# CIVILIZING SCIENCE:

# THE JOINT CONSTRUCTION OF SCIENCE AND CITIZENSHIP IN MODERN DEMOCRACY

by

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# ABSTRACT OF THE DISSERTATION


Civilizing Science: The Joint Construction of

Science and Citizenship in Modern Democracy

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This dissertation examines several conceptual and institutional modes of relating science, technology, and politics in light of their implications for democracy. It aims to identify a place for science and technology that is intellectually credible, instrumentally effective, and politically legitimate. The dissertation begins with a case study on the California electric vehicle program that illustrates the effects of technocratic policymaking on both technological development and democratic citizenship. The case study serves as a concrete reference point for the more abstract analyses that follow. The next section develops a historical perspective on technocracy, locating its modern origins in the coevolution of natural science and liberal-democratic ideology in the seventeenth and eighteenth centuries. This section shows that the power of technocracy derives not simply from the instrumental use of technical knowledge, as its critics often assume, but from its adoption of the modern scientific notion that truth emerges from rational

deliberation among qualified individuals subject to public scrutiny. The dissertation then explores several prominent critiques of technocracy and other forms of instrumentalism, arguing that their embrace of deterministic conceptions of technical development hinders the democratization of science and technology. The next part of the work offers an alternative critique of technocracy that is epistemologically and ontologically moderate but politically progressive. It argues that because science and technology continually reshape the political world, technical artifacts should in some respects represent the public. This is followed by a look at the notion of publicly representative science and technology, showing that political and technical representation are conceptually distinct but practically intertwined social practices. The dissertation closes with an assessment of recent attempts to integrate political and technical representation by creating institutions that facilitate lay participation in the construction of science and technology. These efforts show that, within practically determined limits, lay citizens can help shape the technical artifacts that increasingly shape their lives.

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# CHAPTER 1

# INTRODUCTION

In the spring of 1996, the California Air Resources Board cancelled a major portion of its program to promote the development and sale of electric vehicles. At one of the press conferences held to defend the decision, Board Chairman John Dunlap angrily remarked, "This is not a political decision, it is a technical decision. Quit looking under every rock for a deal, because there isn't one."[1] Chairman Dunlap made this statement after a year of intense public debate, the receipt of thousands of letters from concerned citizens, the recording of hundreds of hours of testimony at public hearings, and the review of dozens of conflicting expert reports on electric vehicle technology, air pollution, and consumer preferences. Given all this controversy, how could he say such a thing?

This dissertation offers an extended response to that question. Chairman Dunlap's comment, though apparently ludicrous, is by no means uncommon. Governments today frequently depend on technical expertise to address public problems, but often exacerbate thereby the political exclusion of ordinary citizens. Laypeople have grown increasingly skeptical toward claims to objective knowledge, but continue to seek the solace of various forms of expertise. The parties to political controversies commission endless scientific studies to bolster their public standing, but then cry out for nonpartisan experts to arbitrate their disputes. In short, the pervasiveness of science and

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[1] Marla Cone, "Air Panel Bending Under Pressure," *Los Angeles Times* (Dec. 20, 1996), A3.

technology in contemporary industrial societies presents a host of dilemmas for democratic politics.

On the one hand, more and more of the world today seems to be a product of science and technology. Science-based technologies pervade private and public life, effecting an ongoing transformation of relations between and among employers and workers, men and women, parents and children, public officials and citizens. The contemporary self-help movement has expanded the technology of virtues promoted in Benjamin Franklin's *Autobiography* to include technologies of friendship, love, marriage, sex, childcare, education, health, wealth, death, and mourning—to name a few.[2] Given the unpredictable long-term consequences of releasing genetically-engineered organisms into the environment, Ulrich Beck has argued that science has transformed the entire world into a giant laboratory.[3] And Bill McKibben has assessed the prospects of global warming and concluded that "By changing the weather, we make every spot on earth man-made and artificial."[4]

On the other hand, many lay citizens have become increasingly skeptical toward science and technology. During the twentieth century, and especially the past thirty years, various intellectual and political developments have raised many new questions, and given renewed urgency to some old questions, about the relationship between science and democracy in Western societies. These developments include anti-nuclear,

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[2] See Wendy Kaminer, *I'm Dysfunctional, You're Dysfunctional: The Recovery Movement and Other Self-Help Fashions* (Reading, MA: Addison-Wesley, 1992); Alfred H. Katz, *Self-Help in America : A Social Movement Perspective* (New York : Twayne, 1993).

[3] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of the Risk Society*, trans. Mark A. Ritter (Atlantic Highlands, NJ: Humanities Press, 1995), chap. 8.

[4] Bill McKibben, *The End of Nature* (New York: Doubleday, Anchor Books, 1989), 58.

environmentalist, and feminist critiques of science and technology; academic and grassroots challenges to various forms of professionalism and expertise; the end of the Cold War and its military rationale for basic research; repeated high-profile cases of scientific fraud; the increasingly high costs of large-scale research; and the dissemination of various constructivist theories of science. In this context, laypeople find it increasingly difficult to justify the traditional understanding of science and technology as inherently progressive and value neutral.

Citizens today thus find themselves using science without quite believing in it, producing alternating feelings of hubris and cynicism. And without a conceptual understanding of science that fits popular experience, laypeople have difficulty articulating a satisfying political response to science. This difficulty manifests itself in a variety of ways, including an uneasy sense that the world is being radically remade without anyone's conscious control. As Michael Sandel notes, many people today "fear that, individually and collectively, we are losing control of the forces that govern our lives."[5]

These tensions between science and democracy were long suppressed by what I will call the Enlightenment image of science, according to which science supports democracy insofar as it remains free of politics.[6] During much of the Cold War era, an implicit "social contract for science" granted scientists generous public funding and wide-reaching freedom from political control in exchange for a steady stream of new

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[5] Michael Sandel, *Democracy's Discontent: America in Search of a Public Philosophy* (Cambridge: Harvard University Press, 1996), 3.

[6] As I show in Chapter 3, the conception of science now often associated with the Enlightenment did not become widespread until the late-nineteenth century.

defense, medical, and consumer technologies. This implicit social contract was always a fragile construction, and scientists' autonomy was never as complete as some nostalgic critics of political efforts to regulate science now claim.[7] But in recent years the postwar social contract has become increasingly unstable. Widespread challenges to the Enlightenment conception of science have led many to ask whether it is time to abandon our long-standing faith in the basic congruence of science and democracy. An old question now seems more important and more vexing than ever before: How can science and technology do more to promote than threaten the prospects for genuine democratic politics?

One way of responding to the destabilization of the Enlightenment image of science is to attempt to revive it. Some scientists have thus attacked constructivist and other allegedly "postmodern" theories of science in the hope of restoring public deference to science. In the context of the recent "science wars," constructivist theories of science have often been read as efforts to destroy scientific prestige, authority, and even the very

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[7] David Guston describes the social contract for science as "a map of institutional arrangements and their intellectual underpinnings," a "dominant ideology," according to which "the political community agrees to provide resources to the scientific community and to allow the scientific community to retain its decision-making mechanisms and in return expects forthcoming but unspecified technological benefits" (David H. Guston, *Between Politics and Science: Assuring the Integrity and Productivity of Research* [Cambridge: Cambridge University Press, 2000], 39, 62). Guston argues that the social contract for science came to an end in the early 1980s, with the creation of institutions within which scientists and their political patrons can work together to assure the integrity and productivity of science. For several perspectives on the social contract for science, see Guston, *Between Politics and Science*, chap. 2; David H. Guston and Kenneth Keniston, "Introduction: The Social Contract for Science," in *The Fragile Contract: University Science and the Federal Government*, ed. Guston and Keniston (Cambridge: MIT Press, 1994), 1–41; Bruce L. R. Smith, "The United States: The Formation and Breakdown of the Postwar Government-Science Compact," in *Scientists and the State: Domestic Structures and the International Context*, ed. Etel Solingen (Ann Arbor: University of Michigan Press, 1994), 33-62; Donald E. Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation* (Washington, DC: Brookings Institution, 1997). On the pure science ideal in postwar America, see David A. Hollinger, "Free Enterprise and Free Inquiry: The Emergence of Laissez-Faire Communitarianism in the Ideology of Science in the United States," *New Literary History* 21 (1990): 897-919.

idea of science itself.[8] Constructivist science studies seem to endorse the idea that "anything goes," thus undermining the foundations of democracy and opening the way to irrationalism and mob rule.

A more promising response to the widespread criticism of the Enlightenment conception of science, which I pursue in this dissertation, is to devise concepts and institutions that create a legitimate role for social conventions and political decisions in scientific practice. Although this dissertation is above all a study in democratic theory, I develop an uncommon perspective on science and democracy by drawing on two academic subfields that have tended to be isolated from one another: political theory and science and technology studies (STS). The dissertation seeks to specify and advance the common agenda of each of these subfields by clarifying the conceptual and practical relationships between science and politics as they appear in contemporary politics and political theory, and as they might be transformed in the future.

**The Argument**

The overall argument of this dissertation is that the possibilities and limits of democratic politics are shaped by the institutions, artifacts, and prevailing conceptions of science and technology. Science and technology help constitute the norms and practices

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[8] On the science wars, see Paul R. Gross and Norman Levitt *Higher Superstition: The Academic Left and Its Quarrels with Science* (Baltimore: Johns Hopkins University Press, 1994); "Science Wars," *Social Text* 46/47 (Spring/Summer 1996); Alan Sokal, "A Physicist Experiments with Cultural Studies," *Lingua Franca* (May/June 1996): 62-64; Nick Jardine and Marina Frasca-Spada, "Splendours and Miseries of the Science Wars," *Studies in History and Philosophy of Science* 28, no. 2 (1997): 219-235; Noretta Koertge, ed., *A House Built on Sand: Exposing Postmodernist Myths about Science* (New York: Oxford University Press, 1998). Recent critiques of social studies of science acquire added punch by dovetailing with a set of attacks on postmodern intellectuals for allegedly selling out "real-world" leftist causes to fashionable academic trends. See the discussion of "Left Conservatism" at http://www.press.jhu.edu/journals/theory_&_event/v002.

of democratic politics and are in part constituted by them. I make this argument at three levels: historical, philosophical, and political.

Historically, science and technology have provided conceptual resources for the legitimation of three forms of liberal-democratic politics: technocracy, participatory democracy, and laissez-faire democracy.[9] Only one of these, technocracy, is commonly associated with science and technology. Technocracy continues to shape much contemporary policymaking, as I show in a case study of the California's electric vehicle program. Technocracy's critics typically portray it as the instrumental application of scientific knowledge to political affairs and, as such, the antithesis of democracy. In contrast to this view, I argue that the astonishing endurance of technocratic politics in Western society has only been possible because technocracy shares the conceptual resources of modern science with the other two forms of liberal democracy. I also argue that the legitimation of technocratic politics often draws at least as much on the norms and culture of science as on substantive scientific knowledge. Given this reliance of liberal-democratic ideology on modern science, emerging changes in the prevailing conception of science entail significant changes in liberal-democratic politics.

Philosophically, a constructivist conception of science and technology, while contributing to the destabilization of each of the above modes of liberal-democratic politics, is potentially conducive to the revitalization of democracy. But fulfilling the democratic potential of constructivism requires more than yet another inquiry into "the social construction of _____." It requires a theory of science that acknowledges the role

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[9] See Yaron Ezrahi, *The Descent of Icarus: Science and the Transformation of Contemporary Democracy* (Cambridge: Harvard University Press, 1990), chaps. 1-2.

of both real attributes of nature *and* social and political factors in the creation of science and technology. Science and technology are neither "determined" by natural imperatives, as some still assume, nor are they "socially constructed," if that means they simply mirror society and politics. The making of science and technology involves the independent input of both human and nonhuman (i.e., "natural") elements.[10]

Most importantly, realizing the democratic potential of constructivism requires a theory of *political* construction, which grants a greater role to individual agency and collective purpose than often found in sociological theories of constructivism.[11] Science needs to be understood as both emerging from and responding to collective human desires, problems, and goals. In this respect, the structure of the dissertation itself illustrates the conception of science it defends. It begins with an empirical case study on a typical dilemma of environmental policymaking, proceeds through a historical and philosophical analysis of the underlying causes and implications of that dilemma, and then proposes several practical responses to it. Along the way, I explicate the notion of political construction with three related lines of argument:

First, the relationship between science and society needs to be understood as a *potentially political* question. I take "the political" to refer to an ideal realm of deliberative and authoritative decisionmaking regarding matters of general concern.[12]

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[10] See the following debates: David Bloor, "Anti-Latour," *Studies in the History and Philosophy of Science* 30 (March 1999): 81-112; Bruno Latour, "For David Bloor...And Beyond: A Reply to David Bloor's 'Anti-Latour,'" Ibid.: 113-29; H. M. Collins and Steven Yearly, "Epistemological Chicken," in *Science as Practice and Culture*, ed. Andrew Pickering (Chicago: University of Chicago Press, 1992); Bruno Latour and Michel Callon, "Don't Throw the Baby Out with the Bath School! A Reply to Collins and Yearly," in Ibid., 343-68.

[11] On the distinction between sociological and political constructivism, see Dick Pels, "Mixing Metaphors: Politics or Economics of Knowledge?" *Theory and Society* 26 (1997): 685-717.

[12] Cf. Sheldon S. Wolin, *Politics and Vision: Continuity and Innovation in Western Political Thought* (Boston: Little, Brown and Company, 1960), 6-10.

Science and technology are always potentially, though not always in fact, matters of general concern subject to the democratic exercise of political authority. The extent to which particular technical activities and artifacts are appropriately conceived as political depends on the degree to which they have significant consequences for public life.[13] This position differs from the common view that science and technology are only political when a combination of expert disagreement and political controversy leads to the "politicization" of expertise. Even in cases of technical and political consensus, science and technology may have subtle effects on political life.

Second, the political construction of science and technology entails the *sovereignty of politics* over science and technology. At the most basic level, the assertion of political sovereignty over technical activities and artifacts begins with the recognition that it is human agents and not divine will, nature, or the market that conducts inquiries and builds machines. The making of science and technology depends on socially-embedded interactions between human beings and nature, but it is relatively self-conscious human agents who initiate the interactions and employ the results. And because science and technology are human creations, they are subject to governance by human communities. In this emphasis on human agency, the constructivism defended here contains a strong instrumentalist element, broadly conceived to include a wide range of human goals.

To assert the sovereignty of politics, one might note, does not imply the shaping or control of science and technology by any particular sovereign authority. The

[13] On public consequences as the criterion for deeming an activity political, see John Dewey, *The Public and Its Problems* (New York: Henry Holt and Company, 1927), 12-15.

sovereignty *of* politics is not the same as sovereignty *within* politics. Many contemporary democracies, such as the United States, have systems of multiple and overlapping sovereignty, so that different controversies are referred to different arbitrators of last resort, including legislatures, councils, juries, and courts. At the same time, however, in a democratic society, each of these various arbitrators is ultimately, if usually not immediately, subject to the sovereign authority of "the people." The political authority of these arbitrators, therefore, rests on the best possible realization of democratic norms of deliberation and participation. Science and technology are thus not only subject to political sovereignty, but to *popular sovereignty*. Because science and technology continuously transform political life, democratic citizens require opportunities to participate in the construction and regulation of science and technology.

The third component of my concept of political construction resides in the claim that science and technology need to be conceived as sites of *political representation*. Despite many conceptual overlaps, neither political theorists nor science studies scholars have done much to examine the relationship between scientific and political representation. It is generally assumed that political representation can only be of political subjects and scientific representation of natural objects.[14]

Like all forms of representation, political and scientific representation each "re-present" something—i.e., they each make something present which simultaneously

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[14] Among the many recent treatments of political representation, see Brian Seitz, *The Trace of Political Representation* (Albany: State University of New York Press, 1995); Melissa S. Williams, *Voice, Trust, and Memory: Marginalized Groups and the Failings of Liberal Representation* (Princeton: Princeton University Press, 1998). On scientific representation, see Michael Lynch and Steve Woolgar, eds., *Representation in Scientific Practice* (Cambridge: MIT Press, 1990).

remains absent.[15] In politics, elected representatives make their constituents "present" in the legislative process by both defending their substantive best interests and responding to the demands they express through formal procedures for public participation. Genuine political representation has thus rightly been said to require a combination of substantive and procedural elements.[16]

In science, representation has traditionally been understood in descriptive terms, as providing linguistic, pictorial, or mathematical "representations" of natural entities and processes. A geneticist thus makes a tissue sample taken from a laboratory mouse "present" in a journal article by describing it with diagrams, figures, and text. Occasionally, scientific representation has also been understood in symbolic terms, when scientific institutions and even individual scientists are seen as representative of various societal values and goals, such as rational discourse, technological progress, national security, or public health. Isaac Newton was thus thought to represent the ideals of the Enlightenment, and the National Institutes of Health might today be said to represent the nation's commitment to finding a cure for cancer.

Beyond these forms of representation, which focus on established scientific knowledge, recent studies on scientific practice suggest that a complete account of scientific representation needs to include procedural elements as well. That is, the concept of scientific representation must account for the practical activities through which science is produced. Moreover, if technical artifacts continually reshape the practices and institutions of politics, as suggested above, then democratic norms require

[15] See Hanna Fenichel Pitkin, *The Concept of Representation* (Berkeley: University of California Press, 1967), 8-9.

[16] Ibid., 232-40.

that scientific procedures, at least in some respects, represent the public. Although there remain important differences between political and scientific representation, science needs to incorporate procedural elements that create a role for laypeople in scientific practice.

Finally, on the level of politics, institutions can and should be created to facilitate the participation of lay citizens in both the construction and regulation of science and technology. This promises to improve both the effectiveness and legitimacy of contemporary policymaking. Rather than seeking to conceal the values and decisions that enter into the creation of technical knowledge and artifacts, policymakers should create ways of subjecting them to democratic legitimation. I locate assistance for this endeavor in recent experiments with institutional mechanisms such as "consensus conferences," which incorporate the deliberative judgments of lay citizens into policymaking on technically complex issues. Consensus conferences and related institutional experiments should be promoted as viable means of democratizing science and technology.

## Disciplinary Context

### *Political Theory*

The politics of science and technology has not been a common topic of inquiry among contemporary political theorists. Although contemporary theorists have formulated important critiques of technical rationality, they have often neglected the political dimensions of concrete technical practices and artifacts.[17] Many contemporary

[17] Important exceptions include Langdon Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (University of Chicago Press, 1986); Donna J. Haraway, *Modest Witness@Second_Millenium. FemaleMan© Meets OncoMouse™: Feminism and Technoscience* (New

theorists implicitly follow Jürgen Habermas and Hannah Arendt in their defense of a division between "work" and "interaction," or instrumental and communicative action, often assuming that genuine politics is concerned only with the latter.[18] Contemporary theorists thus often conceive of science and technology as elements of the pre-political "material preconditions" of politics, the anti-political "realm of necessity," or the apolitical resources for technocratic decisionmaking.[19] This division between science and politics has helped theorists defend a richer conception of political life than that typically assumed by "positivist" political scientists.[20] But as students of the field have often noted, contemporary theorists' efforts to erect a wall between political theory and positivist approaches in social and natural science have usually assumed that positivism accurately portrays scientific practice.[21] Ironically, this implicit acceptance of the

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York: Routledge, 1997); Timothy Kaufman-Osborn, *Creatures of Prometheus: Gender and the Politics of Technology* (Lanham, MD: Roman and Littlefield Publishers, Inc., 1997). Kaufman-Osborn (21-25) offers some helpful speculations on the reasons underlying contemporary political theory's relative lack of interest in the politically constitutive role of technological artifacts.

[18] This point is made in Mary G. Dietz, "'The Slow Boring of Hard Boards': Methodical Thinking and the Work of Politics," *American Political Science Review* 88, no. 4 (1994): 873-86.

[19] These three conceptions of science and technology might be very loosely identified with Arendt, Horkheimer and Adorno, and Habermas, respectively.

[20] I use the term "positivist" to refer very broadly to any method of inquiry that purports to employ logically-given procedures for producing objective knowledge that mirrors the external world. While this neglects important distinctions between empiricism and logical positivism, and between behavioralism and rational choice, it highlights their shared aspirations. Many contemporary political theorists thus follow Charles Taylor's strict division between explanatory and interpretive approaches to inquiry. See his classic essays, "Interpretation and the Sciences of Man" and "Social Theory as Practice," in *Philosophy and the Human Sciences* (Cambridge: Cambridge University Press, 1985), 15-57, 91-115. For a critique of Taylor similar to my argument about contemporary theory more generally, see Clifford Geertz, "The Strange Estrangement: Taylor and the Natural Sciences," in *Philosophy in an Age of Pluralism: The Philosophy of Charles Taylor in Question*, ed. James Tully (Cambridge: Cambridge University Press, 1994), 83-95.

[21] See Richard Ashcraft, "One Step Backward, Two Steps Forward: Reflections upon Contemporary Political Theory," in *What Should Political Theory Be Now?*, ed. John S. Nelson (Albany, NY: State University of New York Press, 1983), 518-22; Jeffrey C. Isaac, "After Empiricism: The Realist Alternative," in *Idioms of Inquiry: Critique and Renewal in Political Science*, ed. Terrence Ball (Albany, NY: State University of New York Press, 1987), 187-205, at 190, 198; John G. Gunnell, "Realizing Theory: The Philosophy of Science Revisited," *The Journal of Politics* 57, no. 4 (1995): 923-40, at 924.

positivist image of science often alternates with endorsements of constructivist conceptions of science as an interpretive, value-laden, practical activity. That is, in their efforts to combat the disciplinary ascendance of scientific approaches to political inquiry, political theorists have found it rhetorically useful to draw on the positivist image of science *and* the constructivist theories of Thomas Kuhn, Paul Feyerabend, and others.[22]

The positivist image of science has persisted in part because contemporary theorists have tended to focus their occasional analyses of science and technology on important but highly abstract questions of ontology, ideology, or the general character of modernity.[23] Very few political theorists have in recent years addressed themselves to the politically constitutive aspects of laboratory research or technological innovation, not to mention the mundane material objects of everyday life. This relative lack of attention to the politics of technical practice is surprising, perhaps, given many political theorists' familiarity with writers such as Thomas Hobbes, John Locke, and Thomas Jefferson, for whom the study of nature and politics were intimately intertwined. These and other canonical political theorists asked questions about the relationship between scientific and political practice that contemporary political actors and theorists often forget to ask.

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[22] I defend this claim at length in "Conceptions of Science in Political Theory: A Tale of Cloaks and Daggers," in *Vocations of Political Theory*, ed. Jason A. Frank and John Tambornino (Minneapolis: Minnesota University Press, 2000), 189-211.

[23] See, for example, Arthur M. Melzer, Jerry Weinberger, and M. Richard Zinman, eds., *Technology in the Western Political Tradition* (Ithaca, NY: Cornell University Press, 1993). In his introduction to this volume, Leon R. Kass rightly argues that technology must be understood as more than a collection of material artifacts, but like most contributors to the volume he largely ignores the material dimension and restricts his concerns to technology understood as "the disposition to rational mastery" (5). See also George Kateb, "Technology and Philosophy," *Social Research* 54 (Fall 1997): 1225-46. Kateb rightly questions the common equation of "the technological project" with "anger, alienation, resentment" (1245), but he appears uninterested in what he calls the "common sense" understanding of technology as problem-solving. He focuses instead on the truly "philosophical" questions that "add depth": those basic passions that have "called forth" the "much larger and rather mysterious project" of modern technology (1125-27).

