30 Making Order: Law and Science in Action

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In the subtitle of his 1987 book *Science in Action*, Bruno Latour articulated what has become a guiding methodological prescription for the field of STS: the best way to understand the scientific enterprise is to "follow scientists and engineers through society" (Latour, 1987). Simple to state, that injunction has proved not so simple in practice. The pathways that scientists, and their close kin in medicine and engineering, trace through society in modern times have grown increasingly complex. No longer even notionally restricted to laboratories or field stations,[1] scientists and scientifically trained professionals are as likely to make their appearance in corporate boardrooms, university administrations, legislative hearings, advisory committees, and courts of law. Traffic on the highway between law and science has grown particularly dense and its patterns, if any, correspondingly hard to decipher. Not only are technical experts implicated in ever more varied legal proceedings, but many of the key institutions of modernity—health care, environmental protection, insurance, education, security, financial markets, intellectual property, and criminal justice—demand an intense and ongoing collaboration between the institutions of law and those of science and technology (Jasanoff, 1995). Elucidating that interaction has become a distinct project of STS research; this chapter describes the main results of that undertaking.

Following scientists through society may lead, indeed has led, STS scholars into spaces that are emphatically not those of science; but that strategy alone cannot lay bare the interactive dynamics of two institutions that, perhaps more than any other, are responsible for making order, and guarding against disorder, in contemporary societies. At issue, after all, is not only how scientists produce facts for legal use but also how science supports ideas of causality, reason, and justice in the law, and how scientific experts supplement the work of jurists, advocates, and other actors engaged in the project of securing social stability and order. To get at that deeper level of understanding, STS scholarship has had to expand its theoretical repertoire and adopt methods that go well beyond close readings of what scientists do in or out of their own workplaces. What emerges from the growing literature on science and law is, in effect, a "*stronger* program"[2] for looking at science and technology in their wider social, cultural, and political contexts. Three sets of presumptions mark this newly

contextualized study of science in relation to law, humanity's other most indispensable instrument of authority-making.

First, STS scholars have recognized a need for greater symmetry in exploring the processes and practices of science and the law. So thoroughly are these institutions enmeshed that close investigation of various dimensions of legal practice (e.g., evidentiary hearings, advisory committee meetings, patent litigation), and the actors who engage in them, is as likely to shed light on the production of scientific knowledge as studies of laboratory science-in-the-making or of scientific controversies. Put differently, the law is now an inescapable feature of the conditioning environment that produces socially embedded—or so-called Mode 2 (Gibbons et al., 1994)—science. Accounts of the development of science are incomplete without taking on board the shaping influence of legal imperatives and imaginations, and of necessity the work of legal practitioners and institutions. The law, moreover, operates with its own ideas of facticity and truth that are not identical to those of the sciences. How facts are contested and established in various legal contexts neither blindly conforms to, nor determines, similar processes in science (Jasanoff, 2005). A comprehensive "social history of truth" (Shapin, 1994) for the modern world cannot be written from starting points originating within science and technology; we need equally to follow law-work and law-workers as they pass into and through the workplaces of science and technology.

Second, the divergent cultural attributes and ambitions of law and science raise distinctive questions not only about the relationship of power and knowledge but also about the methods by which to study them. Law's language is human language, a prime achievement of culture, situated in both place and history; the social study of law and of legal cultures has tended to be similarly situated within national research traditions, permitting relatively little communication across different legal systems (consider, e.g., Leclerc, 2005; Latour, 2002; Hermitte, 1996). Science's language, as the presumed language of nature, claims a kind of universality that transcends culture, time, and place. In practice, moreover, English has gradually established itself as the *lingua franca* of science, facilitating communication among scientists, and all those who claim to act on the basis of science, wherever they are located. Science studies, to some extent, partakes of that same catholicity: academic communities in STS are sooner defined by their shared objects or periods of study (e.g., genomics, early modern science, or risk assessment) than by researchers' cultural or linguistic origins. Following legal and scientific practitioners as they interact, then, entails asymmetries of method and interpretation, on the part of analysts as well as actors, that pose significant challenges for STS.

Third, the perspectives gained on science-law interactions by simply following practitioners in either domain are necessarily limited. Scientists and lawyers move about in their professional worlds in accordance with well-established conceptions of their roles and missions; even reflexivity, a part of each institution's modes of thought, operates within circumscribed interpretive conventions. To gain analytic purchase on their epistemologies and practices, the very definition of these institutions must, to some extent, be put in play in ways that may surprise and even estrange practitioners. Just

as science no longer happens exclusively within laboratories, so law too unfolds in settings far beyond the courtroom. Needed for insight into these dispersed yet mutually sustaining activities are sets of theoretical or conceptual lenses that do not precisely replicate the self-understandings of either institution. In part, the lenses used in recent STS work to look behind the public performances of law and science have derived from established disciplines, such as anthropology, history, or sociology; in part, theoretical approaches have also evolved in more organic and inductive ways from work done within STS itself.

Any literature review of the kind undertaken here necessarily performs its own boundary work, most importantly through decisions about what to include and what to exclude from coverage. On the assumption that STS, as a relative newcomer to the social sciences,[3] is still advancing through critical encounters with neighboring areas of scholarship, this chapter includes relevant works from fields such as the anthropology and sociology of law, legal history and philosophy, and law and society. This strategy not only provides a fuller, more textured account of current social science conversations concerning law, science, and technology, but it also helps contextualize the contributions that are distinctive to STS. The juxtaposition of STS writing with that emanating from legal scholarship and practice is particularly illuminating. In contrast to science, which perennially sheds its history, the law advances by openly reflecting on and continually reincorporating its own past performance; it is, in this respect, possibly the most reflexive of modern social institutions. The relationship of science and law is one area that has engaged the legal system's reflective capacities, and comparing the results of that self-analysis with analyses by STS scholars, who write from standpoints in neither science nor law, helps bring the latter's insights into sharper relief.

This chapter reviews the STS literature on law, science, and technology under four linked, yet analytically separable, headings: *engagements*, *authority*, *epistemology*, and *culture*. The section on engagements traces the relationship of science and technology with the law as a historical phenomenon and an emerging field of academic inquiry. The theme of authority addresses the varying discourses and registers in which analysts have sought to represent the authorization (and, sometimes, the destabilization) of science within the legal system, and, to a more limited extent, of the law within scientific communities. Epistemology, a central concern of STS, refers in this chapter to the law's contributions to making and unmaking scientific facts and to shaping the processes of fact-making. Finally, the heading of culture brings together a heterogeneous and still developing body of work on the varying guises in which science-law interactions play out across divergent legal and political arenas. The chapter concludes with reflections on productive future directions for STS research on science, technology, and the law.

