Sociotechnical Imaginaries and Science and Technology Policy: A Cross-National Comparison

Sheila Jasanoff, Sang-Hyun Kim, Stefan Sperling

Project Summary

Intellectual merit: This two-year comparative project, grounded in the field of science and technology studies (STS), aims to develop a new theoretical framework for understanding the global politics of innovation in science and technology (S&T). It will examine the relationship between national political cultures and the production of *sociotechnical imaginaries* in S&T policymaking in the United States, South Korea, and Germany. Sociotechnical imaginaries are defined, for purposes of this project, as "imagined forms of social life and social order that center on the development and fulfillment of innovative scientific and/or technological projects." Through systematic cross-national comparison, the project hopes to overcome the micro-focus of many STS studies and to illuminate how three different democratic political cultures are framing the goals, risks, and benefits of technological innovation, and how they are meeting the associated political challenges of democratic inclusion, expert advice, ethics, and accountability.

Sociotechnical imaginaries are at once descriptive of attainable futures and prescriptive of the kinds of futures that ought to be attained. As an influential part of the currency of contemporary politics, these imaginaries have the power to shape technological design, channel public expenditures, and justify the inclusion or exclusion of citizens with respect to the presumed benefits of technological progress. Given the political salience of such imaginaries, and the risks and instabilities that inevitably accompany their realization, understanding how they are formed and implemented is necessary to any serious exploration of what the sociologist Ulrich Beck has called a "cosmopolitan" vision of intercultural collaboration and coexistence.

Phase I of the project will develop national case studies of S&T policy, focusing on three technologies—one old, one current, and one emerging: nuclear power; stem cells and cloning; and nanotechnology. This design will provide historical depth as well as contemporary insight into national technoscientific imaginations. The cases will be organized thematically along several dimensions, including the treatment of national needs, solidarity, temporality, competitiveness, and risks and benefits. Phase II will compare the results of Phase I cross-nationally, draw normative and policy-relevant conclusions, and disseminate the results. The research will use qualitative, interpretive STS methods, integrating approaches from policy analysis, law, anthropology, and history and sociology of science.

The proposed study will advance our understanding of contemporary S&T developments in three rapidly innovating regions of the world (US, Europe, Asia) by shedding light on the following issues:

- How ethical, social, and political commitments get built into national trajectories of technoscientific development; and how such commitments contribute to national styles or systems of innovation.
- What it means to "democratize technology" in different national settings; what alternative models of democratization exist, and what are their advantages and disadvantages.
- How S&T policy functions as a site and instrument of meaning-making or sense-making—e.g., by shaping concepts of citizenship, participation, public good, and public reason.
- What factors influence the perceived successes and failures of S&T policy, and what new conceptual tools are needed to assist governments and publics in a globalizing world in making better informed, better reasoned, and more democratic policy choices.

Broader impacts: The comparative analysis of S&T policymaking and sociotechnical imaginaries in three nations promises to have three kinds of broader impacts. First, it will improve cross-cultural understanding of the global politics of S&T, thereby building stronger foundations for transnational cooperation and governance. Second, it will provide new conceptual and empirical resources that can be used to improve S&T policy analysis and implementation, specifically: in assessing the risks and benefits of new and emerging technologies; in standard-setting and the treatment of uncertainty; in the design of new forms of public engagement; in developing improved processes of ethical analysis and deliberation; and in highlighting opportunities for, barriers to, and possible modes of international S&T collaboration. Third, it will contribute to postdoctoral, graduate, and undergraduate teaching and training.

Project Description

Sociotechnical Imaginaries and Science and Technology Policy: A Cross-National Comparison

Sheila Jasanoff, Sang-Hyun Kim, Stefan Sperling

This is a revised and resubmitted research proposal. We are grateful to the reviewers for helpful comments and criticisms on an earlier version. All sections of the proposal have been carefully revised to address and accommodate the issues raised by the reviewers. Our revisions center on the following recurrent points of concern: (1) concepts and methods; (2) deliverables; (3) investigator qualifications; (4) budget justification.

I. Background and Objectives

The globalization of science and technology (S&T) has raised new challenges for Science and Technology Studies (STS) and for the governance of science. This proposal addresses these issues through cross-national, comparative research on the construction of sociotechnical imaginaries in three democratic societies representing three rapidly innovating regions of the world: the United States, South Korea, and Germany. Its primary aim is empirically grounded theory-building, with eventual policy applications.

Recent transnational movements in science and industry point to the need for cross-culturally intelligible and mutually acceptable approaches to the management of S&T. Indeed, a publication of the UK think tank Demos has called for an era of "cosmopolitan innovation" replacing traditional techno-nationalism (Leadbeater and Wilsdon 2007). As yet, however, the cross-cultural understanding of diverse national contexts of S&T innovation needed to implement such ideals remains underdeveloped. Work on the social shaping of S&T trajectories seldom recognizes the role of culture (see, e.g., Singh et al. 2007). Prior comparative work in STS, including the PI's own, focused more on regulation than on innovation. By investigating the foundations of national innovation policies, this project thus represents a significant departure from most earlier STS research. The three countries selected for comparison in this project not only offer great analytic and explanatory power (as further described below), but also move beyond West-West comparisons that do not adequately address the patterns and consequences of S&T globalization.

Consider, for example, the following case, illustrating how supposedly universal science is inflected with national purposes and self-understandings. In 2005, the international biomedical research community was shaken by the announcement that Dr. Hwang Woo-Suk, a celebrated South Korean scientist, had fabricated results and violated ethical norms in work that had led to highly acclaimed publications in leading journals such as *Science*. Hwang, who initially came to fame for animal cloning research, hit global headlines when he announced that his research team had succeeded in growing human blastocysts via nuclear transfer, and had also created 11 patient-tailored stem cell lines from them in a remarkably efficient manner (Hwang et al. 2004, 2005). These studies quickly won international recognition as a major scientific breakthrough with significant economic and social implications. Koreans, however, saw them above all as demonstrating South Korea's world-class scientific capabilities, paving the way to the country's "next-generation growth engine industries." Even after it was revealed that Hwang and his co-workers had committed serious scientific and ethical misconduct (SNU-IC 2006; KNBC 2006), one poll indicated that nearly 70 percent of South Koreans still wanted to give them a second chance if they had the "indigenous technology" to produce human blastocysts from cloned embryos (CBS Radio 2006).

Korean responses to this episode suggest that the scientific credibility of Hwang and the ethical implications of his research were not simply ignored or misperceived, but rather were actively interpreted and understood through the lens of national aspiration—in particular, the protection of "Korean" technology against foreign competitors to secure the techno-economic future of the Korean nation. Observers in other nations were quick to dismiss this reaction as "nationalist." And yet, strong support for therapeutic cloning and stem cell research in Western nations, including Germany (by the executive) and the United States (especially by the states), suggests that novel, cutting-edge, or emergent S&T projects are implicated in national or communal identity-building in many parts of the world (Jasanoff 2005; Ezrahi 1990).

Thus, stem cell policy in Germany has been framed as a conflict between a need for innovation and national regeneration on the one hand, and the danger of instrumentalizing (potential) human beings on the other (Sperling 2004, 2006). In other words, though ostensibly focused on S&T, it is at the same time a deeper conflict between a vision of what Germany could be and a vision of what Germany has been in the past. By contrast, US stem cell policy is framed as a pluralist tug-of-war: for some, between rational, pro-science groups and anti-science fundamentalists, in a battle to preserve the nation's Enlightenment foundations; for others, between competing visions of human beings' right to life (Jasanoff 2005). In short, in all three nations (United States, South Korea, Germany), stem cell projects are examples of what we term in this proposal *sociotechnical imaginaries*, which we define as "imagined forms of social life and of social order that center on the development and fulfillment of innovative scientific and/or technological projects."

Sociotechnical imaginaries are at once descriptive of attainable futures, and prescriptive of the futures that ought to be attained. As an influential part of the currency of contemporary politics, such imaginaries have the power to shape technological design, channel public expenditures, and justify the inclusion or exclusion of citizens with respect to the benefits of technological progress. Given the growing political salience of such imaginaries, and the risks and instabilities that inevitably accompany their realization, understanding how they are formed and pursued is necessary for any deep exploration of what the sociologist Ulrich Beck (2006) calls "the cosmopolitan vision," by which he means an openness to otherness and difference, and an acknowledgment of the possible coexistence of—even positive synergy among—multiple identities.

II. Study Design: Objectives and Approaches

This two-year, comparative STS project (7/1/07-6/30/09) aims to develop a new theoretical framework for understanding the global politics of S&T innovation, by examining the relationship between national political cultures and the production of sociotechnical imaginaries in the United States, South Korea, and Germany. This section briefly explains the choice of S&T policy as a site for comparative study; the significance of sociotechnical imaginaries as a focus of research; and the selection of three-way cross-national comparison as the study design. Subsequent sections describe in detail the project's broader impacts, theoretical foundations, and methods.

Why S&T Policy?

