used to propel more successful cooperative ventures.

Learning Alliances as Expert-Lay Trading Zones – The Case of Integrated Water Resources Management

Integrated water resources management in urban centers is facing unprecedented challenges in the face of rapid urbanization and climate change. In early 2008, the world reached a significant and alarming milestone; for the first time in its history, urban population (3.3 billion) exceeded the rural population (3.2 billion). The trend in urban population increase is expected to continue and by 2030 it is expected that some 81% of world population will live in its cities (Schlein et al. 2008). Driven by this rapid growth, most urban centers are facing unprecedented water management challenges. Growth pressures have been compounded by the changing climate. Many urban centers have experienced rainfall events of increased intensity interposed between periods of prolonged draught. Conventional water management approaches appear to be ill-equipped to adapt to the combined impacts of population growth and climate change. In addition to their lack of adaptability, conventional water management approaches are also questioned for their lack of sustainability. [12] The inability of governments to fund

[12] A report published by the Government of Ontario, Canada in 2005, stated that the current water and wastewater infrastructure in the province is at approximately $72B. Of this, 70% is invested in collection and distribution. To maintain the current system and accommodate growth, an estimated $34B investment is required by 2020. Unless

increasingly centralized and complex water infrastructure has led to privatization of these systems in several large urban centers. A case in point is the City of Buenos Aires, where privatization of the water supply system has limited access to clean water and sanitation for large numbers of the poor.

The emphasis of conventional water management approaches on supply-side management and their dependence on large, centralized, end-of-the-pipe infrastructure put into question their ecological sustainability. Therefore, one may ask why, despite the seeming inability of conventional water management practices to meet the pressing demands of urbanization, there has there been little attempt to implement alternate large-scale approaches? Although numerous pilot and demonstration projects in sustainable water management have taken place in Europe, for example, it is generally agreed that a shift in paradigm in water management has not yet been witnessed (Moriarty et al. 2005). The situation is not much different in North America. Although many water planning and management projects bear the semblance of a sustainable approach, the overall culture of planning and management in water and sanitation is still firmly based on conventional practices and approaches. In the Fourth World Water Forum in Mexico, the delegates declared that:

> *It is clear that a lack of technology or even funding are no longer the main obstacles to making progress in terms of the MDGs (Millennium Development Goals). The real bottleneck lies in the capacity or the lack thereof to address the problems faced in an effective and sustainable way over a period of time.*

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the rate of capital investment increases, the report claims that Ontario will face a shortfall of about $18B. The conventional approaches to water management, therefore, do not seem to be economically sustainable. Further supporting this claim is a recently published report by the Federation of Canadian Municipalities entitled: "Danger Ahead: The Coming Collapse of Canadian Infrastructure." The report puts the current national infrastructure deficit (including water and wastewater infrastructure) at $123B. The report claims that without addressing such a deficit there would be more catastrophic failures in our roads, water systems, bridges and other vital infrastructure (Mirza 2007).

A review of the literature indicates that capacity development involves the acquisition of new knowledge and its application to achieve individual, organizational and societal goals. But it is not access to knowledge that is a barrier, as this is no longer a challenge in the information age. What seems to hinder capacity development is an ineffective knowledge translation process that does not lead to the empowerment of individuals, organizations and large-scale uptake of innovations.

Much of the research conducted in sustainable water management takes place with little plan for the uptake of key outcomes and findings. As a result, the generated knowledge and innovation fails to reach the key end-users, hence impeding its widespread and sustainable replication and implementation. A number of reasons for the failure of knowledge translation and transfer can be identified.

First, the current knowledge transfer approaches do not promote diversity of solutions. Solutions are typically predetermined by a group of "experts" prior to attempts for knowledge transfer. As the result, we have witnessed a "mono-culture" of water management in the past 50 years. For example, water management systems in urban centers around the world are characterized by often a single source (lake, river, groundwater), a number of (often one) centralized treatment facilities, and conveyance of highly treated water through centralized, underground distribution system to end-users. Despite the diversity of end-uses (i.e., toilet flushing, consumption, washing, irrigation, industrial application, etc.) the source water, method and extent of treatment and conveyance have remained more or less unchanged. The same applies to wastewater collection and treatment (i.e., collection of wastewater in large, underground conveyance systems and treatment in one or two centralized treatment facilities) and stormwater management (centralized collection and treatment). This is in great contrast to

pre-urbanization and sub-urbanization, where water management was much less centralized with the end-users being in greater control of their water management strategies.

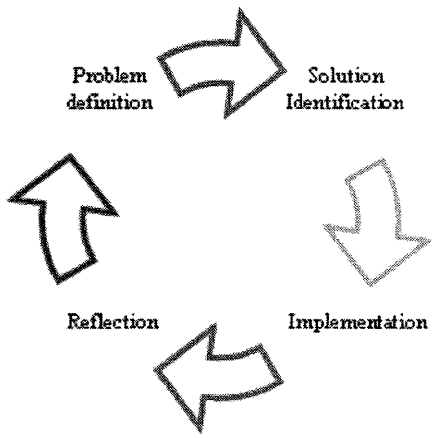
Second, relegation of knowledge translation to a minor role results in poor knowledge translation strategies and alienation of stakeholders and end-users. Moriarty et al. (2005) also identified lack of attention to capacity development as another reason for the failure of knowledge translation in sustainable water management. Adaptation of water management strategies to the uncertainties of climate change and rapid urbanization requires an environment that promotes diversity of solutions. Diversity can be best promoted when stakeholders and end-users are involved, together with other experts, in the process of innovation and knowledge development from the outset.

> Extended peer communities…produce a body of knowledge that integrates technical and contextual matters and is legitimated by all relevant stakeholders…so as to facilitate the development of shared meaning of uncertainty, and the knowledge to which it attaches, rather than the imposition of one particular perspective (Healy 1999: 667-668).

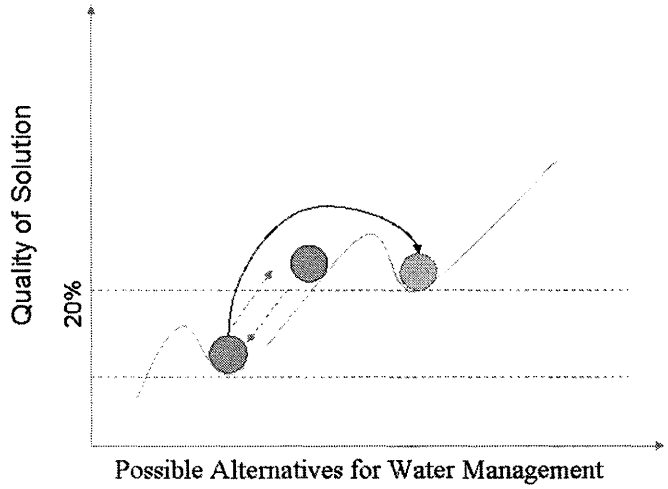
Inclusion of end-users and stakeholders in the process of innovation can be promoted through expanding the trading zone concept using the LA model.

A major strength of the LA is its ability as a multi-stakeholder platform to bring together experts and lay experts from a variety of backgrounds to initiate a process of innovation to address specific social/technical challenges. The LA model defies the notion of "concentrated expertise" and acknowledges the importance of "distributed expertise". All participants are encouraged to participate equally in the process of innovation. Another important aspect of a LA is the emphasis on the cyclic nature of knowledge development as opposed to the conventional linear approach. The linear approach, characteristic of conventional knowledge transfer, includes at its best, three stages of problem definition, solution identification and implementation. The involvement of lay experts in this approach is often initiated during the implementation stage.

The cyclic approach (shown in figure below), on the other hand, is characterized by four stages; 1) problem definition; 2) solution identification; 3) implementation; and 4) reflection. Graphically this process can be depicted as shown below.



The above process is characterized by the involvement of the relevant stakeholders (experts and lay) in all stages of the knowledge development process. Such involvement not only ensures that the solutions are relevant to the end-users' needs, but also it encourages solution diversity. In addition, by its very nature, the above process promotes incremental solution development rather than 100% solutions, most common in conventional engineered systems. Attempts to develop and implement 100% solutions may be one reason sustainable water management approaches have not seen widespread implementation. As little capacity currently exists for sustainable water management, an incremental solution identification and implementation process is required to ensure wide-scale uptake of solutions. This incremental process is depicted in the following figure (after Sieker, 2006).



The LA is not a new concept but its use in the sustainable water management area is relatively recent. The LA concept combines several approaches in knowledge translation and community development such as "action research", "participatory research and social learning", "communities of practice", and "capacity building" (Laban and Moriarty 2005). Its premise revolves around the belief that by involving key stakeholders and end-users (localized knowledge) in the process of knowledge development, many barriers to knowledge translation can be overcome. It asserts that much of the technology needed for sustainable water management already exists. The technology however, needs to be adapted to particular circumstances and refined or modified to meet the need of particular end-users. Such adaptation can be best accomplished in trading zones that integrate scientific and technical expertise with those of localized knowledge and lay expertise.

Knowledge translation is partially achieved as various stakeholders within the expert-lay trading zone engage in a collaborative process to identify suitable innovations. Due to the process of interaction within the LA and the participatory approach to defining relevant

innovations, end-users are more likely to take ownership of the solutions. This ensures that not only are the solutions appropriate to specific local conditions, but also there is a greater chance for their widespread implementation (Taylor and Leendertse 2005). The LA as an expert-lay trading zone within urban water management may very well depend on members orienting themselves toward the four cyclical stages of knowledge development, translation and its subsequent incremental development. Without this common vision, it is unlikely that an expert-lay trading zone and its subsequent boundary object or inter-language, would provide for successful knowledge transfer, capacity building and long-term sustainable solutions.

Conclusion

"The most exciting breakthroughs of the 21st century will not occur because of technology but because of an expanding concept of what it means to be human" (Naisbitt and Aburdene 1990:16).

