Section One: Practice

The story of the *Choices and Challenges* Project

My involvement during the 1999-2000 academic year as Forum Coordinator and Research Associate for the *Choices and Challenges* Project at Virginia Tech can be described in one word: frustrating. My desire to explore the guiding assumptions, practices and positioning of science-education-in-action is a result of my own frustration with naming and describing the "success" of the most recent *Choices and Challenges* forum: 'Reinventing the Human: The Six Million Dollar Body'.

The *Choices and Challenges* Project at Virginia Tech was established by Doris Zallen in 1985 as part of the Humanities, Science and Technology concentration (a college minor), modeled on a similar project initiated by her at Nazareth College in Rochester, NY in the early 1980s: *Science and Morality – A Dialogue Between Scientists and Moralists*. The narrative of *Science and Morality* provided by Zallen and Colleen Clements in the introduction to an edited collection of the papers presented at the first (and only) three *Science and Morality* conferences points to three motivating factors in its development: 1) emerging controversies resulting from scientific research; 2) the need for discussion about the ethical issues of such scientific research; and 3) the lack of mechanisms for such discussion.

> Scientific developments of the last thirty years, and especially the last ten, have had a tremendous impact within the scientific community and have raised many major ethical, moral, legal, and political questions for the whole of society. These questions have arisen in basic research areas and in actual clinical practice. Recombinant DNA is the prototype of an area of basic research in current biological science that is a focus of such concern. Ethical aspects have always accompanied the healing arts of clinical medicine, an activity that is applied science rather than a basic one. Recent advances in medical research, however, such as in vitro fertilization and techniques for prolonging human life, have particularly heightened the ethical issues. Yet despite the very great need, few mechanisms currently exist for a creative interaction involving the various groups whose participation would be crucial in meeting these new problems and challenges.
>
> To provide a forum for such interaction, Nazareth College of Rochester instituted a unique series of conferences with the title: *Science and Morality* – A Dialogue Between Scientists and Moralists (Teichler-Zallen & Clement 1982: i).

The *Choices and Challenges* Project is premised on these same factors. Both *Science and Morality* and *Choices and Challenges* are represented as one-of-a-kind mechanisms to encourage public discussion about the social and ethical dimensions of emerging sciences and technologies.

According to its public mission statement, the *Choices and Challenges* Project "represents a unique, ongoing effort to encourage the humanistic components of science and technology to be identified and addressed – and to engage public audiences as key participants in this process." [1] The narrative of the *Choices and Challenges* Project provided on its website, in press releases, and so forth, cites – again – dramatic scientific and technological developments in medicine, agriculture, and industry, among other arenas. A primary aim of the project is to help community members make decisions for themselves, their families and their region about the challenges these scientific and technological developments pose. To accomplish this task, the *Choices and Challenges* Project moves away from questions of scientific and technological merit, and focuses, instead, on what the humanities disciplines can offer to the decision-making process:

> Through historical studies, there is the opportunity to trace factors that have led to present-day policies and practices. Philosophical and literary analyses can reveal the tacit beliefs and hidden assumptions that often underlie personal or institutional

[1] This discussion uses, at its source for quoted material, the *Choices and Challenges* Project website as updated in March 2001, unless otherwise stated. This self-description of the project, so-to-speak, in many cases co-authored by Director Doris Zallen and staff, and its evolution from 1985 to the present, would form a very interesting analytical project in its own right, but not one that will be explored at length in this particular project. I will say that in the past months (from February 2001 to present), that the project self-description has undergone, in my mind at least, significant revision as we (the project team) have applied for and received such opportunities as an Innovation Award for Humanities Programs from the Woodrow Wilson National Fellowship Foundation, an internal grant from the Virginia Tech Center for Innovation in Learning to develop online learning modules around *Choices and Challenges* Project material, and an opportunity to present at the National Institute of Standards and Technology conference, "Communicating the Future: Best Practices for Communication of Science and Technology to the Public" on March 6-8 2002. This shift in language may or may not be a result of my own participation in the evolution of the project's self-description.

> action. And examination of ethical systems, legal theories, cultural standards, and theological thought can assist in evaluating the acceptability of proposed individual and public actions. (Website)

In this way, ideally, expertise in scientific and technological decision-making is broadened to included non-scientific professionals and public citizens.

The primary programs of the *Choices and Challenges* Project are its one-day forums held on the Blacksburg campus at Virginia Tech. These events (the 20th of which took place in Fall 2000, under my coordination) occur around a specific subject area, "ranging from new medical technologies to environmental and energy concerns to the relationship between diet and disease." Typically, the morning sessions are educational in intent, providing background information in science, ethical frameworks, and so on, in an effort to position all attendees as potential participants in the later discussions. Local and academic community members lead these breakout talks. The main session is a panel discussion in which "individuals representing expertise in a variety of professions discuss, with each other and with the participants, the various issues raised." Finally, in the afternoon, breakout sessions reconvene, to "provide participants with the opportunity to further explore specific issues of interest by choosing among a number of discussion groups." See **Figure 1.1** for a sample schedule, with text that appeared in a grant application written in Summer 2001 describing the sections and layout of the forum.

The *Choices and Challenges* series has experienced much success, both in terms of public participation:

> Attendance at the full-day forums has continued to grow until it now exceeds 500.
>
> For more than a decade, the main session of each forum has been broadcast, via satellite, to every region of the U.S. thereby bringing the forum to many thousands more. (Summer 2001 grant application)

and recognition:

> **Nationally:**
> The *Choices and Challenges* series has received national awards for its work: in the 1988 Frandson Competition of the National University Continuing Education Association (NUCEA) for "creative and innovative programs in the humanities" and the designation "Program of Excellence" by that same organization. In November 1999, the Virginia Foundation for the Humanities and Public Policy (the state council of the National Endowment for the Humanities) selected these forums for special recognition as a builder of bridges between science and the humanities. *Choices and Challenges* programs have been featured in publications such as *Humanities Discourse*, *Human Genome News*, *Teachers Clearinghouse for Science and Society Education Newsletter*, and the *American Journal of Clinical Nutrition*." (Summer 2001 grant application)
>
> **and Locally:**
> Tech President Charles Steger said programs like "Choices and Challenges" are important because "we have an obligation to be a responsible social institution and to raise key questions that foster public debate." (Michael Sluss, *Roanoke Times*, 6/6/00).

This type of success continued through the 20th forum: 'Reinventing the Human: The Six Million Dollar Body', which occurred on Thursday November 9th, 2001. See **Figure 1.2** for a description of this forum's focus. See **Appendix A** for further information on the 2002 forum. .

Registration	Ongoing; Open to the Public at No Charge
Morning Tutorial Sessions (1 hour, 15 minutes)	Five sessions are planned, running concurrently, to provide background information for subsequent forum discussions. These sessions are important. Members of the public, many of whom have been away from an educational environment for a long time, are frequently concerned about whether they will be able to understand the presentations and follow the discussions. By attending one of the tutorial groups, members of the public who might otherwise be reluctant to attend the forum, are provided a fuller awareness of the main issues and shown how humanistic analysis — philosophical, historical, cultural — can be used to gain a better understanding of these issues. Comments about these tutorial sessions obtained at past forums show how valuable they are for public audiences.
Main Panel Session (1 hour, 30 minutes)	All the panel speakers are eminent leaders in their respective fields and have already worked to develop links to other disciplines and to the public. In this way, an adversarial tone is avoided and real cooperation — a *partnership* in furthering understanding of the issues — can occur. Not only do the audience members benefit, but we have learned from past speakers that they themselves emerge from this experience with a more profound appreciation of the human aspects of scientific and technological activity.
Lunch (1 hour)	
Main Panel Question & Answer Session (30 minutes)	The session offers an opportunity for additional discussion between the panelists and the audience.
Policy Follow-up Sessions (1 hour, 15 minutes)	Five sessions are planned, running concurrently, each of which is geared toward an in-depth examination of policy options.
Reception (45 minutes)	

Figure 1.1
Sample Schedule, *Choices and Challenges* Forum

Reinventing the Human: The Six Million Dollar Body

Among the most dramatic achievements in modern medicine is the ability to replace body parts. Kidneys, hearts, livers can all be transplanted from one human to another. Artificial joints, bones, or heart valves can substitute for the real thing. These procedures have been used to promote the quality of life and extend the lives of the recipients.

Such remarkable advances are providing many new treatment choices. But they are also creating a number of challenges: Who is entitled to receive human organs when the supply is so limited – the youngest, the sickest, the nearest, the wealthiest? These procedures can be extremely expensive. How do we balance the costs against other urgent medical needs? And how do we decide?

Research currently underway - exploring the use of animal organs or of organs derived from stem cells – is raising still more challenges: Are these acceptable sources of organs? Are there limits to what should be done to extend an individual life? Is medicine changing what it means to be human?

Figure 1.2
11.9.00 Forum Description

On November 9th, between 450 and 500 persons attended all or part of this forum. The attendees were from a wide variety of local and regional communities, including: university, high school, and middle school students and their instructors; Virginia Tech faculty (from humanities, science, engineering, and veterinary disciplines); Virginia Tech staff; members of the local faith communities; medical and public health professionals (some receiving 4.75 hours in Category 1 Continuing Education Credit through the joint sponsorship of Carilion Health System and the *Choices and Challenges* Project/Virginia Tech); lawyers; professionals and researchers from the Virginia Tech Corporate Research Center; community activists; and so on. Additionally, a number of community members attended and spoke as 'organ donor recipients' from the audience – both in the main session's question and answer period, and the smaller discussion sections. Excerpts from the main panel session were played on the local NPR affiliate, WVTF, with commentary from local broadcaster Fred Echols. In April 2001, two 30-minute edited programs from the footage of this

forum were broadcast through the PBS Adult Learning Service as part of their distance-learning curriculum, available to 500 downlink sites throughout the country.

In Spring 2001, the *Choices and Challenges* Project received a grant from Virginia Tech's Center for Innovation in Learning to develop module-based learning activities as a resource for students and instructors of classes in Humanities, Science, and Technology (HST). The central element of each module is excerpts from the video and audio collections of the project, recorded at each of the twenty forums occurring since 1985. These recordings feature "eminent philosophers, scientists, historians, sociologists, and policy analysts examining social and ethical aspects of advances in science and technology." The 2000 forum, 'Reinventing the Human: The Six Million Dollar Body', is the second module to be completed, and all modules should be ready for course use in Fall 2002. In this format, numerous Virginia Tech students will participate in activities based on the 2000 forum. In the future, we hope that these learning modules will be incorporated across the university curriculum, in addition to their availability through the Virginia Tech Alumni Network and to a wide variety of web users and other interested groups.

In Summer 2001, the *Choices and Challenges* Project was selected as one of fifty projects invited to present at a poster session at a National Institute of Standards and Technology (NIST) conference entitled "Communicating The Future: Best Practices for Communication of Science and Technology to the Public" from a field of 150 submissions. The conference organizers described the selection process as based on the following criteria:

> … reviewers looked most favorably on those programs whose applications and supporting packages provided excellent scientific/technical content and crisp, clear writing and/or images understandable by lay audiences; considerable forethought in matching up potential audiences with the materials being produced, or tailoring existing materials to new audiences; a sincere effort or commitment to regular and meaningful evaluation; and a reasonable

> expectation that at least significant parts of the program could be adapted to other science communication efforts. (Gail Porter, NIST, personal communication 8.6.01)

This conference, originally scheduled for the third week in September 2001, has been rescheduled for March 6-8 2002, and I will represent the project in this context.

This narrative of the *Choices and Challenges* Project is one of measurable success. However, thinking as an STS researcher, rather than as part of the project, I remained trouble: What was the project actually accomplishing? Were we empowering people to think critically about emerging sciences and technologies, or were we, in fact, participating in shoring up divisions between scientific and technological experts and non-experts? How successful was the 2000 forum? How would we know?

My own concerns about the 'success' of the most recent forum were mirrored to a certain extent in the feedback generated by event participants. Attendees' comments ranged widely in level of detail and intent, but many addressed these three themes:

1. The role of discussion leaders and panelists and their positioning as 'experts' in comparison to the attendees who were positioned as 'audience' or 'spectators':

   > "I sensed a 'showmanship' on the part of some speakers who seemed unduly conscious of the TV cameras. The moderator was decently unobtrusive for the most part, and kept the discussion pretty much on track. Still, I would have preferred a give-and-take discussion involving the audience more. Good variety of viewpoints represented by the panel – but there was not much effort to compare & confront."
   >
   > "Strengths – Organization, planning; Success – I couldn't improve the forum being put together, logistically, any better; Weaknesses – Some of the earlier sessions, with the so-called 'experts' were not as open, or enlightening, as other sessions with more audience participation."
   >
   > "Use 'experts' to bring in a crowd, but don't lord their credentials so much, because in these issues, experts really have no more insight than others"

2. A lack of space for discussion and a frustration at time constraints:

   > "More time for discussion, questions."

"Allow the audience to interact during & immediately after the session."

"Have two repeat sessions in morning and two in afternoon, so we can attend a total of four."

"I wish I could have attended more than one!"

"Would be nice to be able to get information presented by other sessions; would give out a notebook with overviews of other presentations."

"I would like to have attended more of the sessions in the morning, focused on ethical issues. By the afternoon I was fairly exhausted – any way we can spread this out more?"

"Finally, a place to discuss & talk among ourselves & share information" (from a participant at the last break-out session)

3. Our failure to enroll important communities:

"How do we attract more 'decision-makers' who really need to think about ethical issues?"

"You need to promote the programs better at the High School & VA Tech level."

As an organizer and a participant, my own concerns included:

- The relationship presented between science, technology and society;
- The interaction between expert and non-expert knowledges;
- The level of success a one-off event can achieve;
- The potential mechanisms for achieving 'more' democratic decision-making processes about science and technology in the United States;
- The relationship between the *Choices and Challenges* project, the academic community, and the local community;
- Our failure to reach certain target audiences; and
- General concerns over the notion of community and community space.

For the last year, my duties as a Research Associate for the *Choices and Challenges* Project have shifted from forum coordinator to grant-writer and online learning module developer. In these contexts, however, the questions I've raised about 'what counts as success' for projects like *Choices and Challenges* remain overwhelmingly relevant – and these questions have become a central part of my research program.

The 'gaps' I witnessed on the day of the forum were highlighted by the earlier success of a first for the *Choices and Challenges* Project: the use of Judy Upton's play, *Pig in the Middle* (performed originally by the Y Touring TheatreCompany, UK) to present an exploration of the complex debate surrounding xenotransplantation (animal-to-human organ transplantation) through drama. As indicated in the press release I developed to publicize our local production of the play, the audience is introduced to four characters dealing with the very real possibility of using genetically-altered pig organs to replace kidneys in humans. See **Figure 1.3**.

In the UK, *Pig in the Middle*, as part of a trilogy of plays exploring the social and ethical dimensions of science and technology performed in 1995-1998, "has been universally acclaimed both by the worlds of science and the arts for their artistic achievement as first class dramas and as a ground breaking model for future drama's that bridge the worlds of science and the arts" (Y Touring Website). By Summer 1998, the three plays were seen by over 73000 young people, teachers, governors, parents, scientists and the general public in the UK. Lewis Wolpert, of *The Independent*, has written that the plays, followed by discussions in which the actors stay in character and interact with the audience, show a new way to increase the public understanding of science:

> Ways of engaging the public in debate on scientific issues, like the applications of genetic technology, are desperately needed. The way not to do it is for the media to provide images of scientists and their creations as monsters. But a highly imaginative theatrical venture by Y Touring theatre company may have found a brilliant solution. (cited in Y Touring Website)

For our performance we followed a similar format, and hoped to achieve some part of the success of Y Touring.

LOCAL THEATER COMPANY TO PROMOTE EXPLORATION OF ETHICS INVOLVED IN ANIMAL-TO-HUMAN ORGAN TRANSPLANTATION

BLACKSBURG, October 24, 2000—A locally based *ad hoc* theater company will perform Judy Upton's *Pig in the Middle* Monday, Nov. 6, at Baylee's Restaurant, 117 South Main Street, Blacksburg.

An opening reception will take place 4:30–5 p.m.

Pig in the Middle will be staged 5–6 p.m. (No Cover) Open discussion with the actors, director, and other audience members will follow the performance. Baylee's will open for dinner at 6:15 p.m. Audience members are encouraged to continue the community dialogue over dinner. Baylee's offers a variety of delicious local and international foods prepared to suit your budget and your taste, including a wide selection of vegetarian dishes. The *Choices and Challenges* Project, a public-outreach service of Virginia Tech, is sponsoring the play and opening reception.

Pig in the Middle presents an exploration of the complex debate surrounding xenotransplantation--animal-to-human organ transplantation--through drama. The audience is introduced to four characters dealing with the very real possibility of using genetically-altered pig organs to replace kidneys in humans.

Gemma is an 18-year-old diabetic, a vegan, and an animal rights activist currently being treated for kidney failure at the university hospital. **Ryan is** an athletic 16-year old, recently diagnosed with kidney failure, who is worried about the effect of ongoing kidney treatment on his future. He is offered the option of enrolling in a clinical trial involving the use of pig kidneys in humans.

Mum is Ryan's mother. She wants her son to have the best medical treatment possible and to make his own decision about the pig kidney, but is concerned about the risks involved in HIS receiving an animal organ. **Dr. Angela Mayhew** is a young, up-and-coming medical researcher and practitioner currently engaged in work on xenotransplantation. She offers Ryan the opportunity to participate in the clinical trial.

Upton's goal in writing *Pig in the Middle* was "to show how the issue of animal to human transplants will effect real people."

"The decisions that Ryan and Gemma have to make are ones that anyone of us may have to face in the near future," Upton said.

The production is being presented to promote discussion in the Virginia Tech and Blacksburg community. **Director Wyatt Galusky** feels that "too often issues like xenotransplantation can be kept at arms length because they seem so distant from everyday experience and everyday people."

"This distance inhibits sustained public debate on the ethics and implications of these emerging biotechnologies, even in communities such as ours, which have a close tie with their development," Galusky said. "However, public involvement in the decision-making process about these sciences and technologies is absolutely critical. The social and ethical issues tied to these new advances should be examined before decisions are made that will affect all of our lives. We hope that this play facilitates an open and sustained dialogue on this issue by making it more plausible and more personal."

Cast Members include **Amy Nichols** (Gemma), **Jody Roberts** (Ryan), **Denise Collins** (Mum), and **Brandy Ellen Cowing** (Dr. Mayhew).

This performance is being staged in conjunction with the Thursday, Nov. 9, Choices and Challenges forum on Reinventing the Human: The Six Million Dollar Body. The forum is open to the public free of charge and will examine the future of one our most dramatic achievements in modern medicine: the ability to replace body parts. Both activities are made possible by support from the Center for Interdisciplinary Studies and University Outreach at Virginia Tech.

For more information, write Jane Lehr at the *Choices and Challenges* Project Office, 254 Lane Hall (0227), Virginia Tech, Blacksburg VA 24061; phone her at 540/231-6476; e-mail her at choices@vt.edu; or visit the web site http://www.cis.vt.edu/choices&challenges.

Figure 1.3
Press Release, *Pig in the Middle*, 10.24.00

I believe we did. As I wrote to the cast and crew following the event, "We were thrilled by the standing-room only turnout for the production and the passionate participation in the informal discussion between the cast, director and audience following the performance. We feel that in an effort to create a public space to provide an opportunity for a community-wide dialogue on the emerging technology of animal-to-human organ transplantation, the *Pig in the Middle* project was an absolute success" (11.27.00).

In a way that the actual forum did not, the vehicle of the play seemed to create a public space that encouraged the participation of the attendees in the construction of discourses around xenotransplantation – and, in some cases, the disruption of dominant narratives about its potential risks and benefits. Both academic and non-academic speakers evidenced a comfort in critiquing the characters' actions AND the reasoning motivating the actions – including the safety and efficacy of the scientific research on xenotransplantation, not just the 'ethics' of animal research in general.

Audience members directly challenged the characters, even the xenotransplantation 'expert', Dr. Mayhew – whereas three days later, many forum participants felt restricted by the 'expertise' of the discussion leaders and main panelists. Why the difference? Was it because the actor playing Dr. Mayhew was explicitly participating in the conversation as a 'performer'? If we had produced the play with a scientist from PPL Therapeutics' Blacksburg branch 'playing' the part of Dr. Mayhew, would the challenges to this character still have occurred? Did the play's performance and the space in which it was developed (at a pub/restaurant in downtown Blacksburg, with informal seating, a minimalist set, and a

diverse audience) offer a different way of imagining what the entities of science, technology, and public are, and the relationship between them?

As described above, my work with the *Choices and Challenges* Project continues through the present: as public representative, research associate, and online module developer. Simultaneously, as an STS researcher, I remain invested in exploring the theories and practices of nontraditional science education projects and situating the *Choices and Challenges* Project within this arena – i.e., I am engaged in an ongoing process of sensemaking and evaluation of *Choices and Challenges* that has involved participant observation, archival research, and interviews with the director of the project, Doris T. Zallen. This particular writing represents and, in a way, records the embodied tension I have been living as someone working back-and-forth and in between theory and practice. It is an ongoing and difficult conversation.

Section Two: Theory

The structuring frameworks of nontraditional science education

Current approaches to nontraditional science education include programs located under the frameworks of Public Understanding of Science (PUS) and Scientific Literacy (SL). Historically, however, Jane Gregory and Steve Miller (1998) argue that "Popular science is at least as old as science, itself" (1998: 19), pointing to England's Royal Society of the 17th century as an early mechanism of education and popularization – Shapin and Schaffer's documentation (1985) of the three technologies of fact-making used by Boyle in his air-pump experiments, particularly the literary technology of *virtual witnessing*, can indeed be read as a form of science popularization. Targeted public information campaigns, along with public science appreciation campaigns, began in earnest by the 20th century – for instance, the American Medical Association's 1909 crusade against "quack" remedies (Gregory and Miller, 1998: 26). By the 1920s, 'popular science' was part of cinema newsreels, general interest magazines, and some novels (1998: 29). After World War II, communication of science news became further professionalized, with the establishment of the National Association for Science Writers (1998: 37-38). And, as is well known, following the launch of Sputnik in 1957, both traditional and nontraditional science education efforts were increased in the United States, including the American Association for the Advancement of Science (AAAS) publication *An Inexpensive Library: A Guide to Science Reading*, targeted at the "scientists of tomorrow" (40).

