Expertise, Policy, and Publics

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The topics addressed in this lecture represent the policy-relevant side of STS, where the conceptual frameworks and research problems discussed in previous lectures and in the book can be brought together into analyses that inform problems of expertise, policy, and democratic participation. Although one might conceptualize the issues as applied, they pose new empirical research problems and require theorization. As a result, the topic has become one of the leading areas of STS research. This lecture has ordered the subject matter into three related topics: expertise and policy, public understanding of science, and public engagement in science

Expertise and Policy

In the ideal of a representative democratic society, the public (in the sense of the collectivity of voting citizenry) is the ultimate authority over policy, including science and technology policy, but it exercises the authority indirectly through elected representatives. In turn, elected representatives rely on scientific expertise and advice when attempting to formulate

problems and develop policies to solve them. As David Guston suggested in *Between Politics and Science,* the distinction between principal and agent is a helpful way of describing the relationship between policymakers and scientific experts, who serve as the "agents" of the delegated authority of the policymakers. As occurs in other principal-agent relationships, the relationship creates some general problems. For example, policymakers are often unsure about what kinds of experts are needed ("adverse selection"), and they may find that experts redefine problems and research in ways that serve their own interests ("moral hazard").

Guston and colleagues argued that one way of managing the principal-agent tensions is through the creation of boundary organizations, which operate at the interface of science and government. For example, in the United States the Office of Research Integrity and the Office of Technology Transfer mediate the worlds of policymakers and scientists for problems associated with research integrity and research productivity. Another example is the former Office of Technology Assessment for the United States Congress, which provided scientific expertise and reports to the Congress. The organizations create and manage boundary objects, translate across social fields and geographical scale, and engage in the boundary-work of constructing divisions between science and politics. In the process they enable and filter information flows as well as the social interaction of people from diverse organizations. Often boundary organizations employ experts whose role is to sift through scientific expertise and package it in ways that enables it to translate across different organizations and social fields.[1]

Assuming that boundary organizations or other mechanisms can solve some of the principal-agent problems, other problems emerge when the advice is received. For example,

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1. Cash 2001; Guston 2000, 2001; Guston et al. 2000; Miller 2001a, 2001b. On the similar concept of intermediary organizations, see Rip 1994.

policymakers must negotiate between what their constituents want and what the experts advise. Furthermore, because different policymakers may turn to their own sources of expertise, especially for contentious issues, the expertise itself is easily divided in ways that align with political positions. For that reason, David Collinridge and Colin Reeve argued that scientific advice is rarely useful for policymakers. When there is policy consensus before scientific advice, the advice has little effect on policy, and when a policy consensus is lacking, the advice becomes subjected to technical questioning.[2]

However, not all students of expertise and policy have drawn such negative conclusions. Sheila Jasanoff suggested that there are occasions when scientific advice can influence policy, but two primary conditions must be met: there must be ongoing negotiation between the scientific advisors and policymakers about the nature of the advice, and the scientists must be able to complete successful boundary work that distinguishes science from policy. By drawing boundaries between science and policy, the advisors can effectively post "keep out" signs on the expertise to avoid its capture by political partisans. An effective boundary can also enable an expert to give policy advice, provided that the role is distinguished from scientific expertise. Jasanoff suggested that when the conditions are met, scientific expertise can play a significant role in policymaking, especially in four areas: long-term research policy, certification of methods, definitions of standards, and analyses of inferences made from studies and experiments.[3]

Building on this work on science and advising, Roger Pielke argued that experts may adopt different strategies with respect to providing technical advice or general policy advice depending on the levels of value consensus and uncertainty. In the relatively rare situation of a

2. Collinridge and Reeve 1986.
3. Jasanoff 1994.

value consensus with low uncertainty, the scientist may choose between simply summarizing knowledge in the field or serving as an arbiter of disputes by providing a more detailed answer. In contrast, where consensus is lower and uncertainty higher, scientists may align themselves with some partisans and adopt the position of an issue advocate, or they may attempt to play the role of "honest brokers" who clarify policy alternatives. For Pielke all three strategies are justifiable as long as they are explicit, but scientists who serve as "stealth issue advocates," that is, who pretend to be neutral when they are not, are duplicitous. Pielke's set of strategies is not necessarily inconsistent with Jasanoff's conclusions. In all four strategies the expert may draw a boundary between science and policy, but once that boundary is established, the expert still has decisions to make about adopting the roles of representation and advocacy.[4]

Another set of problems facing scientific experts is how to present their advice in the media and to a broader public. Stephen Hilgartner has shown that experts carefully manage the presentation of their expertise in public, and they also make decisions about what kinds of information to leave "backstage," such as negotiations over reports. Such strategies become especially important for scientific bodies that wish to maintain credibility from one study to the next. As Barbara Allen noted, individual scientists involved in controversies also must select a strategy of public presentation. She contrasted two scientists involved in research on the health effects of chemical exposure in Louisiana's Cancer Alley. One scientist chose to avoid the limelight and publish research in peer-reviewed journals, with the hope that the credibility of the peer-reviewed science would have some value for advocacy organizations in legal disputes. Another scientist avoided peer-reviewed publication and disseminated the research in the media,

4. Pielke 2007.

with the hope that the media attention would trigger greater public awareness and funding for more research.[5]

In climate science at the international level, there is intense political scrutiny from both governments and industry associations that do not want to see increased regulation such as carbon trading or carbon taxes. Paul Edwards and Stephen Schneider argued that a widely inclusive and extensive peer-review process, much more so than is standard in most scientific research fields, can achieve a higher level of consensus among scientists. The higher level of consensus is both more useful for policymakers and more resistant to deconstruction by skeptics. Likewise, Clark Miller argued that boundary organizations that function in an international arena must also attend to differences in political culture and work with already-existing policy advisory groups at the international, national, and local levels. Dale Jamieson added that by making value choices explicit and negotiating a normative framework for policy, it may be possible to achieve greater consensus than by relying on policy based on expert panel advice.[6]

Studies of climate science also raise the important problem of how scientists reveal uncertainty, ignorance, and disagreements among experts when presenting their research and consensus reports to policymakers, the media, and the broader public. Some reports of expert bodies, such as those on climate change, have attempted to reveal uncertainties by framing the discussion in terms of multiple scenarios and assumptions rather than a single consensus scenario. To the extent that the experts display disagreements and admit uncertainty and nescience rather than produce consensus about what is known or at least uncertain, they may tend to sanction a precautionary approach to policy. However, the relationship between a

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5. Allen 2003, 2004; Hilgartner 2000. There is also an emerging literature on STS in the courts, with a good introductory chapter in Yearley 2005. Other ways in to the literature are Lynch 2005 and Edmund and Mercer 2006.
6. Edwards and Schneider 2001; Miller 2001a, 2001b; Jamieson 2001.

reflexive sociology of openness to disagreement and ignorance and a policy of precaution is by no means guaranteed. Increased transparency about a lack of expert consensus and certainty can also sanction policy inaction based on the call for more research. Thus, the effects of drawing attention to the lack of consensus on policy outcomes and the acknowledgement of ignorance depend significantly on the policy cultures in which the advice is embedded.