Among most practitioners in integrated water resources management there is a general agreement that technology is no longer a bottleneck in the process of innovation and large-scale uptake. What seems to be lacking is a process that supports innovation and implementation of currently available technologies. The global concern around issues of sustainability will stagnate unless and until international policy recognizes that viable long-term solutions are dependent on an open dialogue with local expertise. Scientific discourse must create permeable boundaries so as to not shut out localized epistemology. Otherwise, "...a particular form of science may 'frame' the issues in a manner which may not be open to other ways of knowing and other ways of living in a sustainable fashion" (Irwin 1995:7). If science is to contribute to matters of sustainability it must be self-reflective and open to other forms of knowledge and innovation. And most importantly it must encourage diversity of approaches and solutions.

A LA conceptualized as an expert-lay trading zone advocates participatory practices as a

means to effectively bridge the gap between expertise and lay end -users of technology. Furthermore, bringing about higher levels of creativity, accountability and trust without dismissing the value of traditional scientific and engineering approaches.

The Post-Normal Science approach should not be interpreted as an attack on the accredited experts, but rather as assistance. The world of 'normal science' in which they were trained has its place in any scientific study of the environment, but it needs to be supplemented by awareness of the 'post-normal' nature of the problems we now confront. The management of complex natural and social systems as if they were simple scientific exercises has brought us to our present mixture of triumph and peril. We are now witnessing the emergence of a new approach to problem solving strategies in which the role of science, still essential, is now appreciated in its full context of the uncertainties of natural systems and the relevance of human values (Funtowicz and Ravetz 2007:9).

Innovation is as much about a unified community as it is about technology. Technology is useless until and unless it can be modified to suit local end-use. This of course requires a trading zone that is willing to entertain and cultivate an egalitarian ethos among its members. A LA mandate may bring about further advances in the democratization of science by way of its explicit four stage cyclic approach and emphasis on incremental processes, thus facilitating collaboration among all stakeholders. This model provides researchers a detailed prototype for establishing and sustaining an 'extended peer community'. We view the four- stage cyclical approach within the LA as a processual and pragmatic model in knowledge translation. This working template exemplifies an expert-lay trading zone and thus further advances and encourages a more self –reflective and creative science; a 'post-normal science' that can accommodate the uncertainties and risks characteristic of environmental problems, now and in the future.

References

Beck, U. 1992. *Risk Society: Towards a New Modernity*. New Delhi: Sage

Becker, H. 1967. "Whose Side Are We On?" *Social Problems*. 14:239-47.

Bowker, G. and S. Star. 1999. *Sorting Things Out: Classification and its Consequences*. Cambridge: The MIT Press

Callon, M. 1999. "The Role of Lay People in the Production and Dissemination of Scientific Knowledge." *Science, Technology & Society*. 4:81-94.

CIHR 2008. "Knowledge Translation Overview". http://www.cihr-irsc.gc.ca/e/7518.html, Last accessed: April 4, 2008.

Clarke, A. 2005. *Situational Analysis: Grounded Theory After the Postmodern Turn*. Thousand Oaks: Sage Publications.

Clarke, A. and S. Star. 2003. "Science, Technology, and Medicine Studies". Pp.539-574 in *Handbook of Symbolic Interactionism*, Edited by L. Reynolds & N. Herman-Kinney. New York: AltaMira Press.

Epstein, S. 1996. *Impure Science: AIDS, Activism, and the Politics of Knowledge*. Berkeley: University of California Press.

Fine, G. 1997. "Naturework and the Taming of the Wild: The Problem of "Overpick" in the Culture of Mushroomers." *Social Problems*. 44:68-88.

Frickel, S. and K. Moore. 2006. *The New Political Sociology of Science: Institutions, Networks, and Power*. Madison: The University of Wisconsin Press

Fuller, S. 2000. *The Governance of Science: Ideology and the Future of the Open Society*. Milton Keynes, U.K.: Open University Press.

Funtowicz, S. and Ravetz. 1993. "Science for the Post-Normal Age." *Futures*. 25:735-

755.

----------. 2007. "Post Normal Science: Environmental Policy Under Conditions of Complexity."http://www.nusap.net/sections.php?op=viewarticle&artid=13, last accessed December 20, 2007.

Galison, P. 1997. *Image & Logic: A Material Culture of Microphysics*. Chicago: University of Chicago Press.

----------. 1999. "Trading Zone: Coordinating Action and Belief." Pp. 137-160 in *The Science Studies Reader*, Edited by M. Biagioli. New York: Routledge.

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow 1994. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

Habermas, J. 1987. The *Theory of Communicative Action, Volume 2: Lifeworld and System: A Critique of Functionalist Reason*. Cambridge: Polity Press.

Hannigan, J. 2006 (2nd Ed) *Environmental Sociology*. New York: Routledge

Healy, S. 1999. "Extended Peer Communities and the Ascendance of Post Normal Politics." *Futures*. 31:655-669.

Irwin, A. 1995. *Citizen Science: A study of People, Expertise and Sustainable Development*. London: Routledge

Laban, P. and P. Moriarty. 2005. "Learning Alliances for Local Water Resource Management in Egypt, Jordan and Palestine: Lessons from the EMPOWERS Project." *Proceedings of the Symposium on Learning Alliances for scaling up innovative approaches in the water and sanitation sector*; 7-9 June 2005, Delft, the Netherlands.

Liberatore, A. and S. Funtowicz. 2003. " 'Democratising' Expertise, 'Expertising' Democracy: What Does this Mean, and Why Bother?" *Science and Public Policy* 30:146-50.

Mirza, S. 2007. "Danger Ahead: The Coming Collapse of Canada's Municipal Infrastructure. A report prepared for the Federation of Canadian Municipalities". Ottawa, Ontario.

Moore, K. 2006. "Powered by the People: Scientific Authority in Participatory Science" Pp. 299-323. in *The New Political Sociology of Science: Institutions, Networks, and Power*, Edited by S. Frickel and K. Moore. Madison: The University of Wisconsin Press.

Moriarty, P., C. Fonseca, S. Smits and T. Schouten. 2005. "Background Paper for the Symposium: Learning Alliances for Scaling Up Innovative Approaches in the Water and Sanitation Sector." *IRC International Water and Sanitation Center.* http://www.irc.nl/content/download/16138/208040/file/Background_paper_symposium_.pdf

Naisbitt, J. and P. Aburdene. 1990. *Megatrends 2000: Ten New Directions for the 1990's.* New York: William Morrow.

Nowotny, N. 2005. "High-and Low-Cost Realities for Science and Society." *Science.* 308: 1117-1118.

Nowotny, N., P. Scott and M. Gibbons. 2001. *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty.* Cambridge: Polity Press.

Ravetz, J. 1999. "What is Post-Normal Science." *Futures* 31:647-653.

----------. 2006. "Post-Normal Science and the Complexity of Transactions Towards Sustainability." *Ecological Complexity* 3:275-284.

Schlein, L., J. De Capua, and S. Krüger. 2008. "For Humanity's Sake, Developing World Must Prepare for Soaring Urbanisation." *City Mayors Society.* http://www.citymayors.com/society/urban-population.html, last accessed February 5, 2008.

Sieker, H. 2006. "Sustainable Water Management in the City of the Future." *A presentation made at the CMHC Seminar*, June 2006, Toronto, Ontario.

Star, S. 1989. *Regions of the Mind: Brain Research and the Quest for Scientific Certainty.* Stanford: Stanford University Press.

Star, S. & Griesemer, J. 1989. "Institutional Ecology, "Translations" and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science* 19:387-420.

Taylor, P. & Leendertse, K. 2005. "Capacity Building Networks - An Effective Way to Scale Up Capacity Building." *Proceedings of the Symposium on Learning Alliances for Scaling Up Innovative Approaches in the Water and Sanitation Sector*; 7-9 June 2005, Delft, the Netherlands.

Vanderburg, W. 2000. *The Labyrinth of Technology.* Toronto: University of Toronto Press.

Wynne, B. 1989. "Sheep Farming After Chernobyl: A Case Study in Communicating Scientific Information." *Environmental Magazine* 31: 244-73.

----------. 1992. "Misunderstood Misunderstanding: Social Identities and Public Uptake of Science." *Public Understanding of Science* 1: 281-304.

----------. 1996. "May the Sheep Safely Graze? A Reflexive View of the Expert-Lay

Knowledge Divide." Pp.43-83 in *Risk, Environment and Modernity: Towards a New Ecology*, Edited by S. Lash, B. Szerzynski and B.Wynne. Los Angels: Sage.

CHAPTER 5 – CONCLUSION

In the introduction, the relevance of a social worlds approach to understanding Mode 2 knowledge production amongst environmental scientists was established. Each of the preceding papers was associated with the enactment or construction of Mode 2 science. In this conclusion, I concentrate on how each essay contributes to a better understanding of how experts go about enacting Mode 2 science. More specifically, I focus on how scientists and engineers co-construct alternative forms of knowledge with others outside their discipline as a means of best practice and public service. I conceptualize the Learning Alliance efforts to integrate others in the formation of knowledge production as a practical accomplishment I term *Mode 2 work*. In addition, I also demonstrate how these essays represent my own progression towards a Mode 2 inspired public sociology. I conclude by highlighting areas of future research.

Common Themes and Contributions: Mode 2 Work & Boundary Objects

I call the Learning Alliances' various activities, *Mode 2 work.* This generic theme runs through all three essays and best describes the knowledge production of Alliance members. Work is being used here as a metaphor to describe how individuals interact within social worlds by subjectively constructing and mediating their own shared ideological position while adjusting to an objective reality on a daily basis (Berger 1981; Harris 2008). I use this concept to further draw out how the Learning Alliance articulates the major tennets of Mode 2 science. Gibbons (1999: 15) claims that Mode 2 science is determined by its contextual and heterogeneous organization. He writes:

> Since expertise now has to bring together knowledge that is itself distributed, contextualized and heterogeneous, it cannot arise at one specific site, or out of the views of one scientific discipline or group of highly respected researchers. Rather it must emerge from bringing together the many different 'knowledge dimensions' involved. Its authority depends on the way in which such a collective group is linked, often in a self-organized way.