Drawing on historical political theory to understand and question contemporary conceptions of science and technology raises a host of methodological issues. Until quite recently, academic political theory was characterized by a methodological gap between the advocates of "historical" and "instrumental" approaches to the study of canonical texts.[24] The historical approach, represented by George Sabine, J. G. A. Pocock, and Quentin Skinner, argued that canonical works need to be studied in terms of the context in which they were written. Any attempt to draw "lessons" from these texts is bound to attribute meanings to the texts unintended by, and perhaps even inconceivable to, the authors themselves. The instrumental—or perhaps better, "educative"—approach, represented in very different ways by Leo Strauss and Sheldon Wolin, suggested that the study of canonical texts can facilitate efforts to understand and remedy contemporary political problems.[25] This division between history and politics in the study of canonical texts, perhaps always more a matter of meta-theoretical rhetoric than scholarly practice, has relaxed somewhat in recent years. Advocates of an educative approach acknowledge the importance of attending to historical context, and few historians of political thought would claim their work remains entirely uninfluenced by or irrelevant to contemporary politics. Skinner has written, for example, that by studying the "alien character" of past

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[24] I take these terms from Arlene Saxonhouse, "Texts and Canons: The Status of the 'Great Books' in Political Science," in *Political Science: The State of the Discipline II*, ed. Ada W. Finifter (Washington, DC: American Political Science Association, 1993), 3-26.

[25] For Strauss, the canonical texts, principally those of the ancients, can reveal eternal truths to those scholars trained in the proper techniques of exegesis. Wolin, in contrast, sees in the political theory canon a series of contingent responses to societal crises. These texts comprise an evolving tradition of thought that can provide intellectual resources for understanding and seeking to influence current events. Both approaches are "educative" in a broad sense, insofar as they attempt to draw lessons from the past for life in the present. See Sheldon S. Wolin, *Politics and Vision* (Boston: Little, Brown and Company, 1960); Leo Strauss, *What is Political Philosophy?* (Glencoe, IL: Free Press; 1988 reprint: Chicago: University of Chicago Press, 1959).

ideas "we provide ourselves with one of the best means of preventing our current moral and political theories from degenerating into uncritically accepted ideologies."[26] There also seems to be an increasing tolerance, at least in some quarters, for the coexistence of a variety of approaches to political theory.

This is not to suggest political theorists have reached a happy methodological consensus. Many theorists, for example, have yet to fully consider the implications of claims that the very language of canonical political theorists often embodies oppressive assumptions about gender, race, and class.[27] In fact, to scme extent at least, the methodological debates among political theorists mirror those among educators and public intellectuals on the pedagogical status of the "great books."[28] As multiculturalists have made clear, the dominant accounts of Western intellectual history have long excluded female and minority authors. It can no longer be denied that the canon is in many ways an artifact of power relations. This does not mean, however, as some have claimed, that canonical texts should be abandoned altogether. Rather, "the" canon needs to be seen as a site of contestation that serves genuine education only insofar as it remains open to critique and revision. Many of the great books have attained that status in part because they repeatedly provoke new generations of readers in unexpected ways—many of the great books, that is, are really quite good. While this dissertation is attentive to

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[26] Quentin Skinner, "A Reply to My Critics," in *Meaning and Context*, ed. James Tully (Oxford: Basil Blackwell, 1988), 231-88, at 287.

[27] See, for example, Wendy Brown, *Manhood and Politics: A Feminist Reading in Political Theory* (New York: Roman and Littlefield, 1988); Linda M. G. Zerilli, "Machiavelli's Sisters: Women and the 'Conversation' of Political Theory," *Political Theory* 19, no. 2 (May 1991): 252-276.

[28] For recent discussions of canon politics see Benjamin R. Barber, *An Aristocracy of Everyone: The Politics of Education and the Future of America* (New York: Ballantine Books, 1992), esp. 28-30, 105-6, 213-15; J. Peter Euben, *Corrupting Youth: Political Education, Democratic Culture, and Political Theory* (Princeton: Princeton University Press, 1997), chap. 1.

changes in concepts and language over time, and to the social biases of canonical authors, it is inspired by the notion that, as Hanna Pitkin puts it, thinking about canonical texts and contemporary politics can become "interconnected enterprises, each illuminating and obscuring the other."[29]

Although drawing extensively on canonical texts, this dissertation delves somewhat further into the details of contemporary politics than many studies in political theory, insofar as I discuss several concrete episodes of public policymaking. In this respect, I cautiously take up the challenge posed by several recent, often unduly polemical calls for using historical political theory to illuminate concrete problems of contemporary politics and policy.[30] Such calls for "relevance" go back to the 1960s, as do the accusations of "co-optation" made by those inclined toward more "fundamental" modes of analysis—modes which from the perspective of those calling for relevance seem not fundamental but merely "academic." Co-optation by existing structures of power, on the one hand, and retreat into academic professionalism, on the other, remain real threats for theorists of each persuasion. These threats have not prevented political theorists from analyzing a host of conceptual questions central to contemporary politics, e.g., rights, identity, gender, race, etc.[31] But there are still relatively few recent efforts to

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[29] Hanna Fenichel Pitkin, *Fortune is a Woman: Gender and Politics in the Thought of Niccolo Machiavelli* (Berkeley: University of California Press, 1984), 3.

[30] Douglas W. Rae, "Political Theory and the Division of Labor in Society: Asleep Aboard the Titanic and Steaming into Halifax," *Political Theory* 9 (1981): 369-79; John G. Gunnell, *Between Philosophy and Politics: The Alienation of a Political Theory* (Amherst, MA: University of Massachusetts Press, 1986); Ethan Fishman, "Political Philosophy and the Policy Studies Organization," *PS: Political Science and Politics* 24 (1991): 720-23; Terrence Ball, *Reappraising Political Theory* (Oxford University Press, 1995), 53-61; Jeffrey C. Isaac, "The Strange Silence of Political Theory," *Political Theory* 23 (1995): 636-688.

[31] See Iris Marion Young, "Political Theory: An Overview," in *A New Handbook for Political Science*, ed. Robert E. Goodin and Hans-Dieter Klingemann (New York: Oxford University Press, 1996).

use historical political theory as a resource in the analysis of concrete problems of politics and policy.[32] While such efforts risk adopting the assumptions underlying current political conditions, they hold out the promise of a fundamental critique of existing practices that simultaneously suggests plausible measures for reform.

Drawing on the work of canonical authors can contribute to more historically grounded, intellectually nuanced, and theoretically reflexive analyses of contemporary political issues than those commonly found in policy studies today. To some extent, at least, all writers must speak the language of their times, but the depth and complexity of many canonical works allows them to speak beyond their times as well. Many canonical texts analyze key political concepts—justice, freedom, authority, obligation, etc.—with a force and clarity simply not available in most contemporary treatments of the same subjects. Although the specific content of political concepts changes over time, and although new concepts emerge and others disappear, many political concepts have for centuries remained sites of contestation.[33] To the extent that current political concepts exhibit continuities with the past, studying early formulations of these concepts—such as technocracy—can help clarify current political dilemmas. And to the extent current concepts—such as scientific practice—radically differ from those of the past, studying past ways of thinking can help put the present in a new and suggestive perspective.

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[32] Examples include Robert E. Goodin, *Political Theory and Public Policy* (Chicago: The University of Chicago Press, 1982); Sheldon Wolin, *The Presence of the Past: Essays on the State and the Constitution* (Baltimore: The Johns Hopkins University Press, 1989); Iris Marion Young, *Justice and the Politics of Difference* (Princeton: Princeton University Press, 1990); Ethan Fishman, ed., *Public Policy and the Public Good* (New York: Greenwood Press, 1991); Amy Gutmann and Dennis Thompson, *Democracy and Disagreement* (Cambridge: Harvard University Press, 1996); Barber, *An Aristocracy of Everyone*; Euben, *Corrupting Youth*.

[33] See William E. Connolly, *The Terms of Political Discourse*, 3rd. ed. (Princeton: Princeton University Press, [1974] 1993); Terrence Ball, James Farr, and Russell L. Hanson, eds., *Political Innovation and Conceptual Change* (Cambridge: Cambridge University Press, 1989).

Finally, the ambiguities and contradictions contained within many canonical texts, those ambiguities that make it possible for different readers to glean different messages from them, highlight the importance of a reflexive approach to the study of politics. That is to say, canonical authors—such as John Dewey—are often their own best critics, thereby reminding their readers of the necessarily tentative character of any effort to understand the ever-changing world of political affairs.[34]

While the study of canonical texts cannot provide detailed guidance on specific policy problems, it can illuminate the structure and implications of the conceptual framework within which contemporary policymaking operates. Such study can also propose alternative conceptual frameworks, thereby increasing the space for creative political action. In the following I do not treat canonical texts as repositories of eternal truths, nor do I seek to support my views merely by showing that they are shared by canonical authors. Rather, I draw on canonical texts to reveal historical continuities and disjunctions, make conceptual distinctions, highlight political dilemmas, and suggest directions for reform unfamiliar to contemporary ways of thinking.

### *Science and Technology Studies*

In my efforts to use historical political theory to illuminate the role of science in contemporary politics, I have found the relatively new field of science and technology studies (STS) especially helpful.[35] Through a growing collection of empirical case

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[34] See Euben, *Corrupting Youth*, 16, 54, chap. 7.

[35] For overviews of science and technology studies, see David J. Hess, *Science Studies: An Advanced Introduction* (New York and London: New York University Press, 1997); Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch, eds., *Handbook of Science and Technology Studies* (Thousand Oaks, CA: Sage Publications, 1995).

studies, such as ethnographic studies of laboratory practice, or sociological analyses of public controversies over new technologies, STS scholars have shown how science and technology are intertwined with public life. In many respects, STS builds on earlier work in the sociology of knowledge, the sociology of science, and the history of science.[36] But over the past thirty years, STS has developed its own disciplinary identity, as widely invoked as it is vaguely defined. Research running under the heading of STS is characterized by, among other things, a rejection of determinist conceptions of science and technology; an interest in the concrete practices through which science and technology are produced and used; and a commitment to the integration of historical, sociological, and philosophical perspectives.

Although a rejection of determinism is probably the most widely shared attribute of STS scholarship, there is little agreement on just what this means. Most often, it seems, technical determinism is conceived as a theory of history.[37] Common examples include statements such as: "The printing press caused the Reformation," or, "The birth control pill caused the sexual revolution." This type of technological determinism appears in the old children's rhyme that describes how "for want of a nail, a shoe was

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[36] See Peter L. Berger and Thomas Luckman, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge* (New York: Doubleday, Anchor Books [1966] 1967); Robert K. Merton, *Social Theory and Social Structure*, revised and enlarged ed. (London and Glencoe, IL: The Free Press, [1949] 1957); Ludwik Fleck, *Genesis and Development of a Scientific Fact* ed. Thaddeus J. Trenn and Robert K. Merton, trans. Fred Bradley and Thaddeus J. Trenn (Chicago: University of Chicago Press, [1935] 1979); Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd Edition (Chicago: University of Chicago Press, [1962] 1970).

[37] This is the orientation, for example, of most of the essays contained in Merritt Roe Smith and Leo Marx, eds., *Does Technology Drive History?* (Cambridge: MIT Press, 1995). See Bruce Bimber, "Three Faces of Technological Determinism," in *Does Technology Drive History?* ed. Merritt Roe Smith and Leo Marx (Cambridge: MIT Press, 1995), 80-100. Bimber argues that the phrase "technological determinism" should be reserved for "a view of history in which human will has no real role--in which culture, social organization, and values derive from laws of nature that are manifest in technology" (99).

lost, for want of a shoe, a horse was lost," and so on, until a soldier, battle, war, and kingdom have been lost, "all for want of a nail." An equally unlikely if less entertaining example appears in Lynn White's famous claim that the eighth-century introduction of the stirrup, by causing a shift from infantry to mounted shock combat, brought about feudalism.[38]

Another form of technological determinism as a theory of history appears in what have been called "substantive" theories of technology, exemplified by the work of Jacques Ellul, Martin Heidegger, and the early Frankfurt School.[39] According to this view, greatly simplified, "technology" is not merely a collection of material artifacts, but an abstract social force and mode of thought. The distinguishing feature of modernity is the ongoing transformation of human relations through the inevitable progress of technical rationality. As I argue in Chapter 4, this conception of technical determinism not only neglects the role of non-technical norms in the creation of technical artifacts, it underestimates the potential of political efforts to turn technology to emancipatory ends.

Technological determinism can also be understood in a more limited sense, as a theory of how science and technology are created, rather than how they affect social history. This dissertation is primarily concerned with this latter type of determinism. A mild and quite plausible form of this version of technical determinism appears in the

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[38] Lynn White, Jr., *Medieval Technology and Social Change* (Oxford: Clarendon Press, 1962), chap. 1. For an early review, see R. H. Hilton and P. H. Sawyer, "Technical Determinism: The Stirrup and the Plough," *Past and Present* 24 (April 1963): 90-100.

[39] Martin Heidegger, *The Question Concerning Technology and Other Essays*, trans. William Lovitt (New York: Harper and Row, [1954] 1977); Jacques Ellul, *The Technological Society* (New York: Alfred A. Knopf, Inc., 1964); Max Horkheimer and Theodor Adorno, *Dialectic of Enlightenment*, trans. John Cumming (New York: Continuum, [1944] 1993). On the notion of a "substantive" theory of technology, see Andrew Feenberg, *Alternative Modernity: The Technical Turn in Philosophy and Social Theory* (Berkeley: University of California Press, 1995), 23-24.

notion of "path dependency," which states that once a particular course of technological development begins, future development tends to follow the direction established by the initial technology. A more extreme form of this type of technical determinism appears in the notion that science and technology develop according to their own internal logic, unaffected by social and political factors. A technical artifact becomes socially established, it is often assumed, because the impersonal mechanism of a financial market or "marketplace of ideas" have determined that it works or is true. Determinism thus neglects the effect of social norms and political decisions on prevailing conceptions of what it means for something to work in the first place. This version of determinism is presupposed by the historical theory, but not vice versa. That is, it is not inconsistent to claim that although science and technology are immune to social factors (which they are not), science and technology are not the sole causes of social change.

The notion that science and technology develop according to their own inexorable logic is pervasive in contemporary public discourse, despite the above mentioned popular skepticism toward claims to scientific objectivity. This version of technical determinism appears, for example, in the mantra that workers today must learn to be "flexible" in response to technological change. Just as corporations have responded to shifts in consumer demand with "flexible specialization," workers are increasingly expected to become similarly flexible. That one might adapt the technology to the workers rarely occurs to anyone. As Langdon Winner argues, "In our times people are often willing to make drastic changes in the way they live to accommodate technological innovation while at the same time resisting similar kinds of changes justified on political grounds."[40]

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[40] Winner, "Do Artifacts Have Politics," 39.

One of the best examples of this sort of determinism appears in the work of Alvin Toffler, author of the widely influential *Future Shock*. Toffler acknowledges that technology, "that great, growling engine of change," is only one among several determinates of societal change, but he admits no reciprocal influence of social factors on technology. Rather, Toffler identifies just three factors in technological innovation, linked in an ever accelerating virtuous circle: "First, there is the creative, feasible idea. Second, its practical application. Third, its diffusion through society."[41] New technologies "suggest novel solutions to social, philosophical, even personal problems," but they remain immune to social influence, let alone political control. The goal of his book, accordingly, "is to help us come to terms with the future" by means of "a broad new theory of adaptation."[42]

This version of technological determinism dovetails with a similarly determinist and equally pervasive conception of science. According to this view, which might be loosely labeled "positivist," the term "science" designates any one of the following: 1) a logically given, uniquely rational method of inquiry; 2) a uniquely rational community of inquirers; and 3) a uniquely valid body of knowledge. While philosophers of science differ in their assessment of the extent to which actual scientific practice, practitioners, and knowledge live up to this ideal, mainstream philosophy of science has traditionally endorsed the notion that science is in some way fundamentally different from other human activities, and that the difference is grounded in logic, nature, divine sanction, or some other nonhuman source of authority.

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[41] Alvin Toffler, *Future Shock* (New York: Random House, Bantam Books, 1970), 25, 29.

[42] Ibid., 3.

According to this view of science, moreover, even the most "basic" scientific research leads inexorably to technological applications. This "linear model" of science and technology assumes, first, that technological development depends on scientific knowledge, and second, that the latter leads automatically to the former.

Building on earlier critiques of positivism and technological determinism, STS research has strongly challenged these determinist conceptions of science and technology. In the case of science, STS research has highlighted the role of social values, linguistic customs, political interests, personal ambition, and other "extra-scientific" factors in the creation of scientific procedures, communities, and facts. Expanding on the so-called Duhem-Quine thesis, STS scholars have argued that scientific knowledge is always "underdetermined" by the available evidence. Any given set of empirical reports can always be explained by more than one theory. This looseness of fit between theory and evidence opens a space for social factors to enter into the creation of scientific knowledge. Insofar as science is not, therefore, the automatic outcome of a logically given procedure, scientific knowledge is "constructed."

Similarly, STS research challenges the notion that laws of nature, progress, or the market by themselves determine technological development. The establishment of new technologies is often preceded by a period of what has been called "interpretative flexibility," during which proponents of different technical options compete to determine which option will become the accepted standard.[43] A particular technical option becomes an established element of public life, in part, because its advocates successfully recruit

[43] Trevor J. Pinch and Wiebe E. Bijker, "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," *Social Studies of Science* 14 (1984): 339-441, at 419-24.

allies that support their favored option over others. Similarly, many technologies become established, in part, because they reinforce existing social norms and institutions. Once competing options have been vanquished, the technology's former contestability is quickly forgotten. The history of power, persuasion, and luck that went into establishing the technology is retold as a story of superior effectiveness and necessary victory. Established technologies become "black boxes." They reliably produce predictable outputs from given inputs, with no need for users to understand how or why they work. As the new technology spreads through society, users can effectively employ the technology with no awareness of the alternative options that once existed. Constructivist analyses attempt to show how black-boxed technologies embody the social, political, and economic controversies that accompanied their creation.[44]

These challenges to technical determinism imply neither that technology has no effect on society, nor that social factors alone determine technical development. On the contrary. STS scholars have developed a variety of ways of articulating the notion that technology and society mutually constitute each other. Of most interest here is the idea of technology as a form of legislation. As Langdon Winner argued long ago, "New technologies are institutional structures within an evolving constitution that gives shape to a new polity, the technopolis in which we increasingly live."[45] And as Richard Sclove more recently put it, "Technologies do not merely *affect* society or states, they also *constitute* a substantial portion of societies and states."[46] Like more explicitly political

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[44] Bruno Latour, *Science in Action* (Cambridge: Harvard University Press, 1987), 130-31.

[45] Langdon Winner, *Autonomous Technology: Technics-Out-of-Control as a Theme in Political Thought* (Cambridge: MIT Press, 1977), 88ff, 324.

[46] Richard E. Sclove, *Democracy and Technology* (New York: Guilford Press, 1995), 17.

forms of legislation, technologies are potentially open to popular influence. And also like other forms of legislation, technologies do not always influence society in the way their creators intended. Sclove thus highlights the "polypotency" of technology, its multiple meanings and unintended effects. Technologies that are democratic in their intended, "focal" effects may have undemocratic "nonfocal" impacts. While many have praised the democratic promise of political participation via the internet, for example, Sclove emphasizes the adverse consequences of the decline in face-to-face communication that increased computer use implies. For Sclove, understanding a technology's relationship to democracy requires weighing its various direct and indirect consequences in the particular social context where it is put to use. Going beyond the promotion of focally democratic technologies requires a vision of "a technological order that structurally manifests a democratic design style."[47]

Unfortunately, the explicitly political perspective of Sclove and Winner is relatively unusual and many constructivist scholars have neglected the democratic potentials of their research. Although STS has been extremely helpful in explaining how technical artifacts become socially established, STS has often failed to give due consideration to politics as a relatively autonomous sphere of purposeful human activity. Similarly, STS case studies often fail to capture the structural inequalities among different social groups. By focusing on those social groups involved in shaping technological development, STS case studies often ignore those who may be affected by new technologies but are unable to participate in their construction.[48]

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[47] Sclove, *Democracy and Technology*, 31.

[48] These criticisms are made in Langdon Winner, "Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology," *Science, Technology, & Human Values* 18, no. 3 (1993): 362-78; Brian Martin, "The Critique of Science becomes Academic," *Science,*

STS has thus frequently taken an implicitly liberal pluralist view of politics, casting government as simply one "social group," "system component," or "actant" among many.[49] Many STS case studies give little consideration to political actors' long-term goals or implicit values, assuming that policy develops through a quasi-mechanical process of incremental adjustment to the pressures exerted by self-interested social groups.[50] Just as political theorists have more consistently applied constructivist perspectives to politics than to science and technology, STS scholars have often developed constructivist theories of science and technology while retaining what might be called a technologically-determinist conception of politics. It has long been clear, however, that democratic government cannot be adequately characterized as the mechanical arbiter of group competition, nor as just another social group.[51] Democratic governments make uniquely authoritative claims on the public, and face uniquely authoritative demands from the public.

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*Technology, & Human Values* 18, no. 2 (1993): 247-59; Stewart Russell, "The Social Construction of Artefacts: A Response to Pinch and Bijker," *Social Studies of Science* 16 (1986): 331-46.

[49] Wiebe E. Bijker, for example, discusses the role of "the social group of the government" in constructing a technological artifact without considering whether governments exert the same kind of influence as other groups ("The Social Construction of Fluorescent Lighting, Or How an Artifact Was Invented in Its Diffusion Stage," in *Shaping Technology/Building Society: Studies in Sociotechnical Change*, ed. Bijker and John Law [Cambridge: MIT Press, 1992], 75-102, at 81). Similarly, Thomas P. Hughes suggests that "legislative artifacts, such as regulatory laws, can also be part of technological systems," but does not explore the qualitative differences between government regulations and other components of technological systems ("The Evolution of Large Technical Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch [Cambridge, MA: MIT Press] 51-82, at 51). A similar conception of government appears in Michel Callon's studies of the electric vehicle in France ("The State and Technical Innovation. A Case Study of the Electric Vehicle," *Research Policy* 9 [1980]: 358-376; "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," in *The Social Construction of Technological Systems*, ed. Bijker, et al., 83-103).

[50] David Collingridge and Colin Reeve, *Science Speaks to Power: The Role of Experts in Policymaking* (New York: St. Martin's Press, 1986), 147-9.

[51] Theodore J. Lowi, *The End of Liberalism: The Second Republic of the United States*, 2nd ed. (New York: W. W. Norton and Company, 1979); William Connolly, ed., *The Bias of Pluralism* (New York: Atherton Press, 1969).

Despite its lack of attention to explicitly political questions, by exposing the contingency of technical artifacts, STS offers important resources for understanding the politics of science and technology. By combining perspectives gleaned from STS and historical political theory, this dissertation aims to show how science and technology can become more amenable to democratic politics.

