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Fact, friction, and political conviction in science policy controversies

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The joke about the poor fool who spends half the night looking for lost keys under the sliver of light thrown off by a street lamp illuminates something revealing about human nature. It is natural to search for what one lacks where it is easiest to see, especially when the alternative is to plumb dark stretches of the unknown. Scholars bathed in the warm glow of their own academic disciplines sometimes express this same human instinct by throwing themselves headlong into what Chomsky (1994) calls 'wild goose chase[s]' producing 'extremely detailed microanalysis and discussion of things that don't matter' (p. 163). Multiplied on a collective scale, such intellectual myopia feeds the 'ivory tower problem' (Andersen 1993), where universities become increasingly detached from the arguments that swirl in the shifting currents of public controversies beyond the academy. Such ivory tower detachment is a major factor accounting for the impoverishment of public discourse today, since withdrawal of intellectuals from public spheres of deliberation bottles up the considerable energy and wisdom that academic scholars might otherwise contribute to contemporary public controversies.

As the development of technology so often has direct political, social and economic impact that affects a wide variety of stakeholders, it is no surprise that 'many of the great controversies of our time are essentially public controversies about science—nuclear power, AIDS research, toxic waste disposal…' (Farrell 1997, p. 324). Contemporary society's dependence on science as a source of useful technology has led to a blurring of science and technology (as well as basic and applied research) as distinct categories.[1] Just as grass pushes its way up through cracks in sidewalk concrete, scientific controversies tend to sprout in the points of cleavage and uncertainty that are scattered throughout the science/technology continuum.

While these 'trans-science' (Weinberg 1972) controversies often feature opaque technical argumentation, they also include struggles over the appropriate role of scientific reasoning in public life. In 'boundary disputes' (Cohen and Arato 1992, pp. 493–563), crucial questions of communicative practice are at stake. What role

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should public participation play in science policy planning? How much decision-making authority can be delegated safely to scientific institutions? Who should decide the proper pace and direction of scientific research?

Dishing out arguments with what Farrell (1997) called 'tour de force relish' (p. 318), Gaonkar (1993) recently launched a blistering critique of the 'rhetoric of science' project. It is interesting to note that in follow-up commentary, Gaonkar seems to have gestured in the direction of the questions listed above as fruitful topics for rhetoric of science inquiry. 'The contemporary critic needs a better understanding of the relationship between the public sphere, where rhetoric does its business of ideological integration, and social formations like the economy, technoscience and bureaucracy that are run on a non-dialogic, systemic logic,' Gaonkar (1997 p. 343) wrote in the final chapter of *Rhetorical Hermeneutics*, a book-length anthology of pieces combusting out of his incendiary 1993 article.

Gaonkar's suggestion was one factor driving the decision to establish the American Association for the Rhetoric of Science and Technology (AARST) Science Policy Forum (SPF). Designed as a bridge to connect the intellectual traditions of deliberative and forensic rhetoric to the emergent Science and Technology Studies (STS) research program in 'controversy studies' (Engelhardt and Caplan 1987, Brante 1993), the SPF concept presents a unique methodology for exploring scientific controversies. The hermeneutic dimension of the approach invites critics to study controversies by *creating them*, then bringing the newly generated arguments, insights, and texts under critical purview. The subsequent follow-on rounds of commentary that question the timing, format and topics used by forum organizers can enact reflexive moments that complicate and enrich efforts undertaken to organize subsequent forums. This special issue of *Social Epistemology* provides a glimpse of the hermeneutic SPF method in action. Readers are presented with a full transcript of the inaugural SPF debate, as well as critical feedback from leading STS commentators focussing on the run-up, execution, impact and analysis of the event.

This paper lays out the theoretical grounding and practical justification for such an endeavour and suggests lines of inquiry that might complicate the project. In part one, an overview of science policy controversies elucidates the range of potential topics ripe for exploration using the SPF method. Part two considers previous work that has posited science's argumentative tradition as a potential engine of political democratization. The forensic tradition of academic debate is the focus of part three, which explores aspects of the debating process that make it a valuable tool of knowledge production. Part four explains how the SPF methodology works simultaneously as an academic exercise and political intervention, and part five proposes avenues of critical reflection designed to highlight the SPF's pitfalls and possibilities, in hopes that such reflection might inform future attempts to convene similar forums.

1. *Science policy controversies*

Argumentation about scientific matters can take a variety of forms and unfold in a multitude of forums. In strictly scientific forums such as laboratories and professional conferences, competing experts voice disagreements and debate topics related to research methods and findings of fact. In policy forums such as congressional hearings, public meetings, and popular journals, a broader array of advocates struggle over the social and political implications of scientific inquiry. These are just a few of the sites

where competing views on science are aired and compared. An important feature of the arguments unfolding in such settings is dialogical interaction. Such interaction forms the essence of scientific controversies, and it also underwrites the important distinction between contradictory scientific beliefs and scientific controversies:

> The difference between contradictory scientific beliefs and scientific controversies (or more generally between epistemic and social factors) is thus that the former refer to contrary propositions and do not necessarily lead to open confrontation, in the same sense that the existence of classes does not have to entail class struggle. They merely reflect the existence of contrary accounts of a phenomenon, whereas a controversy is always a *manifest* of conflict. *Controversus* means 'the clash of opposing opinions; debate; disputation'. In a controversy, the participants are highly aware of the situation and act from it, for instance, by assembling resources for the specific purpose of undermining the position of the adversaries (by arguments, allies, and so forth.)
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> (Brante 1993, p. 181, see also Mazur 1981, McMullin 1992)

The dialectical element of scientific controversies sets disputants on argumentative trajectories that tend to overshoot narrow debates about specific content areas and steer attention to higher level discourses that address prevailing social norms about the proper role of science in society. 'The characteristic feature of consensual contexts—normal science in Kuhn's sense—is precisely that one does not discuss or need to bother about the foundations of one's discipline or activities; they appear as self-evident and rational. All this is called into question during controversies' (Brante 1993, p. 186).

