GUIDING SCIENCE AND TECHNOLOGY:

DEMOCRATIC GOVERNANCE OF SCIENCE IN LATE MODERNITY

by

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ABSTRACT

In conditions of late modernity, the erstwhile faith held by members of the public in both their governments and the technical experts who advise them has been replaced by an ambivalence regarding the accountability of these institutions in regulating science and technology development. This has resulted in a crisis of science and technology governance, as ambivalent relations are systemically maintained among those directly involved in the policy process--technical experts, policy bodies, and the citizenry. In many nations, this problem has been recognized at the government level where a variety of initiatives have been implemented to provide a more open, accountable, and transparent process. However, the governance process is complicated when it concerns highly technical and controversial areas such as biotechnology since both the participatory competence of the lay public and the motives of experts influenced by a highly lucrative industry are under debate. It is the task of this thesis to explore these tensions in science and technology governance and consider options for their amelioration.

This thesis addresses the question: How can the relevant bodies best work together to form an effective and accountable system for regulating science and technology? To answer this question, I first examine the reasons for the existing ambivalent relations and then explore the lessons to be learned from the history of participatory mechanisms in science and technology regulation. The role of participatory mechanisms is addressed as a means of restoring and maintaining public trust in institutions of authority. Specifically, this work explores the potential for establishing flexible, yet fully accountable, participatory structures to achieve sustainably democratic governance over the directions taken by science and technology.

"He said, the trouble with the world was..." She had to stop and think.

"The trouble with the world was," she continued hesitatingly, "that people were still superstitious instead of scientific. He said if everybody would study science more, there wouldn't be all the trouble there was."

"He said science was going to discover the basic secret of life someday," the bartender put in. He scratched his head and frowned. "Didn't I read in the paper the other day where they'd finally found out what it was?"

"I missed that," I murmured.

"I saw that," said Sandra. "About two days ago."

"That's right," said the bartender.

"What *is* the secret of life?" I asked.

"I forget," said Sandra.

"Protein," the bartender declared. "They found out something about protein."

"Yeah," said Sandra, "that's it."

- Kurt Vonnegut (1963), *Cat's Cradle* (pp. 25-26)

Acknowledgements

Sergio Sismondo prefaced a book by crediting his mentors with not only the virtues, but the faults of his work. He claimed that since his mentors were aware that knowledge is socially constructed, he was sure they would not mind. I'm excruciatingly aware of the social construction of knowledge. Not only have I read about it until my eyes bled but I have come to this point only through the support of my communities. So since this is possibly the only big thing I'm ever going to write, I'm going to blatantly disregard the university recommendation that acknowledgement sections should be kept tastefully brief.

First, thanks are due to my committee, Ellen Balka and Pat Howard, for enduring this process. Pat Howard deserves special mention in her role as Chair of the Graduate Program for the majority of my time in the School of Communication. She and her husband Roger have provided unwavering support and mentorship to many graduate students and I know I will seek her calm wisdom again in the future. The School of Communication simply would not run without the phenomenal talents of its administrative staff. I am particularly grateful for the presence of Neena Shahani, who provides support to all graduate students far beyond what is required by her job description. She has somehow managed to establish a unique bond with each graduate student who passes through her office.

My mother has supported me throughout my life, often when doing so meant considerable sacrifices (material and emotional) on her part. Any strength of character I might possess is in some way modeled on her and on my grandmother who died last year, who looks over my shoulder as I write.

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One last note: I like Sismondo's approach to distributing blame and praise. I'd like to do the same thing, but I feel that I have failed a duty to my thesis by losing my writing voice; it seems completely alien to me now. For this fault alone I take full responsibility.

Table of Contents

List of Tables

Preface

My curiosity about the themes explored in this thesis began with an interest in the applications of biotechnology to human reproduction. Ten years ago, the Government of Canada appointed a Royal Commission on New Reproductive Technologies. The task of the Commission was "to examine how new reproductive technologies should be handled in this country" (Royal Commission on New Reproductive Technologies, 1993, p. xxvii). The Commission's report, Proceed with Care, was published in 1993. Based on its findings, and two years after its publication, the Canadian Minister of Health announced a voluntary moratorium on several reproductive technologies that were deemed contrary to the Canadian ethos. One year after that, in 1996, the moratorium evolved into Bill C-47, The Human Reproductive and Genetic Technologies Act (HRGTA) (Health Canada, 1996). Bill C-47 made it to second reading when the 35th Parliament dissolved. The current Minister of Health, Allan Rock, has plans to introduce a re-worked version of the bill under the guidance of an advisory committee (McIlroy, 1999, and Nisker, personal communication, 1999). The technologies banned under the original Act included germ-line genetic alteration, ectogenesis, cloning of human embryos, creation of animal-human hybrids, retrieval of sperm or eggs from cadavers or fetuses for fertilization and implantation, research involving the maturation of sperm or eggs outside the human body, transfer of embryos between human and other species, research on human embryos later than fourteen days after conception, and creation of embryos for research purposes only. It has not been uncommon throughout this regulatory process for press, academic, and grassroots discourse about the reality of these technologies to invoke metaphors from science fiction, underlining the surprise with which the public has confronted possibilities previously assumed to be in the distant future.

During the period of the bill's evolution, I found myself developing a mounting interest in both the subject of the regulation and the process itself. Affiliation with grassroots women's groups and academic feminism, a friend who worked for the Commission, and a seemingly endless series of health care research jobs provided a wealth of opportunities to discuss reproductive technologies from diverse standpoints. Eventually, I began working as a research assistant to someone directly involved in the process, Dr. Jeffrey Nisker. Nisker is a gynecologist in the assisted reproduction unit at University Hospital in London, Ontario and a bioethics professor in the University of Western Ontario Medical School. He currently chairs Minister Rock's Advisory Committee on reproductive and genetic technologies. Dr. Nisker has devoted the majority of his time in the last several years to studying ethical issues in assisted reproduction, and I was hired as part of this project.

At various points in this thesis, I make reference to impressions and experiences I have accumulated over the last several years that have inspired me to pursue the questions I raise here. It was an arduous process to develop a meaningful political and philosophical analysis on the use and development of reproductive and genetic technologies. My original intent in pursuing graduate work was to study the roles of various stakeholders in the regulation of controversial technologies in Canada. In the end, I determined that by focusing on the specific technology, even as a case study, I would not be able to cover the scope of issues I hoped to address in my thesis. I decided to broaden my approach to an exploration of the reasons behind the uneasy relationship the lay public has with the scientific information and those who generate it along with a discussion of existing models for public participation in science and technology policy to uncover how tensions are reflected and addressed in participatory mechanisms. The work you have in front of you is the result.

Chapter 1. Negotiating Science

Faltering Faith

> As we enter the 21st century, government decision making is also taking place in a highly dynamic environment... there are increasing concerns regarding the accountability and liability of scientists and decision makers. Fuelled by increased access to information, there is heightened public interest in science-based issues and greater emphasis on active public involvement in decision making. At the same time, there is greater public skepticism of science, government, industry, and the interactions among them. Greater science literacy and better communication of scientific uncertainty will increase the public's understanding of the capabilities and limitations of science. (Council of Science and Technology Advisors, 1999, p. 2)

The preceding paragraph is taken from a document titled Science Advice for Government Effectiveness (SAGE), produced by the Canadian Council of Science and Technology Advisors (CSTA) in May of 1999. The CSTA consists primarily of individuals who have served on external advisory boards to science-based government departments and were subsequently appointed to the CSTA by Ministers of these departments in 1998. Its mandate is "to provide the federal government with external expert advice on internal science and technology (S&T) issues requiring strategic attention" (CSTA, 1999, p. 1) with the intent of improving federal management of science and technology.

Acknowledging significant changes in the public's perspectives on both science and the government, the SAGE report outlines a framework for the use of expert advice in science and technology policy. In particular, the report points out that some recent government decisions--including mismanagement of issues as diverse as fish stocks and the blood supply--have contributed to the public's loss of faith in "the ability of government to effectively address science-based issues" (CSTA, 1999, p. 1). The report suggests that greater openness about how science and technology decisions are reached will allow policy makers to rely on expert advice without alienating the public and risking a further loss of confidence.

The SAGE report reflects a larger problem: ineffective communication, and therefore mutually held misunderstandings between those who produce science and technology, those who regulate it, and those who must live with the results. The choice of title for this report, SAGE, is interesting and perhaps ironic, as if the authors whimsically refer to the traditional wise elder who is the source of cognitive, even predictive, authority in a society. While the report's guidelines for establishing stronger communicative links between experts, policy makers, and the public are laudable, most references to public involvement describe transparency of the decision-making process as being realized only after decisions have already been made. That is, the public is only given full information when it is too late to influence the direction of policy. This approach communicates a message about the value ascribed to public input. Despite its recognition of the barriers to effective communication of science, the report does little to dispel perceived differences in decision-making capability between experts and the public. It also never questions the authority of science as a guiding instrument for policy.

I have chosen to begin with the SAGE report in this introduction to contextualize the exploration undertaken in this thesis, but it is only one instance of a pattern. The Canadian government, and in fact governments throughout the industrialized world, are touting a commitment to greater transparency and accountability to the public. Such commitments reflect a double assumption that there is a desire by the government to win back public trust that has been lost and a desire on the part of the public to place trust in governing institutions (and the bodies that advise them) that is strong enough to drive the relevant parties to cooperate towards a resolution.

This commitment to cooperation and transparency is laudable, if sincere. However, what I find most interesting is the assumption of an existing condition of lost faith in government on the part of its citizens. This condition and its symptoms have been observed by many theorists who have attempted to determine the reasons for faltering public faith. Troubled relations between governments and those governed have been attributed by Giddens (1990) to conditions of late modernity, which characterize existence in industrialized democratic societies. The work I will draw from later in this thesis to explore the relations between various groups has, in some way, resulted from an acknowledgment of the pervasiveness of rationalism as a mode of political thought arising from the Enlightenment, and its deterioration under conditions of late modernity.

The next section provides a brief discussion of Enlightenment rationality and its interpretation in the work of theorists studying late or troubled modernity (Irwin, 1995) modernity and the related study of risk (Beck, 1992). I have found it useful to draw from such explanations as a basis for understanding how scientific practice has evolved its current nature to help interpret public mistrust and suggest some foci for its mitigation.

Enlightenment Rationality and Late Modernity

To provide a foundation for understanding the public experience of science, it is helpful to consider the influence of Enlightenment rationality in modern political thought. Enlightenment rationality, or rationalism, describes a world view arising from the Scientific Revolution of the sixteenth and seventeenth centuries (Christie, 1990, Redondi, 1990, Schuster, 1990). Inspired by the ability of scientific method to discover truths about nature and thereby to find solutions to challenges presented by nature, Enlightenment rationality is characterized by the conviction that intellectual pursuits provide the means to emancipate society from the 'stagnation' of what were seen as superstitious belief systems. In effect, science instead of the spiritual realm became the source of miracles. Lewontin (1991) explains how science usurped other ways of knowing as the principal institution for legitimizing the dominant world view:

> For an institution to explain the world so as to make the world legitimate, it must possess several features. First, the institution as a whole must appear to derive from sources outside of ordinary human social struggle. It must not seem to be the creation of political, economic, or social forces, but to descend into society from a supra-human source. Second, the ideas, pronouncements, rules, and results of the institution's activity must have a validity and a transcendent truth that goes beyond any possibility of human compromise or human error. Its explanations and pronouncements must seem to be true in an absolute sense and to derive somehow from an absolute source. They must be true for all time and all place. And finally, the institution must have a certain mystical and veiled quality so that its innermost operation is not completely transparent to everyone. It must have an esoteric language, which needs to be explained to the ordinary person by those who are especially knowledgeable and who can intervene between everyday life and mysterious sources of understanding and knowledge. (p. 7)

Enlightenment rationality posits the existence of natural laws and valorizes scientific rationality as the source of truth through discovery of these laws. Truth, in turn, is the path to freedom. During the period of the Enlightenment, a fair and just society was seen to be governed by the operation of universal laws (Giere, 1993, Hess, 1995). This is the paradigm that seems to underlie the current influence of science in political planning.

Anthony Giddens, in The Consequences of Modernity (1990), depicts a political paradigm that is shifting from a modern rationalist philosophy of government to a paradigm of late modernity characterized by complex relationships between citizens, the state, and experts who both define issues and give policy advice. Giddens locates this shift within societies exhibiting features of capitalism and industrialization. That is, such nations house a system featuring commodity production, private ownership of capital, a class system, and a production process that coordinates human labour, machines, and raw materials to maximize profitability. As Giddens asserts, the competitive nature of capitalism supports a culture of constant technological innovation, that is allowed to thrive without significant interference from political institutions.

This is an important point in understanding the current state of scientific and technological development. The nature of modern institutions in industrialized capitalism, especially since World War II, has supported a culture of unfettered discovery. As Giddens (1990) suggests, this has resulted in societies where the scope and pace of change are expanded drastically in comparison with those in historical record. Consequently, the experience of living in a modern society is one of disorientation and "the sense many of us have of being caught up in a universe of events we do not fully understand, and which seems in large part outside of our control" (p. 3). MacBride (1980, p. 32) expresses similar sentiments with regard to new technologies, which, "advancing by their own momentum or due to political pressures and economic requirements, impose themselves before they can be assimilated, and elude both ethical and social control."

In part, the removal of technologies and the technical from social control is accomplished through disembedding mechanisms. Giddens (1990) spends considerable time explaining the process of disembedding, which I will attempt to distill. Disembedding is a process by which social relations are removed from local contexts. Mechanisms have been created in the name of efficiency that have necessitated a shared trust in symbolic tokens, items that abstractly represent more direct social interactions. Expert systems are an example of a disembedding mechanism. Giddens defines these as "systems of technical accomplishment of professional expertise that organise large areas of the material and social environments in which we live today" (p. 27). It is necessary for lay people to place their trust in experts on a daily basis, in the belief that these systems "generally work as they are supposed to do" (p. 29). Citizens further believe that even if expert systems do not work well, regulatory agencies act as a safety net to protect the public. Expert systems, though they represent real locations of social interaction, are nevertheless abstract in the minds of non-experts--and therefore become separated from the social reality of most non-expert people.

Here is where contemporary life has become sticky, and where Giddens (1990) feels we have made a transition to late modernity. In the transition to early modernity, Enlightenment rationality gained pre-eminence over traditional ways of knowing, and its primary expression--scientific discovery--was granted a privileged role. It became a source of truth viewed as more reliable than those based in traditional ways of knowing. It was therefore comforting to have faith in rationality and in scientific experts to provide the means to solve problems. In much of what are now highly industrialized nations, religious (specifically Judeo-Christian) and philosophical traditions represent the natural world, as manifest in agriculture, animals, resources, and their own bodies, as the source of most problems beyond their control. The felt need to control these things means that people will accept the best offered method of control, which since the Enlightenment (and especially since the technological advances brought on from World War II) has been science. The certitude with which scientific knowledge used to be met, however, has become shaky with the recognition of the reflexivity of modernity. As Giddens states, we "are abroad in a world which is thoroughly constituted through reflexively applied knowledge, but where at the same time we can never be sure that any given element of that knowledge will not be revised" (p. 39).

Giddens (1990) also discusses perceptions of risk in relation to trust in expert systems. While it is not demanded of publics to have confidence in their expert systems, i.e., to believe they will protect them from harm, it is expected that the public will accept the judgment of experts on the allocation of risks.

One influential voice in the study of risk is that of Ulrich Beck (1992), who connects risk to the forces of modernization. Beck feels that the industrial age has brought with it increasingly rapid means to generate wealth, which in turn generate threats of a global nature. Risk, like wealth, is socially produced; but where the allocation of wealth is limited and intentional, the allocation of risk is increasingly universal. The role of science in modernization is also a concern of Beck's. He recognizes that modern societies are dependent on scientific knowledge and that, in fact, risks are measured by scientific means; yet the modern manifestation of science involves an intricate division of labour intended to control risks, succeeding only in limiting the number of risks that are consciously acknowledged. As Beck puts it, "the insistence on the purity of scientific analysis leads directly to pollution and contamination of air, foodstuffs, water, earth, plants, animals and humans" (1992, p. 210). He points out that if risks are not recognized scientifically, they are assumed not to exist. The other social institutions that would recognize and deal with risk--the government, the education system--follow the lead of science. Unfortunately, scientific experts are both the creators of risks and the identifiers of them. Therefore, the processes relied on to define risks are also used to generate them. Beck seems to have captured the catch-22 of modern existence.

Of course, the preceding discussion does not do justice to either Giddens' or Beck's broad-ranging analyses, nor does it address critiques of their approaches. I intended only to draw out salient features of these analyses to illuminate a dilemma of social existence.

Science does not offer certainty: a seemingly obvious remark, yet one that runs contrary to what many of us have internalized. A society that has been conditioned to require measurement as evidence, yet whose exposure to sources of information is increasing at unprecedented rates, becomes acutely aware of the arbitrariness of facts. Coupled with indicators that the consumption lifestyles we have been encouraged to lead involve increasing risks to health every day, it becomes difficult to maintain our trust in expert systems to protect us, or to help us protect ourselves, from danger. Yet faith in science cannot be abandoned entirely, as increasing knowledge of risks is accompanied by scientific and technological developments that are perceived as bettering the human condition through health care, efficiency, and environmental protection (despite the damage already inflicted on the environment through scientific developments, such as pollution resulting from industrial processes).

Based on theories of Enlightenment rationality and the movement to late modernity, one could construct a simplified explanation for widespread public ambivalence regarding the accountability of governments and their expert consultants. It could go something like this: For a long time, in industrial countries, science has held a privileged role as the principle source of truth. This way of organizing the world is founded on the assumption that economic progress is paramount, and impediments to it can be addressed with the aid of rational scientific investigation and conclusive recommendations. Scientific practice was encouraged by the state, and structures were set up to support it. Science was seen as a pillar on which to rest the success of the state. Increasing faith in science and reliance on its abilities nourished a culture of unfettered experimentation, which eventually was rewarded with some glaring examples of the fallibility of scientific methods. After witnessing the devastating potential of some technologies, nuclear power, toxic waste, and Thalidomide, for example, public trust began to waver in not only scientific development but in the governing institutions being guided by it.

This explanation has merit and seems 'true' but does not go far in addressing the complexity of the problem as we experience it. For example, as the SAGE report rightly indicates, among those bodies that interact to influence policy (and are consequently subject to public mistrust) are transnational corporations. In 1998, two high-profile scandals shook Canadians' faith in their institutions of authority: the attempt by corporate funder, Apotex, to silence Dr. Nancy Oliveiri's report of negative results of drug trials, and her university's failure to support her (O'Hara, 1998); and the attempts by Monsanto to sway experts at Health Canada on the safety of bovine growth hormone through promises of institutional funding and finally through threats (O'Hara, 1998). These events were followed by the proposed restructuring of the Health Protection Branch, which comprises only part of a large-scale overhaul of government structures to revive their legitimacy and accountability to the public. While scientist-experts, policy makers, and members of the public have (to different extents) direct roles in formulating policy, the role of industry in determining policy is as yet an indirect, or at least nebulous, one. By no means does this imply that its influence is negligible. Industrial influence can be felt through such means as direct lobbying, funding of policy research, and by funding scientists who act as advisors in the policy process. It is not only the fear of economic imperatives outweighing social welfare in determining policy priorities that stimulates the public concern about corporate involvement. The very inscrutability of corporate sector involvement in policy decisions exacerbates public mistrust.[1]

The debt these arguments owe to the study of late modernity must be acknowledged. Lack of faith in policy makers and expert advisors to honestly communicate the health and safety risks associated with industrial progress has become ubiquitous in everyday life. What has become unsettling in late modernity is the recognition that information does not offer any real stability as it is reflexively adjusted with each new influence. The socially constructed nature of knowledge may not be articulated as such in the lay consciousness, but there is a common sense understanding that 'truth' has an arbitrary nature that is the root of faltering faith in experts and decision-makers. The realization that there is no possibility of knowledge that is not influenced in some way by its social context has fostered uneasiness where there used to be public confidence in institutions of authority.

Theories of modernity have been influential in the academic field of science and technology studies (STS). Science and technology studies is a relatively new field that has evolved from a variety of social science disciplines interested in the function and impact of science in society (Giere, 1993, Hess, 1997, Irwin, 1995, Restivo, 1995). I found this literature to be instructive in framing my thoughts about knowledge, public input, and science policy. Studies of the relationship between the world of science and broader society provide a site for addressing the uneasy relationship endured by scientific communities and publics, recognizing that interactions between these groups are necessary for a functioning democratic society. Uneasy relations can escalate into conflict when the object of the relationship is to achieve consensus on controversial technical matters. Developments related to genetic manipulation and biotechnology are possibly the most controversial issues since

[1] One need only turn to the movement protesting the World Trade Organization's steps towards globalizing free trade for compelling arguments to control corporate influence. As tempted as I was to detail these arguments, I

the nuclear energy debates of the 1970s.