At this point, it is worth noting that although science and technology have become increasingly intertwined, and the political analysis of one can hardly avoid the other, it is generally much less controversial to claim that technological devices are "constructed" than to say the same thing about scientific facts. While it is commonly assumed that atomic particles, DNA, or the combustible properties of petroleum were "always already there," before human beings discovered them, no one claims that the automobile existed before human beings constructed it. As Bruno Latour puts it, no one is a Platonist about technology.[52] In this dissertation, however, I follow the lead of authors such as Latour in applying the same constructivist concepts to science as to technology. I have tried to avoid repetition of the cumbersome phrase "science and technology" by using substitutes such as "technical artifacts," and by occasionally letting "science" stand for both. It should be clear from the context where the discussion refers to only one or the other.

## Chapter Outline

Following this introductory chapter, Chapter 2 examines the controversial 1996 decision of the California Air Resources Board to revise its electric vehicle program, providing a concrete illustration of some of the dilemmas posed by the contemporary

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[52] Bruno Latour, *Aramis, or The Love of Technology*, trans. Catherine Porter (Cambridge: Harvard University Press, 1996), 23.

relationship between science and democracy. Against overwhelming public opinion, the agency postponed its requirement that major automakers offer a minimum number of electric vehicles for sale in California by 1998. My analysis of public hearing transcripts and other public documents, as well as a few interviews with agency staff, shows that the Board's program change conveyed a consumerist image of citizens as exclusively concerned with private interests, undermining its otherwise energetic efforts to involve lay citizens in public policymaking. Moreover, I show how this image of citizenship became embodied in the technical design of electric vehicles. I repeatedly return to the electric vehicle case in later chapters to illustrate and refine the theoretical arguments.

Chapter 3 takes a big step back to examine the historical sources and conceptual logic of the technocratic politics apparent in the electric vehicle case study. Drawing on recent accounts of seventeenth-century science, and the writings of such authors as Hobbes, Jefferson, and Dewey, I argue that modern science developed in tandem with an instrumental conception of politics. As I show in later chapters, modern science is itself in many ways an instrumental activity, insofar as it relies on the purposeful manipulation of laboratory phenomena. But seventeenth-century writers concealed the instrumentalism of their scientific practice by portraying the scientific community as governed by norms of publicity and openness, rather than the particular aims of individuals. The disinterestedness thus associated with modern science later made science an indispensable symbolic resource for the justification of several forms of liberal-democratic politics, including technocracy.

Chapter 4 examines several criticisms of liberal-democratic instrumentalism, drawing on Burke, Rousseau, Arendt, and Habermas, among others. I argue that while the most prominent critics of instrumentalism have persuasively revealed its dangers, their tendency to embrace determinist conceptions of science and technology actually hinders contemporary efforts to democratize science and technology. The chapter also takes up Kuhn's critique of the positivist conception of science underlying liberal instrumentalism, showing the limits of Kuhn's internalist view of scientific communities. The chapter closes with a brief look at Herbert Marcuse's call for a "new science." Despite significant shortcomings, Marcuse highlights the importance of the above mentioned distinction between "strong" versions of social constructivism and the notion of political constructivism defended here.

Chapter 5 advances the notion of political constructivism by articulating its relationship to constructivist theories of natural science, drawing primarily on the writings of Dewey and Latour. Dewey's attention to concrete scientific practice provides an explicitly political perspective on the historical turn in the philosophy of science first popularized by Kuhn and further developed by Latour and other STS scholars. Both Dewey and Latour effectively refute technical determinism, described above, as well as more extreme versions of social constructivism. They show how scientific and technical artifacts develop through a process of mutually constitutive, purposeful interaction between human beings and the natural world. This suggests, I argue, that in a democratic society science and technology should, in some sense, represent the popular will.

Chapter 6 explicitly takes up the concept of representation, beginning with a brief consideration of the most common objection to the notion that science should represent not only natural properties, but also political claims: it may lead to totalitarian science. I argue that the problem of totalitarian science lies not in its implicitly constructivist conception of science, but in its conception of politics and the extreme version of constructivism to which it gives rise. This clears the way for an analysis of Latour's provocative claim that there is no essential difference between scientific and political representation.[53] Drawing on Hanna Pitkin's classic study on representation, I argue that political and scientific representation are distinct but not entirely independent human practices.

Chapter 7 returns to the explicitly empirical perspective of the electric vehicle case study. Drawing on the conceptual resources developed in the preceding chapters, I examine recent efforts to integrate political and scientific representation by involving lay citizens in the political construction of science and technology. I discuss the efforts of grassroots initiatives to influence scientific practice, as well as recent attempts to create institutions that can facilitate a more democratic politics of science and technology. Although each of these approaches has important limitations, they provide an opportunity to evaluate the promises and pitfalls of practical efforts to create a new social contract for science that includes a place for lay citizens.

The final chapter summarizes the argument, reinterprets the electric vehicle case study in light of the theory of political constructivism, and highlights some of the future challenges to the democratization of science and technology.

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[53] Latour, *Science in Action*, 72; *We Have Never Been Modern*, trans. Catherine Porter (Cambridge: Harvard University Press, 1993), 143.

# CHAPTER 2

# DESIGNING TECHNOLOGY AND CITIZENSHIP IN THE CALIFORNIA ELECTRIC VEHICLE PROGRAM

The most important point of excellence which any form of government can possess is to promote the virtue and excellence of the people themselves.
-- John Stuart Mill

This chapter presents some unfamiliar implications of a familiar intellectual slogan: *the medium is the message.* Marshall McLuhan developed this well-known dictum with reference to communications media, but he made clear that any technology is a medium. McLuhan argued that people tend to focus their attention on the explicit effects of a medium, commonly called its "content," such as the story told by a play or a film. But media always create effects that go beyond their explicit content. Indeed, by focusing on content, people neglect the secondary effects of the media themselves:

> Our conventional response to all media, namely that it is how they are used that counts, is the numb stance of the technological idiot. For the "content" of a medium is like the juicy piece of meat carried by the burglar to distract the watchdog of the mind.[1]

McLuhan showed how all communications media convey messages beyond their putative content. A play and a film based on the same novel may each have the same content, but they create very different experiences and support very different forms of human association. Recent debates over television content ratings, for example, have focused on parents' ability to regulate what their children watch, largely missing the more important issue of what children are not doing when they are watching television. Like Winner and

[1] Marshall McLuhan, "The Medium is the Message," *Understanding Media* (New York: McGraw-Hill, 1964), 18.

Sclove, mentioned in the last chapter, McLuhan suggested that the politics of technology must address not only the explicit *use* of technologies, but also the more subtle ways in which technologies *structure* political life. In this chapter, I examine the "message" conveyed by two technological media: government policy and automotive technology.

Government, especially in America, has long been understood as a form of technology. The next chapter examines how and why this is so. In the current chapter, I examine the message conveyed by the Zero-Emission Vehicle (ZEV) program, a regulation adopted in 1990 by the California Air Resources Board (CARB) to promote the development and sale of electric vehicles (EVs).[2] The most *direct* consequence of an expert-driven policy design such as CARB's is that it restricts the role of lay citizens in public policymaking. Chapter 7 examines several possibilities for expanding lay participation in government technology policy. This chapter, in contrast, focuses on the *indirect* effects of expert-oriented policy design on both public conceptions of citizenship and technological development.

There is a long tradition of research on the indirect effects of different types of policy design.[3] Recent research has built on this tradition to argue that in addition to citizens shaping policies, policies shape citizens.[4] Some of this research draws on

[2] A shorter version of this chapter is forthcoming as "The Civic Shaping of Technology: California's Electric Vehicle Program," *Science, Technology, & Human Values* 26, no. 1 (2001): 56-81.

[3] Theodore J. Lowi, "American Business, Public Policy, Case Studies, and Political Theory," *World Politics* 16 (July 1964): 677-715; James Q. Wilson, *Political Organizations* (New York: Basic Books, 1973); Aaron Wildavsky, *Speaking Truth to Power: The Art and Craft of Policy Analysis* (Boston: Little, Brown, and Company, 1979), 252-79.

[4] Joe Soss, "Lessons of Welfare Policy: Policy Design, Political Learning, and Political Action," *American Political Science Review* 93, no. 2 (1999): 363-80; Robert B. Reich, ed., *The Power of Public Ideas* (Cambridge: Harvard University Press, 1988); Helen Ingram and Steven Rathgeb Smith, eds., *Public Policy for Democracy* (Washington, DC: The Brookings Institution, 1993); Anne Larason Schneider and Helen Ingram, *Policy Design for Democracy* (Lawrence, KN: University Press of Kansas, 1997).

constructivist theories of science and technology, but it has not gone very far in exploring the indirect effects of policy design on the shaping of technology.[5] This chapter argues that unlike most private associations, governments convey implicit conceptions of citizenship through their policy designs that can become embedded within new technologies.

The second medium I examine in this chapter is transportation technology: both conventional gasoline cars and electric vehicles. As with the policies designed to promote them, I am not primarily concerned with the direct effects of electric vehicles on the environment. Rather, I focus on the contrast between the forms of political life fostered by EVs and by gasoline automobiles. EVs, I argue, particularly those meeting lower performance standards than conventional cars, have the potential to stimulate new types of urban development more conducive to democratic citizenship than those dictated by our current transportation infrastructure.

The details of the argument are as follows. During the early years of the ZEV program, between 1990 and 1994, CARB's policy design promoted a participatory conception of citizenship. By 1996, however, the agency made several significant changes in the ZEV policy design. The agency changed the relative importance of the various technical criteria according to which it evaluated EV technology, and it changed the factors according to which it assessed public willingness to purchase EVs. These changes culminated in CARB's decision, against widespread popular opposition, to postpone its 1998 EV sales mandate. Each of these policy changes, although made in a context of limited information and various political and ideological pressures, was in part

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[5] Schneider and Ingram, *Policy Design for Democracy*, chap. 6.

the result of autonomous decisions by CARB policymakers.[6] The agency obscured the fundamentally political nature of its decision, however, by appealing to technocratic arguments to defend the program change. Most importantly, the revision of the ZEV policy design shifted the conception of citizenship it conveyed toward a view of the public as passive consumers of public policy. This shift, in turn, pushed EV development toward technologies that reinforce a consumerist rather than participatory conception of citizenship.[7]

By offering a concrete illustration of the effects that technocratic policymaking can have on both technological development and democratic politics, this chapter sets the stage for the historical and philosophical investigations of the following chapters. The empirical analysis is preceded by an overview of the ZEV program, a brief consideration of alternative explanations, and a discussion of the concepts underlying participatory policy design.

### Overview of the Zero-Emission Vehicle Program

The California Air Resources Board, a unit of the California Environmental Protection Agency, is the principal agency responsible for regulating air quality in the

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[6] The term "decision" is not meant to imply an instrumentally rational choice based on complete information, a conception often criticized as "decisionism." As shown below, CARB's decision is best understood as a prudential choice made in a context of informational, political, and ideological constraints. See Giandomenico Majone, *Evidence, Argument, and Persuasion in the Policy Process* (New Haven: Yale University Press, 1989), 12-20.

[7] This is not to say that CARB policymakers *self-consciously* sought to promote particular conceptions of citizenship. I show only that the revision of the ZEV program changed the implicit conception of citizenship conveyed by the policy. Indeed, from the perspective of individual policymakers, the change in policy design is perhaps best described as a process of "closure," whereby an initial diversity of views on EV technology was gradually distilled into a rough consensus. See Hans Fogelberg, *The Electric Car Controversy: A Social-Constructivist Interpretation of the California Zero-Emission Vehicle Mandate* (Department of History of Technology and Industry, Chalmers University of Technology, Göteberg, Sweden, 1998).

state. Established in 1967, the Board today employees over 1,000 scientists, engineers and other staff members. CARB sets and enforces emission standards for motor vehicles, fuels, and consumer products; monitors air quality and sets air quality standards; conducts and sponsors research; offers compliance assistance to business; conducts public outreach programs; and oversees and assists local air quality districts.[8] In September 1990, CARB adopted a Low-Emission Vehicle and Clean Fuels program requiring that, among other things, by 1998 a minimum of two percent of the vehicles offered for sale by major automakers in California be ZEVs. The ZEV mandate was to increase to five percent in 2001 and ten percent in 2003. Automakers were to pay a fine of $5,000 for each vehicle by which they fell short of their quota. Since EVs represented the only near-term option for building a vehicle with no tailpipe emissions, the regulation created a surge of international interest in EVs.

Although the ZEV mandate was only one element in the agency's overall clean air strategy, many observers believed it would eventually provide large air quality benefits for California.[9] Unlike gasoline cars, EVs do not produce more emissions when old or when driven erratically. Nor do they have emissions control technologies that can malfunction or be disabled. They have fewer moving parts than conventional cars, require less maintenance, produce very little noise, and can be recharged overnight at

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[8] See CARB's website, http://www.arb.ca.gov

[9] According to a report by the Natural Resources Defense Council, *No more Tailpipes: The Role of Electric Vehicles in Clearing California's Air* (Washington, DC: NRDC, 1994), replacing even the cleanest gasoline cars in Los Angeles with electric vehicles would provide a reduction of hydrocarbons and carbon monoxide by 99 percent, nitrogen oxides by 73 percent, particulates by 61 percent, and carbon dioxide by 66 percent, even when taking the emissions of both in-state and out-of-state power plants into account.

home. And, of course, EVs produce no emissions from the vehicle itself.[10] Despite their high initial price, advocates argued that economies of scale, as well as lower operating costs, would soon make EVs cost competitive with conventional vehicles.[11] Many observers also thought the ZEV mandate would stimulate the creation of high-tech jobs for recently displaced aerospace workers in Los Angeles[12], suggesting to some a model for integrating environmental and industrial policy.[13]

CARB initiated the ZEV program in part in response to a January 1990 announcement by General Motors that the company would build the world's first commercial electric vehicle. The Board simply aimed to hold GM to its word. It was ironic, therefore, that GM, along with Ford, Chrysler and the oil industry, lobbied aggressively against the mandate from its inception. Some companies even went so far as to publicize inflated EV price quotes. In April 1995, for example, Ford announced that the electric version of its Ranger pickup would sell for $30,000--a price guaranteed to make the EV pickup a failure. "Though the lobbyists were careful not to be overt, the commissioners got the message: Ford would sabotage its own EV program, if necessary,

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[10] Although EVs may cause increased emissions at electric power plants, these emissions can be more easily controlled through advanced filter technology than the widely dispersed emissions of millions of conventional automobiles. EVs may not be appropriate for regions that rely on highly-polluting coal for their energy needs, nor for colder regions where EV battery performance is low. But in California the moderate weather and relatively high reliance on renewable energy make EVs a viable means of reducing air pollution. On these issues see also Fogelberg, *The Electric Car Controversy*, 72-80, which provides an interesting discussion of the various redefinitions undertaken since 1990 in the apparently simple notion of "zero" emissions.

[11] Jane V. Hall, "ZEVs and California's Future Prosperity." Document of testimony at CARB Public Workshop on the Benefits and Costs of Zero-Emission Vehicles, Los Angeles, CA (November 8, 1995).

[12] Allen Scott, ed., *Electric Vehicle Manufacturing in Southern California: Current Developments, Future Prospects* (Berkeley: University of California Transportation Center, 1993).

[13] Mark B. Brown, Weert Canzler, Frank Fischer, and Andreas Knie, "Technological Innovation through Environmental Policy: California's Zero-Emission Vehicle Regulation," *Public Productivity and Management Review* 19, no. 1 (1995): 77-93.

to *make* the mandate fail."[14] The oil companies, for their part, spent $1 million on a media campaign to defeat the ZEV mandate.[15]

Given the uncertainties in the rate and nature of technological development for EVs, the ZEV program provided for biennial reviews, during which the agency would hold both internal meetings and public hearings to analyze the program's implementation. At the 1992 and 1994 reviews, CARB decided that EV development was on course to meet the 1998 deadline. The press reported that CARB faced "intense lobbying" from the auto industry, but that the agency "unequivocally upheld its revolutionary mandate."[16]

The third biennial review was preceded by a series of public workshops on the ZEV program, during which CARB received more public comment than on any other program in the agency's history, the vast majority opposing any change to the ZEV program.[17] Nonetheless, the agency decided to eliminate the 1998 and 2001 ZEV mandates, retaining only the 2003 requirement that ten percent of all cars sold in California have zero emissions.[18]

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[14] Michael Shnayerson, *The Car that Could: The Inside Story of GM's Revolutionary Electric Vehicle* (New York: Random House, 1996), 247; see also 213.

[15] Ibid., 247.

[16] Cone, Marla, "State Holds Firm on Deadline for Electric Cars," *Los Angeles Times* (May 14, 1994), A1.

[17] Thomas A. Evashenk, Manager, ZEV Implementation Section, California Air Resources Board. Interview by author. Sacramento, California (May 12, 1999).

[18] In place of the interim deadlines, the agency signed Memoranda of Agreement with the seven largest automakers. These memoranda committed the manufacturers to continue research and development of EV technology, provide biennial reports of their progress, allow periodic CARB inspection of their facilities, and offer for sale, in accord with "consumer demand," a total of up to 3,750 advanced-battery EVs in demonstration programs in California by 2001. Because the ZEV mandate was an essential part of California's 1994 plan to meet the requirements of the federal Clean Air Act, the automakers also agreed to introduce cleaner cars voluntarily nationwide by 2001. See CARB, *Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Response*, Sacramento, CA: CARB, March 28, 1996.

## Alternative Explanations

### *Technical Imperatives*

One explanation for CARB's decision to abandon the 1998 ZEV mandate holds that it was simply an acknowledgement of technical necessity. This is how the agency itself often justified the policy change:

> Reasonable minds may differ about the Board's determination as to the most likely outcome if the existing regulatory requirement was retained, but the Board has been charged by the Legislature with responsibility to make this decision and is constituted of members with special expertise necessary to make such a decision.[19]

CARB used the report of its Battery Technical Advisory Panel to argue that existing EVs could not provide the range and performance consumers expected. The Battery Panel had reported that production-ready lead-acid and nickel-cadmium batteries could provide only slightly over half the 80-100 mile range the Board thought consumers required.[20] Enforcing the mandate would therefore taint the public image of EVs and "poison" the market for years to come.

Technical factors no doubt strongly influenced the agency's decision to eliminate the 1998 deadline. But as STS research has long made clear, the policy implications of technical information are rarely straightforward.[21] I show below that CARB's inference from the Battery Panel's report to the policy change depended on non-technical and highly questionable assumptions about probable consumer behavior. Moreover, CARB

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[19] CARB, *Final Statement of Reasons*, 77.

[20] CARB, *Public Meeting to Update Board on Technological Progress of Zero-Emission Vehicles*, Agenda Item 95-11-3, Sacramento, CA, October 26, 1995, 149-50.

[21] See, for example, Yaron Ezrahi, "Utopian and Pragmatic Rationalism: The Political Context of Scientific Advice," *Minerva* 18 (1980): 111-31.

was well aware that some experts contested the Battery Panel's findings.[22] Technical imperatives, therefore, could not have been the sole cause of the agency's decision.

*Economic Imperatives*

Another potential explanation, also advanced by CARB, sees the agency's decision as dictated by the need to avoid jeopardizing economic growth. CARB recognized, of course, that mandates and subsidies can help correct the market's bias against new technologies such as EVs. But the Board repeatedly argued, "For the ultimate success of the program, EVs must stand on their own and successfully compete in the marketplace."[23] CARB's concerns about the economic impact of the ZEV program owed much to the notion that if automakers were to meet the two percent mandate, they would need to subsidize the sales price of EVs by increasing the price of new conventional cars. This would constitute a drag on the California economy.[24]

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[22] At a CARB public hearing in November 1995, for example, a spokesperson for the Advanced Lead-Acid Battery Consortium, "representing 90 percent of the world's lead-acid battery industry," directly contradicted CARB's assessment: "Existing and commercially available lead-acid batteries are capable of daily commuting ranges of 75 miles, recharging times of a few minutes, and cycle life in excess of 500 cycles, approximately three years. Most importantly, the fuel cost per mile of running an EV powered with lead-acid battery has already dropped by an order of magnitude during the course of ALABC's program. By 1998, the projected cost will drop further to 5 cents per mile and, thus, will be comparable with the cost of fueling conventional engines.... ALABC takes strong exception to any suggestion that advanced batteries will not be available by 1998 (Robert Efrus, Document of testimony at CARB public meeting to update Board on technological progress of Zero-Emission Vehicles, Agenda Item 95-12-4, Sacramento, CA: November 16, 1995, 222-23).

[23] CARB, *Staff Report: Initial Statement of Rulemaking: Proposed Amendments to the Zero-Emission Vehicle Requirements for Passenger Cars and Light-Duty Trucks*, Sacramento, CA, February 9, 1996, 5.

[24] James M. Lyons, "The Cost of the ZEV Mandate: 1998-2001." Document of testimony at CARB public workshop on the benefits and costs of Zero-Emission Vehicles, Los Angeles, CA, November 8, 1995. Lyons also used this point to argue that the ZEV program would actually *increase* air pollution, by slowing the rate at which consumers exchanged more highly polluting old cars for cleaner new cars. This claim was countered by Jane V. Hall, among others ("ZEVs and California's Future Prosperity," Document of testimony at CARB public workshop on the benefits and costs of Zero-Emission Vehicles, Los Angeles, CA, November 8, 1995), who argued that even in the worst case scenario, in which automakers were required to pay huge fines, new car prices would rise by only $10-70, and that the state could offset even this burden with funds from the collected fines.

Additionally, a number of changes during the mid-1990s in the overall political climate—the 1994 ascendancy of the Republican Party in the US Congress; the 1996 presidential campaign of free-market advocate and California Governor Pete Wilson; the mid-1990s revival of the California economy, which robbed the mandate of its rationale as a job creation program; and the emergence of state and federal efforts to "reinvent government" by reducing its scope and increasing its efficiency[25]—may have led CARB to emphasize concerns about the ZEV program's economic merits. In these respects, the agency's decision might be seen as an instance of what Charles Lindblom called the "market as prison" phenomenon.[26] Because government regulation tends to produce a decrease in business investment, the argument goes, political reform is necessarily constrained by the "prison" of the market.

Lindblom also argued, however, that the conflict between government regulation and economic efficiency is as much a matter of free market ideology as actual economic constraints.[27] Indeed, credible predictions about the ZEV program's economic impact varied enormously, depriving CARB of clear expert guidance on this aspect of the issue.[28] CARB's appeal to economic constraints thus concealed a necessarily political decision, shaped in part by free-market ideology.

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[25] On the latter, see David Osborne and Ted Gaebler, *Reinventing Government: How the Entrepreneurial Spirit is Transforming the Public Sector* (New York: Addison-Wesley Publishing Company, Inc., 1992).

[26] Lindblom 1982

[27] Charles E. Lindblom, "The Market as Prison," *Journal of Politics* 44, no. 2 (1982): 324-36, at 333-34.

[28] See Roland J. Huang, "Comments on the Benefits and Costs of the Zero-Emission Vehicle Program," Document of testimony at CARB public workshop on the benefits and costs of Zero-Emission Vehicles, Los Angeles, CA, November 8, 1995.