Over the past quarter century, STS research has done much to open up the cultures and processes of science and technology, revealing complex social dynamics in the production of scientific claims (Jasanoff et al. 1995; Latour 1987; Latour and Woolgar 1979), the design of technological artifacts (Bijker 1997; Bijker et al. 1987; Winner 1986), the assessment of risks and benefits (Porter 1995; Wynne 1982), and the formation of expert knowledges and cultures (Bowker and Star 2000; Jasanoff 1990). However, STS scholarship has generally devoted less attention to the promotion and reception of S&T by external institutions in society, policy, and politics than it has to the production of S&T within scientific disciplines, labs, clinics, and similarly bounded settings (Lakoff 2006; Knorr Cetina 1999; Fujimura 1996), and to the production of "epistemic objects" (Rheinberger 1997; Kohler 1994; Clarke and Fujimura 1992). Even scholars ostensibly concerned with science and democracy sometimes lose sight of society's pre-eminent role in attaching meanings and priorities to S&T (Kitcher 2001). The proposed study addresses this gap at the intersection of STS and work on national policies and cultures of S&T innovation.

Since the middle of the 20th century, governments of both developed and developing nations have converged on the view that advances in science and technology are a powerful driver of economic and social progress—and the promotion of S&T has accordingly become a prominent goal of state spending and public policy (Gibbons et al. 1994). Technology policy often occupies a different institutional niche from policies for science, but support for both is rooted in the same social and political imaginings. In the United States, this history can be traced to the Vannevar Bush model of state intervention (sponsorship of basic rather than applied research) (Bush 1945); ideas of technology-driven futures have developed in other countries as well (Fortun 2001). The European Union (EU), in particular, agreed in the so-called Lisbon Agenda of 2000 to

make the EU "the most competitive and dynamic knowledge-driven economy by 2010." Asian countries, too, have embraced and are aggressively pursuing this credo (Leadbeater and Wilsdon 2007).

However, the relatively uncontroversial, indeed almost universal, appearance of S&T policy on national and transnational political agendas paved the way to unforeseen difficulties, calling into question both the capacity of states to steer S&T effectively, and their ability to gain democratic assent for their S&T policy decisions. Two of the 20th century's most highly touted state-supported technological advances—nuclear power and biotechnology—gave rise to widespread public resistance and disenchantment; space technology enjoys high public support, especially in the United States, but many question the scientific value of manned flight, and that program produced spectacular disasters in the loss of the Challenger and Columbia spacecrafts. In Europe there is growing suspicion that the Lisbon Agenda was largely rhetorical, possibly misguided, and unlikely to be achieved. Current US and European governmental attempts to promote nanotechnology reflect a mood of sober caution born out of those negative experiences.

Attempts to diffuse technology across national borders have provoked additional unexpected conflicts, particularly in the case of technologies based in the life sciences. Examples include the trade war at the WTO between the US and the EU over agricultural biotechnology (Winickoff et al. 2005; Bernauer 2003); protests by citizens and farmers worldwide against imports of genetically modified crops and foods; discrepant national policies surrounding embryonic stem cell research and cloning (Jasanoff 2005); patent controversies involving agricultural and medical biotechnologies; clashes over psychiatric diagnosis and treatment (Lakoff 2006); and divergent ethical standards and practices governing the conduct of clinical trials and use of reproductive technologies (Petryna 2005; Daemmrich 2004). The recent resurgence of interest in nuclear power, in response to climate change, threatens to reopen dormant cross-national tensions. Although many information and communication technologies appear to flow smoothly across borders, conflicts between Google and the Chinese government are emblematic of tensions that lie close beneath the surface of seemingly unproblematic exchanges. Greater cross-cultural understanding of these and similar issues has become imperative for scholars, policymakers, S&T managers, and public beneficiaries of advances in S&T.

Why Sociotechnical Imaginaries?

The concept of *sociotechnical imaginaries* offers an analytic framework for asking basic questions about the relationship of S&T policy to culture, as well as for exploring normative issues surrounding technological design. Elaborating on the term technoscientific imaginaries (Marcus 1995; also Fischer 1999), this concept foregrounds the involvement of society in constructing imagined futures through S&T, and is in this respect consistent with STS ideas of co-production (Jasanoff 2004). The term itself is hybrid, straddling the humanities (*imaginaries*), social sciences (*socio-*), and S&T (*technical*). As such, it provides an appropriately expansive interpretive envelope within which to address questions about the meaning of technological developments, their links to social and political institutions, and the implications of technology's social embeddedness for responsible global governance of both knowledge and technology.

Studies of sociotechnical imaginaries can be expected to advance our understanding of contemporary S&T developments by shedding light on the following issues:

- How ethical, social, and political commitments get built into national trajectories of technoscientific development; how, if at all, such commitments contribute to national styles or systems of innovation.
- What it means to "democratize technology" in different national settings; what alternative models of democratization exist, and what are their advantages and disadvantages.
- How S&T policy functions as a site and instrument of meaning-making or sense-making—e.g., by shaping concepts of citizenship, participation, public good, and public reason.
- What factors influence the perceived successes and failures of S&T policy, and what new conceptual tools are needed to assist governments and publics in a globalizing world in making better informed, better reasoned, and more democratic S&T policy choices.

Why Cross-National Comparison?

The unexpected frictions of transboundary knowledge and technology transfer indicate that we do not live in a world in which a single, homogeneous, global public stands ready to accept any new technology that gains acceptance in any given sociopolitical context (see, e.g., Bauer 1995). Nor do scientists and technology developers operate in a homogenized world devoid of cultural specificities (Sunder Rajan 2005; Rabinow 1999). Rather, there is much indication that the risks and benefits of new technologies are differently assessed by governments and publics around the world (Jasanoff 2005; Daemmrich 2004; Bernauer 2003; Vogel 1986); scientists, too, inhabit different social worlds as they operate in different national contexts, even when they are working in the same fields (Knorr-Cetina 1999; Harwood 1993; Maienschein 1991; Traweek 1988). These findings suggest that nation states and their policies remain critically important sites both for social studies of S&T and for theoretically informed policy learning and policy innovation.

Important, too, for democratic politics, states have not always correctly discerned the needs and wants of their own publics with respect to technological developments; still less, then, can decisions reached in one national context be counted on to satisfy the democratic demands of potential users and consumers in other countries and regions (Bijker et al. 1987). Governments of many industrial democracies have initiated concerted efforts to engage with their own publics "upstream" in the course of technology development (Hagendijk et al. 2005, Wilsdon and Wills 2004). Preliminary evidence suggests that these efforts, which reflect underlying differences in political institutions and philosophies, including ideas of national solidarity and belonging, are leading to differences in framing the benefits, risks, and governance challenges of emerging technologies (Sunder Rajan 2005; Jasanoff 2005; Gottweis 1998; Bauer 1995).

All this points to an ongoing need for systematic comparative analysis of the ways in which features of national political life—or, more accurately, of national political culture—influence the development and reception of new sciences and technologies. How, we may ask, are political cultures implicated in forming powerful visions of the "goods" and "bads" of S&T—in short, in the production, projection, implementation, and uptake of sociotechnical imaginaries? And what implications do these processes of co-production (Jasanoff 2004) have for the future of cosmopolitan, or postnational, politics (Beck 2006) in a world of patchy globalization (Ong and Collier 2004)?

A cross-national comparative approach is necessary for developing a robust theoretical framework that can better address the following questions:

- How do nation-states conceptualize the goals of innovation in formulating S&T policy? In particular, how have the following themes been addressed in each country:
    - National needs (e.g., energy, economic, food security; modernization)
    - Solidarity (who belongs, who should be included, who is responsible)
    - Temporality, memory, history (which futures are desired, which pasts abandoned, which ones reconfigured, cf. Proctor 1988)
    - Competitiveness and sustainability (who is ahead, in what respects, what needs to be remedied, what needs to be preserved)
    - Risks and benefits (who loses and who wins, on what dimensions)
- What has been the public's role in national S&T policy processes?
    - How have relevant publics been identified; and how, in reverse, have new publics constituted themselves, or failed to do so, in relation to the state?
    - What democratic process innovations, if any, have been used (communication, consultation, citizen jury, inquiries, referenda)?
    - Has the scientific community featured as a distinct public or as an adjunct to or extension of the state (cf., Solingen 1994; Mukerji 1989)?
- How have examples of technological "goods" and "bads" from within or outside each country been articulated and translated into the policy process (including via the mass media)? How, in particular, have certain "global" success stories (e.g., Silicon Valley, Asilomar) or failure (e.g., Hiroshima, Chernobyl, Three Mile Island) been used to drive national S&T policies in each country?
- To what extent can we identify distinctively national narratives of democracy in the constitution of sociotechnical imaginaries in each country? What are the elements of such stories, and how do they relate to national political culture? For example,

- What forms of distribution or redistribution are to be promoted through S&T?
- What conditions of unfairness or injustice are to be altered or eliminated?
- How are the risks of innovation to be avoided or fairly apportioned?
- How should publics have a say in highly technical policy deliberations?
- How are democratic control and accountability to be assured?