Although Mode 2 scholars such as Gibbons have little difficultly describing the heterogeneous organization of Mode 2 science, they make the error of neglecting the contingent nature and everyday interactions of scientists who seek to democratize science. There is little empirical understanding of how experts actually go about organizing themselves within a negotiation context that has its members bringing alternative perspectives into the research process. At the heart of *Mode 2 work* lies the Learning Alliance's various attempts to draw in diverse 'knowledge dimensions'. As the Learning Alliance intersects with a number of different social worlds, members participate in *Mode 2 work* as a means of generating practical solutions to environmental problems. These are discursive activities that implicate traditional environmental science as flawed and Alliance members use these flaws as a mandate to include non-scientific others as part of their solution. *Mode 2 work* describes the definitional practices and everyday accomplishments the Learning Alliance enacts to effectively deal with a number of competing logics/perspectives that both constrain and enable their social interactions and overall segmenting processes.

Essay 1

In the first essay, *Mode 2 work* entails the negotiation activities that Alliance members achieve while interacting with industry. The construction of such a narrative involved the Learning Alliance's attempt to balance their Mode 2 vision of environmental science with the "payback" logic embedded within the market system. The first essay was an ethnographic study that examined how the Learning Alliance managed to adjust their alternative research strategies to accommodate the needs of big business while refusing to compromise their 'green' vision. In uncovering two failed collaborative efforts between Alliance members and industry, the essay

speaks to how Mode 2 knowledge production eventually emerged and formed 'transactions spaces' between distinct social worlds despite their conflicting logics.

Recall that the goal of the Learning Alliance was to develop research that allowed all stakeholders to express environmental leadership. For Steel Inc., who were constrained by a market logic, the focus was to invest in sustainability projects that would have little impact on daily operations and immediate profits. Throughout the essay I demonstrated that before an effective boundary object can bring about consensus between diverse social worlds, previous attempts often fail. Despite their frustration with two failed proposals, the Learning Alliance eventually adjusted to the constraints of business by translating the main barrier to negotiations (i.e. "payback period") into an 'inter-language' that accommodated the interests of both parties. Experiencing failure led Alliance members to modify their perspective and co-construct an effective boundary object with industry in a creative way that successfully integrated the needs of business and still maintained their autonomy.

This essay illustrates cooperation is fashioned not around a common definition of the situation but is rather dependent on both social worlds realizing their own self-interest. A mutual focus developed around a technology in which the Learning Alliance managed to meld both profit and environmental narratives. As soon as Alliance members became aware that economic feasibility was the main barrier to collaboration, they modified industry's concern for profit in a way that resonated with both social worlds. The establishment of rainwater harvesting technology and the different meaning it held for industry, despite resistance, created a novel Mode 2 pathway in which members of an activist social world managed to realize their 'green' goals while operating within an asymmetrical context.

A majority of scholars that investigate Mode 2 knowledge production deny the empirical reality of "extended peer communities" and view such concepts as 'polarized rhetoric' (Godin 1998). Rather than view Mode 2 concepts as political ideology (Hessels and van Lente 2008), I utilized them as sensitizing concepts to investigate how a group of experts struggled to create and promote an alternative knowledge system. Asking, how do they perceive "extended peer communities" ? When do they view these efforts as failures and under what social conditions do experts deem the formation of these communities a success? I answered these questions through a social worlds perspective that viewed the efforts of the Learning Alliance as an emerging social process. I found that the "extended peer communities" so central to a Mode 2 model of science bring together a complex tapestry of groups and players, each with its own perspectives, goals, values and concerns. Common ground or a common boundary object must be found before successful collaboration can occur. The case of the Learning Alliance and Steel Inc. demonstrates that the negotiations involved can be difficult and are fraught with tensions that can easily threaten the entire enterprise. On the other hand, the case demonstrates that overcoming these differences and tensions is possible. The Learning Alliance did ultimately succeed in finding a project on which the Alliance and Steel Inc. could collaborate.

The price of success for the Learning Alliance involved having to compromise on the magnitude of the projects they initially had in mind and to lower their sights in terms of their original ambitions. These compromises were necessitated by the fact that the Learning Alliance was negotiating from a position of disadvantage. The collaboration was more important to the Alliance than it was to Steel Inc. However, there is good reason to speculate that the kind of collaboration that scientists are increasingly seeking will become more important to the end-users with whom they want to collaborate, resulting in negotiations that take place in the context

of a more even playing field. Private industry is beginning to feel the pressure from both government and the public to become more environmentally responsible. As a result, industry players may be become more willing to negotiate and collaborate with scientists regarding pollution prevention strategies and technologies. In other words, there may be more of an incentive on the part of business to create "extended peer communities." Nevertheless, such collaborations will still involve the intersection and potential clash of distinct social worlds. Scholars seeking to understand these collaborative efforts would do well to focus on the diverging perspectives, concerns and logics of various groups of players brought together in this negotiative activity, and on the extent to which the groups are moving towards the establishment of effective boundary objects so pivotal to their success.

Essay 2

The second essay provides a conceptual link between the issues and challenges the Learning Alliance faced and similar concerns within public sociology. More specifically, I described how my methodological training provided the Learning Alliance with an expertise through which they could more fully articulate their ever emerging *Mode 2 work*. While Alliance members explored the possibility of acquiring and integrating the perspectives' of end-users in their research, I managed to participate in an ethnography that contributed to the production of Mode 2 knowledge and "mutual education." In their attempts to refashion science, the Learning Alliance often intersected with other social worlds. In doing so they integrated these worlds' resources and ideas as allies who assisted in further segmenting and legitimating the Alliance's ever developing enterprise.

As with the first, the second essay examines joint action between the Learning Alliance and non-scientific others. It presents a case study in interdisciplinary collaboration as an

intersubjective accomplishment between science and sociology. The essay examined how my involvement in the enactment of Mode 2 science raised a number of methodological issues. In my reconciliatory attempts to be both engaged in my participants' activities but detached from their ideology, I uncovered a unique approach to public sociology and Mode 2 interdisciplinary collaboration and further clarified Burawoy's fuzzy concept of "mutual education."

In relation to Mode 2 science, the essay examines how science as a discipline brings other fields of study to assist in their transition from Mode 1 to Mode 2 knowledge production. In addition to the segmenting of a Mode 2 social world within environmental engineering and science, my own experience in the field mirrors these trends in the sciences with those in sociology. My involvement in assisting the Learning Alliance in its vision to integrate lay end-users provided them with the necessary skill-set to further segment their social world from typical Mode 1 definitions of end-users and lay expertise. This process also represented a form of public sociology in which I contributed to my participants' democratic vision of doing research.

While the paper contributes to a processual understanding of social world segmentation and interdisciplinary collaboration within public sociology and Mode 2 contexts, it is also meant to complement the previous essay on boundary objects. Just as the Learning Alliance and industry achieved collaboration without consensus through a boundary object, this essay also illustrates the development of a boundary object between the Learning Alliance and another non-scientific social world to achieve their 'green' goals. In this case, the Learning Alliance brought in an allied social world to assist them in redefining end-users. The discipline of sociology helped the Learning Alliance reconceptualise end-users as a means of establishing a more democratic vision of science. In accomplishing a transaction space with sociology they further solidified a Mode 2 identity distinct from other Mode 1 social worlds. It also provided me with a

new found identification with public sociology and provides an empirical example of how an ethnographic public sociology achieves "mutual education" with others outside the discipline.

Essay 3

The third essay represents *Mode 2 work* in its programatic form. Here, my co-author and I make claims that knowledge translation between scientists and end-users can be made more effective within urban water management when collaboration is built around the incremental process of problem definition, solution identification, implementation, and reflection. Rather than focus a majority of their efforts on new technological development and silver bullet solutions, we suggest that urban water engineers and scientists should make an attempt to develop a reflective science that makes more room for lay expertise. Whereas I am not involved in the Learning Alliance's *Mode 2 work* in the first essay and only indirectly involved in the second essay, this third essay represents my full immersion in their implication of Mode 1 science as flawed.

Just as in the previous essays, this essay utilized and modified a number of sensitizing concepts from social worlds theory and science studies (i.e. boundary objects, extended peer communities, trading zones). These concepts were used in the first two essays for descriptive purposes as a means to obtain insight into collaboration and Mode 2 knowledge production. Here, however, they are offered not so much from an interpretive perspective but incorporated for programmatic purposes. Advocating for the potential benefits of a more democratic approach to scientific research in urban water management, expert-lay cooperation in this essay is considered to play an important role in solving a number of barriers to sustainability.

It is suggested that technological innovation is not the key to solving environmental problems but rather knowledge production that is open to the co-construction of expert-lay

trading zones. These collaborative circles stress local adaptation of technology by encouraging all members to participate in a four stage reflexive process. The essay hypothesizes that by empowering end users and acknowledging lay knowledge, the necessary boundary objects needed to facilitate knowledge translation, capacity building and long term solutions to urban water problems will organically emerge.

In addition to laying out a rudimentary foundation for the democratization of scientific research within urban water management and conservation, this essay is similar to essay two through its representation of an interdisciplinary collaboration between science and sociology. Whereas essay two provides a processual account of the formation of Mode 2 knowledge production and public sociology, this essay represents a Mode 2 end product in itself and offers further evidence of how public sociology contributes to assisting other disciplines in serving the community. The paper serves as an example of the kind of product that a Mode 2 interdisciplinary collaboration can generate. A programmatic model is provided as a means to draw out some of the more salient knowledge transfer processes that constitute an ideal capacity building situation for all stakeholders. Furthermore, this paper also represents my involvement in the Learning Alliance social world. Considered to be "one of them," the lead scientist was comfortable enough to incorporate my sociological expertise as a means to reconceptualize end-users and thus further supplement the Learning Alliance's vision of democratic science. The essay was published in *The International Journal of Technology, Knowledge and Society*.