*Interest Group Lobbying*

Perhaps the most common explanation for CARB's policy change focuses on the extraordinary pressure brought to bear on the agency by the auto and oil industries. According to a *Los Angeles Times* reporter, the agency's decision marked "the first time in three decades that the board has rescinded a regulation under pressure from the auto and oil industries it regulates."[29]

Although interest group lobbying was an important factor, assuming that it tells the whole story reflects a liberal pluralist view of politics, described in the previous chapter, accompanied by characteristic limitations. First, the pluralist account mistakenly discounts CARB's autonomous decisionmaking capacity. CARB's initiation of the ZEV program is difficult to explain with pluralist theory, since leading environmental groups did not begin lobbying for government promotion of EVs until *after* CARB had established the program. Nor can pluralist theory fully account for the program revision, precisely because it was "the first time in three decades" that CARB had failed to resist the auto industry, which suggests that other factors played a role. Although state environmental bureaucracies were long the playthings of powerful interests, during the 1980s, partly in response to the devolution of federal environmental policy, state environmental agencies made major improvements in their effectiveness and independence.[30] Like the federal Environmental Protection Agency[31], many state

[29] Marla Cone, "State Air Board Repeals Mandate for Electric Cars," *Los Angeles Times* (March 30, 1996), A1

[30] Evan J. Ringquist, *Environmental Protection at the State Level: Politics and Progress in Controlling Pollution* (Armonk, NY: M.E. Sharpe, 1993).

environmental agencies today possess the necessary resources to competently evaluate technical claims, promote informed public participation, and provide democratic leadership in the public interest. Indeed, CARB is widely recognized as the world's leading air quality regulatory agency.[32] From this perspective, the pluralist explanation gives too little credit to the relative autonomy of CARB policymakers.

Second, the pluralist account gives too much credit to the direct exercise of political power, neglecting the subtle influence of ideologies on political decisions.[33] The influence of ideology is often most apparent in the reasons policymakers offer for their decisions.[34] I thus argue below that much of the reasoning underlying CARB's revision of the ZEV program was grounded in the ideology of "automobility"—the conceptual, political, and material framework that makes the gasoline-powered automobile a fundamental component of daily life in advanced industrial societies.[35] This ideology is promoted by the auto industry, to be sure, but it is also deeply engrained in contemporary culture. As we shall see, the ideology of automobility greatly restricts prevailing views on what a motor vehicle is in the first place.

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[31] Marc K. Landy, Marc J. Roberts, and Stephen R. Thomas, *The Environmental Protection Agency: Asking the Wrong Questions from Nixon to Clinton*. Expanded ed. (New York: Oxford University Press, [1990] 1994).

[32] William R. Lowry, *The Dimensions of Federalism: State Governments and Pollution Control Policies* (Durham: Duke University Press, 1992), chap. 4

[33] See Steven Lukes, *Power: A Radical View* (London: Macmillan Press, Ltd., 1974).

[34] Frank Fischer and John Forester, eds., *The Argumentative Turn in Policy Analysis and Planning* (Durham and London: Duke University Press, 1993).

[35] Sudhir Chella Rajan, *The Enigma of Automobility: Democratic Politics and Pollution Control* (Pittsburgh, PA: University of Pittsburgh Press, 1996), 6-8.

**Policy Design, Citizenship, and Public Goods**

Although each of the above explanations illuminates important aspects of why CARB revised the ZEV program, they neglect both political ideology and political action. The following account includes elements of each of the above, but it emphasizes: 1) the ideological context within which CARB established and revised the ZEV program; 2) the agency's autonomous capacity to challenge powerful interest groups and ideologies; and 3) the impact of the ZEV program on the relationship between EV technology and citizenship.

Support for this perspective appears in recent studies on policy design, cited above, which have shown that the methods, aims, and public presentation of a policy convey messages about the nature of citizenship. Although people derive their conceptions of citizenship from multiple and diverse sources, direct and indirect experiences with public policy are among the most influential. A policy design's image of citizenship generally has the greatest effect on its explicit "target population" (e.g., union members, immigrants, the elderly, etc.). But some policies have very broad targets (e.g., women and minorities), and even narrowly targeted policies may convey images of citizenship that filter through the mass media into the general public.[36]

A welfare policy, for example, that makes excessive use of economic incentives to direct behavior may encourage recipients to act according to their narrow self-interest; a crime prevention policy that targets a particular racial group may foster distrust of government within that group; a job-training program with biased entrance criteria may convey the message that some types of people are incapable of learning new skills; and

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[36] Schneider and Ingram, *Policy Design for Democracy*, 84-89.

any policy design justified solely on the basis of technical expertise, especially when expert recommendations contradict public input, may convey the message that lay citizens are not welcome participants in the policy process. In sum, poorly designed policies may foster a "weak" conception of citizenship, according to which the private pursuit of personal happiness leaves little room for public involvement in the discovery and pursuit of shared goals.

A policy design, in contrast, that treats citizens as equals, encourages their capacity to learn, and elicits their participation can contribute to the development of "strong" conceptions of citizenship among those who come into contact with the policy. The idea of strong democratic citizenship can be loosely defined as the view that, given the necessary context, individuals can cooperate with others to create and pursue common goals through the exercise of political power.[37] The strong conception of citizenship is implicit in the widely endorsed if frequently neglected notion that governmental legitimacy rests on the expressed will of the governed. In a democratic society, governmental legitimacy cannot be secured by merely satisfying the substantive needs of the population. Legitimacy also depends on the perception that procedures exist through which ordinary citizens play a role—not always, nor on every issue, but at least some of the time, on some issues—in the creation of public policy.[38] If governmental legitimacy depends in part on such procedures, democratic governments have a responsibility to develop policy designs that not only address substantive social problems,

[37] Benjamin R. Barber, *Strong Democracy: Participatory Politics for a New Age* (Berkeley: University of California Press, 1984), chaps. 8-9

[38] As Pitkin puts it, "There need not be a constant activity of responding, but there must be a constant condition of responsive*ness*, of potential readiness to respond" (*Concept of Representation*, 233).

but also foster the norms, practices, and institutions that sustain lay participation in politics.[39] In short, extrapolating from McLuhan, governments must attend to the messages conveyed by their policy media.

One might note that the idea of participatory policy design depends on a somewhat problematic distinction between the roles of consumer and citizen.[40] As consumers, some have argued, individuals make decisions according to self-regarding preferences, aiming to maximize their private welfare. As citizens, people base their decisions on shared values, aiming to promote the public good. This distinction has been helpful in revealing the flaws of the widespread assumption that both economic preferences and political decisions obey the same logic of personal utility maximization and can be ranked in a single hierarchy.[41] The consumer/citizen distinction has made it easier to understand how, as citizens, people might support policies that contradict their consumer interests; e.g., support for increased public school funding by parents who send their children to private school. A key problem with the consumer/citizen distinction, however, is that it usually relies on the implausible assumption that self-interested consumers radically transform themselves simply upon entering the public sphere. This

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[39] Marc Landy thus asks that we think of policies as "constitutions." The enabling statutes passed by legislatures, as well as many of the rules made by executive agencies, "establish broad ends, prescribe specific institutional arrangements, define powers, and delimit membership." Policies not only set out a blueprint for government action, but also provide a "civic teaching." See Marc K. Landy, "Public Policy and Citizenship," in *Public Policy for Democracy*, ed. Helen Ingram and Steven Rathgeb Smith (Washington, DC: The Brookings Institution, 1993), 19–44, at 26.

[40] Mark Sagoff, *The Economy of the Earth: Philosophy, Law, and the Environment* (Cambridge: Cambridge University Press, 1988), 7-14.

[41] Cf. Amartya K. Sen, "Rational Fools: A Critique of the Behavioral Foundations of Economic Theory," in *Beyond Self-Interest*, ed. Jane J. Mansbridge (Chicago: University of Chicago Press, 1990), 25-43.

has left defenders of the distinction open to the objection that, when it comes to *acting* on expressed preferences, the consumer role usually dominates.[42]

Daphna Lewinsohn-Zamir has persuasively addressed this objection by arguing that the distinction between consumer and citizen rests not on the distinction between private preferences and public values, but on the degree to which individuals believe a political environment exists that supports other-regarding action.[43] People maintain both self-interested and other-regarding preferences in both private and public life, but they only act on their other-regarding preferences if they trust others to do the same. Other-regarding behavior is more frequent in political than market settings to the extent that people believe political institutions provide an effective means of realizing their other-regarding preferences.

This raises the obvious question of what counts as a political setting. Lewinsohn-Zamir defines political and market settings according to the goods with which they are concerned.[44] Politics deals with public goods—streets, parks, clean air, etc.—which are indivisible and nonexcludable, and must therefore be shared. Markets deal with private goods—food, houses, cars, etc.—which are consumed by individuals and cannot be

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[42] Andreas Dickman and Peter Preisendörfer, "Environmental Behavior: Discrepancies between Aspirations and Reality," *Rationality and Society* 10, no. 1 (1998): 79-102.

[43] Daphna Lewinsohn-Zamir, "Consumer Preferences, Citizen Preferences, and the Provision of Public Goods," *Yale Law Journal* 108, no. 2 (1998): 377-406. Lewinsohn-Zamir places her argument in the context of what is known among public choice scholars as a "mutual assurance game." Like the "prisoner's dilemma," the mutual assurance game asserts that people have the same preference orderings in public and private settings. Unlike the prisoner's dilemma, however, the mutual assurance game asserts that people often give highest priority to their other-regarding preferences.

[44] Lewinsohn-Zamir, "Consumer Preferences," 399-402

shared. Because people must share public goods with others, Lewinsohn-Zamir argues, they tend to think of public goods in terms of their other-regarding preferences.[45]

Many ostensibly private goods, of course, have salient characteristics of public goods. Philip Green thus classifies goods along a continuum between fully public and fully private, according to four criteria: excludability, individual or collective payment, personal or social consumption, and contribution to the public welfare.[46] Electric vehicles fit into Green's category of "mixed" goods. Like the consumption of gasoline that is taxed to fund public roads, the consumption of EVs is personal and exclusive, and payment is individual, but by reducing air pollution, EVs also contribute to the public welfare.

Combining Green's notion of mixed goods with Lewinsohn-Zamir's analysis of other-regarding behavior, we can say that people are more likely to act toward a particular good in light of their other-regarding preferences when: 1) they believe the good is either a public or mixed good, and 2) they trust others to do the same. This holds true regardless of whether action takes the public form of voting or the private form of purchasing something in the market. Indeed, there is a long history of efforts to effect political change through consumer boycotts, socially responsible investing, purchasing environmentally sound products, and other forms of publicly-interested market activity. Consumer purchasing decisions, of course, are no substitute for more collective forms of political action. Public interest consumerism also risks obscuring the need for more fundamental political change. But given the political dimensions of many consumer

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[45] Lewinsohn-Zamir, "Consumer Preferences," 400 .

[46] Donald Philip Green, "The Price Elasticity of Mass Preferences," *American Political Science Review* 86, no. 1 (1992): 128-48, at 132-33.

products, and the centrality of consumerism to contemporary conceptions of identity, it makes sense to see politically informed consumer choices as acts of democratic citizenship.

Although any association involved in shaping new technologies might convey a strong image of citizenship, political associations have a special obligation to do so.[47] Most people are members of many different associations, but for citizens of a democratic state, political memberships have "a certain practical pre-eminence" over other memberships.[48] This does not mean that citizenship is or should be valued over other social roles, many of which appropriately elicit greater time, energy, and affection than citizenship. But only political associations have as their primary purpose the establishment of rules and conditions that govern citizens' interactions in the other associations to which they belong. Of all the associations involved in shaping technologies, therefore, political associations have a special responsibility to shape their civic characteristics—i.e., their implications for conceptions and practices of citizenship.

The claim that policy designs affect public conceptions of citizenship does not imply a neglect of policy's instrumental effectiveness. Effective policy implementation depends on public compliance with the law, and often relies on active public involvement as well.[49] Public officials, therefore, have not only normative but also instrumental

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[47] Of course, any definition of "political association" is contestable. Although my focus here is on a state agency, it is important to note that there have long been political associations and forms of political activity neither affiliated with, nor directed toward, the state. Many of these, as noted in the introduction, have contributed to the civic shaping of technologies.

[48] Michael Walzer, "The Civil Society Argument," in *Dimensions of Radical Democracy: Pluralism, Citizenship, Community*, ed. Chantal Mouffe (London: Verso, 1992), 89-107, at 105.

[49] Schneider and Ingram, *Policy Design for Democracy*, 81. There is an ongoing debate within environmental political theory concerning the relationship between the effectiveness and legitimacy of environmental policy. See Brian Doherty and Marius de Geus, eds., *Democracy and Green Political Thought* (New York: Routledge, 1996); Bruce A. Williams and Albert R. Matheny, *Democracy, Dialogue,*

reasons for promoting strong conceptions of citizenship. Sometimes, of course, the instrumental and civic goals of policy conflict, in which case policymakers should aim to strike a balance. Policymakers should adopt a policy actively supported by informed citizens, so long as it is not entirely ineffective, even if it is somewhat less effective than an alternative policy. Citizens do not become responsible without being given responsibility, and democracy depends on the freedom to make mistakes. As I show in the next chapter, the problem with liberal democracy has not been that lay citizens are incapable of effective political participation, as "democratic realists" argue, but that its substantive effectiveness has been conceptualized independently of its formal legitimacy.

Finally, it is important to recognize that the voluntarism reflected in the notion of participatory policy design need not exclude consideration of structural factors. Public officials design policies within an "issue context" composed of political interests, institutional cultures, and prevailing constructions of political problems. This issue context is itself shaped by a broader "societal context" composed of pre-existing practices, values, and technologies. The societal context, in turn, is in part shaped by policy designs and the conceptions of citizenship they convey.[50] Indeed, to argue that participatory policy design could by itself create active citizens out of passive consumers would be empty moralizing. Strong democratic citizenship requires sufficient economic, educational, and institutional resources. It especially depends on strong civic

*and Environmental Disputes: The Contested Languages of Social Regulation* (New Haven: Yale University Press, 1995); Daniel Press, *Democratic Dilemmas in the Age of Ecology* (Durham and London: Duke University Press, 1994).

[50] Schneider and Ingram, *Policy Design for Democracy*, 73-81.

associations that provide opportunities for political deliberation and action.[51] Despite structural constraints, however, "There is always the possibility of human agency...and opportunities exist to design policies to support democratic values."[52] Although the impact of policy design on citizenship depends on the social, political, and technological context, thoughtful designs can help shape that context, improving possibilities for the exercise of strong democratic citizenship.

## The Rise and Fall of the 1998 ZEV Mandate

### *Automobility and the Politics of Criteria*

Before examining CARB's revision of the ZEV program, it is important to understand how the program initially challenged the prevailing conception of automotive technology and the ideology of individualism and privatism it supports. As EV advocates often point out, during the early years of automotive technology it was entirely unclear whether future automobiles would run on electricity, steam, or gasoline. Indeed, most observers believed all three options would coexist indefinitely, each finding its own market niche in a "hybrid" transportation system.[53] Gasoline engines had a number of technical advantages, but their eventual dominance owed much to the efforts of wealthy sportsmen and businessmen who pushed for a technology that would fit their purposes of

[51] Benjamin R. Barber, *A Place for Us: How to Make Society Civil and Democracy Strong* (New York: Farrar, Straus, and Giroux; Hill and Wang, 1998); Robert D. Putnam, *Making Democracy Work: Civic Traditions in Modern Italy* (Princeton: Princeton University Press).

[52] Schneider and Ingram, *Policy Design for Democracy*, 5.

[53] David A. Kirsch, *The Electric Vehicle and the Burden of History* (New Brunswick, NJ: Rutgers University Press), 216-21.

automobile racing and long-distance demonstration runs.[54] Electric vehicles, in contrast, were favored by women, who lacked the power to promote their preferred technology. Women tended to be more concerned than men about reliability, comfort, safety, and cleanliness, and their driving needs were well met by EVs. But given a patriarchal culture, the EV's attractiveness to women actually became a factor in its demise. As one automobile journal noted, "The fact that anything, from a car to a color, is the delight of the ladies is enough to change his interest to mere amused tolerance....Having imagined effeminacy into the electric, he dismisses it from his mind and buys a gas car without a struggle."[55] Other factors included the oil industry's aggressive establishment of an infrastructure of gasoline filling stations, and a lack of similar involvement by the electric utilities. Also, despite their lower operating costs, the high initial price of EVs forced makers to concentrate on the relatively stable but very small luxury market. Finally, the introduction of the electric starter in 1912 allowed gasoline cars to co-opt some of the advantages of electrics.[56]

Once the very definition of an "automobile" had become equated with the gasoline engine, it became increasingly difficult to challenge its societal dominance. Indeed, for the past eighty years, automotive technology has remained almost exclusively

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[54] Mikael Hård and Andreas Knie, "The Ruler of the Game: The Defining Power of the Standard Automobile," in *The Car and Its Environments: The Past, Present and Future of the Motorcar in Europe*, ed. Knut H. Sorensen (Brussels: European Commission, 1994), 137-58.

[55] Quoted in Rudi Volti, "Why Internal Combustion?" *American Heritage of Invention and Technology* 6, no. 2 (Fall 1990): 42-47, at 45.

[56] See Kirsch, *The Electric Vehicle*, chaps. 2-5; Michael Brian Schiffer, *Taking Charge: The Electric Automobile in America* (Washington, DC: Smithsonian Institution Press, 1994).

within the image of a "race-travel-limousine": a vehicle that can transport individuals in comfort at high speeds for at least 300 miles on a single tank of gas.[57]

Today this conception of automotive technology is intertwined with an infrastructure and ideology of automobility that poses severe obstacles for democratic citizenship. People have become highly dependent on their cars for both work and leisure, and total driving time increases every year.[58] Automobiles thus impose compulsory privacy on growing portions of daily life, fostering a lack of concern with public affairs.[59] Conventional automobiles also contribute to suburban sprawl, which sucks population and investment capital out of core urban areas, exacerbating economic inequality and racial segregation, imposing further burdens on democratic citizenship.[60] Henry Ford's reformist prophecy—"We shall solve the city problem by leaving the city"—has proven only half correct.[61]

The privatism fostered by automobile use is compounded by the prevailing tendency to see automobiles themselves as strictly private goods. Car sharing programs

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[57] Weert Canzler and Andreas Knie, *Das Ende des Automobils: Fakten und Trends zum Umbau der Autogesellschaft* (Heidelberg: C. F. Müller, 1994), 40-45.

[58] According to a recent study by the Surface Transportation Policy Project (*Why are the Roads So Congested? A Companion Analysis of the Texas Transportation Institute's Data of Metropolitan Congestion* [Washington, DC: STPP, 1999]), between 1982 and 1997 average traffic delays in the US grew by 235 percent. The average amount of driving per day increased by 70 percent. Sixty-nine percent of this increase in driving was caused by factors related to sprawl, including longer car trips, less carpooling, and people switching from walking or transit to cars. Population growth accounted for only 13 percent of the increase in driving.

[59] Rajan, *Enigma of Automobility*, chap. 3.

[60] Robert Bullard and Glenn S. Johnson, eds., *Just Transportation: Dismantling Race and Class Barriers to Mobility* (Gabriola Island, BC; Stony Creek, CT: New Society Publishers, 1997). Eighty percent of the 350,000 people who ride the bus each day in Los Angeles, for example, are people of color, and 60 percent have household incomes of less than $15,000 per year. Lisa Duran, "Labor/Community Strategy Center Organizes Bus Riders Union in L.A.," *Race, Poverty, and the Environment Newsletter* 6, no. 1 (Fall 1995): 8-9.

[61] James J. Flink, *The Automobile Age* (Cambridge: MIT Press, 1988), 139.

have had very limited success, and compared to other areas of environmental politics, transportation policy and automobile regulation have rarely evoked much public involvement. The privatism fostered by automobility seems to discourage popular participation in automotive politics itself.[62] This is ironic, of course, given the very public costs that automobiles impose on society and the environment.

The power of automobility has not been such as to prevent occasional instances of popular opposition to the automobile. A 1911 statute adopted by the Swiss canton of Graubünden, for example, banned all cars, trucks, and motorcycles from the entire canton, Switzerland's largest.[63] CARB itself was created partly in response to popular demands during the 1940s and 50s that the California government do something about air pollution in Los Angeles.[64] These instances have been few and far between, however, and the ideology of automobility helps explains the remarkable lack of public interest or participation in automotive regulatory policymaking, especially when compared to other areas of environmental concern.

This is not to say that the conventional automobile is an *essentially* anti-democratic technology. In Progressive Era Los Angeles, for example, gasoline automobiles provided a quasi-democratic alternative to the poor service and corrupt practices of the trolley companies.[65] To adapt a phrase from Winner, conventional

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62 Rajan, *Enigma of Automobility*, 70-71, 156-60.

63 The statue was later weakened somewhat, but not revoked until 1932. See Benjamin R. Barber, *The Death of Communal Liberty: A History of Freedom in a Swiss Mountain Canton* (Princeton: Princeton University Press, 1974), 245-46.

64 See James E. Krier and Edmund Ursin, *Pollution and Policy: A Case Essay on California and Federal Experience with Motor Vehicle Air Pollution, 1940-1975* (Berkeley: University of California Press, 1977).

65 Scott L. Bottles, *Los Angeles and the Automobile: The Making of a Modern City* (Berkeley: University of California Press, 1987).

automobiles are "strongly compatible with" individualism and privatism.[66] But the extent to which automobiles foster these values, and the extent to which these values threaten democracy, depends on the material and ideological context. Individuality and privacy, after all, are among the key values of any liberal democracy. In contemporary advanced industrial societies, however, automobility tends to foster the dominance of these liberal values over the democratic values of cooperation, community, and commitment to the public good.

By compelling the auto industry to develop EV technology, and by publicly defining EVs as mixed public-private goods, the initial ZEV program posed a significant challenge to this ideology of automobility. Since the 1970s, of course, various hobbyists, businesses, and governments have shown renewed interest in experimenting with EVs.[67] But these precedents do not detract from the fundamentally innovative character of CARB's ZEV program, which becomes clear in light of two considerations.

First, as mentioned above, CARB's establishment of the program owed little to interest group lobbying. The public hearings that preceded the adoption of the ZEV program focused on the other three emissions classifications included in the Low-Emission Vehicle program, and there was little public discussion of ZEVs.[68] Indeed, both public debate and private investment followed rather than preceded CARB's announcement. According to a CARB staff member, "It appears there was a pent-up demand to start developing electric vehicles and advanced batteries that was unleashed by

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[66] Winner, "Do Artifacts Have Politics?" 32.

[67] Fogelberg, *Electric Car Controversy*, 48-54.

[68] Fogelberg, *Electric Car Controversy*, 57.

the ZEV mandate."[69] Given CARB's history and reputation, moreover, it seems reasonable to accept the agency's claim that it adopted the ZEV program to reduce air pollution.[70]

Second, the initial ZEV program employed a set of technical criteria that radically departed from the "race-travel-limousine" image of automotive technology, according to which cars are strictly private goods. From the beginning, CARB evaluated EV technology with the standard criteria of range, acceleration, battery life, and cost. In the early years of the program, however, CARB argued repeatedly that in addition to these criteria, "it is important to consider features like efficiency, maintenance, safety, durability, and environmental impact."[71] Indeed, in 1994 the agency undertook an explicit comparison of EVs and internal-combustion engines according to the criteria of economic cost and environmental impact.[72] In this comparison, EVs came out far ahead. Even when defending its program revision, the Board emphasized the importance of using a wide range of criteria to evaluate EVs:

> Staff believes that the differences between EVs and gasoline vehicles are likely to become their strongest attraction....[W]hile early market EVs may not offer ranges comparable to gasoline vehicles, they will offer the new convenience of home recharging (no trips to the gas station), along with other differences that make them unique, such as a quiet motor, long life, less maintenance (e.g., no oil changes or tune ups), reliable and durable electronic components, and peppy in-

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[69] Tom Cackette, "Explaining California's Continuum," in *Building the E-Motive Industry: Essays and Conversations for Creating an Electric Vehicle Industry*, ed. Scott A. Cronk (Warrendale, PA: Society of Automotive Engineers, 1995), 52-56, at 54.