Something About Protein: The Mystification of Biotechnology

Public attention to the possibilities of genetic manipulation has motivated a response on the part of some governments. Canada established a policy framework for biotechnology in 1993, The Federal Regulatory Framework for Biotechnology, that attempted to protect health, safety, and the environment from any negative impacts while fostering the economic potential of the products and processes of biotechnological research (University of Calgary, 1999). The biotechnology debate with the highest profile at present is that involving genetically modified (GM) foods. These agricultural products have been subjected to genetic manipulation that could not be achieved through regular breeding techniques in plant reproduction. The arguments for the production and marketing of these "novel" foods have hinged primarily on economic rationales--greater yields, larger vegetables, less waste of produce, more productive farms.[2] Yet, the risks associated with altering an element of the ecosystem at the level of the gene are not fully known but have been recognized as potentially disastrous (Ho, 1998, Hubbard & Wald, 1997). As well as potential threats to the ecosystem and human health, broad-scale marketing of genetically altered seed by large multinational corporations has had devastating impacts on small farms in less industrial southern nations, where built-in traits of the seed drives farmers into a dependency they cannot afford (Ritchie et al., 1999). Knowledge of these effects has stimulated protests against GM foods on an international scale, the effects of which were felt at the World Trade Organization meeting in Seattle in November 1999. Nations have recognized these protests

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have elected to relegate this aspect to future research, as noted in my concluding chapter.

[2] It is important to note that many of these claims of great yields and better products have proven to be untrue. See, for example, the work of Mae-Wan Ho (1998) and the International Forum on Globalization (Ritchie,

as representing a loss of public faith in governments and have been struggling both internally and in cooperation with other nations to respond in various ways, which have included the establishment of accountable regulatory structures to reaffirm public faith, to the creation of international guidelines for biotechnology governance.

Controversy over biotechnology is not limited to the single issue of GM foods. Any technology that deals with living matter or portions thereof can be classified as a biotechnology, and especially as understanding of genetics has developed, the implications for biotechnology have spread through many branches of scientific practice. As I have mentioned in the preface, I became interested in biotechnology policy issues through the efforts to construct a regulatory mechanism for human reproductive and genetic technologies. In my capacity as a research assistant to an expert advisor to Health Canada, I consumed vast amounts of literature about reproductive technologies. I read feminist philosophy, ethical analyses, international policy profiles, legal precedents, popular science reports, scientific journals, policy reports (including the Royal Commission on New Reproductive Technologies final report, Proceed with Care), and even personal accounts of treatment seekers. I assimilated all this information and then found myself acutely aware of what I had learned, and could learn, from my immediate environment.

My office was located within an assisted reproduction unit. As is expected in any patient care unit, patient confidentiality is protected, and I respect that right. It is not possible, though, to be within an environment and remain oblivious to its culture. What I observed was a culture that rendered childlessness abnormal, whether voluntary or not. The literature generated by infertility support groups typically characterizes the plight of the infertile as an emotional roller-coaster. In these pamphlets and flyers, the experience of

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Lang, Rosset, Altieri, Shrybman, Krebs, Shiva, & Norberg-Hodge, 1999).

infertility, the inability to conceive, is associated with feelings of inadequacy, abnormality, or incompleteness. Posters on the clinic walls, small talk between staff and patients as they are ushered into treatment rooms, and off-the-cuff comments between physicians all demonstrate that the care team sees their primary role as curing people of infertility, helping them conceive healthy (i.e. disease-free) children. Physicians are trained to be healers. In this case the cure is a baby. Often there are serious risks associated with assisted reproduction treatments for women, and yet the overwhelming atmosphere is not one of caution, but of hope. At the time, it was unclear to me whether the risks were fully acknowledged by patients or physicians in the meager ten minutes allotted for each clinic appointment. Other members of the health care team are themselves wrapped in this culture. Even when they express emotional attachment to patients, their concern (and sometimes pity) reinforces parenthood as the only valid existence. Alternatives such as adoption are seen as a last resort. Childlessness is not even considered within the realm of options.

The culture that stigmatizes infertility and naturalizes the drive to reproduce at all costs is expressed in a seductive discourse, and it is one most of us are trained to participate in from an early age. In my observations, I could even see the effects in myself. Although I have chosen childlessness for political and personal reasons, I experience a certain free-floating anxiety whenever I attempt to emotionally commit to refraining from biological reproduction. The deviance associated with voluntary childlessness, which constructs adults who have made this choice as either irresponsible, immature, unhappy, or incomplete, is woven into society at a deep structural level to discourage full participation in adult life for the childless. That is, having a child is viewed as the true, 'natural' ritual for passage into adulthood, and those who choose to remain childless are viewed as not ready to become adults. They may even lose the respect of colleagues and friends, as time wears on and their voluntary childlessness appears increasingly 'unnatural.' If voluntary childlessness is deviant or unnatural, it should not be suprising that involuntary childlessness (i.e., infertility) is characterized as a disease. Perhaps more alarming, reproduction that results in a 'flawed' child is characterized as a tragedy--and now due to the availability of early diagnostic procedures, as an irresponsible act on the part of the parents. Pre-implantation genetic diagnosis (PGD) allows prospective parents to screen test-tube embryos for inherited disorders before implantation in a woman's uterus. This is seen as mercifully circumventing the 'need' to abort an unwanted pregnancy. However, the choice to undergo IVF when pregnancy could be possible through donor insemination or regular intercourse means that the woman giving up her eggs is required to undergo risky hormone treatments and uncomfortable egg aspiration. Though technologies are valorized as saviours of the infertile, there are always risks associated with invasive procedures, not to mention jury-rigged pregnancies where no pregnancy was possible. In some cases the drive to have a biologically related child may ironically increase the chance of producing a child with birth defects (Nisker, 1996). Beyond this there are also questions about what pressures may be put on a child after such a lengthy process to obtain it, what messages selective abortion or implantation send to people living with disabilities, not to mention concerns about overpopulation (and the stresses the industrialized world places on the environment). In general, a society faced with such technological possibilities must confront questions about the definition of family, self-worth as an adult, and meaningful life in general.

In a much broader sense, technologies like PGD threaten the future of the human species as the Human Genome Project completes its mapping of our genetic infrastructure. If it is possible to select children for physical and intellectual traits, such as slimness or math ability, then widespread adoption of PGD in IVF bodes ill for future diversity of our species. Like food biotechnology, human reproductive biotechnologies have the potential to homogenize humanity. The drive towards homogenization is a fascinating topic, one for which I sadly do not have space here. What I find interesting, however, is the fact that this drive has been naturalized despite what humans have learned over centuries about the value of diversity in both ecosystems and societies. No one really knows the long-term impacts of extensive genetic manipulation, and this fact is used to support the arguments of both proponents and opponents of unchecked biotechnological development.

All members of the public will be affected by biotechnological development. Not only are economies becoming increasingly reliant on biotechnology, but the implications of biotechnology's ecological impacts are receiving greater attention from grassroots organizations, international lobbying groups, the academic community, and even the mainstream media. However, the public's ability to understand technical matters is constantly brought into question in the policy process so that even if citizens have input into science policy decisions, that input may be dismissed as uninformed. Often, for ease of policy formation, decisions are left to elected representatives and expert consultants. The problematic power dynamics involved in this system have significant consequences. Knowledge and information are held in centres of power separate from those who are most affected by that power. The incident between Monsanto and Health Canada over bovine growth hormone (BGH) is an excellent example of this problematic dynamic. Monsanto's attempts to financially persuade and even threaten Canadian government scientists to approve the use of an agricultural product, if they had been successful, would have had ecosystem-wide implications. In this case, the integrity of Health Canada assessors prevented such a conclusion, and the incident provides an important lesson. It was really only after the scandal that the regulation of BGH became newsworthy. Members of the lay public are generally not involved in such deliberations, although the entire public is vulnerable to experiencing the consequences of these major decisions.

Mistrust of governing institutions is naturally recognized as a liability by many states which have attempted to salvage some public faith through the adoption of participatory mechanisms for policy formation. Unfortunately, in the case of science and technology policy, both the citizenry and the experts experience a similar lack of faith in the lay public's ability to fully understand and respond to implications obscured by technical discourse. This in turn exacerbates bad relations, as the policy process can grind to a halt to accommodate learning curves and deliberation periods, which augments negative perceptions of bureaucracy and entrenches the belief that participatory governance of controversial technologies is too cumbersome to be feasible.

In establishing a regulatory framework for these technologies, the government must somehow acknowledge the voices of its constituents and achieve the best possible reflection of these voices, or at the very least, an acceptable compromise. Their task is further complicated by the intricate technical nature of what they are attempting to regulate. There is a sense that society must be protected from what it does not understand and that developments in science and technology have accelerated beyond the public's ability to keep up. However, even when vast segments of the public are uninformed about technical matters, this should not preclude some form of democratic participation in the policy process. Designating time for a learning curve on technical issues can be daunting when regulatory matters require urgent action. Current initiatives in a number of countries to regulate genetically modified foods have brought renewed attention to mechanisms for public participation that enjoyed their strongest presence in 1970s nuclear energy discussions.

Ambivalent relations between technical experts, policy bodies, and the citizenry have been exacerbated by failure on the part of all parties to address the systemic obstacles to effective communication. Here, effective communication means expression of opinions by members of a concerned body (for example, a grassroots organization advocating for people with disabilities) with a justified expectation that the audience, another concerned body (for example, a consortium of scientists developing screening techniques to prevent the birth of people with disabilities), will receive and comprehend the message. In many nations, this problem has been recognized at the government level where a variety of initiatives have been implemented in the hope of ensuring a more open, accountable, and transparent policy process. Initiatives like web postings, public education campaigns, surveys, referenda, consultation sessions, and citizen advisory panels are important parts of the path to democratic governance of science and technology. They suggest a willingness to foster better relationships, and they validate the voices of the powerless. Mechanisms that actively involve many interested parties offer hope not only of improving communication between groups but also of developing space for democratic decision-making. However, public negotiation of scientific information--as well as expert and state negotiation of public input about science and technology policy--cannot be addressed with a simple policy formula. It requires a thorough analysis of communication barriers and possible strategies for their amelioration. It is the task of this thesis to explore the tensions between the relevant bodies directly involved in science and technology policy and, perhaps optimistically, consider possibilities to mitigate these tensions through the use of participatory mechanisms.

Overview of Thesis

Research question.

This thesis addresses the question: How can those directly involved in the policy process--experts, the public, and the policy makers--best work together to form an effective, accountable, and socially responsive system for regulating science and technology, specifically highly controversial technologies such as biotechnology? To answer this, I first examine the reasons for the existing ambivalent relations, including the deteriorating relationship between the world of science and its public audience and increasing cynicism about the ability of governments to effect accountable policy. I will then explore lessons to be learned from the history of participatory mechanisms in science and technology regulation. By considering how existing mechanisms reflect certain assumptions on the part of all participants in science and technology policy development, this work explores the potential for establishing flexible participatory structures to achieve socially meaningful, strong[3] democratic governance over the directions taken by science and technology.

Cast of characters.

In an exploration of this nature it is tempting to resort to oversimplified terminology to describe the collections of people, and the variety of voices, that contribute to the situation under study. It is possible to rely on common sense understandings of categories such as scientists, the public, and the government when undertaking an analysis of the roles these

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[3] See the discussion of Richard Sclove's (1995) definitions of strong and thin democracy in Chapter 3.

groupings play in policy determination. I have elected to reduce[4] these collective bodies into neat groups for the purposes of discussion, in full awareness of the irony in using generalizations to illuminate the complexities of a situation, and of the struggle against the silencing function of such generalizations.[5] However, this thesis addresses a more evident struggle that has been concerning me. Democratic participation is difficult in the best of circumstances, and in a vast multilingual country such as Canada it is fraught with obstacles. Each interest group is best equipped to articulate its own needs, but even then it is possible (or probable) that certain standpoints are neglected or inadequately expressed. Nevertheless, it is not only for ease of discussion that I use such terms. Not only do these terms reflect common sense understandings of group identification, but there are fundamental assumptions and conceptual frameworks that operate to lend some unity or cohesion of perspective to each group in its interactions with others. This thesis addresses some of these assumptions.

The following terms, then, will be used throughout this exploration. As is common in popular discourse, I have usually elected to use the terms science and technology in conjunction, to refer to an aspect of modern society represented by specialized structures and systems of knowledge. I feel it is necessary to combine these terms because problems with the policy process are related to the conceptual separation of science and technology. The actual objects of the regulatory process addressed by participatory mechanisms are technologies, that is, the existing models for public participation deal almost exclusively with products of scientific practice as they are to be applied in the social context. Yet, as I will argue, the need for public participation begins earlier than at the stage of regulating existing

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[4] The next chapter will delve into the dangers of reductionism, as elaborated by Vandana Shiva (1989).
[5] McKechnie (1996) addresses the problem of definition nicely: "Concepts such as 'public', 'science', or 'expertise' are social achievements, subject to differing and competing definitions. The fluid boundaries which define and oppose 'science' and 'publics' are constantly shifting, dissolving, and reappearing. Science and

technologies. The dialogue between scientific experts and members of the lay public is a pernicious influence in the policy process, as both groups harbour perceptions about the professional culture and language of science that inhibit effective communication and understanding of processes and priorities. Since the technologies discussed here are products of scientific practice, it is not possible to deal with either in isolation from each other in the policy arena.

I do not, however, intend to convey by my choice of words that my perception of these two entities is limited to their interdependence, nor do I wish to collapse the distinction between them. As Giere (1993) points out, the intertwining of science and technology has interesting consequences for the cultural analysis of each. He addresses the traditional tendency of sociological analyses of science to study the workings of scientific communities as if they were autonomous from culture and society, which obscures the social construction of knowledge. He states that technology studies have always approached technologies as social and cultural products, thereby suggesting that any analysis must consider not only their contingence on society but also their reciprocal ability to shape society. In light of this distinction, and considering my affinity for a critical approach to science and technology in society, I have chosen to define these two terms separately.

It is perhaps easiest to begin a definition of science with a description of those who practice it. Scientists are easily defined as those who practice science, conduct scientific experimentation, develop and manipulate technologies, and conduct research and development (R&D). They have specialized training and may work in a variety of settings, including industry, clinical practice, and academia. The scientists in whom I am most interested for the purposes of this thesis are those who serve as expert definers of the path of

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publics are situated not in opposition to each other in a vacuum, but in a complex of relationships." (p. 127).

scientific and technological progress (i.e. those who support dominant trends in scientific consensus) and advisors to government on scientific and technological policy. All of those associated with a particular science tend also to recognize group membership through the use of specialized jargon, a point which will be addressed in the second chapter. Science has become naturalized as the principal authority for measurement of both truth and utility. Governments have traditionally accepted their own authority as elected representatives of the public, informed by the expert advice of rational scientific minds, as adequate input for policy decisions. However, it is necessary to question not only the nature of this rationality but its ability to serve as the only form of knowledge in decisions of this kind.

Technology is an abstract concept representing the specialized processes and practices, the technologies, evolved through scientific inquiry. Though I am partial to the approach of Ursula Franklin (1990) in defining technologies most generally as "ways of doing something" (p. 15), for the purposes of this work I will refer to technologies as sets of techniques, developed and used with chemical and/or mechanical assistance in specialized environments by people with relevant training. Though I recognize that technologies can be broadly defined to include instruments used in everyday life without specialized training, I have elected to limit my discussion to those used in specialized circumstances. This is primarily because the technologies that are currently a major focus of regulatory debate internationally, and admittedly the focus of my concern in undertaking this work, are biotechnologies. I refer to biotechnologies as that specific set of practices and techniques that artificially alter living material through techniques that manipulate genetic structure in a laboratory environment.

Though industry is not described as a direct actor in policy formation, its influence can be felt at various stages of the process. When I speak of industrial or corporate bodies, I refer to organizations run for profit, in particular those organizations that have the resources and power to influence the policy process and tend to be described as multinationals, transnationals, or global corporations. Their sphere of influence and interests are larger than can be contained in a national regulatory framework. In a 1999 document prepared by the Task Force of the International Forum on Globalization, it is stated that "governments have transferred much of their sovereignty to the hands of global corporations" (p. 2). This tendency makes it necessary to address the role of industry in policy formation, especially policy dealing with lucrative areas such as biotechnology.

The public (or "lay public" as STS sometimes describes it) obviously represents countless groups. It is best to define it by what it is not: those individuals who compose a society (in this case, residents of Canada) but who do not have membership in another group relevant to the policy under discussion, i.e., experts and elected or appointed policy makers. Scientists and policy makers are also members of the public in their non-professional lives, but for this discussion they will be given separate consideration by virtue of specialized training, access to information and mechanisms of political power. The lay public is characterized as non-experts. This is only a partly accurate characterization, as the lay public may in fact have expertise in areas that, while not defined as such by elected officials or their expert consultants, are relevant to policy deliberations about the applications of science. Indeed, members of the lay public may have as much expert knowledge of the relevant topic as a government-ordained expert, but they are typically excluded from the process because they are not officially recognized as expert. The public is also characterized by a relative powerlessness in the policy process, as their involvement has tended to be indirect (through the electoral process) and only becomes direct through the use of binding participatory mechanisms. Members of the public will likely have varying understandings of scientific information and varying perceptions of its relevance to them personally. Nonetheless, the future effects of biotechnologies are as yet undetermined, and this uncertainty should be a sufficient reason for all members of the public to be perceived as interested parties in biotechnology regulation. For the purposes of this discussion, I occasionally use the term citizens interchangeably with publics. The members of the public to whom I refer are being discussed in terms of their citizenship capacities, that is, their ability to provide input to and influence policy decisions within their governments.

Chapter outlines.

Chapter one outlines the context and background for the research question. Current Canadian conflicts over the structure, process, and facts of biotechnology regulation provide a strong indicator that more investigation needs to be done to uncover the reasons for tension and to explore how to establish effective governance mechanisms for controversial technologies. As is symptomatic of troubled modernity, members of the public operate in a state of precarious trust of, and ambivalence towards, governments and expert authority.

Chapter two provides the theoretical background for this exploration. First, the context of science and technology studies and the particular stream within this area with which I associate my work is explained. To position my analysis within the STS literature, I discuss how knowledge, power, risk, and progress are experienced and expressed by three groups: the Experts (those who operate in the realm of science and technology as sanctioned advisors to government policy makers), the Public (citizens, members of the public), and the State (policy makers who represent the state in the regulatory process). It is also necessary to consider the more nebulous role industry plays in shaping and directing policy on science and technology. Each of the concepts addressed in this section are subject to subtle differences in the ways they are perceived by each group. These differences manifest themselves as double obstructions to effective communication: the knowledge gap and the values gap. Ambivalent relationships between the groups involved, I argue, have resulted primarily from these two obstructions.

The third chapter demonstrates how the themes and experiences described in chapter two support an argument for public participation in generation and evaluation of science and technology policy. Some history of models and frameworks for public participation, stemming from the technology assessment movement in the 1970s is provided, with specific reference to how participatory mechanisms attempt to mitigate the causes of ambivalence to authority. One model to which I devote extensive discussion is the Commission, which has long been a standard in Canada for public consultation. I compare and contrast elements of two commissions that demonstrated drastically different processes: the Baird Commission and the Berger Inquiry. I then discuss the model that seems to be winning the most favour of late, consensus conferences. The Canadian Food Biotechnology Citizens' Conference, held in 1999, was the first one of its kind in Canada. To elicit first-hand impressions of this conference, in March and April, 2000, I conducted telephone interviews of some key participants,. The resulting information is used to support my analysis of the effectiveness of the consensus conference model. Finally, strengths and weaknesses of the Commission and consensus conference models are compared to address their appropriate use in the Canadian context. The participatory mechanisms described in chapter three are discussed in light of theoretical considerations developed in the second chapter to consider what characteristics are promising for effective democratic decision making about controversial technologies.

The fourth and concluding chapter summarizes the theories outlined in chapter two and how they play out in the policy mechanisms described in chapter three. To inform the establishment of effective models for public participation in policy development, I outline some points about democratic governance to maximize political opportunities. At this point, I turn to some analysis of my own assumptions about the participatory models and public involvement. The chapter concludes with suggestions for future complementary research.

To proceed, then, I will launch into the second chapter, which outlines the themes that are defined by, and define, both the bodies involved in biotechnology debates and the obstacles to their mutual understanding.

Chapter 2. How Publics Understand Science: Analytical Themes of Science and Technology Studies

In the first chapter, I briefly referred to theories of late modernity and their usefulness in explaining the drive towards more effective participatory mechanisms for public involvement in science and technology policy processes. I also pointed to the field of science and technology studies as a resource for understanding both the reasons for and the experience of ambivalent relations between the relevant bodies. This chapter outlines the theoretical framework I have selected to interpret the problematic communication between the bodies directly involved in science and technology policy.

The link between theory and its application is in practice often obscure. Exploring the literature of a field devoted to the contextual analysis of science and technology underlines the key issues that must be addressed to successfully correct problematic or inequitable structures. My intent, then, is to describe some of the prominent themes in science and technology studies that will frame my exploration of the science policy process. Specifically, in describing the three groups directly involved in the policy process--scientific experts, the citizens that make up the public, and the policy makers that represent the state--I will address the themes of power, knowledge, risk, and progress to illuminate how members of each group might experience the role of science in society. I will then detail how problematic relations between these groups have resulted in different interpretations of the issues and potentially conflicting priorities when embarking on the regulatory process. In short, those involved in the policy process operate as if a gap in knowledge exists, most notably between members of the public untrained in scientific issues and the experts who have received this specialized training, which suggests an arduous learning curve is unavoidable before informed policy input can be accomplished. In addition to this, the act of seeking regulatory means to protect public interests can reveal apparent incompatibilities in the value systems of interested parties. When members of the public interact with policy makers and their expert advisors, each group is susceptible to a perception that its values do not coincide with the values of the others, but citizens may understandably feel they are in a position of powerlessness relative to policy makers and their scientific advisors. Discrepant values exist among members of the public, but there is a growing tendency for citizens to perceive the motives of experts and government representatives, especially under the influence of industry, as being suspect. Before proceeding with this analysis, I will provide some background about science and technology studies to aid understanding of my own position.