Gregory and Miller question whether current PUS and SL efforts of the late 20th century "in any way merit the label 'initiative', or has it all been said before?" (1998: 18). My question, however, is not with historical precedents for today's efforts. I wish to ask, instead, "With what purpose are today's campaigns occurring and for the benefit of whom?" These questions can be at least partially answered by examining writings promoting PUS and SL

approaches – and identifying the definitions of 'science' and the 'public' that are operationalized in these educational practices.

The impetus behind the current PUS push in the UK began with the publication of a 1985 Royal Society Report, *The Public Understanding of Science* (see: Wynne 1995; Irwin and Wynne 1996; Gregory & Miller 1998; Jasanoff & Wynne 1998). The working committee, chaired by Sir Walter Bodmer, was charged to:

- review the nature and extent of public understanding of science in the UK and its adequacy for an advanced democracy;
- review the mechanisms for effecting public understanding of science and technology and its role in society; and,
- consider the constraints upon the processes of communication and how they might be overcome (Gregroy & Miller 1998: 5)

The committee concluded:

> A basic thesis of this report is that better public understanding of science can be a major element in promoting national prosperity, in raising the quality of public and private decision-making and in enriching the life of the individual … Improving the public understanding of science is an investment in the future, not a luxury to be indulged in if and when resources allow (RS 1985, 9).

In this report, greater PUS is equated with state stability and greater public support for scientific and technological policies. In 1986, Bodmer, in a public lecture, was even more explicit – for him, greater public understanding of science would:

- limit worker hostility towards the introduction of new technologies;
- cause more informed decisions to be made by the public in terms of funding and policy;
- create better policies for science by government representatives; and
- bring about more informed individual decisions by providing individuals with the means to be able to sort out the plausible from the implausible (i.e., pseudoscience) (Bodmer 1986: 4).

In this lecture, Bodmer assumes that worker hostility, 'uninformed' decisions, and 'poor' (meaning unsupportive of scientific and technical development) policies, are simply the

result of ignorance that can be addressed through more information. A 1993 White Paper on Science Policy by the UK government, *Realising Our Potential: science, engineering, and technology* continues in this vein:

> Better overall understanding of science would, in our view, significantly improve the quality of public decision-making, *not* because the 'right' decisions would then be made, but because decisions made in the light of an adequate understanding of the issues are likely to be better then decisions made in the absence of such understanding (Cm 2250; quoted in Irwin & Wynne 1996: 5).

Again, poor decisions are made through ignorance – and greater scientific and technical knowledge can fix that. The knowledge just needs to be transmitted.

The 1985 Royal Society Report, and the policies and programs it generated, use the 'deficit model' of public understanding. As described by Alan Irwin and Brian Wynne this model begins with:

> an apparent assumption of 'public ignorance' in matters of science and technology – an assumption which has been bolstered by recent questionnaire surveys. According to these, the general public often lacks a basic understanding of scientific facts, theories and methodologies. Public controversy over technical issues is created by inadequate public understandings rather than the operation of science itself (Irwin & Wynne 1996: 6).

As Irwin and Wynne suggest, the deficit or 'public ignorance' model of public understanding of science creates boundaries between the public and science and scientific institutions, and focuses the attention of analysts, policymakers, the news media, science educators, and so on, only on the problematic/problematized public – begging the question, "just why aren't the public more responsive?" (Irwin & Wynne 1996: 6). In their review of PUS activities and frameworks, Irwin and Wynne identify two additional assumptions made in 'typical' PUS work: 1) science is assumed to be "an important force for human improvement, … offering a uniquely privileged view of the everyday world"; 2) science is always described and imagined as a value-free and neutral activity (Irwin & Wynne 1996: 6).

Wynne, for instance, finds these three assumptions at work in two common models of PUS practices:

- large-scale quantitative surveys of selected samples of "the public," which have been used to elicit attitudes toward science as well as to measure levels of public scientific literacy or understanding of science
- cognitive psychology, or the reconstruction of the "mental models" that laypeople appear to have of the processes that are the object of scientific knowledge (Wynne 1995: 369)

Wynne, after reviewing critiques of prototypical large-scale quantitative surveys (like the NSF measures of scientific and literacy here in the states) (M. Bauer 1992; Durant, Evans & Thomas 1989, 1992; and Martin & Tait 1992), concludes that "large-scale surveys of public attitudes toward and understandings of science inevitably build in certain normative assumptions about the public, about what is meant by science and scientific knowledge, and about understanding" (Wynne 1995: 370). In addition to privileging scientific knowledge, portraying scientific knowledge as neutral and value-free, and problematizing the 'public', these surveys "take the respondent out of social context and are intrinsically unable to examine or control analytically for the potentially variable, socially rooted meanings that key terms have for social actors" (Wynne 1995: 370) – meaning these large-scale surveys are based on the notion that scientific knowledge and facts are universal across time and space. Wynne concludes: "The survey method by its nature decontextualizes knowledge and understanding and imposes the assumption that their meaning exists independently of human subjects interacting socially" (Wynne 1995: 370).

In PUS projects modeled on cognitive psychology – those using the "mental models approach" as part of an attempt to understand the public understanding 'deficit' – Wynne

again finds an oversimplification of what science is and how it operates, as well as the continuing problem of decontexutalization. Mental models are

> simplified models of the world that organize new information into recognizable patterns; help generate inferences, causal connections, and predictions; and solve problems. They are thought to structure systematically the cognitions of laypeople about most areas of experience, including nature and technology … (Wynne 1995: 370).

Whereas mental models, when used in sociology and anthropology, are conceptualized as socially negotiated and dynamic, once this concept moves to cognitive psychology the mental models, according to Wynne's review, become static – stable resources within the minds of laypersons instead of context-based sensemaking systems (Wynne 1995: 370-371). Thus, as with the large-scale quantitative surveys, the mental models approach to PUS limits the analytical focus to examining 'the public' and its failure to understand the presented (universal) scientific explanations. Wynne, on the other hand, argues that rather than asking, "does it [the layperson's model] work?" or "is it correct?" researchers should, instead, be asking, "does this reasoning work here?" Wynne believes that what are often understood as inaccurate or incomplete understandings of science by PUS researchers *can* work as valid models in localized situations. However, the deficit model of public understanding operating in this case, as with the large-scale quantitative surveys, does not allow for this flexibility.

In the United States, scientific literacy (SL) campaigns likewise continue. For instance, in 1985, the American Academy for the Advancement of Science (AAAS), introduced Project 2061 "to help all Americans become literate in science, mathematics, and technology" (AAAS 2001). Like PUS, SL is seen as promoting a variety of agendas:

> Scientific literacy has been hailed as: the basis for democratic decision-making about public issues; necessary for global economic competitiveness and national security; crucial for the promotion of rational thinking; a condition for cultural literacy; necessary for gainful employment in an increasingly technological world; the basis

> for personal decision making about health-related issues; and necessary for the maintenance of the public image of science (Barad 2000: 225; see also Arons 1983; Prewitt 1983; Miller 1983, among others, for some of these perspectives).

John Durant's 1993 essay, "What is scientific literacy?" identifies three approaches to SL:

1. scientific literacy as "knowing a lot of science"
2. scientific literacy as "knowing how science works," i.e., the processes of scientific knowledge production
3. scientific literacy as "knowing scientific culture," including familiarity with the social structures of institutions of science (Durant 1993)

All of these conceptions of scientific literacy – despite their differences – rely on the assumptions identified by Irwin and Wynne as guiding most PUS work:

- science is value-free, neutral and universal;
- scientific knowledge is privileged over all other forms of knowledge; and
- the public is the problem – questions regarding what is 'understanding' and what is 'science' remain blackboxed.

These definitions of 'science' and the 'public' that emerge from the narratives of scientific literacy are critical to this analysis – they not only describe nontraditional science education, but they structure its practice.

Scientific literacy in the United States is intimately connected to the idea of citizenship and of state stability (Cohen 1952). This connection is longstanding. For instance, Karl Pearson, statistician, socialist, and positive eugenicist, wrote in 1888 that:

> The scientific man has above all things to strive at self-elimination in his judgment, to provide an argument which is as true for each individual mind as his own. … [Science leads to] sequences of laws admitting no play-room for individual fancy. … Modern science, as training the mind to an exact and impartial liberal analysis of facts, is an education specially fitted to promote sound citizenship (cited in Porter 1995: 75).

I.C. Davis, writing approximately 50 years later in 1935, echoed this sentiment. An individual with the proper scientific attitude will:

> show a willingness to change his opinion on the basis of new evidence; ... search for the whole truth without prejudice; ... have a concept of cause and effect relationships; ... make a habit of basing judgment on fact; and ... have the ability to distinguish between fact and theory.

Thirty years later, R. Morrison again emphasized the need for a scientifically literate public – without a greater literacy, the public becomes confused and unsupportive of science and of state support for science: "Too many of these processes [of science] have effects which, though beneficial in many respects, often strike the average man as a threat to his autonomy. Too often science seems to be thrusting society as a whole in directions in which it does not fully understand and which it certainly has not chosen" (Morrison 1969).

In the mid-1970s, B.P.S. Shen called for the promotion of three kinds of scientific literacy: practical, cultural, and civic. Practical scientific literacy is "the possession of the kind of scientific knowledge that can be used to help solve practical problems" that a person encounters on a day-to-day basis in his or her own life (Shen 1975: 45). Cultural scientific literacy "is motivated by a desire to know something about science as a major human achievement. It is a cultural adventure" (Shen 1975: 49). Civic scientific literacy, on the other hand, aims to "enable the citizen to become more aware of science and science-related issues so that he and his representatives would not shy away from bringing their common sense to bear upon such issues and thus participate more fully in the democratic processes of an increasingly technological society" (Shen 1975: 48). Trained commonsense of the undifferentiated public, Shen felt, would necessarily coincide with decisions supportive of science and technology at the individual and the policy level.

The 1983 report of the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology offers further support for the connection between

stability and scientific literacy: "Our children could be stragglers in a world of technology. We must not let this happen; America must not become an industrial dinosaur. We must not provide our children a 1960s education for a twenty-first century world" (cited in Fausto-Sterling 1986, 295). Angela Barton, in looking critically at adult science education, links it with the development of secondary school science education through the common goals of 1) the promotion of citizenship, 2) moral education, 3) practical curriculum, and 4) meritocratic pedagogy (Usher, Bryant, & Johnston 1997, cited in Barton 1998, 124). She concludes: "These four major goals dominate all levels of schooling. Although they play out in different forms, the intention is universal: to maintain society" (Barton 1998, 125). A stable citizenry is a product of adequate science education.

What is motivating this group of writers, scientists and policymakers urging greater public understanding of science and scientific literacy? One feeling that unites this group is a fear of what 'uneducated' citizens would mean to the operation of the state and scientific and technical development. For instance, Wharton and Clifton worry that as "more and more people use modern technology … fewer (relatively speaking) understand how it works" (1981). Instead:

> [W]e are content to be served by cadres of technicians and specialists and, thereby, to cede to them an inordinate, even ominous amount of control over our lives. The great mass of people, including many college graduates, are at least arguably in danger of becoming what a recent rather inflammatory book called "techno-peasants": modern-day serfs, nominally free but disenfranchised by ignorance – and fear – of prevailing technologies (Wharton & Clifton 1981).

A 1983 special issue of *Daedalus* devoted to exploring the need for scientific literacy asked:

- Why is such ignorance or "illiteracy" is hazardous?
- How does it impede social and economic progress?

- What does it do to make certain individuals feel alienated and uncomfortable, never wholly at ease even when not required to cope with complex machines or technologies?
- Why does such illiteracy have larger implications for the society as a whole? (Graubard 1983: v).

The goal, then, of scientific literacy campaigns, emerges as a goal of avoiding the instability of a population of scientific illiterates among the general public. As noted above, a lack of public understanding of science leads to:

- worker hostility towards the introduction of new technologies;
- uninformed decisions to be made by the public in terms of funding and policy;
- poor policies for science by government representatives; and
- less informed individual decisions and a confusion of the plausible with the implausible (i.e., pseudoscience)

But is this the only goal of scientific literacy and public understanding of science campaigns in the US and UK?

Certainly, training the public to respond in a specific way to scientific and technological developments and further training them to support policies supportive of science and technology is of benefit to the stability of any state, particularly post-industrial nations pushing the boundaries of scientific and technical research through public money – like the United States, and to a lesser extent, the United Kingdom. In this light, nontraditional science education training can be read as a large-scale "body project" reminiscent of what Foucault (1975/1995) describes as the third phase of discipline in the history of crime and punishment: "the body subjected to training," disciplined by forces aimed not at the body, but at the soul (1975/1995: 131). Foucault argues that the construction of this 'docile body' within the prison system is representative of the construction of normalcy and docility within the public-at-large, and that his book should serve as "a historical background to various studies of the power of normalization and the formation of knowledge in modern

society" (1975/1995: 308). In this case of nontraditional science education, measurable scientific and technical knowledge, combined with a respect for the privileged position of this knowledge and an understanding of it as neutral, value-free, and universal becomes defined as the normative position, or discipline, for members of the non-scientist public. That is, the public, through PUS and SL campaigns, is trained to respect the authority of science and the given definitions of what it means to understand science. Furthermore, because this knowledge is quantifiable, the concerned public member can monitor his or herself against the established standard – thus, fulfilling Foucault's analysis, that at this stage of discipline power can be understood as being both "visible and unverifiable" (1975/1995: 201), inducing continual self-monitoring and self-observation.

However, ignorance is also clearly delineated. And what happens to the ignorant? Those labeled as ignorant (that is, without this sanctioned scientific expertise) do not have the opportunity to speak. This, perhaps, is a second less recognized goal of public understanding of science and scientific literacy campaigns – the creation of a class of ignorance. On the one hand, PUS and SL programs *do* aim to actively construct scientifically and technically savvy citizens. On the other hand, however, these programs construct a scientific and technical underclass by regularizing and compartmentalizing the non-scientist public into category (a) savvy or (b) ignorant. Either way, these PUS and SL theories and practices make those governed (the public) more legible to the government or the state. They and their measurements are an act of organization of the industrialized and post-industrial state.

James Scott (1998) uses the concept of legibility to discuss the production and maintenance of the modern state. Legibility refers not to an accurate representation of the area (or persons) under examination, but rather to a rendering of the subject under study in a way that allows it to be managed most efficiently.

> Certain forms of knowledge and control require a narrowing of vision. The great advantage of such tunnel vision is that it brings into sharp focus certain limited aspects of an otherwise far more complex and unwieldy reality. This very simplification, in turn, makes the phenomenon at the center of the field of vision more legible and hence more susceptible to careful measurement and calculation. Combined with similar observations, an overall, aggregate, synoptic view of a selective reality is achieved, making possible a high degree of schematic knowledge, control, and manipulation (1998: 11).

What Scott outlines is a process of coproduction: "What is distinctive about this logic … is the narrowness of its field of vision, the degree of elaboration to which it can be subjected, and above all … the degree to which it allow[s] the state to impose that logic on the very reality that was observed" (1998: 13-14). We know from Foucault's earlier work on ordering (1966/1970) that classification, itself, has a politics. Scott's case studies show that classification, in fact, can create realities based on its own reiterative categorization. Legibility – or radical simplification – according to Scott, provides the advantage of standardization, which allows for ease of observation and supervision from a centralized position of authority. The categories, themselves, become more important than the attributes they are said to capture.

Both categories, then, of bodies of the public that PUS and SL identify and produce – not just those who are or become scientifically literate – work to the benefit of state stability. That is, both ignorance and this certain type of scientific expertise created by PUS and SL training are active constructions of different types of 'docile bodies'. The goal of this type of PUS and SL is not so much to train the public in science, but, more importantly, to be sure

that the only categories in which the public fits are either a sanctioned expertise or a sanctioned ignorance. If these remain the only two categories, there is, in fact, no reason to involve the public at all in the scientific and technical decision-making process. The sanctioned expertise provides a given support for scientific and technical development; those labeled as ignorant have nothing to add to the discussion.

In contrast and as a form of resistance to an institutionalized legibility inscribed by a centralized state power, Scott points to local practices based on flexibility and an understanding or recognition of incomplete knowledge – that knowledge is a continual, ongoing rather than fixed process of sensemaking. Scott refers to this type of knowledge as *metis*, a knowledge that "can be acquired only by long practice at similar but rarely identical tasks, which requires constant adaptations to changing circumstances" (1998: 177-178). The concept of *metis* provides a different lens for understanding what members of the non-scientist public *do understand* about science and technology. Scott's book makes an implicit, and sometimes explicit, case for "*metis*-friendly institutions". What would public understanding of science and scientific literacy approaches and campaigns look like if they were reshaped to be "*metis*-friendly"? Below, I argue that contributions to our mapping of the relationship between science, technology, and the public developed within the field of Science and Technology Studies offers critical suggestions for how to begin.

Section Three: Practice

Structuring *Choices and Challenges*

As a practitioner, however, I am not entirely convinced by this account – a theory that begins with theory, not with evidence.

A more accurate reading of *Choices and Challenges*, as an educational and public institution, would see it as simply not challenged the *status quo*. This lack of challenge is not part of a pattern of power reification, but rather determined by the project's institutional history and the resulting organizational structure. For instance, the *Choices and Challenges* Project staff publicly identified the following ongoing dilemmas for the poster session of the NIST Best Practices Conference discussed above:

- Without a constant source of funding, all projects like this are in a tenuous position. Fundraising is a labor-intensive process. As with all large-scale projects based at a university, there is always the danger that it will interfere with research and teaching.
- Follow-up remains the most difficult part of our project. Our newest approach is the production of web-based learning modules using video extracts of the forum's main session in combination with a variety of useful links, synchronous and asynchronous chats, and other module-based learning activities. Of course, efforts to promote continued discussion can conflict with time required for fund-raising. (NIST, *Choices and Challenges* poster, 2001-2002)

Moreover, my own frustration with *Choices and Challenges* can again be explained in many ways as a product of this institutional history.

Institutional location has played a large role in the history of both *Science and Morality* and *Choices and Challenges*. *Science and Morality*, as briefly outlined above, began in Rochester, NY in 1979. As the director and founder of the project, Doris Zallen, tells the story of its inception:

> I think you've heard this story several times. I was working, doing laboratory science at the University of Rochester and, I was developing a new prenatal test, and discovered, to my amazement, that people when we were doing clinical trials, that a lot of people who came in … I mean, they did it out of some sense of civic duty or to help a family member. But they, themselves, had absolutely no personal interest in the tests that I had developed. And, you know, were really quite unhappy about it.

> And so that caused me concern in terms of – was this the right thing? the ethical thing? And why didn't people appreciate the kinds of genetic information that I could now provide them? – that we didn't have before. I also faced things in working with families in which I found non-paternity. And I didn't know what my obligation was as a researcher to share that information with the putative biological father. So I began to grow more and more interested in ethical issues in science, and discovered that there really wasn't much of a literature on the kinds of things I was facing in the laboratory. (Zallen, Interview, 6.20.01)

Zallen's narrative here – combining both the individual recognition of the need to explore the social and ethical dimensions of science and the solitary positioning of herself as alone in recognition of this need – is a story that I *had* heard several times before. She similarly positions herself in the preface to her 1997 book, *Does It Run in the Family? A Consumer's Guide to DNA Testing for Genetic Disorders.*

> Each new era in medicine has brought with it both promise and problems. At the start, hopes arise that we can, at last, defeat disease and improve the quality of human life. Invariably, this is followed by the realization that the new medical advances have themselves created new difficulties and dilemmas. So it is with the era of genetic medicine on which we have just embarked.
>
> We are now in a period of rapidly deepening knowledge of human genetics. This knowledge permits an unprecedented understanding of the relationship between our genes and our health. It offers the promise of better treatments for genetic disorders, perhaps (someday) even cures. It gives us the genetic test, a new way of gaining information about ourselves. But genetic information often includes an element of uncertainty. And genetic information is laden with baggage. This baggage is historical, ethical, emotional, social. In some circumstances, the information can be useful and important; in some, it can be trifling or insignificant. And in some circumstances, it can be harmful.
>
> My own introduction to the complex tangle of issues surrounding genetic tests came very personally. In the early 1980s, while a researcher at the University of Rochester School of Medicine, I was working on developing some early forms of genetic linkage testing. In my contact with the families taking part in those studies, I became keenly aware of the mixed effects that this new form of genetic testing could have, even for different members of the same family. Since 1983, as a faculty member in an interdisciplinary humanities and science-studies program at Virginia Tech, I have concentrated on examining the ethical, historical, and public policy aspects of genetics (*ix*).

When Zallen first began to struggle with these issues at a personal level in the lab at the University of Rochester's Medical School, her simultaneous appointment as a faculty

member in Molecular Biology at Nazareth College (a small, private teaching college also in Rochester) allowed her the flexibility to explore these concerns in a setting outside the laboratory. At Nazareth, she found a) supportive colleagues; b) academic freedom to develop new courses; and c) institutional resources.

> [I was] grappling with some of these ethical issues all by myself. And it happened that one day at lunch, at Nazareth, I was meeting with a couple of colleagues, talking about these ethical issues. They were very interested in them, and suddenly, the idea appeared – and I'm not even sure whose idea it was – to kind of have a conference on ethical issues. But as soon as the idea appeared, I immediately saw the value, in a very selfish way for me – a quick way for me to educate myself about the social and ethical issues in my work. (Zallen, Interview, 6.20.01)

The result of this conversation – *Science and Morality* – was the "original version of *Choices and Challenges*." Each conference took place over three days, and covered a variety of topics. Critically, Zallen was able to coordinate these conferences due to the institutional support provided by Nazareth College. Zallen emphasized, "It was possible to do this financially because Nazareth College gave it financial support. Though I did, occasionally, raise money from the Gannett Foundation – really and truly almost all the support came from Nazareth" (Zallen, Interview, 6.20.01). This support resulted in a fantastic opportunity for *Science and Morality*: multi-day conferences with "leading experts" from a variety of fields – free and open to the public "allowing for a strong public component." Zallen from the onset "saw [*Science and Morality*] as a forum to air social and ethical concerns and to give people information that they could use in making personal decisions or making decisions that need a community contribution" (Zallen, Interview, 6.20.01).