III. Broader Impacts

S&T policymaking is necessarily a site of experimentation: an investment in a particular vision of a good or desirable future driven by S&T innovations, with no guarantee that the goals and instruments selected for this purpose will bring about the future that is desired. Further, it has not yet been adequately noted in the STS literature, nor in associated work in political or policy studies, that S&T policymaking is a site of democratic as well as technical experimentation. National policy processes have long served as vehicles for articulating ideas of inclusion, exclusion, participation, and lay-expert relations. Such experiments, however, tend to be open-ended and unreflexive, in the sense that there are few formal mechanisms for evaluating successes and failures in this field. Indeed, interestingly from the standpoint of social and political responsibility, the negative consequences of innovation are generally labeled "unintended." The implication is that credit for success belongs to the policymaker, whereas failure is deemed to be agent-less. Thus, learning in S&T policy, if it occurs at all, tends to be ad hoc, random, and unsystematic.

Given this backdrop, this project is expected to have three sets of broader impacts:

First, by taking both social and technical experimentation into account, in the North as well as the South, the project will improve cross-cultural understanding of the global politics of S&T. Such understanding has been in short supply. Perhaps because of expectations of universalism that frequently surround both science (Merton 1973) and policy, it was not, until now, even deemed necessary. Interpretive STS research here can break new ground and propel theoretical and conceptual advances across the social sciences.

Second, by strengthening the theoretical foundations of comparative S&T policy analysis, the project will also improve S&T policymaking and implementation, specifically with respect to procedures for:

- Assessing the risks, and the often under-analyzed benefits, of new and emerging technologies.
- Standard-setting, harmonization, and the treatment of cognitive and social uncertainties.
- Design of democratic institutions, particularly new forms of public engagement, inclusion, participation, and "upstream" involvement.
- Ethical analysis and deliberation, including the development of improved institutional forums and normative discourses.
- Design of S&T collaborations that are sensitive to diverse national and cultural contexts of innovation and deliberation.

Third, the project will contribute to human resource development by training two STS postdoctoral fellows in cross-national research and writing, outreach, international collaboration, STS program building, and possible teaching; in effect, this project will be for them also a training grant. Results will also be incorporated into the PI's undergraduate and graduate courses, and her broader dissemination efforts.

IV. Theoretical Foundations

Sociotechnical Imaginaries

There has been growing recognition in the social sciences and humanities that imagination (or the capacity to imagine) is a crucial, constitutive element in social and political life. Imagination is no longer seen as mere fantasy or illusion, but as an important cultural resource that enables new forms of life. Nor is it understood as simply residing in individual minds or limited to aesthetic considerations. Rather, imagination helps produce collective systems of meaning that enable the interpretation of social reality (Castoriadis 1987); it forms the basis for a shared sense of belonging and attachment to a political community (Anderson 1983); it

provides the gaze through which "the Other" is constructed and represented (Said 1978); and it guides the simplification and standardization of subjects so as to control them more efficiently (Bowker and Star 2000; Scott 1998). Imagination is thus "an organized field of social practices," operates in itself as a collective social fact, and serves as a key component in the making of social order (Appadurai 1996; Taylor 2004). The term "sociotechnical imaginaries" is introduced in this proposal to capture these multiple dynamics.

STS scholars have already turned their attention to the role of imagination in the production of S&T. Conventional accounts long maintained that, in these specialized domains, imagination appears only in the creative minds of individual scientists and engineers. Recent STS studies have demonstrated, to the contrary, that the promises, visions, and expectations of future possibilities are embedded in the very practices and organization of S&T (Fujimura 2003; Kitcher 2001; MacKenzie 1996; Marcus 1995); and they inform and shape trajectories of research and innovation (Hedgecoe and Martin 2003; Brown et al. 2000; Kay 1993). These "technoscientific imaginaries" are not only tied to particular scientific or technological projects. They are almost always imbued with an implicit understanding of the social world—for instance, who is the public, what is the public good (or bad), and how S&T can serve public needs (Wynne 2005; Fortun and Fortun 2005; Fortun 2001). In that sense, technoscientific imaginaries are simultaneously also *sociotechnical* imaginaries, encoding visions of the good society, as conceptualized in this project.

By focusing on sociotechnical imaginaries, we can begin to ask how the relationships between science, technology, and society are collectively imagined at the broader political levels of state and society. How are the boundaries and goals of S&T constituted? How are appropriate social goals in furthering S&T identified? How are S&T trajectories organized to achieve these goals? How are the benefits and burdens of innovation dealt with? Who are the relevant actors in effecting change? What roles and responsibilities does each actor have (e.g., the state, the market, the scientific community, industry, and the lay public)? Imagination concerning such issues operates across many sectors of society, not just at recognized sites of technoscientific activity, and may well precede the formation of particular technoscientific imaginaries. It is a basic assumption of this project that the collective, patterned ways in which society conceives and practices its sociotechnical relations can be identified, illuminated, and critiqued through cross-national comparison.

Of the multiple competing sociotechnical imaginaries in any given society, some tend to be more durable at the national level because powerful instruments of identity-making often lie within the control of states (e.g., state controlled media, defense systems, policy instruments). As previous studies have convincingly demonstrated, despite the increasingly global flows of capital, media, knowledge, and skills, the framing and bounding of S&T issues and related policies are closely intertwined with nation-building projects that reaffirm what a nation stands for (Jasanoff 2005, 1995; Vogel 1986; Brickman et al. 1985). National imaginations penetrate the very designs and practices of scientific research and technological development, and the resulting "technopolitics" may in turn shape not only the narrow issues surrounding them but also wider social and political debates (Sunder Rajan 2005; El-Haj 2001; Hecht 1998). Hence, in order to fully understand cross-national divergences in S&T policy, and in the cultural politics of S&T more generally, we need to examine how particular sociotechnical imaginaries emerge and become stabilized, what role political culture and practices play in these processes, what cultural resources are mobilized (Hogle 1999), and what material, social, and policy consequences these imaginaries entail.

Choice of Study Countries

From a comparative standpoint, the three selected countries represent three regions of the world (North America, Europe, and, crucially, Asia) that offer essential insights into the dynamics of S&T globalization. These countries also present numerous points of similarity and variation in both politics and culture that make them rich sites for interpretive analysis and meaningful comparison. All three countries have

- democratic political structures, but with diverse traditions of managing dissent and engaging publics and experts;
- neoliberal economic and regulatory policies, but grounded in different histories of state formation, ideas of community and the market (welfare state or not), and trajectories of modernization (cf. Cumings 1997; Green and Paterson 2005; Katzenstein 1987);

- strong, self-conscious commitments to modernization through S&T, but rooted in substantially different institutional practices of deliberation and governance;
- substantial histories of state and private investment in technological innovation, but with different understandings of the public-private boundary;
- parallel histories of technoscientific controversy, but involving somewhat different actors;
- definitions of S&T policy in imagined opposition to (or imitation of) one or more "Others" that affect the national sense of well-being and security (e.g., antidemocratic states and emergent economies for the US; more and less developed economies for South Korea, with special focus on the US and Japan; East Germany and the US for Germany).

Besides these structured similarities and differences, each country's historical record gives evidence of distinctive cultural preoccupations in and approaches to the construction and implementation of sociotechnical imaginaries. The following brief accounts and the table below summarize the expected differences. A major contribution of the project will be to test and refine these expectations empirically.

United States

With respect to national needs, the United States stresses the role of technology in leading innovation, promoting competitiveness and increasing growth. It is presumed that enhancing the growth of the national economy will produce welfare benefits for all citizens, i.e., innovation is seen as a driver of wealth distribution as well as wealth creation. In general, the benefits of innovation and change are not questioned, and there has been little discussion comparable to the lively debate on the "fourth hurdle" (i.e., the demonstration of likely societal benefits) in the EU. Winners and losers may be identified in policy discourses, but not as markers of a social inequity that itself needs to be redressed through S&T policy.

Technological trajectories in the United States are imagined as constantly and beneficially moving forward. Technology and science, in this sense, erase history, and a discourse of determinism persists in spite of scholarly research undermining that concept (Smith and Marx 1994). Social institutions are, correspondingly, perceived as lagging behind S&T. Politically, instrumental uses of technology have long sustained the national project (e.g., the Apollo missions, the War on Cancer, the War on Terror), consistent with Yaron Ezrahi's (1990) thesis that governments of liberal democracies seek legitimation by creating technological spectacles that position their citizens as attestive, and consenting, witnesses.

Risks of technology are largely conceived in US policy discourses as limited to physical or environmental harms. Benefits tend not to be formally assessed, and risks to social order or forms of life are virtually ignored in S&T policy (Jasanoff 2005, 1995).

South Korea

South Korea's foremost national goal has been rapid economic development, to catch up with economically more advanced nations through an export-led strategy (Song 2003). Almost all societal needs other than national security have been subordinated to economic growth, as exemplified by the policies of "growth first, distribution later" during the 1970s and 1980s. In this imagination, South Korea views S&T primarily as tools and resources for development, international competitiveness, and modernization. Accordingly, S&T policy has been driven by a pro-development coalition of state bureaucracy, politicians, and business, with advice from elite scientists and engineers. Publics were historically excluded from S&T policymaking. Their main role was to support, as dutiful citizens, national efforts to develop S&T for economic growth.