Background: Science and Technology Studies (STS)

A branch of social and cultural research united in the belief that knowledge and artifacts are socially shaped or constructed (Hess, 1997), science and technology studies (STS) focuses on issues such as the dynamics of networks and hierarchies in scientific communities, the political and cultural role of science, and the public understanding of science. The modern practice of STS began in the 1970s (Hess, 1997, Restivo, 1995), but its foundations have been attributed to the traditions of philosophy and sociology of science, with debts to Duhem, Durkheim, Foucault, Habermas, Kuhn, Mannheim, Marx, Merton, Popper, and others (Giere, 1993, Restivo, 1995). Current practice of STS tends to be interdisciplinary, including researchers who officially reside in "anthropology, cultural studies, feminist studies, history, philosophy, political science, rhetoric, social psychology, and sociology of science and technology" (Hess, 1997, p. 144). The core set of this community is said to include Karin Knorr-Cetina, Bruno Latour, Michael Mulkay, Andrew Pickering, Trevor Pinch, Steve Woolgar, Steven Yearley, and Brian Wynne, among others (Hess, 1997). I would add to this list Allen Irwin, a collaborator of Wynne's, who has published an excellent book about citizenship and scientific research and development (Irwin, 1995). Most well-known centres for STS work are in the United Kingdom, although Cornell and Rensselaer in the United States are also prominent.

Science and technology studies, in particular its critical aspect, is a relatively young field. Its actual representation in the academic circles of all industrialized democratic nations is not commensurate with its tremendous social relevance, and there are many academics whose work is attached to STS, although they may not identify it as such. Perhaps because of its interdisciplinary nature, it encompasses a broad range of approaches to research. The spectrum of science and technology studies appears to range from more conservative uncritical analyses to more radical interpretations based in theories of social construction. The implications of this range merits further explanation.

From conservative to critical STS.

Contrasting approaches to modernity and rationalism differentiate streams of science and technology studies. Giere (1993), Hess (1997), and Sismondo (1996) see a correlation between uncritical STS and other political and philosophical approaches such as liberal democratic, realist, or modernist ways of thinking. As these authors point out, there is a tendency to associate the opposite end of the STS spectrum--critical STS--with postmodern analyses. This range, from conservative to critical, modern to postmodern, allows for a rich interplay of theory and approaches, within the basic assumption--that knowledge is socially constructed.

Giere (1993) suggests that the more conservative forms of STS espouse a mostly uncritical approach to Enlightenment rationality. In general, these forms do not necessarily argue against the idea that science operates autonomously from social contexts, nor do they critique the privileged role science holds in industrialized societies. Scientific discovery could still be studied as a social product in the sense that social interactions within the scientific community, laboratory, or academic setting are subject to scrutiny under this approach. But the meaning and impact of scientific discovery in the larger social context is not the focus of this STS branch. That is, the reflexivity of knowledge--that society constructs elements of its reality, which in turn construct society--is dealt with as it operates primarily within microcultures of scientific practice. For example, a conservative forms of STS could be based in sociology of science, and study such questions as the nature of scientific discovery, the ways in which scientific activity and technological structures foster innovation and international fiscal competitiveness, or the ways scientists achieve consensus on accepted models and facts.[6]

While in the conservative model, scientific rationality is a guarantor of democracy and freedom, constructivist critiques of modernity have a different interpretation. As Giere (1993) suggests, much of the current work in STS positions itself in opposition to Enlightenment rationalism to varying extents. Constructivist approaches represent the bulk of the STS project. Hess (1995) differentiates between *social* and *cultural* constructivist viewpoints. Social constructivism is primarily concerned with an explanation of causal relationships between variables. Conservative STS can therefore be considered one social

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[6] This last example is a reference to Thomas Kuhn's The Structure of Scientific Revolutions (1962). Kuhn's work has been extensively criticized for a variety of points, especially his unwillingness to follow his radical analysis to its implications for constructions of truth; however, his work is still seen as a turning point for sociological studies of science.

constructivist approach that constructs narratives about how scientific developments have come to pass through a consideration of limited sources. Social constructivism also encompasses analyses of the broader social context, as the factors included in a constructivist analysis are basically determined by the researcher. In fact, as Hess (1997) states, the original program from which STS evolved was conscious of the fact that both society and scientific practice were constructed from similar patterns and that the framework for analysis and critique of natural scientific practice should also be applicable to practice in the social sciences.

Among others, Sergio Sismondo (1996) has detailed aspects of the social constructivist approach to science and technology, which considers the role of scientists in representing and constructing reality and deals with scientific knowledge as a product of communities and societies. As Sismondo explains, constructivism is sometimes at odds with a realist (conservative) approach, mainly over the issue of the seeming truth of reality. He attempts to show that an analysis of science as a social and political institution is not in conflict with science as a force of representation. That is, science creates a representation and constructs a reality that could be called truth, but truth is dependent on the social and political institutions in which science operates. Wynne's (1995a) work on the public understanding of science describes several approaches that have been used to address this complicated question, including theories of cognition, trust, relevance, agency, and dependency. All of these imply that the lay public experiences science through an active process of negotiation, deciding what information to accept, to what level it should be accepted, and how important it is to life. Giere (1993, p. 106) also positions the "intermediate viewpoints" in constructivist STS as envisioning knowledge to be more subjective than do conservative stances. Social construction suggests that scientific practice represents reality, and in turn helps construct reality, but reality is not considered a reflection of natural laws.

This appears to be a useful analysis as it sidesteps the need to reconcile the intent of scientific activity with truth. Although the practitioners of science may characterize themselves as truth-seekers, the constructivist approach makes a definition of truth irrelevant. Like language, science is a culturally-produced tool that can be used by individuals to describe a reality. Here, reality is a product of societal consensus and is plastic in that its existence can be mitigated through changes in social, political, and cultural structures. Social constructivists not only refute the argument that scientific practice is merely a series of objective observations and discoveries but also make it possible to understand the importance of the context in which science operates and in which scientific information is negotiated by non-scientists.

Cultural constructivism, however, focuses more on the interpretive than the explanatory task of deconstruction. It attempts to determine how different meanings, associated with identity, race, gender, class, etc. are mapped in social practices. This approach, in combination with the explanatory function of social constructivism, leads to the other extreme of the STS spectrum (opposite to conservative studies): the adaptive form described by Hess (1997) as "critical STS." Within the interdisciplinary framework, critical STS draws extensively from radical social analyses of race, gender, class, and related experience of oppression to make observations about the interaction of science culture's value structure and the larger society in which it must necessarily exist. Hess likens the contrast of standard constructivist STS and critical STS to the difference between "a London men's club, in which vigorous but carefully chosen debates end with a good smoke being had by all... [and] a querulous New York neighborhood in which there are many disciplinary transients and where many people do not know--or even want to know--their neighbours" (p. 157).

Critical STS is informed by, and recognizes the possibilities of, a number of approaches to understanding how science and technology operate in society. It does not necessitate a belief in the truth of scientific representations, nor does it demand an outright rejection of the possibility of truth. Instead, it explores the implications, both beneficial and pernicious, of scientific practice for society. It is with this critical approach that I align my work. My exploration of science policy has been influenced by a variety of theoretical positions that are complementary. Though I have found STS in general to be the most satisfying theoretical framework for my examination, the adaptive approach provided by critical STS goes farther to address the complexity of the challenges in science and technology governance. The following discussion will draw from constructivist science and technology studies, theories of systemic oppression and power, political economy, and other analyses to address the consequences of modernity on science and technology, with particular reference to difficulties of governance. The next few sections will describe some characteristics of the groups who have stakes in the policy process: the Experts (in this case, those who operate in the realm of science and technology acting as sanctioned advisors to government policy makers), the Public (citizens, members of the public), and the State (policy makers who represent the state in the regulatory process).

The Experts

> [In the post-war era] Our culture was separating into two parts, scientists and everyone else. Most people were technologically ignorant. Those in the know

composed an increasingly elite aristocracy that held power by its command of counterintuitive knowledge... (C.P. Snow, as quoted in J. Franklin, 1997).

Chubin (1989) refers to this as the cleavage of science from society. The beginnings of this cleavage lie much farther back than the second world war, however. Earlier in this thesis I described the long-term effects of the Scientific Revolution on the role of science in society. As science was elevated as the one source of truth and the solution to problems, rationalism became naturalized as the authoritative way to knowledge. In the centuries following the Enlightenment, the practice of science underwent an evolution from the domain of anyone with the resources and an interest, to the exclusive realm of the professional.[7] Bowen and Schneller (1991) describe the practice of science as being a common pursuit of well-to-do amateurs in the seventeenth and eighteenth centuries, whose goal was to release the results of their discoveries to the public. It was the sign of a gentleman to have a laboratory in one's home, akin to having an artist's studio.

Ben-David (1991) chronicles the changes in scientific productivity since the nineteenth century. There was a consensus about the importance of scientific pursuit in Western nations and a desire to support and encourage the quest for knowledge, but levels of support differed between nations. A key form of government and academic support was the recognition of new areas of specialization and provision of training programs. Further, governments saw the advantages of providing institutional encouragement in the form of financial support within an academic research setting. This also encouraged competition within a field since those interested in pursuing scientific research would covet the opportunity to pursue it full-time. While Ben-David is speaking specifically of clinical research, the professionalization of science was not limited to the clinic. Although scientific

[7] By "anyone with the resources," I am sure the reader will infer the gender, class, race, and location of the

research had originally developed among talented amateurs using their spare time, governments saw it was in the interests of national competitiveness and economic health to encourage this research full-time with pay. Continuous growth in the numbers of specialized scientists, along with increased emphasis on competition, created an atmosphere in which scientific research became a regular career.

Even before professionalization, scientists did not pursue their experiments with the intention that they would be the sole beneficiaries of the knowledge they would accrue. Schott (1993) describes seventeenth-century Europe as a time and place in which science was legitimated, and the pursuit of natural inquiry was open to anyone with resources. [8] Here it was understood that knowledge resulting from such inquiry would be widely disseminated for the public good. As legitimization of science led to its organization and institutionalization, the location of knowledge moved from the public realm to an elite sphere of activity, where public dissemination was no longer foremost in investigators' minds.

Now, as McKechnie (1996) points out, western society is increasingly dependent on specialized roles, and yet members of society have no means to measure the credibility of expertise. Addelson (1983) states that the public is willing to credit scientists with cognitive authority, authoritative knowledge by virtue of special training, experience, and use of rigorous methodology. Researchers and scientists, having been given this gift, exercise cognitive authority within the realm of autonomous science. That is, they are encouraged to act independently and innovatively within a free-ranging system. Dolby (1982) qualifies the attribution of authority and suggests that this autonomy is not accepted wholesale, but criticisms are made in ways that do not affect the operations of science. Scientists engage in

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subject.

prestigious academic pursuits that render them the "custodians of knowledge" (p. 269).[8]

According to Sismondo (1996), ". . . knowledge communities need to establish spaces, both physical and intellectual, for themselves; they need to draw lines that exclude and include certain people, problems, methods and materials" (p. 40).[9] The scientific quest, it can be argued, is one of control--over nature, or human inadequacy--through knowledge. Sismondo suggests that "knowledge is tightly connected to power. We might therefore imagine scientists as politicians or generals, who try to create alliances large enough that nobody can question their power within their domains" (p. 118). Further, he states that "a political economy of knowledge has evolved in which knowledge of the natural world can be used to reshape society and to make the scientist indispensable in its new configuration. Power is given to those who are thought to know" (p. 151). The cachet of power that accompanies such specialized knowledge is supported by various aspects of the practice of science that serve to maintain the veiled quality referred to by Lewontin in the introduction of this thesis.

Irwin reminds us that it is important to emphasize that science and technology are above all human activities (1995, p. 2) operating in complex social structures, which are maintained with social tools such as language. During the past century, increasing professionalization of scientific practice:

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8 O'Reilly (1989) uses a similar term, "expert definers," to describe how the medical profession has situated itself with respect to knowledge about childbirth.

9 Sismondo devotes some space to actor-network theory, as proposed by Latour and Woolgar (1986). In Latour's theory of how scientists use varied resources to build networks of power, scientists define the interests of new actors (here, a technological development can be an actor). Networks define the importance of issues relevant to their work and thereby construct "truths" about the world. The public relies on these expert networks for descriptions of "reality". Latour has been criticized for an overly rationalist and reductivist approach (Sismondo, 1996, p. 125), but some of his observations are to the point. I endorse the idea that each scientist operates in constellations of networks that vary in number, geocentricity, and level of interest. But here, I am concentrating not as much on the process of knowledge production but on the power relations associated with it. Critical approaches like those of Irwin, Sismondo, Wynne, and Winner are therefore more useful in this argument.

> led to the proliferation of jargon. Scientists spoke to their own peers, respected only pure research, and looked down on popularization as 'vulgarization'. In the decades after World War II, even teaching undergraduates was barely tolerated . . . A gulf of language and experience seems to separate the scientist in his specialty from the larger community (Bowen & Schneller, 1991, p. 4).

Indeed, language may in fact be the most important tool to maintain the division between specialists and non-specialists. Sociolinguistic theory has much to offer our understanding of this. Benjamin Lee Whorf was trained as an engineer, but through work as a fire inspector he became fascinated by the power of language. He noticed, for example, that some accidents were caused by people smoking near empty gasoline cans. During the course of his investigations, he discovered that although there was less of a risk smoking near full gasoline cans (since the real danger is in the fumes that fill empty cans), people associated the full cans with a real danger and empty cans with a lack of threat (Whorf, 1956). This story underlines many of Whorf's points about the significance of language in human perceptions of reality.[10] If a false connotation can be attached to a simple concept (e.g. empty = safe) with such grave results, it is possible that opportunities for misunderstanding increase as language adapts to more complex specialties through creation of new and more obscure vocabularies.

Whorf believed that linguistics was central to all human sciences since every advance in science involves a point of crisis in communication. When a discovery has been made, the discoverers have to explain first to themselves, and then to the scientific world, what has been found (Whorf, 1956). He felt that this situation was complicated by the use of

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[10] In fact, this observation led him to draw conclusions now known as the Sapir-Whorf hypothesis, attributed both to him and to his mentor Edward Sapir. Their hypothesis focused on the relationship of thought to language and how the use of language influences perception of reality (Whorf, 1956). Briefly, the Sapir-Whorf hypothesis states that language influences thought, and thought influences language. An individual's perception of reality is reflected in the language they use, and the words they use in turn define their perception of reality. This hypothesis was invoked during much of the debates on the use of politically correct language in the early 1990s. For example, if the word used to represent the leader of a committee is "chairman," then the imagination

specialized jargon. "What we call 'scientific thought' is a specialization of the western Indo-European type of language, which has developed not only a set of different dialectics, but actually a set of different dialects. THESE DIALECTS ARE NOW BECOMING MUTUALLY UNINTELLIGIBLE [his emphasis]" (Whorf, 1956, p. 246). What Whorf is referring to is the development of occupational sociolects, commonly known as jargons. Jargon is a loan-word from 13th century French meaning unintelligible language. Its English adaptation now denotes an obscure, specialized language or vocabulary peculiar to a field (Gumperz, 1968). This is a concept that arose from the linguistic idea of a speech community, where a group of people united by a social bond (organized religion, socioeconomic class, or even regional dialect) communicate using a sublanguage that may or may not share characteristics of the dominant language. Speech communities quite naturally form around occupational affinity, since there is often an efficiency associated with the use of specialized terms and mutually understood concepts. Sublanguages provide a necessarily specialized and highly structured lexicon allowing members of a group to communicate effectively. The use of sublanguages is based on an assumption of shared knowledge among those who use them to communicate with one another (Gumperz, 1968). Language is used as a device to maintain group identity and also to differentiate the group from other communities.

Not only does jargon separate scientists from non-scientists, but it is a tool to maintain distinctions between scientific disciplines so that there are clear indicators of sub-group identity within science. The divisive effects of scientific jargon allow for specialists to construct all others as incompetent in their field and themselves as incompetent in other fields. But the greatest incompetence is pinned on the public. This brings us back to the

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of those who use this language is limited to seeing the person who holds that role as male.

"gulf of language" posited by Bowen and Schneller (1991, p. 4). Specialized language adds to the obscurity of specialized techniques in the eyes of the public. It has succeeded in keeping scientific knowledge in the hands of experts and further rendered it inaccessible to the lay audience. "One estimate haughtily suggests that only .01% of all scientific information can be communicated to the public" (Bowen & Schneller, 1991, p. 3). Aside from acting as a tool for group membership, specialized language also serves to undermine the confidence of the public. It is not so much that the public is unable to understand scientific and technological concepts but that the language that frames such concepts is opaque. What better way to exclude people from expressing their opinions than to convince them they are incompetent in their own language?

> In general, social control in science is not a simple, straightforward matter. If it were, then the high priests of science could simply fix-up their picture of nature and keep themselves in power in perpetuity . . . Fine and subtle webs of commitments and investments are entangled with resources such as expertise, funding and instrumentation. It is very rare for science to reveal itself as naked social power. Indeed, the very strength and durability of science comes from the fact that social power remains largely hidden in things like machines, theories, experiments and expertise. When something looks "natural", "objective" and merely "the way things are", then it is really powerful. (Pinch, 1989, p. 224)

The practice of science has undergone radical structural transformations over the last few centuries. Where science had formerly been pursued privately as a hobby, it has become a highly institutionalized career. While it was once open to anyone with interest and means, it has become competitive and at the mercy of national support. While it was once the understood responsibility of the experimenter to disseminate any knowledge gained to a broader public, the barriers of specialization have come to jeopardize possibilities of effective communication. There is a continuing struggle over scientific knowledge, which revolves around essential questions regarding the nature of knowledge, power, and control.

The discussion undertaken in this section characterizes scientists as maintaining a powerful position by withholding knowledge (and therefore power) from broader society. This is an oversimplified picture, as if the practice of science had no controls placed on it by public and private funding bodies, regulatory and legislative influences, and so on, but nevertheless the practice of science does tend to operate as if its actions were autonomous. This allows scientists and their practice to assume, or to be granted, considerable power. Yet, as the practice of science is subjected to an increasing vigilance from society, the public has a variety of recourses through which to contest that power. Scientists are dependent, to some extent, on the goodwill of society to support them through policy or allocation of resources, for example. As Pinch (1989) states, it is "more and more evident to scientists themselves that science is integrally a part of society as they actively engage in lobbying for funds" (p. 220). Popular culture also provides a potential site of resistance to centres of scientific power. Toumey (1992) suggests that currents of hostility that surround the practice of science are manifest in the "mad scientist" roles in literature and film. Particularly in screen adaptations of Dr. Jekyll and Mr. Hyde, the Invisible Man and sequels, and Frankenstein and sequels, the scientist is not so much a misunderstood seeker of truth as a power-hungry lunatic--a stereotype also exaggerated in parodic works such as Dr. Strangelove and the Rocky Horror Picture Show. Critique by ridicule or negative portrayal does not assert that the object of the portrayal is trivial. In fact, oppositional expressions may indicate the reverse--the significance of their object. Science maintains an important role in society but one that is poorly understood and constantly under negotiation.

Michel Andre (1997) has suggested that science today operates as "knowledge without memory," (p. 282) that it lacks historical perspective, and therefore scientists are unable to place their work in social context. He lists examples of the practice of scientific academic writing, where authors are encouraged to use only references from the last few years--and in some cases this has resulted in young scientists attempting to publish work that duplicated research published twenty years previously. A culture that is sequestering or at the very least socially crippling ensconces the scientists, rendering many unable to connect in their professional capacity to the rest of the world in a meaningful way.

This discussion has focused on the evolution of scientific practice but also on a specific type of scientific practitioner. I am constantly reminded in this discussion of the difficulties of extreme generalization, and it is pernicious indeed to generalize about scientists. Some of the opponents to biotechnology that I cite in this thesis--Ruth Hubbard and Mae-Wan Ho, in particular--have been invaluable as scientists advising non-expert citizens on the potential dangers of genetic engineering. Civil society movements have relied on information from scientists who oppose technologies that threaten the ecosystem to support their lobbying efforts. But of most relevance to this thesis is the assertion that scientific approaches that confront and oppose the dominant pushes in their fields are essential checks and balances for policy determination. In fact, the role of adversarial experts was part of the vision of Arthur Kantrowicz (2000), an American scientist who was given the task of establishing an evaluative mechanism for science and technology known as the science court. Kantrowicz feels that one of the canons of credible policy determination regarding science and technology should require scientists who address the public or lay officials on scientific facts bearing on public policy matters to always be prepared to "publicly answer questions not only from the public, but from expert adversaries in the scientific community" (Kantrowicz, 2000).

John Franklin (1997) makes an appeal to scientists to acknowledge their political responsibility to make their work understood in society. The corollary to this (as he states) is that members of the public must come to terms with the fact that they live in an environment rife with the results of science and technology. The next section addresses this question of the public's experience of science.