Wiebe Bijker, Roland Bal, and Ruud Hendricks proposed a systematic approach to scientific ignorance and policy frameworks based on a study of the Health Council of the Netherlands, a scientific advisory organization. When a "risk problem" is characterized as simple, they found the use of traditional decision-making tools such as cost-benefit analysis coupled with limited public consultation. When the problem is more complex, they found consensus conferences, consultation with external experts, meta-analysis, and scenario construction. Recognition of uncertainty tends to lead to precaution-based policy, with a broader range of stakeholder consultation and policy frameworks that emphasize containment of the problem to reduce future surprises. Another category of problems, which they termed "ambiguous," involves lack of general agreement about fundamental values related to the technology. For example, human enhancement technologies provoke a wide range of fundamentally different approaches. Here they argue that conflict-resolution methods with the integration of stakeholders and an emphasis on communication are more appropriate.[7]

Bijker and colleagues, like Miller on climate-change advice, underscore the importance of differences in political cultures for the study of expertise and policy. In one of the earlier STS policy accounts of the problem, Andrew Webster built on comparative political science by arguing that even in culturally similar countries, such as the United States and the United

7. Bijker et al. 2009.

Kingdom, there are significant cultural differences that affect science and technology policy. Specifically, the United States tends to have an open and competitive policy process, in contrast with the more closed process found in the United Kingdom. However, the Anglophone countries share a relatively pluralistic policy process in contrast with the closed, limited Japanese system. Even the Dutch system, which is open and competitive like that of the United States, has a stronger role for government planning, like other continental European countries and Japan. In a similar vein, Marion Fourcade found that in the United States government officials sought neutral technical advice, which favored quantitative economists from the academic world, whereas in the United Kingdom the elite policy circles favored economists who could communicate ideas eloquently for a broader public.[8]

In a comparative analysis of biotechnology policy in the United States, United Kingdom, and Germany, Jasanoff found significant cross-national differences in the ways that people use and test knowledge to make collective choices such as public policy decisions. Her analysis of "civic epistemology" broke the comparative analysis down into six dimensions. With respect to styles of knowledge-making, she contrasted the interest-based American model with the service-based British model, which bases expertise on a model of public servants who had proved their mettle over time, and the corporatist German model, which actively separates technical deliberation from political and normative questions. Once knowledge claims are established, they are vetted differently. The American model emphasizes agnostic litigation and public testing, whereas the European models rely more on government-managed institutions such as administrative hearings and trust in the capacity of experts to come to reasoned decisions that

8. Webster 1991, Fourcade 2009. See also the analysis of technological styles inaugurated by Hughes 1983. Sovacool 2010 reviews the literature and extends it to a discussion of research styles.

represent the public interest. In the United States, decisions are legitimated based on a high reliance on quantification and risk assessment, and experts are defined as persons with appropriate technical qualifications. In contrast, in Europe quantitative methods are embedded in appropriate political representation. However, whereas in Britain faith in expertise is based on individual reputation, personal experience, and proven credibility as a public servant, in Germany expert committees tended to be constituted as a microcosm of social positions, and experts represent a segment of society. Thus, when the committees reach a consensus, it is taken to have incorporated all relevant viewpoints. Finally, American expert bodies are required to have high levels of transparency and capacity for public scrutiny, whereas in Britain the levels of visibility are variable, and in Germany they are relatively low due to their constitution as microcosms of social differences.[9]

In addition to comparative differences in the study of expertise and policy, there are also significant historical changes that have begun to be studied sociologically. Conclusions for the policy culture of one time period may not apply to an earlier or later time period. For example, there has been significant growth in the systematic production of expert dissensus based on industry funding. Although there are no easy ways to construct a boundary between credible expertise and junk science, for policymakers and public advocates the distinction represents a pressing problem, especially when regulatory policies that may harm industrial profits are up for discussion. Steven Turner suggested that it is increasingly important to distinguish between experts who are located in academic institutions and publish in peer-reviewed journals versus those who are located in industry-funded think tanks and publish non-peer-reviewed science. Although the institutional division may provide a helpful first cut through different types of

9. Jasanoff 2004a.

expertise, the work on the commercialization of science suggests that even such basic distinctions may be difficult to maintain in practice.[10]

Since 1980 there has been a general trend, first prominent in the Anglophone countries, away from government mandates and other forms of interventionist regulatory policies with respect to technology and industry. Instead, policymakers influenced by the ideology of neoliberalism have favored the deregulation or "roll-back" of regulations, such as the repeal of the Glass-Steagall Act, which limited the scope of investment activity for commercial banks in the United States. In addition to regulatory roll-back, neoliberal ideologies have favored regulatory changes that use market-based mechanisms as policy instruments, such as retail competition in electricity markets and cap-and-trade systems for pollution credits. Furthermore, a wide range of organizations—private-sector industrial associations, nongovernmental organizations, and international governmental organizations—has provided an alternative to governmental regulations in the form of voluntary standards, codes of conduct, and certification schemes. Daniel Kleinman and Abby Kinchy argued that the uneven spread of a discourse of "scientism" has played a role in the transformation of the regulatory field. Used in this context, the term refers to the framing of regulatory problems as based on technical considerations that exclude distributional and social impact concerns as well as the discussion of basic issues such as, "Do we even want this technology to go forward?" The framing of regulatory policies for science and technology in narrow technical terms such as risk assessment tends to rule out broader discussions about the general public benefit of the new technology and its impact on

10. Turner 2001. See also Lahsen 2005 on the funding of climate change skeptics.

society. By ruling out a broader consideration, regulatory policy is more easily captured by private-sector interests.[11]