ENGAGEMENTS: PHILOSOPHY AND HISTORIOGRAPHY

Two institutions, both intimately concerned with rules and order, cannot help but influence each other's discourses and prerogatives. Interactions between science and

law have evolved over long ages and on many levels, from the constitutive and conceptual to the mundane and instrumental. For the law not only concerns itself after the fact with remedying the harmful consequences of scientific and technological change. Additionally, and perhaps more significantly, it provides an envelope of social order within which new epistemic constructs and technological objects are constantly fitted out with recognizable meanings and normative implications. No account of the engagements between science and the law can be complete, therefore, without considering the ways in which changes in our knowledge of nature, and in our ability to manipulate nature through technology, challenge and respond to some of the basic categories of legal thought.

A central node of engagement is the concept of "law" itself. Since the beginnings of the scientific revolution, the word *law* has been used to denote both regularities discerned in nature and rules by which religious or secular authorities govern human behavior. That semantic convergence has not gone unnoticed in writing about science or the law, although scholarship concerning each domain has proceeded mostly in disregard of the other. The lack of contact is especially notable given that assumptions about nature and science have long underwritten the authority of the law, just as legal ideas about codes and norms have made their way into descriptions of science (Merton, [1942]1973). A full-blown engagement between STS and legal scholarship concerning each field's presumptions and findings, as seen by the other field, promises much, though it has yet to come into being.

For legal philosophers in the "natural law" tradition, the regularities of nature provide the strongest possible warrant for legislating morality: people should be required to behave in certain ways, in this view, because it is "natural" to do so, and science can aid us in discovering what is natural. Succinctly put, "there are certain principles of human conduct, awaiting discovery by human reason, with which man-made law must conform if it is to be valid" (Hart, 1961: 182). Legal positivists contest this unproblematic derivation of moral prescriptions from the descriptive facts of nature (Waldron, 1990: 32–34). For them, the law is nothing more than what a sovereign authority decrees as the right rules of conduct; in the positivist tradition, law can be valid even if it permits behavior that is, in some sense, against nature, although this is infrequent in an era when sovereigns are routinely held to nonarbitrary, rational, and scientific modes of justification (for an arguable breakdown in such accountability, see Mooney, 2005).

Neither legal positivism nor natural law takes practice centrally into account in building theory. But, paralleling the sociological turn in STS, the law has produced its share of scholars who take their cues about the nature of their enterprise from what practitioners do rather than from what philosophers say. Justice Oliver Wendell Holmes ([1881]1963: 5) most famously captured the spirit of legal realism in his much quoted line, "The life of the law has not been logic; it has been experience." Lon Fuller's influential exploration of the morality of law resonates even more closely with themes in the sociology of scientific knowledge. Like Robert K. Merton ([1942]1973), whom he did not cite, Fuller (1969: 46–91) posited that the law contains its own inner

morality that must be adhered to in a functioning legal system. Fuller's eight principles of legality can be considered in this respect akin to Merton's four familiar norms of science (communalism, universalism, disinterestedness, and organized skepticism). Fuller recognized, too, the parallels between theories of science and the law. In concluding the 1969 revision of his 1964 work, Fuller (1969: 242) pointed to philosophers of science such as Michael Polanyi and Thomas Kuhn who had oriented their field away from concept and logic "toward a study of the actual processes by which scientific discoveries are made."[4] He urged on his legal colleagues a similar "analysis of the social processes that constitute the reality of the law." By concurrently probing both sets of realities, constructivist STS research on law and science follows Fuller's injunction more completely than he himself might have imagined possible.

Out of the pages of theoretical texts, natural law thinking continues to guide judicial decision making, especially in controversies around the life sciences. In 2005, for example, the U.S. Supreme Court abolished the death penalty for defendants under 18 years of age, partly on the ground that minors are more vulnerable than adults to irresponsible behavior and less in control over their immediate surroundings.[5] Similarly, legal decisions on the use of reproductive technologies reflect underlying notions of what constitutes natural modes of kinship or naturally gendered behavior (Hartouni, 1997).[6] Natural law ideals also permeate the thinking of twenty-first-century ethical analysts who have argued for strict legal controls on embryo research, human reproductive cloning, and genetic therapies that would alter human germ lines (Fukuyama, 2002). By contrast, *Roe v. Wade*,[7] the controversial 1973 U.S. Supreme Court decision on abortion, can be seen more as a repository of positivist thinking, in that it gave greater weight to women's constitutionally guaranteed autonomy, under the rubric of privacy, than to arguments about the fundamental sanctity of fetal life. German constitutional law, which accords human dignity to the fetus from the moment when sperm and egg cells fuse, and hence to a naturalistic conception of the origins of human life, stands in sharp contrast to *Roe*'s doctrinal position.

While legal thinkers have turned to nature for firm moral warrants, early modern scientists perceived nature itself as being ruled by law. The very idea of science, according to Evelyn Fox Keller, extended the idea of domination within human societies, through law, outward to encompass the human domination of the universe. Science, in this sense, was law transposed—from social to natural order. Thus, Keller writes, the concept of laws of nature "introduces into the study of nature a metaphor indelibly marked by its political origins"; laws, whether of nature or the state, "are historically imposed from above and obeyed from below" (Keller, 1985: 130). That view of scientific law accords well with the intuitions of legal positivists concerning the authority of law, but it has been complicated by work such as Fuller's that brings society back into explanations of the law's normative power.

Focusing on the origins of experimental practice in Restoration England, Shapin and Schaffer (1986: 99–107, 326–28) describe a more complex dynamic. They note that in this period of unusual political and philosophical ferment the precise basis for scientific and legal authority, as well as the relationship between them, were

simultaneously at stake. Would science, as the experimentalists associated with Robert Boyle believed, advance by adopting the common law's procedural device of witnessing, thereby creating well-defined, practice-based communities of trust? Or did the reliance on human witnesses, as Thomas Hobbes was convinced, substitute fallibility for truth, thus subverting the stability of an order ruled from on high? As we will see, that early controversy, locally resolved in Restoration England in favor of the experimentalists, continues to provide a surprisingly pertinent analytic frame for contemporary debates about fact-making in law and science.

Engagements between law and science occur not only at the level of institutional legitimation but also in the ongoing work of legal dispute resolution. Turning to specific sites of engagement, we note that the law's need for scientific facts is not new. From almost as far back as we can go in history, judges have sought to establish the facts of nature in order to secure a basis for exercising their own normative authority. A Talmudic story tells how a physician's testimony exonerated a woman of trumped-up adultery charges when he testified that the white residue on her bed sheets was egg white, not semen (Jasanoff, 1995: 42). By the late eighteenth century, the industrializing world began generating increasing numbers of controversies that could not be resolved without determining the facts about one or another natural phenomenon. Facts, or more properly claims about facts, were brought into the courtroom by specially skilled expert witnesses. The 1782 English case *Folkes v. Chadd*, in which a court formally accepted the testimony of party-employed engineers, and more generally approved the use of expert witnesses, involved a dispute over what caused the silting up of Wells Harbor in Norfolk (Golan, 2004). Throughout the nineteenth century, partisan experts claiming specialist knowledge on matters ranging from pollution to accidents to murder streamed into common law courts in England and the Anglophone world. In civil law countries, the state retained the right to call expert witnesses, but there, too, legal dispute resolution came to depend more and more on the use of technical experts (Leclerc, 2005).