The Public

> Lay attitudes towards science, technology and other esoteric forms of expertise, in the age of high modernity, tend to express the same mixed attitudes of reverence and reserve, approval and disquiet, enthusiasm and antipathy, which philosophers and social scientists (themselves experts of sorts) express in their writings. (Giddens, in Irwin, 1995, p. 108)

Overwhelmingly rapid developments in science have produced bits and pieces of technical information that both titillate and frighten. This has reinforced a culture of ambivalence towards scientific information. Cumbersome specialized information, often combined with the inscrutable bureaucracy of the academic and political institutions that support scientific practice, allow the public to recognize that they need to know but do not do much to make people believe that having knowledge will change things. There is a sense that while it is important to learn about these things, there is no way the average person can make the time to learn enough to have an opinion on, much less help to guide, science and technology development. The task is too daunting and the rewards not obvious.

A compelling explanation for the impenetrability of scientific practice comes from Brian Wynne (1991): it is necessary to remember that science does not always appear immediately relevant or accessible (though it is often seen as credible) because ordinary social life "is in fundamental tension with the basic culture of science" (Wynne, 1991, p. 113). Michael (1992) suggests that public reception of scientific information is negotiated through a strange cyclical process where science both legitimates projects and is itself the object of legitimation. Science is used in discourse to pejoratively characterize the unscientific mind, yet the unscientific mind is part of what socially constructs (and problematizes) science.

Public understanding of science is therefore an intricate process, not achieved merely from reception of data but built from interaction between sources of information and what may be called common sense interpretations. Individuals decide what to believe, trust, or do, based on common sense interpretations of specialized data (Wynne, 1991). The lay public experiences science as something imbued with interests relevant to society, regardless of the motives of the scientist (Wynne, 1995a). That is, individuals unfamiliar with specialized jargon still have a common sense frame of reference that enables them to decide whether something seems true, based on their own capacities and needs. In Canada, as in most industrialized countries, science is part of the school curriculum. A basic understanding of science is the necessary result of several years of rudimentary experimentation within a supervised setting. While this provides the lay public with a basic framework with which to approach news of scientific discoveries, much of the population does not have the extensive background to understand all the technical information reported about each new discovery from the world of science and technology. As Nelkin (1995, p. 2) states, "[for] most people, the reality of science is what they read in the press. They understand science less through direct experience or past education than through the filter of journalistic language and imagery." It is the information contained in popular science communication that spurs the negotiation of the public understanding of science.

Popular science communication (including books, newspapers, television, and other media) is rooted in a fascination with the power of science and technology that emerged at the end of the 19th century (Nelkin, 1995). Prior to this, science reporting consisted mainly of practical tips and accounts of hoaxes. In the first few decades of the twentieth century, industrialized nations experienced a growing appreciation of the applications and potential of science, countered with a resurgence of mystical beliefs resulting from fear of scientific implications. Nelkin (1995) associates the beginning of a recognition of the widening gap between scientific experts and the lay audience with a series of articles published in the New York Times in 1919. Citing the inscrutability of contemporary physics studies, these articles suggested that democracy was in danger when understanding of intellectual projects remained in the hands of a few. Other writers of the time suggested that an artificial barrier had been raised "between the uninitiated layman and the initiated expert" (p. 81). As Nelkin points out, this barrier also separated scientists and journalists. Press owners of the times saw the value of reporting science news: it assisted in democratic participation, it provided useful advice to the readership, and it often smacked of drama.

> In most people's minds, and certainly in many humanists', scientists are notoriously bad writers. They prefer jargon to clear expressions, sacrifice the beauties of the active voice on the altar of scientific impersonality, and, even worse, they are usually blind to the imaginative side of the ideas they work with, the "big picture." Writers, on the other hand, are passionate, intuitive, and even though sometimes less precise, they have a sense of mystery, and they love graceful, clear prose. Writers labor at the forge of language to create the consciousness of the race; scientists wear white lab coats and record even columns of numbers on graph paper. (Bowen and Schneller, 1991, p. xxiii)

The flip side of the critique of scientists as communicators is illustrated by John Franklin (1997). He states that science is much farther from the journalistic tradition than, say, politics; yet coverage of scientific issues continues to increase. In order to meet their press deadlines, journalists are required to comprehend and translate an unwieldy volume of technical information in order to convey it to the public. These constraints may result in journalistic coverage that over-simplifies the complicated, omits details about processes or findings, or in other ways may be seen to misrepresent science and technology information in the eyes of the scientists who have acted as sources to the journalist. This in turn can create the impression in the eyes of scientist sources that journalists are not competent in reporting science issues.

According to Silverstone (1991), science is a primary focus of popular media, but mainstream reports of science matters are often criticized for being inaccurate. He feels this is in part the result of inconsistent methods of presentation; for example, science is alternatively presented as orderly and factual, and frightening and controversial. Science is therefore vulnerable to sensationalism and controversy. Nelkin (1995) points out that

> ...despite their growing interest in media coverage, scientists mistrust journalists and criticize the reporting about their fields. They complain about inaccurate, sensational, and biased reporting and fear that the press encourages antiscience attitudes. Ironically, as media interest in science increases, so too do the tensions between scientists and journalists, for along with media attention comes greater public scrutiny and pressures for regulation. (p. 8)

The tensions to which Nelkin (1995) refers include a reciprocal tendency on the part of many journalists to have disdain for scientists. Journalists may perceive scientists as overly skeptical about the ability of reporters to accurately represent scientific information. According to Nelkin's interpretation of the relationship between journalists and scientists, journalists may admit that science reporting is indeed flawed, but inaccuracies may be blamed on scientists for providing inadequate or misrepresented facts. In fact, it is suggested that both parties contribute to obscuring the facts: journalists by glossing over scientific details, whether because of lack of personal knowledge or desire to write succinct copy that will not alienate the audience, and scientists by their unwillingness to interpret, perhaps due to a familiarity with public incomprehension or a preoccupation with their own elite status.

> But science remains idealized as an esoteric activity, a separate culture, a profession apart from and above other human endeavors. This is a convenient image, serving the interest [sic] of scientists seeking status and autonomy, while allowing journalists to present problematic incidents as significant "news". But by neglecting the substance of science, ignoring the process of research, and avoiding questions of scientific responsibility, the press ultimately contributes to the obfuscation of science and helps to perpetuate the distance between science and the citizen. (Nelkin, 1995, p. 30)

Nelkin has collected a broad range of examples from media coverage of scientific discoveries, including, of course, biotechnology. Developments in biotechnology lend themselves easily to journalistic stories, with futuristic content, revolutionary discoveries, and controversial experiments. For example, she details some of the media attention to the bioengineered Flavr Savr tomato (1995). She describes how media coverage initially tended to expound on the wonders of genetically modified foods, but then attached to the sensationalist aspect of some vocal critics, writing about "frankenfood," "killer tomato," "tomato war," "tomatogate." As Nelkin recounts, responses from the business press denounced "'crackpots and scaremongers' who hold back the 'wheels of progress' by playing on public fears" (p. 59).

Once again, as in the discussion of jargon earlier in this chapter, we see evidence of constructions of incompetence as a major barrier to public understanding of science. Not only is the public characterized as scientifically incompetent (and therefore susceptible to scaremongering) by supporters of biotechnology, but communicatively so, since it requires science journalism to act as an intermediary to ask questions and make interpretations. Since the media, scientific experts, and policy makers all perform gatekeeping functions for scientific information, it is small wonder that the public may be characterized as intellectually lagging behind professional scientists. This characterization trivializes the implications of the knowledge gap and the deeper reasons the public needs to be informed about issues in science and technology.

I have spent considerable time in this section discussing the way information about science is communicated and how the public might be characterized as receiving this information. The audience for popular science communication can now receive information from a variety of sources, as science reporting has become a legitimate portfolio for print, radio, and television journalists. The lay public can form opinions and interpretations of science news based on information from a combination of mainstream reports and special interest sources. However, there are segments of the population who are less likely to spend the time and effort in assimilating this information and reaching personal conclusions about the meaning of developments in science and technology. Wynne (1995a) has suggested that lay people may ignore science, and therefore science news, because they regard it as irrelevant to their lives and feel they have no power in the scientific realm. That is, only experts have the ability to actually use the information generated by scientific activity.

Yet, members of the public who choose to ignore most science news may still regard science as the authoritative source of knowledge. If an individual who never reads the science column in the newspaper read a statistic that eighty per cent of citizens ignore science news, that individual would likely feel validated by that scientifically measured fact. Though the authority of scientific method is valorized as a means to establish evidence to support important political decisions, information about science and technology may still be too mystified in the eyes of the non-scientist public. The public understanding of science has integrated science as central to belief systems and social practices. Because science has been naturalized as the 'best' way to measure things (and thereby make decisions), those who think scientifically are characterized as the 'best' decision makers. This "allows us not only to measure how far people fall short of some level of scientific understanding--that is, their 'ignorance'--but also to assume that such ignorance indicates a deficit of democratic capability" (Wynne, 1991, p. 112). Hubbard and Wald (1997) recognize that the public may internalize a misperception that their lack of technical knowledge about a scientific issue renders them incapable of making meaningful decisions. One very important point is forgotten in the construction of the public as ignorant. Citizens may not be well-versed in scientific information, but they are eminently qualified to speak to their own experience and to make judgments about their own lives (Irwin, 1995, 1998, Sclove, 1995, Shiva, 1989). This is knowledge that must be a significant factor in policy decisions, and yet it is too often neglected.

An example from long ago in my academic career illustrates how lay people construct frames of experience that are coherent with their own knowledge base. Many years ago, I was enrolled in an applied linguistics programme in which I studied social and cultural linguistics. One of the projects was to record and conduct semantic analysis of stories on a subject of your choosing. I elected to record the childbirth stories of several women I knew. Though all women delivered in North America, they had their children in different cities, with different combinations of birth attendants, in different years. None of them had discussed their stories with each other, and in fact most did not even know each other. I did not interview these women, I merely asked them to talk about their experience. One of the thematic elements that appeared in every story was an assertion that one of the attendant health practitioners (physician or nurse) did not know anything about the woman's experience. The women I interviewed would normally make a statement about the practitioner's incompetence in this particular area (usually, pain control) though they stated no other reservations about the quality of their care. This is a nice illustration of how individuals, while deferring to the authority of scientific experts, can still recognize that their own common sense wisdom may have more value than that of the experts in some instances.

Health care provides a wealth of examples of how members of the public negotiate their relationship with science. Here is another story: Two friends and I were having a beer and talking about health. One said that she was sick of going to medical doctors since they never listened to her and often told her nothing was wrong when it was, or that something was wrong when it was not. Disillusioned, she started researching other types of health experts and ended up at a naturopath by whom she now swears. What is interesting to note here, however, is how science (in this case medical science) is both rejected and used as a yardstick of legitimacy. While my friend was speaking at length about the merits of her naturopath's methods, she described a particular homeopathic therapy that the naturopath had highly recommended. She said this therapy had been proven in a study in the States, and emphasized this with the statement: "It's Medically Proven!" The irony of the sentence struck me at the same time as I understood exactly what she meant by this, and how both of these sentiments can co-exist in a single mind.

Recognition of the validity of different sources of knowledge is an integral part of sound policy decisions. But the collection of such inputs is not enough. The barriers to effective communication between citizens and scientist need to be addressed to establish dialogue between scientists, citizens, and the state. As Hubbard and Wald (1997, p. 126) insist, "we must learn what questions to ask, we must not accept that the answers are too complicated for us to understand" if we are to guide science and technology in a sustainably democratic and accountable manner. It is a compelling call for experts and public to learn how to work not only with each other but with existing institutions of political governance. The next section outlines implications for the state in exercising governance regarding issues related to science and technology.

The State

In the next chapter, I will be discussing in more detail the governance of science and technology and the ways the state has attempted to address inequitable decision-making by instituting public participatory mechanisms. Here, I will consider some of the interests and priorities that may be attributed to the state in its drive for acceptable policy mechanisms.

The state, or the institutions and systems that comprise the government of a nation, has a long and intimate relationship with science. Perhaps the most important aspect of science and technology in relation to the state is the association of science with progress. As many have suggested (Irwin, 1995, Sclove, 1995, Winner, 1986, 1989), science is central to the idea of a modern society. "Science is near the center of western cultures today, but relatively few people know much about how it works" (Sismondo, 1996, p. ix). It is connected with progress, economic power, and military power. It is connected with the standard of living in a world that values efficiency, convenience, hygiene, money, and conquest. As Hill (1989) has suggested, events such as the Apollo moon landings encouraged the world to believe that the power of science and technology was almost without limit--it could take us as far as the moon, after all.

However, this changed in the decades following World War II. Nelkin (1992) has described the "crisis of authority" (p. xii) prevailing in 1970s and 1980s political life, suggesting that the "development of science and technology remained largely unquestioned during the period of rapid economic growth that followed World War II. But by the 1970s belief in technological progress was tempered by awareness of certain ironies" (p. x), such as the health and environmental problems that directly resulted from technological advances. This period was a time when public mistrust of both elected officials and scientific experts was extremely high. A response was required from governments, if only as a means of damage control.

Cozzens and Woodhouse (1995) suggest that the objectivity associated with science is extended to the political stance of its practitioners. That is, scientists have often seen themselves and their work as politically neutral, even (or especially) when asked to act in an advisory capacity to governments. This purported objectivity allows governments to legitimize their policy decisions. In the same way, methods that governments use to solicit public opinion can be understood as attempts to co-opt public consent to achieve legitimation (Cozzens & Woodhouse, 1995). In rendering policy, the task of the government is to make the best possible choice after collecting the most information possible in a reasonable amount of time. I am not asserting that policy makers intentionally misconstrue inputs from the public or scientists, nor do they intentionally disregard them. I would suggest that the process of consultation may serve a legitimizing function for policy formation whether the information gleaned from the consultation is incorporated in policy or not.

An important point to note is that industry does act as an input to policy making, even if industry representatives are not the actual authors of policy. Through lobbying, support of consultant experts, and funding of public research, industry maintains a variety of connections and interests in science and technology. Technical experts involved in the policy process who have industrial support represent "fragmented allegiances" (Hubbard & Wald, 1997, p. 122) that cannot represent the public interest and, in fact, may subvert it. There may be no apparent link between a government's use of an industry-supported expert and its responsiveness to public concerns, but the conflict of interest should be obvious (Cozzens & Woodhouse, 1995). Because industry plays a very concrete role in the lives of citizens, for example in affecting unemployment rates and gross domestic product, policy cannot escape being influenced by business. Economic imperatives gain more and more importance as nations compete globally. These tendencies can act to limit imagination about political options that may better serve the interests of the public.

Thus far, the discussion in this chapter has illuminated what we can learn from science and technology studies about scientific experts, citizens, and policy makers and their views of science's role in society. The next section synthesizes this information to illustrate a succinct way of looking at the crux of problematic communications between these groups: that is, the existence of a knowledge gap and a values gap.

The Knowledge Gap and the Values Gap

The above discussion reveals a picture of how those groups who have a vested interest in directing science and technology policy may perceive themselves in relation to each other. First, the scientific experts whose knowledge and information is used to inform policy comprise a type of intellectual elite. They merit this elite status through specialized training and maintain it through tools such as technical or scientific language. The culture of scientific practice contributes to a perception, often shared with members of the public, that specialized scientific knowledge is beyond the grasp of the average layperson or the average public servant. Policy makers are required to rely on both scientific knowledge and public consultation as major sources of reliable input for policy decisions, but it is not common that a need for scientists and lay citizens to directly communicate is recognized. Yet many members of the public mistrust both scientific experts and the government as they doubt the ability of either to adequately represent their interests. They perceive that the government and its technical advisors have limited knowledge about the life experiences of the public.

These perceptions suggest the existence of a knowledge gap. To be more accurate, they suggest that each group perceives a knowledge gap to exist between themselves and the other groups involved in governance of science. This needs to be distinguished from the idea of a knowledge deficit which, as Irwin (1998) and Wynne (1991) point out, is an outmoded model. A knowledge gap represents the discrepancy between mismatched knowledge systems or bases between two groups. There is some knowledge that is shared among groups, but other areas of knowledge that are held by only the members of one group or the other. The knowledge deficit model suggested a simplified interpretation that non-experts possess quantitatively less knowledge about technical matters than do experts. This approach not only fails to recognize how life experience conditions people's interest in technical matters, but also that people possess a great deal of life-world knowledge and an intuitive sense of contexts, what Wynne (1991) calls body languages of science. This interpretation bears strong connections to the work of Vandana Shiva.

Shiva's (1989) critique of reductionist science[11] suggests that much of modern science follows a standardized method of rational inquiry, reducing everything to parts and essences and disregarding complexity. This is violent in the sense that it destroys the validity

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[11] As some would have it (Ho, 1998, Lewontin, 1995), there is a difference between good science and bad science. Shiva considers reductionism to be characteristic of bad science. Good science is characterized by a more reflexive, socially responsible approach to scientific progress and a definite recognition of the social context of technology. These are useful ways of looking at the application of scientific discovery, but I am not

of traditional and unconventional knowledge systems as well as destroying the ability of scientific experts to know anything outside of their specialty. Ursula Franklin's (1990) analysis of prescriptive technologies and the culture of compliance is also relevant inasmuch as the division of labour in scientific information conceals knowledge. Franklin distinguishes between holistic methods of production, methods in which all decisions are made in a production situation by a hands-on creator, and prescriptive methods of production, that involve standardized methods to ensure homogeneity and compliance on the part of a series of workers. In terms of scientific production, the division of labour by specialty and level of expertise is a prescriptive method of production. That is, specialized forms of knowledge exclude those outside the inner circles and allows these divisions to be naturalized.

Shiva points out that in reductionist science, there are multiple levels of mutually exclusive knowledge. Within the reductionist paradigm, experts or specialists in different fields (or who operate in different networks) are not perceived as adept at communicating with each other. In the same way--and of primary concern to Shiva--experts in highly industrialized, wealthy nations characterize less affluent nations as nations in need of aid and as incapable of fully participating in advanced science discourse and practices. Yet these nations are generally required to adopt many high technology practices and products as conditions to receiving financial aid. Some of these practices and products, including birth control and agricultural biotechnology, are in a pseudo-experimental stage and therefore carry considerable levels of risk. Beck (1992) has said that risk, unlike wealth, is allocated universally. Unfortunately, risk is often more heavily allocated to the poor and

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sure that there is much evidence of government-supported good science in industrialized countries--except on a very small scale, perhaps.

disadvantaged than it is to the wealthy who have resources to mitigate or avoid risks. These less affluent nations do not become more affluent through the use of these technologies--in fact, they merely accrue greater debt--but they do assume the risks. A study of attitudes towards genetic engineering in the United Kingdom found that the lay public has a more complex approach to biotechnologies than other technologies and counters the oversimplified information provided by some scientists with an intricate analysis of what is needed weighed against the risks, as reported by other scientists. The less information the public receives, the less it experiences control over its choices (Frewer, Howard, & Shepherd, 1997).

These critiques represent a discourse critical of a rational paradigm of knowledge based on a particular kind of scientific practice. This rational model not only discounts other ways of knowing, but segments and compartmentalizes human experience as a means of disallowing diffuse control over knowledge (since no one person can be confident about knowing well more than one thing). It enables an acceptance that the power associated with scientific knowledge exists outside the individual non-scientist, therefore making the centralization of power appear more feasible and natural.

This analysis appears to be compatible with the earlier discussion of constructions of perceived incompetence between experts and non-experts. Extensive specialization supports a system that entrenches knowledge divisions. As we have seen, in conditions of modernity the cognitive authority of science was naturalized and unquestioned until there was a realization of the instability of scientifically produced facts. In fact, the proliferation of new technologies and virtually unrestricted scientific practice have progressed so rapidly that lay publics have been placed in a position of ignorance or apathy in their wake. Tatum (1994) feels that the discourse attempting to connect values and ethics to the use of technologies is rooted in the sense that technologies render people incapable of expressing their values. That is, as technologies are increasingly adopted for efficiency and convenience, people become further distanced from all of their social activities and regimented into technological methods of behaving. The one-owner automobile is a perfect example of a distancing technology. The social relations that could be involved in commuting, such as greeting a bus driver, conducting fare transactions, sharing rides with co-workers, or even sitting next to someone on a train or ferry, are rendered superfluous for car owners, who must only get into their device and drive it, alone, from one point to another. The values that are associated with community, cooperation, and environmental responsibility have been sacrificed for the purposes of individuality and convenience. As Tatum would argue, this is not a state that people embrace uncritically. As more technologies influence more routines in everyday life, the distancing from social relations raises questions about the purposes of rapid technological advance and the accountability of scientific practice. This is a useful analysis to lead us into a discussion of the values gap.

I believe that a common theme in analyses of late modernity, the risk society, and the public understanding of science is a perception that experts and the public operate with different value sets. This hinges on a delicate point. When science gained dominance as the home of cognitive authority, it brought with it the assertion that rational, scientific method could discover universal natural laws, universal truths. If Enlightenment rationality assumes that the source of truth is science, and truth is absolute, then inconsistencies in scientific discovery can only result from human error--not interpretation, since absolute truth does not allow for flexible interpretation. I have already referred to science-related disasters that demonstrate the fallibility of science and corporate interests that influence the priorities of scientific practice. I would now like to delve a bit deeper into a question that I believe is motivating many of the actions to establish more accountable science and technology governance.

As constructivist theories suggest, the knowledge springing from scientific endeavour is a product of society and culture. It is instilled with the values of its context. If this is so, why does science sometimes seem to operate independently of a social ethos, to the point where it seems to be driven by something other than a broadly defined understanding of the public good?