Some scientific controversies are never amplified beyond the cloistered confines of professional laboratories, while others simmer for years in relative obscurity until some event charges the debate with ethical, social or legal significance. Such a triggering event has the potential to draw in new voices and propel arguments into wider spheres of deliberation. Consider the dispute over the so-called 'Y2K bug'. In the 1990s, computer scientists debated each other in technical forums about the potential for the Y2K bug to cause major disruptions in computer systems. Such discussions were largely technical in nature, but as the new millennium drew nearer, politicians, citizens, businesspeople, journalists, religious leaders and a host of others joined the argument, which turned more to questions of *policy* as the Y2K countdown proceeded. The ongoing dispute over cleanup of the Marshall Islands serves as another case in point. Nuclear tests irradiated many of these islands during the Cold War, and by the mid-1990s, a scientific consensus emerged that clean-up projects should be funded by the US government to reduce radiation exposure levels on the islands to 100 millirems per year. Such a finding was largely uncontroversial until 1999, when attorney Davor Pevec discovered Environmental Protection Agency documents stating that the appropriate exposure level for similar bomb sites in the continental US was 15 millirems per year. 'Suddenly it's no longer a scientific issue, but a political one', reflected commentator Jack Niedenthal (quoted in Woodard 2000, p. 12).

These examples illustrate an important dimension of policy disputes in a democratic polity—by definition, such controversies are public matters that affect a wide range of overlapping interests. Even when policy arguments touch on highly technical points, participation by members of the general public is important to assure that collective decisions are made democratically. With the foundational norms of science up for debate, science policy controversies become sites where prevailing public opinion, the so-called social knowledge (Farrell 1976) about the proper social and political purposes of the scientific enterprise can be rooted out, contested, and revised. The generative function of rhetorical practice ensures that these types of debates establish social precedents for future controversies, and in the process, come to establish the proper role

of science in society. In what follows, we sketch a few of the many loci, or sites of dispute, around which science policy controversies tend to cluster. Such an exercise brings into view a range of possible topics that might yield ripe questions for investigation through the SPF method.

1.1. *Research trajectory and experimental design*

The very framing of scientific research hypotheses and the selection of problem areas is often infused with political significance that invites contestation. For example, in the mid-1980s, evidence began to surface that the US medical establishment was pursuing research agendas devoted primarily to improving the health of men, giving women the short shrift. Activists began to notice that 'major clinical trials by the National Institute of Health (NIH), including studies on the effects of caffeine on heart disease and the relation between aspirin consumption, heart disease and stroke … included only men in the study population, even though the results of the trials were intended to provide improved medical treatment protocols for both men and women' (Sarewitz 1996, p. 43). When this discrepancy was reported in the public sphere, the resulting controversy featured discussion that overshot health care issues and broached the general problem of gender inequity in science. NIH officials rationalized their decision to exclude women from research trials on the grounds that their hormonal cycles would have a complicating effect on study findings (see Taylor 1996, pp. 143–153). Subsequently, it was disclosed that virtually all of the NIH administrators who ordered the questionable research were men (see Sarewitz 1996, p. 43). This disclosure touched off a heated debate about the role of gender in administrative allocations of scientific resources.

1.2. *Data interpretation*

The meaning of raw data yielded in scientific experimentation is almost never fixed absolutely and competing interpretations of a common pool of experimental data can fuel public controversy. For example, laboratory tests have shown that large doses of chemicals such as formaldehyde and saccharin cause cancerous tumors in rats. Advocates of strict government health regulations have cited this data as evidence that formaldehyde and saccharin are dangerous substances that should be excluded aggressively from the human food chain. On the other hand, corporate advocates have countered with the argument that intrinsic physiological differences between rats and humans undermine the external validity of such data as warrants for industry regulation. In a prototypical example of a narrow scientific disagreement being ratcheted up to higher levels of political significance, advocates on both sides have cited disputes over the health harms of chemicals to be litmus tests for determining the proper level of authority that should be afforded to scientific data in the government's regulatory decision-making protocol (see Dickson 1998, p. 294).

1.3. *Demarcation*

As Rouse (1992) points out, '[t]he boundaries between science's "inside" and "outside", its centers and its margins, are always themselves at issue in interpretive practice, and not something already fixed' (p. 18, see also Gieryn 1999, Taylor 1996). The contingent quality of the criteria demarcating the boundaries of legitimate science

is a lightning rod for disputation. Some engineering problems (e.g. dam construction) are clearly soluble by scientific methods, while other social problems (e.g. racial discrimination) can be worsened when reduced to technical puzzles. Because it is often difficult to isolate which problem areas are appropriate for scientific treatment, there is ripe ground for public controversy when disagreement occurs in this register of demarcation. In the case of human intelligence research, researchers trumpeting the value-freedom of objective data have published findings that allege an inherent racial disparity in IQ test score distribution (Herrnstein and Murray 1994). Critiques of this work have ratcheted up the argumentation to a level that transcends the policy issues of human intelligence measurement to broach more fundamental questions about race, religion, and the proper role of science in society (see Kincheloe *et al*. 1996).

1.4. *Public funding*

To qualify for public funding, practitioners of scientific research must demonstrate the utility of their endeavours to external audiences. Given the scarcity of public funding available and the multitude of competing scientists seeking public support, funding debates are often charged with intense argumentative energy. The Superconducting Supercollider (SSC) was a classic 'big science' project that prevailed in the funding arena by winning substantial financial support from the US Congress in the late 1980s. The SSC project was distinct from other 'big science' initiatives in that instead of promising a tangible and concrete 'end-of-the-pipe' technological payoff, it was packaged as a catalyst of abstract (albeit revolutionary) theoretical knowledge about subatomic phenomena. For several years, this 'basic science' rationale for the project prevailed, as advocates capitalized on popular belief in the notion of an 'endless frontier' in science to win financial backing. However, when the General Accounting Office released a 1992 report that detailed escalating costs and extreme mismanagement in the project, SSC research came under heavy fire. The ensuing public controversy featured robust argumentation regarding the worth of basic scientific research and the need for greater public accountability on the part of big science managers. Some even argue that the ultimate termination of SSC funding was the opening salvo in the so-called 'science wars,' a far-ranging and bitter public debate over the proper role of science in society (Ross 1996, p. 6).