The engagement between law and medicine, illustrated by the Talmudic tale above, has a particularly long and consequential history, rich enough to constitute its own burgeoning subfield in the history of medicine (Clark & Crawford, 1994). For centuries, physicians have offered their expert opinions to help resolve legal controversies involving such issues as abortion, infanticide, murder, criminal intent, mental competence, medical malpractice, and injuries from toxic substances ("toxic torts"). Through these interactions, medical authority has helped to underwrite discriminations that are essential to the implementation of the law and, indeed, to sustaining the notions of lawfulness and legality. Equally, emerging expert communities, such as forensic psychiatrists (Golan, 2004; Eigen, 1995; Smith, 1981), medical examiners (Timmermans, 2006), toxicologists, and radiologists, have consolidated their professional identity and social authority by offering their specialized knowledge as supports to legal decision-making. With the rise of the regulatory state and of biopower since the nineteenth century, medical expertise has increasingly been drawn into projects of governmentality, that is, into underwriting practices of clinical and population-

based oversight that enable institutions to control people on national and even imperial scales (Stoler, 2002; Bowker & Star, 1999; Foucault, 1973, 1978, 1979, 1994).

Rounding out this section on engagements, we should note that science and technology not only assist in resolving legal disputes but also participate in producing them. Since the 1970s, the dominant conceptual frame for dealing with the harmful or destabilizing effects of technological innovation has been that of risk. Famously articulated by Ulrich Beck (1992), through his identification of the "risk society" as a radically new cultural formation, the trope of risk draws attention to the ungovernable dimensions of science and technology, and by extension to the law's role in managing the unmanageable through discourses of justice and reason (Jasanoff, 1995, 1990; Wynne, 1982). But as STS scholarship has importantly shown, the assumption of linearity, almost of determinism, built into the risk paradigm—casting science and technology as proactive and law as reactive—needs to be substantially revised and augmented in favor of more interactive accounts that pay attention to the innovative capacities of both institutions.

AUTHORITY AND COMPETITION

As prime custodians of the "is" and the "ought" of human experience, science and the law wield enormous power in society. Each plays a part in deciding how things are in the world, both cognitively and materially; each also helps shape how things and people should behave, by themselves and in combination. Competition often marks the interactions of law and science, not only in testing the limits of scientific autonomy and self-regulation (see, e.g., Kevles, 1998) but also in areas where the boundary between the legal and the scientific spheres of influence is itself at stake. Several narrative traditions have evolved for describing the relationship between law and science in these contested regions, of which five deserve particular attention: *law lag*, *culture clash*, *crisis*, *deference*, and *co-production*. The first four are encountered primarily in writing by members and critics of the legal profession; only the last is specifically a product of STS. Each frame organizes the law-science relationship in distinctive ways, highlighting and backgrounding different aspects. Each, in consequence, carries implications for legal reform, though not all have received equal attention from legal, scientific, or political actors—for reasons that themselves call out for scholarly analysis.

Together, the four themes of law lag, culture clash, crisis, and deference illustrate not only the centrality of the law-science relationship as a subject of reflection and analysis, especially in common-law countries, but also the fertility of contemporary legal culture in accounting for its interactions with science and technology. STS scholarship, then, stands at a double disadvantage in commenting on the relationship of law and science. Both sides offer the critical outsider a case of what anthropologists have called "studying up" (Nader, 1969). Both, to start with, are institutions of power, and a large part of that power lies, for each, in having commandeered, in the eyes of society, a privileged, almost monopolistic, position from which to explicate its own

workings.[8] Scientists are seen as the most competent commentators on science, as lawyers are on law. Each institution, moreover, shores up the other's status. Neither legal nor scientific practitioners seem inclined to probe too deeply each other's claims concerning the authority of their respective epistemic and normative practices. In this sense, the two are involved in a subtle dynamic of co-production, the major narrative frame that analysts standing outside both domains have invoked to describe their complex, yet mutually sustaining, choreography.

Law Lag

The notion of the law lag can be traced back to the influential early-twentieth-century American sociologist William F. Ogburn (1957, [1922]1950), who argued that interconnected cultural institutions, such as science and law, develop at uneven paces, so that the slower are necessarily out of step with the quicker. Differential rates of innovation, accumulation, and diffusion produce, in turn, a constant need for adjustment between leading and lagging institutions. Ogburn was careful to locate the capacity for innovation in both technology and society, repudiating a simple-minded technological determinism, but he nonetheless viewed science and technology as modernity's prime movers of social change. In 1933, as chair of the President's Research Committee on Social Trends (1930–1933), Ogburn prepared for Herbert Hoover a report identifying irregular change as the chief source of social problems and advocating for better statistical data as the basis for solving the problems. That vision was informed by a positivistic model of knowledge accumulation that has been largely abandoned by post-Kuhnian social scientists. Reviewing Ogburn's contribution a half-century later, the sociologist Neil Smelser took issue with the suggestion that science inevitably leads the law. Smelser noted that even in *Brown v. Board of Education*,[9] the U.S. Supreme Court's seminal desegregation decision, the much-touted input from the social sciences did not alter legal thought but only helped substantiate a moral consensus that had been building for years (Smelser, 1986: 30–31).

Nonetheless, the perception that the law lags behind advances in science and technology dominates academic and popular writing and frequently surfaces in legal opinions. Discursive constraints provide part of the explanation. The law's rhetoric of justification is primarily backward-looking, relying on enacted rules and established judicial precedents. Judges may interpret the law as written, but they stray into dangerous territory if they are seen too openly to be making the law: "A judge disguises new ideas as old in order to enhance their social acceptability" (Goldberg, 1994: 19).

Science, by contrast, unabashedly embraces innovation. Continually erasing its own history as it moves forward, today's scientific knowledge ruthlessly casts aside yesterday's rejected theories and discarded truths. Reward structures in science consistently favor novelty. Nobel prizes are awarded for original discoveries, not for more elegant replications of others' work, and patents cannot be granted for inventions whose basic principles are already known to skilled experts. Not surprisingly, then, scientific inventiveness comes across as an inexorable, agenda-setting force to which the law responds

only by reaction. Indeed, legal practitioners are among the most enthusiastic disseminators of the law lag narrative. Thus, in the landmark U.S. life patenting decision, *Diamond v. Chakrabarty*, Chief Justice Warren Berger observed that "legislative or judicial fiat as to patentability will not deter the scientific mind from probing into the unknown any more than Canute could command the tides."[10] Nothing in the opinion marked this case as a moment of exceptional legal inventiveness, when a court in effect recognized a novel type of commodity and thereby opened the door to new forms of hype and hope, investment, research, and material manipulation, with huge consequences for society.