Choices and Challenges, on the other hand, has a very different history of institutional support at Virginia Tech. When Zallen came to Virginia Tech, she was charged with curriculum enhancement as part of the newly launched humanities program, funded by a grant by the

National Endowment for the Humanities. She went to the director of the Humanities, Science & Technology program, Joseph Pitt, with the idea of doing curriculum enhancement based on the success of *Science and Morality* series at Nazareth.

> I gave him this plan. It was based on Science and Morality at Nazareth College, and I sat back and said, "What do you think?" and he said, "It's wonderful." And I said, "Well, can I do it?" and he said, "Well, if you can raise the money." And that was the first time – remember, at Nazareth, they came up with the money. And it was never an issue. If I needed more money, you know, a private school can do this. Now, it was very clear that not one nickel was going to come out of Virginia Tech to support this. And that was true for a very long period of time. And every, every cent that was *Choices and Challenges* had to be raised from outside (Zallen, Interview, 6.20.01).

Raising money to fund the forums and staff has been a continual issue for the *Choices and Challenges* Project. When questioned about her disappointment that the model of *Choices and Challenges* has not been used at other locations, Zallen replied:

> Yeah, I really saw this as a model, and that people would be able to take it up at other places. I had those visions originally; I had visions of really changing the world. *First of all there's the money problem* – raising the money to do it. It's one thing to support an idea, and it's another thing to put resources behind it (Zallen, Interview, 6.28.01).

Again and again, raising money has taken time and precedence over whatever other activities would be possible.[2]

In addition to this tenuous support situation, and thus the ongoing problem and job of fundraising, *Choices and Challenges* as a project is further structured by its simultaneous placement at Virginia Tech as both a 'curriculum enhancement' and 'community outreach project'. The type of curriculum enrichment that *Choices and Challenges* provides is a system of analysis of controversies generated by advances in science and technology. It is a skill set,

[2] See Appendix B for a graph showing how *Choices and Challenges* has been funded since 1985. While amount given is not provided, Zallen has indicated that many of these sponsors provided $500 or less. Furthermore, bear in mind that the Virginia Foundation for the Humanities considers $8,000 to be a "big grant" (Interview, 6.28.01).

and also an opportunity for students to witness 'real people' grappling with 'real issues'. Zallen indicated that as soon as *Choices and Challenges* began, it was built into the Humanities, Science, and Technology (HST) program, and "it became valuable there pretty quickly. The students seemed to benefit from it and to really like it" (Interview, 6.28.01). For the purposes of curriculum enhancement, the forums need to present consistent themes – Zallen indicated that these include:

> Well, there were themes of the locus of decision-making: how do you decide issues? Where is, at which points should the decisions be made? Who should contribute? That's of course part-and-parcel of every forum. There's the need to look beneath the issue itself, the dilemma itself – at what are the values that are coming into conflict? And, how do they, how are they weighted differently in different contexts? (Zallen, Interview, 6.28.01)

The forums provide the students with:

> a mechanism for dealing with any kind of ethical or social dilemma. This process of first, understanding the background, the scientific basis …and then looking at what are the possible consequences, what are realistic directions? What are the values, what are the issues that are emerging? And what underlies the issues? And, then, this process of weighing issues to see … how do you come to a decision? It has to be made in some decision-making locale, and then who makes the decisions is always an issue. So that's pretty constant from forum-to-forum. So it really didn't matter what particular issue we covered. (Zallen, Interview, 6.28.01).

For the students, then, it is the experience of the forum that is important. For the community, on the other hand, it is the issues.

Zallen believes that *Choices and Challenges* adds something to community – and it does this by providing a public forum that is unbiased and that provides space for the public and for scientists to engage in a dialogue. For instance, in a recent article in *The Roanoke Times* (06.06.01) discussing the questions raised about the health risks and ethical issues surrounding genetic engineering in Southwestern Virginia, Zallen insists that, "People have really been confronting these issues. Scientists don't have the corner on wisdom."

Unfortunately, scientists and concerned citizens "too often talk past each other when discussing ethical issues in science and technology." Of scientists, she continues: "It's not that they're bad people, but nothing in their training prepares them for dealing with these issues in a public setting, so they often appear to be speaking in a foreign tongue." However, "others must bridge the communications gap." She thinks that, "the professional societies can do that. Institutions of higher education can do that."

Choices and Challenges is then positioned in the article – and by Zallen more generally – as a specific mechanism to bridge this gap between people who do not have the ability to speak with each other. *Choices and Challenges* brings "people together. We create a level playing field. Everyone is urged to speak in a normal language." She continues, "We [at the university] should have no agenda except the truth and good policy."

These factors – the continual need for funding and the simultaneous positioning of the *Choices and Challenges* Project as community institution and curriculum enhancement – have worked to structure *Choices and Challenges* towards:

- *The performance of balance and the strong desire to appear unbiased at all times*: first, this desire stems from a need to seek money from funding institutions which seek to promote discussion rather than offer a particular viewpoint; second, the need to be credible and to provide a forum for community members and experts with a variety of opinions to engage in a dialogue with each other; and third, the goal of providing an educational environment for Virginia Tech students;
- *The goal of replicability*: first, funding agencies and other partners (such as PBS) need to see a unique track record of success in order to invest in the project; second, as a community institution, community members should be able to attend each forum and feel comfortable; third, the students deserve the same experience of the forum year after year.

These two goals are what, in the end, actually do structure the way that the *Choices and Challenges* forums are organized – and what, at least partially, determines the experience of forum participants. For instance, Zallen has recounted how she has,

> always tried to get a balance [on the Main Panel] – because, otherwise, it wouldn't have any credibility with the public. If people think they're being fed a canned program, or a hidden agenda, that they're not going to participate, they're not going to value it. It's always important to get a balance. Now, that doesn't mean the day of the forum it comes out balanced – if you have a really superb presenter on one side, and a kind of weakfish presenter on the other – then the final product may be a bit tilted. But that was never the intent or design (Zallen, Interview, 6.28.01).

The forum structure – discussed in section one and reprinted in **Figure 3.1** – repeated again and again as part of the unique track record of *Choices and Challenges*, is what hooks the funding agencies, coupled with a main panel session that is always composed of outside experts (scientists, ethicists, historians, philosophers, and policymakers) that present an array of viewpoints, but never from opposite sides of the spectrum. Replicabilty and balance determine how main panel participants are chosen; how the forum events are organized, and how they are portrayed. This is the answer to the problem of *Choices and Challenges*, not the desire to stabilize the state.

Registration	Ongoing; Open to the Public at No Charge
Morning Tutorial Sessions (1 hour, 15 minutes)	Five sessions are planned, running concurrently, to provide background information for subsequent forum discussions. These sessions are important. Members of the public, many of whom have been away from an educational environment for a long time, are frequently concerned about whether they will be able to understand the presentations and follow the discussions. By attending one of the tutorial groups, members of the public who might otherwise be reluctant to attend the forum, are provided a fuller awareness of the main issues and shown how humanistic analysis — philosophical, historical, cultural — can be used to gain a better understanding of these issues. Comments about these tutorial sessions obtained at past forums show how valuable they are for public audiences.
Main Panel Session (1 hour, 30 minutes)	All the panel speakers are eminent leaders in their respective fields and have already worked to develop links to other disciplines and to the public. In this way, an adversarial tone is avoided and real cooperation — a *partnership* in furthering understanding of the issues — can occur. Not only do the audience members benefit, but we have learned from past speakers that they themselves emerge from this experience with a more profound appreciation of the human aspects of scientific and technological activity.
Lunch (1 hour)	
Main Panel Question & Answer Session (30 minutes)	The session offers an opportunity for additional discussion between the panelists and the audience.
Policy Follow-up Sessions (1 hour, 15 minutes)	Five sessions are planned, running concurrently, each of which is geared toward an in-depth examination of policy options.
Reception (45 minutes)	

Figure 3.1
Sample Schedule, *Choices and Challenges* Forum

Section Four: Theory

Science and Technology Studies

– Reimagining the relationship between science, technology and the public

As an STS scholar, however, I am not willing to fully make sense of *Choices and Challenges* by its organizational and institutional history alone. From this position, what I see as structuring the program is Zallen's conception of the relationship between science and the public. Classification does have a politics (Foucault 1966/1970) – and the way that Zallen classifies what counts as science, the relationship between science and society, and how the public can participate in the decision-making process provides the rules for the format of *Choices and Challenges*.

Zallen sees, "science is a human activity, and it emerges from a human environment" (Interview, 6.20.01). It is an activity located in the laboratory, the "study of the natural world using tools of analysis that reveal how nature works" (Zallen, Interview, 6.20.01). Yet, science is simultaneously an emotionally fulfilling job for scientists.

> science is also an emotional thing. When I was working in the lab, there's that wonderful moment when you find out something that nobody else knows. And, it doesn't have to be a big thing, you know, that DNA's the genetic material. It could be just a small thing: there's certain proteins produced in breast milk … I discovered that and I was, for that moment, the only one – then I went around and told everybody – and that was another part of the emotional aspect, the sharing, the high that you get. So it has that aspect to it – the pleasure of it, endorphins that flow when you are able to see something that nobody else sees. … And you'll ask, well, maybe somebody else knew this, and I didn't know it … but it didn't matter to me. Because at that moment, as far as I knew, nobody else had known it. You know, that was good enough. (Zallen, Interview, 6.20.01)

For Zallen, "Science as an enterprise is always filled with uncertainty, and that's what a lot of people in STS *don't* seem to appreciate. … Scientific truth is not Truth with a capital 'T'." Scientific truth is "just incomplete. And some of it still is. So, uncertainty is the nature of science, and I suppose that it becomes part of the questions that science raises" (Zallen, Interview, 6.20.01).

This conception of what counts as science also works as a boundary for all discussions that occur at the *Choices and Challenges* forums.

> It became apparent that you couldn't discuss the issues intelligently without including in every program, some information about the scientific and the medical background from which the issues emerged. This was a decision made to keep the issues in the realm of the real world. At that time, this was the early *in vitro* babies, and there was a whole lot of hype in the media especially about the reproductive technologies. And a lot of stupid stuff – things that either weren't going to happen or could never happen, or weren't going to happen for another thirty years. So I wanted to limit the discussion to the area it was useful, which was: what do we need to do now about what's happening now? Or is about to happen in the next few years? So, I never regarded any of this as science education. I do accept that you can't talk in a vacuum, you can't talk about nonsense, you can't talk about science fiction. You've got to talk about the real world. And for that you have to include the real world parameters. And so science education *does* get done … as part of the forums, but it was only sort of a matter of education of necessity – you know, what you're talking about. It was always – I always saw it as a forum to air social and ethical concerns and to give people information that they could use in … making personal decisions or making … decisions that need a community contribution. (Zallen, Interview, 6.20.01)

For Zallen, the social and ethical dimensions of science are distinct from the practice of science, and science keeps the discussion centered. Science is what is done by scientists. The social and ethical dimensions are done by someone else. This has been the case since the original series, *Science and Morality*. In the introduction to the edited volume that Colleen Clement and Zallen produced based on the papers at those conferences, note how the separation between science and the social and ethical dimensions is complete and how science, again, works as a boundary setter for the discussion – what is allowed and what is not:

> In designing the programs, considerable emphasis has been given to establishing communication between the disciplines and to achieving a balanced interdisciplinary approach. The scientist participants were contributors to their fields who have also previously addressed ethical issues. The ethicists (philosophers and theologians) were already familiar with scientific literature and terminology. This assured that actual dialogue and relevant discussion could take place. Attention to accurate assessment of the scientific and clinical foundations also allowed the unrealistic outcomes, or scenarios that are more science fiction than science and that only create confusion, to be ruled out. The audience was composed of individuals of diverse backgrounds and interests and included members of academic and medical school communities,

> theologians, lawyers, medical practitioners, and the general public. Such a melting pot of interests and expertise serviced encourage open and informed discussion (Teichler-Zallen & Clement 1982: i).

Yes, there are early signs of what you have termed in the previous section, the goal of a 'performance of balance' – but I would argue that, in part, this push towards balance is predicated on the idea that, on the one side, you have scientific expertise – and on the other, as a balance, you have extrascientific expertise.

For Zallen, however, science – beyond being emotionally fulfilling – is motivated by society, in terms of which areas to research, which areas are funded, and so on. Science – as a knowledge system – does have an impact. Zallen, herself, was in fact motivated to move from plant genetics to human genetics by a close friend's struggle with a genetically-linked disease, Muscular Dystrophy. This was the period when she first began to see links between science and society.

> Well, I came to it late because, again, it was the families of these people who were looking at my work with sadness even, that I began to realize that science has an impact in the real world, and began to appreciate the connections back. Why was I even studying this issue? Well, because I was studying muscular dystrophy. Because … I had a friend who had two children with a form of muscular dystrophy. And it was … this person, my friend, who I loved and cared about, and the pain and the suffering of that family, that moved my work from plant genetics into human genetics. Very quickly. I'd always been interested in human genetics. It wasn't a ripe subject for study until the 70s, really, with the recombinant DNA techniques. But it was … her, trying to help them understand what was going on, that made me change from the genetics of photosynthesis – which intellectually is very fascinating – into another area. So, I think I began to see the connections. Also, I could get support for that work through the Muscular Dystrophy Association. The science became much more complicated as I did more work. So I saw the social aspects of it. But not initially. Because I was just … well after graduate school. Up until then, I believed firmly that it was a wonderful activity, very satisfying, but that the social issues were dealt with in another realm. And you still here that. I still here that when I go to the UK. … I don't believe that anymore. Or, even the choice of a topic, even the decision to label someone with muscular dystrophy as 'abnormal' is – it's not a scientific decision (Zallen, Interview, 6.20.01).

This empathy with her friend caused Zallen to reevaluate the relationship between science and the public, and to include the social and ethical dimensions of science in her thinking about science – but rather than a broad definition of science, this plays out as 'multiple – and yet separate – realms' that she as a scientist began to consider.

The public, the community – as previously noted – is important to *Choices and Challenges* – they are an important contributor to the event, but one, again, with a distinct set of expertise from the scientists or the ethicists who participate. Since the beginning with *Science and Morality*, Zallen has believed that there is expertise outside of the scientific community (Interview, 6.20.01). However, Zallen has remained constant in her demarcation between the expertise that scientists, ethicists, and the public can provide. I questioned her directly:

> You haven't used the term expertise in this discussion, but you have touched on the idea of public (however you want to define 'public' here), [that the public] does bring different types of knowledges to the table. [How does this fit with a] discussion about 'lay knowledges' and 'lay expertise', and 'lay activism' and how does this relates to scientific expertise? Do you see a specific relationship between those types of knowledges? (Lehr, Interview, 6.20.01)

She replied:

> Well, I never use the word 'lay' because that immediately sets up a hierarchy in which somebody knows more than somebody else, you know, that 'lay knowledge' is given less clout. So I try to use public. Now, but then you'll say, how do you define public? And there I'm still struggling. I use the word expertise for both groups – there's scientific expertise and there is the extra-scientific expertise that the public brings. And that's almost more precious because they gain it one at a time by living their life over a very long period. Whereas I used to do an experiment in a day and get an answer, but the other, the extra-scientific expertise might take you years to finally figure out that the certain path, or a certain procedure, or a certain constellation of actions is really better than another constellation of actions. So, I find that it's more valuable – public expertise. … That's so precious. … I'm very grateful to have the public component. I saw that at the first *Science and Morality* conference, meeting people who were talking about end of life issues … and it was a revelation how much more I was learning from the people sitting in the audience than the people on the stage. But, the scientific expertise is important, too, because it sets the boundaries – you know, it tells you what you can do, what you know, what you don't know what you can find out and what you can't find out (Zallen, Interview, 6.20.01)

Zallen was learning more from the people in the audience – yet scientific expertise has remained, after twenty years, on the stage. It is still distinct from what members of the public have learned – even distinct from what her friend, struggling with 2 children with MD has learned. As a non-scientists, that knowledge remains extrascientific.

This understanding of the relationship between science and the public echoes – though in a more benign way – the relationships I charted within the Public Understanding of Science and Science Literacy frameworks. This definition of science guides more than a performance of balance at *Choices and Challenges*, but also the performance of expertise, both on the panel and in the small group sections. Look at what the comments you included from the audience members say: allow for more discussion among 'audience members'; control the role of 'expertise'. What would happen if scientific knowledge were not distinct or privileged? How would that changes the way the *Choices and Challenges* forums operate?

The scholarship found in the field of STS offers new ways of imagining and mapping the relationship between science, technology, and the public in decision-making, policy-making, and educational environments, not available in more traditional disciplinary narratives or training – and currently not available in *Choices and Challenges*. David Hess writes that STS provides

> … a conceptual tool kit for thinking about technical expertise in more sophisticated ways. Science studies tracks the history of disciplines, the dynamics of science as a social institution, and the philosophical basis of scientific knowledge. It teaches, for example, that there are ways of developing sound criteria for evaluating opposing theories and interpretations, but also that there are ways of finding the agendas sometimes hidden behind a rhetoric of objectivity. In the process, science studies makes it easier for laypeople to question the authority of experts and their claims. It teaches how to look for biases, and it holds out a vision of greater public participation in technical policy issues (Hess 1997: 1).

At its best, the matrix of actors working in and across the field of STS – academics, policy analysts, representatives from non-governmental organizations, social and environmental justice activists, science educators, politicians, representatives of regulatory agencies, and so on – create a space or a "forum where people who are concerned with the place of science and technology in a democratic society can discuss complicated technical issues" (Hess 1997: 1), in a manner that provides more equal opportunities for less privileged voices to speak and to produce knowledge.

What role can and should STS (as a discipline, as a theoretical framework) play in the practice of science education? What role does it play? STS is useful for the scholar-activist or citizen-scholar because STS asks new questions. For instance,

> What is the relationship between science and the state – between scientific credibility and political authority?
>
> What should the role of expert knowledge and citizen participation be in the scientific and technological policy decision-making process?
>
> Who should control the production of science *in* policy, and policy *for* science?
>
> How do individual citizens – and their level of scientific or technological literacy – relate to the successful functioning of science and the state?
>
> What should the balance be between scientific and nonscientific judgment, and is the distinction useful?

STS questions what constitutes 'science', 'understanding', and the 'public'. With these new questions come new answers – and a critique of old models of science, technology, and the public, including those represented within the Public Understanding of Science and Scientific Literacy programs discussed above, as well as *Choices and Challenges*. For instance, some scholars working within the field of STS argue that science and technology can be

understood through the idea of coproduction – the "idea that political order and knowledge are coproduced: that their construction is a tightly bound and reciprocal process in which neither can be understood as prior to the other" (Halfon 2000; see also; Jasanoff & Wynne 1998). This idea builds on previous work that "views the truthfulness of knowledge and the success of technology as the outcome of processes of social negotiation and conflict that involve marshalling resources via sociotechnical networks that in turn produce changes in society" (Hess 1997b, 149; see also: Latour 1987; Callon *et al* 1986; Law 1986). Here, the public, or rather, multiple and diverse publics, can be understood as integral to the production of knowledge and of the relationship between science, technology, and the state. In other words, STS can provide a radically different inquiry paradigm, or frame of reference, for thinking about science and science education.

What happens when normative definitions for concepts such as 'science', 'technology', 'expertise', and the 'public' become unstable? A space for intervention within the action of science and technology is created – and *metis* – Scott's concept of a knowledge that "can be acquired only by long practice at similar but rarely identical tasks, which requires constant adaptation to the circumstances" (1998: 177-178) – grows in importance. For instance, Steven Epstein's 1996 project, *Impure Science: AIDS, Activism, and the Politics of Knowledge*, points to successful (or effective) interventions at the level of medical research and clinical trials – the level of practice – by persons without training in science, technology, or medicine. These activists, often with high levels of training in non-technical fields, used tools and analysis from these other arenas to examine scientific, technological, and medical issues. This revolutionary shift in analysis and participation was predicated on the radical notion that science, technology, and medicine are not 'untouchable' or necessarily privileged

domains – and that expertise is a product of many lived experience, not simply scientific and/or technical training. Epstein's work shows that scientific and technical credibility is created by a process of negotiation over the management and resolution of scientific uncertainty (1996: 333). In this negotiation, position within the debate trumps so-called 'scientific facts', and knowledge is fluid, local, and contextual, rather than a stable resource (1996: 342).

A decade earlier, the *Our Bodies, Ourselves* project of the Boston Women's Health Book Collective is emblematic of the real-life intersection of feminist critique and medical practice. Begun in 1969 as a corporeal consciousness-raising group – that is, a group of women gathered together to learn about their bodies without the 'interference' or paternalism of the medical profession – the group eventually broadened their discoveries by offering courses to other women and publishing the first edition of *Our Bodies, Ourselves* in 1970. Critical to the enterprise was realizing both 1) that medical and scientific facts could be understood by "average" women without professional assistance and b) that talking about the experience of their bodies was just as important as understanding the 'medical facts' of them. In the 1973 preface to the second edition, the group wrote, "Once we had learned what the 'experts' had to tell us, we found that we still had a lot to teach and to learn from one another." Again, this project points to the fluid, local, and contextual nature of knowledge and expertise. *Metis*-inspired projects like this build – continually – from the ground up, rather than in top-down, global expertise driven manner.