[70] CARB, *Proposed Regulations for Low-Emission Vehicles and Clean Fuels, Final Statement of Reasons* (Sacramento, CA, July, 1991).

[71] CARB, *Technical Support Document, Zero-Emission Vehicle Update* (Sacramento, CA, April 1994), 12.

[72] Ibid., 39-51 The analysis included emissions of criteria pollutants from tailpipes and from power plants serving EVs, as well as some of the evaporative emissions associated with gasoline transport and use. Oil refinery emissions were not included.

> city acceleration, as well as the clean air benefits of zero tailpipe and in-use emissions. These benefits will be especially attractive to today's new car buyers, who typically own at least one other vehicle, and therefore may be interested in a vehicle with these advantages even if it does not offer the range of a gasoline car.[73]

By defending the importance of alternative technical criteria, the ZEV program partially opened what STS scholars call the "interpretative flexibility" of a technological artifact, as mentioned in the previous chapter.[74] It became more possible than at any time during the past eighty years to think realistically about an alternative to the race-travel-limousine. Moreover, by emphasizing the social and environmental benefits of EVs, CARB helped define EVs as something more than a consumer product. The agency effectively presented EVs as mixed public-private goods.

Automakers and entrepreneurs around the world responded to CARB's defense of alternative criteria with the promotion of a wide variety of EV technologies. At least one of these alternative technologies, the "neighborhood electric vehicle" (NEV), presents a powerful challenge to the individualism and privatism associated with conventional automobiles.[75] NEVs are lightweight, low-cost, low-speed, short-range EVs designed to balance the values of environmental protection, individual mobility, and local community. Their low cost and ease of operation promise increased mobility and social membership for the poor, elderly, and handicapped. Their short range (25-30 miles) and low top speed (25 mph) make NEVs a perfect complement to New Urbanist models of city planning that emphasize mixed-use development, pedestrian safety, and public

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[73] CARB, *Final Statement of Reasons*, 19.

[74] See Fogelberg, *Electric Car Controversy*, 2-3.

[75] Daniel Sperling, *Future Drive: Electric Vehicles and Sustainable Transportation* (Washington, DC: Island Press, 1995), chap. 4.

space.[76] Insofar as political participation is fostered by an urban setting with these attributes, NEVs may be said to embody strong democratic values.

Given their performance limitations, NEVs are intended to complement rather than replace conventional vehicles, just as many multi-car households currently use a pickup, van, or sports car for purposes not served by a mid-sized sedan. NEVs thus revive the turn-of-the-century notion of a hybrid transportation system, mentioned above, in which different automotive technologies serve different purposes. NEVs are not a panacea, of course, for the problems associated with conventional automobiles. But in combination with other policy measures, NEVs could be a key ingredient in a near-term strategy to reduce air pollution *and* a long-term strategy to combat the erosion of civic life associated with urban sprawl.

Unfortunately, during the course of the ZEV program, as the statements quoted above and in the next section suggest, CARB made significant changes in its criteria for evaluating EV technology. Despite its repeated acknowledgment that potential EV buyers would consider a variety of criteria, CARB increasingly emphasized the criteria of range and cost.[77] This narrowing of criteria necessarily put all types of EVs at a severe disadvantage in comparison to conventional automobiles.

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[76] Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream* (New York: North Point, 2000).

[77] When asked whether CARB had shifted its criteria between 1990 and 1996, one CARB staff member told me, "I think that's probably correct but also just a little bit understandable. When you're looking at whether the agency...should make a whole-hearted effort to get behind a certain technology, you're looking at what is the potential of its succeeding. If it's got this [wide] range of benefits, that speaks well for the possibilities of its succeeding. When you're...two years away, three years away from this being in peoples' hands...you've kind of got to look a little bit at a worst case scenario....When the range was so far below expectations at a cost that wasn't commensurate with that, you've kind of got to go, 'You know, all these things are great, but these things are this big and the range and cost issues are *this* big'" (Jack Kitowski. Interview by author. Sacramento, CA, May 28, 1999).

Moreover, the attributes of long range and low cost primarily benefit individual EV owners. CARB's shift in criteria thus conveyed an image of EVs as private rather than mixed public-private goods. As suggested above, people are less likely to govern their behavior toward a private good according to their other-regarding preferences. Additionally, studies have found that willingness to pay for private goods is more sensitive to price than willingness to pay for public or mixed goods.[78] This suggests that the initially high price of EVs may pose less of an obstacle if EVs are seen as mixed goods. Ironically, the agency's concern for consumer preferences led it to emphasize technical criteria that could be expected to weaken consumers' resolve to purchase EVs.

The Board's shift in technical criteria was driven by neither technical necessity nor consumer demand. Several studies have found that EV drivers are generally satisfied with EVs that do not meet the performance criteria established by conventional automobiles. In a 1997 study of Swiss EV drivers, for example, 50 percent reported that they were either "absolutely satisfied" or "rather satisfied" with the range of their EVs.[79] Satisfaction with EV range among drivers of Kewet and Microcar models reached 60 and 70 percent, respectively. Among EV drivers in Berlin, 62 percent said they were satisfied with the range of their EVs.[80] Even General Motors's own PrEView test program, which between 1994 and 1996 loaned prototypes of GM's EV1 to 700 drivers in 11 US cities for two week periods, found that 80 percent of test participants were satisfied with the

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[78] Green, "The Price Elasticity of Mass Preferences."

[79] Andreas Knie, Otto Berthold, Mikael Hård, Trond Buland, Heidi Gjoen, Michel Quéré, Wolfgang Streicher, Bernard Truffer, and Sylvia Harms, *Consumer Use Patterns of Electric Vehicles*, FS II 97-105 (Berlin: Wissenschaftszentrum Berlin für Sozialforschung, 1997), 88.

[80] Ibid., 70

range of their EVs.[81] These studies are admittedly biased by their reliance on current EV owners, who are presumably predisposed toward EVs. Nonetheless, the studies suggest that although range is an important issue in many drivers' minds, it is often not the most important issue. Nor has limited range prevented a high degree of overall satisfaction among EV drivers.[82]

More than technical or economic necessity, CARB's narrowing of criteria was a response to industry lobbyists who pressured CARB to emphasize criteria of range and cost. Environmentalists who lobbied for the preservation of alternative criteria, although supported by most of the public, lacked the industry's political clout. This explanation also remains incomplete, however, until it is made clear that the industry's clout owed a lot to the infrastructure and ideology of automobility. Moreover, CARB has repeatedly shown its capacity to challenge both automobility and the auto industry. Despite various constraints, the agency had the capacity to continue giving due weight to social and environmental criteria. It instead gradually focused its attention on range and cost, thus helping to define EVs as strictly private goods.

*Consumer Surveys and Public Deliberation*

CARB reinforced the effects of its shift in technical criteria with a corresponding shift in its assessment of public willingness to purchase EVs. Whereas the ZEV program initially emphasized the civic capacities of California citizens, especially their potential to

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[81] R. R. Purcell, "Make a Business Out of It." Document of testimony at CARB public workshop on consumer marketability of Zero-Emission Vehicles. El Monte, California. June 28, 1995.

[82] In a recent interview, a CARB staff member responsible for public outreach said that cost, not range, is the biggest issue. "The public is concerned about the cost of these vehicles, but they're supportive of the technology" (Analisa R. Bevan, Manager ZEV Implementation Section, California Air Resources Board. Interview by author, Sacramento, CA, May 28, 1999).

engage in public deliberation and experiential learning, over time the agency became fixated on a narrow conception of short-term consumer preferences.

The original two percent ZEV mandate would have required the sale of about 20,000 EVs in California in 1998. From the beginning, both critics and defenders of the ZEV program commissioned consumer surveys to predict whether automakers would be able to sell that many EVs. In its April 1994 Staff Report, CARB drew a very different conclusion from consumer surveys than it would in justifying the program change two years later. According to the 1994 Report,

> Surveys that are based upon stated preferences of consumers have limited use for a new product line such as electric vehicles, as they tend to measure consumer uncertainty rather than informed opinions. As consumer knowledge of electric vehicles increases, market studies may be better able to capture the value of electric vehicles attributes....Once survey participants reflected on their travel patterns and the potential benefits of home recharging, their perceived range needs were substantially lower that previous market surveys would suggest.[83]

In this statement from 1994, when the agency was still defending the 1998 ZEV mandate, CARB discounted surveys that showed low consumer enthusiasm for electric vehicles. It argued that surveys only showed consumers' lack of information. CARB claimed that once consumers were properly *informed* and had *reflected* on the issues—i.e., once they had deliberated as citizens—they would buy EVs.

In 1996 CARB again discounted consumer surveys as unreliable predictors of consumer behavior. This time, however, the Board ruled out the possibility of creating "informed opinions." Instead, CARB argued that actual consumer behavior would not support the sale of enough EVs to meet the two percent quota in 1998:

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[83] CARB, *Technical Support Document*, 34-35

> Certainly, public surveys indicated that the majority of Californians supported the original ZEV regulation and comments received at public workshops and hearings demonstrated that the majority of vocal stakeholders were against modifications to the regulation. But this does not necessarily indicate how the majority of Californians, as consumers, would view the ZEVs produced by manufacturers in 1998. Political polls and public opinion surveys may not accurately reflect actual consumer purchase behavior.[84]

While this statement from 1996 shows the same distrust of consumer surveys as in 1994, the later statement extends this distrust to citizens themselves. The Board explicitly discounted citizens' own statements regarding their willingness to purchase existing EVs. The agency thus conveyed an image of its constituents as self-interested consumers rather than responsible citizens potentially capable of acting in accord with their self-described other-regarding preferences.[85]

Despite agency statements to the contrary, CARB documents suggest that this change in the agency's use of consumer surveys was in no way dictated by the results of the surveys themselves. At the June 1995 CARB public workshop on EV marketability, workshop participants presented CARB with 1998 EV sales estimates ranging from 3,500 to 98,000 units.[86] These studies were generally of two basic types: technical constraint studies, which assess the number of households that could, in theory, meet their daily range requirements with an EV; and stated preference surveys, which ask respondents

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[84] CARB, *Final Statement of Reasons*, 34-35, emphasis added; see also 77, 42.

[85] In general, CARB officials seem to view the public as basically uninformed and potentially threatening to their work. A CARB staff member thus told me that public opinion does not influence "what we're supposed to do, doing right for the environment....It's something we have to react to and understand" (Evashenk, Interview by author).

[86] CARB, *Public Meeting*, 122.

hypothetical questions about the type of vehicle they would consider buying. The former tend to produce very high estimates and the latter very low estimates of EV sales.[87]

Even though CARB defended the proposed elimination of the 1998 mandate by referring to EV market research, *the agency never stated which studies it considered most reliable*. Indeed, interviews with CARB staff suggest that Board members did not rely on market research at all, but took the wide range of EV market estimates as an excuse to make their own intuitive best guess of what most drivers would expect in an electric vehicle.[88] The Battery Panel appears to have done the same thing.[89]

The Board was certainly right to note that consumers, as discussed above, often fail to live up to the environmental protection beliefs they express in surveys. But in presenting its decision to revise the ZEV program, CARB failed to acknowledge the comparative merits of different survey techniques. Although survey research has become increasingly sophisticated, numerous studies have shown how the individualized,

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[87] Kurani, Kenneth S., Thomas Turrentine, and Daniel Sperling, "Testing Electric Vehicle Demand in 'Hybrid Households' Using a Reflexive Survey," *Transportation Research* 1, no. 2 (1996): 131-50.

[88] When asked about the agency's use of consumer surveys, a CARB staff member said, "It really is a political judgment, because...there's no way to be certain whether those [surveys] are accurate or not....For every [survey] that has had very favorable response to lead acid you can find, obviously, somebody in the industry and some others [who] felt it was less favorable" (Evashenk, Interview by author). Another staff member said the consumer surveys were seen as a "much softer" issue than the battery technology: "that's an area where the Board members can look at themselves and the people they know and go, 'O.K., would a car with a fifty-mile range...be sufficient for me or the people I know?'....And yes, it's not scientific, but it's a pretty good kind of understanding" (Kitowski, Interview by author).

[89] "The Panel did not study the market for electric vehicles or the dependence of market potential on EV range and performance; indeed, we question the validity of existing, very divergent EV market potential estimates. EVs with advanced lead-acid batteries may well be able to gain applications in limited niche markets, but it seems clear that only batteries with substantially higher specific energy will give EVs the real-world driving range...required and/or perceived to be required by the majority of vehicle buyers and users (F. R. Kalhammer, and A. Kozawa, C. B. Moyer, and B. B. Owens. *Performance and Availability of Batteries for Electric Vehicles: A Report of the Battery Technical Advisory Panel*, Prepared for California Air Resources Board. El Monte, California, December 11, 1995, III.7-8).

unreflective setting established by the question-answer format of most polls tends to give an exaggerated picture of citizens' self-interest.[90] In the case of EV market studies, the stated preference method does not account for most respondents' utter lack of familiarity with EVs. Indeed, EV market surveys rarely account for the effect on range preference of consumer learning processes, recharging infrastructure, household fleet composition, or improvements in fuel gauge instrumentation that enable drivers to feel more secure with less range.[91]

In an effort to more accurately predict EV sales, one innovative study encouraged survey participants to reflect on their travel habits and needs with the help of a detailed questionnaire, three-day travel diary, informational video, and a balanced series of articles on EVs. This study, conducted by UC Davis researchers and presented at one of CARB's 1995 public hearings, estimated that purchases of *existing* EVs with a range of only 60-120 miles could account for 7 percent of annual light-duty vehicle sales in California, increasing to 15 percent with the availability of advanced batteries.[92] General Motors' PrEView test program took a similar approach, requiring drivers to complete travel diaries in which they reflected on their EV experiences. As noted above, GM

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[90] Aidan Davison, Ian Barns, and Renato Schibeci, "Problematic Publics: A Critical Review of Surveys of Public Attitudes to Biotechnology," *Science, Technology, & Human Values* 22, no. 3 (1997): 317-348; James S. Fishkin, *The Voice of the People: Public Opinion and Democracy* (New Haven: Yale University Press, 1995).

[91] Thomas Turrentine, Kenneth Kurani, and Daniel Sperling, "The Household Market for Electric Vehicles," Document of testimony at CARB public workshop on marketability of electric vehicles. El Monte, California, June 28, 1995.

[92] Actually, a full 10 percent of study participants said they would choose an EV with a range of only 60-80 miles, but when translating this figure into an assessment of annual sales, other factors, such as the staging of vehicle purchases, were taken into account, thus reducing the low-end estimate to 7 percent. An expanded account of the study appears in Kurani, Turrentine, and Sperling, "Testing Electric Vehicle Demand."

concluded that the vast majority were satisfied with their EVs.[93] Although these studies did not require participants to discuss the merits of EVs with other citizens (except perhaps with family members), they differed from stated preference surveys by providing an opportunity for informed thinking about a public issue. In this respect, they encouraged participants to engage in public deliberation.

Public deliberation is widely regarded as one of the most effective way of creating social trust, which as I suggested above, helps people bridge the gap between expressed other-regarding preferences and actual behavior.[94] In addition to creating more informed opinions and a sense of political membership, public deliberation can reassure citizens that other people share their views, providing an impetus to act according to their other-regarding preferences. Experimental psychologists have thus found that communication among strangers increases cooperation, even when the choices that follow are made anonymously and without binding or enforceable agreements.[95] Although CARB did not explicitly endorse individualized consumer surveys over the deliberative surveys conducted by UC Davis and GM, the agency's shift after 1994 to a more pessimistic prediction of consumer behavior implicitly endorsed the individualized approach.

The change in CARB's assessment of consumer surveys was compounded by the declining importance it accorded to experiential learning. Several studies have found that driving an EV usually changes people's opinions about electric vehicles, as well as their

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[93] When using their linear Market Dynamics Model, in contrast, GM predicted an EV market of only 3,500 units. This model conceptualizes consumer demand as a fixed, pre-existing value, unresponsive to public learning. See R. R. Purcell, "Make a Business Out of It."

[94] Adolf G. Gundersen, *The Environmental Promise of Democratic Deliberation* (Madison: University of Wisconsin Press, 1995).

[95] Lewinsohn-Zamir, "Consumer Preferences," 398.

driving habits and general views on transportation issues. A California study of driver responses to the 1991 Solectrica Force and Solar Car Festiva, for example, found that 96 percent of respondents had a "better" opinion of EVs after driving one.[96] A study of self-reported changes in driving habits among EV purchasers in Berlin, Germany, found that 66 percent became more defensive drivers, 23 percent planned their trips more carefully, and 26 percent reduced their total number of daily trips. Thirty-one percent claimed that since becoming EV drivers they had become more aware of the social implications of their transportation choices.[97] These results have led some observers to suggest that EVs might function as a transition technology, helping drivers get over their "addiction" to individualized forms of transportation in the same way methadone helps drug addicts.[98]

Consideration of experiential learning suggests that by justifying the program change with reference to *existing* consumer expectations, which had been shaped in response to conventional automobiles, CARB gave a false picture of how people would respond to EVs. The Board did occasionally acknowledge that citizens' views on EVs could be expected to improve with experience.[99] For the most part, however, after 1994 the Board increasingly discounted the possibility of citizen learning, arguing that "many consumers, even after they have participated in a demonstration program or have closely

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[96] Thomas Turrentine, Kenneth Kurani, and Daniel Sperling, "Market Potential of Electric and Natural Gas Vehicles" (Davis, CA: Institute of Transportation Studies, 1992). As a CARB staff member told me, referring to *existing* EVs, "You *have* to drive one....It's flat out fun, and I think that's why electric drives...as people get more exposure to them, will really succeed. We understand the air pollution benefit, but there's also a tangible benefit to the person driving....They don't need to be just like a gasoline car, because they are in many ways better" (Kitowski, Interview by author).

[97] Knie et al., *Consumer Use Patterns of Electric Vehicles*, 70-71

[98] Ibid., 73

[99] CARB, *Staff Report*, 20

examined their driving patterns, are still concerned about the limited ranges offered by currently available lead-acid batteries."[100]

Finally, CARB appears to not have considered how its public predictions of consumer behavior could easily become self-fulfilling prophecies.[101] CARB admittedly faced a paradox in this regard: a successful EV market launch *did* depend in part on correctly estimating probable EV sales, but any public indication by a governmental agency that sales would be lower than hoped could itself be expected to lower sales. If one evaluates CARB's decision solely according to the goal of maximizing near-term EV sales, the Board might have been justified in erring on the side of caution. But if the mission of government agencies is in part to promote strong conceptions of citizenship, as suggested above, the Board could have justifiably erred in the direction of assuming a potentially other-regarding public. Similarly, if trust in political institutions strengthens people's willingness to act as citizens, then the Board's reversal on the mandate could be expected to undermine whatever trust it had managed to create during the early years of the program. The Board thus reinforced its own pessimistic assessment of expected consumer behavior, thereby conveying a weak conception of citizenship.

The Board reinforced this image of citizenship, moreover, by claiming that its policy change represented nothing more than an accommodation to the laws of the market. As an academic discipline, economics has long drawn on the social prestige of

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[100] Ibid., 19

[101] Aside from the public hearings, CARB made very little effort to publicize the benefits of EVs. As a staff member told me, "We have a public information office...and we've done our part in terms of going to conventions and public events....But the gap that is missing is actually commercials, or radio, or TV, or newspapers or things like that that would really get some wholesale publicity on EVs and how much better they are....Our agency has not traditionally done that, so it's difficult for us to try to come up with a budget...[but we] would certainly encourage manufacturers to do that. We certainly haven't stood in the way, but we haven't done any of that ourselves, so it's a difficult area" (Kitowski, Interview by author).

modern science to reassure apprehensive citizens that what appears to be disorderly economic competition will in fact produce the public good, or at least public order, without state intervention. CARB's repeated references to the free market ideal thus made its decision seem both more impersonal and more in tune with the public good. Despite the agency's rejection of consumer surveys showing strong public willingness to buy EVs, its claim to have relied on economic science made the decision appear to be a matter of public will than agency discretion. Put differently, the Board's appeal to market necessity effectively suggested that the laws of nature could better represent California citizens than could the Board members themselves (let alone their elected representatives in the California legislature). As I argue in Chapter 6, CARB's implicit view that science represents citizens' best interests was only half wrong. It might make sense to think of science as publicly representative, but only if citizens participate in shaping science.

## Assessing CARB's Decision

This account of CARB's revision of the ZEV program will be of limited interest unless it addresses the question, "Did CARB make the right decision?"[102] No conclusive answer is possible, but even assuming the limited goal of promoting EVs, the above account makes clear that CARB certainly *may* have made the wrong decision. Credible evidence at the time suggested that advertising, public learning, and growing economies of scale would stimulate large numbers of consumers to buy existing EVs. Automakers

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[102] As things turned out, between December 1996 and December 1997, GM leased only 224 of its EV1 electric sports cars to consumers in California, and a smaller number in other states. Other automakers placed a total of 176 EVs with California consumers or fleets (CARB, *Zero-Emission Vehicle Biennial Program Review*, Sacramento, CA: July 6, 1998).

would probably have fallen short of the two percent quota in 1998, but not by as much as they predicted, and they might well have made up the difference within a reasonable time. Indeed, if CARB had consistently portrayed EVs as mixed private-public goods and its public as potentially responsible citizens, it would have been perfectly defensible for the agency to have maintained the 1998 sales mandate.

Beyond the question of whether or not CARB should have revised the ZEV program, this case study illustrates several aspects of the relationship between science and politics that subsequent chapters address from a more general perspective. First, the ZEV case shows that political action cannot be entirely reduced to a function of technical, economic, or sociological necessity. CARB made its decision to revise the ZEV program in response to various pressures and constraints, in a context of limited information about the probable outcomes of different options. And the final decision was to some extent the incremental product of previous decisions regarding the use of technical criteria and consumer surveys. But the agency did in fact make a *decision*. The ZEV program revision was not a passive reaction to technical necessity, economic imperatives, or interest group lobbying. This point will be useful to keep in mind for the more abstract analysis in later chapters of the relative influence of human and nonhuman factors in the making of science and technology.

Second, the ZEV case shows that conceptions of citizenship can have a powerful influence on the shaping of technology, and vice versa. Even if CARB did what was necessary to maximize long-term EV sales, the policy revision directed EV development toward high-performance technologies that are conducive to the existing transportation infrastructure and the weak conception of citizenship it fosters. CARB reinforced this weak conception of citizenship, moreover, by adopting a technocratic mode of policymaking. The agency publicly justified its policy revision with reference to technical experts as the voice of the public good, discounting the very statements it had solicited from the public itself. CARB's influence on EV technology is already apparent in the recent shift in priority, by both CARB and the major automakers, toward long-range hybrid gas-electric vehicles over pure EVs.[103] The agency's decision, rather than any aspects of the technology itself, thus struck a blow against one possible avenue of EV development. Although hybrids offer an effective way of promoting consumer familiarity with EV technology, they lack the civic benefits associated with short-range EVs. The ZEV case thus shows how a technocratic conception of policymaking and citizenship can perpetuate itself through the types of technological development it fosters.