The links between basic science, applied technology and politics cannot be established with formulaic precision. For example, indeterminacy in the experimental process often renders problematic the extrapolation of basic research results to the realm of technological engineering. Likewise, the complexity of technological change often makes it difficult to anticipate the political significance that engineering advances might hold for society. Indeed, the realms of science, technology and politics are linked together by loose tethers, and the inherent slack in such connection provides opportunities for advocates to dispute the relevance, reliability and meaning of scientific truth claims, particularly when issues of power, equity and ethics are at stake. When such disputes take place, the stakes can be even greater than they might appear on the surface, since public controversies represent occasions where citizens revisit and reconstitute social norms about the enterprise of science itself, as they sort through competing arguments pivoting around loci of disputes such as research trajectory, experimental design, data interpretation, demarcation of scientific boundaries and public funding.

2. *Science (as/in) the open society*

Popper (1945) proposes a provocative thought experiment in his famous book, *The Open Society and its Enemies*: could Robinson Crusoe, stranded alone on a remote island, conduct 'real science'? For Popper, the answer is clearly no. Because the very idea of science presupposes the existence of a community of interlocutors sharing 'conjectures and refutations' in group discussions (Popper 1963), Crusoe's scientific project would never get off the ground. On this logic, science might be thought of as the ultimate debating union, where 'argument, which includes criticism, and the act of listening to criticism, is the basis of reasonableness' (Popper 1945, p. 226). There is an inherent democratic spirit built into this concept of shared communal discourse, where under ideal conditions, each person has a say, and collective decisions are guided by the wisdom of the better argument. According to Fuller (1998), historical evolution of this critical debating spirit followed a path of 'uneven development' in Europe after 1600, when it first took hold in scientific communities:

> The experimental method succeeded in democratizing scientific communities much faster than it did European society as a whole. Thus, once the achievements of science were consolidated in Newtonian mechanics at the start of the eighteenth century, philosophers proclaimed a period of 'Enlightenment', the goal of which would be to liberalize, and perhaps ultimately to democratize, society by popularizing science's distinctive critical attitudes.
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> (Fuller 1998, p. 72)

This popularizing instinct reached full expression in Popper's (1945) idea of the 'open society', a democratic polity whose institutional structures and social norms would be modeled after science's tradition of critical argumentation. Later, Campbell (1988) followed Popper in this line of thought, proposing a vision of 'the experimenting society', in which policy-makers would depend on the application of scientific techniques to produce strategies for 'piecemeal social engineering' (p. 292), based on scientific principles. Popper and Campbell were quick to tout their 'open society' and 'experimenting society' proposals as vehicles of large-scale democratization, reforms that promised to breathe the free air of scientific inquiry into the stuffy halls of public policy institutions. However, such plans faced significant challenges when it came to the practical task of reproducing science's tightly controlled, rule governed patterns of discourse on a mass scale. The common background assumptions and shared critical norms that facilitate scientific argument do not map cleanly onto wide-open debates conducted in public spheres of deliberation, where a range of advocates bring heterogeneous and often eclectic discursive practices and personal values to the table. 'Any credible theory of democratic practice must thus devote attention to the possibility of democratizing the mechanisms that integrate scientific expertise and political discourse' (Fischer 1993, pp. 36–37). During the 1960s, a variety of schemes for maximizing citizen participation in science policy formulation were tried as ways to reconcile democratic norms of deliberation with the surging influence of technical knowledge over policy formation (see Peterson 1984). These projects, ranging from science literacy campaigns to science fairs, represented concrete expressions of 'prolescience', Fuller's principle that 'knowledge production should proceed only insofar as maximum public involvement is possible' (Fuller 1993a, p. 117).

Recently, scholars in the field of public policy have taken an 'argumentative turn' that is largely consistent with Fuller's call for maximizing citizen involvement in the policy process. Like Popper and Campbell, scholars pursuing this argumentative turn embrace 'selective radicalization' of scientific norms into the political process (Dryzek

1993, p. 229). Where Campbell saw policy reforms as experiments, the argumentative turn in policy planning suggests that policy reforms 'are best viewed as arguments, a metaphor whose roots lie in the everyday social interaction of policymakers, scientists, and citizens at large' (Dunn 1993, p. 256). It would seem that a key role of the policy planner in such an approach would be 'to keep public debates fueled with a continuing supply of information, forecasts, analyses, arguments, and then the countervailing evidence and propositions that might reinforce opposing sides to disputes' (Webber 1978, p. 160). The Science Policy Forum project shares similar objectives. It seeks to extend science's spirit of critical argumentation to the policy forums where political decisions are forged (à la Popper and Campbell), yet it recognizes that such a spirit must be radicalized with a more expansive and inclusive concept of debate, if the goal of a more democratic science policy process is to be realized.

3. *The forensic debating tradition*

As a forensic practise, debate is as old as the most venerable deliberative bodies and has been used in a wide variety of cultures as a method of analyzing issues of social import and determining policies to address those issues (Branham 1991). From the Athenian law courts, to the British House of Commons, to modern televised debates, debate is firmly entrenched as an activity that can provide the opportunity for arguments to develop in an open environment that supports equitable communicative exchanges and thorough analysis.