Culture Clash

Less deterministic than the law lag narrative, the culture clash frame focuses on the discrepant aims of law and science as the chief sources of conflict between them. In Steven Goldberg's (1994) telling, the clash originates in science's commitment to progress, whereas the law's primary concern is with process. Consequences that flow from this difference include the legal system's commitment to building consensus, or at the very least to airing diverse points of view, whereas science pursues the nature of reality, come what may. Peter Schuck (1993), an analyst of administrative and tort law, triangulates the story of the culture clash by bringing politics into the picture as a third culture. All three, in Schuck's account, are characterized by their distinctive values, their incentives and techniques, and their biases and orientations. On the value axis, Schuck (while citing constructivist ideas from STS) associates science with a core commitment to truth and falsifiability, law with justice, and politics with process (see also Schuck, 1986). For Schuck, as for Goldberg, the culture clash model rests on an unproblematized notion of institutional boundaries, without taking on board the practices discussed by STS scholars through which these boundaries are erected and maintained (Hilgartner, 2000; Gieryn, 1999; Jasanoff, 1990) or the purposes served by such boundary-making.

Crisis

A third narrative invoked to frame law-science relations, particularly in the United States, is that of crisis. This can be seen as an extreme and highly reductive version of the clashing cultures narrative—one that depicts the relationship between the two institutions as pathological in its failure to produce socially desirable outcomes.

Despite Alexis de Tocqueville's early observation that, in America, political conflicts are routinely translated into legal ones, there is continual hand-wringing over the nation's propensity to settle issues through contestation rather than cooperation. America's "litigious society" (Lieberman, 1981) has been blamed for the spiraling cost of medical insurance, and more specifically for a "malpractice crisis" resulting from irresponsible lawsuits and runaway jury awards against physicians. Statistical analysis complicates that reading. A counternarrative put forward by many health policy analysts holds that, although only a small fraction of those filing claims have been

negligently injured, an equally small fraction of those who have been so injured ever file claims. Further, the rise and fall of insurance premiums may have more to do with cycles in investment by insurance companies than with malpractice claims (Sage & Kersh, 2006). This school of policy analysts views with skepticism reform ideas that seek to deter malpractice lawsuits, arguing that these measures alone will not advance the important goals of preventing error and efficiently compensating deserving patients. For STS scholars, the more interesting issue is why the images of a litigation explosion and of uncontrollable jury verdicts persist with such diehard energy despite years of unsubstantiating quantitative research (Vidmar, 1995).

For some, the crisis narrative centers less on the economic costs of litigation than on the threat to science. Law, according to these critics, encourages the production of "junk science" (Huber, 1991)—science that does not meet the scientific community's minimum standards of validity, even though it passes muster with juries and judges. Proponents of this view attribute the law's uncritical reception of scientific claims to many factors: jury ignorance and confusion; mercenary and unprofessional expert witnessing; lax admissibility standards; and the lawyer's ethos of privileging victory above the truth. The rhetoric of "junk science" rests, in short, on a tacit sociology of knowledge that differs substantially, as we see in the next section, from the epistemological accounts of STS scholars (see also David Nelken's comparison of the "trial pathologies" approach with more constructivist approaches in Freeman & Reece, 1998: 14–18). As a powerful contribution to the sociology of error, however, this story line constitutes at once a challenge to STS and an object of possible study for the field.

Among the more careful contributions to the crisis genre is the analysis of science in the U.S. breast implant lawsuits by Marcia Angell (1996), former executive editor of *The New England Journal of Medicine*. Angell brought together the culture clash and crisis narratives in arguing that the law's adversarial zeal, coupled with high financial stakes, produced a settlement based on nonexistent evidence and the consequent withdrawal of a product that many women found beneficial or enabling. Particularly troubling to Angell (1996: 28–29) was the attempt to reach scientific conclusions through adversarial methods that she deemed contrary to science's reliance on cooperation and on "the slow accumulation of evidence from many sources." In her view, an unholy alliance between law and the news media captured public opinion and generated political pressure to support scientifically untenable public policy. Angell's account makes it unnecessary to ask, as the strong program's symmetry principle requires (Bloor, 1976: 7), how it is that strong countervailing beliefs arose, and were sustained, among those seeking compensation for injuries related to breast implants (for such accounts, see below and Jasanoff, 2002). Angell writes off those beliefs through a sociology of error that dismisses presumptively unscientific knowledge as needing no further querying.

Deference

What the "junk science" narrative lacked in methodological rigor, it made up for in political persuasiveness. In the 1990s, this line of criticism laid the conceptual ground

for the fourth major interpretive frame applied to authority conflicts between law and science, namely, deference—more specifically, deference by courts toward science and scientists. A U.S. Supreme Court decision signaled the shift. In the 1993 case of *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,[11] the Court announced that judges should act as gatekeepers in contests over the admissibility of scientific evidence. Their task should be to make sure that only evidence meeting scientific standards of validity and reliability is admitted in court. Although judges already had the power to exclude expert testimony under the Federal Rules of Evidence,[12] *Daubert* took that rarely exercised prerogative and transformed it, in effect, into an affirmative obligation. To guide judges in making the necessary discriminations between valid and invalid science, the Court offered four nonexclusive criteria (testability, peer review, error rate, general acceptance), which are further discussed in the next section.

The deference that *Daubert* mandated in principle, however, turned out in practice to legitimate the free exercise of judicial discretion. Post-*Daubert* judges deferred to an idea of science influenced by their own culturally conditioned understandings of the scientific method, filtered through the demands of courtroom practice. Thus, to function as a legal norm, the notion of scientific reliability mandated by the Federal Rules of Evidence must be translated into tests that trial judges can easily follow. The Supreme Court offered four such explicit tests, but already beginning with *Daubert*'s rehearing,[13] federal judges showed that they were ready, at need, to make up new admissibility criteria beyond those proposed by the high court. In that particular case, the Ninth Circuit Court of Appeals proposed the additional rule that "litigation science," or science generated exclusively for the purpose of pursuing a lawsuit, should not be admitted (see below).

Daubert spurred a small industry in scientific education for judges, along with efforts by some organizations, such as the American Association for the Advancement of Science, to create lists of reliable scientists for use as court-appointed experts. As a significant by-product, the Federal Judicial Center (FJC, [1994]2000), the research and education agency created in 1967 to improve judicial administration, produced a massive *Reference Manual on Scientific Evidence*. Intended as a desktop guide for federal judges, the book contained general articles on scientific evidence and the law, as well as articles on specific types of technical evidence, such as economics, statistics, DNA typing, and engineering practice. In keeping with the theme of deference, the FJC recruited David Goodstein, physicist and vice-provost of the California Institute of Technology (Caltech), to write a chapter entitled "How Science Works." Goodstein critically reviewed the theories of three classic philosophers of science—Bacon, Popper, and Kuhn—before offering his own account of the sociology of scientific knowledge (FJC, [1994]2000: 67–82). In uncritically disseminating a scientist's-eye view of science for legal audiences, the *Manual* helped reinforce a particular understanding of science's relationship to the law. It is a small illustration of the broader proposition that the image of science the law defers to is importantly a construct of the legal process itself. The law serves in this respect as a site and an instrument of co-production.