Each of the preceding essays addressed how the Learning Alliance as a segmenting social world attempted to make the transition from Mode 1 to Mode 2 science. As a whole, these essays ask a novel question: What does Mode 2 knowledge production amongst experts look like as

everyday accomplishment? In answering this question I addressed a number of key sociological factors involved in the collaboration between scientific experts and their non-scientific partners.

In addition, the essays within this dissertation speak to the value boundary objects have in the development of Mode 2 collaboration. Social worlds theory provides the framework in which I was able to explicate how individuals experience group life, acquire perspectives within their communities and orient their interactions toward the social objects that have meaning to them. Herbert Blumer (2004) describes how a social object makes up an 'operating environment':

> Objects constitute…the things toward which the individual is oriented, the focal points around which the individual's activity becomes organized, and the implements by which the individual's activity is built up in a step-by-step sequence…one would be in a position to understand any one of the individual's specific acts to the extent to which one could identify the objects toward which an action is directed and observe how the individual uses objects in developing lines of conduct…Such a group...acts and is organized in terms of its objects…In this legitimate sense of being anything that can be designated or referred to, objects may be material or immaterial, real or imaginary…It should be immediately apparent that objects constitute the world or operating environment of the human being and of a human group (Blumer 2004:39).

Analysis of the data suggests that the three different boundary objects found within the three essays share in three overlapping epistemological foundations, with each boundary object emphasizing one aspect of *Mode 2 work* over others.

Even though science is a heterogeneous activity, its actors are always involved at some level in seeking collaboration and mutual understanding. Total agreement is not always required for successful interdisciplinary work in the sciences. However, as we have seen, members who come from diverse scientific social worlds must find the necessary common ground to reach agreement and to find solutions to scientific problems. Those who study interactions between scientists and others use the concept of *boundary objects* to capture this idea of establishing reciprocity. Boundary objects provide a link or shared understanding among diverse

collaborating members but do not encroach on each member's unique vision and interests (Star & Griesemer 1989). Boundary objects are specifically tailored for local use, but flexible enough to provide a collaborative bridge between social worlds (Star and Griesemer 1989). Clarke and Star (2008:121) situate boundary objects in terms of translations between worlds:

> Here the basic social process of translation allows boundary objects to be (re)constructed to meet the specific needs or demands placed on it by the different worlds involved...Boundary objects are often very important to many or most of the social worlds involved and hence can be sites of intense controversy and competitions for the power to define them. The distinctive translations used within different worlds for their own purposes also enable boundary objects to facilitate cooperation without consensus (Clarke and Star 2008:121).

I use the boundary object concept in all three of my essays. In the first essay I use the concept to explore how scientists and the non-scientists with whom they interact acquire mutually shared perspectives. The generic processes of consensus and conflict among actors with diverse backgrounds are pivotal to understanding the relationship between Learning Alliance members and industrial end-users. Coming together around environmentally sensitive questions and a common desire to do things differently, both members of the Learning Alliance and industry partners with whom they collaborate have to manoeuvre around a range of complicated political, moral and economic issues.

Boundary objects also play a prominent role in the second essay. Uncovering a boundary object not only assisted the Learning Alliance and industry to achieve joint action, it also allowed me as an ethnographer to accomplish "collaboration without consensus" (Clarke and Star 2008) with my participants. I use boundary objects as a sensitizing concept to explore the tensions and challenges associated with fieldwork while following a scientific social world that demands my involvement in helping them redefine scientific research and advocate for environmental justice. I ask: What is the role of ethnography within newly formed alternative scientific segments that

insist all participants, sociologists included, contribute to their democratic vision? The establishment of *boundary objects* can provide a social space in which researcher and participant can experience reciprocity.

In addition to essay one and two, essay three looked at an incremental model of how to incorporate scientific expertise with lay knowledge. It is suggested that boundary objects can play a prominent role in establishing not only interdisciplinary collaboration but also sustainability capacity among expert and lay members of a community.

The Learning Alliance created their Mode 2 approach to democratic science by working out lines of action with non scientific others within various social, political and economic contexts. They managed this Mode 2 work via boundary objects in three distinct ways. Boundary objects constitute *rhetorical* work in essay one, *reflexive* work in two and *normative* work in essay three.

The boundary object of rainwater harvesting technology in essay one, although not completely malleable, was redefined to serve the interests of all parties. The rhetorical work that the Learning Alliance enacted around rainwater harvesting reuse systems to convince industry that it was in their best interest to take up such a project is one example of how boundary objects assist in the development of Mode 2 collaborations.

Essay two, demonstrates how boundary objects are dependent on members' capacity for introspection and reflexivity. I drew on my symbolic interactionist understanding of participants within ethnographic research to help the Learning Alliance integrate end-users into their democratic model of science. Having end-users as a boundary object was made possible by my introspection regarding the pressure placed on me as an ethnographer to both participate and remain detached. Boundary objects are used by scholars to describe how the different social

worlds they are studying manage to collaborate, but I suggest we can turn this very tool onto ideographic research itself and the ethnographer's involvement with participants. In essence, we as social scientists should not shy away from using the same sensitizing concepts we employ to describe others' interactions as a means to reflect on our own involvement and co-operation with our participants and other disciplines. My field experience with participants who are involved in advocating for end-users and environmental issues has shed light on a mutually influential process in which the researcher's and actor's social worlds are altered through negotiating a shared sense of meaning.

Essay three incorporated the generic boundary object as a normative imperative for capacity building and long term sustainability.As we have seen throughout this dissertation, a boundary object, be it rhetorical, reflexive or normative is essentially social and thus provides groups, if effectively promoted and managed, with the necessary fodder to organize themselves and achieve collaboration.

Aside from uncovering how scientists co-constructs boundary objects with end-users, these essays also represent my own Mode 2 trajectory toward a public sociology. In the first essay I believed myself to be a neutral observer with little involvement in the activities of the Learning Alliance. The second essay is an explanation of how Alliance members managed to recruit my expertise for their research. Through the process of 'mutual education' between the two distinct disciplines of environmental engineering and sociology, this essay offers insight into how a public sociology emerges and supplements professional sociology. The third essay is a co-authored paper I wrote with an Alliance member and thus reflects successful interdisciplinary collaboration and my full participation in the production of Mode 2 knowledge.

Future Research

There are several areas of Mode 2 knowledge production that this dissertation did not address. The first essay on collaboration between the Learning Alliance and industry unpacks the social process by which Mode 2 scientists convince business to buy into alternative environmental research. However, I did not look at how industrial managers perceive their interactions with Alliance members. In the near future, I plan to conduct research that will address the experience and negotiation strategies of business personnel in their dealings with Mode 2 oriented scientists.

Alliance members recognize that stakeholders do not want to be overly dependent on experts. In order to be independent, Alliance members must bring in and manage stakeholders in ways that allow them to feel like equals in the development and implementation of pollution prevention technologies and strategies. Although this study investigated how the Learning Alliance achieves this within market (essay 1) and academic settings (essay 2), my future research will be looking at how this is done with end-users in more public settings.

My post-doctoral appointment has me serving in the capacity of social analyst for the Learning Alliance's most recent collaborative project. I will be conducting focus group interviews with household owners who were recruited by the City of Guelph to participate in a pilot project on water reuse technology. I am responsible for uncovering the public perception of water conservation and how end-users within the program interact with new greywater technologies. I will be paying close attention to how the Learning Alliance incorporates homeowners in the installation and maintenance of technology.

The second essay describes the emergence of both Mode 2 science and public sociology through my personal experiences with the Learning Alliance and their attempts to involve me in their democratic mandate. The co-evolution of Mode 2 social worlds that are committed to humanitarian goals and their legitimation activities can also be investigated as professions that are no longer defining themselves through their esoteric knowledge base but rather on their strategies to improve knowledge translation and integrate non-scientific stakeholders in all facets of technological design and implementation.

Instead of protecting and promoting their scientific authority, Alliance members advocate for change in conventional research by participating in a discourse that downplays their own expertise and elevates the tacit knowledge and practical skill set of their non-scientific collaborators. The Learning Alliance's vision of how science should be done re-conceptualizes not only the relationship among and between scientists, but the relationship with end-users as well. I intend to look at how Alliance members go about rejecting the conventional view that end-users have no place in knowledge production. Since many of the environmental problems they are dealing with are very complex and require cooperation with a wide diversity of stakeholders, I will look at how the Learning Alliance continues to build a social world in which they see their own knowledge as limited. As Gibbons (1999: 15) remarks,

> Experts must respond to issues and questions that are never merely scientific and technical, and must address audiences that never consist only of other experts. The limits of competence of the individual expert call for the involvement of a wide base of expertise that has to be carefully orchestrated if it is to speak in unison.

Members believe that environmental problems are too complicated for just one group of stakeholders to solve; everyone has to work together in the spirit of true interdisciplinary and transdisciplinary action. Alliance members wish for their research to be practical. They see knowledge not as pure abstraction for "ivory tower" consumption, but always with an end goal in

mind, that goal being service to humanity and providing end-users with sufficient capacity building so that innovation is sustainable.

Remaining true to the philosophy of 'Mode 2' knowledge production, the Learning Alliance elevates lay knowledge claims while humbling their own training within the 'Mode 1' paradigm of conventional science. This of course has interesting consequences in how members within disciplines and professions (i.e. the Learning Alliance) attempt to segment from their colleagues by redefining their activities during their interactions with potential allies outside their field of study. The irony here is that Mode 2 scientists such as the Learning Alliance are experts who in fact are less interested in demarcating their work as scientific and more concerned with constructing rhetoric that sets them apart from traditional Mode 1 science. There are bound to be interesting variations in Mode 2 scientists' attempts to flatten the *hierarchy of credibility* (Becker 1967) rather than manage it as is traditionally the case. Future research may explore the rhetorical strategies these segmenting scientists and engineers use to distance themselves from Mode 1 science. Academic disciplines, like professions, have a tendency to protect hard won jurisdictions against competitors (i.e. market, bureaucratic and other professional logics) by internally regulating, managing and controlling members and their specialized knowledge (Abbott 1988; Freidson 2001). My future research will examine how Learning Alliance members attempt to re-create themselves as activist-scientists in terms of narratives that 'establish and maintain boundaries' in opposition to conventional science.