The practise of debate is founded on the premise that one particularly useful way to understand a controversy is to allow different sides of the issue to engage each other in a direct, adversarial exchange. Through this process, the arguments for and against a certain proposition can be vigourously expressed and subjected to forceful critique, allowing those witnessing the debate to gain a keener understanding of the issues at stake. Debate assumes that the process of having adherents to various sides of a proposition develop arguments in response to one another ensures that flaws in competing arguments will come to the fore, and that worthy arguments will prove their mettle by exhibiting resiliency in the crucible of disputation. There are three dynamics that facilitate debate's potential in this regard: the presence of argumentative clash, the participation of debate advocates, and the use of appropriate formats and topics.

3.1. *Argumentative clash*

Clash, the friction that arises at points of tension between arguments, is at the core of the debate process (Branham 1991, Weiss 1995). A lively debate is filled with times when advocates express mutually exclusive positions, with the drama of disagreement then drawing the audience's attention to those issues. Clash sparks critical thinking by ensuring that rival arguments are elucidated at points of disagreement. In such moments of clash, it becomes possible to test the clarity of definitional terms, explore criteria for argument evaluation, and compare the substance of competing arguments (Warnick and Inch 1998). If critical thinking is seen as the activity of taking a given argument and challenging its assumptions, probing its structure and making judgements as to its veracity, then the dialectical process of debate is well suited to verbalise this procedure (Ziegelmueller and Kay 1997). In a sense, debate constitutes verbal

expression of the critical thinking process itself, with the advocates and audience members doing the work of challenging assumptions and clarifying various aspects of the argument under consideration.

Quite often, clash can highlight points of convergence as well as incongruity between arguments. In debates, it is frequently the case that arguments are only seemingly in conflict, since 'positions are most often improperly understood, frequently as much by the proponent as by the opponent' (Gilbert 1997, p. 112). Once advocates clarify to each other the nature of their positions, it becomes evident that differences separating them may be less substantial than originally thought. Subsequent disagreements 'often occur at points in the argument well beyond the initial assumptions and attitudes from which the disputed claim(s) flow' (Gilbert 1997, p. 112). This process not only serves the purpose of focussing the debate on matters of genuine disagreement between advocates, it also clears space for common ground to be forged out of argumentative interchange. By clarifying terms, assenting to agreeable counter-arguments and steering discussion to central issues that might unite competing camps, advocates can pursue consensus building and mutual understanding through debate.

Further, clash ensures that different sides of the issue under consideration are developed to their fullest potential. In the debate format, competing advocates are given a specified period of uninterrupted time to make their respective cases, and to critique the case of the other side. The debate process puts competing viewpoints in conversation with each other, and gives audiences an opportunity to see that there are, indeed, at least 'two sides of the story'. In debate, major claims offered by affirmative proponents are not simply asserted in a vacuum. Rather, the back-and-forth dialectic of interactive argumentation creates momentum for advocates to extend, develop and polish their arguments as discussion proceeds. Absent this clash, this direct tension between differing arguments, it would be far more difficult to account for the various possible perspectives on a given topic.

3.2. *Debate advocates*

A lone speaker could simulate argumentative clash in a monological presentation by elucidating both sides of an argument, laying down competing premises and showing where the different positions in a controversy overlap and converge. Debate, however, envisions not just the presence of contradictory arguments, but that advocates animate such disagreement through verbal interaction. In important respects, then, the character of any given debate is tied to the quality of advocates who participate. Advocates likely to invigorate discussion in positive ways include those who have a personal stake in the question under consideration, are well-informed, and are willing to listen to and engage with other viewpoints.

Advocates who are willing to risk arguing for a particular position in front of a public audience are likely to have developed a certain amount of personal conviction that will animate their delivery and stoke their desire to see the best possible case made for their side. Exhibition of such personal conviction is anathema in purely technical debates designed to reach an 'objective' consensus as to matters of scientific fact. However, in policy forums addressing 'transcience' issues, the heavy value-ladenness of topics under consideration places advocates in a position where some judgments based on personal conviction are inescapable. In such situations, advocates can elucidate their convictions with emotion and thus form bonds of identification with audience members who share similar dispositions.

Well-informed advocates provide the debate process with checks against fallacious reasoning. One can imagine a situation where an unopposed speaker would get away with outright deception, lying to the audience when his or her opponent lacks the knowledge to question an illusory assertion. However, it is much harder for one advocate to advance straw person arguments in the presence of an alert and lucid defender of a counter-position. *Non-sequiturs*, or red herring arguments, cannot be used as effectively in a debate featuring well-read advocates on both sides, as such adversaries are able to point out deficiencies in shoddy reasoning and poorly evidenced claims.

Finally, the debate process requires of advocates both a base of knowledge from which to critique and a willingness to engage contrary arguments wholeheartedly. If this commitment is not shared reciprocally by competing advocates, argumentative clash can be shallow and superficial, and the focus of debate can drift easily to tangential issues. Furthermore, an attitude of mutual respect on the part of advocates is important to lend a sense of *gravitas* to the debating event, thus promoting an environment favorable for the constructive interchange of ideas.

3.3. *Debate formats and topics*

The debate format itself has a dynamic impact on the quality of the argumentative clash that occurs in forensic events. For example, US presidential debates have been criticized for not allowing candidates to 'directly confront, question, or refute one another', to the point that some claim that such spectacles are not debates at all (Rieke and Sillars 1997, p. 248). However, there are format wrinkles that can be included in debates to minimize the likelihood that debate encounters do not degenerate into 'two ships passing in the night'. Cross examination periods can help facilitate clash by giving advocates the opportunity to obtain information from their opponents, point out inconsistencies in the other side's logic and highlight aspects of the competing case that deserve attention (see Hollihan and Baaske 1994). Likewise, giving the audience a chance to directly interact with the advocates can both ensure that possible lines of analysis neglected by the advocates are developed, as well as force debaters to adjust their advocacy in response to queries that focus attention on novel or challenging aspects of the controversy (Weiss 1995). Productive debates also require appropriate topics that make clear and reasonable demands on the speakers, steer discussion to salient issues, and provide each side with fair ground for argument (Vancil 1993). Debate formats that provide for direct interaction between advocates and the audience, coupled with topics that focus the debate on the germane issues in an equitable manner, generate the most focused argumentative clash and therefore facilitate more effective debates.