Co-production

The framework of co-production draws attention to the simultaneous formation of social and natural order in knowledge societies. Many STS studies have shown that what one knows in science significantly depends on prior or concurrent choices about how one chooses to know it (Jasanoff, 2004, 2005; Latour, 1993; Shapin & Schaffer, 1986); the "is" and the "ought" of human experience are in this way inextricably linked, as are epistemology and metaphysics. STS scholars have made numerous contributions to legal studies by pointing out sites and processes of co-production when science interacts with the law. The crucial figure of the "expert witness," for example, is a product of science's historical engagements with the law (Golan, 2004; Mnookin, 2001; Cole, 2001). And "evidence," as the law's distinctive contribution to knowledge-making, is a hybrid product conforming to legal as well as scientific criteria of reliability. In both constructing and reinforcing dominant social understandings of expertise and evidence, legal spaces operate at one and the same time as epistemic spaces, a point we return to below.

But the co-productionist interplay of law and science does not end there. As agents of power, law and science also collaborate in sustaining wider understandings of how society works, including ideas of the human self and agency, the market, and the collective good. In a variety of decisions concerning biotechnology, for instance, U.S. courts have favored the party who appears to be the innovator or initiator of change, often also the party with more resources and greater capacity to bring innovations into economic and social circulation. Two California cases illustrate the point. In *Moore v. Regents of the University of California*,[14] the state supreme court ruled that patients possess no property rights in their cells or tissues; accordingly, physician-researchers need not share with their patients the profits from discoveries based on excised biological materials (Boyle, 1996). In *Johnson v. Calvert*,[15] the court held that a gestational surrogate who had carried another woman's genetic offspring to term could not claim to be the baby's "natural mother." The surrogate's role in sustaining fetal life was thereby reinscribed by law as that of a paid service provider (Jasanoff, 2001; Hartouni, 1997), while the genetic mother, as the party intending to procreate, retained the conventional rights of motherhood.

It is instructive to set the co-productionist account of law-science relations beside two powerful schools of thought originating in legal studies that also connect the law's normative aims ("ought") to understandings of how the world works ("is"). The first is "law and economics." Beginning in the 1960s, leading scholars in this tradition argued for reforms that would conceptualize social problems, from negligence to industrial risks (Breyer, 1993), in economic terms and seek to provide optimally efficient legal solutions. Guido Calabresi (1970), dean of Yale Law School and subsequently a federal judge, contributed to the economic analysis of tort law in ways that closely relate to institutionalist modes of thought in STS. His *Tragic Choices* (Calabresi & Bobbitt, 1978) was a classic exploration of how legal institutions permit competing measures of the value of human life to coexist in society, so that tragic contradictions are kept from public review and acknowledgement. Though related in spirit to

concerns about identity, representation, and discourse in STS work on co-production (Jasanoff, 2004: 39–41), Calabresi's brilliant institutional analysis never explicitly engaged with the law's role in producing authoritative social knowledge.

In a still more provocative application of economic thinking to the law, federal judge and law professor Richard Posner (1992) argued that even human sexuality can usefully be studied as rational behavior, and that this framework might lead to more liberal, less interventionist regulatory approaches toward issues such as contraception, abortion, surrogacy, and homosexual conduct. Posner distinguished his analysis from that of "social constructionists," epitomized for him by Foucault. Unlike constructionists, economists, he maintained, are anti-utopian. Their tendency is to assign "less weight to power, exploitation, malice, ignorance, accident, and ideology as causes of human behavior and more to incentives, opportunities, constraints, and social function" (Posner, 1992: 30). For Posner, pervasive ignorance about the facts of sexual preferences, behaviors, and their consequences is the primary obstacle to rational rule-making about sex. He overlooked the co-productionist point that the law, in promoting a fact-based, rational choice approach, may create the very ontologies of rational and irrational behavior that it presumptively seeks to uphold—as, for example, when the California supreme court characterized the gestational surrogate in *Johnson v. Calvert* as a rational economic agent and service provider, not a would-be mother (see also Hacking, 1995, 1999).

More sensitive to the social and epistemic foundations of the law, and therefore closer in spirit to ideas of co-production, is the work of critical legal studies (CLS) scholars and other legal analysts who are interested in the law's ordering functions. CLS flourished as a left-oriented school of thought in American law schools in the 1980s but largely disappeared as an organized movement by the century's end (Kairys, 1998; Unger, 1986). In its heyday, however, CLS destabilized the authority of legal rule-making in much the same way that the sociology of scientific knowledge (SSK) attacked the authority of scientific fact-making. By debunking the power of legal reasoning to justify practical rule application, CLS scholars engaged in the same kind of "unmasking" that Ian Hacking (1999: 53–54) identified as one version of constructionism in STS. Behind formal legal argument, CLS analysts discovered concealed interests and ideology, much as the SSK analysts of the Edinburgh school uncovered interests on both sides in their symmetrical studies of scientific controversies.

The CLS project with regard to the law paralleled that of STS with regard to science in other important ways: in its focus on the indeterminacy of rules (cf. contingency and rule-following in STS), its emphasis on contradictions and dualities that legal doctrine cannot resolve (cf. interpretive flexibility in STS), and its awareness that the law does not simply respond to social needs but creates the very conditions from which those needs arise (cf. rejection of the correspondence theory of truth in STS). The "Critics," as they were called, conceptualized the law, just as STS scholars conceive of science, "as one of many cultural institutions that are constitutive of consciousness, that help delimit the world, make only certain thoughts sensible, thus 'legitimating' existing social relations" (Kelman, 1987: 244). Despite all this commonality, no

systematic effort at intellectual bridge-building developed between STS and CLS during its most active years. In part, the failure to connect may have reflected a dearth of doctrinal synthesis on both sides. Caught up in their own unsolved theoretical dilemmas, and in confrontations with scientists and mainstream legal thinkers, respectively, neither STS nor CLS scholars found much occasion to talk across yet less familiar intellectual divides, although such moves might have led to sustained and productive conversation. In part, the strength of legal professionalization kept even radical critique from spilling out of the law's familiar discursive spaces, such as law journals. And "studying up" in STS did not, until well into the 1990s, generally include the interactions of science and the law, except, as noted, in the history of medicine (but see Smith & Wynne, 1989).

Encounters between these two critical traditions have much to offer to science studies as well as to the law. An STS-inflected analysis of Martha Minow's (1990) work on making social differences illustrates the possibilities. Throughout that work, Minow is concerned with the law's role in making demarcations that matter to how a society treats its most vulnerable members—the disabled, the mentally incompetent, the dying, women, and children. Like STS scholars of her intellectual generation, Minow recognizes that differences between the normal and the abnormal are constructed and that acts of demarcation are far from epistemologically neutral. In particular, she lists five assumptions about differences commonly made in the law that closely parallel STS observations about the essentializing of social categories: differences are intrinsic; they are defined in relation to an unacknowledged reference point; they appear standpoint neutral; their legal treatment either ignores some perspectives or presumes that all will be fairly represented by the judge; and they rest on the naturalization of existing social and economic arrangements (Minow, 1990: 50–74).