Below, I explore the work of STS scholars Dorothy Nelkin, Sheila Jasanoff, and persons working under the heading of "critical PUS," such as Alan Irwin and Brian Wynne, to show

more clearly what STS can offer to nontraditional science education practices through its more sophisticated understanding of the relationship between science, technology, and the public. In different ways, the accounts of Nelkin, Jasanoff, and "critical PUS" provide a more complex understanding of power as it operates at a state, institutional, and individual level. Each of these authors troubles the categories of the public constructed by the PUS and SL programs discussed above: (a) the sanctioned expertise of the scientifically literate, trained to support science and technology; and (b) the sanctioned ignorance of the rest of the public that I discussed in section two.

Dorothy Nelkin: Controversy Studies

Sociologist and legal scholar Dorothy Nelkin's work on scientific and technological controversies remains a strong influence in (re)constructing the relationship between science, technology and the public – particularly around issues of expertise and uncertainty. Her edited collection of controversy studies (now in a revised 3rd addition) was published originally in 1979, and is one of the first books produced specifically for use in the classroom as part of an undergraduate education examining science, technology and society – "For, in the course of disputes, the special interest, vital concerns, and hidden assumptions of various actors are clearly revealed" (1992: vii). Nelkin believes that close study of public scientific and technical controversies,

> can provide students with a sense of the kind of reasoning that motivates public agencies, government officials, scientists and engineers, and protest groups. They can provide a realistic understanding of a science and technology policy, its social and political context, and its impact on the general public or in particular communities. Disputes can highlight the social contradictions inherent in many decisions about science and technology, and the problems of developing public policies in the absence of definitive agreement about potential risks (1992: vii).

Studying controversies also provides an explanatory mechanism for why disputes develop: *conflicting values and ideologies*, rather than ignorance, is the thrust of Nelkin's argument. In this way, Nelkin's portrayal of the public, and their at times "contradictory" responses to emerging issues in scientific and technological development is much more nuanced and multifaceted than the explanation of 'ignorance' used in PUS and SL work to explain public reactions. The 'public ignorance' or 'deficit' model of science education, through the lens of Nelkin's work, is inherently flawed and unworkable.

For Nelkin, "Controversies over science and technology [have always] revolve[d] around the question of political control: Who controls decisions about the development and application of science?" (Nelkin 1992; see also Nelkin 1979; Nelkin 1995). In the 1990s, she began to note the increasingly "moralistic spin" of current debates – over creation science, environmental issues, abortion, stem cell research, and so on – leading her to describe controversies today as both political challenges and moral crusades (1992; 1995).

The paradox of the relationship in the United States between science, technology and the public that Nelkin consistently develops is one of conflict between a public acceptance (and indeed pressure for) new science and technology versus a growing awareness of the associated risks:

> The persistent controversies over science and technology reflect a history of ambivalent public attitudes toward science in American society. The acceptance of the authority of scientific judgment has long coexisted with mistrust and fear … But controversies today also reflect the scale of science and its pervasive influence on contemporary life. Science these days is both a source of progress and a source of fear (1992: xi).

For Nelkin, controversies are also a reflection of "broader tensions in American society – the disagreements over the appropriate role of government, the struggle between individual

autonomy and community goals" (1992: xi). In this way, "science policy is no different from other policy areas … [and] Resolution of conflicts necessarily reflects the relative power of competing interests" (1992: xxi-xxii). Again, this type of analysis of controversy suggests that the relationship between science, technology, and the public is much greater than a sum of binary oppositions – the public occupies many positions, not just one (sanctioned expertise) or the other (sanctioned ignorance).

On the other hand, Nelkins' models do need to account for growing public ambivalence to science and technology: it is a "response to the obscurity and complexity of science, which appears to threaten the power of the citizen," and the growing importance of scientific and technical expertise in the decision-making processes (Nelkin 1992: xi). In the end, Nelkin's work on controversies points to the difficulty of including the multiple positions occupied by the public within the decisionmaking process, even after they are recognized. However, Nelkin's insight remains a substantial contribution towards beginning a productive dialogue between nontraditional science educators and STS scholars.

Sheila Jasanoff: Controlling the Crisis between Science & the State

Legal scholar Sheila Jasanoff's work points to a "crisis of confidence surrounding not only political but scientific authority" in the United States (1990: vi) – in contrast to the picture of science as a privileged form of knowledge, as provided in the nontraditional science education efforts, PUS and SL, discussed above. Jasanoff seeks to provide a more complete discussion of the "crisis of confidence" and potential "solutions" to the persistent problem of scientific and technological controversy, its impact on policymaking, and the possible roles of the lay public in this resolution.

For Jasanoff, this crisis of confidence links directly to problems in the apparatus of decisionmaking for scientific and technological policy. Jasanoff asks,

> How can decisionmakers make sure their policies affecting the health and safety of the American public and the quality of the national and global environment are not perceived as politically self-serving and scientifically unsound? How should agencies minimize the potential for bias and conflicts of interests in their dealings with advisory committees? Can scientists be more deeply involved in the regulatory practice without risking their political neutrality or, worse yet, actually making policy, and thereby eroding democratic controls on decisionmaking? Alternatively, can the scientific advisory process be organized in ways that further public participation but do not lead to the capture of science by political interests? (1990: vi)

She also highlights the issues of access to the highly technical debates, asking: "Is it possible – and if so, how – to preserve a meaningful role for the lay public and its political representatives in areas of decisionmaking that seem increasingly less accessible to those who do not possess specialized knowledge?" (1990: viii) In this way, the problem she identifies is similar to what Nelkin describes: how can knowledge and credibility be managed in a way that recognizes multiple forms of expertise (including non-scientific) in the decisionmaking process? However, her primary focus is not 'how and why controversies develop' but rather, 'how and why decisions are made about science and technology and what would make these decisions less controversial'.

Jasanoff (1990) argues against two commonly accepted paradigms for controlling the 'crisis' in the relationship between science and the state, and between scientists, policymakers, political representatives, and the publics:

- the "technocratic" approach [which] identifies the 'crisis' as a result of "technical incompetence" on the part of the decisionmakers; "favored by commercial and industrial interests, [the "technocratic" view] holds that the solution is to get more and better science into decisions … by expanding the role of the expert community in decisionmaking" (1990: 15-16); legitimation through experts (1990: 38)

- the "democratic" approach [which] locates the problem in the "failure of regulatory agencies to incorporate a full enough range of values into their decisionmaking"; this view asks for "mechanisms that will broaden the participatory base of agency action" and "modes of accountability" that are nonscientific (1990: 16); legitimation through public participation (1990: 38).

Why? She suggests that neither of these models works to satisfy the simultaneous scientific AND political character of scientific and technological decisionmaking:

> The notion that the scientific component of decisionmaking can be separated from the political and entrusted to independent experts has effectively been dismantled by recent contributions to the political and social studies of science. With the accumulation of evidence that "truth" in science is inseparable from power, the idea that scientists can speak truth to power in a value-free manner has emerged as a myth without correlates in realty. At the same time … it has become clear that broad citizen participation alone cannot legitimate decisions that do not command the respect of the scientific community (1990: 16-17).

This notion of the coproduction of the political and technical orders within the policy and educational arena is crucial to any future work done collaboratively by STS scholars and nontraditional science educators.

In later projects, Jasanoff continues to write about the relationship between scientific and technological decisionmaking and the public in terms like: the "unraveling of the postwar consensus on U.S. science policy" (2000: 45), "postmodern alienation (2000: 49), and "civic dislocation," the latter defined as "a mismatch between what government institutions were supposed to do for the public, and what they actually did" (1997: 21) leading to a decline in public trust of the government and scientific expertise culminating in disengagement from the state (as in the case of BSE, or mad-cow disease) (1997: 23). The reasons she provides for this continued 'civic dislocation' include "rising skepticism about the integrity of research" (2000: 50) and the growing "reliance on science to legitimate the slightest political demands" (2000: 51)

combined with "distrust of scientific authority" (2000: 52):

> As expertise is more widely shared, consensus becomes more difficult to achieve and the limitations of all expert claims become ever more transparent; expertise precipitates, in effect, an attack on its own authority. Coupled to this phenomenon of 'reflexive modernization' is the recent tendency of the liberal state to disavow regulatory responsibility for technological systems it previously sought to manage … the state's retreat has left large domains of productive activity in the control of agents whose accountability to the public is secured, if at all, only through the imperfect mechanism of the market (1997: 227).

In these articles, Jasanoff again locates the 'problem' of science and science policy today in the constructed gap between scientific and political expertise coupled with a lack of citizen input. Little faith in the public combined with an over-reliance on 'objective mechanisms' leads, in her words, to a situation in which, "the representations of the world that policy-makers respond to can drift dangerously far from the world than their fellow citizens experience and inhabit" (1997: 231). Jasanoff's recognition that expertise is at once political and scientific changes the way expertise is represented – rather than as a static entity, expertise becomes constituted in local and contextualized practices. This recognition, again, is Jasanoff's critical contribution to the emerging dialogue between science educations and STS scholars.

Alan Irwin and Brian Wynne: Critical Public Understanding of Science

The work of critical PUS scholars also seeks to provide a more complicated picture of science, technology and the public – and the fluid and multifaceted relationships among these categories. Brian Wynne, in his analysis of the two models of public understanding of science discussed above – quantitative studies and cognitive models – concludes that PUS (and likewise SL) ignores recent work in the history of science (what I have been referring to as the "field of science and technology studies"), which:

> systematically exposes how the tacit rhetorical constructions of the social order help constitute scientific knowledge (Golinski, 1991; Shapin & Schaeffer, 1985) and how this knowledge helps shape the social order, in processes of mutual construction of science and society. (Wynne 1995: 362).

Wynne contrasts these typical PUS approaches to emerging PUS research that, instead, begins from an SSK (Studies of Scientific Knowledge) or constructivist (STS) perspective, and which "attempt[s] to investigate how people experience and define 'science' in social life, and how particular scientific constructions incorporate tacit, closed models of social relationships that are or should be open to negotiation" (1995: 362).

What would this new, "critical" PUS look like? Namely, according to Wynne, it would share:

> a commitment to avoiding a priori assumptions about what "proper" science is. Through ethnography, participant observation, and in-depth interviews, it attempts to examine the influence of social contexts and social relations upon people's renegotiation of the science handed down from formal institutions as if already validated and closed. This general approach immediately opens to question the very notion of what counts as a scientific-technical issue or as scientific-technical knowledge. A common thread in all this research is the encounter of different cultures: on the one hand, scientific culture, which tends to reduce issues to those of control and prediction within the terms of the scientific field in play, and on the other hand, social worlds that reflect fundamentally different models agency and also recognize many more crosscutting and open-ended agendas and interests beyond those embodied in scientific discourse (1995: 375).[3]

This "critical PUS" begins with problematization of terms such as 'science', 'public', and 'understanding' – setting it apart from most other literatures examining this subject area, which problematize only 'the public' "and thus, in effect, help to propagate the existing

[3] In this article, Wynne identifies 6 areas in which qualitative, critical PUS research is prominent: medical sociology and sociology of public health; community responses to technological accidents, emergencies, and other forms of expert intervention; women's studies, especially in relation to reproductive technologies; environmental controversies, campaigning, and regulations; studies of lay uses of expertise, such as decision makers' use of toxic waste chemistry; lay residents' relationships with "building science"; or lay constructs of deviant knowledge such as UFOlogy; and anthropology of "Third World" encounters with scientific culture (Wynne 1995, 375).

institutionalized cultures and boundaries of science as natural and given, as a universal standard of judgment and 'rationality'" (1995: 384).

Critical PUS, on the other hand, "highlights the culture of control and standardization that characterizes scientific knowledge" – for it is this standardization, according to Wynne, "that engenders ambivalent responses from those who encounter it in the public. By constructing the public as ignorant, when that public may in its own idiom be expressing legitimate concern or dissent, scientific institutions inadvertently encourage yet more public ambivalence or alienation" (1995: 364-365). Furthermore, as I have argued above in section two, the way in which typical PUS and SL practices work to categorize and train the public based on a narrow concept of scientific literacy removes (or attempts to remove) the public from the scientific and technical decision-making process completely.

Examples of "Critical-PUS-in-action" are represented in the essays collected by Alan Irwin and Brian Wynne in their 1996 publication, *Misunderstanding Science? The Public Reconstruction of Science and Technology*. Irwin and Wynne parse the included articles into four categories of important contributions. The first two essays demonstrate that the *contexts in which public understanding of science takes place greatly shape what counts as science, credibility, and expertise.* Wynne's article on Cumbrian sheep farmers argues that trust and credibility are locally and culturally situated negotiations. In the second essay, Irwin, Alison Dale and Denis Smith focus on a specific instance of environmental inequity and injustice, and argue that a) science has no special status as knowledge within this context but that b) it often implicitly operates to sustain unequal power distribution.

Secondly, included essays show that *the public responds in an active rather than a passive manner to specific encounters with scientific and technical expertise*. Helen Lambert and Hilary Rose examine the situation of patients diagnosed with a genetic metabolism disorder, and describe an active process of making sense of and coping with medical knowledge production that is part of a continually modified, interpretive relationship between patients, experts, and science. Frances Price, in a case study on embryo imaging technologies, argues for a focus on science-in-the-making that includes recognition of the negotiation of knowledge and the importance of uncertainty to patients, medical practitioners and technicians.

The third insight is that *what is typically read as 'ignorance' or a simple deficit is, in fact, an actively constructed response to science and technology*. Mike Michael focuses on the reflexive and social character of the relationship between identity, lay scientific knowledge, and scientific expertise to argue this point. Rosemary McKechnie uses a case study on the Isle of Man to argue that not only is expertise negotiated in informal settings, but also in formal settings; at all times the role of the 'local' shapes and constitutes expertise in active relationships to manage ambiguity. Her main point is that concepts such as 'science', 'technology', the 'public', and 'expertise' are all 'social achievements'.

The fourth contribution offered by this collection again points to the importance of context, but, in this case, emphasizes that *contexts of public understanding, themselves, are always shifting.* Sharon MacDonald argues that within the museum setting, scientific communicators act as authors of science for the public; the construction of the exhibits is not a simple translation of 'science'. Furthermore, the exhibits simultaneously construct the public. Steven Yearley discusses the tension in environmental organizations and campaigns over using science as

"nature's advocate" due to ambivalence and opposition towards science, itself. He concludes that there is no single successful way to harness scientific authority. Finally, Harry Rothman, Peter Glasner and Cameron Adams broadly consider how science is contextualized and mobilized by different groups, arguing for the heterogeneity of scientific knowledge and understanding. They offer a firm critique of PUS projects based around quantitative data and mental models as operating within a technocratic discourse of public ignorance.

All of these essays question:

- What do people mean by 'science' and 'scientific expertise'?
- Where do they turn for technical information and advice?
- What motivates them to do so?
- How do they select from, evaluate and use scientific information?
- How do they relate this expert advice to everyday experience and other forms of knowledge? What is involved in its integration at this level? (Irwin & Wynne 1996: 7)

Further, they force the reader to rethink and reconceptualize the relationship between science, technology, and the public. It is these types of questions that should be brought to the table in a discussion and production of nontraditional science education practices. Again and again, local knowledge and practices – Scott's concept of *metis* – complicate what is meant by the "public understanding of science" and "scientific literacy."

Conclusion

In this section, I have just mined the surface of the work within the field of STS on science, technology, and the public to show what it has to offer to reimagining how nontraditional science education is practiced at local levels. Questioning what constitutes science, understanding, literacy, and the public would revolutionize – or destroy – many of the PUS or SL inspired projects currently active. What would it do for *Choices and Challenges*

specifically? First off, it would necessarily increase 'public' participation in the construction of the forums. Further, I imagine that this increased level of public participation would dramatically alter what *Choices and Challenges* looks like and what it has to offer – as an institution – to the local and more global communities in which it is situated. This is a place to start.

Section Five: Practice

What would STS add to *Choices and Challenges*?

Again, what you read as the "guiding role" of Zallen's conception of science, technology, and the public in structuring *Choices and Challenges*, I see as more of an artifact of the way Zallen manages the project. She does control almost all aspects of the project's coordination. The public is nominally enrolled in the early decision-making process through a committee structure in which ideas are solicited from invited guests, namely local persons with some expertise on the broad topic area. However, as Zallen has remarked on a number of occasions – to paraphrase – "It doesn't really matter what the committee says at the meetings. We [*Choices and Challenges* project staff] get to make all the decisions in the end."

Choices and Challenges is managed from a position of central authority. It is a top-down management style. However, incorporating the "new ways of imagining the relationship between science, technology, and the public" that STS provides into nontraditional science education projects like *Choices and Challenges* does not guarantee that that this management style will be disrupted. I offer as a key example Steve Fuller's program in social epistemology, which clearly shows that policy recommendations motivated or produced by a framework of STS do not necessarily change the way power is marshaled and the way in which the public takes part in the policy production process.

Social Epistemology in Theory

Steve Fuller's program of social epistemology is an attempt to institutionalize critical intervention within the field of STS. This decade-old program attempts to push other STS practitioners to evaluate the success of their work in non-academic terms by asking, "*Who* uses *which* knowledge [that you produce] to *what* end – and *should* they?" (1992, 396) This program – and challenge to the field of STS as a whole – is clearly enunciated in his 1992

article, "Social Epistemology and the Research Agenda of Science Studies." Aimed primarily at science studies practitioners, the work has two primary agendas: 1) providing a substantial critique of the direction of the field; and 2) offering working suggestions for its transformation.

Fuller's critique focuses on what he terms the 'descriptive turn' in science studies. For Fuller, the STS practitioners' implicit consensus that: "Science must be studied in its own terms, not in terms that are alien to the scientific enterprise," … "serves to define science as a self-regulating, and, in that very general sense, a 'rational' enterprise" (1992, 391). Thus, STS practitioners are limited in their analysis to discussing the norms of science only in the terms that scientists, themselves, would use (e.g., Knorr Cetina 1981; Hacking 1983; Pickering 1984; Fine 1986; Galison 1987; Giere 1988; Hull 1988; Gooding 1992). Fuller states,

> From the social epistemologist's standpoint, however, the descriptive turn has emasculated the normative dimension of science studies and in the process has limited the field's potential for radical critique and revision of our knowledge enterprises (1992, 391).

Namely, Fuller contends, while there are vast differences in theories about how science works among these science studies practitioners, "nobody seems to want to deny that science runs *well*" (392). In this article (and his 1988 work), Fuller calls for a return to the normative impulse, one that allows the social epistemologist to ask how science *should* work, in addition to how it *does* work today.

Fuller continues, "Science studies is generally seen, by insiders and outsiders alike, as a subversive cluster of disciplines – but subversive of *what* exactly?" (1992, 393). The most natural answer, as Fuller points out, would be science itself. However, rather than hostility

towards science, Fuller reads much work within STS as being hostile toward the *philosophy* of science, instead, and its attempts at normativity (1992, 393-394).

Fuller's program of social epistemology begins with a challenge to the idea that science works *well*:

> … there is a big difference between claiming that science works well enough to sustain itself and claiming that it works optimally toward a desired outcome. The first claim is borne out simply by science's continued existence, whereas the second is hard to establish, requiring as it does that we determine the relative the relative efficacy of the possible means and ends of knowledge production (1992, 395).

Asking if science works *well* would involve, according to Fuller, answering such questions as:

- Why do we want knowledge in the first place?
- What sorts of knowledge would satisfy our reasons for wanting knowledge?
- What are the relative costs and benefits of producing these sorts of knowledge?
- How would the costs and benefits be distributed among members of society? (1992, 395)

In short, Fuller is arguing that science should not be viewed as "knowledge for its own sake" (and written about as such by science studies practitioners), but rather that science should be held accountable by the society in which it is located. The goal of science studies, then, should be to determine the success of science and science policy in meeting the goals to which it is accountable.

The goal of exploring accountability, however, is not sufficient to produce the type of STS work that Fuller calls for – there is flexibility in this type of scrutiny. The question, according to Fuller, must be: "How accountable [should] the knowledge producers (i.e., the scientists) … be to the knowledge consumers (i.e., the public at large)?" Fuller identifies two poles:

1. *Plebiscitarianism*: which argues that science should be subject to public scrutiny only to the extent that it can proceed with its largely self-determined business (particularly, scrutiny should not involve research agenda setting); and,

2. *Proletarianism*: which argues that science should proceed only to the extent that it can be subject to public scrutiny (396).

Fuller's program of social epistemology pushes for proletarianism. Proletarianism discussed in this specific context has two threads:

1. The public should be made "more scientific" by changing the way science education occurs, and tracking 'chains of effects' via actor-network theory, for instance;
2. Scientists should be made "more public" via professional training on how to communicate with people, such as colleagues, administrators, students, and lay citizens (396-397).

Following these courses of action, Fuller predicts that,

> … the most radical phase of proletarianization may be set in motion: the elimination of any principles distinction between the "production" and "distribution" of knowledges, or in more down-to-earth terms, between "research' and "teaching" (397).

This program necessitates an immediate and close examination of the patterns of knowledge consumption today – within science and within STS as a field, as indicated above: "*Who* uses *which* knowledge to *what* end – and should they?" (1992, 397)

How does the program of social epistemology differ from typical science studies practice?

According to Fuller, most science studies practitioners believe that:

1. Most of what scientists do in their natural settings makes some kind of sense.
2. The primary aim of science studies is to develop interpretive strategies that make the most sense possible out of what scientists do in their natural settings (401).

The social epistemologist, on the other hand, replaces these claims with the following:

1. Most of what scientists do in their natural settings makes some kind of sense only if you do not look too closely and are of a rather charitable turn of mind.
2. The primary aim of science studies is to develop metainterpretive strategies that reveal the extent to which what scientists do makes sense only if the interpreter intervenes on the scientist's behalf by adopting roughly the scientist's frame of reference (1992, 401).

Social epistemology aims to study science on its own terms, without call to notions such as 'assumed rationality', 'background knowledge', and 'tacit knowledge' (404). Fuller argues for

an 'experimental frame of mind' in science studies that would "embolden the science studies researcher to tinker" (408). Science studies scholars do not need to uncritically adopt the frame of reference of the scientist, herself (412).