4. *The Science Policy Forum*

The SPF explores science policy controversies through the medium of public argument. Its organizing principles overlap in significant ways with the rationales for other moves to democratize the policy process, such as Popper's 'open society', Campbell's 'experimenting society' and the recent 'argumentative turn' in the field of public policy. One unique facet of the SPF is that it is rooted in the tradition of forensic debating. Most forensic debating activities today feature undergraduate students

competing in intercollegiate tournaments that are largely insular, academic affairs.[2] What separates these debating events from the SPF is that the latter is designed as a vehicle to carry arguments beyond academic circles, to reach public and professional audiences directly involved in the policy controversies under scrutiny. This section explores the SPF's dual function as an academic exercise and political intervention into public spheres of deliberation, with particular attention given to the avenues of critical analysis and potential lines of public argument opened up by the project.

4.1. *Scientific separatism and epistemological border crossings*

In the current age of rapid technological advance, the intense pressure of complex technical issues impinging upon agents of political decision-making tempts those in power to reduce daunting transcience controversies into tidy packages of technical disagreement. Rather than grapple forthrightly with the delicate political components of vexing public policy disputes, authoritative decision-makers have shown a preference to isolate the 'purely' scientific elements of these arguments, asking technical experts to decide such questions in separatist institutions of scientific judgment such as so-called 'science courts' (see Kantrowitz 1967). This predilection for what Yellin (1983) calls 'scientific separatism', requires clear borders to be drawn that delineate exact boundaries between the 'policy' and 'science' dimensions of a given issue. Although such boundary drawing is often presented as a politically neutral maneuver, Jasanoff (1987) rightly points out that 'the effort to make such distinctions is politically charged. ... How one characterizes an issue on the spectrum between science and policy bears on the way it is ultimately decided, both institutionally and procedurally' (p. 224).

Rather than downplay the political dynamics in this boundary drawing process, the SPF seeks to highlight such dynamics by facilitating argumentative 'border crossings', with advocates moving back and forth between the scientific and political aspects of questions that are fashioned deliberately to foreground a mixture of science and policy elements.[3] As a method of critical inquiry, this squares with Dryzek's (1993) suggestion that in policy deliberation, '[t]he essence of judgment and decision becomes not the automatic application of rules or algorithms but a process of deliberation which weighs beliefs, principles, and actions under conditions of multiple frames for the interpretation and evaluation of the world' (p. 214). Endorsement of this 'border crossing' principle presents certain challenges to advocates participating in SPF deliberations, since such a format calls on them to engage in both public and technical 'spheres of argument' (see Goodnight 1982).

Argumentation theorists have developed an extensive body of literature delineating the difference between technical argumentation conducted in specialized scientific forums and practical argumentation carried out in public spheres of deliberation. A central concept supporting this distinction is that there are different standards regarding argumentative burdens of proof in the respective spheres. One cannot assume that a group of laypersons will apprehend an argument in the same way as a specialized audience, versed in technical language and sharing a common professional vocabulary. Toulmin's theory of argumentation offers a conceptual scheme that sheds light on this phenomenon. Toulmin (1958) posits a distinction between *data* and *warrants* in arguments, with the former being 'the facts we appeal to as the foundation of the claim' (p. 97), and the latter being the parts of the argument that, 'taking these data as a

starting point', show that 'the step to the original claim or conclusion is an appropriate and legitimate one' (pp. 97–98). In other words, where the data supporting arguments are like cooking ingredients, warrants are like recipies that specify how components of the argument fit together to support an overall claim.

Advocates in both technical and public spheres of argument shoulder a common burden of proof to provide data backing up their claims. However, argumentative warrants tend to function differently in the two spheres. In technical argumentation, relatively stable background assumptions and rules of argument evaluation enable advocates to support their claims with data alone, since audiences are able to draw upon shared background knowledge to sort out the broader meanings such data might hold for particular arguments. Such opportunities do not frequently obtain for advocates participating in policy debates in the public sphere, where the data used to support claims mean vastly different things to persons from different socio-cultural backgrounds. Such circumstances require advocates to spell out their argumentative warrants more frequently, showing in detail how their chosen data justify acceptance of their claims for policy action.

Given that much scientific argumentation occurs in the technical sphere, where assumptions are made as to the efficacy of certain ways of knowing, it can be difficult for experts to be self-reflexive about the warrants behind their policy prescriptions, if such prescriptions are never tested in the crucible of public debate. Placed before an audience that might not share those assumptions, successful advocates will not only have to defend their conclusions, but defend the assumptions warranting those conclusions. 'Dialectical confrontation between generalists and experts often succeeds in bringing out unstated assumptions, conflicting interpretations of the facts, and the risks posed by new projects' (Majone 1989, p. 5). According to Fuller (1999), such occasions provide the opportunity for scientists to increase the 'epistemic fungibility' of their knowledge claims (pp. 141–146), a development that facilitates democratization of the science policy process by spurring interdisciplinary and extra-academic interchange.

4.2. *Academic criticism*

As an academic enterprise, the SPF shares much in common with the branch of STS scholarship focussing on the analysis of scientific controversies. In anthologies such as *Controversial Science* (Brante *et al*. 1993) and *Scientific Controversies* (Engelhardt and Caplan 1987), one finds essays that analyse science policy debates over topics such as government regulation of Laetrile research, health harms of cotton dust, gendered aspects of psychological tests and risk assessment of nuclear power. These essays detail arguments advanced by competing advocates, steer attention to key points of contention and highlight the connections between the science and policy elements of selected controversies under consideration. Such paths of critical inquiry parallel the SPF method in many respects. However, the vast majority of STS essays that address scientific controversies do so through proverbial rear-view mirrors, providing retrospective commentary on arguments already made by scientists, policy-makers and other players in the science policy process.