To support her constructivist analysis of legal demarcations, Minow draws broadly from poststructuralist work in the social sciences and humanities, but her reliance on science studies is limited to feminist theory (e.g., Keller's 1983 study of Barbara McClintock) and philosophy of science. Accordingly, she does not explore how categories come into being in particular cultures, are kept in place through social practices, or become embedded in material technologies. Further, in advocating a social relations approach to resolving "dilemmas of difference," she assumes a degree of fixity and invariance in social groups and identities that STS scholars have rightly called into question. At the same time, Minow's study of legal categorization is far more sensitive to possibilities for activism and social change than most canonical work in STS. Never interested in the phenomenon of demarcation for its own sake, Minow is most concerned to show how line-drawing in the law affects the allocation of rights and obligations; and she demonstrates how acknowledging the non-neutrality of the resulting demarcations might open up processes of governmentality in institutions such as schools and hospitals. That grounded attention to the normative consequences of knowledge-making practices has been missing in much STS work on the epistemic foundations of social difference (for some exceptions, see *Social Studies of Science* 1996, vol. 26).

EPISTEMOLOGY: LAW'S KNOWLEDGE

In the modern world, it is not only science's obligation but increasingly also that of the law to find out how nature works and to settle contested facts for its own purposes. By 1887, when Arthur Conan Doyle published *A Study in Scarlet*, forensic science was already well established as a distinct branch of knowledge in Britain. Dr. John Watson first encounters Sherlock Holmes in a hospital laboratory, most likely in 1881, in the process of conducting a chemical test for trace quantities of human blood. Watson admires the chemistry but innocently wonders what use such a test could have. Unrestrained by false modesty, his future flat mate and biographical subject exclaims, "Why, man, it is the most practical medico-legal discovery for years." Holmes is a natural scientist engaged in curiosity-driven research, but the questions that propel him derive from the law.

Both science and law are committed to ascertaining the facts of the matter as accurately as possible; indeed, the law's capacity to render justice depends on finding the right facts and finding them right (see, e.g., Lazer, 2004, on legal conflicts over DNA fingerprinting). The authority of both institutions depends, as Hobbes so well recognized, on appeals to transcendental truths; neither can allow itself to be seen as subjective, arbitrary, or mired in the specificities of particular cases. Yet both include among their procedural devices the systematic, if socially bounded, capacity for questioning that Boyle and his adherents cultivated within their communities of "virtual witnesses" (Shapin & Schaffer, 1986: 55–60) and that Merton (1942) three centuries later famously termed "organized skepticism." How each institution strikes a balance between the contingency of fact-making and claims to transcendence, and how the fact-finding practices of each interact with, support, or destabilize the practices of the other, have been focal points of STS inquiry—adding a distinctive and neglected dimension to work done by legal scholars and analysts on these topics.

To contextualize the insights of STS literature into the law's ways of knowing, it is helpful to begin with work on science and evidence done by other students of the law. Much of that analysis focused, especially from the early 1990s onward, on the law's capacity to distinguish reliable from unreliable science and on the impact of the Supreme Court's trilogy of evidence rulings. At stake in these writings is the very nature of the adjudicatory process, with associated struggles for authority between science and the law, and between judges and juries. Huber's (1991) blistering attack on "junk science" opened the door to a series of books arguing that the courtroom was no place for establishing scientific truths. Judges (Foster & Huber, 1997), juries (Sanders, 1998), and the culture of litigation (Faigman, 1999; Angell, 1996) were all held responsible for the inability of courts to find facts as scientists wish them to be found. As we have seen, these works contributed to the sense of crisis surrounding the law's relations with science and lent weight to the Court's call for deference to science in *Daubert*.

Not all legal scholars agreed with these bleak assessments, however, and a counter-literature of sorts also began to form. Students of jury behavior, for example, challenged the crisis proponents' claim that juries are swayed by emotion, and by the

possibility of reaching into the deep pockets of corporations and hospitals, into making irresponsibly large awards in tort actions (Vidmar, 1995). Evidence scholars argued that, under the guise of deferring to science, *Daubert* and its progeny provided a powerful rationale for judges to usurp the jury's role and silently alter the burden of proof in tort cases, making it more difficult for plaintiffs to win or even pursue their cases in court (Berger, 2001). Implicit in these works, too, was a growing sense that *Daubert*'s deference model not only increases judicial discretion (Solomon & Hackett, 1996; Jasanoff, 1995) but also subtly deflects courts from their normative concern with rendering justice (Jasanoff, 2005).

While legal scholars debated the crisis narrative, STS attention turned for the most part to investigating the nature of the knowledge produced in legal settings. Although science arguably plays a more pervasive role across the broad domain of public health, safety, and environmental regulation than it does in trials, the topic of "regulatory science"—science done or applied in support of governmental policy (Jasanoff, 1990: 76–80)—has attracted less attention from STS researchers (but see Daemmrich, 2004; Bal & Halffman, 1997). This work remains significant, however, for its careful demonstrations of the state's self-legitimation through boundary-drawing between science and politics and through discourses of risk that represent uncertainty as manageable by the regulatory state (Abraham & Reed, 2002). STS investigations helped focus attention on so-called boundary organizations, bodies such as expert advisory committees whose primary function is to maintain a clear demarcation between the authority of experts and political decision-makers (Guston, 2001). The political utility of this research became apparent in 2003–2004, when both proponents and opponents of the U.S. Office of Management and Budget's efforts to control the peer review of regulatory science cited Jasanoff's (1990) work on expert advisory committees.[16]

If boundary work was of paramount interest in studies of regulatory science, expertise emerged as the concept to watch in work on litigation-related science. Following early demonstrations that the law actively constructs the scientific facts that it presumes to "find" (Jasanoff, 1995), as well as the persons (expert witnesses) whom it regards as competent to represent those facts, STS researchers looked in more detail at the making of specific bodies of knowledge within the law, such as fingerprinting (Cole, 2001) and DNA profiling (Lynch & Jasanoff, 1998). Forensic sciences like these owe their existence to the law's need for unambiguous identification, especially in criminal cases, but also in areas such as paternity testing and immigration. However, establishing the facts of the matter demands more than determining a witness's expert status, and legal proceedings often serve as sites for the construction of highly *ad hoc*, technical narratives of causation. In one *outré* example, a Dutch court had to reconstruct the facts of a woman's death caused by a ballpoint pen lodged entirely within her brain case. The question before the court was whether the pen had entered her eye through a freak accident occasioned by a fall, or had been intentionally shot in with a cross-bow by a murder suspect. Lacking any precedents for choosing between these two bizarre and unlikely possibilities, the presiding judge had to determine

within the four corners of the case what counted as a valid experimental demonstration of the cause of death and who was expert enough to speak authoritatively about it (Bal, 2005).