> After all, who says that science takes only in the region to which a scientist has immediate sensory access, namely, the laboratory work site? Who says that the science occurring in this region is restricted to those practices that most clearly set science apart from other social practices? Who says that an account of science must be framed around achieving or failing to achieve some result? Indeed, who says that science makes sense? The answer to all of these questions is that scientists and their well-wishers say these things. And science studies practitioners … accept what the scientists say here uncritically (413).

Social epistemology attempts to produce, instead, a critical perspective by reconceptualizing the relationship between science studies and science via a call for the scientific management of scientific labor.

Why scientific management? Fuller's narrative suggests that prior to Frederick Taylor, "labor was commonly regarded as the final authority over how the job was done. … The most management could do was to fire an unproductive worker" (413-414). He continues, "The revolution came when management realized it could intervene in the work process itself by training the worker to become more productive, or productive in the right ways" (414). What Fuller points to here is a shift from understanding work as a craft to understanding work as a practice that can be subject to critical scrutiny: that is, work as an "organic skill" to work as a "mechanical routine" (414). Fuller argues that because Taylor was able to "take a step back and observe the variety of activities that were passing without notice – or at least without question" as the same work practice (coal-shoveling), this enabled Taylor to develop a more efficient practice of work.

Fuller argues that if one were to look at science "from a step back" and begins to "account for [scientific] knowledge production without falling back on the specialized discourse of the discipline under study or of science more generally," as social epistemology recommends, then science studies practitioners would then be able to offer recommendations about how science *should* work (415). Instead, today, Fuller argues that science studies practitioners actually reify:

> the image of science's natural autonomy … by the typical inability of science studies practitioners to integrate their talk about science within the categories normally used to talk about the rest of society. As a result, it does not look as though science has any consequences beyond its natural habitat until it has been explicitly transferred to some more robustly "social" arena (415).

Social epistemology would work as an interpretive strategy by first "treat[ing] the word 'science' as designating, not a simple practice clearly demarcated from other social practices, but rather a complex practice consisting of a cluster of behaviors each of which can be found clustered with other behaviors to form social practices" (416).

> In other words, properly analyzed, science would be shown to exhibit the power and motivation structure of other competitive fields, an organization of labor that is reminiscent of industries whose products require a similar level of technical sophistication, the flow of communication common to networks of spatiotemporal diffuseness, the codification of knowledge expected of traditions with similar interests in historical continuity and prospective retrieval – not to mention the deployment of capital normally found among businesses operating at a certain level of investment intensity. In each case the strategy would force the inquirer to move from the laboratory site of science to other sectors of society in which these variables have been studied more fully (416).

Thus, scientific work would be demystified: "each … behavior can be analyzed separately and compared with its counterparts in the rest of society" (418).

The data-gathering aspect of science studies practice must also, according to Fuller, shift significantly to embody a "strategically critical attitude" (418) – a "procedure by which

history can be converted into experimentally testable hypotheses, which can then be used as the basis for informed intervention in the scientific workplace" (419). At this early stage in the development of Fuller's program of social epistemology, this appears to involves a program of rigorous methodological analysis of scientific practice that moves beyond anecdotes provided by the scientists, themselves, to a study that involves questions aimed to relate scientific practice directly to social goals and social policies, though this section of Fuller's methodological treatise is not well developed.

Fuller does caution against "pursuing the analogy with Taylorism too closely" (422). While Taylorism presupposes the compliance of the worker in the shift towards more efficient production – and thus often was more inefficient rather than less, in practice – Fuller believes that social epistemology can learn from history, rather than repeat it:

> The trick seems to be tread the fine line between adopting an uncompromisingly third-person perspective that unilaterally divests any sense of expertise from the scientists (the Taylor) route and uncritically capitulating to the first-person on-site authority of the scientists (the more typical science studies route). … a second-person perspective is needed to complete the normative transformation from mere criticism to genuine improvement. In other words, the scientists whose practices the social epistemologist criticizes have to be made not only part of the problem but part of the solution as well (423).

This shift – from "power over" to "power with" – "a project in rhetoric that involves what may be called a 'rehabilitation of the scientist's sense of agency" calls for the "social epistemologist to arrive at *principles of epistemic justice*, that is, principles by which knowledge producers come to change their practices in an epistemically and socially responsible manner" (423). Fuller closes his paper with two such principles:

> *The Principle of Reusability*: When trying to get someone to change her ways, avoid tactics that are nonreusable or likely to wear thin over time.
> *The Principle of Humility*: The person whose ways you are trying to change may have good reasons to resist your efforts, which, if you gave her a chance, she would tell you and perhaps even change your mind in the process (424).

These two principles are to guard against coercion and highhandedness on the part of the social epistemologist.

Social Epistemology in Practice

This 1992 article, then, lays out the project of social epistemology, or the "interventionist turn" in science studies. Fuller's more recent project, the book entitled *The Governance of Science: Ideology and the Future of the Open Society* (2000), can be read as his attempt to provide an example of "social epistemology in practice." He also locates the project by way of the so-called "Science Wars" that erupted between scientists and practitioners within the field of science and technology studies (STS) following the funding cut for the Superconducting Supercollider in 1992-93.

This example of "social epistemology in practice" is not aimed at science studies practitioners, per se, but rather at university and state-level policymakers and students of democratic social and political theory, as well as the general public. The book deserves much richer discussion than will be provided here – but my focus will primarily be on the proposals for science policy that Fuller provides in the third section, as it is here that Fuller's version of the interventionist turn is realized.

Part One is entitled "The political and material conditions of scientific inquiry" and examines the knowledge production practices of science today, attacking the premise that science functions as an 'open society', or under the rubric of 'republicanism', popularized by Karl Popper in 1945. Republicanism, as Fuller sees it, requires certain material conditions:

- that people's opinions might change for the better as a result of hearing opposing opinions;
- that people need not fear the consequences of their expressed opinions on their material well-being;
- that there is a 'public good' or 'civic ideal' to which people may appeal in deliberation which transcends specific individual and group interests (2000, 15).

In short, this is what Fuller terms "the right to be wrong." Fuller argues, however, that while science may be discussed in terms of this republican ideal, in practice, it is constrained by liberalism and communitarianism. The latter works to limit what scientific studies can be undertaken due to the potential negative links between scientific findings and social policies, while the former links "free market" to "free inquiry": the bulk of scientific practitioners must function at a level of "low risk" in order to secure funding and publications (2000, 11-12, 20-25). However, scientists with greater social capital (via university pedigree, funding, publications, and citations) are afforded a greater opportunity to practice the republican ideal of science: "the experimenting society."

In scientific practice today, the distribution of social capital is thus more important than the distribution or even production of knowledge. Fuller argues that this, in part, is a result of the phenomena of 'Big Science', the ever-increasing scale and scope of scientific projects (cf. Price 1963/1986). Today, however, like Latour, Fuller argues that the construction of credibility in science via literature reviews and other methods is "measured by a scientist's ability to get other scientists interested, and ultimately engaged, in their own projects. If they succeed, they have avoided oblivion – at least for a little while" (2000, 39). Credibility is critical because it is impossible to guarantee that one's work will be subject to critical scrutiny do to the largeness of the field (2000, 39); this lack of critical scrutiny is exacerbated by science's ties to what C. Wright Mills (1956) referred to as the 'military-industrial complex'

(2000, 40). For Fuller, this lack of critical scrutiny leads to a lack of accountability for science, which leads to a failure of democracy.

One solution to this dilemma would be scale down science to make it more accountable to the community in which it is practiced (Feyerabend 1975, 1979). Fuller argues against this position, however, because he concludes that:

1. science's general impacts on society will continue to be ignored;
2. funding decisions will remain important to the direction of science; and
3. this ignores the growing tendency for scientists to spend more time on entrepreneurial, managerial, and accounting task rather than 'research', per se (2000, 43).

In short, Fuller argues that whether 'Big Science' or 'Little Science', science as a search for knowledge open to critical inquiry has come to an end. Why so?

1. Fewer people have become eligible to dispute a given knowledge claim as the qualifications needed for entering the forum have increased. These qualifications include not only the training needed to read and write in the relevant journals, but also the more elusive knowledge needed for turning archival and technical resources to one's advantage;
2. At the same time, as the eligibility for disputing knowledge claims has come to be restricted, those claims have come to play a greater role in explaining and legitimating policies, actions, and events – hence the increased government reliance on science to underwrite its activities (Mukerji 1990: Ch. 2) (2000, 44).

Thus, according to Fuller, shifting the scale of scientific practice will not make it more republican, or 'open' – it will still not be 'ideal', no matter what the size of shape of its packaging.

A second solution to the problem of 'Big Science' is "science literacy": "namely, 'education', especially when this term is taken to imply the elimination of epistemic privilege simply by distributing the crucial elements of the privileged class body of knowledge or set of reasoning skills to society at large" (2000, 45). For Fuller, scientific literacy efforts fail, not

because laypersons can't *learn* science, but rather due to the seemingly always already unequal distribution of power in society: citizens have very little control over the research agenda of science, and even over where and how scientific products are 'applied' (2000, 45). On these grounds, Fuller rejects the solution of scientific literacy because:

1. it presumes a false sense of the intellectual differences separating 'scientists' from 'ordinary' people;
2. even if it presumed a correct sense of those differences, increasing the public's scientific literacy does not, by itself, open up any new opportunities for citizen participation in the conduct of science (2000, 46).

Power distribution is key to how science works – and how it works with and on society. Thus, a change in scientific and technological decision-making and practice *necessitates* a shift in the power distribution of society at large.

Part Two of Fuller's book, "The university as a site for the governance of science," examines the university as a battleground for a tug-of-war between liberalism and communitarianism. Chapter 3 relates the history of the link between knowledge production and the university, centering on the tension between 'teaching' and 'research'. In Chapter 4, Fuller argues that self-censorship has been taken to an extreme via a discussion of the tensions between the "two roads of multiculturalism" – High Church and Low Church (2000, 65) – and political correctness in the academy. Again, this dispute centers on the aims of teaching and research. Chapter 5 returns to a discussion of science and science policy, focusing specifically on citation practices and the commodification of knowledge in order to secure social and business capital. Primarily, Part Two of the book makes the case that science as a practice is not functioning optimally in today's university system.

Part Three – most critical for my purposes of proving that an STS-informed approach to policy-making does not necessarily disrupt established relations of power – makes recommendations towards reorganizing science along the republican ideal. Here, then, is the normative impulse of social epistemology – how you wish to manage the *Choices and Challenges* Project.[4] First, Fuller calls for the "secularization of science," or the separation of science and state. He argues that, on the one hand, a decentralized science – one without strong state funding for specific projects – would make a return to the 'open society' in which scientists have the "right to be wrong." On the other hand, he also argues that citizens of the state would benefit because politicians would not to be able to coerce them via the invocation of scientific findings (2000, 104).

What Fuller imagines is a separation at the state level of the power to *distribute* knowledge from the power to *produce* it (2000, 104). A secularized science would involve the state in distribution, but not in production. Expansions of the 'distributional' functions of the government would include:

1. the testing of knowledge claims and products for validity, efficacy, and safety, coupled with the regular mass publication of those results; and
2. the institution of 'citizen education in science' that would empower students to critically engage with science-based issues in public forums, alongside the wider provision of such forums (2000, 105).

State-supported science facilities would then shift in emphasis – a shift culminating in:

1. the redeployment of laboratories currently pursuing 'original' research for purposes of conducting these critical tests; and
2. the enhancement of laboratories that support science education at the undergraduate university level and below (2000, 105).

[4] I will be providing a somewhat detailed analysis using, at times, lengthy quotations from this section of the book. I do this mainly to provide the reader with the opportunity of more completely grasping the scope of Fuller's plan as outlined here, and because I feel that the words, themselves, illustrate, in many cases, the immediate need of critique of Fuller's approach to re-imagining the governance of science.

This move, according to Fuller, would shift knowledge production to corporations, unions, charities and other special interest groups. Fuller recommends that these organizations be offered tax incentives for foregoing intellectual property rights. As a consequence, Fuller predicts that "the very principle of science funding may shift from *pay for effort* to *pay for results*" (2000, 105). He argues that this would bypass the problems of 'social capital' in science outlined in Part One.

Throughout out the book, one of Fuller's key premises is that the "cycle of endless innovation" promoted by 'Big Science' and national science policy today ignores quality of life issues for the state's citizens. And that, in fact, "for most social and even scientific problems, there is already a sufficient knowledge base but its potential has not yet to be realized in public policy debate and implementation" (2000, 106).

> In so far as there is a need for state-driven research innovations at all, it is in information science, so as to enable people to locate and utilize information already available. Under the circumstances, the call for "more research" should be understood as an attempt to delay our drawing upon current knowledge as a basis for action – a call that researchers heed in their need for new sources of income, given the increasing tenuousness of academic tenure. However, were these economic pressures removed, the issue would boil down to whether the existing body of knowledge is sufficient to license people trying out course of action on themselves (2000, 106).

With this shift from calls for more research to calls for action, citizens should, according to Fuller, have more control in shaping the way existing knowledge is used, presumably beginning by addressing quality of life issues.

Following the secularization of science, Fuller believes that the university would reunite the "performance and evaluation of teaching and research … which would probably mean a renewed focus on undergraduate education" (2000, 113-114), and other practices aimed at

the general public – "the university would thus aim to reduce the complexity of the social world as part of an overall strategy of empowering citizens to pursue common ends" (2000, 114).

The following chapter turns to an examination of science policy, arguing that it is time to return to the road not taken: New Deal science policy. Prior to the institutionalization of state-sponsored science following World War II through the establishment of the National Science Foundation, Fuller points to a system of scientific production that relied less on 'cumulative advantage' and social capital and more on the basis of equality. New Deal science policy proposal (such as the prohibition of the same scientists serving as peer reviewers for major journals, professional societies, and funding agencies), were modeled on the claim that,

> science was a suitable site for redistributionist policies precisely because its mode of enquiry, in principle, could be known and done by anyone. Any difference in scientific performance among universities or regions could be attributed to differences in the quality of the training and research facilities at their disposal, not the quality of people staffing them (2000, 120).

Fuller argues that if science policy were returned to a New Deal standpoint, the distinction between scientists and nonscientists would lessen: "Public involvement would not seem so alien to scientific autonomy if a wider range of scientists sat on such [peer review and advisory] panels in the first place" (2000, 129-130).

The final chapter lays out a "new deal for science," and Fuller's strategies to democratize science and achieve a genuinely 'experimenting society'. Fuller writes, "The most natural way to construct a democratic science policy regime is by specifying the grounds on which a choice between competing proposals should be made in a resource-scarce environment"

(2000, 136). Fuller sees this as governing science by the "principles used by scientists to govern their inquiries into nature" (2000, 136). The strategies include:

> **Finalization**: based on the idea of diminishing returns on investment as research becomes more specialized … A finalization policy would thus empower a state agency to monitor the growth of the various scientific fields. [And] Once a field had progressed to the point that its theoretical base was consolidated and most of its practitioners were solving technical puzzles, the agency would offer financial incentives to divert the practitioners away from continuing work on such puzzles and toward participating in interdisciplinary projects that addressed outstanding social problems (137). … It is science *for* the people, but not necessarily *by* the people (2000, 138).
>
> **Cross-disciplinary relevance**: based on the idea that the more expensive the research proposal, the more value it must have for fields outside the principal investigator's field (originally proposed by Alvin Weinburg 1963) (2000, 138-139).
>
> **Epistemic fungibility**: argues that scientists from different fields [should be] required to defend their proposals to one another in an open forum … Historians, philosophers and sociologists of the scientific enterprise could be called in initially to design procedures for publicly examining the scientists' claims. Once provided with an incentive to interrogate each other's claims, the scientists themselves would be in a position to intensify the investigation, stripping away gratuitous jargon, overstatement and all-around obfuscation that might otherwise mystify non-experts (2000, 142).

From here, Fuller develops a single social contract that would "provide a clear sense of public access to science's decision-making processes" and "criteria for accountability in an era of Big Science" (based on Dahl 1989: Chs 15-21) (2000, 146). These include:

1. *Coalitions*: this involves treating research programmes as party platforms … to force scientists to reflect on the multiple ways in which various constituencies might come to have a stake in the outcome of scientific research. … as people see themselves as potential components in a scientific coalition, they are likely to become more self-conscious about the ends of knowledge production: what are the costs and benefits of pursuing one research programme rather than another? (2000, 146-147)
2. *Contestation*: alternatives [in research programmes] must be subject to comparative evaluation in an open forum. Instead of having the public engage with the technical details of these alternatives, competitors could confront each other through televised episodes of formal cross-examination. As the competing research proposals would often represent disparate fields and the television audience would consist of a wide range of interest and areas of expertise, the resulting debate would bring to lift the sorts of unclarity, hyperbole and deception that would otherwise remain hidden in the technical language of the competing proposals (2000, 147).

3. *Elections*: the importance of elections in Big Democracy testifies to the reversibility of all political programmes. … By requiring that ongoing projects account for themselves on a regular basis, science elections would enable alternative coalitions to propose novel ways of configuring available intellectual and material resources (2000, 147-148).

Fuller recognizes that his scheme is utopian – but not because scientists may refuse to participate, but rather because citizens in Big Democracy are not "sufficiently engaged in politics to be able to add scientific research as one more issue around which coalitions can be formed and elections fought" (148). Fuller argues that this is because the stakes are not clear, not because the public is unable to grasp the complexity. After all, he counters, the public easily engages with the complexity of sport:

> In short, transcending the utopian status of my proposal would involve importing to science the sorts of things that make sports so compelling for so much of the world's population. What would get people sufficiently interested in the conduct of science that they were driving to increase their stake in it? (2001, 149)

So, Fuller proposes new features to attract 'rational gamblers'. These include:

1. *An easily accessible canonical accounting procedure*: statistical data … regularly gathered and published on the officially recognized coalitions, component interest groups, level of support, current projects and output to date as some function of input (149).
2. *Fair and explicit rules of the game*: to provide incentives for scientific coalitions to challenge each other in an open forum (150).
3. *Something worth contesting*: this raises the question of which features of science are worth betting on. If we envisage that research programmes covering quite different fields can challenge one another, then among the more fruitful debates would be one over which programme is more likely to generate the more desirable knowledge products, given the resources at stake (150).

In making these proposals, Fuller assumes that (a) scientific contests can be made transparent and 'scored', and (b) scientific elections do not have to be zero-sum claims (151).

Thereby, or so Fuller indicates, the practice of science is saved via a harnessing of the natural competitive instincts of the public-at-large. Fuller concludes:

> In this chapter, I have proposed some concepts and strategies designed to regain the republican ideal in the era of Big Science. My overarching approach is

> 'constitutionalist', in that the fundamental problems facing the governance of science today rest on issues of representation: both how science represents its own interests and how it represents the public's epistemic interests. Answers to these questions can be given only once we specify who can participate in science, and how. This, in turn, depends on the social dynamics of knowledge production one presupposes. In this respect, the traditional image of inquiry as 'the search for truth wherever it may lead' is not so much wrong as uninformative, since it is compatible with any of the sociological formulations of knowledge production entertained in this chapter: a social movement, a political campaign, a collaborative project, a resource allocation problem, a question of social justice, an industrial enterprise, a network of communications, a risky investment and even a sporting event. In each case, I have highlighted democratically oriented policies that take seriously the size and diversity of the activities and institutions devoted to the pursuit of knowledge today. All that is now needed is the political will and an experimental turn of mind to make the republican ideal a reality (2000, 155).

This conclusion – and the entire third section of the book – creates a peculiar tension in the reader, presuming the reader agrees to some extent with Fuller's critique of current scientific practices as undemocratic and operating, in some cases, in a rather distinct fashion from the interests of the so-called public-at-large. From this perspective, Fuller's aim of reimagining the relationship between science, technology, and the public in a decision- and policy-making environment is laudable. However, Fuller and his proposals are notable either for a lack of reflexivity or a straight-faced presentation of well-concealed mirth, as surely evidenced in my extensive portrayal of his proposals. Fuller's example of 'social-epistemology-in-practice', while definitively interventionist and non-descriptionist, falls short on fulfilling the so-called promise of science and technology studies and its "reimagining of the relationship between science, technology, and the public." Fuller's work, in fact, reifies existing power relationships, not – this time – between science and the public, but rather between a science studies expert and the public. In all cases, Fuller's book speaks for rather than with the public, and positions the writer's expertise above all others. This is not new, nor productive – and I hope it is not all the program of social epistemology has to offer, either to science studies practitioners, nontraditional science educators, or others.

While I find Fuller's portrait of scientific knowledge production, distribution, and use more compelling than that offered by many practitioners within the field of STS – and for use beyond the field of STS – I cannot endorse this example of 'how to do the theory and practice science and technology studies at the same time'. Aside from proposing only top-down, expert-driven, managed efforts at reform, the product of Fuller's work contained in *The Governance of Science* violates the two principles of social epistemology that he, himself, proposed in 1992:

> *The Principle of Reusability*: When trying to get someone to change her ways, avoid tactics that are nonreusable or likely to wear thin over time; and,
> *The Principle of Humility*: The person whose ways you are trying to change may have good reasons to resist your efforts, which, if you gave her a chance, she would tell you and perhaps even change your mind in the process (1992, 424).

Science and technology studies, and social epistemology as discussed in 1992, begins with a critique of expertise that extends to the STS researcher. Fuller's 2000 work obviously does not. Furthermore, Fuller's proposals, perhaps due to his lack of contact with members of the public he wishes to 'help', are, quite frankly, unworkable. Social epistemology, as it stands today, also does not offer a way forward for the types of questions useful to a broad range of individuals and interest groups – nor to a redistribution of power in society as a whole.

Is there hope for the program of social epistemology? Based on this work, it may be up to scholars other than Fuller to realize its potential. But, at this moment, talking about science and technology studies offers very little to me by way of practice. How can these theoretical insights be negotiated for practice-based use? Again, how would STS approaches actually (re)shape the way *Choices and Challenges* functions?

Section Six: Theory and Practice

Doing the "hard work" of theory and practice at the same time

In this final section, I speak both as a theorist and as a practitioner, wanting to pursue the "hard work" of doing theory and practice at the same time in nontraditional science education projects like *Choice sand Challenges*. We must look outside the fields of science and technology studies and nontraditional science education to those already working on the theory | practice gap to reorient ourselves and to begin again.