There are significant differences in the role of scientism in regulatory policy, with the United States tending for favor it, and the European Union tending to support more inclusive criteria. As Saul Halfon has argued, at the international level there may be a tendency for risk-based and precautionary approaches to be brought together. Furthermore, social movements often oppose the scientization of policy and seek to open policymaking to both distributive and precautionary perspectives. But as Kleinman and Kinchy showed, public-interest organizations can also use scientism strategically, for example when opponents of recombinant bovine growth hormone in the European Union pursued a safety argument after other approaches failed. Thus, scientistic discourses do not always coincide with neoliberal approaches to policy.[12]

In summary, the study of expertise and policy includes the strategies for obtaining and managing credible expertise and the analysis of the general policy cultures in which expertise operates. Increasingly, the literature has developed a clearer understanding of important comparative differences in policy cultures, and that understanding has become increasingly historical as well. The proliferation of junk science and the mixes of scientistic and deliberative approaches to policymaking create an increasingly complicated landscape that expert advisors and the policymakers who seek advice must negotiate and remake. Increasingly, the use of experts is combined with public engagement to ensure the credibility of decisions. As a result,

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11. Kleinman and Kinchy 2003, 2007; Kinchy et al., 2008.
12. Halfon 2010; Kleinman and Kinchy 2003, 2007; Kinchy et al., 2008; McCormick 2009. Kinchy and McCormick discuss social movements and the opposition to the scientization of policy. See also Wynne 2007b, who pursues a similar line of argument about risk and in favor of greater institutional reflexivity. Technological standards for risk assessment can provide opportunities for grassroots groups to construct a citizen-based science, but the standards can also undermine the reception of the knowledge that they produce. See Ottinger 2010.

the topic of expertise and policy is closely connected with public understanding and engagement in policy.

Public Understanding of Science

Historically, there was a widespread sentiment among the public and policymakers that scientific research and technological innovation were closely associated with social progress. However, during the twentieth century public skepticism about the automatic linkage of scientific and technological progress with social progress has grown. A prominent factor is the capacity for military technologies to wreak new levels of destruction, but there are also general concerns about the toxicity of industrial chemicals and the negative side effects of other industrial technologies. Thus, a decline of public trust in the automatic benefits of science and technology has translated into less unconditional support from policymakers for science and technology research and development. However, another important factor, especially since 1980, has been the growth of financial pressure on government budgets due to the increased commitments for entitlement expenditures, reductions of taxes on the wealthy, and the spread of industrial competition to a wide range of countries. As budget deficits and government debt have grown in the industrial democracies, the public appetite for support of scientific research has waned.

There are various responses that scientists have developed to the more qualified public and governmental support for science and technology research. One is to break down the older formulation of the policy of scientific "exceptionalism," that is, the view that it is healthy for a democratic society to leave the choice of research problems in basic science up to scientists, because long-term benefits are unpredictable but likely. Instead, research policy has become

increasingly mission-based, and government funding of both basic and applied research has become aligned with general policy goals, such as increased industrial competitiveness.[13]

However, another response from scientists, and also from industries with new products that face public skepticism from public-interest groups and the lay public, is to frame the problem of weak public support as caused by poor public understanding. In other words, if only the public understood science and technology better, it would support them more firmly. Associated with the view is the sometimes explicit, and sometimes implicit, assumption that public skepticism toward a new technology (such as nuclear energy, genetically modified food, or nanomaterials) is based on an exaggerated sense of risks due to lack of knowledge of the technology and a failure to understand risk-benefit analysis. From the diagnosis of the problem a research field emerged that documented the lack of public understanding of basic science and technology. Surveys revealed that lay understandings of even the most basic scientific concepts and research were very poor. As a result, concern with documenting and understanding the scientific knowledge "deficit" among the wider public grew, and interest in policies intended to reduce that deficit, such as science communication and science education, also grew.[14]

One policy implication of research that documents the lack of knowledge among the lay public is that there is a need for better science communication and education. From an industry perspective, the public lacks appropriately balanced information so that public acceptance of new technologies is enhanced. However, both industry and government can also agree on a general interest in science education so that there is an educated and globally competitive workforce. On the surface, the proposal that better education and communication of science and technology is

13. Kleinman 1995.
14. For a history of the concept of "public understanding of science," see Lewenstein 1992, and for a literature review, see Wynne 1994.

needed is hardly controversial; most policymakers support education in the abstract, and economists also associate the human capital of education with higher wage potential.

However, the strategy of public communication and education for purposes of reducing public skepticism about the uncertainties of new technologies can have an antidemocratic implication. In effect, the strategy rejects public skepticism as unfounded rather than taking it seriously and encouraging a broad debate that attends to public concerns. Instead, the approach is to solve the lack of support with better communication that promises to illuminate the great unwashed. Consequently, the policy of increased science communication as a remedy for public skepticism of science and technology can be consistent with a scientistic or technocratic approach to the public engagement in policymaking. The approach tends to define policy problems in narrow terms such as risk and consign the policy analysis and deliberation to experts, who can develop technical studies of narrow aspects of the problem, including cost-benefit analyses. The result is that not only broader public participation but also broader deliberation over issues (such as "do we even need or want this technology?") can be limited or foreclosed.[15]

STS research has challenged the ensemble of public deficit research, remedial communication policies, and technocratic policymaking with a range of different studies. Whereas the deficit-oriented research tended to use survey methods, an alternative interpretation was developed, often with the use of qualitative methods, that revealed a more complicated picture. As Brian Wynne noted, surveys frequently "reinforce the syndrome...in which only the public, and not science or scientific culture and institutions, are problematized" (1994: 370). In contrast, fieldwork-based studies tend to emphasize the processes of how laypersons actively

15. Wynne 1996a, 1996b, 2005, 2007a, 2007b, and 2008.

reconstruct science and also offer a wider perspective on science and technology policy issues than that of technocratic risk assessment. Studies in this vein by sociologists and anthropologists demonstrated that laypeople often rely on other forms of knowledge, such as occupational knowledge or general knowledge about politics and the government, in order to evaluate expertise. Furthermore, laypeople can develop fairly sophisticated understandings of science when it is in their interest to do so. An example is patient advocacy groups or neighborhoods that have mobilized to challenge their exposure to toxic chemicals. Often laypeople can become quite knowledgeable about a narrow-band of scientific knowledge, and some of the leadership of the organizations can include people with the educational and occupational knowledge to engage scientific expertise with confidence.[16]