It might be helpful to note here that although technocratic thinking continues to dominate contemporary policymaking, some government agencies have had considerable success in developing alternative models. Public officials have increasingly found that they cannot legitimate their policies with simple references to expert authority, as CARB attempted, because the various parties interested in shaping policy often do not recognize a single set of technical procedures as authoritative.[104] Since the 1970s, government

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[103] Regulations approved by CARB in November 1998 (CARB, *Resolution 98-53*, Sacramento, CA, November 5, 1998, 7-10), which go into effect for model year 2004, give partial ZEV credits for vehicles that achieve near-zero emissions, such as electric-gasoline hybrids, vehicles using fuel cells, and those meeting a new standard for "super-ultra-low-emission-vehicles." Another immediate effect of CARB's decision was that Silent Power, an EV developer owned by Germany's largest electric utility, RWE Energie, ended its sodium-sulfur battery development program. The company said the delay in the mandate meant the EV market would develop too slowly for them to justify the investments required for further development of that particular battery technology. Ironically, the company's sodium-sulfur program had been developed in direct response to the ZEV mandate in the first place. Sodium-sulfur batteries had promising performance characteristics but were plagued by safety problems on account of their high temperature operation. The RWE program was the last remaining effort focused on the sodium-sulfur battery. See Kalhammer et al., *Performance and Availability of Batteries*, IV.6; Taylor Moore, "The Road Ahead for EV Batteries," *EPRI Journal*, Vol. 21, No. 2 (March-April, 1996), 12.

[104] See Sheila Jasanoff, "Science, Politics, and the Renegotiation of Expertise at EPA," *OSIRIS* 7 (1992): 195-217.

agencies have increasingly been forced to turn from making simple statements of fact—"substance X is a carcinogen"—to providing ever more detailed expositions of the *procedures* whereby facts were determined. Since different procedures in policy-relevant science often lead to very different results, with different political implications, many policymakers have found themselves compelled to adopt an implicitly constructivist conception of science and technology.

That is to say, policymakers have repeatedly discovered, through bitter experience, that they can only protect their regulatory decisions from repeated legal and political challenge by incorporating as many relevant political interests as possible into the establishment of technical advisory procedures.[105] In our skeptical age, as CARB discovered, simply asserting that a policy is supported by "the technical evidence" does not end debate. When the stakes are high, reliance on technical advisors has often not prevented ongoing challenges to science-based public policy.

Indeed, policymakers have found that, paradoxically, the integration of diverse political interests often proves effective in establishing the authority of regulatory science. Both government agencies and their advisory committees are finding that they must enforce a boundary between science and politics so as to maintain their respective types of legitimacy. But they are also finding that this boundary must be flexible and permeable enough to allow scientists and agency officials to negotiate decisions acceptable to both sides.[106]

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[105] Sheila Jasanoff, *The Fifth Branch: Scientific Advisors as Policymakers* (Cambridge: Harvard University Press, 1990), chap. 11.

[106] David Guston has thus developed the notion of a "boundary organization" that provides an institutional context for such negotiations. See David H. Guston, "Stabilizing the Boundary between U.S. Politics and Science: The Role of the Office of Technology Transfer as a Boundary Organization," *Social Studies of Science* 29, no. 1 (1999): 87-112.

For the most part, such negotiations have only included representatives of elite interest groups. This raises the question of whether these efforts to bridge the flexible boundary between technical advisory boards and government agencies adequately *represent* the public will. Are these technicians and policymakers the public's representatives? More generally, what would be required of a strong democratic conception of the relationship between scientific and political representation? Addressing such questions will be much easier once we better understand the conceptual logic and historical sources of the technocratic approach toward science and politics apparent in the California ZEV program.

# CHAPTER 3

# MODERN SCIENCE, INSRUMENTALISM, AND LIBERAL DEMOCRACY

For by Art is created that great LEVIATHAN called a COMMON-WEALTH
– Thomas Hobbes

We have it in our power to begin the world over again.
– Thomas Paine

The preceding chapter argued that contemporary policymaking suffers from a disjunction between the traditional image of science as an apolitical account of objective fact and the often blatant intrusion of political values and decisions into the creation of technical knowledge. The electric vehicle case suggests that efforts to legitimize policy by reference to technical knowledge often conceal the social biases and political interests embedded in technical criteria and artifacts. More generally, the defense of a rigid division between science and politics, I argued, supports technocratic politics and the implicit propagation of a consumerist image of citizenship. In the next chapter, I consider various criticisms of modern technocracy, most of which have conceived of technocracy and democracy as opposites. Indeed, when democracy is understood as the rule of the many and technocracy as the rule of the few, or democracy as the rule of popular will and technocracy as the rule of disembodied reason, they seem to have little in common. This does not yet explain, however, why technocratic forms of politics have had such staying power in societies ostensibly committed to democratic ideals.

In this chapter, I locate the answer to this question in a set of conceptual resources that technocracy has shared with liberal democracy, originating within the practices of modern natural science.[1] To some extent, of course, technocracy has no political allegiance.[2] Individual experts often have opposing political views, and technocratic decisionmaking has characterized liberal, socialist, conservative, and fascist regimes. But in Western political thought, there has been a powerful affinity between technocracy and liberal democracy.

In the first section of this chapter, I frame my argument in terms of the ancient tension between immanence and transcendence in the philosophy of natural science—or to put it less grandiosely, the problem of linking the concrete practices of scientific investigation with abstract laws of nature; and conversely, that of linking abstract laws with concrete natural phenomena and human problems. During the seventeenth century, dissatisfaction with the prevailing mode of managing these problems led to changes in the relationship between science and common sense, and between knowledge and power. Unlike their Aristotelian predecessors, the founders of modern science insisted on a sharp separation between scientific and lay knowledge, and a correspondingly close linkage of scientific knowledge and instrumental power.

Seventeenth-century thinkers thus rejected much of the basic outlook of Aristotelian science, but they still faced the problem of connecting the universal claims of scientific knowledge with the particularities of scientific practice. The second section of the chapter shows how they addressed this problem by conceptualizing natural science, especially experimental science, as a distinctly *public* form of knowledge. Drawing on

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[1] At a more general level, of course, technocratic conceptions of politics can be traced as far back as Plato's *Republic*. My concern in this chapter, however, is not to provide a history of technocracy, but to examine the conceptual dynamic between technocracy and liberal democracy.

[2] Frank Fischer, *Technocracy and the Politics of Expertise* (Newbury Park, CA: Sage Publications, 1990), 20-21.

recent work in the history of science, I argue that early experimental scientists legitimized the knowledge they produced by constituting the community of scientists as a distinctly open community, despite its actual exclusivity. Modern science came to rely on the notion that scientific claims are produced and validated both before and through a witnessing public.

The third section of the chapter explains how early liberal-democratic thinkers drew on the notion of science as public knowledge to manage a key problem in modern political thought, analogous to that of relating immanence and transcendence in the philosophy of science: how can a sovereign political authority legitimately represent particular, diverse, freely acting citizens? Expanding on Habermas's account of the bourgeois public sphere, I argue that the liberal-democratic ideal of a rational public that holds government accountable draws in various ways on the modern scientific ideal of a witnessing public that validates the results of scientific experiments.

Before proceeding, a few words of warning regarding terminology are in order. The division between technical expertise and common sense that seemed so self-evident to the California policymakers discussed in Chapter 2 was far from clear for the Renaissance intellectuals who shaped the early development of modern science. It is thus very difficult to discuss the "relationship between science and politics" without assuming conceptions of each that are themselves products of the historical transformation known as the Scientific Revolution.[3] It is important to recognize, therefore, that "science" and "politics," though clearly distinguished since ancient times, did not refer to specialized and professionalized spheres of activity until well into the nineteenth century.

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[3] Steven Shapin, *The Scientific Revolution* (Chicago: University of Chicago Press, 1996), 164-5.

Enlightenment thinkers conceived of scientific, political, economic, and religious questions as far more closely intertwined than the rigid divisions established by the modern professions would lead one to believe. Indeed, until the nineteenth century, natural philosophical knowledge was produced by amateurs. The term "scientist" did not appear until 1833, coined by William Whewell. The French term "science" long meant only knowledge in a general sense. In English the equivalent term was "natural philosophy," which remained in use until the late-nineteenth century. The English word "science" did not acquire its current meaning until the early twentieth century.[4] This does not mean that one cannot study seventeenth-century science as a set of practices relatively distinct from those of politics or religion. But one must pay special attention to interactions between different spheres of activity, and try to avoid reading current conceptions of science back into a context where they did not exist. As I argue in later chapters, prevailing conceptions of natural science do not even work very well for understanding what scientists do today.

Similarly, it will be important to keep in mind that our current disciplinary division between the philosophy of science and its ostensible topic of study, the natural sciences, was largely unknown until the nineteenth century. Seventeenth- and eighteenth-century natural philosophers saw themselves as philosophers at large. Because they were in the process of creating a new form of intellectual activity, they were compelled to engage simultaneously in *producing* natural philosophical knowledge and *justifying* it as philosophical. Twentieth-century academic philosophers of science,

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[4] Dorinda Outram, "Science and Political Ideology, 1790-1848," in *Companion to the History of Modern Science*, ed. R. C. Colby, G. N. Cantor, J. R. R. Christie, and M. J. Hodge (London and New York: Routledge, 1996) , 1008-1023, at 1012-13.

in contrast, have focused their attention on formal questions of scientific justification, largely ignoring scientific practice. Natural scientists, for their part, usually concentrate on producing substantive knowledge without much concern for the philosophical adequacy of whatever canons of justification currently dominate their particular field.

Recent empirical studies of scientific practice have called into question this split between methodology and practice, justification and discovery. As I show in Chapter 5, STS scholars have become increasingly interested in the way methodology often serves less as a guide for scientific practice than as a rhetorical resource for the public legitimation of scientific knowledge. Similarly, a key theme in recent history of science has been the relationship between the methodological norms of science and concrete scientific practice. According to Steven Shapin,

> There is much to commend a revisionist view that formal methodology is to be understood as a set of rhetorical tools for positioning practices in the culture and for specifying how those practices were to be valued. This is not, however, to deny formal methodology a role in seventeenth-century science. Methodology may be in part, as it has been called, a "myth," but myths may have real historical functions.[5]

It is important, in other words, to neither conflate myths with practices, nor to neglect the effect of myths on practices. This chapter is concerned with one of the key historical functions of the myth of modern scientific method: the legitimation of liberal-democratic politics.

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[5] Shapin, *Scientific Revolution*, 95.

## Modern Conceptions of Knowledge, Experience, and Power

The Scientific Revolution is a much contested concept, but in general terms it can be said that during the sixteenth and seventeenth centuries a series of fundamental transformations occurred in the dominant Western conception of the physical world.[6] In astronomy, an earth-centered cosmos replaced a sun-centered one. In physics, quantities subject to precise measurement took the place of Aristotelian qualities subject to common sense perception. In natural philosophy, an atomistic and mechanistic conception of nature gained ascendance over the holistic view of the ancients. These transformations were neither immediate nor complete, and elements of the Aristotelian worldview persisted or reappeared at various points well into the nineteenth century. But as natural philosophers began to construct the history of "the Scientific Revolution," the scientific ideas of previous eras were gradually reinterpreted to eliminate their non-mechanical elements.[7] By the middle of the seventeenth century, the trend among European philosophers was to see all matter as governed by linear and uniform causal mechanisms, susceptible to precise measurement and quantification in terms of size, shape, and motion. For the purposes of this chapter, the key feature of the Scientific Revolution was the transformation it effected in the relationships among knowledge, power, and common sense.

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[6] The literature on the Scientific Revolution is immense. For recent overviews, see John A. Schuster, "The Scientific Revolution," in *Companion to the History of Modern Science*, ed. Colby et al., 217-42; and the excellent bibliographic essay in Shapin, *Scientific Revolution*, 167-211.

[7] Schuster, "The Scientific Revolution," 238-39.

*Science and Common Sense*

Aristotelian science was largely compatible with everyday experience. Aristotle argued that because the "form" of an object is always embodied in its "matter," forms can be perceived. In contrast to Plato, who conceived of the Forms as invisible Ideas and everyday objects as mere reflections of the Forms, Aristotle believed that ideal forms are "contained in" everyday objects. Similarly, Aristotle's notion that bodies move toward their natural ends—that an object rises because of the "fire" it contains or falls because it has more "earth" than the air around it—seemed to fit common sense observation.[8] Aristotelian philosophy thus assumed a basic congruence between essence and existence, between how the world is and how we experience it.

This is not to say that Aristotelian science was purely inductive. The conclusions of Aristotelian science were to be deduced from generalizations from experience, and these generalizations were not the result of controlled experiments, nor often even concrete observations. Rather, Aristotle identified experience with common sense, with what "everybody knows." The sun sets in the west; heavy bodies fall; an arrow shot up in the air falls back to same spot. Such generalizations provided the starting points for a science of nature in harmony with common sense.[9]

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[8] Aristotle's assumption of a basic harmony among nature, sense experience, and knowledge is wonderfully expressed in the opening passage of his *Metaphysics*: "All men by nature desire to know. An indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves; and above all others the sense of sight. For not only with a view to action, but even when we are not going to do anything, we prefer sight to almost everything else. The reason is that this, most of all the senses, makes us know and brings to light many differences between things" (Aristotle, *Metaphysics*, I.i, in *A New Aristotle Reader*, ed. J. L. Ackrill [Princeton: Princeton University Press, 1987], 255).

[9] Shapin, *Scientific Revolution*, 81.

By the late-sixteenth century, this epistemological optimism was being challenged by a variety of developments. The publication in 1543 of Copernicus's *On the Revolutions of the Celestial Spheres*, for example, although not widely accepted until much later, suggested that celestial motion does not correspond to common sense perception.[10] More generally, suspicions toward common sense were strengthened by the renewed faith in human creativity associated with Renaissance humanism. Although humanism inspired new efforts to understand the natural world, it also suggested that knowing was itself a creative activity. Humanism thus fostered the idea of "maker's knowledge," later associated with Francis Bacon, Giambattista Vico, and Thomas Hobbes, which asserted that people could only know what they had made themselves.[11]

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[10] J. R. Ravetz, "The Copernican Revolution," in *Companion to the History of Modern Science*, ed. Colby et al., 201-216.

[11] Vico placed Baconian natural science, as well as other disciplines devoted to the study of particular facts and events, such as philology or history, under the heading of *coscienza*. This form of study could yield *certain* knowledge, necessary for daily life, but potentially false. *Scienza*, in contrast, could provide *true* knowledge. Scienza included the study of all those things human beings had made themselves, such as logic, mathematics, poetry, and art. Experimental science fell into an interesting midpoint within Vico's division between certain and true knowledge. On the one hand, Vico agreed with Hobbes that because nature had not been created by human beings, natural philosophy could not rely upon the empirical study of nature.

> Whoever reflects on this cannot but marvel that the philosophers should have bent all their energies to the study of the world of nature, which, since God made it, He alone knows; and that they should have neglected the study of the world of nations, or civil world, which, since men had made it, men could come to know (Vico, *The New Science of Giambattista Vico*, trans. Thomas Goddard Bergin and Max Harold Fisch [Ithaca, NY: Cornell University Press, [1948]1984], 96, par. 331).

On the other hand, however, Vico thought natural scientists might acquire true knowledge of those natural phenomena they (re)create in their laboratories. "The things which are proved in physics are those to which we can perform something similar, and ideas about natural things which are thought to have the most perfect clarity, and on which there is the completest consensus, are those to the support of which we can bring experiments by which we so far imitate nature" (*De Antiquissima*, quoted in Isaiah Berlin, *Vico and Herder: Two Studies in the History of Ideas* [London: Hogarth Press, 1976], 20; see also 110). If human beings can only know what they have made, they can know nature insofar as they make it themselves in the lab. For Vico, as Einstein would also remark, insofar as human science refers to reality, it is not certain; and insofar as it is certain, it does not refer to reality (Arthur Child, "Making and Knowing in Hobbes, Vico, and Dewey," *University of California Publications in Philosophy* 16, no. 13 [1953]: 271-310, at 286). See also Antonio Pérez-Ramos, *Francis Bacon's Idea of Science and the Maker's Knowledge Tradition* (Oxford: Clarendon Press, 1988).

The notion that knowledge of the natural world was to some extent a human creation opened the door to epistemological skepticism, also fostered by the first Latin publication in 1562 of the *Pyrrhonian Hypotyposes* by the ancient skeptical philosopher Sextus Empiricus.

Sixteenth-century skeptical philosophers, following the ancient Skeptics, obsessively examined a wide range of everyday instances in which common sense apparently failed to reveal the truth about nature. Distant objects appear smaller than they are; a stick partially submerged in water appears bent; vivid dreams seem real. Both Protestant Reformers and Catholic Counter-Reformers employed skeptical arguments to assert the impossibility of certain knowledge in either religion or politics.[12]

Doubts about the reliability of human knowledge, of course, were nothing new. The dismal view of ordinary sense experience expressed in Plato's cave analogy had reappeared in the Christian doctrine of original sin. Christian teachings long maintained that human beings, and thereby human sense perceptions, are fundamentally flawed. Medieval Christendom considered natural philosophy an acceptable way to glorify God, but viewed with suspicion any suggestion that human beings might be capable of understanding God's creation without the help of the Church.

Nonetheless, the above developments contributed to a gradual erosion of the ancient assumption of an essential harmony between human sense perception and the natural world. According to Hobbes, for example, "Every man hath so much experience

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[12] The Protestants argued that skepticism supported religious freedom; the Catholics claimed it proved the need to accept Church doctrine on faith. Some members of each group embraced *ataraxia*, the rejection of all claims to knowledge and a consequent suspension of political commitments. Removing the epistemological grounds for political action, it was argued, would lead citizens to obey established authorities. See Richard H. Popkin, *The History of Skepticism from Erasmus to Spinoza* (Berkeley: University of California Press, 1979), chaps. 1-2.

as to have seen the sun and other visible objects by reflection in the water and in glasses, and this alone is sufficient for this conclusion: that colour and image may be there where the thing seen is not."[13] Bacon argued that "as an uneven mirror distorts the rays of objects according to its own figure and section, so the mind, when it receives impressions of objects through the sense, cannot be trusted to report them truly, but in forming its notion mixes up its own nature with that nature of things."[14] For many philosophers at this time, the world was no longer as it seemed.

The deceptions of common sense led prominent seventeenth-century thinkers, including Galileo, Descartes, and Locke, to distinguish between *primary qualities*, which belong to the essence of things and cannot be experienced, and *secondary qualities*, which are mere appearances and do not resemble anything in the object. Our experience of secondary qualities is caused by an object's primary qualities, but the former do not tell us anything essential about the latter.[15] The sweet smell of a flower, for example, or the white color of snow, are secondary qualities not located in the objects but produced in our minds by the primary qualities of those objects. Primary qualities include such

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[13] Hobbes, *The Elements of Law, Natural and Politic*, ed. J. C. A. Gaskin [Oxford: Oxford University Press, 1994], I.ii.5. From this and other considerations Hobbes concludes that our sense impressions are not directly of the things outside of us, but of the motions inside our bodies. These motions, are caused, however, by the interaction between the motions of real things outside of us and our internal motions. "And from thence also it followeth, that whatsoever accidents or qualities our senses make us think there be in the world, they are not there, but are seemings and apparitions only. The things that really are in the world without us, are those motions by which these seemings are caused" (*Elements*, I.ii.10).

[14] Bacon, *The Great Instauration*, in *Selected Writings of Francis Bacon*, ed. Hugh G. Dick (New York: Modern Library, 1955), 444-45. A century later, Voltaire, the great popularizer of modern science, ridiculed the pretensions of the learned, but also argued that common sense perceptions easily deceive, as when we see the sun as being "about two feet in diameter, when in truth it is a million times bigger than the earth." Voltaire, "Prejudices of the Senses," *Pocket Philosophical Dictionary*, in *The Portable Voltaire*, ed. Ben Ray Redman (New York: Viking Press, Inc., 1949), 180.

[15] See John Locke, *An Essay Concerning Human Understanding*, ed. Peter H. Nidditch (Oxford University Press, [1689] 1975), Bk. II, chap. viii.

properties as bulk, number, and motion, which unlike secondary qualities, lend themselves to precise measurement. This distinction, as Shapin puts it, "drove a wedge between the domain of philosophical legitimacy and that of common sense."[16] As we shall see, it also drove a wedge between natural scientists and lay citizens that has proven extremely difficult to remove.

This is not to say that common sense experience was unimportant for the new science. On the contrary. Among the key maxims of the emerging worldview was the humanist injunction to favor the evidence of one's own eyes over textual, ecclesiastical, or political authorities. Truth was to be founded upon the evidence of individual sense perception and subsequent internal reflection on one's perceptions. This ideal was captured in the Royal Society's motto, *Nullius in verba* (On no man's word), and in Locke's claim that the greatest threat to true knowledge lay in

> "*the common recieved Opinions*, either of our Friends, or Party; Neighborhood, or Country....As if honest, or bookish Men could not err; or Truth were to be established by the Vote of the Multitude."[17]

This appeal to individual sense perception as a source of knowledge constituted a radical challenge to the Christian doctrine of the fall. It also paralleled and drew strength from the Reformation claim that Christians could interpret the Bible for themselves, without the mediation of priests. If Protestants could read God's Holy Scripture, the argument went, scientists could read God's other book, the Book of Nature.[18] In this respect, as I

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[16] Shapin, *Scientific Revolution*, 53.

[17] Locke, *Essay Concerning Human Understanding*, Bk. IV, chap. 20, sect. 17. See also Bk. IV, chap. 15, sect. 6. For Locke's qualification of this position with regard to the knowledge used in everyday life, see Bk. IV, ch. 11, sect. 10.

[18] Shapin, *Scientific Revolution*, 78.

show in Chapter 5, advocates of the new science created an image of epistemic individualism that contradicted the cooperative character of much scientific inquiry.

So how did the founders of modern science reconcile their epistemological individualism with their skepticism? How could they, like the California policymakers, simultaneously embrace and reject the common sense claims of non-experts? Well, the early defenders of individual experience rarely meant *actual* experience. Rather, especially for the "rationalist" proponents of the new science, including Galileo, Pascal, Descartes, and Hobbes, "experience" meant the hypothetical experience of Everyman. Many of Galileo's famous inclined plane experiments were probably thought experiments and were never performed. Hobbes, though sometimes acknowledging the need for laboratory experiments, ridiculed those "who content themselves with daily experience, which may be likened to feeding upon acorns."[19] In this respect, and despite their attacks on Aristotelian philosophy, many seventeenth-century thinkers retained much of Aristotle's notion of experience as a universal statement of fact. Experience was not "what happened," but "what happens."[20]

This rationalist conception of common sense was challenged, but only in part, by the experimentalist approach to natural philosophy. Francis Bacon and Robert Boyle moved beyond experience to experiment. Or rather, they developed an experimental

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[19] Hobbes, *De Corpore*, in *Body, Man, and Citizen*, ed. Richard S. Peters (New York: Crowell-Collier Publishing Co., Collier Books, 1962), I.i, cited hereafter as *De Corp.* At the same time, one should note, Hobbes thought common sense a far more reliable guide than Scholastic philosophy.