First, we must ask new questions – and, in some cases, ask old questions but seek new answers.

- What are our projects?
- What are the goals of our projects?
- Who are the people we are working with and how should we work with them?
- What methodologies are appropriate?

Below, I draw on a number of different fields such as critical theory, feminist studies science and technology, feminist philosophy of human rights, community health organizing, critical ethnography, and practice theory to map initial ways of approaching these questions.

What are our projects?

First, we must reevaluate what our projects are and why we do them. The answer to this question may involve a change of our inquiry paradigm. What is an 'inquiry paradigm' – "the basic beliefs that define inquiry paradigms can be summarized by the responses given by proponents of any given paradigm to three fundamental questions, which are interconnected in such a way that the answer given to any one question, taken in any order, constrains how the others may be answered" (Guba & Lincoln 1998: 200-201):

- *The ontological question*: What is the form and nature of reality and, therefore, what is there that can be known about it?
- *The epistemological question*: What is the nature of the relationship between the knower or would-be knower and what can be known?
- *The methodological question*: How can the inquirer (would-be knower) go about finding our whatever he or she believes can be known? (Guba & Lincoln 1998: 201)

Guba and Lincoln offer four types of inquiry paradigms: positivism, postpostivism, constructivism, and critical theory. It is time for STS to shift from constructivism to critical theory. Critical theory is sketched by Guba and Lincoln as poststructuralism, postmodernism, and a blending of these two. Critique and transformation are at the heart of qualitative research beginning from this perspective, as indicated by Joe Kincheloe and Peter McLaren's definition of a 'criticalist' as:

> a researcher or theorist who attempts to use her or her work as a form of social or cultural criticism and who accepts certain basic assumptions: that all thought is fundamentally mediated by power relations that are socially and historically constituted; that facts can never be isolated from the domain of values or removed from some form of ideological inscription; that the relationship between concept and object and between signifier and signified is never stable or fixed and is often mediated by the social relations of capitalist production and consumption; that language is central to the formation of subjectivity (conscious and unconscious awareness); that certain groups in any society are privileged over others and, although the reasons for this privileging may vary widely, the oppression that characterizes contemporary societies is most forcefully reproduced when subordinates accept their social status as natural, necessary of inevitable; that oppression has many faces and that focusing only one at the expense of others (e.g., class oppression versus racism) often elides the interconnections among them; and, finally, that mainstream research practices are generally, although most often unwittingly, implicated in the reproduction of systems of class, race, and gender oppression (1998: 263).

For me, critical inquiry adds to the theory of STS a new practice orientation, and a shift in aim and motivation. Whereas more typical STS theory, to a certain extent, can be located under what Teresa Ebert (1991) identifies as "ludic postmodernism" (a deconstruction of the metanarratives of science and technology at the local level via an analysis of the 'endless chain of signification' and play), what Kincheloe and McLaren call for is a strategy of "resistance postmodernism" (271-273, after Ebert 1991). (As Kincheloe and McLaren

further indicate, resistance postmodernism has also been conceptualized as "oppositional postmodernism" (Foster 1983), "radical critique-al theory" (Zavarzdah & Morton 1991), "postmodern education" (Aronowitz & Giroux 1991), and "critical postmodernism" (Giroux 1992; McLaren 1992, 1997; McLaren & Hammer 1989)).

Kincheloe and McLaren position resistance postmodernism as "appropriations and extensions" of the critique offered by ludic postmodernism.

> Resistance postmodernism brings to ludic critique a form of materialist intervention, because it not solely based on a textual theory of difference but rather on one that is also social and historical. In this way, postmodern critique, can serve as an interventionist and transformative critique of Western culture (272).
>
> Resistance postmodernism does not abandon the undecidability or contingency of the social altogether; rather, the undecidability of history is understood as related to class struggle, the institutionalization of asymmetrical relations of power and privilege, and the way historical accounts are contested by different groups (272).
>
> The synergism of the conversation between resistance postmodernism and critical theory involves an interplay between the praxis of the critical and the radical uncertainty of the postmodern. As it invokes its strategies for the emancipation of meaning, critical theory provides the postmodern critique with a normative foundation (i.e., a basis for distinguishing between oppressive and liberatory social relations). Without such a foundation the postmodern critique is ever vulnerable to nihilism and inaction (272-273).

The criticalist, then, may see much of STS theory as incomplete projects – for "what good" are 'more accurate' descriptions of the work of science, technology, and in some cases, the public, if no action is proposed to address systemic flaws and unequal power relations in the system? The criticalist at least has a commitment to addressing practice, whereas most persons in the field of STS act as if they do not. It is not their job.

Feminist studies of science and technology, on the other hand, begins at this level of praxis. It is within feminist studies of science and technology, not STS, that the possibility (and

need) for intervention and action at the level of practice is clearly articulated. Many feminist scholars, in fact, entered the discussion of science, technology and medicine because of political motivations. For instance, Faye Ginsburg and Rayna Rapp's edited collection entitled *Conceiving the New World Order: The Global Politics of Reproduction*, is situated within two agendas:

- to transform traditional anthropological analyses of reproduction, and
- to clarify the importance of making reproduction central to social theory (1995, 1).

The book is located in fact, on the border of theory and practice, an "unapologetic concern with the political nature of both reproduction and research about it" (9), and the multiple audiences include other scholars, feminists, health care providers and policymakers.

Feminist studies of science and technology, on the whole, recognizes that, "[t]he point is to make a difference in the world, to cast our lot for some ways of life and not others. To do that, one must be in the action, be finite and dirty, not transcendent and clean. Knowledge-making technologies, including crafting subject positions and ways of inhabiting such positions, must be made relentlessly visible and open to critical intervention" (Haraway 1996: 360). For instance, Judith Wajcman argues that, "technology is more than a set of physical objects or artifacts. It also fundamentally embodies a culture or set of social relations made up of certain types of knowledge, beliefs, desires and practices" (1991: 149). In her conclusion, she adds that, "Feminist debates about political strategy concerning technology posit forms of action that break with conventional politics. They are about making interventions in every sphere of life" (1991: 166).

Haraway, in fact, addressed this tension between theoretical projects and projects at the level of practice as early as 1988. She wrote:

> So I think my problem, and "our" problem, is how to have *simultaneously* an account of radical historical contingency for all knowledge claim and knowing subjects, a critical practice for recognizing our own "semiotic technologies" for making meanings, *and* a no-nonsense commitment to faithful accounts of a "real" world, one that can be partially shared and that is friendly to earthwide projects of finite freedom, adequate material abundance, modest meaning in suffering and limited happiness (1988: 579)
>
> We need the power of modern critical theories of how meanings and bodies get made, not in order to deny meanings and bodies, but in order to build meanings and bodies that have a chance for life (1988: 580).
>
> I would like a doctrine of embodied objectivity that accommodates paradoxical and critical feminist science projects: Feminist objectivity means quite simply *situated knowledges* (1988: 581).

Haraway, in this influential work on the meaning and use of speaking from a position of situated knowledge, offers a simultaneous critique of totalization and relativism because, "both deny the stakes in location, embodiment, and partial perspective; both make it impossible to see well" (1988: 584) – just as the continued split between theory and practice makes it almost impossible to do both at the same time.

Elizabeth Grosz' notion of "corporeal feminism" further links systems of knowledge production with material practices and women's bodies. Corporeal feminism suggests that: (1) the body is a central symbolic resource for cultural work; (2) the discursive, symbolic body and the material body are mutually determining; and (3) gender is often a submerged discourse within many studies of the body and culture (1994). Researchers such as Anne Balsamo (1996) and Martha McCaughey (1997) have used Grosz' work to relocate the construction of material bodies at the level of discourse and to highlight resistances to discourse at the level of material or corporeal practice.

The field of STS must – if it wishes to work as part of a practice, whether that practice is nontraditional science education or something else – look to feminist studies of science and technology as a model for a doubled agenda of theory and practice. This type of criticalism will change the nature of our projects, and we will begin to pursue not just what is interesting, but what is useful. There is a potential for significant overlap between these two categories.

What are the goals of our projects?

In imagining the goals of our projects that work at the level of theory and practice, Martha Nussbaum's adaptation of the 'capabilities approach' to human rights has much to offer. The capabilities approach, as Nussbaum develops it, allows for judgment to occur across cultures regarding human rights (and their violation), thus providing a critique of judgmental relativity (or the trouble of analyzing a culture that is not your own) and working the tension between theory and practice.

As indicated, Nussbaum switches focus from issues of human rights to human capabilities. In practice, the capabilities approach means switching, as a theorist and practitioner, from working towards changes in the functioning of citizens ("our objects of research") to working towards changes in the capabilities of these citizens "to perform various important functions" (1998, 42). Nussbaum's emphasis on capabilities relies on the assumption that "human capabilities exert a moral claim that they should be developed" (43)

> The capabilities approach insists that a woman's affiliation with a certain group or culture should not be taken as normative for her unless, on due consideration, with all the capabilities at her disposal, she makes that norm her own. We should take care to extend to each individual full capabilities to pursue the items on the list – and then

> see whether they want to avail themselves of those opportunities. … Why should women cling to a tradition, indeed, when it is usually not their voice that speaks or their interests that are served? (Nussbaum 1998, 46-47)

While Nussbaum's focus is on the role and status of women throughout the world, as is evident in the above quotation and in the capabilities for which she pushes (see **Figure 6.1**), it is possible that as a programmatic idea, it can be extended for all persons working towards a theory of practice and the practice of theory. What I find useful about Nussbaum's approach to justice – the capabilities approach – is, as indicated above, that it allows for judgment to occur from the inside and outside of specific living circumstances, or culture. This allows a scholar to navigate between the tension of theory and practice by offering a way to talk about making changes at the level of practice without managing all practice from a centralized, top-down perspective. It allows for flexibility.

What is not useful is that Nussbaum reads the identified 'moral imperative of developing human capabilities' to allow her to speak throughout her work from what I see as a 'positionless position'. The capabilities that she identifies are represented as stable and timeless. She, by speaking through that position, thus, again, reifies boundaries between experts and non-experts – and those who have access to power and those who don't. However, developing a goal of capability-building – in which the capabilities are established as a negotiated and contextualized goal set from within a community – shows promise within the arenas of nontraditional science education an STS more broadly.

Central Human Functional Capabilities

1. *Life*. Being able to live to the end of a human life of normal length; not dying prematurely or before one's life is so reduced as to be not worth living
2. *Bodily health and integrity*. Being able to have good health, including reproductive health; being adequately nourished; being able to have adequate shelter
3. *Bodily Integrity*. Being able to move freely from place to place; being able to secure against violent assault, including sexual assault, marital rape, and domestic violence; having opportunities for sexual satisfaction and for choice in matters of reproduction
4. *Senses, imagination, thought*. Being able to use the senses; being able to imagine, to think, and to reason – and do these things in a "truly human" way, a way informed and cultivated by an adequate education, including, but by no means limited to, literacy and basic mathematic and scientific training; being able to use imagination and thought in connection with experiencing and producing expressive works and events of one's own choice (religious, literary, musical, etc.); being able to use one's mind in ways protected by guarantees of freedom of expression with respect to both political and artistic speech and freedom of religious exercise; being able to have pleasurable experiences and to avoid nonbeneficial pain
5. *Emotions*. Being able to have attachments to things and persons outside ourselves; being able to love those who love and care for us; being able to grieve at their absence; in general, being able to love, to grieve, to experience longing, gratitude, and justified anger; not having one's emotional developing blighted by fear or anxiety. (Supporting this capability means supporting forms of human association that can be shown to be crucial in their development.)
6. *Practical reason*. Being able to form a conception of the good and to engage in critical reflection about the planning of one's own life. (This entails protection for the liberty of conscience.)
7. *Affiliation*. (a) Being able to live for and in relation to others, to recognize and show concern for other human beings, to engage in various forms of social interaction; being able to imagine the situation of another and to have compassion for that situation; having the capability for both justice and friendship. (Protecting this capability means, once again, protecting institutions that constitute such forms of affiliation, and also protecting the freedoms of assembly and political speech.) (b) Having the social bases of self-respect and nonhumiliation; being able to be treated as a dignified being whose worth is equal to that of others. (This entails provisions of nondiscrimination.)
8. *Other species*. Being able to live with concern for and in relation to animals, plants, and the world of nature.
9. *Play*. Being able to laugh, to play, to enjoy recreational activities.
10. *Control over one's environment*. (a) *Political*: being able to participate effectively in political choices that govern one's life; having the rights of political participation, free speech, and freedom of association (b) *Material*: being able to hold property (both land and movable goods); having the right to seek employment on an equal basis with others; having the freedom from unwarranted search and seizure. In work, being able to work as a human being, exercising practical reason and entering into meaningful relationships of mutual recognition with other workers.

Figure 6.1
Nussbaum's Central Human Functional Capabilities

Nussbaum offers only two options: judgmental relativism and judgmental realism We need a third way – one that blurs theory and practice. For this blurring to be successful, we must take into account and work from within the local community, with full attention to the institutionalized power structure of the community and to the needs and desires of the community within. Coupled with a broad understanding of the capabilities approach as outlined by Nussbaum, this strategy of theory and practice can be modeled within STS on other community organizing projects that have sought to address the tension between the local and the global in a productive and empowering model.

Who are the people we are working with and how should we work with them?

Theories of community organizing and community building within community health practice may offer suggestions for how we can work with various communities of people without reifying the expert | non-expert divide and without falling into the trap of top-down management of community change projects. These theories and practices emphasize the importance of addressing the distinction between universalizing, global agendas and working towards meeting the goals of local communities – that is, the importance of working and *speaking with* local communities rather than *working on* or *speaking for* various constituencies.

Community health practitioners have adopted community organizing principles to focus on facilitating a "process whereby communities use their voice to define and make their health concerns known" as much as "providing prevention and treatment" (Wallack, et al 1993). Jacqueline Mondros and Scott Wilson describe these community organizers as 'conscious contrarians', in that each individual working on this theory | practice gap adopts:

- a particular *worldview* or set of beliefs and values about people and society

- a *power analysis* that rejects the dominant ways of thinking about power and how power is distributed, and,
- a *deliberate selection of work* (community organizing) that is consistent with the other two (1994, 14-16)

Community health organizer Meredith Minkler adds a fourth component to this list: "the social change professional's role in *doing things differently* and in the process challenging traditional ways of thinking" (Minkler 1997). Working towards theory and practice, it will be critical to recognize our role as facilitators of these types of discussions and decisions as well as "experts."

The field of community health organization offers a second key distinction that may help us further enrich our projects and emphasize our role as facilitators – community organizing versus community building. Minkler and Wallerstein (1997) define community organization as:

> the process by which community groups are helped to identify common problems or goals, mobilize resources, and in other ways develop and implement strategies for reach the goals they have collectively set (1997: 30).

Community organization can occur in a variety of ways, with leaders emerging internally to the community or from an outside organization. Community building, on the other hand, is: "not a method so much as an orientation to the ways in which people who identify as members of a shared community engage together in the process of community change" (1997, 30). The concept of community building works to specifically mark the outside organizer as a facilitator rather than a leader in the community organization, thus more surely guaranteeing that the types of decisions that are made within the community organizing project emerge from within the community – in a bottom-up fashion.

Minkler and Wallerstein's conclusion is worth quoting in full here, as it speaks to all potential community interventionists, not just community health practitioners:

> The continued pivotal role of community organization in health education and related disciplines reflects not only its time-tested efficacy but also its high degree of philosophical fit with the most fundamental principles of effective community health education and other social change approaches. Community organization thus stresses the principle of relevance, the principle of participation, and the importance of creating environments in which individuals and communities can become empowered as they increase their community competence or problem-solving ability. Similarly, news conceptualizations of community building stress many of these same principles within an overall approach that focuses on community growth and change from the inside through increased group identification; the discovery, nurturing, and mapping of community assets; and the creation of critical consciousness, all toward the end of building stronger and more caring communities. Using community organizing and community building skills and approaches, heath educators and other social change professionals can help communities identify and build on their strengths, select the issues they feel are of greater relevance, and work together in mobilizing their resources and in other ways addressing the goals they collectively have set.
>
> Of at least equal importance, however, professionals can challenge themselves to examine their own dynamic of power, with their professional colleagues and members of the community, to understand the complexities of working in partnership towards the goals of community ownership of the projects undertaken and increased empowerment and community competence. In sum, both community organization and newer conceptualizations of community building practice have essential messages for health educators and other social change professionals in a wide variety of settings and may hold particular relevance in the changing sociopolitical climate at the dawn of the twenty-first century (1997: 48).

Working towards both a theory of practice and a practice of theory, we will necessarily work on two fronts. Bearing in mind Minkler and Wallerstein's call to challenge the communities in which we work to empower themselves and to challenge ourselves to empower the communities in which we work will be critical to a sustained success of doing theory and practice at the same time, and the avoidance of the trap of top-down prescription.

What methodologies are appropriate?

The preliminary questions and 'answers' discussed above all link directly to a question of methodology. While offering no final solution, I suggest, again, that exploring work already located on the theory | practice gap – such as within traditions of critical ethnography and practice theory – may be useful as more and more of us operating within the field of STS and nontraditional science education move in this theory and practice based direction.

Methodological Example: Critical Ethnography

Ethnographer Jim Thomas has identified a series of distinctions between what he terms 'conventional' and 'critical" ethnography which may here be useful:

Conventional Ethnography/Ethnographers	**Critical Ethnography /Ethnographers**
• Tradition of cultural description that displays meanings by interpreting meanings	• Reflective process of choosing between conceptual alternatives and making value-laden judgments of meaning and method to challenge research, policy, and other forms of human activity (Thomas & O'Maolchatha)
• Speak *for* their subjects to an audience of other researchers	• Raise their voices to speak *to* an audience *on behalf* of their subjects as a means of empowering them by giving more authority to their subjects' voices
• Study culture for the purpose of describing it	• Study culture in order to change it (by modifying consciousness or invoking a call to action)
• Attempt to repress biases in research, even while recognizing the impossibility	• Celebrate their normative and political position as a means of invoking social consciousness and societal change

• Assumes the status quo, affirms assumed meanings, and seldom reveals the perspective of the researcher on the subjects	• Examines culture, knowledge, and action to expand our horizons for choice and widen our experiential capacity to see, hear, and feel; deepens and sharpens ethical commitments by forcing us to develop and act upon value commitments in the context of political agendas; describe, analyzes, and opens to scrutiny otherwise hidden agendas, power centers, and assumptions that inhibit, repress, and constrain.

For Thomas, critical ethnography is possible for all sectors of society, "because researchers judge that all cultural members experience unnecessary repression to some extent." He continues, "Critical ethnographers use their work to aid emancipatory goals or to negate the repressive influences that lead to unnecessary social domination of all groups. *Emancipation* refers to the process of separation from constraining modes of thinking or acting that limit perception of and action toward realizing alternative possibilities. *Repression* is the condition in which thought and action are constrained in ways that banish recognition of these alternatives" (Thomas 1993, 4).

Critical ethnography again emphasizes the need to speak and work with our "objects of research" rather than speaking for and working on them. Thomas' methodological program embodies the idea of criticalism as a project of resistance. What would STS as a practice of critical ethnography look like? Where would it fit with the practice of nontraditional science education? Again, turning to previous work on the theory | practice gap may be useful.

Methodological Example: New Ways of Talking About Science Education – Practice Theory

Doing theoretical and practical work within science education from within the fields of STS and nontraditional science education will mean asking new questions about how learning

takes place, not just repositioning ourselves within both fields. It means moving beyond the deficit model in science education, and reconceptualizing learning as a site of action. Margaret Eisenhart and Elizabeth Finkel's work on women and science offers a place to start: viewing science education as a social practice and cultural production. Practice theorists (such as Bourdieu 1977 and Connell 1987) "focus on the generation of meaning systems by people as they participate in everyday, local activities (or "social practices") and on the way these meaning systems connect people to broader patterns of social reproduction or change" (Eisenhart & Finkel 1998, 43). Eisenhart and Finkel identify three conceptual issues that dominate practice theory:

1. what meanings are produced within and about everyday activities;
2. how knowledge, identities (e.g., the meanings of being a scientist, a woman, an expert, etc.), and learning are made socially available (or "situated in practice in the activities in which people actually participate"); and,
3. how everyday activities and meanings organize participants in wider relations of power (43-44).

To study 'where the women are' in science education and practice, Eisenhart and Finkel developed three conceptual categories to address the issues above: "cultural productions," "situated learning," and "networks of power" (44). It is these categories that may be useful in rethinking the theory and practice of nontraditional science education projects.

Eisenhart and Finkel define "cultural productions" as the emergent outcomes of societal subgroups using "discourses, meanings, materials, practices, and group processes to explore, understand, and creatively occupy particular positions in sets of general material possibilities" (Willis 1981, 59). For instance, in an early project, Eisenhart (1996) explored the meaning of the term *scientist* in three different locations, "to illustrate how the meaning of being a scientist is constructed differently depending upon the organization of the activity in the sites" – in terms of consistency, opposition, and modification (Eisenhart and Finkel

1998, 44). The focus here is on the relational features, "because they reveal the workings of power, that is, how some 'scientist identities' and the activities associated with them are made the prototype, norm, or "center," while others becomes unusual, 'marginal', or 'heretical"' (44).

Eisenhart and Finkel use Jean Leave and Etienne Wenger's theory of situated learning (1991). Lave and Wenger's work adds to studies of cultural productions by analyzing the meanings produced in activity to examine "the content and organization of the activities in which people actively participate over time" (50) – that all learning is "situated" in social phenomena. For Eisenhart and Finkel, this means that,

> in order to understand what individuals come to know, how they come to view themselves, and how these things change and develop over time, we must first understand their social practice: how group activities are organized; how knowledge and identity are represented in activity; and how individuals can change their participation over time.

Social practices should be conceptualized simultaneously at a local and global level, conflating micro- and macro- movements. For Eisenhart and Finkel, "Any analysis of practice, and thus of knowing, identifying, and learning, must include an analysis of how structure is realized in local practice" (50).