After the democratic transition in the late 1980s, South Korea's civil society grew rapidly, and policies of "growth first, distribution later" came under criticism from several quarters. Controversies over the risks and environmental costs of technology, such as nuclear power, also followed. By the late 1990s, NGOs increasingly demanded, and the government began to acknowledge, the need for public deliberation about S&T (Song et al. 2003).

Nevertheless, the underlying logic of South Korea's approach to S&T remains essentially unchanged: S&T are resources for national economic development (Branscomb and Choi 1996; Kim et al. 1997). The risks of S&T are taken more seriously than before, but are weighed against what South Korea perceives as the bigger threat—falling behind leading nations in an increasingly competitive global economy.

Germany

Germany has conceptualized the need for innovation in terms of sustainability. The most urgent risks that Germany perceives are emigration, aging, and loss of national culture. Germany feels that it has experienced a brain drain and wants to slow the exodus of people who have received their educations and then left the country, and even to lure some of them back with attractive programs (e.g., Emmy Noether, which fast-tracks young PhD's to professor level positions, and the "excellence initiative" that hopes to make German universities globally competitive).

Germany is fascinated by the example of American pragmatism, speed, and flexibility, accepting in general US accounts of American achievements and approaches. Unlike the United States, however, Germany seeks to innovate from above and to distribute the benefits of innovation more or less evenly. In these respects Germany still resembles a planning state. Innovation is often directed and managed by expert commissions. For example, advisory bodies on higher education produce precise figures on what percentage of students to specially promote and turn into an elite.

While engaging in planned stratification, Germany is also concerned with having everyone on board in important policy decisions. Sometimes symbolic inclusion suffices, such as when governmental committees are filled with representatives from various domains, to show that all voices are being heard. Germany has, however, innovated procedures in the domain of citizen juries, where public representativeness has been the key criterion (Sperling 2006).

The following table summarizes the foregoing preliminary observations concerning sociotechnical imaginaries in the three study countries:

	United States	South Korea	Germany
Form of Government	Presidential	Presidential	Parliamentary
Policy style	Pluralist	Statist-Corporatist	Corporatist
Expert role	Boundary work to produce objectivity	Authoritative policy legitimation	Production of collective reason
Public role	Stakeholders	National interests	Reasoning agents
Political and social risks	Over-regulation; terrorism	Falling behind	Lawless innovation
Benefits	Staying ahead; winning	Catching up; developing	Regeneration; regaining lost position

Choice of S&T Policy Cases

Our research will focus on three science-based technologies—old, current, and emerging—that have gained policy salience in each country: nuclear power, a past and future site of intense controversy; stem cells and therapeutic cloning, currently widely debated in all three countries; and nanotechnology, a case of newly emerging S&T. This cross-sectoral and cross-temporal approach is necessary for identifying recurrent features of national imaginaries that would not be apparent from a focus on single cases (e.g., only stem cells, as recommended by some reviewers). The selection of multiple cases is consistent with a new generation of STS research that seeks to move beyond the descriptive, micro-focus of individual cases to a more normative and macro analysis of the trade-offs that nations make in S&T policy, and how these in turn are shaped by divergent cultural assumptions and enduring imaginaries.

The cases are appropriate for additional reasons: they are all of national-level policy significance and hence related to national imaginations; they cover a sufficient time span to display what is durable in national imaginaries; they have engaged official, expert, industrial, and civil society actors; they have generated a sufficient documentary record for interpretive analysis. They also represent different sciences (life, physical, engineering), entailing different lay-expert configurations.

V. Research Methods

This project will use established methods of interpretive research and analysis in STS, the field represented by all three members of the project team. STS research integrates qualitative methods from several social science and humanities disciplines, incorporating both micro- and macro- perspectives. STS methods, however, are used in distinctive ways to explore the epistemological and material constructions that are the specific concerns of this field.

Qualitative Comparative Analysis: Cross-Sectoral and Cross-National Dimensions

The primary method used in this study is interpretive comparison based on the work of the PI and other STS comparatists (Jasanoff 2005; Parthasarathy 2005; Daemmrich 2004; Porter 1995; Wynne 1987). Political scientists have long used controlled variation among countries to identify causal relationships. Methodological debates in that field have centered on the use of small-*n* and large-*n* studies, the use of "paired comparison," and the use of "most similar" or "most different" research designs (e.g., Tarrow 1999). In these debates, nation states are the primary units of comparison, and the primary challenge is to identify the independent variables that account for differences in a preordained dependent variable. The ultimate goal is to identify causal connections that can be generalized across cases. By contrast, STS research is concerned with meanings, discourses, epistemes, and representations. Hence, while STS analysis is similar to small-*n* political science studies in its attention to micro-scales and use of qualitative methods, STS studies interrogate the categories of similarity and difference on which much political science comparison is based (Jasanoff 2005; Gottweis 1998).

Interpretive STS comparison often uses case studies as a starting point, but supplements that work with in-depth thematic analysis that probes traditional macro-constructs such as "national styles of regulation" (Vogel 1986; Brickman et al. 1985) or "national systems of innovation" (Lundvall 1992). STS work is concerned to explain how such constructs are themselves constituted and achieve meaning, and how they remain robust despite political pressures that threaten to deconstruct them. Thus, endpoints that large-*n* empirical research seeks to measure (e.g., innovation, progress, risk) are seen by STS scholars as discursive constructs held in place by micro-practices and discourses that need to be investigated. Importantly for this project, rather than accepting "nation" or "national interest" as given categories, the research aims to show (consistent with Anderson 1983; also Elam 1997) how ideas of nationhood and national interest are imagined, or reimagined, and performed in processes of technoscientific policymaking and development. This requires a research design that has to go beyond the study of single countries and cases.

The project therefore adopts a two-stage comparative design: (1) national case studies are used to probe the discourses and practices that are constitutive of national sociotechnical imaginaries; (2) the results are compared across countries. The first, more empirical stage of the study will be particularly attentive to the components of national imaginations identified above on p. 4: national needs, solidarity, temporality, competitiveness, risks and benefits. Attention will also be paid to policy discourses, such as risk and ethics, and ideas of democratic engagement that are particular to each country.

The second, more analytic and evaluative stage will tease out the commonalities and differences in the resources, discourses, and practices brought to bear on the construction of sociotechnical imaginaries in each country. This cross-national phase of comparison will investigate how competing political ideals are embedded in choices of S&T policy and technological design (Jasanoff 2006; Latour 1996; MacKenzie 1990: Winner 1986). This phase will also evaluate alternative methods of democratic deliberation and weigh the

pros and cons of competing policy approaches (for illustrations of such policy-relevant assessment in STS research, see Brickman et al. 1985; Jasanoff 1986, 1990, 1995, 2005).

Data collection for the project will use a variety of qualitative methods adapted to meet the theoretical, empirical, and analytic (interpretive) objectives of this proposal. Research will be guided by the following general principles:

- for each type of data and each case, most intensive attention will be paid to the past five years, when all three S&T policy cases have been "in the news";
- for each case, additional country-specific focal points will be chosen for special attention (e.g., Hwang case for stem cells in Korea, plus repercussions elsewhere; Chernobyl in Germany and Three Mile Island in the US for nuclear power; 21st Century Nanotechnology Research and Development Act in the US and Nanotechnology Development Promotion Act in Korea for nanotech).

Specific methods used for data gathering and case study construction are described below.

Documentary Analysis

As a study focusing on official policy discourses and practices, the project will involve a thorough interpretive analysis of the administrative and legal documents and decisions that have shaped national S&T policies, and those that pertain to the three technologies—i.e., nuclear power, stem cell research, and nanotechnology. This research will be the starting point for identifying the nationally specific elements that are involved in the constitution of sociotechnical imaginaries—in particular, how in each country national needs, solidarity, temporality, competitiveness, and risks and benefits have been defined, framed, and understood by the government, expert bodies, and other influential actors in technoscientific policymaking and development. Materials to be investigated include governmental publications and web sites; reports of administrative hearings and consultations; expert advisory reports, lawsuits and legal decisions; and publications by influential stakeholders. Because of her extensive experience with such research, Jasanoff will be primarily responsible for guiding this component of the study.

Research on relevant documents will necessarily be partly historical in nature. Some of the chosen technologies have been debated for longer than the others in the three countries. Moreover, in each country, there have been particular historical moments (or turning points) that may have sharply influenced national scientific and policy imaginations and that will not be identical to the other national cases (e.g., deregulation in post-Reaganite America, reunification in Germany, the switch from military rule to democracy in South Korea) (cf. Kim 2003; Cumings 1997; Green and Paterson 2005; Macrakis and Hoffman 1999). These historical turning points are important moments for identifying changes in national sociotechnical imaginaries. Kim, who is trained in history and sociology of science, will be primarily responsible for the identification and analysis of Korean historical materials; Sperling for Germany; and Jasanoff for the US.