Wynne's work on local understandings of radiation pollution in the Lake District of northern England is among the most influential and will be considered here in some detail. The radiation fallout from the Chernobyl incident was accompanied by high levels of rainfall in the region, and government scientists subsequently informed sheep farmers that their flocks were contaminated. However, the government intervention involved mixed messages, and government scientists did not take local knowledge into consideration as they developed their analyses. As a result, some of the scientists' recommendations were ludicrous in light of the farmers' knowledge about grazing patterns, local ecology, and local soil types. Furthermore, longstanding concerns with contamination from the nearby Sellafield Nuclear Plant reemerged as farmers began to suspect that the Chernobyl incident was being used to cover up the long-term contamination problem from a local nuclear power plan. Thus, Wynne demonstrated not only that lay groups can develop relatively sophisticated understandings of technical issues (provided

16. Hess 2004; Epstein 1996, 2007b.

that it is worth their while to do so), but also that expert groups fail—both technically and politically—by not taking into account the other knowledges of their publics, in this case local and occupational knowledges.[17]

If the scientists had listened to the farmers, they would have produced better scientific models of the radiation as well as better policy recommendations for handling the contamination. However, in this case the government scientists demonstrated little sensitivity to the potential of lay knowledge, the way that scientific expertise was being perceived, and, perhaps even more important, the limitations of scientific expertise that the encounter with lay knowledge revealed. Wynne drew attention to one particular farmer because he had conflicting identities based on networks that connected him to workers in the Sellafield plant, who did not wish to have the plant blamed for the radiation exposure, and to more distant farmers, who saw the plant as partly to blame. The more distant farmers mistrusted the official view that evidence for radiation contamination was from the more recent Chernobyl accident, and they suspected instead that for years government and industry had not been telling the truth about contamination from the nearby Sellafield plant. The opinion of this farmer was at least partly conditioned by social identities and relations, and the farmer was quite reflexive about the social basis of his opinion. In contrast, Wynne argued, the experts of state and industry tended to cut themselves off from such reflexive self-understanding. Finding reflexivity to be inversely related to power, he turned the public deficit model of scientific expertise on its head by drawing attention to the reflexivity deficits among scientists and governments. As Wynne suggested, the failure of technical experts

17. Wynne 1996a, 1996b, 2008.

to develop a reflexive self-understanding of the limits of their own knowledge generated public mistrust in science.[18]

Other studies have shown that when experts disregard the broader values issues that are of concern to citizens, citizens will tend to discredit and mistrust the experts. Whereas scientists are largely concerned with credibility in the sense of their standing among peers, for citizens the credibility of scientists rests on communication skills and the relevance of research to concerns that citizens have. In highly contentious issues, citizens may also be polarized, and they may discredit scientists who do not validate their beliefs by perceiving them to have covert interests. In other words, the asymmetry that scientists often use in explaining differences among them ("My views are based on reason and evidence, and yours are based on interests") reappear in the context of public understandings of science. The asymmetrical view of expertise is especially prominent when the opinions of experts are themselves divided.[19]

Generalizing on the social studies of the public understanding of science and public acceptance of technology, Steven Yearley argued that public assessments of the trustworthiness of expertise and official stories do not require a high level of technical knowledge but instead can be based on general lay knowledge about how to make judgments about the credibility of political leaders, organizations, and individuals. Furthermore, because expert attempts to communicate official knowledge may include assessments of the credibility of official organizations and political leaders that are at odds with the broader lay assessments of the trustworthiness of institutions, the credibility of experts can collapse.[20]

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18. Durant 2008; Wynne 2007a, 2008. The initial book in this area was Irwin and Wynne 1996.
19. Beecher et al. 2005, Irwin 1995, Irwin and Michael 2003, Lach et al. 2003.
20. Yearley 2005.

In summary, STS researchers have developed an incisive critique of the standard model of the public understanding of science, which is based on the perceived deficits of lay knowledge with respect to expert knowledge and the need for better communication to remediate the deficit. Instead, STS research proposes that lay knowledge may contain other knowledges that are of relevance to a policy issue, such as the farmers' knowledge of their pastures and local ecology, and that laypeople may possess a reflexive social knowledge that enables them to assess the credibility of experts and public institutions. However, the question of how the critique is translated into policy recommendations becomes a vexed issue.

Public Engagement in Science

The critique of the public deficit model has policy implications. Silvio Funtowicz and Jerome Ravetz developed an analysis of what they call post-normal science (where there are complicated issues, high levels of uncertainty, and strong value commitments) to argue that "safety" is a better framework than risk, because the discussion of safety is more open to the general political concerns raised by citizens. The legitimacy of technological decision-making could be increased if the public were more engaged in the decision-making process through "extended peer communities." One might argue that even safety is not a broad enough rubric to include concerns with nescience, but the idea of extended peer review does provide an alternative to the technocratic and scientistic model of decision-making for technology-related policy issues. [21]

Harry Collins and Robert Evans develop a similar but more specific argument that in cases of technical decisions, the decision-making capacity would be improved if lay groups that

21. Funtowicz and Ravetz 1992, Ravetz 2005. On the potential convergence of community-based participatory research and post-normal science, see Bidwell 2009.

possess contributory expertise, such as the sheep farmers in Wynne's case, were included in the experts' decision-making process. If a segment of the public has contributory expertise in a relevant field for the technical decision, then public participation is warranted. For example, the sheep farmers had a high level of occupational knowledge that could have been combined with the expertise of toxicologists to make a more robust, synthetic assessment of toxic exposure in the Sellafield region. As a result, the farmers had "contributory" expertise that was based on their occupational knowledge and complementary to that of the toxicologists. Together, the two streams of expertise could have produced a more robust technical decision-making process. However, bringing the two streams of expertise together requires that at least one of the parties has interactional expertise or that an outside party, such as an STS researcher, can bring that capacity to the table. In other words, there must be both contributory expertise and the interactional expertise that permits the two streams of contributory expertise to be brought together.[22]

The prescriptive arguments of Funtowicz, Ravetz, Collins, and Evans have been subjected to some qualification. With respect to the concept of post-normal science, Steven Yearley argued that the goal of having broad inclusion is likely to bring out other concerns that go beyond the concept of extended peer review. Citing work by Wynne, Yearley suggested that an important component that public deliberation reveals is indeterminacy, that is, lack of knowledge about how a system will work because the system includes unpredictable social behavior. With respect to Collins and Evans, Wynne argued that because the distinction between technical and political decision-making is part of what is at stake in politics, it is necessary to explore the politics of how the boundary is constructed. Doing so may also result in a challenge