Added to their attention to how and where meaning is produced, Eisenhart and Finkel employ Jan Nespor's work to specifically focus on networks of power or "how power, not simply history, is reproduced by individuals as they participate in specific activities" (51). Nespor's 1994 book, *Knowledge in Motion*, conceives of learning as "a process of moving individuals into and through specific organizations of time and space … These organizations of time and space also connect individuals to each other in relations of power. Different sites

… organize time and space differently, thereby connecting individuals in power networks of distinctly different kinds" (51). Eisenhart and Finkel use this idea of spatial-temporal arrangement to analyze within different sites, the representation, physically and symbolically, of what "individuals are supposed to do in a 'space' and how they should use 'their time'" (51). They read spatial-temporal arrangements as creating "the opportunities for certain kinds of social and power relationships, while making others unlikely or impossible" (51).

Using these three conceptual categories, Eisenhart and Finkel developed four questions to focus their study:

1. What forms of science (or engineering) practice occur in each site, and how do these practices compare to each other and to the sites of elite science?
2. What meanings of *science* and *scientist* are produced in each site, and how do these cultural productions compare to each other and to those produced in elite science?
3. What relations of power are organized and represented in these sites, and how do these relations compare to each other and to those in elite science sites?
4. How do women participate and fare in these sites?

Similar questions must be asked about the *Choices and Challenges* Project – and the answers must come not from me or from others positioned like me, but by talking with the actual participants of the forums. Currently, there is really very little data that has been gathered to actually evaluate this experience. Portrayals must come from the actual participants in the *Choices and Challenges* forum experience. We must develop better tools of evaluation.

Zallen, herself, has recognized this problem – as indicated in section three, follow-up is one of our ongoing dilemmas. Zallen and I talked about this directly in one of our interviews. She stated:

> Well, you haven't asked something that's also a problem for me – how do I know it's made a difference? And, I only know anecdotal, from experience. And the fact that it's – if we think there's anything to Darwinian ideas – that it's survived so long, and

> people still want to participate. … But I really – and other than the evaluation forms that we do the day of the forum – to know whether there's, any enduring benefit. I just don't know how to measure that. I think it's the nature of education that we really can never measure it – enduring benefit. And we have to just have confidence in the system that you've created, and the work that you've done, that it *has* helped some people, in some ways. You know, it hasn't helped everyone. There are people who come who probably emerged no wiser, but that's the way it is in the classroom. That's the way it is everywhere. I mean I have faith that it has made a difference with people, and helped them to think more clearly and more wisely about decisions. But, I don't know if there is perhaps a way to, to measure the effect. And … so, I've never been able to really to think of a way to do it. I mean, I haven't done it. (Zallen, Interview, 6.28.01)

As the coordinator of the project and as an instructor, I have of course struggled with the same issue:

> Even if one were to, to do follow-up interviews of participants, it's likely that, in terms of how they think about issues, the effect could be there, but they wouldn't even recognize that they were using the tools to look at a totally different issue or different subject matter that might be completely not related. (Lehr, Interview, 6.28.01)

Zallen added in agreement:

> Exactly. Right. You know, it's just another little chink in their scheme of thinking , and they can't even identify where the origin of that little chink … But, you know, I wouldn't have worked so hard for so long if I thought it wasn't making a difference. I don't think it ever would have survived if it wasn't And I suppose I would be surprised to hear that.somehow it wasn't making a difference. But I think any of us who work with education, really have to learn to take it on faith that what we do matters, that it has had some impact. … I mean it would be a terrible thing as a result of your research, you said, "Well, actually, Doris, ah, …" (Zallen, Interview, 6.28.01)

To this I said, "I'd be surprised if I am ever able to, to *prove* (laughs) that."

Zallen summed up by saying:

> You see, that's the thing. I think there are certain things in the world that you just believe in because you've done the best thinking you can ahead of time, you've carried it out in the best way possible – and then you just have to let it go . . . in the air, and hope that somehow you've made a difference. If you didn't, I suppose, you wouldn't go into education at all, you'd find something else to do, I guess. (Zallen, Interview, 6.28.01)

However, there must be a way to capture that experience and to evaluate what we are doing – either through a new positioning of the investigator or new questions posed to the participants. Further work on the theory and practice of *Choices and Challenges* cannot proceed until we have a better understanding of what the project is and what it means to a much broader variety and number of people

Postscript:

Rethinking nontraditional science education and STS

This project emerged from within a space of contradiction and tension in my own life – what I read, and continue to read, as a gap between my work as a scholar within the field of Science and Technology Studies and my work as a Research Associate and Forum Coordinator for the *Choices and Challenges* Project at Virginia Tech. As I wrote in an early draft of this thesis,

> I chose to enter the field of Science and Technology Studies for what I read as its commitment to intervention at local and global levels, inside and outside of the academy; for its broad understanding of what counts as knowledge production; and for the space the field provided for 'scholar-activists' and 'citizen-scholars'. (Lehr, 8.29.01)

Central to my commitment to this field is a belief that changing the way "we" talk about science and technology will dramatically change power relationships between scientists and non-scientists, technologists and non-technologists, empowering different segments of the public to participate in and shape the production of these "expert knowledges." More broadly, I believe that the field of Science and Technology Studies (STS) offers a mode of critical analysis extremely useful in projects of social justice throughout the current techno-political environment. Yet, as I moved through my formal training in STS, most of my work at the interface between science, technology, and the public took place under the rubric of *Choices and Challenges*, a setting in which I felt limited in terms of what I could say, what I could imagine, and where I could intervene.

Completing this project involved a great deal of negotiation and reflection. I emerged from this process with an increased respect for the work of *Choices and Challenges*, and project director, Doris T. Zallen. This respect only intensified during my recent participation at the NIST conference (discussed briefly in the first section of my thesis), "Communicating the Future: Best Practices for Communication of Science and Technology to the Public" (March

6-8, 2002). Here, other attendees described *Choices and Challenges* as "innovative" and "unique" – and within the company of the other national and international "best practices" assembled, I came to believe that it is. *Choices and Challenges*, with a small number of other projects (including Y Touring, also represented at NIST), was set apart by its recognition of

a) multiple types of expertise, including what Zallen refers to as 'extrascientific' expertise,
b) the importance of history (and insights provided by other humanities disciplines) in making sense of current scientific developments; and,
c) the necessity of public participation – at some level – in shaping scientific and technical practice.

Mainly, *Choices and Challenges* stood in contrast to the other projects in that *it does not exist to advocate for the support of science or technology*. Most of the presenters had moved away from the simplistic framework which states that greater public understanding of science necessarily leads to a greater appreciation of science. However, the question remained, often quite explicitly: "How can we get the public (or a targeted public audience) to be more supportive of science, and specifically of a) funding for scientific research, and b) products of scientific research?" This is not the reason *Choices and Challenges* exists. Within this context, *Choices and Challenges* serves a critical function offering an alternative meaning for communication of science and technology to the public – and I hope that many of those with whom I spoke during the conference will look to *Choices and Challenges* as a model for extending their work and for questioning the assumptions that form the basis of it. This environment radicalizes *Choices and Challenges*, and complicated my perspective and analysis.

However, I remain unsatisfied with the model of *Choices and Challenges* as an ultimate goal in the practice of science education. My belief in the power of the insights of STS to transform situations of social inequity and abuse of power remains unchallenged – and questioning what counts as science and scientific expertise (as a beginning) is not an implicit or explicit

goal within the established framework of *Choices and Challenges*. Changing the way science and technology are defined, represented, and enacted within the context of *Choices and Challenges* or similar projects can challenge the organization and the production of the events, the roles of educators in this organization and production, and the academic field of STS.

Broadening one's conception of participation in the production of scientific and technical knowledge would cause a shift in who can participate in the construction and organization of the forums. STS research points to the thick interconnections between the technical and political orders in the production of knowledge. This challenges the distinction between science and its social and ethical dimensions, and the types of expertise that the "public" and "scientists" embody, bypassing Zallen's distinction between 'scientific' and 'extrascientific' expertise, and questioning the distinction between event coordinators and event audience. Currently, the organization of the *Choices and Challenges* forums creates and maintains these distinctions in its program design and production. What would happen if power in the management of the events shifted to reflect the notion of the coproduction of the political and the technical?

Reimagining my role – the role of science educators – in the production of forums becomes an urgent step. Rather than thinking of ourselves as event directors or coordinators in the exploration of emerging issues in science and technology, reconceptualizing ourselves as community dialogue and action facilitators would begin the process of shifting the management of the forums from a top-down to a bottom-up production. We must recognize the capacity and expertise of the communities in which we live – not just on the days of the forums but throughout the organization of whatever events transpire.

Understanding ourselves as members of the community rather than detached, unbiased academics – that is, moving from community outsiders to community insiders – situates science educators as involved and integral parts of the community's capacity to act. As science educators we do embody a certain type of knowledge that may significantly add to our communities' base, but we must remember that our knowledge is just as but no more important than the types of knowledge that other community members bring to the table. What *Choices and Challenges* looks like must then become a matter of discussion, and the current structuring issues of replicability and balance in forum design would lose their preeminence. *Choices and Challenges* could become part of the organizing fabric of the community, with a life of its own.

Reshaping *Choices and Challenges* in this manner would raise a series of new tensions. Shifting the management and goals of the project would only increase funding difficulties, as well as trouble its position within the university as curriculum enhancement. Difficulties in outreach to members of the community with different levels of experience and a diversity of opinions would also increase if the constructed position of objectivity were removed from the language of *Choices and Challenges*. Without a strong central management, it is even possible that the project would disappear. However, I believe that a science educator– positioned as an involved facilitator – can work with the community to negotiate through many of these dangers. Grant opportunities do exist for community-based projects and research – but only if we – as science educators – change our language that describes the relationship between the community and science education projects as we seek to fund them, in addition to our actions.

At the end of this project, at a point that almost achieves retrospect, I can see now that part of my frustration with *Choices and Challenges* can be explained through a distinction between "outreach education" and "advocacy education." *Choices and Challenges* succeeds in the outreach mission of Virginia Tech, serving the community by "putting knowledge to work" in our regional area through a series of public forums designed to increase awareness of the social and ethical dimensions of science and technology. This outreach mission directly extends the normative undergraduate classroom experience at this university. This understanding of pedagogical practice is predicated on an assumption of neutrality and objectivity of the instructor in the classroom. In scientific and technical classrooms, the instructor uses his or her subject matter to reinforce this position. In humanities classrooms, the instructor distances him or herself from the controversial material, using this distance, again, to shore up a position of neutrality. *Choices and Challenges* currently combines both these strategies with the aim of producing unbiased and balanced public forums.

However, scholarship within the field of STS, among other emerging disciplines, points to the impossibility of this positionless position. All forms of knowledge, including scientific and technical, have a politics. Thus, in our community involvement and within our university roles, maintaining this false distinction between our academic and personal commitments rings false. It rings false in our classrooms, it rings false at *Choices and Challenges* events, and it rings false in our participation as political figures through our donations to certain groups, our letters to elected representatives, and all the other actions involved in being a member of particular communities. Most importantly for my project here, all this noise troubles to the core the idea of neutral "outreach education," showing that even the most carefully produced outreach education must necessarily be advocating for one position or another. If

all forms of knowledge have a politics, and if each knowledge creator is always already politically positioned, the goal of neutral outreach is inherently misguided.

All researchers within the field of STS must begin to recognize that maintaining the false split between our academic research, undergraduate teaching, university outreach, and community involvement is a failed project. As an STS researcher, I believe it is, in fact, my obligation to my local and global communities to use my work – without apology – for directly political ends. It is time for the field as a whole to move towards this interventionist strategy within our work and our communities. Challenging the technoscientific-political context in which we live always involves a level of real risk – but it is also our only opportunity to achieve real success. Our participation in this challenge is a responsibility to ourselves and to our communities that we must recognize and accept. This participation should not be shunned, but rather applauded

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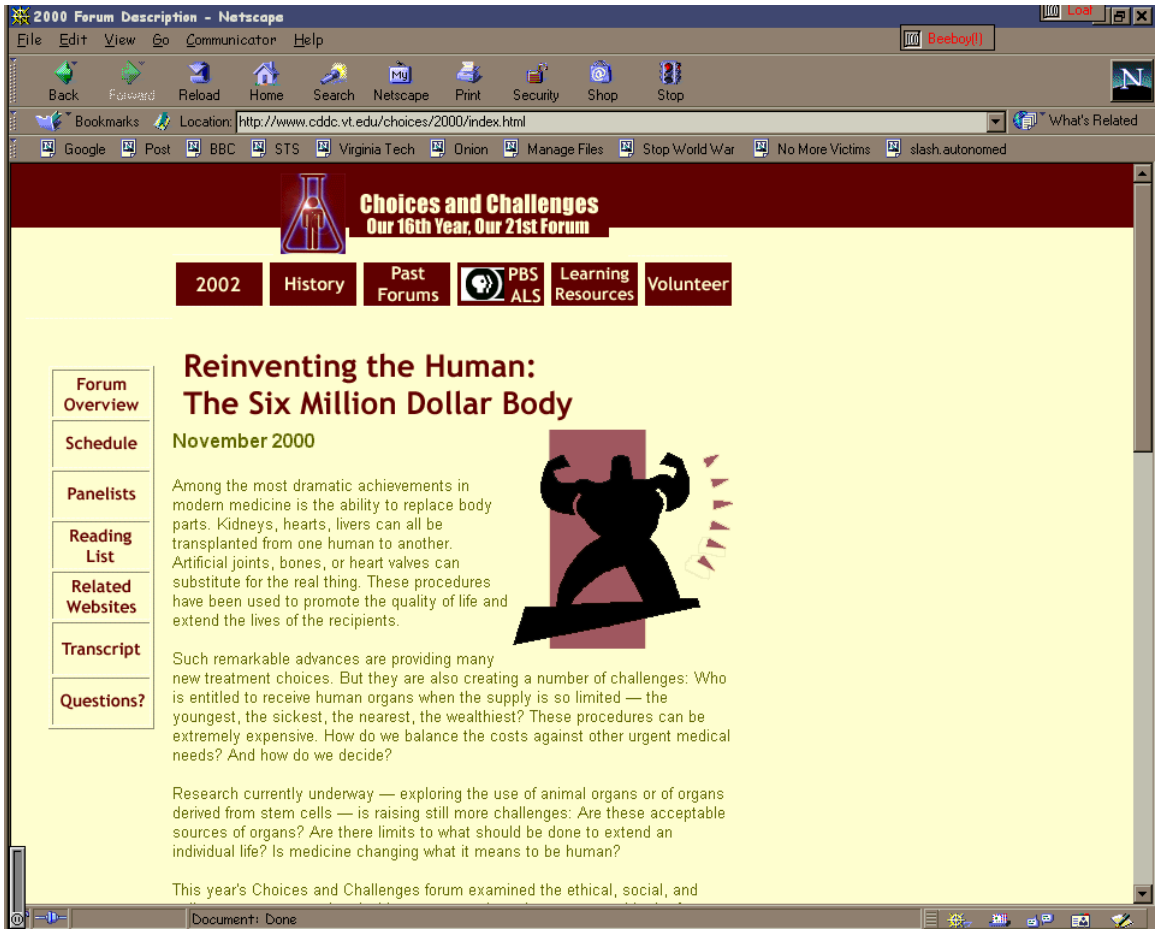
Appendix A:

For additional information about the *Choices and Challenges* Project, go to the website, available at http://www.cddc.vt.edu/choices.

For further details of the 2000 forum – Reinventing the Human: The Six Million Dollar Body – go to that section of the website, available at http://www.cddc.vt.edu/choices/2000.



Appendix B: *Choices & Challenges* Forums

New Reproductive Options: in vitro fertilization, embryo transfer, and surrogate parenthood

Forum Date: 2/28/85

The *Choices and Challenges* series has been established by the Center for Programs in the Humanities at Virginia Tech to allow the social and ethical aspects of recent, significant developments in science and technology to be identified and deliberated. All members of the community who wish to share in addressing these important and sensitive issues are cordially invited to attend.

The topic of the first forum – New Reproductive Options – reflects the expanded range of reproductive choices made possible by fundamental new insights achieved in the laboratory. The nature of these choices, and the societal challenges that they present, will form the core of our discussions.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy

Weapons in Space

Forum Date: 5/23/85

Choices and Challenges, an ongoing series of forums organized by the Center for Programs in the Humanities at Virginia Tech, explores the social and ethical dimensions of recent advances in science and technology. To permit the widest possible participation, these programs are open to the public at *no charge*.

In the second forum – Weapons in Space – we will be examining President Reagan's proposal to defend again nuclear missile attack using "Star Wars" techniques. Our discussions will focus on the technological feasibility of this multi-billion dollar plan, its impact on arms control strategies, and its overall personal and public policy implications.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy

Scientific and Technological Literacy

Forum Date: 9/30/85

Choices and Challenges, the forum series of the Center for Programs in the Humanities at Virginia Tech, investigates the personal and societal impact of recent advances in science and technology. To allow the fullest consideration of the issues, each event is open to the community at no charge.

The third forum in the 1985 series will deal with scientific and technological literacy. In this program, the focus will be on questions such as: How familiar are we with the vocabulary and concepts of science and technology? How much do we need to know – as individuals and as citizens – to make informed choices in a complex and increasingly technological world? What are the responsibilities of the schools, of government, and of the media in promoting understanding?

Sponsor(s): Virginia Foundation for the Humanities and Public Policy

Limits to Care (:The Aged and the Terminally Ill)
Forum Date: 11/20/85

Patient treatment decisions have always involved more than just purely medical data. This is especially so when life-prolonging procedures for the aged and the terminally ill are being considered. Such decisions have important ethical, economic, legal, and political components. And there are no easy answers to the troubling questions which have been raised – how much to do, when to stop, how to deal with the financial costs, and who is to make the critical choices. In this program we will examine the problem from its many perspectives to try to determine what, if any, are the limits to care.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy; 4 Prescribed hours by The American Academy of Family Physicians; 4 Continuing Medical Education Credits through Roanoke Memorial Hospital

Coal: Its Environments, Its Futures
Forum Date: 4/4/86

Coal has long been a vital part of the US energy picture and a key factor in the economic and cultural life of southwestern Virginia. For many years little change occurred in the way coal was mined or used. This is no longer the case. The fruits of an increasing emphasis on coal research are now being seen at all stages in the cycle of coal – from its extraction at the mine site to its utilization by industry. This program, part of the *Choices and Challenges* forum series, will examine the effects these new techniques and procedures have in coal's three environments: the workplace, the coal-producing community, and the extended ecosystem.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy

Intelligence Testing
Forum Date: 9/30/86

Intelligence testing has been described as one of the most important technologies to emerge in the field of psychology. In the decades since its first appearance, IQ testing has been simultaneously endorsed and attacked, encouraged and suppressed. The controversy continues today.

At this *Choices and Challenges* forum we will be taking a new look at intelligence testing. Among the issues we will be exploring are:

- what intelligence testing currently involves;
- what qualities or characteristics these tests are actually measuring;
- how meaningful are the scores obtained;
- the ways in which these tests are used to evaluate students, teachers, the aged, the handicapped;
- the benefits and the risks associated with the use of such tests.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy; Virginia Department for the Rights of the Disabled; Blacksburg Branch of the American Association of University Women (AAUW)

Genetic Engineering
Forum Date: 10/20/86

Genetic engineering in some form has been practices since humans first planted crops and domesticated animals. Only recently – for a little more than a decade – techniques for the manipulation of genetic material have become much more precise and powerful. These new procedures are revolutionizing agriculture, industry, and medicine.

At this *Choices and Challenges* forum we will:

- examine the ethical, religious, and social concerns raised by the new forms of genetic engineering;
- evaluate the special issues associated with the environmental release of engineered organisms and with human gene therapy;
- explore the most appropriate ways for the research and its applications to proceed.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy; Division of Research and Graduate Studies; Departments of Biology, Religion, Plant Pathology, Physiology, and Weed Science at Virginia Tech

(High Risk Technologies:) Nuclear Power and Space Science After Chernobyl and Challenger
Forum Date: 5/1/87

The recent loss of the space shuttle *Challenger* has called into question the goals and methods of the US space program. The nuclear meltdown at Chernobyl has renewed debate on the value of nuclear power. Should space exploration be pursued with manned missions? Can nuclear power be safely developed? How is technological risk determined and who decides what risks are acceptable? How are other nations dealing with nuclear power and space science? These and related issues will form the basis of discussion at this very timely program.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy; Virginia Environmental Endowment; College of Engineering at Virginia Tech

(Antireproductive) New Reproductive-Control Options
Forum: 10/1/87

Events surrounding the fertilization of the human ovum are now subject to greater and more scientific study than was formerly possibly. The information obtained has been used to promote fertility in otherwise infertile couples. However, this same information can also be used to help *prevent* pregnancy. At this forum, recent advances in contraceptive technologies

will be explored and the social and ethical issues – from personal to global – that these new options are raising will form for focus of the discussion.

For the first time in the *Choices and Challenges* Series, the Plenary Session will include participation by audiences on other campuses in an interactive video conference.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy; Learning Resources Center at Virginia Tech; Department of Religion at Virginia Tech; Blacksburg Branch of the American Association of University Women (AAUW), *Interplay* (Vignettes)

Altering the Aging Process
Forum Date: 4/18/88

Inquiry into the factors responsible for the aging process has been at the core of an increasing number of research programs in recent years making the study of the aging one of the most important areas in biomedical research. Will this work make possible a more healthy and vigorous old age? Might it lead to the ability to *extend* the life span? What will be the personal and societal effects of any change in the patterns of aging? To date there has been little examination of the state of our knowledge of aging and of the likely impact of advances in this field. At this forum we will examine recent progress in aging research and explore the economic, public policy, social, and ethical issues associated with increasing active life expectancy and with extension of the life span.

Audiences receiving the plenary session at teleconference locations through the country will be participating in our discussions.