[20] Shapin, *Scientific Revolution*, 80-85. On seventeenth-century conceptions of knowledge and experience, see Peter Dear, *Discipline and Experience: The Mathematical Way in the Scientific Revolution* (Chicago: University of Chicago Press, 1995); Charles B. Schmidt, "Experience and Experiment: A Comparison of Zabarella's View with Galileo's in *De motu*," *Studies in the Renaissance* 16 (1969):80-137; Julian Martin, *Francis Bacon, the State, and the Reform of Natural Philosophy* (Cambridge: Cambridge University Press, 1992).

notion of experience, emphasizing not what "everyone knows," but what actually happened in a particular instance. Science was to be composed not of generalizations concerning "how stones fall," but of reports relating how a particular stone fell in a particular place, as seen by particular observers. According to Bacon, "Neither the naked hand nor the understanding left to itself can effect much. It is by instruments and helps that the work is done, which are as much wanted for the understanding as for the hand."[21] Indeed, not even instruments are good enough, Bacon argued, for they merely enlarge the flaws inherent in human sense perception. A telescope will enable a person to see farther, but it will not eliminate many of the optical illusions created by the naked eye. Bacon concluded that "all the truer kind of interpretation of nature is effected by instances and experiments fit and apposite; wherein the sense decides touching the experiment only, and the experiment touching the point in nature and the thing itself."[22] Objectivity is thus guaranteed by allowing the experiment to mediate between the scientist and nature. This suggests that despite the experimentalists' embrace of concrete experience, they still saw a need for filtering and controlling that experience.

By prescribing rules for conducting experiments, the experimentalists no less than the rationalists found ways of relegating the common sense experience of ordinary people to the margins of science. Scientific "method" provided a way of disciplining the mind so as to render experience rational.[23] Doing science without method, Bacon argued, would be "Just as if some kingdom or state were to direct its counsels and affairs not by

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[21] Francis Bacon, *Novum Organon*, in *Selected Writings of Francis Bacon*, ed. Hugh G. Dick (New York: Modern Library, 1955), I, aph. 2, 461.

[22] Bacon, *Novum Organon*, I, aph. 50, 474.

[23] Shapin, *Scientific Revolution*, 90-96.

letters and reports from ambassadors and trustworthy messengers, but by the gossip of the streets."[24] Expansion of knowledge depended upon a "studied correction of sense by reason."[25] Experimental science thus offered emancipation from the deceptions of vulgar sense experience, but it did so by means of an esoteric method that was in practice available only to the educated. Science was thus conceived as a medicine too potent for those who needed it most. And common sense was an illness most valuable to those who had freed themselves from it.

This paradoxical conception of science and common sense is still very much alive today. It was apparent in the stance of California policymakers toward the thousands of people who wrote to the agency in support of the ZEV mandate, many saying that they personally would consider buying an electric vehicle. As we saw in the previous chapter, agency officials simultaneously dismissed lay citizens' claims concerning their commitment to EV technology *and* argued that the ZEV program had to be brought in line with the common sense notion that a true automobile has a range of at least 80-100 miles. Similarly, although CARB repeatedly said that lay participants at the agency's public hearings had provided much useful input, the Board also made clear that all this input could not be relied upon, since it lacked the agency's expertise.[26] Like the seventeenth-century experimentalists, the California policymakers idealized common sense in the abstract while denigrating its concrete manifestations.

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[24] Quoted in Ibid., 87.

[25] Quoted in Ibid., 93.

[26] According to one staff member, "All these people said, 'Hey, we want you to maintain the ZEV program.' How many of those thousand people that wrote us mail in '96 would be willing to lease a vehicle that has a shorter range and costs more? Not many. So you have to take them into consideration, but if you're looking at the facts, and if you're looking at the technology, you're looking at the cost effectiveness...that's more important than when people in a more visceral reaction make their comments (Evanshenk, Interview by author).

*Knowledge and Power*

The contemporary tension between science and democracy can also be traced to another key feature of the Scientific Revolution: the newly emerging conception of the relationship between knowledge and power. In most respects, ancient philosophers had maintained a strict boundary between knowledge and power. Socrates's attempt to bring philosophy to bear on political life led to his execution, and Plato drew the consequences in his assertion that the rule of philosopher-kings would depend on a complete restructuring of society. Although Aristotle believed that philosophical and practical knowledge rely on each other in various ways, he contrasted those who possess wisdom (*sophia*), with those who show prudence (*phronesis*), saying of the former: "their knowledge is exceptional and marvellous and profound and supernatural, but useless, because the objects of their search are not human goods."[27] Philosophy, strictly speaking, was to be pursued for its own sake, not for any practical purposes.

By the seventeenth century, the need for a practical philosophy was readily apparent. The gradual breakdown of traditional authorities from the late-medieval period onward had brought about a state of continual religious and political unrest, culminating in the Thirty Years War and the English Civil War. Many philosophers came to believe that the prevailing mode of academic philosophy could never remedy such controversies. The Schools were widely condemned for their pedantic reliance on ancient texts, and for their method of examining philosophical questions through "disputation," based on the doctrine that every question has several equally valid and mutually incompatible answers.

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[27] Aristotle, *Nicomachean Ethics*, VI.vii.

Hobbes complained, for example, that Scholastic philosophers achieve no progress in knowledge, constantly contradict themselves and each other, and fail to settle disputes. Whatever conclusions they do eventually reach, he argued, are hopelessly biased.

> This part of Philosophy is in the same situation as the public roads, on which all men travel, and go to and fro, and some are enjoying a pleasant stroll and other are quarelling, but they make no progress.[28]

In a similar vein, Bacon argued that "the sciences we now possess are merely systems for the nice ordering and setting forth of things already invented...." What was needed, he said, are "methods of invention for directions for new works."[29]

In this context, many saw in experimental science a promise of untold practical benefits. Seventeenth-century natural philosophers sought to abandon the litigious debates of the Schools by attending to things rather than words, experimental evidence rather than ancient authorities, fixed rules of method rather than rhetorical tools of persuasion. The new science was widely perceived, rightly or wrongly, as the source of many technological innovations. In *De Cive*, for example, Hobbes writes that

> whatever is beautiful in buildings, strong in defence-works and marvellous in machines, whatever in short distinguishes the modern world from the barbarity of the past. is almost wholly the gift of Geometry; for what we owe to Physics, Physics owes to Geometry. If the moral Philosophers had done their job with equal success, I do not know what greater contribution human industry could have made to human happiness....But as things are, the war of the sword and the war of the pens is perpetual.[30]

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[28] Thomas Hobbes, *On the Citizen*, ed. Richard Tuck and Michael Silverthorne (Cambridge: Cambridge University Press, 1998), Epistle Dedicatory, 4-5, cited hereafter as *De Cive*. See also Hobbes, *Elements*, I.xiii.3.

[29] Bacon, *Novum Organon*, I, aphor. 8, 462.

[30] Hobbes, *De Cive*, Epistle Dedicatory, 4-5.

Whereas Scholastic philosophy had offered only endless controversy, geometry and the physical sciences were thought to have produced useful technologies. And whereas Plato saw in the practical use of knowledge a threat to its truth, the founders of the new science thought instrumental power provided a test of philosophical truth. "For fruits and works," Bacon writes, "are as it were sponsors and sureties for the truth of philosophies."[31]

Beyond its promised technological benefits, by providing a reliable method for securing knowledge, the new science also promised a remedy for the widespread epistemological skepticism apparently corroding the social fabric. If a reliable method could be found for reading the Book of Nature, it might secure knowledge in other areas of life as well. Hobbes's *Leviathan* thus offered a deductive demonstration, modeled on geometry, of the grounds of civic obligation. And as I show below, Boyle's experimental philosophy relied on a set of social norms and practices widely deemed conducive to civil peace.

This notion that the new science could serve instrumental purposes stood in tension with the division it asserted between science and common sense. If science could only be developed in isolation from the world of everyday experience, how could it solve problems within that world? If science required a method inaccessible to laypeople, how could it help them end their controversies? Far from resolving the ancient tension between knowledge and power, modern science internalized it. How was this tension managed? How did natural philosophers establish their enterprise as simultaneously disinterested and useful?

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[31] Bacon, *Novum Organon*, I, aphor. 73, 492.

## Science as Public Knowledge

Answers to these questions can be found in the strategies developed by seventeenth-century experimentalists for employing various conceptions of "the public" in the making of natural science. Experimental philosophers granted the notion of publicity—and, to some extent, actual members of the lay public—a key role in the conduct and rhetorical portrayal of scientific experiments. The notion of publicity served as a mediator between the local and universal, practical and aesthetic dimensions of science outlined above. Associating science with publicity allowed the experimentalists to plausibly claim that the knowledge they produced was both universally true and locally applicable.

Thinking of scientific work as a fundamentally public activity goes against the long-standing image of science as the solitary pursuit of individuals. Aristotle argued, for example, that although "the wise man, no less than the just one and all the rest, requires the necessaries of life...the wise man can practice contemplation by himself, and the wiser he is, the more he can do it."[32] Over two-thousand years later, the first Nobel Prize for Literature awarded to an American went to Sinclair Lewis for *Arrowsmith*, in which the protagonist eventually abandons wife, child, and colleagues to retreat with a single friend to a cabin in the woods where they unlock nature's secrets in isolation.[33] From mountain tops and deserts to libraries and laboratories, the pursuit of truth in Western culture has long been associated with social isolation. And in part for good reason—as any doctoral candidate can attest!

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[32] Aristotle, *Nicomachean Ethics*, X.vii.

[33] Sinclair Lewis, *Arrowsmith* (1925).

But to say that scientific work is socially mediated need not contradict the relative isolation that science often requires. As Jan Golinski points out, in accord with philosophers such as Dewey and Wittgenstein, just because scientists are sometimes deliberately *antisocial* does not mean science is *asocial*.[34] That is, the claim that scientists must sometimes work in relative isolation only makes sense within a social context that associates truth with autonomy. Also, even when scientists work alone, they think and act with languages and practices developed in society. Moreover, even if scientific propositions are initially produced in relative isolation, their truth status has usually been thought to depend on public validation. Karl Popper thus argued that scientific objectivity depends not on the virtues of particular scientists, but on the process of public scrutiny to which they subject their hypotheses.[35]

The question is, however, *which* public? Popper argued that a scientific test of experience "is 'public' if everybody who takes the trouble can repeat it."[36] As we shall see, restricting science's public to those people capable of "taking the trouble" effectively excludes laypeople from the making of science. Science's public thus designates a more select group than the general public or the notion of publicity. On the one hand, of course, given inevitable limitations on lay competence, this was and remains a necessary aspect of scientific practice. As we shall see, however, the notion of an exclusive

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[34] Jan Golinski, *Making Natural Knowledge: Constructivism and the History of Science* (Cambridge: Cambridge University Press, 1998), 81-84. See also Steven Shapin, "'The Mind is Its Own Place': Science and Solitude in Seventeenth-Century England," *Science in Context* 4 (1990): 191-218, esp. 195.

[35] Karl R. Popper, *The Open Society and Its Enemies*, 2 vols., 5th rev. ed. (Princeton: Princeton University Press, 1966) 2: 217-18.

[36] Ibid., 218.

scientific public has long stood in tension with scientists' efforts to enlist a more inclusive notion of "the public" in the making of science.

Although seventeenth-century philosophers proposed various ways of dealing with this tension, by the 1760s a dominant strategy had emerged, according to which natural philosophical knowledge was made not only *for* the public but *through* the public. As Steven Shapin and Simon Schaffer write in their seminal study on the philosophy of experiment,

> Matters of fact were the outcome of the process of having an empirical experience, warranting it to oneself, and assuring others that grounds for their belief were adequate. In that process, a multiplication of the witnessing experience was fundamental....In this way, the matter of fact is to be seen as both an epistemological and a social category.[37]

According to Shapin and Schaffer, Robert Boyle and his colleagues at the Royal Society used three means of establishing the truth of their experimental findings, each of which served to define experimental science as a distinctly public form of knowledge production. They employed a *material technology* of experimental instruments; a *social technology* for prescribing the relations among natural philosophers and between them and the general public; and a *literary technology* for communicating what had happened during laboratory experiments.[38] I briefly consider each in turn.

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[37] Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985), 25. See also Ezrahi, *Descent of Icarus*, chap. 3.

[38] Not all science, of course, is laboratory science, and a complete account of the public legitimation of the Scientific Revolution would need to consider astronomy, botany, geology, and other non-laboratory sciences. Recent studies of such non-laboratory sciences, however, have found similar strategies for coping with the tensions between the locally specific conditions under which science is produced and the universal validity and utility science is expected to have. Golinski (*Making Natural Knowledge*, 95-102), for example, outlines a constructivist analysis to scientific knowledge production in museums (botany, zoology, mineralogy, etc.) and fieldwork sites (ecology, geography, demography, anthropology, etc.).

With regard to material technology, the experimentalists' increased reliance on experimental devices had ambiguous implications for the relationship between science and the public. On the one hand, as noted above, the use of experimental devices separated science from the common sense observations of the general public. The new instruments of the day, including the microscope, telescope, and Boyle's air-pump, either enhanced human perception of visible objects or enabled the study of previously invisible objects. Observation of the planets or the eye of a fly could be greatly enhanced, and invisible phenomena like air pressure could be literally brought to light. In this respect, experimental instruments imposed a discipline on the senses that lay people lacked.

On the other hand, however, by providing visible material referents for scientific knowledge, experimental devices helped make science part of a shared public world. The use of experimental apparatus established a mediator between nature and the scientist. Insofar as it allowed experimental findings to be seen as produced by a machine rather than a scientist, experimental apparatus depersonalized scientific activity. When two scientists reached contradictory findings, for example, they could blame the instruments rather than each other.[39] Unassisted observation of nature, Boyle and his colleagues argued, was inevitably tinged by the idiosyncratic judgments of the individuals who made them. The impersonal operation of an air-pump, however, when combined with the use of measured gauges and graduated flasks, presented the same phenomena to everyone present. Boyle thus often conducted his air-pump experiments in the assembly rooms of the Royal Society, places that he—if not his critic Hobbes—deemed essentially public. Boyle also explicitly distinguished the private space in which alchemists and magicians

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[39] Shapin and Schaffer, *Leviathan and the Air Pump*, 77.

did their work from the public space of the laboratory.[40] By abstracting scientific knowledge from the choices and values of particular scientists, the use of experimental apparatus made science available for public appropriation. Although designed and executed by individuals, the material technology of laboratory experiments facilitated the transformation of science into public knowledge.

In addition to innovative devices and procedures for the study of nature, modern science also relied on a set of cultural values and practices, what Shapin and Schaffer call the "social technology" of experimentalism. This social technology centered on an ambiguous understanding of the relationship between knowledge and communication. On one level, the founders of the new science implicitly suggested that communication among scientists was not important. What mattered, as discussed above, was the scientist's reliance on his individual sense perception, undistorted by the views of others. But this image of the scientist as a solitary spokesman for nature belied the importance attached to the public communication of scientific findings. For the founders of the new science, scientific knowledge only achieved that status through being communicated to others. Even those who objected to many elements of the new science, such as Hobbes, agreed that the work of a truly private scientist would be lost to the world, and would for that reason not really be science at all:

> [T]hough some one man, of how excellent a wit soever, should spend all his time partly in reasoning, and partly in inventing marks for the help of his memory, and advancing himself in learning; who sees not that the benefit he reaps to himself will not be much, and to others none at all? For unless he communicate his notes

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[40] Moreover, in some cases at least, the public quality of experimental science emerged from the practical necessity of sharing equipment. Many of the new instruments, especially Boyle's air-pump, were expensive to build and difficult to operate. As a result, experimental devices were often treated as public goods.

> with others, his science will perish with him. But if the same notes be made common to others, sciences will thereby be increased to the general good of mankind (*De Corp*, II.ii, 32-33).

Hobbes is not suggesting here that individual scientists must engage in direct cooperation with one another.[41] Scientists might work alone, but the transformation of their work into genuine science requires that it be publicly communicated.

The notion that science depends on public communication was strengthened through the use of public witnesses to validate experiments. Witnesses were not merely observers or spectators, but were treated as active participants in a public process of knowledge production.[42] The new science even drew explicitly on standards of evidence then common in legal thought, according to which a minimum of two witnesses were required to establish the "moral certainty" of a claim. Because witness testimony was assumed to be uncoerced, the public demonstration of experiments helped constitute the resulting knowledge as a product of voluntary assent. Voluntary assent by a diverse group of witnesses, the experimentalists argued, would correct the biases of individual sense perception feared by the skeptics.[43]

This only worked, of course, if everyone assented to having seen the same thing. Witness testimony had to be voluntary and uncoerced, but it also had to be grounded in something more compelling than individual fancy, else the diversity of witnesses produce a diversity of testimonies. The compelling force was nothing less than nature itself.

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[41] Until the second half of the twentieth century, most day-to-day laboratory work was conducted by individual scientists and their assistants. Today, most research is conducted by large teams of scientists, now linked together in global networks. The lone genius sweating over his apparatus, however, remains the dominant image of scientific work.

[42] Steven Shapin, "The House of Experiment in Seventeenth-Century England," *Isis* 79 (1988): 373-404, at 390.

[43] Shapin and Schaffer, *Leviathan and the Air-Pump*, 56-57.

Nature was understood as that which caused the uniformity of testimony among diverse witnesses. This allowed the experimentalists to present witness testimony as simultaneously public, collective, and the foundation of objective knowledge *and* voluntary, individual, and grounded in subjective experience.

Not everyone's voluntary assent, of course, was equally valued. Only credible witnesses, after all, could be expected to give reliable testimony. Witnesses were thus required to be not only numerous, but competent and trustworthy as well. In practice, the most reliable warrant of competence and trustworthiness came to reside in gentlemanly status. Put simply, because lying could lead to expulsion from the circle of gentlemen, a gentleman-scientist could be trusted to tell the truth. Only gentlemen, moreover, were thought capable of controlling the private passions that inevitably cloud the judgments of lesser men. The empirical testimony of gentlemen thus replaced appeals to tradition, religion, or speculative philosophy as an acceptable ground of belief.[44] Truth telling was not one of the ancient Greek virtues, and if lying is distinguished from the more specific case of "bearing false witness," lying is also not one of the Christian sins. Modern science, along with Puritan morality, elevated honesty to a key virtue for the first time.[45]

By relying on gentlemanly status as an indicator of honesty, the new science raised justified suspicions about its claim to be a distinctly public form of knowledge. Hobbes, for example, argued that Boyle's laboratory was not in fact open to the public,

[44] Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth Century England*) Chicago: University of Chicago Press, 1994), chaps. 2-3. By the same token, Shapin writes, "Those whose placement in society rendered them dependent upon others, whose actions were at others' bidding, or who were so placed as to need relative advantage were *for these reasons* deemed liable to misrepresent real states of affairs..." (86).

[45] See Hannah Arendt, "Truth and Politics," in *Between Past and Future* (New York: Viking Press, 1968; reprint Penguin Books, 1993), 227-64, 232.

but allowed access to only a select group. The beliefs of this witnessing public, therefore, could not be considered truly representative of the public at large.[46] Hobbes's claim was and remains well founded. Although women, for example, were occasionally audience members at publicly performed experiments, they were not admitted to seventeenth-century laboratories. Membership in European scientific institutions was completely barred to women until the twentieth century.[47] Despite the many women who have managed in the face of prejudice to become recognized scientists, feminist scholars have shown how prevailing conceptions of gender continue to influence not only scientists' questions, but their answers as well.[48] Scientific laboratories today are still not truly accessible public spaces, but are probably more closed to the public than ever before. Hazardous materials, intellectual property rights, and national security concerns dictate strict controls on public access.[49] Legal, practical, and ideological restrictions on public access help explain why anthropological study of "laboratory life" was a rarity until the late 1970s.[50]

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[46] Shapin and Schaffer, *Leviathan and the Air-Pump*, 112-14.

[47] Golinski, *Making Natural Knowledge*, 88; Londa Schiebinger, *The Mind Has No Sex? Women in the Origins of Modern Science* (Cambridge: Harvard University Press, 1989); "The History and Philosophy of Women in Science: A Review Essay," in *Sex and Scientific Inquiry*, ed. Sandra Harding and Jean O'Barr (Chicago: Chicago University Press, 1987), 7-34.

[48] Evelyn Fox Keller, *Reflections on Gender and Science* (New Haven: Yale University Press, [1985] 1995); Sandra Harding, *The Science Question in Feminism* (Ithaca: Cornell University Press, 1986).

[49] The claim that scientists must restrict public access to their work also has a seventeenth-century precedent, in Henry Stubbe's claims that the Royal Society failed to protect the proprietary rights of the craftsmen and tradesmen whose knowledge was being used to design experiments (Golinski, *Making Natural Knowledge*, 85).

[50] Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Sage, 1979; Princeton: Princeton University Press, 1986); Sharon Traweek, *Beamtimes and Lifetimes: The World of High-Energy Physicists* (Cambridge: Harvard University Press, 1988).

Limitations on public access notwithstanding, by establishing at least informal criteria for trustworthy witnesses, seventeenth-century natural philosophy became associated with a set of behavioral norms that fostered civil peace. Indeed, in the view of Shapin and Schaffer, Boyle's experimentalist program beat Hobbes in the contest for public credibility in large part because it shared a "form of life" with Restoration society.[51] This form of life required a particular kind of citizen, a person who would accept monarchical authority and resist the temptations of subversive ideologies. The humble witness of the new experimental science fit the bill.

> The ideal scientist, it was claimed, was so in virtue of a character of austere probity, which would have nothing do with the machinations and intrigues of courts and patrons. Such a character's absolute rectitude and solitary self-sufficiency guaranteed his very capacity to see and interpret the natural world correctly.[52]

These character traits initially supported the political ideology of the Restoration. A century later, they would be deemed suitable for liberal-democratic citizens.

The experimentalists underscored their adherence to these behavioral norms by conducting their experiments in places considered part of the public sphere. Toward the end of the seventeenth century, scientist-entrepreneurs made a business out of demonstrating the wonders of nature, especially crowd pleasers such as electricity, in coffee houses, salons, and other public places.[53] Conducting experiments in public was

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[51] Shapin and Schaffer, *Leviathan and the Air-Pump*, 341-42. As Latour points out, Shapin and Schaffer somewhat overstate their case on this point, overemphasizing the social factors in Boyle's success. See Latour, *We Have Never Been Modern*, 25-26.

[52] Outram, "Science and Political Ideology," 1013.

[53] These were to some extent the same salons and cafes in which Habermas locates the rise of a culture of rational-critical discourse. Indeed, as I discuss below, the public demonstration of experimental science was an instance of such discourse and a contributing factor in the establishment of the bourgeois public sphere. See Jan C. Rupp, "The New Science and the Public Sphere in the Premodern Era," *Science in Context* 8, no. 3 (1995): 487-507; Larry Stewart, *The Rise of Public Science: Rhetoric, Technology, and Natural Philosophy in Newtonian Britain, 1660-1750* (Cambridge: Cambridge University Press, 1992);

explicitly conceived as a way of demonstrating not only the physical principles involved, but also the scientist's trustworthiness. A scientist willing to display his discoveries before the public, it was argued, must have nothing to hide. Public demonstrations thus helped establish the credibility not only of particular scientific claims, but of the new science itself. Experimentalists thus sought to control the market for such public demonstrations by inveighing against charlatans who used the same experiments to support claims about miracles and other supernatural phenomena.