22. Collins and Evans 2002, 2007.

to technocratic approaches to political decision-making, such as defining problems as scientistic ones of risk assessment that exclude broader public concerns and framings of problems. Wynne suggested that experts and policymakers should open up their debates from technical issues of risk assessment to "the proper ends and purposes of knowledge" (Wynne 2007a: 219).[23]

So how does a well-intentioned policymaker go about engaging the public in decisions that involve technology regulation and/or a high level of technical expertise? One general rubric for the approach to public engagement in policymaking is "technology assessment." As Johan Schott and Arie Rip explained, the term includes a wide range of approaches, mostly initiated in northern Europe during the 1980s, that were developed to increase participation from multiple stakeholders and lay individuals in the design of new technologies and the regulatory policies intended to govern them. One method is to establish government funding for technology assessment research, so that a social mapping of stakeholder perspectives is available for consideration in the design of research projects and in policy guidance for new technologies at the earliest stages. Another method involves early experimentation with new technologies, so that user interactions and reactions can be anticipated and brought into the design process. A third method includes direct public participation via events such as the consensus conference. For the subset of technology assessment activities that Schott and Rip define as constructive technology assessment, there are three policy strategies: technology forcing, which stipulates social goals (such as automotive emissions standards) but does not specify design, so that innovation emerges from industry; strategic niche management, in which government agencies help to develop alternative technologies; and the alignment of supply and demand. At a broader level, the approach can involve the management of large technical systems, and a related body of

23. Yearley 2000; Wynne 1992, 2003, 2008. There were several other commentaries on Collins and Evans in the 2003 issue of *Social Studies of Science* along with that of Wynne.

Dutch research known as "transition theory" has explored how the large-scale systems undergo long-term changes.[24]

Daniel Barben, David Guston, and colleagues have developed a similar approach called "anticipatory governance," which they define as an approach to technology policy that brings together laypeople and experts in a variety of institutional settings to "imagine, critique, and thereby shape the issues presented by emerging technologies before they become reified in particular ways" (2008: 992-993). More concretely, they discuss three main aspects of anticipatory governance. One form includes a diverse range of exercises in foresight, from technical forecasting and predictive assessments such as life-cycle analysis to more open-ended techniques such as scenario development. Those exercises could be open to public engagement but are likely to be guided by experts in such techniques. The second form includes public engagement events such as consensus conferences and public consultations, and the third form includes the proposal to integrate social scientists and other nonscientists in the research and development process.

With respect to the second from of anticipatory governance, the consensus conference has often been hailed as a way to improve the public engagement in science and technology policy, but the use of it has revealed significant limitations. The consensus conference builds on the longstanding tradition of direct participation in democratic societies. In New England, some towns still continue the tradition of direct democracy, in which town meetings are open to all voters in the district and decisions are made by popular vote. In the United States, a participatory (but generally not deliberative) model has also become commonplace during presidential

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24. Schott and Rip 1996; Geels 2002, 2007. On some of the dilemmas of upstream engagement in the case of nanotechnologies, see Rogers-Hayden and Pidgeon 2007. For a discussion of the approaches in the American context, including the ill-fated Office of Technology Assessment, see Sclove 2010.

campaigns, when the media assemble "town halls" composed of laypersons. The selected public can then pose questions to candidates, or it can provide answers to journalists about what they think about candidates and issues. Unlike the traditional New England town hall, public deliberation among the assembled citizens generally does not precede or follow the media town hall, and the opinions expressed by the citizens lack political decision-making capacity. The approach enables a mild form of public engagement by allowing an interaction between a candidate or journalist on one side and a sampling of the public on the other side.[25]

In the consensus conference, the goal is similar but it includes more extended deliberation in order to provide a perspective from laypeople on technology policy and/or technology design in formation. Although practiced in various forms in many countries, the common elements are usually a sample of laypersons who represent ordinary citizens and are selected on a quasi-random basis, a group of experts who can answer questions and inform the laypersons about the issue under discussion, and a report or press conference by the laypersons about the outcomes of their deliberations. Although the consensus conference may involve the education of laypersons, the broader purpose is to deploy the layperson as a citizen who does not have a special interest, expertise, or stake in the topic under discussion. As a result, the selection of laypersons for participation may involve exclusions of people who have a predefined stake in the outcome of the process, including both industry and civil society representatives.

The consensus conference was developed in Denmark but has since diffused globally and been adopted in diverse settings and formats, including Internet-mediated experiments. As Maja Horst and Alan Irwin have noted, the Danish consensus conference was an expression of a

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25. At the scale of international governance, Jasanoff and Martello 2004 have argued in favor of reforms that would include a greater role for local knowledge and grassroots perspectives in global governance. Among the reforms that they suggest are greater openness and transparency, forums that include grassroots organizations, and lowered barriers to public participation.

particularly Danish political history and culture, and as a result its political effectiveness was related to its position in that society and history. The Danish government actually institutionalized its support of the consensus conferences between 1986 and 2002. In contrast, in other countries governmental support and use of consensus conferences was much less firmly institutionalized. Nevertheless, according to Horst and Irwin even in the relatively hospitable setting of Denmark, consensus conferences had little impact on political decisions. Furthermore, after 2002 they suffered from declining political support.[26]

Another form of public engagement is the public consultation. Usually a consultation process involves open meetings held by policymakers or paid consultants who solicit public input into decisions. Javier Lezaun and Linda Soneryd noted that consultation processes can be designed to incorporate the views of the lay people (and exclude those of stakeholders such as activist groups) or they can be set up to encourage dialogue and debate among stakeholders. Wynne added that when the government attempts to seek out lay opinions, it may do so more with the intention of manufacturing public consent for regulatory policies rather than using public perspectives to encourage greater reflexivity. In other words, STS researchers have quickly pointed out the potential for public consultations to be coopted. However, STS researchers are also describing important differences in types of public consultations. For example, Alan Irwin found that a government-directed public consultation carefully preframed issues and limited the agency of the lay public, in contrast with the more open processes of consultation developed in the universities.[27]

Another form of public consultation is the stakeholder conference, a practice that is becoming more widespread as a preamble to the political battles that ensue over significant

26. Horst and Irwin 2010.
27. Lezaun and Soneryd 2007, Wynne 2007a, Irwin 2001.

policy reform efforts, such as health-care reform in the United States. When practiced in the United States, the "stakeholders" usually include government, industry, and civil society representatives. The convenor, such as the president or a governor, controls the selection process, which is far from random and may be weighted toward one constituency or another. The event can be arranged to include deliberation or debate, just as it can be arranged to include a wide or narrow spectrum of stakeholders. To the extent that stakeholder conferences produce consensus or shifts of opinion and strategy among the most powerful stakeholders, they may have political effects. But like the consultation of lay publics, stakeholder conferences can also be used to legitimate a policy position held by the dominant political party or parties, which can incorporate a few of the positions of opponents and use the process for legitimation of subsequent power brokering.