In the third essay, my colleague and I describe the benefits of the Learning Alliance's approach to knowledge translation. The perspective we took was normative in that we did not problematize Alliance members' problem making or solution strategies. Rather than define the social and economic issues surrounding environmental problems and their solutions, I intend to

explore Mode 2 rhetoric from a social constructionist perspective. The social constructionist approach to social problems does not concern itself with objective conditions, but instead views social problems as "the activities of groups making assertions of grievances and claims with respect to some putative conditions" (Kitsuse and Spector 1973:415). These activities are rhetorical in nature and the researcher should be concerned with the definitional processes that are involved in constructing alleged problematic conditions (Spector and Kitsuse [1977] 2001). I wish to continue to study the moral and political undercurrents that surface when Alliance members are negotiating their perspectives, as both activists and scientists, with end-users.

BIBLIOGRAPHY

Abbott, A. 1988. *The System of Professions. An Essay the Division of Expert Labor.* Chicago: University of Chicago Press.

Adler, P.A. and P. Adler. 1987. *Membership Roles in Field Research.* New York: Sage Publications.

Argote, L. and P. Ingram. 2000. "Knowledge Transfer: A Basis for Competitive Advantage in Firms." *Organizational Behavior and Human Decision Processes* 82: 150–69.

Bavington, D. 2009. "Science Manages the Sea." Pp. 238-56 in *Ideas on the Nature of Science*, Edited by David Cayley. Toronto: Goose Lane Editions.

Becker, H. 1967. "Whose Side Are We On?" *Social Problems*. 14:239-47.

Berger, B. 1981. The survival of a counterculture: Ideological Work and eveyday life among rural communards. Berkeley: University of California Press.

Blumer, H. 1969. *Symbolic Interactionism.* Berkeley: University of California Press.

Blumer, H. 2004. *George Herbert Mead and Human Conduct*. Walnut Creek: AltaMira Press.

Carolan, M. 2008. "The Bright and Blindspots of Science: Why Objective Science is not Enough to Resolve Environmental Controversies." *Critical Sociology* 34(5): 725-40.

Carolan, Michael S. 2008 "Democratizing Knowledge: Sustainable and Conventional Agricultural Field Days as Divergent Democratic Forms." *Science, Technology and Human Values* 33: 508-528.

Charmaz, K. 2006. *Constructing Grounded Theory.* London: Sage Publications

Clarke, A. 1998. *Disciplining Reproduction: Modernity, American Life Sciences and the "Problem of Sex."* Berkley: University of California Press.

Clarke, A. 1991. "Social Worlds Theory as Organizational Theory." Pp.17-42. in *Social Organization and and Social Process.* Edited by D. Maines. New York: Aldine de Gruyter.

Clarke, A. and Gerson, E. 1990. "Symbolic Interactionism in Science Studies." Pp. 179-214. in *Symbolic Interaction and Cultural Studies.* Edited by H. Becker and M. McCall. Chicago: The University of Chicago Press.

Clarke, A.and Star, S. 2008. "The Social Worlds Framework: A Theory/Methods Package." Pp.113-138 in *The Handbook of Science and Technology Studies*, Edited by E. Hackett, O. Amsterdamska, M. Lynch and J. Wajcman. Cambridge: MIT Press.

Cooley, C. 1902: *Human Nature and the Social Order.* New York: Charles Scribner's Sons

Crossan, M. and A. Inkpen. 1995. "The Subtle Art of Learning through Alliances" *Business Quarterly*. 60(2): 68-78.

Epstein, S. 1995. "The Construction of Lay Expertise." *Science, Technology & Human Values.* 20: 408-437

----------. 1996. *Impure Science: AIDS, Activism, and the Politics of Knowledge.* Berkeley: University of California Press.

Freidson, E. 2001. *Professsionalism: The third logic.* Chicago: The University of Chicago Press.

Fuller, S. 1999. *The Governance of Science: Ideology and the Future of the Open Society.* Milton Keynes, U.K.: Open University Press.

----------. 2000. *Thomas Kuhn: A Philosophical History For Our Time.* Chicago: University of Chicago Press.

Funtowicz, S. and R. Ravetz. 1993. "Science for the Post-Normal Age." *Futures*. 25:735-755.

Gibbons, M. 1999. "Science's New Social Contract." *Nature*. 402: 81-84.

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow. 1994. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies.* London: Sage.

Glaser, B. 1992. *Basics of Grounded Theory Analysis. Emergence vs Forcing.* Mill Valley: Sociology Press

Glaser, B. and A. Strauss. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research.* New York: Aldine.

Godin, B. 1998. Writing Performative History: The New Atlantis? *Social Studies of Science.* 28 (3) 465-483.

Gubrium, J. and J. Holstein. 2000. "The Self in a World of Going Concerns." *Symbolic Interaction.* 23: 95-115.

Gubrium, J. and J. Holstein. 1997. *The New Language of Qualitative Method.* Oxford: Oxford University Press.

Gulbrandsen, M. and L. Langfeldt. 2004. "In Search of 'Mode 2': The Nature of Knowledge Production in Norway." *Minerva.* 42: 237-250.

Hamlett, P. 2003 "Technology Theory and Deliberative Democracy." *Science, Technology & Human Values.* 28: 112-140

Harris, S. 2008. "Constructionism in Sociology." Pp.231-250 in *Handbook of Constructionist Research*, Edited J. Holstein and J. Gubrium. New York: The Guilford Press.

Hessels, L and van Lente, H. 2008. Re-thinking New Knowledge Production: A Literature Review and a Research Agenda. *Research Policy*. 37. 740- 760.

Holstein, J. and G. Miller. 2003. *Challenges & Choices: Constructionist Perspectives on Social Problems.* New York: Aldine de Gruyter.

Hughes, E. 1971. *The Sociological Eye.* New York: Aldine Publishing Company.

Khanna, T., Gulati, R., and Nohria, N. 1998. "The Dynamics of Learning Alliances: Competition, Cooperation, and Relative Scope." Strategic *Management Journal.* 19(3):193-

210.

Kitsuse, J. and Spector, M. 1973. "Toward a Sociology of Social Problems." *Social Problems* 20: 407-441.

Kemmis, S., and R. McTaggart. 2000. "Participatory Action Research." Pp. 567-605. in *Handbook of Qualitative Research (2nd ed.)* Edited *by* N. K. Denzin and Y. S. Lincoln. Thousand Oaks, CA: Sage

Knorr-Cetina, K. 1999. *Epistemic Cultures: How the Sciences Make Knowledge.* Cambridge: Harvard University Press

Kuhn, T. 1962. *The Structure of Scientific Revolutions.* Chicago: University of Chicago Press.

Laban, P. & Moriarty, P. 2005. "Learning Alliances for Local Water Resource Management in Egypt, Jordan and Palestine: Lessons from the EMPOWERS Project." *Proceedings of the Symposium on Learning Alliances for scaling up innovative approaches in the water and sanitation sector*; 7-9 June 2005, Delft, the Netherlands.

Latour, B. and S. Woolgar. 1979. *Laboratory Life.* Beverly Hills: Sage Publications

McCormick, S. 2007. "Democratizing Science Movements: A New Framework for Mobilization and Contestation." *Social Studies of Science.* 37:609-623.

Miall, C. and A. Maill. 2004. "The Exxon Factor: The Roles of Academic and Corporate Science in the Emergence and Success of a New Global Model of Sequence Stratigraphy." *Sociological Quarterly*, 43: 307-334.

Moore, K. 2006. "Powered by the People: Scientific Authority in Participatory Science" Pp. 299-323 in *The New Political Sociology of Science: Institutions, Networks, and Power* Edited by S. Frickel & K. Moore. Madison: The University of Wisconsin Press.

McCormick, S. 2007. "Democratizing Science Movements: A New Framework for Mobilization and Contestation." *Social Studies of Science.* 37:609-623.

Morrison, M and Mezentseff, L. 1997. "Learning Alliance- A New Dimension of Strategic Alliances." *Management Decision.* 35(5): 351-357.

Nowotny, N., P. Scott, and M. Gibbons. 2001. *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Cambridge: Polity Press.

----------. 2003. "Mode 2 Revisited: The New Production of Knowledge." *Minerva* 41:179-194.

Oudshoorn, N and T. Pinch. 2003. (ed). *How Users Matter: The Co-construction of Users and Technology*. The MIT Press.

Pickering, A. 1995. *The Mangle of Practice*. Chicago: University of Chicago Press.

----------. 2008. *The Mangle in Practice*. Durham: Duke University Press.

Prus, R. 1996. *Symbolic Interaction and Ethnographic Research.* New York: SUNY Press

----------. 1997. *Subcultural Mosaics and Intersubjective Realities: An Ethnographic Research Agenda for Pragmatizing the Social Sciences.* New York: SUNY Press

Ravetz, J. 1999. "What is Post-Normal Science." *Futures* 31:647-653.

Sandstrom, K., D. Martin and G. Fine. 2006. *Symbols, Selves and Social Reality*. Los Angeles: Roxbury Publishing Company.

Spector, M and J. Kitsuse. ([1977] 2001). *Constructing Social Problems*. London: Transaction Publishers.

Strauss, A., L. Schatzman, R. Bucher, D. Ehrlich and M. Sabshin. 1964. *Psychiatric Ideologies and Institutions.* New York: Free Press.

Strauss, A. 1978. "A Social Worlds Perspective." *Studies in Symbolic Interaction.* 1:119-128.

----------. 1993. *Continual Permutations of Action*. New York: Aldine de Gruyter.

Star, L. & J. Griesemer 1989. "Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science* 19: 387-420

Star, S. 1989. *Regions of the Mind: Brain Research and the Quest for Scientific Certainty.* Stanford: Stanford University Press.

van de Kerkhof, M. and P. Leroy 2000. "Recent Environmental research in the Netherlands: towards post-normal science?" *Futures*, 32: 899-911.