In contrast, the SPF method enables the study of scientific controversy *as it unfolds*. The live debates generated out of the SPF process yield new arguments and fresh perspectives that may not have been voiced previously in public spheres of deliberation. By selecting advocates and formulating topics for debate, SPF organizers exert

significant influence over the kinds of arguments and perspectives that spring forth in these moments of knowledge production. The productive element of the SPF method is similar to so-called action research (see Kincheloe 1993) conducted to generate understanding *through* intervention into the arena being studied.[4] Such intervention has potential to produce new texts that can serve as artifacts for subsequent criticism.

Transcripts of SPF debates are particularly useful and interesting artifacts in this regard. The contributions to this special issue illustrate how the transcript of a forensic event can serve as a heuristic resource for spurring wide-ranging commentaries. For example, scholars responding to SPF performances and examining transcripts can shed light on science policy controversies by using the deliberations to locate the *stases* of disputes, situating the disagreements in wider socio-cultural contexts, and identifying which norms are being tested as controversies unfold (see e.g. David Hingstman's comments in this issue, pp. 176–179). In classical rhetorical theory, *stasis* is a concept that refers to the centre of discussion, the locus of dispute, or the key point around which argumentation pivots. In controversies where the locus of dispute rests on so-called 'demarcation' issues, 'the relationship between scientific practice and rhetorical efforts at defining what is and what is not science' (Taylor 1996), the broader significance of the controversy as constitutive of the definition of 'science' itself is often expressed clearly on the surface of the controversy's textual artifacts (see e.g. Elzinga 1993, pp. 127–152, Condit 1996, pp. 95–97, Martin 1996, pp. 265–266):

> It has been argued persuasively that scientific controversies form a strategic research site for studying science. During a controversy, social processes not normally visible within science can become unusually explicit. What counts as a repeatable experiment, the relationship between theory and experiment, the types of scientists who can legitimately contribute to the production of scientific knowledge, what counts as bias, impropriety and breaches of the scientific method, and the role of the media are just a few of the matters which are given concerted attention during a controversy. Under the lens of a scientific controversy, the good, the bad and the ugly within science come into focus as never before.
>
> (Pinch, 1994, p. 88)

Controversies not only serve as sites where the character of 'science' as an institutional enterprise is revised and updated; broader social norms are also often at stake in such disputes. For example, in their reading of the controversy surrounding the Three Mile Island nuclear accident, Farrell and Goodnight (1981) show how the rhetoric of nuclear power experts, politicians and members of the media reproduced 'visions of the public' that constructed citizens as helpless spectators ripe to be manipulated by scientific experts in a cyclical pattern of technical breakdown and catastrophe. As a method of interpretation, their approach is rooted in the assumption that rhetoric's capacity to 'generate' social knowledge (see Farrell 1976) provides critics with the opportunity to produce insightful social commentary, by examining the argumentative dynamics of salient public controversies. This tack could lead to useful interpretations of many other types of science controversies where broader social norms are at stake.

One possible strategy of critique could use SPF debates as normative benchmarks to inform analysis of science policy discourse. To the extent that SPF debates fulfill their promise as pedagogical events featuring robust argumentative clash and equitable give-and-take, they could be viewed as illustrations of what a democratic policy-making process *might* be like. Following Kemp's (1985) suggestion that 'communicative ethics' in policy planning receive more attention, critics could utilize SPF proceedings as reference points for critique of policy dialogues unfolding in the corridors of power, where official science policy decisions are actually crafted. In cases where dramatic differences between these academic and policy realms would appear, commentators

might leverage critique of technocratic or exclusionary patterns of decision-making, showing how such patterns of official policy planning fall short of the normative benchmarks set by the example of SPF deliberations.

4.3. *Political intervention*

Since SPF debates are both academic inquiries and political interventions, they function simultaneously as tools of scholarly reflection and contributions to political discourse.

> Science is a social institution, and scientists, as members of that amorphous entity called 'the public', need to participate in public discourse about science and science policy. Those scientists who share their scientific expertise in public as well as professional forums provide a vital ingredient for an informed discourse (Swazey 1992, p. 53).

While it is clear that scientific expertise plays an integral role in the formation of science policy, it is not always clear how the findings of science translate into public arguments appropriate for the policy arena. For example, scientists can show how many particulates are in the air, but they can have trouble explaining how to craft appropriate policy instruments to deal with such pollution, or even if such instruments should be crafted at all. The SPF invites persons with scientific knowledge to express their wisdom as arguments that bear directly on practical policy questions. The public advocate 'must speak that language of knowledge which translates easily into the language of action, and promotes a fusion of the two' (McGee and Lyne 1987, p. 391).

The language of action spinning out SPF debates makes the content of such proceedings potentially interesting to policy-makers. SPF deliberations afford policy-makers a unique, dialectical perspective on science policy controversies foregrounding aspects of scientific disputes that might not be apparent in written reports, briefing papers or recommendations from advisory bodies presenting settled scientific conclusions. Furthermore, policy-makers could draw on SPF deliberations to inform their assessments of the degree of uncertainty associated with scientific judgments that are relevant factors in policy planning. Such understanding could provide valuable insight regarding the appropriate framework for negotiating particular policy challenges.

> An understanding of the different levels of certainty in policy advice should prompt the use of different modes of decision. If there is agreement and virtual scientific certainty, then rather straightforward decision-making can be trusted. When there is greater uncertainty, models which include risk in the analysis should be used' (Barker and Peters 1993, p. 4).