More generally, consensus conferences and public consultations appear to be growing in popularity, but as Wynne has argued, "Virtually all of the mushrooming commitment to public citizen engagement" has, to date, been "something of a mirage" (2005: 68). On this point John Dryzek and colleagues noted that deliberative processes tend to produce policy recommendations consistent with the precautionary principle, whereas elites favor "Promethean" policies, that is, policies that favor the production of new technology with low restrictions. Dryzek and colleagues argued that elites attempt to manage contrary policy recommendations in one of three ways: influence the institutions to manipulate the outcome, ignore the outcome if it is more precautionary than desired, or give some ground in response to the criticisms. Only the third response represents a genuine influence on policy. On a more optimistic note, Alan Irwin and colleagues argued that it is possible to avoid a black-and-white view of public engagement institutions. For example, one might explore the conditions under which consensus conferences

come closer to the ideal of democratic, anticipatory governance, those under which they approximate the manufacture of consent by elites, and factors leading to the coexistence of both types of effects.[28]

One model for increasing the political effectiveness of the consensus conference is the trial jury. Like the consensus conference, the jury is a deliberative institution that is based on demarchy (the principle of random selection in politics), but unlike most consensus conferences it has extensive government support and has institutionalized, albeit limited, power in the political system. Thus, the jury's function is to produce a verdict, but it does so in the context of restrictions on the capacity to ask questions of the prosecution and defense and the ability to provide a sentence. However, the model of the trial jury suggests a way in which the consensus conference or other forms of public consultation might be granted greater institutional authority. Although policymakers would be unlikely to surrender authority to a randomly selected lay jury for all aspects of regulatory policy, the approval of a citizen jury might be used as an obligatory step in the approval process for regulatory reform.[29]

The often negative or at least mixed evaluations of consensus conferences and public consultations do not imply that they are without positive benefits. As Maria Powell and Daniel Kleinman have shown, consensus conferences may be transformative for the laypersons involved, and laypersons experience a greater sense of "efficacy" in the sense of capacity to understand and participate in politics. However, bringing deliberative institutions to a scale that would transform changes in individuals or small groups into broad public opinion shifts and

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28. Dryzek et al. 2009, Horst and Irwin 2010, Irwin 2006. For a more optimistic assessment of consensus conferences and similar "hybrid fora," see Callon et al. 2009; cf. Fuller 2011.
29. See also Irwin 2001, 2008; Katz et al. 2009; Yearley 2000. The consensus conference is sometimes distinguished from the citizen's panel, which is not open to the public and public consultations, in which the government engages citizens on very limited terms. On demarchy see Carson and Martin 1999.

higher levels of public participation is cost prohibitive. Even if a beneficent billionaire were found to fund a scale shift, one would expect that attempts to connect such institutions to public policymaking would meet with significant resistance. Because lay deliberation tends to favor a broad public interest over specific industrial interests in circumstances where the two clash, it is likely that resistance to deliberative institutions would grow as they began to challenge neoliberal and technocratic models of regulation.[30]

Research by Frank Fischer suggests that deliberative approaches to public policy can be effective at a large scale, but it tends to occur in very special political circumstances. In the case of Kerala, India, the bottom-up approach to public policy depended on strong support from the state government, which was committed to the idea and also provided substantial financial and personnel support for the project. The leaders recruited participants at the household level and also relied heavily on assistance from local civil society organizations that supported the effort. Fischer argued that without support from the government, such processes will tend to occur in civil society.[31]

Finally, there are some experiments in public engagement that focus more on the research agenda of scientists and designers than on the policymaking process (the third aspect of anticipatory governance). Social scientists or humanists who work with scientists at the upstream point of designing research programs can serve as a proxy for representing a broad public interest to scientists. Their efforts or other interactions with the public may lead scientists to think more carefully about the societal implications of their work. For example, Elise McCarthy

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30. Powell and Kleinman 2008, Kleinman et al. 2007. On the weak publics problem, see Fraser 1997. On the limits of deliberative approaches to science and technology policy, see also Hagendijk and Irwin 2006. On the problem of how consensus is constructed and maintained in a policy setting, see Halfon 2006. On the use of upstream engagement by elites, see Joly and Kaufmann 2008.
31. F. Fischer 2009.

and Christopher Kelty found that a discourse of responsibility among nanotechnology researchers had replaced that of risk and risk assessment, which the scientists they studied perceived to be a failure. Nanoscientists took on the burden and opportunity of responsibility by rethinking problem selection and by designing new organizations that helped to configure a safe and responsible approach to their research. The societal implications that are generally left to the downstream problem of regulation and diffusion of technologies then become built in to research problem choices. The broader scope of decision-making criteria for problem selection does not mean that the autonomy of the research field is weakened; rather, it becomes permeated by a new set of criteria that enable and constrain the field's autonomy and shift the criteria for evaluating innovation.[32]

However, the capacity for embedded social scientists and humanists to bend the trajectory of research agendas remains to be proven. Certainly, the power dynamics between well-funded scientists and engineers and their less well-funded colleagues from across the campus limit the maneuvering room of social scientists. As Gary Edmonds and David Mercer asked:

> Are there grounds for believing that embedded anthropologists (or other human scientists), whose prospects may be dependent upon the success of bioscientific groups, will afford more effective forms of participation and regulation (regardless of whether they have enhanced appreciation of the ways the research is being undertaken)? Will the participation of potentially interested nonscientists improve safety and security or will it facilitate further deregulation? (2009: 459).[33]