Interviews and Participant Observation

This study raises questions that neither documents nor archival materials can address in enough detail. Because the period under study is relatively recent, not all the relevant materials are publicly available. Interviews with key actors involved in national S&T policymaking and policy debates related to the three selected technologies will thus be an important source of data for this project. Potential interviewees include officials from research ministries and related government agencies (e.g., *National Institutes of Health* and *Department of Energy* in the US, *Bundesministerium für Bildung und Forschung* in Germany, and *Ministry of Science and Technology* in Korea); experts from government advisory committees (e.g., *President's Council on Bioethics* in the US, *Nationaler Ethikrat* in Germany, and *Korean National Bioethics Commission* in Korea); leading scientists in the appropriate S&T fields; and activists from NGOs that have engaged in debates over these S&T issues (e.g., *Union of Concerned Scientists* in the US, *Bund für Umwelt und Naturschutz Deutschland* in Germany, and *Korean Federation for Environmental Movement* in Korea). All three investigators are experienced in this method and will conduct elite interviews, based on semi-structured interview protocols, in their respective primary study countries. Interviewees (about 50 in each country) will

be identified through the public record during the early stages of documentary analysis, and those lists will be further developed using snowball techniques. Protocols will be designed to ensure comparability of findings, and will be revised in the light of experience to accommodate new questions and changing understandings. With regard to access, Jasanoff, through her extensive contacts in S&T policy studies, is familiar with many principal actors in Germany and the US; Kim has considerable access in Korea, and Sperling has comparable credentials for Germany.

To better understand how sociotechnical imaginaries are articulated, received, or contested on the ground, we will collect ethnographic data on actual policy practices through participant observation and open-ended interviews. Ethnographic research will be conducted at various sites, including government demonstrations to present the technologies, public protests against them, and consensus conferences to inform citizens about their risks and benefits. Events like these typically surround the introduction of controversial technologies in democratic societies, and we will attend events that are staged during the years of the project's duration. Such research is consistent with multi-sited, topic-driven approaches that are widely used in STS and anthropology (Rabinow and Dan-Cohen 2004; Marcus 1998). Sperling, a cultural and medical anthropologist, will be primarily responsible for US and German ethnographic research, building on his participant observation in the German Parliament and several parliamentary commissions. Jasanoff will supplement that work in the US and Germany, and Kim will carry out comparable research in South Korea.

Media Analysis

The project will include a comparative, discursive analysis of media coverage of S&T policy, focusing on the specific case studies chosen for closer investigation. Media analysis is essential in order to identify cultural perspectives that are not those of official decisionmakers. Large newspapers, public television, and the Internet provide informational content to millions, and powerfully shape and consolidate public opinion on topics including S&T (Ezrahi 2004). Since mass media strive to maximize their audience in national contexts, they typically tailor their content to local cultural demands, thereby providing important windows onto national concerns and preoccupations. Governments also strategically use mass media to transmit their messages to the public. A study of the media as sites of claims-making and framing will thus be extremely helpful in examining how the role of S&T is imagined by both governments and civil societies.

For manageability, the research will focus on one or two elite newspapers in each country (e.g., *New York Times* for the US; *Chosun Ilbo* and/or *Hankyoreh Shinmun* for South Korea; and *Frankfurter Allgemeine Zeitung* and/or *Sueddeutsche Zeitung* for Germany); and a similarly restricted choice of TV programs from national broadcasters (e.g., the Public Broadcasting Service *PBS* in the US; the Korean Broadcasting System *KBS* and/or Munhwa Broadcasting Company *MBC* in South Korea; and Allgemeine Rundfunkanstalten Deutschlands *ARD* and/or Zweites Deutsches Fernsehen *ZDF* in Germany).

To meet reviewer concerns, we note that this project does not aim to carry out its own detailed content analysis. While informed by previous content analyses of media coverage of S&T (Durant et al. 1998; Gamson and Modigliani 1989; McComas and Shanahan 1999; Nisbet and Lewenstein 2002; Nisbet et al. 2003), this component of the study is designed as a qualitative, interpretive analysis to help identify multiple discursive frames operating in the production and dissemination of sociotechnical imaginaries in the public sphere, and thereby to complement other research methods used. One distinctive aspect of our use of media analysis will be its comparative, cross-cultural dimension (see, e.g., Ferree et al. 2002).

VI. Research Plan

The project will be divided into two phases, each with an approximate duration of 12 months, roughly corresponding to the two stages of research and analysis (cross-sectoral, cross-national).

Phase I (Months 1-12)

The project will begin with a review and reconfirmation of contact lists and interview protocols for each country, as well as preliminary documentary research on each of the S&T case studies. This preparatory stage will be followed by 4-week research trips to South Korea (Kim) and Germany (Sperling) and several shorter research trips to locations in the United States (project team). During these trips, we will:

- collect material on national S&T innovation policies (official documents from government agencies, legislative proceedings and hearings, and reports from the scientific community, industry, and NGOs);
- collect material on the specific technologies (stem cell and therapeutic cloning research, nuclear power, nanotechnology) that will be used for detailed cross-sectoral analysis;
- identify relevant key actors in case-specific policymaking and development, including government officials, policy experts, leading scientists, and NGO activists;
- conduct interviews with some of these key actors, with particular focus on how they perceive national needs, solidarity, temporality, competitiveness, and risks and benefits in relation to each selected area of S&T;
- conduct participant observation at relevant public and policy meetings, scientific conferences, and NGO activities (particularly in emerging or continuing areas of debate);
- analyze newspaper articles and media reports and other forms of coverage of the three cases to identify how the role of S&T in national development, as well as the benefits and risks of S&T, are discursively framed and performed in public domains.

In preparing the technology-specific case studies, each investigator will begin by mapping the place of the given technology in the national culture. To this end, it will be necessary to delineate the local social networks engaged in the production, regulation, and contestation of each case. Research will include (as far as possible) observing the activities of researchers inside and outside of laboratories, attending relevant state or local legislative public policy meetings, and making contact with advocacy groups. In the highly contested South Korean stem cell case, where access is now limited, Kim will draw on data already compiled by researchers with whom the project team has long-established contacts (e.g., H. Gottweis in Vienna).

The collected materials will be analyzed and synthesized over the remainder of Year 1 to produce three sets of extended case studies for each country. We will also refine our preliminary comparative framework for organizing and evaluating the findings from the national case studies. Using this refined framework, we will attempt to characterize the "national sociotechnical imaginaries" currently at play; trace how they have changed or remained dominant over other competing imaginaries; and examine their distinctive features as reflected in the S&T policies and popular discourses of the respective countries. Following this analysis, an interim report on "national sociotechnical imaginaries" will be prepared for each country.

Phase II (Months 13-24)

In the initial months of Phase II, we will continue our review of the relevant literatures and sources, and identify any remaining information gaps. The project team will collect more material on the sciences and technologies in question, especially on continuing developments pertaining to all three cases. A second round of research trips to South Korea and Germany will be organized, along with visits to relevant institutions in the United States. This phase will focus particularly on interactions with civil society actors, including the scientific community, industry, NGOs, and the media. We will conduct additional in-depth interviews and participant observation at sites of interest, including not only major research institutions and S&T policy agencies but also national ethics and scientific expert committees.

The bulk of Phase II will be devoted to examining whether and how national sociotechnical imaginaries are reproduced, maintained, or challenged in the development, diffusion, and reception of S&T in the three countries, and to sharpening the analysis of cross-national similarities and differences on the basis of the cases developed in Phase I. During this analysis, our theoretical framework will be reassessed against the body existing STS and related literatures.

Building upon ongoing STS discussions about the democratic governance of S&T (Jasanoff 2005, 2004b, 2003; Latour 2004; Maasen and Weingart 2005; Liberatore and Funtowicz 2003; Kleinman 2000), we will analyze the trade-offs between democracy and other factors (e.g., competitiveness, speed, encouragement of entrepreneurship) driving S&T policy in each nation. Solutions adopted in the three countries will be compared, with a view to identifying culturally specific practices in S&T policy analysis and governance—in areas such as the assessment of risks and benefits, the management of uncertainties, the design of new forms of public engagement, and the development of new ethical discourses and institutions.

The project team believes (contrary to several reviewer comments on the previous proposal) that exchange with other national and disciplinary projects is essential to overcoming the limits of small-*n*, qualitative research and to strengthening macro- and normatively oriented approaches within STS. In order to test the robustness of the concept of sociotechnical imaginaries, it will be specially important to exchange our findings with other researchers who are working on the relationship between S&T and national imaginations, or the cultural politics of S&T more generally, in other regions. Therefore, in Phase II, with funding from other sources, a theoretically-oriented, interdisciplinary workshop on the comparison of national sociotechnical imaginaries will be held. Potential invitees include; M. Fischer (MIT) for Israel; M. Fortun (RPI) for Iceland; J. Fujimura (Wisconsin) and S. Traweek (UCLA) for Japan; A. Lakoff (UCSD) for Argentina; P. Rabinow (UC Berkeley) for France; W-C. Sung (Toronto) and P. Song (Harvard) for China; K. Sunder Rajan (UC-Irvine) for India; B. Wynne (Lancaster) and R. Doubleday (Cambridge) for the UK.