STS work on expertise vigorously takes issue with the "junk science" charge that proponents of the crisis narrative popularized so effectively. Instead of focusing on aggregate jury behavior, as sociologists of law have done, STS researchers have tended to look more closely at judicial reasoning, as offering textually grounded insights into legal epistemology. Painstakingly reviewing the Bendectin cases, one of which led to the *Daubert* ruling, Gary Edmond and David Mercer (2000) showed how the symmetrical approach of science studies undercuts the sociology of error story told by legal scholars such as Joseph Sanders. In Edmond and Mercer's reconstruction, the "favor epidemiology" rule that judges used to dispose of Bendectin cases prior to trial emerges as an artifact of judicial reasoning rather than an exogenous scientific consensus deferentially relied upon by the courts. Edmond's equally detailed analysis of briefs and judicial opinions in another U.S. Supreme Court evidence decision, *Kumho Tire Co. v. Carmichael*,[17] presents that case as a form of "judicial literary technology" that stabilized a particular social representation of expertise while crafting a new admissibility standard for nonscientific expert testimony (Edmond, 2002).

Going beyond writing about law and science, STS scholars of varied backgrounds have also participated as experts in legal proceedings, and, ironically in a field often criticized for relativism, this engagement has prompted reflexive discussion of the epistemic authority of STS. In most instances, interventions were designed to offer courts and judges a more nuanced interpretation of how science works and how it relates to legal or political decision-making (Jasanoff, 1992). Thus, in 1992, a group of historians and sociologists of science filed an *amicus curiae* ("friend of the court") brief in *Daubert*; similarly, in 2005, a group of academics submitted a brief to the World Trade Organization in a case involving the European Union's allegedly unlawful moratorium against genetically modified crops exported by U.S. producers (Winickoff et al., 2005). In possibly the most salient such intervention, philosophers of science testified against, and in one case for,[18] alternatives to the theory of evolution in cases challenging the teaching of evolution in U.S. schools (Quinn, 1984). In these instances, the philosophy and sociology of science were mobilized to establish that doctrines such as creationism and intelligent design were not scientific but rather were religiously inspired. The legitimacy of STS itself as a domain of expertise came into question when Simon Cole sought to testify, on the basis of his STS training, that fingerprinting was not a science within the terms set forth by *Daubert* (Lynch & Cole, 2005; see also Cole, 2005). Judicial skepticism toward Cole's qualifications underscored the field's still-emergent status but also the importance of specific technical skills as a basis for claiming expertise in court. In all of these cases, powerfully socialized, mainstream judicial views of the nature of science withstood the critical insights offered by STS academics.

SCIENCE, LAW, AND CULTURE

The idea of law may be universal, but the ways in which the law functions in any society are culturally specific, and that specificity can be observed in the law's interactions with science and technology. In turn, those workings help shape the evolution of both knowledge and norms, imparting distinctive flavors to what a society wishes to know for purposes of securing social order. Forensic science, for example, develops and operates differently in a common-law, jury-based legal system from the way it functions in legal cultures descended from Roman law, in which the judge acts as the principal fact-finder (Leclerc, 2005; Bal, 2005). Similarly, regulatory science has developed differently in political systems that address uncertainty and produce consensus through disparate institutional mechanisms (Jasanoff, 2005; Winickoff et al., 2005; Porter, 1995; Brickman et al., 1985). More generally, social understandings of evidence and proof, the aims of advocacy, the nature of expertise, and indeed the status of science in relation to politics and power are all refracted through the lenses of the law. STS scholarship has illuminated some aspects of this complex dynamic, but the interplay of culture, science, and law remains an underdeveloped zone of academic analysis.

Given the field's abiding concern with epistemology, it is not surprising that the production of evidence for courtroom use has attracted particular attention in STS research. That work indicates that competing accounts of disputed facts may arise even within so-called inquisitorial systems, in which the parties do not control the production of evidence as of right, and judges are responsible for ensuring that relevant points of view are fairly heard (Leclerc, 2005; van Kampen, 1998). In French civil law, for example, a general right to contest the other side's claims underwrites discovery and disclosure rules that may not, in practice, be far different from those of common law systems (Leclerc, 2005: 312–22). In the Dutch ballpoint pen case cited above, the efforts of the suspect's father to show that death could have been accidental led to the production of tests beyond those conducted by the Dutch Forensic Institute (NFI). Counterexpertise in that case helped destabilize the absolute certainty of the prosecution's story and exonerated the suspect; yet, the very contingency of the outcome underscores the Dutch courts' continued reliance on the neutrality of expertise and deference to the NFI as the legitimate source of forensic knowledge.

Preoccupied with the concept of expertise, and more generally with the problem of demarcation, STS scholars have not on the whole attempted to integrate their concerns for epistemological issues with sustained investigations of how the law's knowledge-making capacities relate to deeper cultural ideas (and ideals) of reason and normativity. Thick descriptions of legal controversies can sooner be found in works by legal scholars, such as Schuck's (1993) account of the Vietnam veterans' epic lawsuit against manufacturers of Agent Orange, or Jonathan Harr's (1995) compelling story of a trial lawyer's ultimately disappointing crusade on behalf of alleged water pollution victims in Woburn, Massachusetts. A notable exception is Marie-Angèle Hermitte's study of France's contaminated blood scandal, in which large numbers of hemophil-

iacs were infected with the AIDS virus in the 1980s. In a deeply sociological and historical account, she traces how French notions of solidarity among all citizens led to decisions that, in the name of making no invidious distinctions between social groups, inflicted fatal harm one of the nation's most medically vulnerable populations (Hermitte, 1996).

Investigations of the interactions between science and the law might be expected to add nuance to Foucault's grand narrative of governmentality by revealing culturally specific ways in which modern societies come to know the subjects who are governed. As yet, however, STS analysis of law-science interactions has tended to focus on in-depth studies of individual cases or institutions rather than on varying practices across cultures or political systems. A case in point is Latour's study of France's highest administrative court, the Conseil d'Etat, in which he applied ethnographic methods to showing how judicial actors construct legal objectivity and truth, much as his earlier studies focused on the making of truth in science (Latour, 2002). Missing in this briskly demystifying treatment of legal epistemology, however, was an analysis of what, if anything, makes the Conseil d'Etat's intuitions about facticity and legality specifically French.

Cross-national comparison has provided one means of interrogating the role of culture in shaping law-science interactions and their consequences. Although such research is in its infancy, STS work points to intriguing connections between styles of legal thought and the practices and cultures of public reason. For example, what counts as objective in the construction of argument and proof in the public sphere is importantly conditioned by legal assumptions concerning impartiality, transparency, truthfulness, and expertise. Thus, the vulnerability of decision-makers in America's particularly legalistic, and hence open and adversarial, political culture correlates with a wide-ranging preference for impersonal, mathematical modes of justification—the "view from nowhere"—in policy domains (Porter, 1995; Brickman et al., 1985). More generally, legal traditions appear both to reflect and reinforce the forms of "civic epistemology," that is, institutionalized public expectations concerning the state's knowledge-making practices, which prevail in contemporary democracies (Jasanoff, 2005).