One of the biggest reasons is the role of industry in directing the course of science and technology. Several authors have researched corporate involvement in research and development (Kimbrell, 1993; Menzies, 1989; Rappert & Webster, 1997; Rifkin, 1998; Sclove, 1995). A study conducted to summarize academic-corporate ties in biotechnology suggests that such ties affect both the behaviour of scientists and the norms of academic research (Krimsky, Ennis, & Weissman, 1991). Packer and Webster (1996) suggest that the emergence of a patenting culture in academic settings causes some university scientists to divide their professional existence between the two distinct worlds of patents and academia. Scientists in this situation set boundaries between the two worlds so that one does not affect the other, but the boundaries become increasingly difficult to maintain. Scientists may experience a conflict when they make a revolutionary discovery, and they must choose between going public to receive the academic credit or remaining silent to preserve the competitive business edge. In cases where academic scientists are funded from corporate sources, even the decision inherent in this conflict may be taken away from them. There is a growing level of awareness of the dangers of commercialization and the control of corporate interests over scientific research (see, for example, Savan, 1988). What is most germane here is the effect of corporate involvement on the way science works.

In a general sense, as Krimsky has stated, "the more academic scientists become financially involved with industry, the more they may ignore the social impact of their work." (Rowland, 1992, p. 223). Savan (1988) echoes this:

> ... the independent choice of research fields and problems, the openness and vitality of the laboratory atmosphere, the free exchange of views ideal for research advancement, and even the quality and integrity of the science itself, can be compromised by the intrusion of corporate motives on scientific conduct. (p. 78)

More specifically, researchers and corporate funders use their powers in unusual ways. Rowland (1992) describes how scientists at Monash University attempted to have the Freedom of Information Act changed to protect the University's potential commercial interests. Elsewhere, researchers respond to government attempts at regulation by threatening to take their research to another lab in another country. There are more serious implications than this. If, for example, medical science is so dependent on the funding available from corporations for the development of new drugs and technologies, to what extent will medicine's resources be directed towards prevention?

> This is an era of specialists, each of whom sees his own problem and is unaware of or intolerant of the larger frame into which it fits. It is also an era dominated by industry, in which the right to make a dollar at whatever cost is seldom challenged. (Carson, 1991, p. 159)

The establishment of authority, use of jargon, and involvement of corporate interests that have occurred in the evolution of science and technology also influence its practitioners' experience of the world. I believe this to be central to understanding why scientific experts seek to control the knowledge they produce. All of these factors do allow the experts to exist as an elite group. This allows them power, but it also accords them responsibility. I would suggest that the naturalized segregation of scientists through jargon, their acceptance of cognitive authority, and their increasing reliance on corporate funds and structures to continue their research all contribute to a paradigm of the scientist as custodian of the public interest.

Most of the concerns expressed by critics of biotechnology assume that this concern is abrogated once commercialization is involved. If the scientist is operating in a corporate paradigm and is recognized by peers and employers as having the authority to know the best course of action, it would not be suprising to find that scientists perceive economic competitiveness, GDP, protection of intellectual property, and free market activity as supporting the best interests of the public. If scientists can no longer turn to funding bodies with regulatory checks, then they must choose between turning to corporate funding or seeing their research die (not to mention losing their jobs, projects, collegial networks, livelihoods, etc.).

A scientist who works within that paradigm would see protection of economic interests as paramount. Any mechanisms that restricted the commercialization of their research would then appear to be pernicious--not just to the individual scientist but to society at large. Rabino (1994) studied two populations of genetic engineering scientists, one in Europe and one in the U.S., to elicit their views on public attention to their field. European scientists are faced with strong regulatory limits and public demands for accountability. They tended to respond unfavourably to public attention as a result. American scientists reported enjoying the public attention as a means to bring their work into the public consciousness and thereby get better access to funding. Nelkin (1995) has described this situation: scientists formerly concerned that external controls would result from popular communication of science now see media visibility as a way to secure funding. The use of the word 'funding' may seem like a reference to the personal interests of the scientist, but in fact it generally serves a much larger purpose. Corporate funding can support personnel, laboratory supplies, conference presentation, but most importantly it ensures the smooth progression of the research.

If scientists see public knowledge of their work as potentially limiting or stopping their research, if they are operating in a corporate structure of competitiveness where leaked information about ground-breaking projects could ruin their funder and prevent them from continuing their work, then the risks associated with release of information are extremely significant. They are perceived not only as personal risks but as risks to the progress of research and therefore to society as a whole. Therefore, scientific experts who have been granted the authority to act as consultants to government policy may actually hold quite different value systems from the electorate that installed the government. Further, the information held by these scientists may easily be attributed extra worth commensurate with the levels of specialization.

The structure that has traditionally relied on the electoral process to represent citizen viewpoints, and consultant experts for evidentiary support of policy decisions, has re-routed the democratic process through systems of expertise and authority. This is a powerful structure that has remained powerful over time, as the professionalization of scientific expertise and its institutionalized role in government seemed quite natural as long as the public accepted science's cognitive authority and the government's decision-making authority. In an environment where these authorities are being contested by the less powerful, these sources of power are made vulnerable. Contested authority motivates the struggle over knowledge and the political power it entails.

Summary

The above analysis provides a sense of the underlying assumptions that inform science, the government, and the public in seeking to direct science and technology. I have outlined how science and technology studies can facilitate an understanding of the interactions between experts, the public, and the state as they struggle around governance of science and technology. This analysis provides the framework to explore the means to address problematic interactions. The policy arena has great potential to empower the disenfranchised and foster greater mutual tolerance, even understanding, between groups that may feel they have differing priorities in directing an activity as large as scientific practice. Involving the public directly in science policy decision making holds a promise of both better relations and more accountable decision-making.

Elzinga and Jamison (1995) state that at the time of their writing, the broad STS community had focused little attention on studies of science policy. The authors feel that STS has an important role in explaining science policy trends, the interplay of policy cultures, and "the various ways in which science policy is embedded in a broader political sociology of scientific knowledge" (p. 574). Chapter three makes the link between the STS theories explored in this chapter and their reflection in mechanisms of science governance. Options for public participation in policy formation have been tested by countless governments with varying degrees of success. The next chapter traces a brief history of participatory mechanisms, from the birth of technology assessment to the present. To illustrate the benefits of public participation I showcase several models of participatory policy mechanisms while highlighting how they deal with the concerns raised in this chapter.

Finally, I will focus on a lengthy discussion of two models that have been used in the Canadian context: the Commission, a longstanding instrument of the Canadian government, and the consensus conference, which has been used in Europe and elsewhere, but has just seen its Canadian inauguration last year. I will conclude by critiquing the process of these models and considering their effectiveness in establishing accountable policies as well as potentially mitigating public ambivalence regarding the government's capability to protect them from the hazards of unrestrained scientific and technological "progress".

Chapter 3. Participating in Science and Technology Policy

In the previous chapter, I drew from science and technology studies to help explain the social context that underlies the political events outlined in this chapter. Science and technology studies deal with themes that can assist us in understanding the characteristics of those involved in science and technology policy creation. Using theories of the public understanding of science and the social construction of knowledge to position the experience of these groups, I have argued that interactions between scientists, policy makers, and members of the lay public suffer from power differentials, perceived gaps in knowledge between members of different groups involved in the policy process, and perceived differences in the values each group brings to their political role. Since each group requires some form of support from the other two, a need to bridge these gaps exists, and all groups in turn search for instruments to accomplish this end. One of the means available to bridge the gaps is the use of participatory mechanisms for policy determination. The purpose of this chapter is to review why an informed public and effective consultation between policy makers, experts, and citizens is a necessary part of a democratic society. In describing the modern foundation for public participation in science and technology policy and the participatory models that have evolved from this foundation, I will discuss how the themes discussed in chapter two correspond to patterns in the establishment of participatory mechanisms. Essentially, I will trace the path from the early technology assessment movement to a current popular trend in participatory models, the consensus conference. The critique at the end of the chapter will address not only the effectiveness of the consensus conference model but the potentially pernicious influence of naturalized assumptions that may not be adequately dealt with through participatory models.

The Impetus for Democratic Governance

Pinch has said that the "demythologising of science and technology is surely needed if we are ever to reassert democratic control over these institutions" (Pinch, 1989, p. 224). Why is democratic control so important?

Where science is concerned, the issues often seem more urgent and less approachable than most fields of information that are the object of power struggles. Increasing doubts about the equation of science with progress, combined with the recognition that "scientists and technologists appear to have interests and political views of their own" (Hamstra, 1995, p. 55), weaken any reasons for the public not to have a voice in decisions about technological applications that could affect masses of people. Perhaps the best current argument for public participation in science and technology decision-making is articulated by Richard Sclove. Sclove, former head of the U.S.-based Loka Institute, has conducted research on the benefits of public input into research, design, and development (RD&D) and studied the results of successful projects around the world. In Democracy and Technology Sclove (1995) describes the difference between what he identifies as "strong" and "thin" democracy (p. 25). Strong democracy is active, egalitarian, and participatory. Town hall meetings, a jury of peers, and self-governing collectives are examples of strong democracy. Thin democracy is manifest in the dominance of representative institutions, elections, and competing private interests. In thin democracy, power is less evenly distributed though it may appear to be representative (i.e. through elections) (pp. 25-6). Sclove feels that technological decisions are made based on social structures and forces that dominate at the time, but these are also influenced by political struggles. In these struggles citizens' needs may be pushed to the side. It is in the public's interest to have an active voice in decision-making. He recognizes that it is impossible for all citizens to have the same outlook and interests and that courses of action based on non-expert recommendation are often avoided by government decision-makers for fear of mistakes being made. But as he points out, catastrophes have happened when only experts have made the decisions. There is no reason why an adequately informed public would not be capable of making decisions just as well as, even better than, experts as they bring their own individual knowledge into play.

Sclove's arguments are valuable, but unfortunately they tend to assume that it is possible to govern science at a very local level. This type of argument is supported by Hubbard and Wald (1997), for example, and also by much of the discourse associated with the opposition to global free trade agreements. The potential for the local to have worldwide effect is, I feel, uncontestable. However, there are governance difficulties associated with phenomenon that operate on a global level, difficulties that are characteristic of the operation of science.

Because of its association with progress, the pursuit of science is encouraged within national agendas. One interesting definition of science policy describes it as "the collective measures taken by a government in order, on the one hand, to encourage the development of scientific and technical research, and, on the other, to exploit the results of this research for general political objectives" (Elzinga & Jamison, 1995, p. 572). This is interesting in that it conflates all the consultations and inputs that government solicits for policy purposes, and subsumes them under the mantle of government's progressive agenda. It is also interesting because it suggests that scientific practice falls under the aegis of governmental regulation. But science itself operates as a global community. National scientific communities exist according to resource allotment and geographic convenience, but collegial ties through international communication transcend national borders. An associated development is the international convergence of issues and approaches in science policy (Elzinga & Jamison, 1995). The globalization of science adds to the sense that science and technology are being further removed from public control.

As Schott (1993) suggests, the centres of scientific knowledge naturally formed where the greatest discoveries were made; it is from these centres that ideas and institutional models diffused:

> Present-day participation in the scientific tradition is worldwide. Not only is science practiced in every society, but its practitioners are receptive to ideas from any place on earth, pursue long-distance collegial ties, and disseminate their creations globally. The globality has only recently evolved...Until the 19th century, the tradition was concentrated within one area, Europe where it had become established just a few centuries earlier. Global participation emerged only in the 20th century. (Schott, 1993, p. 198)

What Schott is describing is a type of scientific colonialism, where the aggression lies in the equation of science with progress. Western centres of discovery provided the core of knowledge upon which non-Western scientists modeled their projects. In spite of this geographic location of knowledge, the competitive aspects of science rest mainly between labs, not between nations. As Schott illustrates with the example of collegial communication between Western scientists and scientists behind the Iron Curtain during the Cold War era, the nationalistic construction of scientific competition exists mainly in the eyes of governments.

It may be argued that scientific discovery is historically attached to national pride, not universal domain; this may be true in the sense that governments tout all national achievements to bolster patriotism. However, I would suggest that this is not a vision held in the eyes of scientists themselves. Scientific communities of the western world, Schott argues, are the centre of a "global science policy regime" (p. 199). By this he refers to a constellation of influences that shape science policy around the world, including the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Organization for Economic Cooperation and Development (OECD), the Rockefeller Foundation, and the World Bank. In designing policy with the aid of expert consultants or funding scientific projects, these organizations support less tangible doctrines and belief systems about science that are held internationally. The global science policy regime is characterized by a hierarchy of knowledge that is based in cores of scientific activity that do not necessarily reflect national boundaries. Yet these centres of scientific activity are located in privileged Western nations, and therefore the hierarchy still favours the generally powerful and thus reproduces international inequalities. Just as in the knowledge differential between experts and non-experts, the traits of a scientific approach have assisted in entrenching the division between those nations with power (as embodied in scientific expertise and knowledge) and those without.

It has become abundantly clear that the implications of scientific developments aligned with the reach of transnational corporations are under scrutiny. Grassroots movements have had great success in the past at bringing the destructive effects of industrialization to the political agenda. India is home to some of the strongest grassroots actions against technologies harmful to their people, such as the Narmada Valley Dam protests which ended in the withdrawal of the World Bank from the project, rejection of patenting and genetically altered seed by farmers, and women's movements to curb misogynist practices such as the preference for male children as exercised through selective abortion, and the experimentation on third world women with the 'population control' strategies that are often conditional to receiving World Bank aid. But there are important examples of citizen resistance to the hazardous consequences of some of the results of modern scientific developments within North America as well. Citizen groups have lobbied at the local level to prohibit the development of natural areas, promote alternative transportation to reduce fossil fuel usage, and exercised the not-in-my-backyard argument to resist the installation of toxic or polluting industries in their communities. On a larger scale, there are excellent examples of successful citizen organizations in the 1970s against toxic and nuclear waste dumping, widescale industrial pollution, and the death of fresh water bodies. Much more recently, public protests in Seattle and Washington D.C. against transnational corporations, the World Bank and the International Monetary Fund to set the agenda for international trade agreements have brought to the forefront countless potential (and real) disasters that can result from overweening corporate influence. The message that the public will not accept a vision of progress that is defined by risk-laden, unfettered technological growth is becoming louder daily.

The voices of dissatisfied citizens have brought concerns about destructive scientific practices onto government policy agendas. In response to the recognition that science and the state need to establish greater accountability to the public, governments have experimented with a variety of participatory mechanisms. The next section describes the foundation for public participation movements from the 1970s, which (not coincidentally) heralded the beginnings of science and technology studies. This history centres on technology assessment.

A History and Critique of Technology Assessment

Participatory models for science and technology policy owe a debt to the technology assessment initiatives of the 1970s, which were introduced by the United States government and the Organization for Economic Cooperation and Development (OECD) in response to public concerns about the risks related to technologies in nuclear energy production, polluting industrial processes, and toxic waste storage and disposal. Other nations followed, including Canada (Canadian Coordinating Office for Health Technology Assessment, 1998). The initiating bodies recognized the need to provide some mechanism for assessing the consequences of rapidly evolving technologies. They felt that the creation of expert panels would allow the ramifications of both new and existing technologies to be thoroughly explored with an eye to recommending legislative actions to control the use of technologies.

In a widely quoted definition, Joseph Coates (1975) describes technology assessment as: "...the systematic study of the effects on society that may occur when a technology is introduced, extended, or modified, with special emphasis on the impacts that are unintended, indirect, and delayed" (p. 37). The need to establish a means of measuring the impact of technologies was given legal recognition in the United States with the 1972 Technology Assessment Act:

> The Congress hereby finds and declares that
>
> a) As technology continues to change and expand rapidly, its applications are
> 1) large and growing in scale
> 2) increasingly extensive, pervasive, and critical in their impact, beneficial and adverse, on the natural and social environment
>
> b) Therefore, it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems.
> (O'Brien & Marchand, 1982, p. 263)

From this act, the Office of Technology Assessment (OTA) was born. Briefly, the purpose of the OTA was to identify probable positive and negative impacts of technology or technological programs; determine cause and effect relationships; identify alternative courses of action, including comparative impact analyses; and determine where further research is needed, with an eye to conducting that research. All of this was to be accomplished within a structure of accountability to the government and, ostensibly, the public (O'Brien & Marchand, 1982).

On a broader scale, the Organization for Economic Cooperation and Development (OECD) was at the same time establishing methodological guidelines for technology assessment. Their mandate was to evaluate not only the "technical and economic aspects" of technologies, but also the "foreseeable social, cultural, and individual impacts" (Organization for Economic Cooperation and Development, 1975, p. 6). In their 1975 report, they combine a comprehensive set of guidelines for assessment with several theory papers contributed by recognized experts in the field. According to their cyclical model, public awareness and identified need are the instigators of the process, while a sponsoring agency (with appropriate resources) is the implementer. Three simultaneous processes are then carried out: decision-making, analysis, and information collection. All centre on an intensive identification process of all affected parties in the context, relevant elements of the structure in which the technology will operate (e.g. legal, governmental, and cultural systems), and possible alternatives and their consequences. The information generated in this identification process is fed back to the instigators of the assessment. Following an identification of extenuating factors and alternative action models, a further feedback loop is created through the information contained in responses from other interested parties and quality control criteria.

Porter, Rossini, Carpenter, & Roper (1980) emphasize the importance of predictive validity (through balance of information, and understanding cause and effect), utility (relevance, timeliness, credibility, communicability), and improving methodology. They provide a taxonomy for the process listing qualitative questions on safety, marketability, efficacy, cost-benefit, economic and environmental impact, identification of alternatives, and identification of affected parties and decision-makers, in that order. They make a comparison between methods that shows there is some discrepancy between theorists about how to proceed once the problem is identified. However, all focus on identifying and evaluating impacts, identifying and evaluating decision-makers, and communicating results.

Despite the predominantly expert-based assessment, there has been considerable work on non-institutionalized assessment methods. Morgall (1993) contrasts non-institutionalized technology assessment with institutionalized forms, in that the former is usually motivated by special interest or lobbying groups concerned about a specific issue, while the latter involves the recruitment of experts relevant to the technology to be assessed and generally is commissioned by governmental or academic bodies to inform decisions about legislative control. Non-institutionalized technology assessments undertaken by interest groups are also known as adversarial assessments, which have the potential to complement institutionalized approaches by placing greater weight on social value issues (Balka, 1987). Citizen-based lobbying groups have a distinct disadvantage in terms of access to information compared to government-sanctioned assessments. This does not mean they are ineffective. In a 1984 referendum, the Danish public voted against the use of nuclear power as a result of a strong social movement that has been considered a technology assessment carried out by the whole population (Andersen & Jaeger, 1999). Institutionalized and non-institutionalized technology assessment provide a tidy illustration of the tensions discussed in chapter two, since citizen-based lobbying groups can identify lacks (associated with social values) in the assessments conducted by government-sanctioned experts and respond by conducting their own assessments with their own expert advisors. Naturally, the institutionalized assessment tends to have a direct line to policy formation, which is not as readily available to non-institutionalized assessments. Instead, it must be conveyed to policy makers through indirect mechanisms such as lobbying.

While the beginnings of technology assessment demonstrated an acknowledgement of previously neglected impacts of science and technology, as a method it is problematic on several points. There appears to be considerable disagreement on the importance of certain criteria for assessment; some work appears to place great emphasis on economic and safety factors, while paying only cursory attention to social impact; others place greater emphasis on the social and cultural context than on quantitative measures. A related concern is the link to policy formation. First, if an assessment is to suggest policy options, it should clearly delineate the criteria whereby the assessment was made. Second, a definite mechanism must be in place to ensure the assessment reaches its intended audience.

Like science, technology assessment is vulnerable to the biases of those who conduct it. For example, the OECD has made several contributions to the discourse on technology assessment, among them consideration of its role in policy option formulation, the question of public participation in the assessment process (Organization for Economic Cooperation and Development, 1983), and OECD guidelines that indicate a concern for individual and cultural issues. Yet, as OECD member nations hold ninety-five per cent of the five hundred largest transnational corporations (and comprise twenty-nine of the world's wealthiest countries) (Hesse, 1997), the potential for profit-motivated interests to skew the execution of a technology assessment project is tangible. Despite the well-phrased intentions of the

OECD documentation of technology assessment, its noble motives are vulnerable to subversion by the profit motive--just as are governments and experts engaged in the policy process. In some cases, policy requires technology assessments to be conducted by the company or corporation who wishes to use the new technology. Corporations then can use their own expert assessors to generate a report based on the criteria stipulated in the request for assessment. While this process defrays costs to corporations that would otherwise be carried by governments, it also renders the assessment team vulnerable to the biases of the corporation that provides their pay cheques.

Technology assessment is also hampered by several problematic assumptions. First, by relying predominantly on expert authority, institutionalized technology assessment is unable to fully address social impacts. Second, the influence of commercial interests can be largely disregarded. This is especially pernicious as the OECD, a principal developer of technology assessment, is an association of economic interests. Third, efforts to develop technology assessment have always relied in some measure on lists of quantifiable criteria. While the importance of qualitative information about social impacts was recognized, it is unclear how effectively the analysis of social impacts could be carried out alongside items that are easily measured by comparison, such as efficiency and expense. Finally, when operationalized, technology assessment did not address the social construction of technology, since it focused on impacts. Even when it addressed technological processes and development, it ignored the broader social environment in which scientific ideas are gestated. Wynne (1995b) points out that technology is "a social vehicle that already represents, and tacitly reproduces, social commitments; not . . . a social entity which only has post-hoc social impacts." (p. 20-21). He feels that the danger of neglecting this aspect of technology is that the discourses surrounding technology assessment valorized it as a socially-sensitive instrument, while shutting down discourses of controversy that contain the real possibilities for social learning about the place of technology in society.