As open forums involving members of the general public, SPF deliberations serve an additional political function by creating channels of communication that facilitate public participation in science policy dialogues. Citizens are presented with scientific information in a format that is not usually available in public spheres of deliberation. The debate format affords audience members the opportunity to witness how various arguments on different sides of a policy questions measure up against one another. They see flaws exposed in arguments. Biases and assumptions are brought to the surface. The arguments are dissected and defended by those knowledgeable on the subject, increasing the amount of quality information available about matters of social import. This opportunity for social learning opens up spaces for citizens to voice their concerns on political matters connected to science. Since, as Fuller (1993b) observes, 'there are no true experts in matters concerning the public sphere' (p. 285), the contributions citizens

make to science policy dialogues are integral to the process. According to Bechmann (1993), 'it is non-experts who recognize problems, impacts or potential dangers that the expert cannot perceive' (p. 15). Empirically, the public sphere works as a 'warning system with sensors' (Habermas 1996, p. 359) that has a long track record of thematizing and pushing onto the agenda of public discussion problems relating to the nuclear arms race, risks of genetic engineering, ecological threats in an overstrained environment, impoverishment of the Third World and other issues (Habermas 1996, p. 381).

5. *Re exion*

One unique aspect of the SPF approach is that its dual status as a political intervention and site of academic criticism creates space for insight to spring from the interplay between these interlocking dimensions of inquiry. Woolgar (1991) characterizes this synergistic interplay as a 'dynamic of iterative reconceptualization', a process whereby 'practitioners in social studies of science from time to time recognize the defects of their position as an occasion for revising its basic assumptions' (p. 382). According to Woolgar, what sets this dynamic in motion is practitioners' embrace of 'reflexivity', the affirmative problematization of their own conceptions of themselves as critical agents, in light of continually shifting theoretical assumptions. 'Reflexivity currently asks us to problematize the assumption that the analyst (author, self) stand in a disengaged relationship to the world (subjects, objects, scientists, things)' (Woolgar 1991, p. 383).

This posture shares much in common with the research orientation of critical ethnography, which insists on commitment 'to study the character and bases of one's own work practices and their relation to the knowledge such practices produce' (Simon and Dippo 1986, p. 200). 'Once we understand the value of reflexivity in terms of the dynamic of iterative reconceptualization—in short, as an attitude for enhancing our ability to pose fresh questions about epistemic matters—we recognize that social studies of science have the capacity to revisit taken-for-granted assumptions which underpin particular phases/research perspectives' (Woolgar 1991, p. 382). In the context of rhetorical theory, Leff has located a similar dialectic at work in the synergistic interplay between the 'productionist' and 'interpretive' impulses of classical rhetoric (see Leff 1997, pp. 89–100). The mixture of productive and interpretive aspects in the SPF process affords opportunities for scholars to evaluate reflexively the merits of the knowledge production process in which they are engaged. Through intermittent and alternating episodes of text creation and criticism, scholars can concomitantly refine strategies for close reading of rhetorical artifacts and turn their critical impulses inward, asking whether their theoretical commitments need revision. It is possible to elucidate these opportunities schematically by visualizing them scattered across various points plotted on a hermeneutic circle (see figure 1). In this rendering, the evolution of each individual forum might be charted as a full sweep around the circle, beginning with the selection of a topic, progressing through productive phases such as advocate recruitment, publicity and performance of the debate, then moving to interpretive episodes involving transcription, editing and retrospective textual criticism. In the final phase of methodological reflexion, insights gleaned from the forum itself, and knowledge gained from derivative commentaries, could be used to interrogate and revise the method, in hopes that such changes might reflect positively on subsequent attempts to convene similar forums. There are a number of avenues for reflexive interrogation that

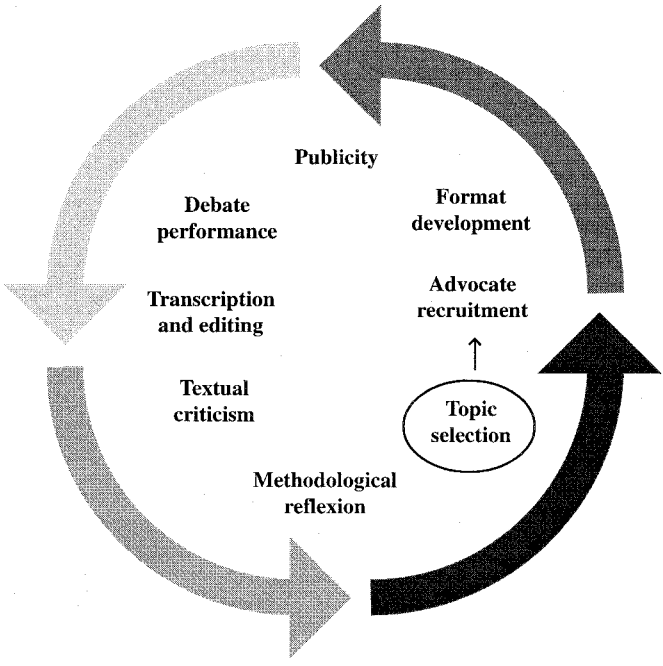

Figure 1. Science Policy Forum method plotted on a hermeneutic circle.

might usefully turn the critical spirit of forensic debating on itself and prompt SPF practitioners to recalibrate their theoretical and political orientations in light of such experience.

5.1. *Balancing the value of clash and the excesses of agonism*

Although our previous comments suggest that argumentative clash can serve as a valuable tool for knowledge production, there is a danger that when procedures are formalised to produce such clash, the byproduct can be more heat than light. Adversarial debate tends to foster an 'ethic of aggression' that promotes 'slash and burn thinking' (Tannen 1998, p. 22). The challenge for debate forum organizers and participants is to invent ways of communicating that generate heuristic frictions, while being mindful that the ensuing heat should not melt away the bonds of trust that are necessary prerequisites of collective understanding. According to Goodnight, 'refutation must be coupled with a constructive moment, when a counterstatement accounts for the source of misunderstanding, that thereby affirms the capacity of common reason to reach an opposing judgment' (Goodnight 1991, p. 12). Through experimentation with different formats, topics and moderating strategies, it may be possible to steer SPF dialogue toward the direction of 'responsible rhetoric': 'Reasoning that strengthens communicative bonds affirms or creates a *shared ethos*, a mutual respect that emerges from the communicative relationship between interlocutors' (Goodnight 1993, p. 339, see also Jorgenson 1998).