Vessuri, H. 2000. "Mode 2 or the Emblematic Disestablishment of Science: A View from the Edge." *Science Technology & Society 5:195-207*

Weber, M. 1947. *The Theory of Social and Economic Organizations*. Ed. A. Henderson and T. Parsons. New York: Free Press.

Weingart, P. 1997. "From Finalization to Mode 2: Old Wine in New Bottles?" *Social Science Information* 36(4): 591-613.

Wilkie, A. and M. Michael. 2009. "Expectation and Mobilisation: Enacting Future Users." *Science, Technology and Human Values*. 34(4): 502-22.

Woodhouse, E., D. Hess, S. Breyman and B. Martin. 2002. "Science Studies and Activism." *Social Studies of Science* 32: 297-319.

Wynne, B. 1992. "Misunderstood Misunderstanding: Social Identities and Public Uptake of Science." *Public Understanding of Science* 1: 281-304.

----------.1996. "May the Sheep Safely Graze? A Reflexive View of the Expert-Lay

Knowledge Divide." Pp.43-83 in *Risk, Environment and Modernity: Towards a New Ecology*, Edited by S. Lash, B. Szerzynski and B.Wynne

Appendix A

Democratizing the Science of Risk Management in First Nations Communities

First Nations communities across Canada have historically faced numerous challenges. Over the past several years, the issue of reliable and safe drinking water has been particularly stressful for a growing number of aboriginal populations. According to a report from Health Canada (2009), the frequency of drinking water advisories in First Nations communities has risen from approximately 130 in 2003 to over 250 in 2007.

"Experts" have traditionally conceptualized risk reduction associated with water contamination by way of scientifically-driven notions of risk and what they conceive as a manageable community's acceptable tolerance to risk. Approaching risk from the expert's (scientists, policy makers, etc) point of view often ignores the fact that risk as a whole is inferred, complex, multidimensional, ambiguous and plagued with uncertainty. Such views often focus on "rational" and "objective" aspects of risk, ignoring more subjective and community-specific knowledge systems. The risk assessment tools generated by experts influence policy-makers, and these standards then determine how limited financial resources are best distributed among "at risk communities". Usually local knowledge is not integrated into these models, thus increasing the potential for improper assessment of risk. This lack of inclusion may significantly harm First Nations communities.

Risk assessment tools generally suffer from a number of limitations; most evident are the conflicting priorities and the social-cultural disconnect that emerges between those who develop and administer the tools and those mostly affected by them. Specifically, these limitations represent conflicting definitions of what is considered "acceptable risk". What may be acceptable for administrators and experts may not be acceptable to community members and vice versa.

Most risk assessment tools focus on "hazards" and their potential community exposure. Hazards are usually defined by experts as chemical and biological contaminants that can lead to some type of waterborne illness. For community members, taste and odour may be a far more important indicator of risk than chemical and biological contaminants.

In a study conducted by one of the authors, various risk assessment tools were evaluated from the perspective of First Nations end-users (i.e., operators, public work personnel, etc.). Although criteria identified by First Nations end-users corresponded reasonably well with those identified in the scientific literature, they did diverge on a number of important culturally specific non-technical issues. Other uses of water such as traditional and spiritual uses and fishing that were identified as important by First Nations participants are generally absent in the scientific literature. As a result, none of the risk assessment tools include assessment of water availability and safety for traditional uses. Most risk assessment tools treat drinking water in isolation whereas according to the First Nations participants, drinking water should be assessed in conjunction with watershed, wastewater, housing and land use.

Considering that end-users' perspectives and priorities are diverse, inclusion of these priorities into a risk assessment tool will result in an overly complicated and cumbersome tool. Even using a fully integrated tool (assuming one exists) may not ensure safety of water supplies as risk assessment does not necessarily result in effective risk management. Risk management that recognizes expert-lay collaboration requires a model of knowledge translation that builds capacity among end-users to manage their own risk (see Kelly & Farahbakhsh 2008). In general, risk assessment tools are not concerned with capacity development. A bottom-up approach to risk management that includes end-users' priorities and perspectives and involves building the capacity of the end-users may be a more beneficial way of ensuring safer water supplies in First

Nations communities. Such an approach should empower communities to understand risk as it relates to both lay and expert epistemologies, therefore promoting positive decisions based on a sound understanding of drinking water, both technically and culturally. An end-user driven bottom-up approach may help identify risk management processes that are flexible and representative of the diversity of First Nations communities. The "one size fits all" approach may not be suitable in managing water-related risks and ensuring safety of water supplies.

A more democratic approach to improving drinking water safety may eventually involve a shift from more rigid risk assessment tools to an approach that enables communities to develop their own plans for water safety. This seems to be the direction now promoted by the World Health Organization. A democratic, bottom-up approach to the development of a water safety plan would empower communities to choose acceptable levels of risk instead of having risks imposed from above. If adequate resources were supplied to build capacity in communities and enable development of proactive water safety plans, these plans could be used to direct funds towards building safer water systems based on each community's vision for the future.

References

Health Canada 2009. Drinking Water Advisories in First Nations Communities in Canada – A National Overview (1995 – 2007). < http://www.hc-sc.gc.ca/fniah-spnia/alt_formats/pdf/pubs/promotion/environ/2009_water-qualit-eau-canada/2009_water-qualit-eau-canada-eng.pdf. >2010, Feb. 15

Kelly, Benjamin and Khosrow Farahbakhsh, 2008. Innovative Knowledge Translation in Urban Water Management: An Attempt at Democratizing Science. *International Journal of Technology, Knowledge and Society* 4: 73-83.

Appendix B

Managing Complexity & Promoting Usability: A User-led Design Approach

The ability of designers to meaningfully engage end-users in addressing their needs has resulted in a market saturated with unusable devices. To increase usability and reduce complexity, we propose a user-led design process where addressing user's real need is the goal rather than developing new technologies or products. Such an approach places emphasis on the process of design rather than the final product. We live in very complex societies. How and why such complexity has emerged is the topic of much deliberation and debate. Even more debatable is the necessity for such complexity. It appears that our complex system of managing society emerged not by design, but from a lack thereof. Technology, far from simplifying our lives, has served the cause of complexity and many have blamed it as the main reason for our complicated life styles. Tools that equip our modern lives are designed by sufficiently trained individuals who are bound by their own limitations and by those imposed on them by businesses that exploit technology purely for profit. It appears that the needs of those who use technology are often ignored. Take automobiles as an example. The primary function of automobiles is to transport people and goods. However, the efficiency of a typical automobile to transport individuals is miserably low. In fact the majority of fuel (up to 98%) is either wasted (engine inefficiencies) or used to move the very heavy automobiles themselves. Despite such desperately poor performance, vendors continue to manufacture conventional automobiles and consumers continue to purchase them. Not only do the designers seem out of touch with the actual needs of peoples and the society, the individual users appear to be "fashion victims" and do not seem capable of making choices based on usability. All this has led to what some call the ""un-usability culture".

Tainter (1988) argues that *"Complexity is a problem-solving strategy that emerges under conditions of compelling need or perceived benefit"*. Society's response to stresses and challenges has been to become more complex. Tainter however, argues that development of complexity is an economic process with diminishing returns as shown in Figure 1. Beyond certain levels of complexity, societies experience negative returns (point B1, C1), and become vulnerable to collapse. One reason for increased complexity, Tainter suggests, is selection of more complex solutions to address increasing challenges as simpler solutions appear to be exhausted. Tainter refers to this as the "economics of problem solving". As compelling as it is, Tainter's theory of increasing complexity and possible collapse seem to find its antithesis in nature. Nature's problem solving approach has, over millennia, led to a highly integrated system of tested and tried solutions with a great deal of sustainability. Although seemingly complex, the natural system enjoys an elegant balance of highly efficient and simple solutions. The question is therefore; can humanity faced with ever-increasing challenges devised a similar sustainable system of efficient and inherently simple solutions?

In this paper, we suggest that a fundamental change to conventional problem solving and design approach is needed to address the problem of increasing complexity. We further use a case study to demonstrate its application.

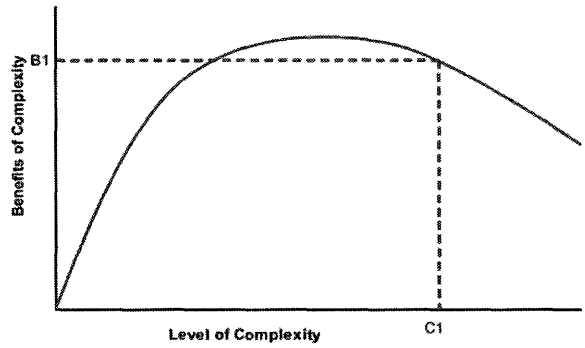


Figure 1. Diminishing returns of complexity (Tainter 1988).

A Critique of Conventional Design and Problem-solving Approach

According to Tainter, complexity increases as new solutions are developed for emerging crises and problems. Engineering design is fundamentally a problem-solving process and has often been used to address problems. The Accreditation Board for Engineering and Technology (ABET) provides the following definition of engineering design:

"Engineering design is the process of devising a system, component, or process to meet desired needs. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing and evaluation."

The objective of engineering design according to ABET is to meet desired needs, indicating that one of the first steps in engineering design is to define a need. This step however can be plagued with a great deal of ambiguity as individual perceptions impact the definition of needs. The distinction between the real needs and the perceived needs often becomes quite blurry, caused partly by what is referred to earlier as the "un-usability culture". Unfortunately, too often designers focus on perceived needs rather than the real needs of the end-users or the

society. The inability to adequately define "needs" (analogous to problem definition in the problem solving strategy) is therefore, the first critique of the conventional design approaches.

Another aspect of engineering design is, according to ABET, the devising of a system, component or process. Designers often tend to narrow this definition to primarily devising a "product", whereas the final outcome of a design may well be a process or a system rather than a product. The emphasis on product development may have been driven by the commercialization of technology and the underlying drive for profit making. The consequence of such an approach is that design (including engineering design) is guided by the desire to produce a profitable product rather than addressing a real need.