Finally, in fact, technology assessment is a methodology without a method. Coates (1975) emphasizes the ambiguity inherent in the method; since analysis is conducted under varying sponsorship, through various disciplines, and examining hypothetical futures, he suggests that a static set of guidelines cannot be formed such as that offered by the Organization for Economic Cooperation and Development. Lee and Bereano (1981) echo this, concluding that there is no universally accepted method for technology assessment, since it is difficult to apply a standardized methodology to a process that involves studying values and social impacts. In light of this, technology assessment can be seen more easily as a research framework (or a philosophical approach) in which information is gathered from a variety of sources, combined and assimilated into a thorough assessment. These features make it difficult both for the assessor, who must formulate a process within a basic theoretical perspective, and for the public, who rightfully may question the assessor's methodology. Nonetheless, this ambiguity is in some ways a strength, as it allows for a somewhat revolutionary flexibility and adaptability of approach to studying new technologies in a social context.

Despite its limitations, technology assessment is remarkable for actually attempting to establish mandates and sets of criteria for evaluating the role and function of technologies in society. This is the most institutionalized expression of the call to return to a science for the people, or appropriate technology, that arose in the 1970s (Irwin, 1995, Sclove, 1995, Winner, 1986). It represents an attempt to include social criteria in decisions to pursue technological development.

Later efforts attempted a much more hands-on role for the public in science and technology decision making. Foremost among these is the transition to constructive technology assessment (CTA). CTA evolved in the Netherlands in the early 1980s with a mandate to consider a broader range of implications and actors involved in the design and development of new technologies (Rip, Misa, & Schot, 1995). It attempts to address some areas neglected in earlier technology assessments, including TA's original vision of foreseeing impacts in the development stage, and acknowledging the social construction of technology. According to Schot (1992),

> CTA is based on the idea that during the course of technological development, choices are constantly being made about the form, the function, and the use of that technology and, consequently, that technological development can be steered to a certain extent. (p. 37)

CTA adapts tools used in technology assessment to monitor the social dynamics involved in the development of scientific ideas and processes (Hamstra, 1995). It encourages all interested parties to become involved at an early stage in decision-making about science and technology. The benefits of this approach would be felt in tangible ways such as cost-effectiveness, efficiency, and safety, as well as in the less easily measured cultural and social effects. Attempts to operationalize the vision of CTA in recent years have been made through the use of participatory mechanisms such as the consensus conference, which will be discussed later in this chapter. However, it is necessary to return to the earlier participatory models to understand the evolution of public participation in science governance.

In the late 1970s, the OECD undertook a comparative study of the experiences of public participation in government decision-making on science and technology. The study stemmed from the work of their Committee for Scientific and Technological Policy and emphasized that:

> Informed and responsible public participation can and should play an increasingly important and effective role in the articulation of social and political goals and in the elaboration of scientific and technologically-related programmes. (OECD, 1979, p. 7)

Public participation was seen as a means to both give the public more responsibility for policy and make government more accountable through a better informed public. At the time, the OECD outlined six factors that distinguish science and technology issues from other public controversies: 1) the rapidity of change brought through advances in science and technology have resulted in feelings of insecurity, and fatalism; 2) many such issues, such as genetic engineering, are entirely new (causing a lack of understanding and fear); 3) the complexity and interdependency of the issues is of an unprecedented magnitude; 4) some of the effects are severe and irreversible; 5) these advances threaten deeply-held social values and give rise to ethical concerns; and 6) concern about real or imagined threats to human health and perceived dangers inherent in science and technology advances is high in the public consciousness (OECD, 1979, p. 16). The OECD also identified four broad categories of government response to public pressures for direct participation in decision-making on science and technology issues: inform the public, expand the use of mechanisms to inform policy makers of public needs, reconcile conflicting interests by increasing opportunities for citizen interaction in government regulatory proceedings, and provide citizens with opportunities to participate in collaborative decision-making.

It is twenty years since the publication of this work, and all of these points remain relevant today. The concerns that distinguish science and technology issues from other controversies have not been assuaged. In fact, much of the OECD study focuses on public participation around nuclear power policy. Around the same time, a group of molecular biologists were convening to place a moratorium on recombinant DNA research. This group felt that the development of recombinant DNA techniques (genetic engineering) implied applications as dangerous to humanity as those resulting from the discovery of nuclear fission (Winner, 1989).

Some of the participatory mechanisms showcased in the OECD report are worth mentioning. They illustrate attempts, some more experimental than others, to restore public trust in the policy process through direct involvement in it. The models that best represent strong democratic approaches are the study circle and the science shop.

Strong Democratic Models

Study circles.

The 1979 OECD study relates Sweden's experience with establishing small study groups to consider issues related to energy policy and planning. Sweden has been using this technique since the 1800s. To discuss the civil nuclear power programme, the Swedish government recruited volunteers through advertisements and gave them free access to government information resources as well as some financial incentives to participate. The government also set up a reference group of scientists and technical advisors to act as a resource for the study circles. The dual purpose of these circles was to broaden the decision-making base and to establish consensus on energy policy. The project began in 1973 and lasted a year. Eighty thousand individuals participated in ten thousand circles. The results of each circle's project were submitted to the government and the public, and polls were then conducted. The result was a more cautious energy policy with a built-in mechanism for review in three years. As Irwin (1995) notes, in some ways the increased knowledge participants gained served to confuse them further, and it was later determined through follow-up surveys that there was little difference of public opinion on the issue between participants and non-participants. In general, though, the project improved public opinion of the government and was successful in bringing issues to the public agenda. The government later abandoned their public education project and replaced it with a government-appointed Energy Commission of technical experts for reasons not made clear in the OECD report.

Study circles were effective in some ways. The process used to recruit its participants was more or less random, although people who respond to advertised solicitations are self-selecting. However, the broad approach to publicity suggests that there was at least a commitment on the part of the state to reach a vast number of citizens. Over a year, eighty thousand is indeed a large number to recruit for such an intensive exercise. The provision of an expert reference panel also served to improve dialogue between citizens and scientists and enhance public understanding of science. Finally, the reports submitted to government were then followed up by a poll. Although public opinion did not seem drastically different from that before the study circles were implemented (perhaps this is why the project was abandoned), the very fact that a poll was conducted shows another strong feature of this model: the use of a type of participatory evaluation for the model's success.

In this model, the state actively recruited citizens to participate in panels. With science shops, the onus is on the citizen to make the first move.

Science shops.

This model is only briefly referred to in the OECD report as a pilot project, though its features may have been influential in the development of more recent participatory models.

According to Irwin (1995), it was intended as a structure to mediate between university researchers in the Netherlands and client groups for the purpose of promoting socially relevant research. Clients qualified for science shop assistance if they were unable to pay for research, had no commercial motives, and would be able to implement the results for practical purposes. Each shop had a paid staff to screen prospective clients and refer them to university volunteers. These were usually faculty, but in some cases, students would take on the task (Sclove, 1995). The science shops dealt with such issues as occupational health and environmental matters. The experts involved came from a variety of disciplines, many of which would fall under social sciences.

One of the stated advantages of the science shop is the connections established between academia and local communities. Communication between these parties was strengthened as a result of science shop participation, and researchers became more aware of community issues. As well, knowledge of the issues allowed all participants to maintain networks of connections and to refer each other to relevant sources as they came up. It also helped both the academics and the community to determine productive ways to formulate socially relevant research questions. Irwin also describes a science shop in Northern Ireland that reported positive results, as clients were able to receive legitimating evidence for their common sense interpretations of events. Of course, the legitimating function of science shops still reinforces the idea that common sense interpretations without scientific 'proof' are not valid evidence to support instigating regulatory change. Nevertheless, this science shop succeeded in establishing a mutually positive experience for clients and experts alike. Sclove (1995) also points to evidence of success illustrated by the fact that every Dutch university now has at least one science shop, and as a result, their university system has achieved a more socially relevant research culture.

On the negative side, Irwin (1995) describes critiques of the French science shop experience that seem to replicate some of the complaints I have discussed in chapter two. The greatest problem lay in the fact that the dialogue between researchers and the community served to underline communication difficulties between the public and scientists. Also, experts in the science shops would forego offering assistance if they felt unqualified in the specialized area required by the question asked. I find this an interesting example of one consequence of reductionist science, as described by Shiva (1989). Science that over-specializes to allow the study of nature in reduced parts can result in such narrow scientific subcultures that none is confident of understanding the others.

Both science shops and study circles are very localized, small group, strong democratic approaches to creating effective communication between the public, experts, and the state. They are not the only models that have been tried. Sharing some characteristics with these localized mechanisms is the consensus conference model, which has its roots in Denmark and has recently been used for the first time in Canada. Before describing the Canadian experience of the consensus conference, it is instructive to explore some aspects of what is perhaps the most familiar means of soliciting public input in Canada: the Royal Commission. For the purposes of illustrating the strengths and weaknesses of the Commission, I have chosen to discuss two very different examples of this model: the Baird Commission and the Berger Inquiry.

From Far and Wide: Public Input in the Canadian Context

Commissions and Inquiries.

The Royal Commission on New Reproductive Technologies (or the Baird

Commission), like all commissions, was expected to conduct a public inquiry in the hopes of best representing citizens' viewpoints on the issue at hand. The Commission was plagued with difficulties throughout its inquiry, not the least of which was the highly publicized suit brought against it by ex-members. After a long struggle and considerable staff turnover, its report, Proceed with Care, was published in 1993 to mixed reviews. Common criticisms addressed the impact of its internal difficulties, the flaws in its process of inquiry, and the deliberately vague caution that blanketed its recommendations (Anonymous, 1993, Eichler, 1993, Massey, 1993, Vandelac, 1993). A vast literature exists as evidence of public dissatisfaction with the Commission's process and report. An excellent representative of these is the analysis undertaken by Christine Massey.

Massey (1993, 1994) conducted a thorough analysis of the public participation process of the Royal Commission. She found a variety of procedural flaws, including a lack of rigour in publicizing hearings and seeking participation (hearings were mostly held in large urban hotel ballrooms, with no provisions for travel allowance or child care), an intimidating and dismissive hearing atmosphere, and a dearth of adequate information (no real public information campaign was undertaken by the Commission, nor did it provide ongoing summaries of its work) (Massey, 1993). An internal memo of the Commission pointed to the lack of representation from a variety of communities including industry, francophones, ethnocultural groups, youth, religious groups, and aboriginals, suggesting that lack of input from these groups was "because they had nothing to say on our mandate or because they did not understand the issues or our process" (p. 248).

Admittedly, conducting thorough public consultation is not an easy task in Canada. But as Massey insists, it can and has been done. The Berger Commission is respected internationally for its commitment to inclusivity and provision of information (see below). It may be true that the public "has never been considered a legitimate partner and contributor to science and technology policies" (Massey, 1993, p. 237), but the role of a Royal Commission is to make members of the public partners in policy formation. Considering its troubled existence and the critiques, it seems the Commission lost sight of its mandate early in the process. It is no surprise that the process of developing legislation based on the report's regulatory framework has been far from smooth.

Though flawed, Proceed With Care (1993) was better than nothing. Its recommendation of caution in dealing with reproductive technologies suggested the need for legislative action. At the time, it was felt among feminist circles that anything good related to the report would be somehow indefinitely shelved. It was even suggested that concurrent economic changes would render the Commission's recommendations not viable. Cameron (1993) provided an analysis of articles of NAFTA that would prohibit any attempts by the Canadian government to restrict some reproductive technologies that fell under criticism in the Commission's report.

In issues of this nature, it may seem especially difficult to communicate effectively with significant portions of the public who see reproductive and genetic technologies as inscrutable. Yet the implications of complex technical change can be understood, and the goal of public input should not be subverted by an apparent communication obstacle. Canadian history provides excellent examples of successful public consultation processes on technical matters, and in fact one of the best, the Berger/Mackenzie Valley Pipeline Inquiry has become a widely cited model of consultation internationally (Irwin, 1995, Massey, 1993, OECD, 1979, Sclove, 1995). When given the task of conducting an inquiry about the impact of a pipeline in the Canadian North, Justice Thomas Berger first held hearings to determine how the inquiry should proceed. On the basis of public input, he determined that hearings should not be limited to the pipeline's impact but should also address potential activities related to a transportation corridor as well as the economic, environmental, human and cultural impact. He held four sets of hearings: a formal set intended to disclose all technical studies and reports conducted by all relevant groups; a special set specifically for the gas companies; a southern set, held in large cities to raise consciousness about a geographically distant issue; and a community set held in every Mackenzie Valley community. Berger literally met with every community in the last set of hearings, sometimes in unusual settings. He arranged for the CBC Northern Network to broadcast the entirety of the formal hearings to improve access to information for all concerned. He also arranged for some financial assistance for disadvantaged groups to send a representative. In 1976, the Berger Inquiry issued a report that recommended pipeline construction be delayed for ten years. A participant in the inquiry was quoted as saying, "It's the first time anybody bothered to ask us how we felt" (OECD, 1979, p. 74).

It is apparent from the contrasts between these two examples of commissions that achievement of effective public participation is not an easy task with this model. Berger's commitment is quite exceptional--hence his worldwide acclaim. The Baird commission suffered from unstable administration and a process that was not driven by an equivalent philosophical commitment. In each case, the telling evidence of success or failure can be found in the reports of participants. The comment quoted above from a Berger inquiry participant is a stark contrast to the disenfranchised experience Massey (1993) describes of participants in the Baird commission. Also, Berger made every reasonable attempt, short of sending participants to engineering school, to educate them on the technical matters concerned. Conversely, though many grassroots organizations created their own translations of descriptions of reproductive technologies, the Baird commission did not put adequate effort into an education campaign.

Commissions, at least in the Canadian experience, are a method of soliciting an extremely wide range of public opinion within the constraints of a reasonable investigative period. When done correctly, as in the Berger example, they are accompanied by thorough education campaigns to inform citizens of the issues prior to soliciting their participation. Berger also took the initiative in travelling as extensively as possible to actively seek out opinions from the farflung populace of the north. In contrast to these two features, the Baird commission provided inadequate prior information and made minimal attempts to encourage participation or even seek out marginalized opinions. These examples illustrate both the best and the worst features of the Commission model. I would suggest that the Berger Inquiry succeeded due in great part to the efforts of its Chair, whereas the Baird Commission failed despite (at least in part) the efforts of its Chair. This fact, coupled with the great expense and public perception of Commissions, suggests that although the Commission is still a proven effective model for public participation in policy formation, it is time to consider some alternate models to elicit public input.

Having described some participatory mechanisms of note, I will devote the next section to a model that bears an affinity to these and other models from the 1970s and is receiving considerable attention: the consensus conference.

The Consensus Conference

This mechanism bears some similarity to study circles and more commonly known methods of participation such as public advisory panels. In part, this model arose from the technology assessment (and the related impact assessment) projects of the 1970s. It is a popular model within the European science and technology policy-making community, though it is recognized as one of many options for public participation. Design of the method is attributed to Denmark in 1987, although a version of it has been used in the United States by the National Insitutes of Health since the 1970s (Joss & Durant, 1995). Consensus conferences were developed in response to arguments that technology assessment that consulted only experts would fail in one of its purported essential functions, "enlightenment and the creation of consensus on the consequences of scientific and technological developments" (Joss & Durant, 1995, p. 9). The consensus conference model involves a group of ten to sixteen citizens in a learning process to understand complicated technological issues for the purposes of exploring their health, ecological, and social impact. Members of a citizen panel are recruited, and then given access to information on an issue. They must formulate questions to ask an expert panel, and generate a report for submission to policy makers, all through the process of consensus decision making (Andersen & Jaeger, 1999, Joss & Durant, 1995). Consensus decision making attempts to reconcile conflicting opinions through a process in which all members of a group must consider the issue brought to the group, raise concerns, discuss options, and achieve a solution which is agreeable to all members. Since the citizen panel utilized in this model hopes to represent the diversity of society, achieving agreement on policy strategies through consensus is no small feat.

Citizen or consensus conferences have been held on a variety of topics in several countries, including Australia, France, Korea, New Zealand, Norway, Switzerland, the United Kingdom, the United States, and Canada (University of Calgary, 1999). The consensus conference model intentionally addresses some of the concerns raised in science and technology studies, as it is grounded in research on the public understanding of science (Joss & Durant, 1995). It recognizes challenges to the public understanding of science and seeks strong democratic participation in science and technology policy design and evaluation. Its greatest strength may be its structural insistence on dialogue, as the lay panel is expected to formulate and ask questions of experts and then synthesize their resultant understanding into a report. Since it has its foundations in technology assessment, it has the benefit of a history of experimenting with the application of theories of social impact.

In countries where they have been held, consensus conferences demonstrate the potential to have direct impact on policy. In France, for example, a 1998 consensus conference on genetically modified (GM) foods produced a report containing several recommendations including a ban on antibiotic-resistant marker genes, mandatory labelling of GM foods, identification of altered products through the food chain. The panel was split on whether GM foods should be banned altogether. The French government responded a month later by placing a two year moratorium on transgenic plants that cross over to other species, and the mandatory identification of altered products through the food chain, and the reform of their expert assessment process. Although they approved two new transgenic corns at the same meeting and rejecting the imposition of mandatory labelling, the results of the conference had an undeniable impact on regulation (University of Calgary, 2000). Another promising result of consensus conferences internationally include the formation of Biotechnology Australia, a body set up by the Australian government to oversee the regulation of gene technology and public consultation on the same, in response to their consensus conference on the same issue (Australian Broadcasting Corporation, 2000).

Finally, in Denmark, the Danish Board of Technology has been organizing consensus conferences for years on a variety of topics. Danish conferences have had impact on policy in a number of instances, including the striking example of the ban on gene testing for employment of insurance purposes (Danish Board of Technology, 2000). The potential for meaningful policy impact with this model is real.

In Canada, the first consensus conference was held in 1999 in Calgary. Titled "The Food Biotechnology Citizen Conference" and sponsored by the University of Calgary, the National Institute of Nutrition, and the Food Biotechnology Communication Network, this event was funded by the Social Sciences and Humanities Research Council, Alberta Agriculture Initiatives, and the University of Calgary. It involved fifteen citizens (selected through an application process, after a publicity campaign) who conducted intensive research and selected an expert panel for consultation in the course of a few weeks (University of Calgary, 1999). When possible, experts were drawn from within Canada (Einsiedel, 2000) and included representatives from the biotechnology industry, university science faculties, environmental activist groups, the farm community, and government.

The panel conducted their inquiry based on the following questions:

> 1) Consumer Health and Safety: What are the risks of consuming genetically engineered foods in comparison to conventional foods?
> 2) Environmental Impacts: What are the environmental impacts of genetically modified organisms(GMO's)?
> 3) Economic and Social Impacts: What are the economic and social advantages and disadvantages of food biotechnology?
> 4) Ethics: What are the ethical considerations of food biotechnology?
> 5) Legislation: What implications do existing International Trade Agreements have on biotechnology decisions made in Canada?
> 6) Public Interaction: The 1998 Biotechnology Strategy states that the emphasis on public participation is a key element of the strategy. What kind of process would ensure that ongoing public participation is integral to policy development and implementation? (University of Calgary, 1999)

Results of this conference were summarized in report form, presented at the conference, and submitted to relevant ministerial bodies. The conference was open to the public for a small fee, thereby supporting a reasonable amount of public involvement beyond the lay panel. The resulting report of this conference clearly demonstrates that given the proper resources, the time commitment for previously untrained citizens to become adequately informed to question expert opinion is quite minimal.

I had the opportunity to interview the conference organizer, a member of the expert panel, and a member of the lay panel to elicit their impressions of the conference. I was fortunate enough to have two acquaintances who were also present for the conference (observing for the purposes of their own Masters' research). Informal conversations with these colleagues (Downey, 2000, Kelly, 2000) helped crystallize my thoughts about the conference model. The following discussion derives from the information collected in the interviews I conducted and addresses aspects of the model I feel are most relevant to STS theory.

Learning.

Everyone I spoke with felt that one of the strongest features of the consensus conference as it was conducted in Calgary was the extent of learning accomplished by all involved. The organizer, Dr. Edna Einsiedel from the University of Calgary, stated that "the lay panelists go through this intense process, the organizers go through a learning process, the expert panelists when interviewed right after the conference were quite impressed with the lay panelists" (Einsiedel, 2000). She also pointed to the potential for scientists to learn about lay perspectives of information and government to learn about new ways to engage the public. The lay panel participant (who requested anonymity) agreed that all panelists left feeling as if they had learned a remarkable amount, and the intensity of absorbing it was daunting but also exhilarating.[12] The organizer noted that she received a great deal of positive feedback from the expert panel after the fact, expressing admiration for the ability of the lay panel to conduct a thoughtful and prepared inquiry.

There were a few problems with the learning process, however. First, the lay panelist expressed the frustration the panel felt when, after working so hard to develop a knowledge base on food biotechnology, they encountered experts who began by "talking down" (Anonymous, 2000) to them. This sentiment was echoed by the conference organizer, who stated that it became necessary to intervene with the expert panel and remind them that the citizens had undergone an intense learning process in order to prepare for the conference. Another problem was the nature of the information supplied. The conference organizer and the students who were present spoke of the vast amount of information that was carefully selected for thoroughness and balance before supplying it to the panelists. The expert panel participant I spoke with, author/activist Brewster Kneen, felt that the information provided still demonstrated a bias in its omission of alternative radical analyses of biotechnology, considering the wealth of information available of this nature. He expressed the opinion that the possibilities for meaningful learning were hampered by the neglect to address the bias inherent in the resource material.