In the final stage of the project, we will prepare publications. Three categories of publication are envisaged: individual refereed articles and chapters; one or more edited volumes, including one resulting from the workshop; and sole- or co-authored articles and volumes on national sociotechnical imaginaries, their cultural foundations, and their role in the global politics and democratic governance of S&T.

VII. Project Personnel and Management

The project involves one senior investigator and two postdoctoral investigators: Sheila Jasanoff (PI), Sang-Hyun Kim, and Stefan Sperling. All three are extensively trained in cross-disciplinary and comparative STS research, and each has additional areas of core disciplinary competence relevant to this project: Jasanoff in S&T policy, comparative politics, and law; Kim in history and sociology of science; and Sperling in anthropology of science and medicine. Each has worked on S&T policy in at least two study countries: Jasanoff in the US and Germany; Kim in South Korea and the US; Sperling in Germany and the US. Jasanoff is a pioneer in the use of comparison as a research method in STS and S&T policy, and has contributed to training Kim and Sperling. Already experienced in their own right, the postdoctoral researchers will gain valuable further research skills, analytic experience, and professional exposure during the project. The project will thus enhance their professional development and job prospects.

As an experienced comparatist and senior STS scholar, Jasanoff will be responsible for the overall supervision and management of the research; analysis of empirical materials and theory-building; intellectual design of the workshop; editorial direction of collaborative publications; and dissemination plan. She will also be responsible for advising and training the two postdoctoral co-investigators. Since the project requires significant methodological innovation, as well as considerable primary research, Jasanoff will also devote one funded summer month each year to research on the project, with planned visits to each of the three countries. She will attempt to find support from Harvard or other sources to cover her additional time spent on the project, including (hopefully) a semester of teaching relief.

Kim will be employed full-time on the project. His duties will entail approximately the following percentage time allocations: literature review and analysis of Korean studies of innovation and S&T policy (10 percent); field research in South Korea, including interviews, ethnographic research, and collection of Korean language materials (25 percent); creating and maintaining data base of research materials for all three countries (10 percent); analyzing some of these materials, especially historical records (15 percent); assisting project management, including website design and maintenance, workshop logistics and preparation, and other miscellaneous tasks (15 percent); writing up and disseminating project results (25 percent).

Sperling will be employed half-time on the project (the other half to be covered by Harvard for STS program development); approximate percentage allocations of his time on the project are indicated for each task. In connection with his primary responsibility for the German case, he will design (and in large part conduct) bibliographic, interview, and ethnographic research in Germany (70 percent); he will also as needed conduct participant-observation research and interviews in the United States (15 percent). He will be responsible for supervising student assistants who will transcribe interviews, identify and analyze TV programs, and collect and interpret newspaper articles from the US and Germany (15 percent).

VIII. Work Products, Deliverables, and Dissemination

The project team sees great value in broad dissemination of research results to the S&T policy community. The team is based at a leading public policy school, where the PI has created a new STS program (as she did at Cornell) geared to research and dissemination. Through expert committees and many invited appearances, the PI is engaged in constant dialogue with policymakers and institutions, both in the US and transnationally. Recent dissemination achievements beyond academia include, among others: a chapter on imaginaries in a 2007 expert group report to the European Commission (PI was the sole US representative); 2006 report (with Sperling and Kim) to the Pew Initiative on Food and Biotechnology on institutional approaches to animal bioethics; 2004 *amicus curiae* brief to the World Trade Organization in GMO case; and 2003 contributions to debate on US OMB proposals for peer review of regulatory science. The PI also led the creation of the Science and Democracy Network, a 5-year old organization of largely younger STS scholars and practitioners who are linking cutting-edge normative research in STS with contemporary policy debates. For further details concerning the PI's training and outreach activities, see http://www.ksg.harvard.edu/sts/.

Given the theoretical ambitions of this project, the primary means of dissemination must be through academic publications. Not only is this the usual indicator of productivity for research scholars, but it is also the avenue over which researchers exercise the most control. Other dissemination routes, including into policy as recommended by some reviewers, are slower to develop and demand ongoing opportunistic entrepreneurialism—and hence are less predictable, less immediate, and emerge only over time. Although the number and types of publications cannot be precisely foreseen in advance, all of the PI's prior NSF-funded projects have resulted or are resulting in authored and/or edited books and other refereed publications in a wide variety of journals and edited volumes; this project should be similarly productive.

In addition to works by the project investigators, an edited collection will be prepared with selected papers from the Phase II workshop on *national sociotechnical imaginaries and S&T governance*. This publication will explore the realization of sociotechnical imaginaries in different cultural contexts and help generalize the project's findings. To further develop the STS community doing comparative S&T policy research, we also plan to create an online forum for exchange of views and ideas; this may be done in collaboration with CSPO at Arizona State, where the PI has close professional connections. Additional opportunities for training and dissemination will be pursued through the Science and Democracy Network and its annual meetings.

Because of the high political salience of the study topic, the following additional dissemination avenues will be explored, relying on the investigators' collective experience working in such fora:

- posting working papers on relevant Harvard servers, e.g., at the Kennedy School and the Weatherhead Center for International Affairs (where the PI is an affiliate);
- creation of a comparative S&T policy/politics working group within the interdisciplinary STS Circle established by Sperling and Kim in Jasanoff's STS Program at the Kennedy School;
- end-of-project workshop for STS students and faculty, other social scientists, and policymakers working on comparative S&T politics and governance (including but not necessarily restricted to Harvard-MIT participants if other funding can be found);
- incorporation of project results into PI's undergraduate and graduate courses and seminars, and exploration (within constraints of Kennedy School curriculum) of a possible new course (e.g., "Politics of Science and Technology: A Comparative Perspective");

- panel presentations of work in progress at relevant professional societies of social scientists, natural scientists, and policymakers (e.g., 4S, EASST, AAAS, ISA);
- special issues in relevant STS journals (e.g., *Social Studies of Science, Science, Technology & Human Values, Science and Public Policy, Science as Culture*);
- cross-national dissemination through collaborative seminars with various South Korean and German research groups, building on the team's close institutional ties, specifically with: Program in History & Philosophy of Science at Seoul National University (Kim); Center for Innovation Policy at the Science & Technology Policy Institute, Seoul (Kim); Institute for European Ethnology, Humboldt University, Berlin (Sperling); Wissenschaftszentrum Berlin (Jasanoff); University of Bielefeld (Sperling, Jasanoff); University of Halle (Jasanoff).

IX. Results from Prior NSF Projects

1. *"Constituting Nature and Society in the Global Environment,"* (NSF Award No. SES-0328230). PIs Sheila Jasanoff and Clark Miller. Societal Dimensions of Engineering, Science, and Technology Program. Award period 9/1/03-8/31/05 (extended to 8/31/06). Award amount $400,000. Project focus was on environmental science, politics, and regulation, not (as here) on S&T innovation.

This award, shared between two collaborative research groups at Harvard and University of Wisconsin-Madison, explored emerging discourses of global environmental governance—sustainability, vulnerability, and precaution; their grounding in new, hybrid, human sciences of the environment; and their reception, interpretation, institutionalization, and uptake in national contexts. The project was comparative, contrasting the uptake of the three discourses across the government, corporate, scientific, and non-governmental sectors of the United States, Germany, and India. The project has made and will continue to make extensive theoretical, empirical, and policy contributions by adding to our understanding of environmental globalization and comparative responses to it, as detailed in final project reports to NSF by both teams. Significant new contributions were made to literatures on environmental citizenship, vulnerability analysis, and risk governance. A major early publication from the Harvard component was Jasanoff and Martello, eds., *Earthly Politics: Local and Global in Environmental Governance* (MIT Press, 2004). An additional book authored by Jasanoff, provisionally entitled *The Imagined Earth*, is in preparation. Through work by Martello (and Miller), project results were incorporated into numerous policy-relevant assessments. The Harvard component also provided postdoctoral training for two scholars and substantially contributed to undergraduate research and training.

2. *"Reframing Rights: Constitutional Implications of Technological Change"* (NSF Award No. SES-9906834). PI Sheila Jasanoff; Co-PI Fred Schauer. Award period: 9/1/99 – 8/31/05. Award amount $299,990.

This grant supported research-based training of nine pre- and postdoctoral fellows, five of whom were supported by NSF funds, while the remainder joined the project with funding from other sources. The project helped establish the Kennedy School as a center for STS activities at Harvard and was partly responsible for the creation of a new STS Program at the School in 2002. Fellows came from several fields (anthropology, law, STS, history of science, biology). The project provided financial and/or intellectual support for the completion of four doctoral dissertations (S. Sperling, J. Reardon, J. Dratwa, J. Aronson) and for revisions leading to two dissertation-based books (Reardon, Sunder Rajan). It also supported the development of a new course ("Bioethics, Law and the Life Sciences") taught by Jasanoff (once with postdoctoral fellow D. Winickoff), and sponsored workshops on varied topics related to science, technology, and constitutionalism. Four fellows received tenure-track academic offers or appointments at US universities importantly as a result of work done in the program (J. Aronson, J. Reardon, K. Sunder Rajan, D. Winickoff). The project's wider influence can be seen in the subsequent writings and outreach activities of the PI and postdoctoral participants. Through the involvement of M. Tallacchini (University of Piacenza, Italy), for instance, the project provided some of the impetus for the initiation of a new law and science doctoral program at the University of Catania in Sicily. A capstone conference was held in April 2004 and an edited volume entitled *Reframing Rights* (likely to be published by MIT Press) is in the final stages of preparation.