32. McCarthy and Kelty 2010.
33. The comments were based on an analysis of Rabinow 2009.

To summarize, on the upside mechanisms that engage lay publics or their proxies (such as embedded social scientists and humanists) on emerging problems of science and technology can provide a way to make science and technology policy more democratically accountable. On the downside the mechanisms can delegitimate civil society organizations that claim to speak on behalf of a broad public interest by arguing that another, more legitimate public has been consulted. By showing that the public has been consulted and engaged, and by making a few adjustments in policy or research design to show an effort to meet public concerns, policymakers and designers may achieve greater legitimacy and incorporate some criticisms and concerns in order to avoid mistakes. Although the term "mistakes" is ambiguous, the referent is often the antinuclear energy movement and the subsequent movement against genetically modified food. Thus, the "mistake" may be to put policymakers in the situation that the public mobilizes against their decisions. From this viewpoint, the goal of public engagement is, in effect, to provide a machinery that minimizes the risks of social movement mobilization and weakens the claim of mobilized civil society organizations to speak for the public benefit. This conclusion provides a point of departure for another branch of STS literature on expertise and publics.[34]

Mobilized Publics and Counterpublics

In the literature on the public understanding of science and deliberative processes such as consensus conferences, the concept of a "public" with respect to science and technology tends to be used with two assumptions: the public is composed of individuals (rather than organizations or social movements) who, sometimes with assistance, can form opinions about research fields and technologies; and the individuals are holders of lay knowledge in the sense that they lack the

34. Buroway 1979.

expertise of the particular science and technology in question. A "member" of the public may hold other forms of knowledge (occupational, local, gender, class, etc.) that may be relevant to assessing or interacting with scientific and technological expertise, but the person is presumed to be "lay" with respect to the area of scientific expertise that is in question. From a political perspective, the public may also be identified as in some way a politically neutral citizen or what in American political parlance is now described as an "independent." Thus, the individual layperson can be translated into the ideal of a politically neutral citizen, at least for the purposes of eliciting an opinion on a specified topic. The opinion poll transforms individual opinion into collective public opinion, but when the individual opinion is unformed (as is often the case for new technologies), other mechanisms must be used, such as the consensus conference. Thus, the consensus conference takes a selection of individual members of the public and produces an approximation of what an aggregate lay opinion might be on an issue should it crystallize in the presence of additional information.[35]

From this perspective, the consensus conference operates a little like a laboratory in the sense of serving as a machine for producing knowledge. It becomes an autonomous field in which an uninformed, individual layperson can be aggregated and transformed into a prediction of aggregate public opinion. Just as a laboratory enables the manufacture of knowledge, so a consensus conference enables public opinion to be manufactured under the assumption of adequate background knowledge about a policy issue. Furthermore, the increased knowledge is considered in some way to be politically neutral; in other words, public opinion is not manufactured by an interested public relations campaign. In practice, the goal means excluding from the consensus conference or similar institutions participants who have a vested interest in

35. This sections builds on an approach that I developed in Hess 2011b.

the policy outcome, such as representatives of industrial corporations or social movements. They are framed as stakeholders who can contaminate the process of manufacturing the public.

As I have argued in my essay "To Tell the Truth: On Scientific Counterpublics," by excluding social movement organizations and other organizations that claim to represent the public interest, a series of displacements occurs. First, whereas the movements are concerned with encouraging a debate on the public good, an evaluative project, the deliberative process shifts the task to finding the public as public opinion, an empirical project. Second, representations of public good are reduced to stakeholder views, so the idea that one view of the public good may be evaluated and deemed better than others gets lost in the dismissal of all arguments for public good as stakeholder viewpoints. Third, articulations of the public interest are equalized in a pluralistic model of politics that lumps elite and social movement views together as stakeholders. Likewise, the leveling of mobilized publics as stakeholders does not distinguish between social justice movements and astroturf movements generated by elites. Any kind of mobilized public opinion becomes simply a stakeholder view, and inquiry into the grounds upon which one might select one view as better representing the public good are set aside. Fourth, because a mechanism is created that claims to construct a credible public opinion, claims by social movements to represent the public are undermined. Fifth, there is little analysis of the ways in which social power differentials are embedded in the kinds of expertise that are allowed inside the deliberative space as part of the education of laypersons that enables them to deliberate and form a public opinion. In other words, expertise is itself presumed to be uniform rather than characterized by an intellectual field with dominant and subordinate positions that may have homologies with dominant and subordinate positions in the broader economic and political fields.

The model of the public that is created through deliberative mechanisms such as the consensus conference and lay consultations relies heavily on an image of the public as individualized and uniformed. However, as Pierre Bourdieu notes, other forms of the public may also exist, such as "mobilized opinion" (1993: 155). Mobilized publics could also be considered as an alternative starting point when discussing problems such as the public engagement in science and technology and their governance. Recognizing the existence of a mobilized public does not require rejecting the individualized, lay opinion public. However, it may mean dethroning the lay opinion public by reinterpreting it as a constructed entity that can be shaped not only through public relations but also through mechanisms such as consensus conferences, public consultations, virtual town halls, and focus groups. Even for issues involving new or emergent technologies, there are reservoirs of public interest based on civil society organizations' experience with previous technologies that often would urge high levels of investment in health and safety research, broad public debate, and a precautionary approach to regulation. In contrast, consensus conferences create an asymmetry in the construction of the public by seeking to generate public opinion from unmobilized lay opinion rather than from mobilized opinion, whether representing the powerful elites, the countermovements, or a compromise formation of both.[36]

A vocabulary is needed to think through the idea of the public engagement in science and technology policy under the assumption of a mobilized public, and I have argued that the existing discussion of "counterpublics" provides a good starting point. Counterpublics can be thought of as collective, mobilized public opinion that is developed in subordinate social

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36. Nelkin's work warrants reexamination in this context because she focused on mobilized publics. She approached controversies as articulations of wider conflicts that involved two "goods," such as political priorities versus environmental values, economic interests versus health risks, and individual rights versus social goals. See Nelkin 1992, 1994.

positions and has emerged to contest "official publics." The latter is also a mobilized public, but one constructed by political, economic, and, in some cases, intellectual and civil society elites. In both counterpublics and official publics, a public is formed when networks of organizations and individuals make alignments between their sectional interests and the general good by claiming to speak for the society as a whole and its "public interest": that is, what the public is, needs, and should have. In other words, they do not speak as an interest group, which has the goal of gaining more resources, however well deserved, for a segment of the society. Rather, they claim to speak for the whole or at least a wide section of the whole and against the interests of the segments.[37]