Compounding the above deficiencies is the underlying failure of most designers to meaningfully incorporate the end-users in the design process. Even the so called "user-centered design methodologies" often remain essentially "top-down" in nature, providing little opportunity for end-user involvement. This has created an elitist approach to design, alienating a large portion of society whose lives are becoming ever more complex and unmanageable. Adler and Williams (1991) argue that the most critical failure of the majority of prevailing design methodologies has been their inability to "*exploit user's own capacity for innovation*". In other word, the conventional design processes often fail to benefit from relevant insights that exist among lay end-users, referred to sometimes as "lay expertise"(Kelly and Farahbakhsh 2008). In essence, rapid technological advancement in the past century has created a rift between "scientific expertise" and "lay expertise". For a design process to become fully beneficial to society, these two types of expertise must be reconciled.

User-involved Design and Problem Solving Processes

Several modified design approaches have emerged in the past two decades to address the problems associated with the usability and relevance of products and services. The thrust of most approaches is the importance of inclusion of end-users in some aspect of the design and problem solving process. This may include end-users involvement with the identification of new products or service opportunities, design reviews, usability testing and prototype testing. A number of methods have emerged to facilitate user involvement.

Designers have long used scenarios to gain insight into end-users preferences and ensure end-users needs are considered during the design process. Scenarios are similar to stories with characters and a clear context associated with particular issue and end-user community. Personas, a variation of the scenarios, are fictional people with specific profiles and needs intended to heighten the designer's attention to end-users needs. Market surveys and interviews are another common tool for end-user engagement. Von Hippel (2005) argues that the problem with end-user surveys and interviews is that most users are also constrained by their present experiences and thus unlikely to generate novel ideas for future solutions. He introduces the concept of a "lead user". Von Hippel defines a lead user as: "users whose present strong needs will become general in a marketplace months or years in the future." He suggests surveys or interviews should focus on "lead users" rather than a typical end-user.

Other approaches such as "participatory design", and "distributed participatory design" (particularly in computer-human interaction) incorporate various stages to encourage user input, involvement, or participation in the design and problem solving process.

Participatory design (PD) initially was proposed in Scandinavia and grew out of a desire to democratize design process by involving the end-users in the software design process (Floyd et al. 1989). The Scandinavian PD process was based on the principle of "humanization of design": "the system is primarily designed to compensate human weaknesses or to support human strengths". Other PD processes place more emphasis on the "democratization of design" where design process reflects the interests of system owners or those affected by the system. Both PD approaches promote an evolutionary design process with end-user involvement and reflection incorporated at various stages of design.

The participatory design process emerged in the late 1970's to meaningfully facilitate worker's input and involvement in the way computers were used in the workplace. As such, the primary focus of PD research has been in the arena of human-computer interaction (HCI). Although PD has been successful in varying degrees in reaching its original goal, it suffers from several limitations. An important limitation is that the PD process does not attempt to involve end-users in defining the needs (problems), since the focus of PD has primarily been defined by HCI (computers and their effective use). As such, the participatory process may center energies and effort on an ill-defined or "perceived" need or problem. Additionally, the extent of workers (or end-users) involvement in the design can vary from "providing designers with access to workers' skills and experiences" to more extensive involvement in the process including design, evaluation and prototyping (Kensing and Bloomberg 1998). The third limitation is that the PD process has focused mainly on technology (product) development and human interaction with the technology rather than problem solving or design of new processes. Finally, the PD projects often take place under unrealistic conditions, shielded from the conditions of real world (Kensing and Bloomberg 1998).

Another extension of participatory design is the Open-Source Software Design (OSSD). This is a more informal process where large numbers of designers are involved in software development under unstructured conditions without particular specifications, project plan, schedule or deliverables. The main means of communication is through the Internet. A recent survey conducted regarding the OSSD community found that interestingly, the community represented little diversity. For example, the survey found that 98% of designers were male, 75% less than 30 years old, 60% single and 83% without children with a large majority from Europe (particularly France and Germany) and North America (Detienne et al. 2006) The OSSD movement has led to other interesting collaborative design scenarios such as those that resulted in the development of the Wikipedia and other wiki-based resources available on the Internet. This has resulted in an informal collaborative design process with end-users involved in the evolutionary development of a product (Wikipedia, for example).

The User-led Design Process

The user-led design process is an extension of the PD process and is defined as a process of enabling end-users to have a direct role in the problem solving, design and development process and "exploit opportunities for social learning – the sharing of ideas, experiences and innovations" (Procter et al. 1999). The goal is to improve the quality of life or address a real need or problem rather than new product development. The user-led design process typically occurs in small collaborative groups. Many suggest that these user-led collaborative approaches lead to "social creativity" that they believe is more productive that individual creativity (Procter et al. 1999). Although user-led design processes have been employed in the past, the process itself has not been clearly defined. This may be a consequence of the process as meaningful user

involvement should lead to diversity of approaches. However, there seem to be certain characteristics that are shared among user-led processes that we attempt to identify.

Inclusion of lay expertise

Fundamental to user-led design processes is the recognition of the importance of the lay expertise and its inclusion in the process. This implies that the selection of end-users should not be solely based on the end-user's level of technical or scientific expertise. Whereas technical and scientific expertise may be necessary during the later stages of the design process, inclusion of lay expertise ensure that real needs are identified and simpler solutions are given priority. Tainter's concern that new and emerging crisis lead to exploitation of more complex solutions and consequent increase in complexity may be partly addressed by the inclusion of lay experts who generally tend to select simpler solutions. Lay expertise is provided through the selection of relevant end-user groups.

Identification of needs (problem definition)

Once appropriate end-user groups have been identified, the design process must identify end-users need. It may be important to select a large end-user community to ensure that the identified needs are representative of the selected group. Various tools may be employed in identifying end-users need including surveys, interviews, scenarios and personas, and data from published literature. The results of surveys or interviews must then be appropriately analyzed using various qualitative analysis methods such as grounded theory to identify and prioritize most relevant needs.

Solution identification

Once a real need has been identified, the design team will then initiate the process of solution identification. The design team would be comprised of both technical and lay experts, carefully selected to ensure both comprehensiveness and diversity. Solution identification will be an iterative process characterized by the narrowing down of a large number of possible solutions. Flexible criteria and constraints may be introduced at this stage to guide the solution identification process. It is also important to note that lay experts involved in this stage may be a subset of the larger end-user group or a different end-user group (i.e., the end-user community that is involved in the solutions identification does not have to be the same as the one involved in the problem definition). It is also important that the aim should not necessarily be achievement of a 100% solution as this is against the spirit of an iterative evolutionary design process. It is also possible that a number of solutions are identified and implemented.

Solution implementation

Solution implementation (sometimes referred to as prototyping) involves implementation of identified solution(s) for the purpose of evaluation. The aim at this stage is not to implement a final solution but to evaluate the preliminary solutions. The solution(s) will be implemented or tried by the end-user groups under real world conditions. Results of implementation will then be brought back to the design group for reflection.

Reflection

The reflection process will involve the lay-technical expert group that identify original solutions. The aim of the reflection process is to attempt to improve upon the original solution(s)

based on feedback from the implementation stage. The outcome of the reflection stage would be improved solution(s) that can be implemented or tried by the end-user community. The reflection stage may also result in the redefinition of the need followed by revision of the solution(s). The entire process is depicted in Figure 2.

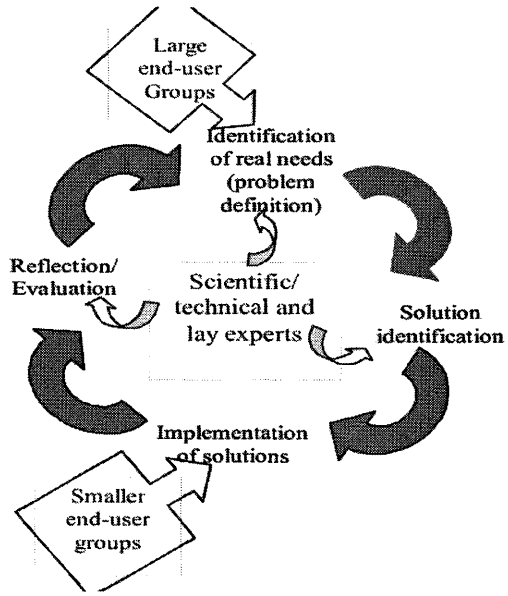


Figure 2. The proposed user-led design process

The Grounded Approach to Investigating and Implementing User-led Design Projects

As user engagement and understanding user needs are important components of a user-led design process, we are devoting a section on elaborating the grounded theory approach (GT) which we suggest as a powerful tool of achieving meaningful user engagement (Glaser and Strauss 1967).

> Only through appreciation can the texture of social patterns and the nuances of human engagement with those patterns be understood and analyzed. Without appreciation and empathy we may gather surface facts regarding the phenomenon and criticize the

> enterprise connected with it, but we will fail to understand in depth its meaning to the subjects involved and its place in the wider society (Matza 1969).

A grounded theory (GT) approach places analytical weight on the interpretive behaviour of the individual (end-user) in relation to their own sense of self, others and the situations in which they derive meaning. The primary method in which to uncover these social processes is what Cooley (1909) terms "sympathetic introspection" or what is now more commonly referred to as ethnography or participant observation (Prus 1996). Participant observation demands that the researcher commit themselves to the "social roles that fit into the worlds they are studying" (Adler and Adler 1987). Attempting to experience what their participant's experience, feel what they feel and behave in a similar fashion gives the researcher insight into how those they study perceive the world around them. The main conceptual and methodological tenants of GT are derived from an interactionist view of human social conduct. We argue that a research mandate that advocates for a user-led perspective would do well to incorporate GT and its emphasis on the experience and knowledge of end-users.