References

Anderson, Benedict. 1991. *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, revised edition. London and New York: Verso.

Appadurai, Arjun. 1996. *Modernity at Large: Cultural Dimensions of Globalization*. Minneapolis: University of Minnesota Press.

Bauer, Martin, W., ed. 1995. *Resistance to New Technology: Nuclear Power, Information Technology and Biotechnology*. Cambridge: Cambridge University Press.

Beck, Ulrich. 2006 [2004]. *The Cosmopolitan Vision*. Cambridge: Polity.

Bernauer, Thomas. 2003. *Genes, Trade, and Regulation: The Seeds of Conflict in Food Biotechnology*. Princeton, NJ: Princeton University Press.

Bijker, Wiebe E. 1997. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge, MA: MIT Press.

Bijker, Wiebe E., Thomas Hughes, and Trevor Pinch, eds. 1987. *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. Cambridge, MA: MIT Press.

Bowker, Geoffrey C. and S. Leigh Star. 2000. *Sorting Things Out: Classification and Its Consequences*. Cambridge, MA: MIT Press.

Branscomb, Lewis M. and Young-Hwan Choi, eds. 1996. *Korea at the Turning Point: Innovation-Based Strategies for Development*. Westport, CT: Praeger.

Brickman, Ronald, Sheila Jasanoff and Thomas Ilgen. 1985. *Controlling Chemicals: The Politics of regulation in Europe and the United States*. Ithaca, NY: Cornell University Press.

Brown, Nik, Brian Rappert and Andrew Webster, eds. 2000. *Contested Futures: A Sociology of Prospective Techno-science*. Aldershot: Ashgate Press.

Bush, Vannevar. 1945. *Science, The Endless Frontier*. Washington, DC: US Government Printing Office.

Castoriadis, Cornelius. 1987. *The Imaginary Institution of Society*. Cambridge, MA: MIT Press.

CBS Radio. 2006. Talk Show 'Today and Tomorrow.' Broadcast on January 16, 2006, South Korea.

Clarke, Adele and Joan Fujimura, eds. 1992. *The Right Tools for the Job: At Work in the Twentieth-Century Sciences*. Princeton, NJ: Princeton University Press.

Cumings, Bruce. 1997. *Korea's Place in the Sun: A Modern History*. New York: W.W. Norton.

Daemmrich, Arthur A. 2004. *Pharmacopolitics: Drug Regulation in the United States and Germany*. Chapel Hill: University of North Carolina Press.

Durant, John, Martin W. Bauer and George Gaskell, eds. 1998. *Biotechnology in the Public Sphere: A European Source Book*. London: Science Museum Publications.

El-Haj, Nadia A. 2001. *Facts on the Ground: Archaeological Practice and Territorial Self-Fashioning in Israeli Society*. Chicago: University of Chicago Press.

Elam, Mark. 1997. "National Imaginations and Systems of Innovation." Pp. 157-173 in Charles Edquist, ed. *Systems of Innovation: Technologies, Institutions, and Organizations*. London: Pinter Publishers.

Ezrahi, Yaron. 2004. "Science and the Political Imagination in Contemporary Democracies." Pp. 254-273 in S. Jasanoff, ed. *States of Knowledge: The Co-Production of Science and Social Order*.

Ezrahi, Yaron. 1990. *The Descent of Icarus: Science and the Transformation of Contemporary Democracy*. Cambridge, MA: Harvard University Press.

Ferree, Myra Marx et al., ed. 2002. *Shaping Abortion Discourse: Democracy and the Public Sphere in Germany and the United States*. Cambridge: Cambridge University Press.

Fischer, Michael M.J. 1999. "Emergent Forms of Life: Anthropologies of Late or Postmodernities." *Annual Review of Anthropology* 28: 455-478.

Fortun, Michael. 2001. "Mediated Speculations in the Genomics Futures Markets." *New Genetics and Society* 20 (2):139-156.
Fortun, Kim and Michael Fortun. 2005. "Scientific Imaginaries and Ethical Plateaus in Contemporary US Toxicology." *American Anthropologist* 107 (1): 43-54.
Fujimura, Joan. 1996. *Crafting Science: A Sociohistory of the Quest for the Genetics of Cancer*. Cambridge, MA: Harvard University Press.
Fujimura, Joan. 2003. "Future imaginaries: Genome Scientists as Sociocultural Entrepreneurs." Pp. 176-199 in A.H. Goodman, D. Heath, and M.S. Lindee, eds. *Genetic Nature/Culture: Anthropology and Science between the Two-Culture Divide.* Berkeley: University of California Press.
Gamson, William A. and Andre Modigliani. 1989. "Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach." *American Journal of Sociology* 95 (1): 1-37.
Gibbons, Michael, Camille Limoges, Helga Nowotny, and Simon Schwartzman. 1994. *The New Production of Knowledge.* London: Sage.
Gottweis, Herbert. 1998. *Governing Molecules: The Discursive Politics of Genetic Engineering in Europe and in the United States.* Cambridge, MA: MIT Press.
Green, Simon and William E. Paterson, eds. 2005. *Governance in Contemporary Germany: The Semisovereign State Revisited*. Cambridge: Cambridge University Press.
Hagendijk, Rob, Peter Healey, Maja Horst and Alan Irwin, eds. 2005. *Science, Technology and Governance in Europe: Challenges of Public Engagement.* Volume 1. STAGE (HPSE-CT2001-50003) Final Report.
Harwood, Jonathan. 1993. *Styles of Scientific Thought: The German Genetics Community 1900–1933*. Chicago: University of Chicago Press.
Hecht, Gabrielle. 1998. *The Radiance of France: Nuclear Power and National Identity after World War II.* Cambridge, MA: MIT Press.
Hedgecoe, Adam and Paul Martin. 2003. "Expectations and the Shaping of Pharmacogenetics." *Social Studies of Science* 33 (3): 327-364.
Hogle, Linda. 1999. *Recovering the Nation's Body: Cultural Memory, Medicine, and the Politics of Redemption*. New Brunswick, NJ: Rutgers University Press.
Hwang, Woo-Suk, et al. 2005. "Patient-Specific Embryonic Stem Cells Derived from Human SCNT Blastocysts." *Science* 308:1777-1783.
Hwang, Woo-Suk, et al. 2004. "Evidence of a Pluripotent Human Embryonic Stem Cell Line Derived from a Cloned Blastocyst." *Science* 303:1669-1674.
Jasanoff, Sheila. 2006. "Technology as a Site and Object of Politics." Pp. 745-763 in Charles Tilly and Robert Goodin, eds. *Oxford Handbook of Contextual Political Analysis*. Oxford: Oxford University Press.
Jasanoff, Sheila. 2005. *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton, NJ: Princeton University Press.
Jasanoff, Sheila, ed. 2004. *States of Knowledge: The Co-Production of Science and Social Order*. London: Routledge.
Jasanoff, Sheila.(guest editor) 2004b. *Science and Public Policy* 31 (2): 90-158 (Special Issue on 'Science and Citizenship: A New Synergy').
Jasanoff, Sheila. 2003. "Technologies of Humility: Citizen Participation in Governing Science." *Minerva* 41 (3): 223-244.
Jasanoff, Sheila. 1995. "Product, Process, or Programme: Three Cultures and the Regulation of Biotechnology." Pp. 311-331 in M. Bauer, ed. *Resistance to New Technology*.
Jasanoff, Sheila. 1990. *The Fifth Branch: Science Advisers as Policymakers.* Cambridge, MA: Harvard University Press.
Jasanoff, Sheila, Gerald Markle, James Petersen, and Trevor Pinch, eds. 1995. *Handbook of Science and Technology Studies.* Thousand Oaks, CA: Sage Publications.