Finally, it was expressed by everyone I spoke to in some manner that it was not clear any real learning occurred on the expert panel, in particular, the industry representatives. At the conference end there was a great desire on all parts to continue the discussion, but much of this seemed motivated only by the need to further reinforce their own positions as opposed

[12] This sentiment has been noted by lay panelists in other consensus conferences, for example Lee's (1995) account of the U.K. food biotechnology consensus conference.

to learning more about others' viewpoints. Although the consensus conference model provided a stimulating forum to unpack the food biotechnology issue, there was an overwhelming sense that many members of the expert panel were present to defend their positions and left without having altered them minutely. In this respect, the learning component may be described as only partially successful.

Recruitment.

According to Einsiedel (2000), the consensus conference model is so familiar to the Danish public that organizers there are able to send invitations to participate randomly through the mail, making the recruitment process similar to our process for jury duty. Unfortunately, the freedom to recruit participants randomly was not possible with an unfamiliar model run independently from the government. Participants were recruited by an advertisement in which they were asked to apply by writing an essay about why they wished to serve on the lay panel. Their applications were submitted to a review process before selection was made (see Appendix 1 for a list of lay panel members). The lack of a randomly selected representation on the lay panel did not seem to be of concern to anyone I spoke with, with the exception of the organizer. She mentioned that there had been some discussion about the recruitment method, but in the end it was determined that advertising for panelists was the most cost and time efficient route to take.

Selecting the expert panel, however, was much more complicated (for a list of expert panel participants, see Appendix 2). Since the organizer had hoped to use Canadian experts where possible, this limited the pool on which they could draw, especially when they were seeking scientists critical of food biotechnology applications to date. In fact, one scientist who fit this profile refused to participate due to concerns about being vulnerable to attack by colleagues in industry and academia who did not share those views. Some participants felt the presence of corporate representatives on the expert panel undermined the policy shaping goals of the conference model. The expert panelist I interviewed was of this opinion and only agreed to stay after some convincing.

The lay panel participant expressed no strong opinion about the recruitment process itself. However, later in our conversation it was revealed that this panelist had some concerns about group dynamics within the panel. The members of the panel got along extremely well for the most part. By the end of the conference, during the late night sessions when the lay panel split into groups to compose the final report, the panelist experienced a situation where an opinion was not valued and effectively silenced. In part because of the exhaustion the panelist was experiencing, the panelist became uncharacteristically submissive.

It is not surprising that personality dynamics could have an influence on the outcome of the intense team effort required of the consensus conference. As I observed during one interview, it bears remarkable similarities to jury duty in that a consensus must be achieved by a group of strangers who are temporarily forced into unnaturally close relationships. The lay panelist felt that having more time and money could allow organizers to find ways to deal with this type of problem, but the panelist was not sure what the solutions would be.

Funding.

Einsiedel (2000) described a frustrating process of applying unsuccessfully to several government ministries to fund the conference. In the end, she achieved funding from the Social Sciences and Humanities Research Council and the Alberta Agriculture Program. The budget for the conference was quite modest compared to budgets for similar conferences run in the United Kingdom, Norway, and Australia (Einsiedel, 2000). She eventually realized that she was pleased not to have government funding, as the conference may have had to be "run a certain way" (Einsiedel, 2000).

Kneen (2000), however, was not convinced that a conference like this is the most effective use of such funds. He gave examples of public education efforts such as small workshops or free public lectures that could be funded at a fraction of the cost and still have a significant impact. Although he felt the conference had potential, he voiced a concern that structures already exist to provide public feedback to the government about policy, and these structures are sadly neglected. In effect, according to Kneen, it is not in the government's interest to support democratic participation in policy, therefore it is not in the government's interest to encourage members of the public to take advantage of existing mechanisms for input.

Policy Input.

This aspect of the conference appears to be the most contentious. Einsiedel (2000) explained that though the conference was not linked to a specific policy question at the time, she defines policy as an ongoing, evolving process looking at a range of issues, involving a variety of stakeholders who participate at various points in time with different levels of involvement. In this sense, the impact of the conference is defined more powerfully. She admitted that the link to policy was not made clear to all participants at the outset, and this was an error that she would correct in the future. However, in the end the panel's report did get distributed to several ministries, and Einsiedel has received much positive feedback from government representatives who have read the report or heard accounts of the conference. She is currently working on projects related to the consensus conference and participatory models.

Kneen (2000), as mentioned above, was not satisfied with the effectiveness of this model. He observed that from his experience in public speaking and touring as an author, there is a growing portion of the population that is primarily cynical about the government's motives in seeking public input. He felt that this not only partially explains why citizens do not access the structures already in place to provide input but also reflects government reluctance to seek public input.

While the lay panelist (Anonymous, 2000) I interviewed did not express this sentiment so strongly, the panelist claimed to have entered the conference with no illusions about its weight as policy advice. The panelist believed that the work the lay panel accomplished was excellent and thorough but felt that it would end up on someone's desk in government and never have a real impact. The panelist felt that the conference's main value would be as someone's thesis or published paper. When I asked this participant's reasons for applying for the conference, considering these statements, I was told, "I needed a break" (Anonymous, 2000). This panelist struck me as very intelligent and energetic and enthusiastic about the experience of the panel and their final report. All of this was placed in stark contrast to the almost demoralised expression of the futility of this action.

When I spoke with colleagues who were present at the conference, one expressed an opinion that she was uncertain how radical an instrument the consensus conference could be (Kelly, 2000). She pointed to the report of the lay panel, which has a decidedly balanced approach to biotechnology (a concern of Kneen's, also). What she did feel was radical about the conference was the perspective on public participation. She observed the greatest social learning occurring not on issues related to biotechnology but on the possibilities for the public to have different mechanisms to influence policy.

Analysis: Commissions and Consensus Conferences

The observations I elicited about the Calgary Food Biotechnology Citizens' Conference were all made roughly a year after the conference was held, and yet still seem quite fresh in the minds of those involved. It was clear to me that the conference was a significant experience in the lives of many participants. The lay panelist reported that several members of the lay panel were sobbing when they had to say goodbye at the end of the conference, realizing not only that they would never see each other again but that this incredibly powerful experience was now over.

My own thoughts on possibilities of participatory models continue to evolve. First of all, as Hamstra (1995) has suggested, participatory models are essentially normative in that they work on the assumption that including a greater quantity and variety of voices in decision-making will lead to more benefits and less negative impacts in the technology integration process. I suspect this desired effect could seldom be guaranteed. However, the potential benefits to empowering individual citizens, equalizing power dynamics, and improving communication between relevant groups are I believe the real strengths of such participatory methods of decision-making. Each of the models I have discussed here attempts to address through more direct means of involvement the marginalization experienced by members of the public. They reflect a commitment to listen to public voices through direct dialogue and to demystify scientific information through public information strategies. If they work as intended, they offer a means to mitigate ambivalent relations between experts and the public and, in some cases, the state. They provide a forum in which individuals can communicate and begin to understand each other's priorities and sources of knowledge. As Andersen and Jaeger (1999) suggest, at the very least the consensus conference and other participatory methods are a valuable supplement to existing methods of political decision-making, as they offer opportunities for citizens to present their opinions openly in a structure they are allowed to mold and influence. The importance of this lies in the fact that "society is full of people--experts, technocrats, politicians and so on--who have time and resources to set the agenda for public debate on technology" (Andersen & Jaeger, 1999, p. 339). If participatory methods can ameliorate the power differential even slightly, they have an important contribution to make.

It is this supplementary role that demonstrates the real value of a participatory model such as the consensus conference. I would like to return for a moment to the comparison of the commission and consensus conference models. I contend that the consensus conference model is a useful addition to Canadian political mechanisms, and it is clear from the success of the Berger Inquiry that the commission model has great utility. Superficially, both models are appropriate political responses to the problem of ambivalent relations in late modernity. It is clear, however, that they exhibit different strengths and weaknesses.

The first is the question of weight. If public input mechanisms are not government-driven and funded, or if there is no serious commitment to incorporate the recommendations into policy, then their existence risks becoming merely a token effort to listen (Andersen & Jaeger, 1999). Under such circumstances, the state supports mechanisms for the expression of public input without taking this input seriously, and yet the government still derives the legitimizing effects of public consultation on its actions. Einsiedel (2000) mentioned in our interview that European consensus conferences rely heavily on media coverage to publicize the issues and bring them onto the public agenda. It is structured into the model that the media cooperate to educate the public on the issue under debate so that the conference has a dual impact: through generation of a report and through a public education campaign (Hamstra, 1995). The regional nature of the Calgary conference, combined with the fact that food biotechnology was a much lower profile news item then than it is now, meant that news coverage was not wide or extensive. Until consensus conferences are incorporated into the Canadian consultation system they will be vulnerable to resting in oblivion.

Commissions, unlike consensus conferences, are entrenched in the Canadian consciousness. My memories of becoming aware of Canadian politics include hearing adults joke about striking a Commission to solve an insignificant question, such as "Why do Canada geese have black bills instead of orange bills?" The perception that Commissions were expensive and sometimes futile tended to be worked into the punchline. Yet, it is exactly the expense and resonance of the Commission mechanism that makes it an effective participatory model. When a Commission is struck, its actions and inquiries are required reporting. Many Canadians are aware of the existence of Commissions and of the impact of specific Commissions on their life. Public attention to a Commission's activities naturally extends to its findings. In this way, public attention can be, or should be, an instrument to bind the government to addressing those findings.

Another challenge for participatory mechanisms is the recruitment process. Many of the concerns with recruitment for a consensus conference are described above. The methods employed still privilege people of a certain type: those who consume media enough to respond to advertising, those who have the time and energy to devote to an intensive process, those who have adequate literacy skills and support systems to allow them to participate, those who have an interest in participation in the first place. The recruitment process was not identified as an important shortcoming by those I interviewed for the Calgary conference, but it was apparent that the organizers had discussed it at length initially. I also asked all interviewees if they had concerns about running a model like this in a country as large as Canada, considering diverse language populations, and travel and time commitments for participants. This did not appear to be an insurmountable obstacle for anyone. In fact, one of the reasons the lay panelist participated was to get a chance to see Calgary. The opportunity to be involved in this type of project--assuming of course that all expenses were covered by the conference--could be a reward instead of a burden. I suspect that an institutionalized form of the consensus conference, that is, one funded and run by the government, would have the resources to revisit their strategies for recruitment and determine a better method. As I noted earlier, Danish conferences have been able to graduate from advertising recruitment to random mailed invitations, so it may be just a matter of time and practice until a more random method of recruitment is possible.

Public participation in Commissions has the potential to be extremely representative through open advertised hearings held extensively throughout Canada. As we can see from the Berger example, it is possible to structure a Commission to be extremely effective in encouraging representative participation. Because of the travelling nature of the Commission, the acceptance of submissions in a variety of media, and the amount of staff, money, and time allowed, this model is structured to make participation possible for as many people as possible. Those who are not literate can make oral submission, those who cannot afford to travel can either have the hearing come to them or receive some monetary compensation to attend hearings, those with communicative disabilities have a choice of media from which to gather information, often translated into a variety of languages.

The consensus conference model has strengths in that it is rooted in a social analysis that supports a more critical approach than the other mechanisms available. It can accommodate issues that require an extremely steep learning curve because labour-intensive teamwork is built into the structure. The types of issues for which the consensus conference model has been employed internationally include internet systems, food biotechnology, human reproductive technologies, and the telecommunications infrastructure (University of Calgary, 1999). It supports a strong democratic process through the use of small groups who can directly dialogue with experts and policy makers. It provides the option for a concurrent public education campaign as well as generating a report for government bodies. It also endorses an evaluative component that has the potential to act as a kind of watchdog on the application of the model. All of these features have the potential to breach gaps in both knowledge and values between experts and non-experts as their dialogue will reasonably foster better mutual impressions. It also provides a means by which the public can regain some control over scientific knowledge and the policy process and have their own knowledge validated. One of the things that struck me about the Calgary conference was that even though the issue of food biotechnology was still young in the public consciousness, the level of awareness achieved by the lay panel exceeded the level many citizens have achieved after months of assimilating news reports and discussions from a variety of sources. In this way, I suspect, the consensus conference requires of its lay panel at the very least an encapsulated version of the more gradual period of learning that would be experienced through regular news consumption. The consensus conference, if planned well, may then provide a means to gage the public mood on an issue slightly ahead of its broader expression. Of course, if the conference model is working appropriately, then the information it generates will become an excellent manifestation of the reflexivity of knowledge construction as it drifts into the consciousness of media consumers through news reports.

The Commission model is particularly well-suited for issues that do not require steep learning curves but have a broadly recognized significant impact. The lay panelist I spoke with mentioned the issue of gambling (Anonymous, 2000). Government-run casinos do not constitute a complicated issue. Most people have a common sense understanding of gambling and what the effects of a casino in their community might be. In an inquiry about the suitability of incorporating government-run casinos throughout Canada, there may be support for the economic benefits to a community and moral or safety concerns about the element casinos might attract, for example. To use an example of a more technology-related issue, an inquiry to determine public opinion about the switch to electric automobiles from gas automobiles would be intellectually accessible to many Canadian citizens. A large number of Canadians have driven cars, and many own them. Those who have taken auto mechanics in highschool shop classes would have a basic understanding of how combustion engines work. People who have been involved in the environmental movement have some knowledge about the implications of continued use of fossil fuels. These are just some of the issues that could be addressed with broad participation in the public discourse surrounding the widespread adoption of electric automobiles. This is an example of a technology related issue that would be well-suited for exploration in an inquiry or commission, a model that features a great strength in its accessibility.

An argument can be made for the appropriateness of both these models in the Canadian context. Either will flounder if it fails to remain flexible and adaptable. As new issues arise, they are likely to bring with them new complications. Though the Commission model is an integral part of the Canadian political consultation process, there would be a definite benefit to adding smaller-scale, information-intensive mechanisms to the consultative roster.

Summary

This chapter emphasized the motivation for strong democratic processes in creating science and technology policy. It may seem obvious in our cultural context that democracy is desirable, but our understanding of democracy sometimes suffers in the translation to practice. Spurred by public interest groups, governments have been returning to the robust, strong democratic participatory mechanisms that were flourishing in the 1970s, especially related to the rise of technology assessment.

Unfortunately, the achievement of conditions of strong democracy is challenging. As illustrated in Table 1, each of the participatory models described in this chapter has its strengths and weaknesses, in terms of its contribution to strong democratic practices. A commitment to providing a thorough range of information on the issues (for the purposes of public education as well as sound decision making), to representing diverse viewpoints, to ensuring face-to-face discussion between public and experts, and to guaranteeing that actual weight be granted to each mechanism's results in policy planning, are all strong democratic practices. In contrast, thin democratic models allow for provision of thorough information to the public but rely more on elected officials to assimilate, interpret, and make policy decisions based on the information available. While there are no restrictions against dialogue between the public, experts, and policy makers the commitment to such a dialogue on the part of government bodies is demonstrably weak, as opportunities are not built into the political structure.

Table 1. Democratic characteristics of participatory models.

	Strong	Thin
Study circles	• demonstrates commitment to involve citizens by recruitment • allows for dialogue between experts and public through provision of expert pool • provides public education through publishing reports • suggests potential for policy impact through polls conducted after publication of reports	• risks lack of diversity since recruitment process is not random • does not mitigate power differential between experts and public to allow for meaningful dialogue • may not accomplish effective public education, per Swedish experience, therefore may be perceived virtually meaningless in terms of policy impact
Science shops	• ensures ongoing dialogue between citizens and experts • ensures public education with access to a thorough range of information • addresses political power inequities by controlling for commercial motives • supports expert ties to local communities	• operates passively; only active/interested citizens participate • does not guarantee diversity as participants volunteer • has potential for expert control, as participants are screened • features no direct link to policy
Commissions & inquiries	• allows for extensive public education through campaigns and media attention • allows for diverse representation through actively soliciting input in public hearings, broad in geographic scope • may control for power inequities by providing resources to participate • provides possibility for dialogue between experts and public • allows lengthy period of time for public to absorb information • features direct policy link	• does not standardize the features that are necessary for strong democracy, such as guaranteed dialogue and provision of resources to allow participation • requires lengthy process from initialization and translation into policy; results may be outdated once operationalized, and may thus contribute to public perceptions of model as heavily bureaucratic and co-opting public opinion through consultation
Consensus conferences	• demonstrates commitment to involve citizens by recruitment • allows for face-to-face dialogue • balances power inequities by placing citizen panel in position of control • provides public education through published reports and media coverage • operates on consensus model, in which all perspectives may be heard, and concerns addressed, within citizen panel • may allow for diverse representation through random selection, in current Danish attempts*	• allows potential for expert control, as participants are screened • requires considerable learning in condensed time allotment, which may subvert education function • uses a decision making process of contestable success; consensus may be unable to control for social power inequities in small group interactions • does not guarantee diversity of representation through random recruitment, in early forms*

* This point is contestable, as the screening process may actually ensure greater diversity than random mailings. However, the rigour of the selection process is still dependent on the qualities of the conference organizers.

As a societal commitment to strong democracy evolves, structures may be incorporated to enhance public involvement in policy decision making which in turn influences public perceptions of government decision making and public involvement. Theoretically, as more participatory models are incorporated (in a binding way) into government structures, the public's perception of its own role in policy decision making will change, and chip away at public passivity and/or cynicism towards regulatory matters. This process is akin to what Sclove (1995) calls democratic structuration, an adaptive process in which "the means and the ends . . . should be guided by an overarching respect for moral freedom . . . [it] develops individual moral freedom, while its structural results constitute conditions requisite to perpetuating maximum equal freedom" (p. 35). Democratic structuration is not antithetical to thin democratic practices (such as the electoral process), but requires that strong democratic mechanisms be standardly integrated into the government's structure. This ideal illustrates how strong participatory models owe at the very least a philosophical debt to the technology assessment framework, as described in this chapter.

Having explored some options for public participation, their strengths and limitations, the next chapter will conclude by summarizing the main themes of the exploration undertaken in this thesis, public concerns about governance of science and technology, and the potential for these to be mitigated through government intervention. Finally, several avenues for future related research are described in terms of their potential contribution to understanding the complex interaction between science and society.

Chapter 4. If everybody would study science more...

Chapter three essentially described some responses to the questions raised in chapter two. The second chapter dealt with factors contributing to ambivalent relations between experts, the public, and the state, three groups which are of principal concern in science and technology studies but which also shape the policy that governs scientific and technological practices. I have addressed these relations with specific attention to how they demonstrate conditions of late modernity, the erosion of Enlightenment notions of rationality as the primary source of legitimation in decision making, and the gaps in knowledge and values related to the distancing between the public and experts. Chapter three detailed the evolution of specific participatory mechanisms that have been adopted to shore up the public's dwindling faith in their institutions of cognitive and political authority. After describing the technology assessment initiatives that provided the foundations for mechanisms such as study circles and science shops, the chapter focused on two participatory mechanisms in the Canadian context. One of these is the tried and true Commission model. The other is the European-based consensus conference, tried in Canada in 1999. All are attempts to address public concern or mistrust through direct dialogue and communication.

The most effective participatory models provide means to address the complicated relationships that influence people's negotiation of science and technology. Policy planners would do well to inform their consultative practices with insights derived from experience with such models.

Strategic Directions for Public Participation

The utility of an exploration such as the one undertaken in this thesis is in its ability to suggest certain ideas to guide policy-makers who must tackle such regulatory challenges. I am hesitant to characterize the following as "guiding principles," a term which has lost its impact through overuse. Instead, the following points, drawn from the analysis of the strengths and weaknesses of participatory models, should serve as reminders to focus efforts to move towards sustainable science and technology governance and anchor them to their social context.

First, if citizens do not vote or actively inform their government of their concerns, it does not mean that they have none. Strong democracy provides the means to encourage and support citizens to speak their minds. In many cases considerable support may be needed, but inconvenience and expense should not preclude public participation.

Second, citizens who have extensive training in sciences do not comprise the only expert population that needs to be consulted in policy formation. Members of the lay public are experts on their own lives and conditions and concerns in their diverse communities, which will necessarily be affected by science and technology regulation as well as deregulation and lack of regulation. Experience of everyday life is as valid a source of insight and advice as expert testimony in making policy decisions.

Third, considering perceived conflicts of interest associated with industrial interests, it should be a given that state structures to support scientific progress and those to ensure its accountability and responsibility should not be one and the same. It is not unusual to encounter government structures that are responsible for a generalized national science agenda, that includes both fostering innovation and promoting a responsible research and development program. It is becoming more and more apparent that this combined structure cannot meet both ends.

Finally, the control exercised by industrial funders poses serious risks to public control of the national research agenda, and more importantly, to human health. As industry becomes more and more involved in research and development, it is more and more likely that their interests will compete with, or even take precedence over, those of the larger Canadian population. It is part of the government's task to protect its citizens from the deleterious effects of dangerous technologies recklessly developed in the pursuit of monopoly profits.

Having addressed the practical points of operationalizing a sound participatory approach, I would now like to address some of the analytical concerns that have been haunting me as I have conducted my exploration of participatory mechanisms. Researching the nascent (in Canada) consensus conference model foregrounded some ideas that had been dormant or underdeveloped, and I believe that discussing the model in light of these ideas will be uniquely instructive.