CONCLUSION

Since the early 1990s, STS scholars have increasingly turned to science's interactions with the law as a fruitful field of study. A growing body of work attests to the productivity of these investigations, both as an extension of core concerns in STS with the construction of facts and truth and as a means of exploring the social relations of science and technology from standpoints outside the conventional spaces of scientific or technological activity. The law has emerged from these inquiries as a research site of paramount significance for STS. Not only are legal proceedings instrumental in producing and certifying new types of scientific knowledge, but the very building blocks of public reason are formed in engagements between science and the law, for example, notions of expertise, objectivity, evidence, and proof.

Intellectually rewarding as this territory has proved to be, it remains in some respects rocky. The science wars of the 1990s pointed to some of the dangers of "studying up," especially as the social sciences sought to create new, autonomous ways of describing scientific and technological activity. Socializing epistemology proved to be no easy task. STS analysts faced a two-fold challenge. They had to find meaningful ways of redescribing scientists' interactions with nature, imbuing those processes with new social meaning; and they had to break the monopoly that scientists had long enjoyed as the only actors authorized to produce trustworthy accounts of the nature of their activities. Law, too, has enjoyed a similar double monopoly—first, by controlling the language in which legal products must be written to be recognized as law, and second, by guarding the professional right to tell the rest of society how the law "really works."

The dominant narratives used in framing law-science interactions show how far STS remains from winning the two-fronted struggle of studying up with respect to law as well as science. Four of the five dominant story lines discussed in this chapter emanate primarily from lawyers and scientists rather than from STS scholars, while the fifth—co-production—remains in the domain of actor's language, understood by specialists, but with little resonance as yet for legal scholars, lawmakers, or wider society. Science studies, when all is said and done, continues to function as an agonistic field, in which analytic prowess and disciplinary insight by no means suffice to ensure that STS insights and findings will circulate to audiences outside the field.

To gain that wider hearing, STS research will have to reach beyond its parochial, field-specific, epistemological concerns and find new ways to engage with sympathetic critics of the law, both within and outside the circles of formal legal scholarship. STS analysts have been most sensitive thus far to the law's role in making scientific facts and in drawing the boundaries between legitimate and illegitimate expertise. In Latour's terms, it is the law's role in producing "indifference" that has attracted the most sustained interest; and, not surprisingly perhaps, judges, as the supreme text-writers of the law, have commanded more diligent attention than other less forceful and sometimes less articulate players, such as lawyers, juries, and litigants themselves. As we have seen, the focus on epistemology has led some STS scholars into playing active roles in the legal system, most visibly as actual or would-be expert witnesses on behalf of science, but also, less visibly, as advisers and educators to the elites of the law, in the trial bar, advisory committees, regulatory agencies, and the judiciary. But these *ad hoc* and personal encounters only skim the surface of the field's potential for constructive critique. With modernity's two most important ordering institutions as their objects of study, STS analysts of science and the law are uniquely positioned to explore and question the hidden normativities underpinning the demarcations that matter in contemporary society. These, as the CLS movement and its intellectual descendants most cogently argued, are the divides that consistently separate the weak from the strong, the rich from the poor, the disabled from the competent, and the socially marginal from the powerful and privileged.

Relentlessly concerned with the law's epistemic authority, STS students of science, technology, and the law have been on the whole less attentive to the law's

magisterial role in constructing and maintaining justice, legitimacy, and constitutional order—and, of course, in holding at bay the disruptive forces of injustice, illegitimacy, and disorder. Nor has STS systematically explored the interplay of law and science with cultural notions of self-hood, kinship, exchange, or community that introduce subtle differences into the kinds of modernity that we, as modernity's inhabitants, experience in our everyday lives. To the inquiring mind, these are not omissions but openings. Through them, future STS research can be expected to push forward to new levels of insight, by bringing within its investigative reach not only law's fabrication of knowledge but also its power to establish order and justice in the world.

Notes

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1. Leading scientists and inventors have from the beginnings of the scientific revolution been enmeshed in webs of patronage and power, so that the notion of the disinterested ivory tower scientist is something of a myth—one that justifies science's claim to self-governance (Biagioli, 1993; Latour, 1988; Shapin & Schaffer, 1986).

2. See Bloor (1976) for a statement of the "strong program" for research in science studies. The aims of the strong program were to shed light on the sociology of scientific knowledge-making and so to challenge the notion that science advances through logic and through direct correspondence between nature and scientists' observations.

3. The 2001 *International Encyclopedia of Social and Behavioral Sciences* included for the first time a set of entries under the heading of Science and Technology Studies (Smelser & Baltes, 2001).

4. Interestingly, Kuhn was not mentioned in Fuller's original 1964 text, nor was he cited for any particular ideas in the 1969 revision.

5. In keeping with the spirit of legal positivism, the Court also cited a growing national and international consensus against the death penalty for minors. *Roper v. Simmons*, 543 U.S. 541 (2005).

6. In the United States, leading decisions that incorporate natural law understandings of gender and motherhood include *In the Matter of Baby M*, 109 N.J. 396 (1988), declaring surrogacy contracts to be invalid as a matter of law and policy in New Jersey; and *Johnson v. Calvert*, 5 Cal. 4th 84 (1993), holding that a gestational surrogate had no parental rights and that the genetic mother was the natural mother under California law.

7. *Roe v. Wade*, 410 U.S. 113 (1973).

8. It is worth noting, for instance, that no other STS scholar served on the joint AAAS-ABA National Conference of Lawyers and Scientists during my six years of service on that body. Similarly, apart from the historian of science Daniel Kevles, no other STS scholar sat on the National Academy of Science Committee on Science, Technology and the Law in its first six years. The membership of both bodies consisted of professional lawyers and scientists. Even I, of course, had a law degree.

9. *Brown v. Board of Education of Topeka, Kansas*, 347 U.S. 483 (1954).

10. *Diamond v. Chakrabarty*, 447 U.S. 303 (1980), p. 317.

11. *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993).

12. Rule 702 of the Federal Rules of Evidence stipulates that expert testimony is admissible only if it "is the product of reliable principles and methods." The corollary is that testimony based on

unreliable principles and methods can be excluded. After *Daubert*, parties may challenge each other's proffered testimony, and judges are required to determine whether it meets the test of reliability.

13. *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 43 F. 3d 1311 (9th Cir. 1995).

14. *Moore v. Regents of the University of California*, 51 Cal. 3d 134 (1990).

15. *Johnson v. Calvert*, 5 Cal. 4th 84 (1993).

16. See Office of Management and Budget, Final Information Quality Bulletin for Peer Review, December 15, 2004. My own December, 2003, comments on the guidelines as originally proposed made it clear that my arguments were inconsistent with OMB's aim of centralizing control over regulatory peer review.

17. *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999).

18. The philosopher of science Steve Fuller testified in favor of "intelligent design" (ID) as an alternative to evolution in a widely watched federal case in Pennsylvania. In *Kitzmiller v. Dover Area School District*, 400 F. Supp. 2d 707 (M.D. Pa. 2005), Judge John E. Jones concluded that, contrary to proponents' claims, ID was rooted in religious beliefs.

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