Kay, Lily E. 1993. *The Molecular Vision of Life: Caltech, the Rockefeller Foundation, and the Rise of the New Biology*. Oxford: Oxford University Press.
Katzenstein, Peter. 1987. *Policy and Politics in West Germany: The Growth of a Semisovereign State*. Philadelphia: Temple University Press.
Kearnes, Matthew, Phil Macnaghten, and James Wilsdon. 2006. *Governing at the Nanoscale: People, Policies and Emerging technologies*. London: Demos.
Kleinman, Daniel L., ed. 2000. *Science, Technology and Democracy.* Albany: SUNY Press.
Kim, Samuel S., ed. 2003. *Korea's Democratization*. Cambridge: Cambridge University Press.
Kim, Young Woo et al. 1997. *Korea's Science and Technology Policy: 50 Years of Achievements*, Policy Research No. 1997-01 [in Korean]. Seoul: Science & Technology Policy Institute.
Kitcher, Philip. 2001. *Science, Truth, and Democracy*. Oxford: Oxford University Press.
Knorr-Cetina, Karin. 1999. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, MA: Harvard University Press.
Kohler, Robert. 1994. *Lords of the Fly: Drosophila Genetics and the Experimental Life*. Chicago: University of Chicago Press.
Korean National Bioethics Commission (KNBC). 2006. *Interim Report on Ethical Problems in Professor Woo Suk Hwang's Research (February 2)* [in Korean].
Lakoff, Andrew. 2006. *Pharmaceutical Reason: Knowledge and Value in Global Psychiatry*. Cambridge: Cambridge University Press.
Latour, Bruno. 2004. *Politics of Nature: How to Bring the Sciences into Democracy*. Cambridge, MA: Harvard University Press.
Latour, Bruno. 1996. *Aramis, or the Love of Technology*. Cambridge, MA: Harvard University Press.
Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.
Latour, Bruno and Steve Woolgar. 1979. *Laboratory Life: The Social Construction of Scientific Facts.* Beverly Hills: Sage Publications.
Leadbeater, Charles and James Wilsdon. 2007. *The Atlas of Ideas: How Asian Innovation Can Benefit Us All.* London: DEMOS
Liberatore, Angela and Silvio Funtowicz. (guest editors) 2003. *Science and Public Policy* 30 (3): 145-225 (Special Issue on ' Democratising Expertise, Expertising Democracy').
Lundvall, Bengt-Ake, ed. 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.
McComas, Katherine and James Shanahan. 1999. "Telling Stories about Global Climate Change: Measuring the Impact of Narratives on Issue Cycles." *Communication Research* 26 (1): 30-57.
MacKenzie, Donald. 1996. *Knowing Machines: Essays on Technical Change*. Cambridge, MA: MIT Press.
MacKenzie, Donald. 1990. *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance.* Cambridge, MA: MIT Press.
Macrakis, Kristie and Dieter Hoffmann, eds. 1999. *Science Under Socialism: East Germany in Comparative Perspective.* Cambridge, MA: Harvard University Press.
Maienschein, Jane. 1991. "Epistemic Styles in German and American Embryology." *Science in Context* 4 (2): 407-427.
Marcus, George E. 1998. *Ethnography through Thick and Thin*. Princeton, NJ: Princeton University Press
Marcus George E., ed. 1995. *Technoscientific Imaginaries: Conversations, Profiles, and Memoirs.* Chicago: University of Chicago Press.
Maasen, Sabine and Peter Weingart, eds. 2005. *Democratization of Expertise?: Exploring Novel Forms of Scientific Advice in Political Decision-Making* (Sociology of the Sciences, Vol. 24). Dordrecht: Springer.

Merton, Robert K. 1973. "The Normative Structure of Science." Pp. 267-278 in R.K. Merton and Norman W. Storer, eds. *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: University of Chicago Press.

Mukerji, Chandra. 1989. *A Fragile Power: Scientists and the State*. Princeton: Princeton University Press.

Nisbet, Matthew C., Dominique Brossard, and Adrianne Kroepsch. 2003. "Framing Science: The Stem Cell Controversy in an Age of Press/Politics." *The Harvard International Journal of Press/Politics* 8 (2): 36-70.

Nisbet, Matthew C. and Bruce V. Lewenstein. 2002. "Biotechnology and the American Media: The Policy Process and the Elite Press, 1970 to 1999." *Science Communication* 23 (4): 359-91.

Ong, Aihwa and Stephen J. Collier, eds. 2004. *Global Assemblages: Technology, Politics and Ethics as Anthropological Problems*. Oxford: Blackwell Publishing.

Parthasarathy, Shobita. 2005. "Architectures of Genetic Medicine: Comparing Genetic Testing for Breast Cancer in the USA and UK," *Social Studies of Science* 35 (1): 5-40.

Petryna, Adriana. 2005. "Ethical Variability: Drug Development and Globalizing Clinical Trials." *American Ethnologist* 32 (2):183-197.

Porter, Theodore M. 1995. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. Princeton, NJ: Princeton University Press.

Proctor, Robert. 1988. *Racial Hygiene: Medicine under the Nazis*. Cambridge, MA: Harvard University Press.

Rabinow, Paul and Talia Dan-Cohen. 2004. *A Machine to Make a Future: Biotech Chronicles*. Princeton, NJ: Princeton University Press.

Rabinow, Paul. 1999. *French DNA: Trouble in Purgatory*. Chicago: University of Chicago Press.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford: Stanford University Press.

Said, Edward W. 1978. "Imaginative Geography and Its Representations: Orientalizing the Oriental." Chapter 2 in *Orientalism*. London: Routledge & Kegan Paul.

Scott, James C. 1998. *Seeing Like a State: How Certain Schemes to Improve the Human. Condition Have Failed*. New Haven, CT: Yale University Press.

Seoul National University Investigation Committee (SNU-IC). 2006. *Final Report on Professor Woo Suk Hwang's Research Allegations (January 10)* [in Korean].

Singh, Jennifer, Joachim Hallmayer, and Judy Illes. 2007. "Interacting and Paradoxical Forces in Neuroscience and Society," *Nature Neuroscience* 8: 153-160.

Smith, Merritt Roe and Leo Marx, eds. 1994. *Does Technology Drive History?* Cambridge, MA: MIT Press.

Solingen, Etel, ed. 1994. *Scientists and the State: Domestic Structures and the International Context*. Ann Arbor: University of Michigan Press.

Song, Byung-Nak. 2003. *The Rise of the Korean Economy*. Oxford: Oxford University Press.

Song, Sungsoo, et al. 2003. *Policy Network Analysis of Social and Ethical Debates on New Technologies: Focusing on the Legislation Process of Bio-ethics and Internet Contents Regulation*, Policy Research No. 2003-08 [in Korean]. Seoul,: Science & Technology Policy Institute.

Sperling, Stefan. 2006. *Science and Conscience: An Ethnography of Stem Cells, Bioethics, and Citizenship in Germany*. Unpublished doctoral dissertation. Princeton University.

Sperling, Stefan. 2004. "Managing Potential Selves: Stem Cells, Immigrants, and German Identity." *Science and Public Policy* 39 (2): 139-149.

Sunder Rajan, Kaushik. 2005. *Biocapital: The Constitution of Postgenomic Life*. Durham, NC: Duke University Press.

Tarrow, Sidney. 1999. "Expanding Paired Comparison: A Modest Proposal." *APSA-CP Newsletter* 10 (2): 9-12.

Tarrow, Sidney. 1998. *Power in Movement: Social Movements and Contentious Politics*, 2d. edition. Cambridge: Cambridge University Press.
Taylor, Charles. 2004. *Modern Social Imaginaries*. Durham, NC: Duke University Press.
Traweek, Sharon. 1988. *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge, MA: Harvard University Press.
Vogel, David. 1986. *National Styles of Regulation.* Ithaca, NY: Cornell University Press.
Wilsdon, James and Rebecca Willis. 2004. *See-Through Science*. London: Demos.
Winickoff, David, Sheila Jasanoff, Lawrence Busch, Robin Grove-White, and Brian Wynne. 2005. "Adjudicating the GM Food Wars: Science, Risk, and Democracy in World Trade Law." *Yale Journal of International Law* 30: 81-123.
Winner, Langdon. 1986. *The Whale and the Reactor*. Chicago: University of Chicago Press.
Wynne, Brian. 1982. *Rationality and Ritual: The Windscale Inquiry and Nuclear Decisions in Britain*. Chalfont St. Giles, UK: British Society for the History of Science.
Wynne, Brian. 1987. *Risk Management and Hazardous Waste: Implementation and the Dialectics of Credibility*. Berline: Springer-Verlag .
Wynne, Brian. 2005. "Reflexing Complexity: Post-genomic Knowledge and Reductionist Returns in Public Science." *Theory, Culture & Society* 22 (5): 67-94.

Sociotechnical systems (STS) in organizational development is an approach to complex organizational work design that recognizes the interaction between people and technology in workplaces. The term also refers to the interaction between society's complex infrastructures and human behaviour. In this sense, society itself, and most of its substructures, are complex sociotechnical systems. The term sociotechnical systems was coined by Eric Trist, Ken Bamforth and Fred Emery, in the World War II era National sociotechnical imaginaries are defined as â€œcollectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and / or technological projectsâ€ (120). â€œSuch visions, and the policies built upon them, have the power to influence technological design, channel public expenditures, and justify the inclusion or exclusion of citizens with respect to the benefits of technological progressâ€ (120). In these and other usages of the phrase â€˜sociotechnical imaginaryâ€™ within STS in particular language plays a central to the construction ...Â Imaginaries are also distinguished from discursive frames guiding media representations of science and technology. Key words: Sociotechnical Systems; Sociotechnical transition; Health Information Technology; Standardisation; Pharmacovigilance.Â 1 Technocentrism is a value system rooted in classical science, technology, conventional economic thinking, and in the human control over nature. Page 4 of 16. International Association for Management of Technology IAMOT 2018 Conference Proceedings.