In GT, the designers study participants within their own natural setting, and through observation and participating in their social milieu, conceptual analytical frameworks grounded in participant's own experience are constructed. The researcher is ever cognizant never to stray too far from their participant's common sense knowledge of the everyday world and how that knowledge is used to construct and make sense of reality. This approach is distinct from the more popular hypothetico-deductive method that is characteristic of normative approaches that rely on official reports and statistics to explain causal relations between variables. Such a methodology is unable to accommodate the perspective of the end-user and perhaps the popularity of these positivistic models and their putative objectivity is one reason end-user led

approaches are so rare within engineering circles. GT as both a methodology and ontology is germane to investigating the "best practices" of user-led design processes and their emphasis on the inclusion of lay expertise and their identification of needs. The following four points propose how GT can address the aforementioned limitations in participatory design (PD) research:

1) *The PD process does not attempt to involve end-users in defining the needs (problems) and so these needs can appear rather ambiguous with perceived and real needs being conflated.* GT recognizes the experience and meaning-making activity of the end-user and thus their needs and definitions of their problems can be clearly articulated through its emphasis on sympathetic introspection.

2) *End-user involvement varies greatly.* This wide variation will be better understood as researchers committed to the GT perspective will determine the social conditions and situations that lead to variation concerning involvement (i.e. lack of involvement due to limited recourses, due to a sense of intimidation, due to apathy)

3) *Overemphasizes "product" at the expense of process.* GT specializes in acquiring a processual understanding of group life and is therefore more than capable of explicating the stages involved in user-design led initiatives.

4) *Takes place under unrealistic conditions.* GT prefers to study individuals in their natural setting. This is appropriate given the fact that we advocate for a user-led design approach that is respectful of user's everyday interaction with technology.

If the goal is in fact to improve the quality of life or address a real need or problem rather than a new product development, then participatory observation is required. The methodological tools of GT get to the core of the user's experience. Observing the interaction amongst end-users and interviewing them often as the project matures, will uncover some of the misunderstandings embedded in expert-lay interactions and with this information the group can clearly define the needs of the end-user and the limitations that expertise may face given this unconventional focus on process and end-user expertise. Moving away from a 100% solution requires a trust in the emerging process of collaboration. GT analysis can identify the progress made at any stage as it collects and analyzes data before, during and after every phase of the project via its method of

abduction (Peirce 1958). (i.e. moving back and forth between deductive and inductive analysis embedded within solution identification, solution implementation, and reflection). Although social life is complex, GT makes it simpler (not simplistic) through coding and conceptualization and thus provides a framework in which to sensitize and orient member's toward the data that best serves the purposes of design-led usability. The emergent conceptual framework is grounded in the end-users experience and not the expert, and therefore it informs stakeholders and policy on how they can adjust accordingly to the real needs of the end-user during the reflection stage. Furthermore, testing ideas derived during reflection can once again move back into the implementation stage. GT is an excellent methodology in which to investigate the incremental back and fourth movement characteristic of the proposed user-led design approach.

Case Study – User-led Design of Technology to Improve Quality of Life for People with Dementia

A collaborative user-led design process was undertaken to improve the quality of life for people with dementia. This multidisciplinary project involved the Universities of Liverpool (Social Science), Sheffield (Architecture) and Bath (Engineering) as well as representatives from Northamptonshire Social Services, Dementia Voice, and Huntleigh Healthcare, as well as Sheffcare and the Research Institute for the Care of Older People (RICE). RICE provided the design team contact with a large number of local people with dementia to try out prototype devices (Orpwood at el. 2008). Instead of developing a product to improve the quality of life, this project first investigated what the "quality of life" meant to people with dementia. Loosely structured interviews were initiated with 26 people in the early to moderate stages of dementia and the results were transcribed and analyzed using grounded theory. Issues related to the quality of life that were most important to people with dementia were identified. During the interview stage there was little discussion of specific items related to the technology or product.

The designers "were keen for the work to be led by user-needs rather than by any concern about technological feasibility".

One of the issues that were identified during the interviews was the importance of music to the well-being of the people with dementia. Another important issue was the need for any equipment to "build on the sense of familiarity" – the way the equipment dealt with use or misuse should not be outside the common experience of the end-user. The approach meant that the design process had to be iterative and use any clues that were provided by the end-users during various stages of design. To minimize complexity and ensure familiarity, various designs of a music player were explored to reduce end-users control to one or possibly two buttons. Infrequently-used control features were hidden away from the end-user but accessible to the care giver. The design started from a simplified CD player (iteration 3a). But following end-user's trials, two important problems were identified. First problem was opening and closing of the CD lid and the second was the delay between pressing the on button and playing of the music. To address these problems the second design iteration used solid state recordings similar to an MP3 player (3b). This prototype had two round speakers and a large illuminated button for on/off applications. Other concerns were raised as the end-users tried the second design iteration. The users confused the round speakers as on/off buttons and the start button did not clearly signal playing of music. It was decided to remove the round speakers, making speakers much less conspicuous. End-users were also asked to specify which symbols represented playing of music. Most selected musical notations as an appropriate symbol. There was also the issue of choice – user's ability to change the type of music. Adding an additional button for music selection was not considered as it added to the level of complexity and hence confusion among the users. Instead opening and closing of the music player's lid was deemed as an appropriate on/off

mechanisms. A large round button placed under a clear lid was then selected as a means of changing music type (3c). So far all design iterations were tested at the user's home with close monitoring. Iteration 3c was equipped with a monitoring device to determine the extent the users employed the device and was yet again tested at the end-user's homes. The results indicated that following a certain period of time (number of days) the end-users forgot about the device and the frequency of use dropped significantly. The fourth iteration (3d) was then equipped with a simple illuminated panel that would light up for two minutes every ½ hour to draw the attention of the end-user. The sign read "open lid to listen to music". This modification worked very well and the design was finalized.

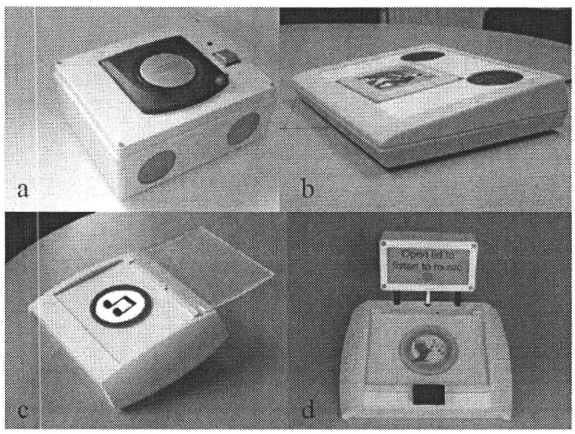


Figure 3. Design iterations of the music player (Orpwood et al. 2008)

Conclusion

Although technology has given us a perceived notion of choice, it has also added greatly to society's level of complexity. We argue that most technologies are driven not by humanity's need, but by the desire for profitability. Many designers are becoming aware of the fundamental flaws of such an approach and new methods such as user-centered and participatory design have gained attention in the past three decades. We propose that a user-led design process, one driven

by addressing user's real needs, can help tackle the problems associated with complexity and usability. The key distinguishing factors of a user-led approach is the emphasis in identifying the real needs using methods such as the grounded theory approach, evolutionary and iterative design processes informed by the end-users and evaluation of the design under real world conditions. This iterative process although inherently slower than the traditional design approach, would lead to a more diverse and robust set of solutions and reduce complexity by lowering the number of unusable devices currently marketed to the consumers. In the context of engineering design education, we propose that engineering students should be introduced to the user-led design process through a set of real-world problems that allow them to interact with end-users in a collaborative environment.

References

Adler, P. & Adler, P. 1987. *Membership Roles in Field Research.* London: Sage Publication

Adler, M. & Williams, R. 1991. The Social Implications of the DSS Operational Strategy. Social Policy Series No. 4, the University of Edinburgh.

Cooley, C. 1909. *Social Organization.* New York: Shocken.

Détienne, F.; Burkhardt, J.M; and Barcellini, F. 2006. Open source software communities: current issues, PPIG September Newsletter.

E. von Hippel. 2005. Democratizing Innovation. The MIT Press, Cambridge, MA.

Floyd, C.; Mehl, W.; Reisen, F.; Schmidt, C.; & Wolf, G. 1989. Out of Scandinavia: Alternative Approaches to Software Design and System Development. Human Computer Interaction, 4:253-350.

Glaser, B. & Strauss, A. 1967. *The Discovery of Grounded Theory.* Chicago: Aldine.

Kelly, B. & Farahbakhsh, K. 2008. Innovative Knowledge Translation in Urban Water Management: An Attempt at Democratizing Science. *The International Journal of Technology, Knowledge and Society*, 4-3:73-84.

Kensing, F.; & Blomberg, J. 1998. Participatory Design: Issues and Concerns. *Computer Supported Cooperative Work* **7:** 167–185.

Matza, D. 1969. *Becoming Deviant.* Prentice-Hall, Inc.: New Jersey. Procter, R.; Hartswood, M.;

Sharpe, M.; and Doris, A. 1999. A Case Study of User-Led Systems Design and Development in Healthcare Informatics. In Proceedings of the workshop on How to Make User Centred Design More Usable, INTERACT'99, Edinburgh, August.

Orpwood, R.; Chadd, J.; Howcroft, D.; Sixsmith, A. Torrington, J.; Gibson, G. & Chalfont, G. 2008. User-led Design of Technology to Improve Quality of Life for People with Dementia. In Designing Inclusive Futures, Edited by Langdon, P.; Clarkson, J. & Robinson, P. Springer Publishing.

Peirce, C. 1958. *Collected Papers.* Cambridge, MA: Harvard University Press

Prus, R. 1996. *Symbolic Interaction and Ethnographic Research.* Albany, NY: State University of New York Press.

Tainter, J. A. 1988. The Collapse of Complex Societies. Cambridge: Cambridge University Press.

Warr, A.; and O'Neill, E. 2005. Understanding design as a social creative process. Proceedings of the 5th Conference on Creativity & Cognition, April 12 - 15, London, UK.