Sponsor(s): GTE Foundation Lectureship Program; Research and Graduate Studies Division; 5.75 Continuing Medical Education hours with The American Academy of Family Positions; Continuing Medical Education Credits with Roanoke Memorial Hospital (5 hours)

High Temperature Superconductors: The Prospects for a New Technological Revolution
Forum Date: 10/26/88

Within the past two years a dramatic scientific breakthrough has occurred with the development of new kinds of materials – called high-temperature superconductors – which can conduct electricity, without any loss, at much higher temperatures than had ever before been observed. It may now even become possible to achieve superconductivity at room temperature. Materials with such superconducting properties could be used in a variety of ways – to create smaller and more efficient computers, highly accurate medical devices, entirely new modes of electrical power generation and transmission, and high-speed transportation networks. Are we at the brink of a new technological revolution?

At this Choices and Challenges forum we will:

- gain a basic introduction to the scientific and technical issues;
- examine what technological advances may realistically emerge from the scientific work;

- explore the social, economic, and political implications of such technologies.

Audiences receive the plenary session at teleconference locations throughout the country will be sharing our discussions.

Sponsor(s): Virginia Tech Division of Research and Graduate Studies; Bradley Department of Electrical Engineering and Department of Physics at Virginia Tech

The Pesticide Dilemma
Forum Date: 11/29/88

PESTICIDES. The word affects people in different ways. To some, the wide array of chemicals that fall into this category are life-saving and life-promoting – key elements in food production, environmental stability, disease control. To others, pesticides are a deadly hazard that contaminate the food supply, harm the land and pollute the water, and cause adverse health effects in those who come in contact with them.

Pesticides are everywhere – on the farm, in the home, in the workplace. More than $15 billion is spent annually on pesticides throughout the world. Where does the truth lie? Are pesticides friend or foe? Are there any alternatives to their use? How can we receive the benefits while reducing the burdens of pesticide use? Who decides – and how?

Join us as we explore the ethical, environmental, health, and public policy issues related to the dilemma of pesticide use.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy; C&P Telephone Company of Virginia; Research and Graduate Studies Division of Virginia Tech

Food Frights: Deciding How to Decide About Diet and Disease
Forum Date: 4/19/90

Low Cholesterol • High Fiber • Low Sodium • High Potassium • Low Saturated Fats • High Beta-Carotene

We are currently being bombarded with health claims linking specific dietary factors to the prevention of cardiovascular disease, cancer, and a number of chronic illnesses. Such claims can be found on the food products we buy and appear almost daily in newspaper articles and on TV programs we see. But how real is this connection between diet and disease? Can we actually protect ourselves against the onset of serious illness by altering what we eat? How do we make wise decisions about our diets when the information we receive can be confusing, incomplete, and often conflicting What should be the role of government, the food industry, consumer organizations, and the medical community in influencing our food choices?

We invite you to join us at this forum, the fifth anniversary of the Choices and Challenges series, as a distinguished group of presenters explores these and other related social, ethical, and public policy questions.

Sponsor(s): Virginia Foundation for the Humanities and Public Policy; C&P Telephone Company of Virginia; Research and Graduate Studies Division of Virginia Tech

The Information Revolution
Forum Date: 4/91 (not held)

The Genie in the Genome: The New Project to Map All the Genes on the Human Chromosomes and to Determine Their Precise Chemical Structure
Forum Date: 4/9/92

A major new scientific endeavor whose effects will reach far into our lives has just begun. Called the Human Genome Project – and organized under the joint auspices of the National Institutes of Health and the Department of Energy – this effort is intended to locate, map, and decipher the chemical structure of every one of the approximately 100,000 genes that are part of the human genetic make-up.

The scientific data obtained from the Human Genome Project will vastly increase our understanding of how genes function and what causes genes to malfunction throughout the course of our lives. This information may well alter the practice of health care, allowing genetic defects which bring about disorders to be detected even in the early embryonic stage and permitting our susceptibility to disorders – such as heart disease, cancer, and Alzheimer's disease – to be known years before any symptoms are observed.

Such detailed knowledge of our genes will raise significant issues that will directly affect our lives as individuals and as citizens. For instance, who should have access to the information about our genes – other family members? employers? insurers? the government? Might this lead to new forms of eugenics policies about who should be allowed to reproduce or who should be born? Could it lead to the genetic engineering of humans with "desired" characteristics?

Please join us as we explore the Human Genome Project and delve into its likely social, ethical, and public policy

Sponsor(s): ELSI – Program on Ethical, Legal, and Social Implications of the National Center for Human Gene Research; Virginia Foundation for the Humanities and Public Policy; C&P Telephone Company of Virginia

Quality of Life at the End of Life
Forum Date: 3/24/94

Among the most pressing concerns facing us today are those related to the end of life. Medical technologies exist that can intervene in the last stages of human existence in ways that were not previously possible. With machines, drugs, and surgical measures, death and dying have become greatly altered in our society. Patients, families, health-care workers are now being forced to confront a number of exceedingly difficult ethical and social questions:

- In what ways are these new medical options contributing to the "quality of life"?
- How much control should individuals have in deciding their own care and is physician-assisted suicide ever an acceptable choice?
- In the current economic environment, what kinds of restrictions on access to medical care would be reasonable?
- How can conflicts between individual preferences and social needs be resolved?

Please join us as we explore these and related issues at an especially timely *Choices and Challenges* forum.

Sponsor(s): Public Humanities Projects Program, Division of Public Programs, National Endowment for the Humanities; PBS Adult Learning Service; Continuing Medical Education Credits with the Roanoke Memorial Hospital

Quality of Life in the Electronic Village
Forum Date: 3/30/95

The expansion of computer network technologies may soon significantly alter traditional patterns of human existence. The US government and many businesses are actively promoting development of a telecommunications infrastructure that will make electronic villages possible – indeed common – by the year 2010. This information infrastructure is considered by many as vital to advancing the quality of life in American society.

In the rapid move to implement these technologies, however, little attention has been given to the human consequences. These new forms of communication and information exchange are certain to have revolutionary effects on nearly every aspect of human life and thought. This conference will examine the potential effects of computer networks, addressing questions such as:

- What will be the consequences for education, the workplace, government, health care, and social interactions?
- How will we balance increased access to information with the need to keep some types of information private?
- As greater reliance on these technologies is encouraged, how do we provide access for individuals who might lack the resources or knowledge to participate?

Please join us as we explore these and related issues at an especially timely *Choices and Challenges* forum.

Sponsor(s): Public Humanities Projects Program, Division of Public Programs, National Endowment for the Humanities; PBS Adult Learning Service

Quality of Life in the Global Environment: Sharing the Earth's Water Supply
Forum Date: 10/17/96

How do we, as individuals and as a society, make choices about the use of natural resources? How do our traditions shape our thinking and influence our decisions?

What are the consequences of these decisions for the quality of life of all Earth's residents?

Many areas of the world, including parts of the US, are facing inadequate supplies of fresh water. Choices are made every day about the use of this vital resource, by us personally and by our governments. But we are often unaware of factors that influence our decisions. At this forum we will explore these often unrecognized factors – historical, ethical, legal, and cultural – that influence our thinking about water and, by extension, nature itself.

Come join us as we examine some of the complex water-supply dilemmas in the US, identify the underlying foundations of our thinking about water – and the natural world, and consider the links between our personal choices and our public environmental policies.

Sponsor(s): National Endowment for the Humanities; Virginia Foundation for the Humanities and Public Policy; PBS Adult Learning Service; Virginia Tech Water Center; Virginia Tech: Provost's Office; Research and Graduate Studies Division; College of Arts and Sciences; College of Forestry and Wildlife Resources; the Charles E. Via, Jr., Department of Civil Engineering, and the Center for Organizational and Technological Advancement at Virginia Tech; Montgomery County League of Women Voters

Quality of Life in the Global Environment: Preparing for the Next Century
Forum Date: 4/3/97

What condition will the earth's environment be in by the middle of the next century?

Predictions vary. But even the most optimistic of these raise serious concerns. Without doubt, we face a major task in striving to safeguard the planet's ecological health while meeting the needs of a human population estimated to nearly double by the year 2050.

The crucial environmental issues ahead make it necessary that we examine our current views of nature, our lifestyles, the institutions that define our culture, and our notions of quality of life. Are these adequate, or do they need to be altered?

Come join us as we explore these important issues. This forum will present social, political, economic, and ethical perspectives to inform our thinking about how the decisions we make now will affect life in the future.

Sponsor(s): National Endowment for the Humanities; Virginia Foundation for the Humanities and Public Policy; PBS Adult Learning Service; Virginia Tech: Provost's Office; Research and Graduate Studies Division; College of Arts and Sciences; College of Forestry and Wildlife Resources; the Charles E. Via, Jr., Department of Civil Engineering, and the Center for Organizational and Technological Advancement at Virginia Tech

Reinventing the Human: Designer Children
Forum Date: 3/25/99

Babies made to order. Parents picking the particular traits they want in their children. Is this possible?

New genetic-engineering procedures now permit human genes to be identified and transferred. These procedures are being developed to cure disorders and correct serious childhood health problems. But they could also be used, before birth or during infancy, to endow healthy children with traits they would not otherwise possess or to enhance the ones they do. The possibilities go beyond changing physical appearance (for example, height and build). They might include intelligence, athletic skills, personality, and behavior.

Is it desirable – or even acceptable – to create the ideal child through genetic technology? And who decides what "ideal" means? This Choices and Challenges forum will examine the ethical, social, and public policy components associated with the upcoming ability to redesign children. Join us at these discussions.

Sponsor(s): Center for Interdisciplinary Studies and the Outreach Division of Virginia Tech; Virginia Foundation for the Humanities and Public Policy; Continuing Medical Education credits through Carilion (7 hours)

Reinventing the Human: The Six Million Dollar Body
Forum Date: 11/9/00

Among the most dramatic achievements in modern medicine is the ability to replace body parts. Kidneys, hearts, livers can all be transplanted from one human to another. Artificial joints, bones, or heart valves can substitute for the real thing. These procedures have been used to promote the quality of life and extend the lives of recipients.

Such remarkable advances are providing many new treatment choices. But they are also creating a number of challenges: Who is entitled to receive human organs when the supply is so limited – the youngest, the sickest, the nearest, the wealthiest? These procedures can be extremely expensive. How do we balance the costs against other urgent medical needs? And how do we decide?

Research currently underway – exploring the use of animal organs or of organs derived from stem cells – is raising still more challenges: Are these acceptable sources of organs? Are there limits to what should be done to extend an individual life? Is medicine changing what it means to be human?

This year's *Choices and Challenge* forum will examine the ethical, social, and policy concerns associated with organ transplantation – now and in the future. Please join us and share in these discussions.

Sponsor(s): Center for Interdisciplinary Studies and University Outreach at Virginia Tech; Continuing Medical Education credits through Carilion (4.75 hours)

Jane L. Lehr

Science and Technology Studies
Virginia Tech, Mail Code: 0227
Blacksburg, VA 24061

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Fax: 540 231 7013
Email: jlehr@vt.edu

EDUCATION

M.S. *Virginia Tech*, May 2002, Science and Technology Studies: Social Studies & Policy Track
Thesis Title: "Doing" Theory and Practice: Steps Towards a More Productive Relationship Between Science and Technology Studies and Nontraditional Science Education Practices

B.A. *University of Rochester*, May 1997
Art History, *cum laude*
Concentrations: Visual & Cultural Studies
Architecture, Methods and Materials

ACADEMIC and ADMINISTRATIVE APPOINTMENTS

6/01-6/02 Graduate Research Assistant
The Choices and Challenges Project Online: Helping Students & Faculty Explore the Social and Ethical Dimensions of Science & Technology
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

5/01-5/02 Co-Chair, Funding Committee, Mephistos, a conference organized for graduate students by graduate students, to be held at Virginia Tech, March 14-17, 2002; money raised to date: $12,350

5/01-8/01 Intern Advisor, Minority Academic Opportunities Program (MAOP) at Virginia Tech; Project: Eugenics Policies and Minority Groups in Southwest Virginia

5/00-present Research Associate
The *Choices and Challenges* Project
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

5/00-present Website Coordinator
The *Choices and Challenges* Project
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

1/01-2/01 Associate Producer
Reinventing the Human: The Six Million Dollar Body, two half-hour segments for PBS Adult Learning Service (broadcast 4/01) Video/Broadcast Services and the Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

5/00-1/01 Forum Coordinator
Reinventing the Human: The Six Million Dollar Body
The *Choices and Challenges* Project
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

9/00-11/00 Producer
Pig in the Middle, a play by Judy Upton
The *Choices and Challenges* Project
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

8/99-5/00 Coordinator, Center for Science and Technology Studies Brown-Bag Thursday Lunch Discussion Series, sponsored by the Science and Technology Studies Graduate Student Organization
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

8/99-5/00 Graduate Teaching Assistant
Humanities, Science and Technology Concentration
HST 1504, Introduction to Humanities, Science and Technology (with Doris Zallen, PhD)
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

5/99-8/99 Project Manager
Engineering Cultures Online: Helping Students Achieve Personal and Global Understanding Through the Web and CD/ROM
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

5/99-6/99 Consultant (Data Verification)
Susan C. Allender-Hagedorn's *Arguing the Genome: A Topology of the Argumentation Behind the Construction of the Human Genome Project*," unpublished dissertation (defended: 10 April 2001)

1/99-5/99 Graduate Teaching Assistant
Humanities, Science and Technology Concentration
HST 1504, Introduction to Humanities, Science and Technology (with Eileen Crist, PhD)
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

8/98-12/98 Graduate Teaching Assistant
Humanities, Science and Technology Concentration
HST/HIST 2154, Engineering Cultures (with Gary Downey, PhD)
Center for Interdisciplinary Studies, Virginia Tech, Blacksburg, VA

GRANTS RECEIVED (as part of the *Choices and Challenges* Project)

6/01 Center for Interdisciplinary Studies and the *Choices and Challenges* Project, recipient of $10,000 by a Woodrow Wilson National Fellowship Foundation Innovation Award to develop and implement a new doctoral level course, "Science in the Public," which explores the social and ethical

dimensions of emerging issues in science and technology. Innovation Awards "recognize and support departments and programs in the humanities that encourage Ph.D. students to interact with the world outside the academy as part of their graduate training."

3/01 *The Choices and Challenges Project Online: Helping Students & Faculty Explore the Social and Ethical Dimensions of Science & Technology*, recipient of $41,360 for fiscal year 2001-2002 with Doris T. Zallen and Valerie G. Hardcastle form the Center for Innovation in Learning at Virginia Tech

GRANTS RECEIVED

3/02 $100 Travel Grant, Graduate Student Assembly to present at the National Association for Science, Technology and Society Annual Conference, Baltimore, MD (2/02)

1/02 $100 Travel Grant, Center for Science and Technology Studies to present at the National Association for Science, Technology and Society Annual Conference, Baltimore, MD (2/02)

6/01 $350 Travel Grant, Loka Institute to attend the 4th Annual Community Research Network Conference, Austin, Texas (7/01).

5/01-5/02 $12,350 raised to support Mephistos, an international, multidisciplinary event for graduate students preparing for careers in the fields of history, philosophy, policy, and sociology of science, technology, and medicine, organized each year by graduate students at rotating universities, to be held March 14-17, 2002 at Virginia Tech.

9/99 $200 Travel Grant, Center for Science and Technology Studies to present at the Social Science Historians Association Annual Conference, Ft. Worth, Texas (11/99).

9/99 $100 Travel Grant, Center for Interdisciplinary Studies to present at the Social Science Historians Association Annual Conference, Ft. Worth, Texas (11/99).

PROFESSIONAL EXPERIENCE

5/98-9/98 Information Analyst/Independent Contractor
Weber & Associates, Sterling, VA

10/97-5/98 Technical Support Representative
MindSpring Enterprises, New Cumberland, PA

5/97-10/97 Registrations/Publications Coordinator, Script Coordinator
Independent Feature Film Market
Independent Feature Project, New York, NY

8/96-1/97 Curatorial Assistant, Photography
George Eastman International Museum of Photography, Rochester, NY

REPORTS and PUBLICATIONS

6/01 Why so Few Women in Science and Technology," a book review of *Athena Unbound: The Advancement of Women in Science and Technology* by Henry Etzkowitz, Carol Kemelgor, Brian Uzzi with Michael Neuschatz, Elaine Seymour, Lynn Mulkey, and Joseph Alonzo (New York: Cambridge University Press, 2000), *BioScience*, June 2001, Vol. 51, No. 6.

1/01 "Final Report of the Graduate Student Compensation Review Committee," co-authored by Launcelot I. Brown, Bronson P. Bullock, Jane L. Lehr and Stephanie B. Scheer for the Office of the Executive Vice President, Virginia Tech

3/00 "Professionally Employed But Not Insured: The Graduate Student Population in the Commonwealth of Virginia," report for the Graduate Student Assembly, Virginia Tech

11/99 Junior Fellow, "Research Tomorrow Project," A Report to Dr. Steven Breckler, Division of Behavioral and Cognitive Sciences, National Science Foundation by Mark Benson and Jack Lesko, based on an NSF-sponsored two-day conference at Virginia Tech (10/22/99-10/23/99)

Ongoing Numerous interviews, op-eds and articles published in local papers on issues ranging from scientific and technical controversies to social justice and anti-war movements.

PROFESSIONAL PRESENTATIONS and INVITED LECTURES

4/11/02 Policy Follow-Up Session: "Professional and Public Involvement," *Choices and Challenges*: Food Frights, a public forum on food safety, Blacksburg, VA

3/15/02 "Scholarship on the Theory/Practice Split," a roundtable discussion as part of the Mephistos International Graduate Student Conference, Blacksburg, VA

3/4/02-3/6/02 "The *Choices and Challenges* Project as a Best Practice," National Institute of Standards and Technology Best Practices Conference on Communicating Science to the Public, Gaithersburg, MD

2/21/02 "Stepping Towards a Theory and Practice of Nontraditional Science Education", National Association for Science, Technology & Society, 17th Annual Meeting and Conference – "The Way We Live: Can we live with what we create?", Baltimore, MD

4/10/01 "Reinventing the Human: Designer Children," an invited lecture for BIOL

3444, Explaining Molecular Cell Biology, Virginia Tech

4/7/01 "Locality and Public Understanding: Three locally-based PUS Projects," Exhibiting STS: The 2001 Virginia Tech STS Graduate Student Conference, Blacksburg, VA

1/01-3/01 "Final Report of the Graduate Student Compensation Review Committee," co-authored by Launcelot I. Brown, Bronson P. Bullock, Jane L. Lehr and Stephanie B. Scheer and presented to Minnis Ridenour, Executive Vice President; James Bohland, Interim Provost; Joseph Merola, Dean of Graduate Studies; and the Virginia Tech Board of Visitors

12/1/00 "Reading AIDS: An Introduction to Science and Technology Studies," an invited lecture in honor of World AIDS Day for English 1105, "Critical Literacy: The Dream That Was America," Virginia Tech

7/15/00 "Professionally Employed But Not Insured: The Graduate Student Population in the Commonwealth of Virginia," presented to the Office of the Executive Vice President, Virginia Tech

4/24/00 "Genetically Modified Foods: Are They Safe?" an invited lecture for HST 1504, Introduction to Humanities, Science and Technology, Virginia Tech

3/23/00 "An Examination of Genetically Modified Foods," for the Center for Science and Technology Studies Brownbag Lunch Discussion Series, Virginia Tech

2/3/00 "The Center for Science and Technology Studies Today – in relation to its inception, history and its futures(s)," for the Center for Science and Technology Studies Brownbag Lunch Discussion Series, Virginia Tech

11/12/99 "CFIDS Online: A Case Study of a Virtually Healthy Community – Steps Toward Definition, Model-Building and Evaluation of Healthy Online Communities," Social Science Historians Association Annual Conference, Ft. Worth, Texas

9/23/99 "Activism and Objectivity," with Chris McDermott, for the Center for Science and Technology Studies Brownbag Lunch Discussion Series, under the theme, "The CSTS Community and Outreach: Finding Our Place," Virginia Tech

9/16/99 "The CSTS Community and Outreach: A Beginning," with Chris McDermott, for the Center for Science and Technology Studies Brownbag Lunch Discussion Series, under the theme, "The CSTS Community and Outreach: Finding Our Place," Virginia Tech

9/1/99 "Chronic Fatigue Syndrome – Medicalization, History, and Online Research," an invited lecture for History 3724: History of Disease, Medicine, and Health, Virginia Tech

3/6/98 "Science, Technology and Culture in Marlon Riggs' 'Tongues Untied: Black Men Loving Black Men'," Center for Science and Technology Studies Brownbag Lunch Discussion Series, Virginia Tech

HONORS & AWARDS

2/02 Finalist, Virginia Tech College of Arts and Science's Outstanding Graduate Student Award

2/02 Best Graduate Student Paper, National Association for Science, Technology & Society, 17th Annual Meeting and Conference – "The Way We Live: Can we live with what we create?", Baltimore, MD

5/97 The Celeste Heughes Bishop Award for Academic Accomplishments

8/93-5/97 University of Rochester Alumni Scholarship

5/93-5/97 The Xerox Award for the Humanities

5/93-5/97 The Robert C. Byrd Award for Academic Excellence

SERVICE ACTIVITIES

8/01-present PhD Representative of the Science and Technology Studies Graduate Student Organization, Policy Committee, Program in Science and Technology Studies, Virginia Tech

9/01-present AWOL (http://www.go-awol.org), Blacksburg, VA

4/01-present FTAA Unorganizing, New River Valley, VA

1/01-present Vice President, Students Against Sweatshops – Virginia Tech (SASVT)

10/00-present Member, Graduate Compensation Review Committee
Office of the Executive Vice President, Virginia Tech

8/99-9/00 MS Representative of the Science and Technology Studies Graduate Student Organization, Policy Committee, Program in Science and Technology Studies, Virginia Tech

9/98-5/00 Chair, Graduate Student Assembly *ad hoc* Committee on Health Care, Virginia Tech

9/98-8/99 Graduate Student Assembly Representative, Virginia Tech