You're Talking to an Academic: Combining Grassroots and Theoretical Approaches

When I asked Edna Einsiedel (2000) if she felt that the consensus conference model's grounding in theory was an asset, she replied "well, you're talking to an academic, so yes... absolutely!" The consensus conference model is a manifestation of what many academics struggle to achieve: the practical enactment of theoretical positions. Approached from an academic perspective, it seems that of all available participatory mechanisms, the unusual strength of the consensus conference is its foundation in analyses of the public understanding of science. Consensus conferences raise questions about relationships between science, the state, and the public and provide a means for dialogue between experts and lay citizens. This structure has a dual effect in that it not only enables dialogue and public understanding at the individual level of conference participants but also stretches the limits of political imagination. Such dialogue is not only possible, but it can be quite rich and rewarding. As well, the model has an evaluative component built in which is testimony to its carefully wrought structure.[13]

Unfortunately, as was apparent from the interviews, the academic perspective interprets experience differently from other perspectives. This is a nice, if ironic, illustration of the distance between expert and non-expert stances. It became quite clear to me that even from my own rather junior academic perspective, I had made assumptions about the conference process that were challenged through the interviews, informal discussions, and review of the conference website. For example, I completely underestimated the emotional component of sharing an exercise that is intellectually and politically empowering, as evidenced by the lay panelist's account of tearful goodbyes. This is a powerful motivator that should not be neglected. It is likely an unintended but useful consequence of the conference structure. It is a feature that is present in most grassroots actions, in my experience, and could prove to be the inspiration for further social learning and the desire to continue achieving social change. Despite my history of grassroots involvement, my focus on the model had prevented me from seeing its possible connections to grassroots-style advocacy. If the model were incorporated into the Canadian political system, it may indeed result in conferences being run "a certain way," as Einsiedel (2000) put it.

Another blindspot ambushed me during the course of conducting interviews. Though I invoked the theory of late modernity in this thesis to describe conditions characterized by public ambivalence to institutions of authority, I was still surprised by the extent of public cynicism implied by Kneen (2000), the lay panelist, and my colleague in Calgary (Kelly,

[13] At this writing, the Calgary conference is currently undergoing its follow-up evaluation.

2000). Even though Einsiedel (2000) provides a promising account of the impact of the conference report thus far, and the lay panelist I interviewed expressed feeling alone in skepticism about the report's potential impact, I find myself wondering if public cynicism is so persistent that it could preclude acceptance of the legitimacy of any new model as a meaningful political mechanism.

So, on the one hand, I support the adoption of more flexible models of public participation in science and technology policy, as I feel that these models have potential to act as public education campaigns, enhance social learning, bring complicated issues into the public agenda for scrutiny, and stretch the limits of the public's political imagination. On the other hand, I must confront the recognition that such models may not address the real problem of ambivalence and faltering faith in institutions of authority that has been central in my analysis.

Another limitation of the smaller group deliberations that are required of many strong participatory models is their limited ability to tackle very large issues. As Andersen and Jaeger (1999) explain:

> We have to consider these disadvantages when we talk about democracy and technology assessment. In several cases, technological problems cannot be solved by either individuals or small, local groups. Solutions in fields such as nuclear power, genetic modification of food, irradiation of food or the whole way of producing our food demand decisions at a higher level than local, and sometimes not even the national level but the international level. In these situations, local participatory democracy is insufficient.
> (p. 334)

This does not mean that ordinary citizens cannot be involved in decision making at a global level. The effectiveness of non-governmental organizations and small grassroots groups to organize on a variety of issues, bring attention to injustices, and inspire social change is proven, and it is stronger than it has been in a long time in the current political climate. I think it would be interesting to consider alternative arrangements and coalitions for continuing flexible small-scale models in a semi-institutionalized manner in conjunction with other activities. For example, if government effectiveness was recognized as resting on its connection to its citizens, then it would be reasonable to expect that funds could be made available to partially fund consensus conferences (run by non-governmental organizations) as issues arise. Governments could provide enough resources and information to obtain appropriate experts and offer a serious commitment that action will be taken on the conference report when generated.

In this way, a model could be adapted to not only act as a barometer of public opinion and a mechanism for public input but also a means to continue non-institutionalized forms of public education and action. The realization of social change is such a complex process. If progress is defined not as economic competitiveness, technological efficiency, or high industrialization but instead as collective education and enlightenment, a commitment to social justice, and the true ability to sustain the environment, then progress implies the kind of social change that is accomplished gradually and through constellations of catalysts. The following suggestions for future research projects may serve this notion of progress.

Future Directions

Effective public participation in science and technology policy development.

Chapter three touched on some initiatives to include the public in policy decisions about science and technology. There have been varying results of such efforts and much research and commentary on the same. Since the move towards consensus conferences and similar strong democratic models appears to be strengthening, it would be useful to conduct thorough comparative research on how each of these has been used around the world. It would be particularly valuable to compare mechanisms for cooperative interaction between expert and lay advisors. An important feature of any participatory mechanism must be some form of evaluation, both by participants in the process and external observers. To be fully effective, recommendations generated by participatory mechanisms must not only be implemented but internalized by those who carry out and maintain them. It is likely that the implementation phase will continue to be a challenging one.

Science communication in popular media.

Perhaps the easiest starting point to delve into this issue is content analysis. To benefit from the complementarity of qualitative and quantitative data, a combination of standard content analysis combined with detailed semantic analysis of news coverage of a specific biotechnology issue would be an interesting contribution to the field. Many of the issues around gatekeeping and agenda-setting could be clarified with the assistance of such data on the reality of science and technology reporting.

Impact of the transition to private funding sources.

In the course of following Health Canada's recent activities, I have been observing the ministry's reactions to two major events: the attempt by Monsanto to influence government advisors on bovine growth hormone policy and the harrassment of Dr. Nancy Oliveiri, a researcher who was pressured to cover up life-threatening results of drug trials. Health Minister Allan Rock has taken several steps towards improving openness and public involvement in the policy process, but as yet these initiatives are in early stages. It strikes me that the Minister's actions are an attempt to mitigate the effects of a long history of scientific (and political) authority contested by lay publics. This reflects the ambivalence towards scientific authority addressed in chapter two. In the case of health-related scientific activities, I think this ambivalence is augmented by what is perceived by publics as the corruptive influence of commercial interests. It would be worthwhile to conduct international comparative studies of science research funding and public attitudes.

Globalization studies.

A wealth of meaningful information has been generated by opponents of the World Trade Organization's free trade initiatives. Free trade agreements have countless implications for the practice of science and technology. In an increasingly politically convergent world, the borderless operation of science supports a borderless approach to its guidance. I have strong concerns about the impacts of a global practice of science, especially in terms of how it will affect dialogue with lay publics (which is usually best accomplished in local settings).

A different approach to controversial technologies.

Though some technologies have been dealt with individually in legislation (e.g. cloning), it would be beneficial to consider some general ways to approach all of biotechnology towards preparing for future implications and developments. Further research needs to address how technologies that manipulate the basic units of life, which in turn have an impact on all aspects of environmental health, can be integrated into social consciousness in a way that is less fearsome and fatalistic. A solely terrified approach does not serve the public consciousness well. If a topic as mystifying as biotechnology could be made more accessible to as many citizens as possible, then the possibilities for truly sound management of these problematic technologies would enjoy a much more favourable forecast.

Conclusion

In general, there are infrastructural problems that remain in cultural institutions and social systems that both inform and direct our human activities. The ways in which certain types of knowledge are valorized and others derogated mirror power relations and the reproduction of inequality. It is sometimes easy to forget that this is how and why we operate.

I strongly feel that any policy framework that fails to address the social bases of the technological push will never be able to provide a sustainable form of governance. In this light, I recommend a re-visioning of society's relationship to science and technology. There are political methods to assist this. For example, Minister Rock's recent initiatives in cigarette package labelling indicate that, in certain circumstances, he is willing to adopt drastic measures to effect social paradigm changes. This is not a ban--which would have little effect on the public's desire to consume cigarettes--but a type of aggressive education campaign.

I suggest that a similar thing is possible for biotechnologies. The likelihood of successfully implementing bans or boycotts on food or human biotechnologies is slim when multinational corporations have access to the articles of free trade agreements. I am not confident that attempting to stave the commercialization of the gene through regulatory or criminal code measures can be successful. I think, however, it could be effective to adopt a similar approach to these technologies as has been proposed for cigarette packages--perhaps something akin to mandatory warnings about ovarian hyperstimulation syndrome on hormone inhalers used in IVF treatments. Labelling of genetically modified food is still a possibility here and has been implemented elsewhere. It may be that this type of measure could be seen as a barrier to trade, but I think if it could be successfully implemented, then it has the potential to assist in the kind of broad social paradigm shift that is necessary to influence the public's views of science. Further, I don't feel it is too drastic to compare cigarette addiction with the societal addiction to reproduce one's genetic line or to always be able to buy unnaturally large, glaringly red tomatoes. Both are dangerous, potentially fatal, and can have second-hand effects.

To continue with the cigarette parallel, what is really needed to effectively address the ambivalent relations of late modernity is a broad societal change of the type connected to cigarette smoking. I remember as a child perceiving smoking as an activity that all adults did, and being a non-smoker was the exception to the rule. I can also remember the time when I realized the opposite was true and that instead of experiencing cigarette smoke as part of my environment, it was a noticeable distraction. The discomfort with technical knowledge that plagues public experience of science is a phenomenon that could shift in the same way. Conscious efforts to involve the public directly in science governance will go far in opening the dialogue, but any real movements towards a science and technology that is responsible and accountable to the public will only be possible when those involved recognize the validity of different sources of knowledge, the real impact of commercial interests in guiding science for profit instead of for people.

Appendix 1: Food Biotechnology Conference, Citizens' Panel

designer genes at the dinner table

The Canadian Citizen Panel

The Citizen Panel for *Designer Genes at the Dinner Table* is comprised of fifteen individuals from the four provinces of British Columbia, Alberta, Saskatchewan and Manitoba.

The panel is a diverse group of eight women and seven men ranging in age from 17 to 60.

Individuals from both urban and rural backgrounds are represented, as are a multiplicity of occupations.

Employment backgrounds include students, farming, ranching, retail food management, small business, engineering, teaching, trades and administrative occupations.

INTRODUCING THE CITIZENS' PANEL:

Tom Anthony, 29, Calgary, Alberta

Tom is a geological engineer. His work focuses on environmental problems related to groundwater.

Bruce Bauman, 59, Cumberland, British Columbia

Bruce is a heavy equipment mechanic. His interest in food extends to gardening and preparing most of his family's meals.

Debbie Brodie, 41, Richmond, British Columbia

Debbie is a letter carrier for Canada Post. The majority of the food on her family's table is grown organically by Debbie and her husband.

Emilie Cameron, 20, Vancouver, British Columbia

Emilie is a second year student at the University of British Columbia. She has traveled extensively and is focusing her studies on human geography, agricultural science, international relations and environmental studies.

Bridget Cameron, 50, Edmonton, Alberta

Bridget is a Junior High School science teacher for Edmonton Public Schools and the mother of three teenaged children.

Brooke Culley, 40, Magrath, Alberta

Brooke works as a cowboy on a large cattle ranch in southern Alberta. He has an extensive background in various aspects of the restaurant business and is father to a toddler.

Safiya Karim, 17, Calgary, Alberta

Safiya is a grade twelve student at Strathcona-Tweedsmuir School just outside Calgary. She plans to major in biotechnology or genetics in university next year.

Barb Kristjansson, 33, Forrest, Manitoba

Barb and her husband operate a cattle farm north of Brandon, Manitoba. She also works for Agriculture Canada at the Brandon Research Centre. Barb has two young sons.

Jeff Latta, 46, Balmoral, Manitoba Jeff has two teenaged children and runs a mixed farm and a hog feeder operation near Balmoral.

Trevor Lien, 29, Regina, Saskatchewan

Trevor owns a coffeehouse in Regina, Saskatchewan where he provides foods that subscribe to popular trends in healthy eating. He is also a property developer and musician.

Carole Parks, Calgary, Alberta

Carole is an administrative assistant for a diagnostic medical laboratory in a major Calgary hospital. She is an active volunteer for women's' health and a member of "Sistership", the 1998 Alberta Women's Dragonboat Championship team.

Ian Perkins, 43, Calgary, Alberta

Ian manages a large food retail centre in Calgary. He has 25 years experience in the retail foods industry focusing on fresh products. Ian is married with two teenaged children.

Brenda Ryan, 41, Regina, Saskatchewan

Brenda teaches secondary science at Lumsden High School in the community of Lumsden, Saskatchewan. Market gardens and farming communities surround Lumsden.

Curt Schroeder, 45, Regina, Saskatchewan

Curt is an environmental management and training consultant. He holds a master's degree in Environmental Design.

Denny Warner, 32, Vanderhoof, British Columbia

As manager of the Vanderhoof Chamber of Commerce, Denny is interested in the impact of biotechnology innovations on the agricultural members of her region. Her great-great grandfather, Samual Larcombe, "Canada's Wheat King", cultivated many new types of hardy wheat that would survive in Canadian climates.

Over 350 individuals from all over Western Canada submitted letters of interest to participate in the public conference. It was extremely difficult for the advisory committee to narrow down the selection from such a large number of enthusiastic replies! Our thanks again to everyone who expressed interest in this 'democratic experiment'.

modified: March 06, 1999

Appendix 2: Food Biotechnology Conference, Expert Panels

designer genes
at the dinner table

The Resource Panel for the Canadian Citizen Conference

1. Consumer Health and Safety

What are the risks of consuming genetically engineered foods in comparison to traditional foods?

Paul Mayers, Health Canada

Graham Scoles, Department of Plant Sciences, University of Saskatchewan

Corinne Eisler, Vancouver Food Policy Society

Margaret Kenney, Canadian Food Inspection Agency

2. Environmental Impacts

What are the environmental impacts of genetically modified organisms (GMO's)?

Stacy Charlton, Canadian Food Inspection Agency (CFIA)

Raphaël Thierrin, Canadian Environmental Network

Keith Downey, Agriculture & Agri-Food Canada

3. Economic and Social Impacts

What are the economic and social impacts of food biotechnology?

Margaret Gadsby, AgrEvo

Joseph Hulse, Siemens-Hulse International Development Associates Inc.

Cory Ollika, National Farmers' Union

Greg Porozni, Farmer

4. Ethics

What are the ethical considerations of food biotechnology?

Brewster Kneen, Ram's Horn

Burleigh Trevor-Deutsch, Biotech Canada ethics committee

5. Legislation

What implications do existing International Trade Agreements have on biotechnology decisions made in Canada?

Douglas Mutch, Canada Grains Council

Peter Pauker, Department of Foreign Affairs & International Trade

William Anderson, Ag-West Biotech

Edward Hammond, Rural Advancement Foundation International

6. Public Interaction

The 1998 Biotechnology Strategy states that the emphasis on public participation is a key element of the strategy. What kind of process would ensure that ongoing public participation is integral to policy development and implementation?

Representative from the Citizen Panel

THE EXPERT PANEL BIOGRAPHIES

Dr. William Anderson, Manager, Regulatory Support Services, *Ag-West Biotech Inc.*

Dr. Anderson received a Ph.D. in biochemistry from the University of Saskatchewan in December 1993. Prior to his current position at Ag-West Biotech he was involved in research at the University of Saskatchewan and with the national Research council, Plant Biotechnology Institute.

Stacy Charlton, Plant Biotechnology Office, *Canadian Food Inspection Agency*

Mr. Charlton holds an M.Sc. in molecular biology and genetics from the University of Guelph. Following his degree, he worked in research at the University of Guelph and Agriculture and Agri-Food Canada before moving to the Plant Biotechnology Office of the Canadian Food Inspection Agency three years ago.

Dr. R. Keith Downey, Research Scientist Emeritus, *Saskatoon Research Centre*; Adjunct Professor of Crop Science, *University of Saskatchewan*

Dr. Downey has been involved in rapeseed and mustard breeding and improvement since the late 1940's and was in charge of the rapeseed and mustard improvement project at the Saskatoon

Research Station from 1958 until his retirement in 1993. In addition to his teaching and research, he runs his own consulting business, Canoglobe consulting Inc. Through which he has served as adviser to many biotech companies and the government.

Corinne Eisler, *Vancouver Food Policy Society*

Ms. Eisler is a Public Health Nutritionist and a Registered Dietitian/Nutritionist with the Vancouver/Richmond Health Board, and is also one of the founding directors of the Vancouver Food Policy Society. She has been working in the Food Policy/Food Security arena for some time, and is an advocate of comprehensive food policies which promote the health of the public and respect the integrity of the food system now and in the future.

Dr. Margaret Gadsby, Director, Regulatory Affairs - Biotechnology, NA, *AgrEvo Canada Inc.*

A professional Agrologist, Dr. Gadsby holds an M.Sc. in biological control from the University of British Columbia. In addition to her position at AgrEvo, she currently sits as the Chair, Board of Directors, BIOTECanada. Her major field is environmental impact assessment.

Edward Hammond, *Rural Advancement Foundation International*

Edward Hammond is a Program Officer at the Rural Advancement Foundation International, a Winnipeg-based international non-profit organization focusing on agricultural genetic diversity and the impacts of biotechnology and intellectual property on rural societies. Edward's work at RAFI includes research and writing for RAFI Communique and international advocacy work at the UN Environmental Program, Food and Agriculture Organization, and regional governmental and non-governmental organizations.

Joseph Hulse, President, *Siemens-Hulse International Development Associates Inc.*

Siemens-Hulse is a consulting company in industrial biotechnology and agroindustrial development. Mr. Hulse is also visiting professor at the M S Swaminathan Research Foundation, Chennai and Central Food Technological Research Institute, Mysore, India and scientific adviser to India in Ecoconservative agroindustrial development.

Margaret Kenny, Acting Director, *Canadian Food Inspection Agency*

The Canadian Food Inspection Agency carries out safety assessments for novel feeds, biofertilizers, plants with novel traits and veterinary biologics produced through biotechnology. Ms. Kenny has worked in the regulatory area for over 12 years and most recently was involved in the Federal Government's renewal of the Canadian Biotechnology Strategy. In addition to her current responsibilities, Margaret has been involved in administering federal regulations and evaluating microbial products of biotechnology. She is a graduate of the University of Guelph and her academic background is in horticultural and agricultural science.

Brewster Kneen, *Ram's Horn*

An author and former theologian, Mr. Kneen's interest in biotechnology began when he was farming in Ontario. He and his wife co-publish Ram's Horn, an alternative agricultural newsletter.

His field is structural analysis.

Paul Mayers, Acting Director, Bureau of Microbial Hazards, *Health Canada*

Mr. Mayers' substantive position is Head of the Office of Food Biotechnology in the Food Directorate of Health Protection Branch, Health Canada. The office of Food Biotechnology coordinates the safety assessment of novel foods derived from genetically modified organisms. Mr. Mayers also chairs the Food Directorate Working Group on Biotechnology which has responsibility for the development of guidance documents to assist in the safety assessment of biotechnology-derived products.

Douglas Mutch, Executive Director and CEO, *Canada Grains Council*

With over 20 years in the agricultural industry, Mr. Mutch's position includes lecturing at McGill University, commodity market columnist for the Montreal Gazette and Financial Times of Canada and private consulting. Previously he was the Director of Economic Research and Corporate Secretary to the Livestock Feed Board of Canada and subsequently the Director of Economic Research for the Livestock Feed Bureau of Agriculture and Agri-Food Canada.

Cory Ollikka, President, *National Farmers Union*

Currently farming on the fourth generation mixed cattle and grain farm where he was raised, Mr. Ollikka heads the National Farmers Union in which he has been active for twelve years. He has a B.Ed. from the University of Alberta.

Peter Pauker, *Department of Foreign Affairs and International Trade*

Peter Pauker is a Senior Trade Policy Officer in the Technical Barriers and Regulations Division of the Trade Policy Bureau. He has been seconded to this bureau from Health Canada's Office of Food Biotechnology.

Greg Porozni, *Farmer*

Mr. Porozni is a fourth generation farmer farming north of Vegreville, Alberta where he raises cattle and grows canola, wheat and peas. He served the Alberta Canola Producers Commission for seven years and was appointed in 1996 to the Alberta Agricultural Research Institute for cereals and oilseeds. Mr. Porozni has a diploma in Petroleum Engineering Technology.

Dr. Graham Scoles, Professor and Head, Department of Plant Sciences, College of Agriculture, *University of Saskatchewan*

Dr. Scoles received a Ph.D. in plant breeding from the University of Manitoba. He is an associate editor of GENOME, an International Cytogenetics Journal and is also President of the Genetics Society of Canada.

Raphael Thierrin, Past Chair, *Canadian Environmental Network*, Biotechnology Caucus

Mr. Thierrin is a graduate of the Faculty of Environmental Design at the University of Calgary. He is active in environmental matters especially as they pertain to biodiversity and biosafety. Through his company, ECOBIO Designs and Business Services he consults with corporate and government clients.

Dr. Burleigh Trevor-Deutsch, Chair, *BIOTECanada* Bioethics Committee

Dr. Trevor-Deutsch is a bioethicist in private practice, based in Ottawa. He consults at the Ottawa Hospital, General Campus and chairs the Ethics Committee of the Ottawa Hospital, Riverside Campus. He has served as consultant to Health Canada and Industry Canada and is currently an advisor to the World Health Organization. Dr. Trevor-Deutsch also chairs the Bayer Advisory Council on Bioethics and is an Adjunct Professor in the Faculty of Medicine, University of Ottawa.

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