The literature on counterpublics emerged from critical accounts of Jürgen Habermas's study of the bourgeois public sphere. The literature raised several crucial arguments: the public is not a single entity but composed of multiple publics, including those socially positioned in subaltern social categories; the boundaries between public and private are contestable, and hence the definition of what constitutes the public good or public discourse should be included in public deliberation; and the boundaries between the public sphere and the state should not be presumed a priori but left open to analysis and contestation. Although the three assumptions are an important aspect of how one conceptualizes counterpublics, in the context of STS research on the problem of the public engagement in science, technology, and policy, the definition of counterpublics requires three main shifts of focus.[38]

First, counterpublic theory generally assumes that the social position of counterpublics is associated with subaltern categories such as "women, workers, peoples of color, and gays and lesbians" (Fraser 1997: 81). In developing the idea of a counterpublic, it is better to use a broader

37. Hess 2011b.
38. Habermas 1989, 1992; Warner 2002.

definition that is situated in subordinate positions or alternative pathways (a term that includes social movements but is not limited to them). Rather than assuming that a counterpublic is limited to a social category marked by race, class, gender, or sexuality as a historically dominated or oppressed social category, counterpublics can emerge in any social field: civil society, the polity, and the economy. That the relationships between subaltern groups and subordinate field positions are often closely correlated is understood as an empirical rather than definitional claim.

Second, whereas counterpublic theory often focuses on the discursive aspects of publics and tends to remain enclosed within a culturalist methodology, institutional or field sociology would locate the social position of the publics in agonistic social fields characterized by networks of individuals and organizations. Because subordinate positions in social fields are anchored, or at least often anchored, in organizations, they often have the capacity to generate both interactional and contributory expertise that is on par with that of the expertise of scientific and technological communities. Here, we get at one of the deeper implications of the idea of mobilized opinion that Bourdieu did not explore. It also undermines the association of the public with lack of expertise that characterizes the public understanding of science literature and some of the public engagement of science literature.

Third, following Bourdieu's critique of Habermas, the assumption that personal interest must be left behind as a criterion for the ideal conditions of public opinion formation requires rethinking in light of the capacity for semi-autonomous fields to channel personal interest into the production of relatively disinterested discourse and at least partially objective knowledge. Thus, the construction of objectivity or even political consensus does not depend on a Habermasian assumption of a self-effacing *moi commune*, and the assumption may even

contribute to further marginalization of perspectives rooted in subordinate positions. Because a social field like the scientific field requires that participants make arguments that are recognized as legitimate by the field (such as arguments based on evidence and consistency criteria), it can channel extrafield interest into objective knowledge (or at least more strongly objective knowledge) through agonistic engagement.[39]

When shifting the analytical attention from the individualized, lay opinion public to the oppositional counterpublic, it is possible to maintain a central insight of "public understanding of science" studies, such as Wynne's argument that the study of publics with respect to official expertise should also involve the problematization of scientific authority. But that insight can also be transposed onto a different analytical terrain. In addition to the study of lay individuals who can be interviewed for their (mis)understandings of science and, conversely, scientists who can be interviewed for their (mis)understandings of public opinion, the perspective outlined here suggests a complementary project of exploring knowledge claims anchored in the subordinate positions of various social fields and the linkages among such claims. From this perspective one can also search for a public in the "scientific counterpublics" that are formed when the subordinate positions in the scientific field provide the basis for cross-field coalitions that articulate an alternative view of scientific research agendas based on a rationale of greater public benefit. By locating a "public" of science not only outside the scientific field but also partially within it, it is possible to deepen work in the public understanding of science studies oriented toward the goal of mutual problematization of publics and scientists.[40]

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39. Bourdieu 2000, 2001. I am using "objective" in Harding's sense of knowledge that has less projection of cultural assumptions and social interest. See Harding 1992.
40. Wynne 2008.

In order for a subordinate network within the scientific field to become a scientific counterpublic, it must attain publicity or visibility in other social fields. Publicity occurs when scientists speak out about the politics of research agendas and argue that alternative research agendas would better match the public interest. The leaders of a subordinate network in a research field may also claim that there is a systematic distortion of the relationship between research agendas and the public interest, so that the research agendas of the dominant networks do not reflect a broad public interest as well as those of one or more subordinate networks. Instead, they make a case that what is perceived as negative non-knowledge or simply not considered is a case of undone science, or positive non-knowledge. A full-blown scientific counterpublic occurs when the subordinate networks in the scientific field are connected with subordinate networks in the civil society, economic, and political fields and their parallel views that the dominant positions in their fields do not represent a broad societal benefit.[41]

One should not assume that the institutional location of the scientists in the subordinate networks will be in a university; in examples of scientific counterpublics that I have described elsewhere, at least some of the leadership comes from researchers who are funded by and located in nonprofit and civil society organizations. Regardless of institutional location, a scientific counterpublic is formed when scientists who are located in subordinate positions in their respective research fields generate publicity by addressing a broader public audience about the public-interest implications of agenda conflicts in their respective research fields.[42]

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41. Although the extent of such cross-field linkages can be explored empirically, behind the confidence in the view that the linkages exist is a broader theory of societal power differentials that is consistent with the political sociology of science and a view of social change based on the ongoing struggles of countermovements. See Frickel and Moore 2006, Polanyi 1994.
42. Hess 2011b.

Conclusion

By proposing an alternative way to think about the public, science, and technology policy, it is possible to conceptualize alternatives to the consensus conference and related institutions that are potentially more effective at achieving the goal of increasing the public accountability of science and technology policymaking. One might begin with the exclusion criteria that often operate in a consensus conference and sometimes in public consultations as well: to disallow any participants who are associated with a social movement or an interested industry. The symmetrical treatment of asymmetrical power relations creates its own asymmetries. An alternative that emerges from this perspective might be to establish a dissensus conference, in which debate between mobilized publics is encouraged. An outcome of disagreement is likely but publicly beneficial, but publicity for such events might spur wider public deliberation. Another alternative is to establish mechanisms for debating claims from social movement organizations and scientific counterpublics that areas of undone science (such as research on presumptive diseases or the health effects of carcinogens) should be funded. Just as funding agencies have provisions for funding "ELSI" (ethical, legal, and societal implications) research, they might also have provisions for evaluating proposals for undone science research.[43]

By contrasting the idea of "mobilized publics" with the individual representative of the lay public, one also draws attention to a completely different dimension of the public and public engagement in science. Here, the focus of attention is on social movements, reform movements,

43. See also Cozzens and Woodhouse 1995, Woodhouse and Nieusma 2001.

advocacy and activist groups, and other aspects of mobilized civil society. This is a vast topic, and one way in is our review essay in the *Handbook of Science and Technology Studies*.

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