5.2. *Juggling policy relevance with participant reward*

If one accepts the premise that the SPF has potential as a tool for examining science policy controversies, it would seem useful to heighten the policy relevance of SPF

deliberations by, for example, establishing channels that would connect forum proceedings to formal political structures such as legislative bodies or regulatory agencies. Such a move would represent apparent progress toward satisfying what Rowe and Frewer call the 'criterion of influence' for procedures designed to increase public participation in science policy making: 'The output of the procedure should have a genuine impact on policy' (Rowe and Frewer 2000, p. 14). However, tradeoffs are likely in the pursuit of heightened policy influence. For example, direct linkage to the formal policy making process could undermine efforts by SPF organizers to recruit advocates. 'Scientists have an institutional stake in reducing public interactions between science and the administrative process, since these interactions emphasize the indeterminacy and lack of consensus within science, thereby weakening science's claim to cognitive authority' (Jasanoff 1987, p. 224). Additionally, the SPF's roots as an academic enterprise lend organizers the freedom to experiment and innovate with formats and topics. Such free-wheeling independence could be undercut by a decision to integrate SPF proceedings formally into the science policy apparatus, since such integration would bring a host of political officials (and their attendant bureaucratic mindsets) into the forum planning process. Reflection and debate on these tradeoffs would seem important for organisers to make wise choices regarding the relationship of the SPF to institutional apparatuses of formal decision-making.

5.3. *Navigating between academic interest and democratic need*

Topic selection is perhaps the most important aspect of SPF organizing, since the general area chosen for discussion and the specific wording of the question to anchor forum deliberations shape all other dimensions of the SPF process and focus considerable energy and resources on a particular policy dispute. In an ideal world, the most interesting and dynamic science policy disputes (from an academic perspective) would also be the ones most politically valuable to discuss and investigate through intensive argument. However, the congruence of academic interest and political need cannot be taken for granted. Public interest groups locked in scientific disputes with corporations may want to see SPF deliberations convened to explore controversies to which they are party, but such controversies may not have the same appeal as topics of inquiry for scholars. Similarly, scholars may be interested in science policy disputes that have only marginal political relevance in the contemporary political milieu. Decisions about which topics to pursue in such instances of conflicting interests are likely to raise important questions about the purpose of SPF deliberations and present SPF organizers with the challenging task of juggling the academic and political priorities implicated by their projects. One possible approach to this juggling act would be to add another layer of debate onto the SPF organizing process, convening debates *about* appropriate SPF topics. In such forums, advocates could lay out cases for and against possible topics, with argumentative give-and-take serving as a heuristic tool to facilitate collective decisions in the topic selection process.

6. *Conclusion*

Others have organized public debates between scientists for the purposes of drawing academic work out of the so-called 'ivory tower' and enhancing the democratic content of science policy decision-making. For example, Kantrowitz has worked tirelessly with

collaborators to popularise his 'science court' project, which brings technical experts together to debate narrowly-drawn scientific propositions (Kantrowitz 1967, Kantrowitz and Masters 1985). Durant's *Science Frictions* media series showcases a British television show featuring scientists debating topics in an adversarial format.[5] According to Rose (1998), Durant's televised debates 'have been conspicuous for their lack of liveliness, with scientists cosily agreeing with one another' (p. 118). Unfortunately, Rose's review suggests that *Science Frictions* falls short of sparking the energy of argumentative clash that might be generated by more lively debate forums.

The SPF builds on these previous attempts to harness argumentation as a tool of academic pedagogy and political judgment in the science policy context. Consonant with Condit's (1996) call for development of a 'broad' rhetoric of science program, this strategy invites scholars (especially so-called rhetoricians) to embrace roles as 'rhetors', drawing upon rhetoric's tradition as a productive art to extend and amplify the political impact of their scholarly work. The approach also calls on scholars to blend the 'interpretive' and 'productivist' aspects of the rhetorical tradition imaginatively in such a way that steers scholarship toward political engagement that engulfs critics in the swirling waters of lived controversy. Such a plunge prompts scholars to revise constantly their political and theoretical orientations in light of new political interventions.

Notes

1. What has emerged instead is the hybrid category of 'technoscience' (Latour 1987, pp. 174–175).
2. There is a movement afoot in intercollegiate debate circles to challenge this dynamic. Recently, the National Parliamentary Debate Association was formed in an attempt to provide a public debate forum for competitive intercollegiate debaters. This organization hosted the largest national debate championship tournament of 2000. This trend parallels moves by members of the intercollegiate policy debate community to call for a heightened emphasis on public debate as strategy to amplify the arguments developed by competitive debaters to wider spheres of public deliberation (see Mitchell 1998).
3. Our use of the phrase 'border crossings' is inspired by Henry Giroux, whose book *Border Crossings* highlights the importance of interrogating and redrawing prevailing cultural and political borders through critical pedagogy: 'As a pedagogical process intent on challenging existing boundaries of knowledge and creating new ones, border pedagogy offers the opportunity for students to engage the multiple references that constitute different cultural codes, experiences, and language' (Giroux 1992, p. 29).
4. As Martin explains, 'generally speaking, action researchers see the process of gaining knowledge and changing society as interlinked, even inseparable. Intervention to change society produces understanding—including new perspectives of fundamental theoretical significance—which in turn can be used to develop more effective intervention (1996, p. 264).
5. We are indebted to Durant for creating the 'science frictions' metaphor, which is used in the title of this article.

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