This social technology of behavioral norms and public demonstrations was supported by the literary technology through which experimentalists constituted their findings as public in yet another way.[54] Experimental reports were explicitly linked to the idea of *replication*, alluded to in the above quote from Popper, according to which an experiment can be repeated by anyone who correctly follows the original procedures. The new scientists thus wrote highly detailed accounts of their experimental procedures, as they still do today, with the aim of allowing others to repeat the experiments and verify the results. By presenting an open invitation to "see for oneself" whether or not particular scientific claims were true, the notion of replication supported the public character of science. In practice, one might note, neither public demonstrations nor meticulous lab reports were sufficient for establishing the publicity of scientific knowledge. Demonstrations could only be witnessed by a limited number of people. And even today, as Michael Polanyi famously argued, replicating experiments depends

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Simon Schaffer, "Natural Philosophy and Public Spectacle in the Eighteenth Century," *History of Science* 21 (1983): 1-43; Raymond Phineas Stearns, *Science in the British Colonies of America* (Urbana: University of Illinois Press, 1970), 506-514; Roger Cooter and Stephen Pumfrey, "Separate Spheres and Public Places: Reflections on the History of Science Popularization and Science in Popular Culture," *History of Science* 32 (1994): 237-267.

[54] Shapin and Schaffer, *Leviathan and the Air-Pump*, 60-69.

not so much on detailed research protocols as hands-on training in the tacit skills of building and operating experimental apparatus.[55] Despite his meticulous laboratory protocols, Boyle eventually admitted, few people had been able to replicate his experiments.[56]

Nonetheless, by writing detailed accounts of experimental procedures and results, natural philosophers sought to create in the reader's mind a vicarious experience of witnessing an experiment. If it worked, neither seeing nor replicating an actual experiment was required to generate trust in the account. Boyle thus adopted a highly circumstantial style of writing, reporting all possible particulars about any given experiment. He even included naturalistic engravings of the air-pump in his reports, allowing readers to better imagine how it worked. Diderot would later employ a similar style in the illustrations of machines and instruments in the *Encyclopedia*.[57]

Generating trust in experimental reports also required a highly modest literary style, conveying an image of impartiality and trustworthiness, and encouraging civilized debate among readers. Boyle achieved this in part by communicating both experimental successes and failed trials. Relating experimental failures implied that the scientist had nothing to hide. It was impossible, of course, to report everything that happened in the laboratory. But the description of detailed circumstances and procedures served to emphasize the scientist's modesty and trustworthiness. The use of plain language and an

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[55] Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (Chicago: University of Chicago Press, 1958).

[56] Shapin and Schaffer, *Leviathan and the Air-Pump*, 59.

[57] See Ezrahi, *Descent of Icarus*, 82.

essay form, as compared to the systematic philosopher's florid treatises, served a similar function.

The modest literary style adopted by the experimentalists reinforced two larger commitments which were as much political as scientific: a belief in separating questions of cause from questions of fact, and private beliefs from public actions. Like many seventeenth-century thinkers, Boyle associated causal questions with the religious and political upheavals the new science was supposed to help bring to an end. He thus rejected not only the "litigiousness" of the Scholastics, but also the "dogmatism" of deductive thinkers like Hobbes and Descartes.[58] Each of these approaches to knowledge production had fomented years of political controversy. Whereas Boyle encouraged experimentalists to speak confidently about matters of "fact" observed in the laboratory, when it came to matters of "cause," he urged the utmost circumspection:

> [I]n almost every one of the following essays I...speak so doubtingly, and use so often, *perhaps*, *it seems*, *it is not improbable*, and such expressions, as argue a diffidence to the truth of the opinions I incline to, and that I should be so shy of laying down principles, and sometimes of so much as venturing at explications.[59]

Boyle thus describes the measured tone and endless qualifications we have come to expect of the experimental scientist. This rhetoric of humility, we saw in the previous chapter, has often been adopted by non-scientists seeking to direct attention away from their voluntary decisions and toward scientific facts that appear to compel assent. When

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[58] As proponents of the new science often pointed out, one can measure the moving hands of a clock without ever asking about the cause. Indeed, different clocks might work differently, even if their hands move in the same way. Similarly, the experimentalists argued that religious humility requires that one acknowledge God's power to create the same natural phenomena in a variety of ways.

[59] Boyle quoted in Shapin and Schaffer, *Leviathan and the Air Pump*, 67.

policymakers want to avoid responsibility for their decisions, what better way to do so than to let the facts speak for themselves?

Parallel to this boundary between experimental facts and their metaphysical causes, the experimentalists drew another boundary between the public character of laboratory experiments and the private opinions of those who performed them. To enforce this boundary between public and private the experimentalists distinguished their mode of thought from modes that tended to blur public and private, such as the religious "enthusiasm" of the Protestant sects.[60] Here Hobbes and Boyle were on common ground. Despite the moral individualism praised by each, Hobbes and Boyle both feared epistemic individualism.[61] Both condemned the "private judgment" of religious and political questions, because it threatened to erode any epistemic basis for political authority and community. In contrast to the Protestant sects, the experimentalists presented their form of knowledge as distinctly impersonal. Boyle even published guidelines for scientific discourse that prohibited *ad hominem* attacks, advising the partners in scientific debates to treat each other as potential converts rather than enemies.

> As for the (very much too common) practice of many, who write, as if they thought railing at a man's person, or wrangling about his words, necessary to the confutation of his opinions; besides that I think such a quarrelsome and injurious way of writing does very much misbecome both a philosopher and a Christian, methinks it unwise, as it is provoking. For if I civilly endeavor to reason a man out of his opinions, I make myself but one work to do, namely, to convince his

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[60] See James Farr, "Political Science and the Enlightenment of Enthusiasm," *American Political Science Review* 82, no. 1 (1988): 51-69.

[61] On the problem of epistemic individualism, see James R. Jacob, *Robert Boyle and the English Revolution: A Study in Social and Intellectual Change* (New York: Burt Franklin, 1977), chap. 3; Michael J. Heyd, "The Reaction to Enthusiasm in the Seventeenth Century: Towards an Integrative Approach," *Journal of Modern History* 53 (1981): 258-280; Shapin and Schaffer, *Leviathan and the Air-Pump*, 112-15, 320-24; Robert P. Kraynak, "Hobbes's *Behemoth* and the Argument for Absolutism," *American Political Science Review* 76 (December 1982):837-47.

> understanding; but, if in a bitter or exasperating way I oppose his errors, I increase the difficulties I would surmount, and have as well his affections against me as his judgment: and it is very uneasy to make a proselyte of him, that is not only a dissenter from us, but an enemy to us.[62]

While Boyle thus urged circumspection in all disputes, he argued that one might rightly condemn those who do not conduct experiments, because their opinions cannot be impartially evaluated by others. (Popper later made a similar point when he argued that a scientific theory could be distinguished from a nonscientific theory according to whether it provided criteria by which it would be proven false.[63]) As long opinions are supported by experimental evidence, Boyle argued, one can ignore the opinions and make one's own use of the evidence. Boyle even invited the otherwise ridiculed alchemists to contribute their experimental findings to the new science: "Let his opinions be never so false, his experiments being true, I am not obliged to believe the former, and am left at liberty to benefit myself by the latter."[64] In concert with his reliance on experimental apparatus, public demonstrations, humble style, reluctance to address causal questions, and rejection of dogmatism, Boyle's impersonal approach to inquiry supported the claim that science is a distinctly public form of knowledge.

## Science in the Public Sphere

So the experimental program presented itself as a distinctly public form of knowledge. But what did this conception of science mean for the public itself? To what extent were the norms and practices described above, otherwise known as the "republic of science," transferred to the emerging political republics of the time? To be sure, there

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[62] Boyle, "Prömial Essay," quoted in Shapin and Schaffer, *Leviathan and the Air Pump*, 73-74.

[63] Karl Popper, *The Logic of Scientific Discovery* (Hutchinson Education, [1934] 1959; London and New York: Routledge, 1992), 40–42.

[64] Boyle, "Prömial Essay," quoted in Shapin and Schaffer, *Leviathan and the Air Pump*, 71.

are no *necessary* connections between particular forms of politics and the conception of science as public knowledge established in the late-seventeenth century. As discussed above, the "form of life" defended by experimentalists at the Royal Society offered ideological support for the 1660 Restoration of the British monarch. But by the end of the eighteenth century, concepts drawn from modern science had become firmly entrenched in the rhetoric of liberal democracy. In the following I outline the conceptual linkages that evolved between modern science and liberal-democratic ideology, beginning with the eighteenth-century public sphere. My concern is to show how the notion of science as public knowledge was used, paradoxically, to both legitimate liberal-democratic institutions and exclude most of the public from political decisionmaking.

In his classic treatment of the rise and decline of the bourgeois public sphere, Habermas traces the development of a realm independent of both the state and the market constituted by "people's public use of their reason."[65] In the late-medieval period "the public" had been identified with the person and accouterments of the ruler. Lordship was represented "not for but 'before' the people."[66] The king, the court, and the Church embodied, and through their dress, speech, and conduct physically represented, the idea of the public. Then during the seventeenth and eighteenth centuries, the public became an increasingly *impersonal* concept, separated from individual rulers and identified with "the state." Eventually, however, a distinction evolved between two elements of the public, with the state on one side and "civil society" on the other. Civil society was initially conceived as a realm in which private persons engaged in the public activity of

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[65] Jürgen Habermas, *The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society*, trans. Thomas Burger (Cambridge: MIT Press, [1962] 1989), 27.

[66] Ibid., 8.

commercial exchange. The public thus became an object of state action, as European governments increasingly took measures to support and regulate commerce.

Out of this context, Habermas argues, civil society eventually came to define more than an object of state action or a collection of economic actors. Citizens began to see themselves as members of a self-conscious collective, capable of taking voluntary, directed action in opposition to the state. It was the modern revival of the ancient Greek ideal of self-government, formulated in a distinctly voluntarist and individualist idiom that reflected its origins in the struggle against traditional authorities. Habermas locates the historical manifestation of this self-conscious public sphere in the eighteenth-century world of letters, centered around a bourgeois culture of newspapers, novels, coffee houses, and salons. The bourgeois public sphere constituted a domain between the state and the family where private citizens could rationally discuss matters of public import.

The bourgeois public sphere, Habermas writes, "lasted only for one blissful moment in the long history of capitalist development," and the twentieth-century rise of mass society and consumer capitalism prevent it from being revived in its previous form.[67] Habermas also admits that the bourgeois public sphere was always restricted to a wealthy male elite. But he suggests that by establishing the concept of a *universal* public, or "public opinion," as the appropriate audience of public discourse, the bourgeois public sphere articulated a principle that was eventually used by excluded groups to force their way into the public sphere.[68] The bourgeois public sphere thus provides both a critical

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[67] Ibid., 79.

[68] Ibid., 36-38, 85-86.[69] See Nancy Fraser, "Rethinking the Public Sphere: A Contribution to the Critique of Actually Existing Democracy," in *Habermas and the Public Sphere*, ed. Craig Calhoun (Cambridge: Massachusetts Institute of Technology, 1992), 109-42; Mary P. Ryan, "Gender and Public Access: Women's Politics in Nineteenth-Century America," in Ibid., 159-88; Geoff Eley, "Nations, Publics, and Political Cultures: Placing Habermas in the Nineteenth Century," in Ibid., 289-339.

ideal and historical exemplar of the public use of rational discourse to address matters of general concern. This claim is no doubt correct, as far as it goes, and the following chapters are in part concerned with the possibility of increasing public access to what might be called the scientific public sphere.

In another sense, however, as Habermas's critics have argued, the notion of a public sphere has functioned not only as an ideal, but as an ideology.[69] By presenting itself as *the* public sphere to which anyone wishing to enter public life had to apply for access, the bourgeois public sphere marginalized the many "unofficial" public spheres constituted by women, peasants, and members of the working class. From this perspective, as Nancy Fraser argues, "A discourse of publicity touting accessibility, rationality, and the suspension of status is itself deployed as a strategy of distinction."[70] The bourgeois public sphere was thus not merely an unfulfilled ideal, but also a tool of oppression. The ideological function served by the bourgeois public sphere need not negate its value as an ideal, but both dimensions must be kept in mind if the concept is to serve an inclusive democratic politics.[71] As we shall see, the concept of science as public knowledge has also served both ideal and ideological functions, each of which, moreover, have been intertwined with the concept of the public sphere.

Habermas says little about natural philosophy in his account of the bourgeois public sphere, and his later works draw a strict boundary between scientific and political reason.[72] Whereas Habermas locates the origins of the public sphere in the information

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[70] Fraser, "Rethinking the Public Sphere," 115.

[71] On the relationship between the public sphere's ideal and ideological functions, see Fraser, "Rethinking the Public Sphere," 139, n14.

[72] See Jürgen Habermas, *Knowledge and Human Interests*, trans. Jeremy J. Shapiro (Boston: Beacon Press, 1971), esp. 308-11.

needs of the emerging commercial class, several scholars have more recently argued that eighteenth-century conceptions of publicity and public discourse originated in a variety of non-economic spheres, including seventeenth-century natural philosophy.[73] Indeed, it is no exaggeration to say that by the end of the seventeenth century, natural philosophy had become the leading exemplar of civil public discourse.

More generally, I argue in the following, modern science provided a set of conceptual resources that played a key role in the development of liberal-democratic ideology. Making this argument requires looking beyond the familiar concern with the cognitive dimensions of science. It requires an examination of science as a set of practices, institutions, and symbols, as an orientation toward experience and action, which can potentially be transferred to the political realm. Just as the study of the role of religion in politics must address more than the pursuit of salvation, the study of science in politics must include more than the place of truth in public affairs.[74]

My argument is not that modern science "caused" the rise of liberal democracy. Rather, science provided a conceptual tool kit that was among the sociocultural resources available to those promoting liberal-democratic ideas and institutions. Some writers made more use of science's tool kit than others, but scientific modes of thought and action eventually became entrenched in several different forms of liberal-democratic ideology. In the following I examine the contribution of modern science to liberal

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[73] See Thomas Broman, "The Habermasian Public Sphere and 'Science *in* the Enlightenment'," *History of Science* 36 (1998): 123-149; Paul Wood, "Science, the Universities, and the Public Sphere in Eighteenth-Century Scotland," *History of Universities* 14 (1994): 99-135; David Zaret, "Religion, Science, and Printing in the Public Spheres in Seventeenth-Century England," in *Habermas and the Public Sphere*, ed. Calhoun, 214-235.

[74] Ezrahi, *Descent of Icarus*, 10-12.

democracy in terms of four dimensions of modern science: epistemology, discursive norms, substantive content, and instrumental power. With the first two dimensions, science has offered support for procedural elements of liberal-democratic conceptions of political representation. With the latter two, it has fostered the substantive elements of representation.

### *Epistemology*

The epistemological assumptions of seventeenth-century natural philosophy played a key role in the formation of the eighteenth-century public sphere. The above account suggests that modern science, despite its reliance on various instruments for enhancing human perception, depends on the basic assumption that knowledge of the world can be acquired through the careful examination of *visible* phenomena. Modern science conceives of the world as "a view," as knowable through visual inspection. Moreover, modern science assumes that rational witnesses can agree that they all see the same thing. This is only possible if the experience of witnessing is thought to be determined by the external, objective characteristics of "reality" rather than the internal, subjective qualities of individuals. The success of the scientific community thus confirms "the feasibility of extracting from subjective worlds of perception and experience the objective communicable elements which could furnish the building blocks of an intersubjective, objective sphere."[75] Modern science would not be possible without the real existence a shared world.

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[75] Yaron Ezrahi, "Science and the Problem of Authority in Democracy," in *Science and Social Structure: A Festschrift for Robert K. Merton* (New York: New York Academy of Sciences, 1980), 43-60, at 51.

Most seventeenth-century thinkers identified this intersubjective sphere with the natural world created by God and studied by natural philosophers. By the eighteenth century, however, the notion that competent witnesses could validate laboratory experiments had migrated to the political realm. It came to be associated with the idea of a public sphere created by citizen-witnesses who collectively certify the visible effects of political action. Just as Boyle used the witnessing public to guarantee the reality of his experimental findings, political reality in liberal-democratic ideology was conceptualized as a product of collective witnessing. The liberal-democratic public thus differs from several other conceptions of the public, including the Romantic's organic public constituted by shared history, the elitist's rowdy mob united by shared passion, and the twentieth-century communitarian critic's "lonely crowd" that lacks any shared identity at all.[76] In contrast to each of these, the liberal-democratic public emerges from a shared commitment to the modern scientific conception of the world as a view.

Another way in which modern scientific epistemology reappears in liberal democratic thought lies in the eighteenth-century notion that democratic citizenship depends on some form of science education. As I suggested above, seventeenth-century experimentalists used the distinction between lay and expert knowledge to constitute the laboratory as a public yet highly exclusive place. By the second half of the eighteenth-century, more democratically-inclined thinkers were using the same distinction to enhance lay knowledge.

The French *philosophes*, for example, although generally not believers in political democracy, intended the publication of their great *Encyclopedia* to promote the education

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[76] Ezrahi, *Descent of Icarus*, 87-88.

of ordinary citizens. In some respects, of course, the Encyclopedists' praise for the mechanical arts often left the artisans themselves by the wayside. Like the experimentalists of the previous century, the Encyclopedists argued that the expansion of knowledge depended upon a "correction of sense by reason."[77]

In a broader sense, however, the Encyclopedists' defense of a Lockean sensationist epistemology suggested that scientific knowledge begins with bodily sensations experienced equally by everyone.[78] Their articles addressed not only the knowledge produced by elite scientists, but also the craft knowledge of artisans. In his "Preliminary Discourse," for example, d'Alembert exclaims, "How strangely we judge! We expect everyone to pass his time in a useful manner, and we disdain useful men."[79] D'Alembert goes on to argue that "there is hardly a science or an art which cannot, with rigor and good logic, be taught to the most limited mind...."[80] The Encyclopedists often suggested that with enough time, and a careful and logical exposition, any idea could be made clear to a person of most any level of intelligence.

The *philosophes*' rather cautious epistemological democratization is taken much further by Jefferson.[81] Jefferson's writings frequently suggest the notion, developed later by Dewey, that scientific inquiry should resemble common sense problem solving. When discussing classification in natural history, for example, Jefferson argues against the

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[77] Shapin, *Scientific Revolution*, 90, 93.

[78] Jean Le Rond d'Alembert, *Preliminary Discourse to the Encyclopedia of Diderot* (1751), trans. Richard N. Schwab (Chicago: University of Chicago Press, 1995), 7-11.

[79] D'Alembert, *Preliminary Discourse*, 6. "But while justly respecting the great geniuses for their enlightenment, society ought not to degrade the hands by which it is served" (42).

[80] D'Alembert, *Preliminary Discourse*, 31.

[81] See Douglas L. Wilson, "Jefferson and the Republic of Letters," in *Jeffersonian Legacies*, ed. Peter S. Onuf (Charlottesville: University Press of Virginia, 1993), 50-76, at 66.

Linnaean system's reliance on anatomical dissection. Drawing on the modern scientific rhetoric of transparency, he writes, "It would certainly be better to adopt as much as possible such *exterior and visible* characteristics as every traveller is competent to observe, to ascertain and to relate."[82] Despite his aristocratic habits, Jefferson appeals frequently to the honesty and good sense of ordinary citizens.[83] His assistance in the founding of Charles Wilson Peale's museum of natural history in Philadelphia, the first successful museum in America, was one of many ways Jefferson sought to strengthen popular understanding of and involvement in science.[84] And in 1785 Jefferson boasts from Paris: "In science, the mass of the people is two centuries behind ours."[85] Jefferson did not believe, of course, that science can rely on the common sense of an uneducated citizenry, and he acknowledged that most of his contemporaries lacked the ability to think scientifically. But he hoped to change this with his many proposals for public education.[86]

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[82] Jefferson to Dr. John Manners, 22 Feb. 1814, *Writings*, 1331 (emphasis added).

[83] Jefferson to Edward Carrington, 16 Jan. 1787, *Writings*, 880; Jefferson to Peter Carr, 10 Aug. 1787, *Writings*, 902; Jefferson to John Melish, 13 Jan. 1813, *Writings*, 1270.

[84] John C. Greene, *American Science in the Age of Jefferson* (Ames, IO: The Iowa State University Press, 1984), 20-7. As Greene notes, Jefferson's popularization of science also supported the professional interests of the scientists who depended on public support and patronage to conduct their work. Preoccupied with establishing their political and economic independence, Americans of the period had little leisure for the pursuits of science. Scientists did all they could to make their work appeal to a broad public and welcomed Jefferson's assistance.

[85] Jefferson to Charles Bellini, 30 Sept. 1785, *Writings*, 833.

[86] See his "Bill for the More General Diffusion of Knowledge," in *Writings*, 365, 367; Jefferson to George Wythe, 13 August 1786, *Writings*, 859; Jefferson to Samuel Kercheval, 12 July 1816, *Writings*, 1395-1403; Jefferson to Major John Cartwright, 5 June 1824, *Writings*, 1492. One might note that eighteenth-century conservatives worked actively against such politically radical conceptions of science. England's Seditious Societies Act of 1799 required government licensing of all public meetings addressing controversial subjects. The Act reflected a broader movement to enlist science for conservative politics, and assisted London's Royal Society in its efforts to act as a gate keeper for the licensing of scientific societies. See Outram, "Science and Political Ideology," 1017.

*Norms of Discourse*

The seventeenth-century scientific community also exemplified certain norms of discourse, described above, which were eventually deemed appropriate for liberal-democratic politics. The figure of the humble yet competent witness with which the Royal Society legitimated its experimental program reappears in liberal-democratic ideology as the vigilant citizen-witness capable of evaluating governmental action. "The humility of the experimental scientist before the facts of nature translates in the context of liberal-democratic political culture into the deference of political actors before the public facts of social and political 'realities.'"[87] If citizens are conceptualized as competent witnesses, they can be seen as capable of holding public officials accountable for the effects of their actions. The Royal Society's behavioral norms are readily apparent in a variety of later efforts to enlist science in support of liberal democracy, perhaps most famously those of John Dewey and Robert K. Merton.

Throughout his writings, Dewey draws on the eighteenth-century notion of a "republic of science" to articulate his democratic ideals. Following C. S. Peirce, Dewey often describes the scientific process as a model of democratic decisionmaking.[88] Science relies, according to Dewey, on "objective and public procedures of scientific investigation."[89] Unlike common sense judgments, experimental science "introduces no

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[87] Ezrahi, *Descent of Icarus*, 89.

[88] According to Peirce, "The opinion which is fated to be ultimately agreed to by all who investigate, is what we mean by truth, and the object represented in this opinion is the real" ("How to Make Our Ideas Clear," in *The Essential Peirce*, ed. Nathan Houser and Christian Kloesel [Bloomington and Indianapolis: Indiana University Press, 1992], 139). See also John Patrick Diggins, *The Promise of Pragmatism: Modernism and the Crisis of Knowledge* (Chicago: University of Chicago Press, 1994), 190-204.

[89] John Dewey, *The Quest for Certainty* (1929), in *The Later Works* Vol. 4, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1988), 69, cited hereafter as *QC*.

elements save such as are public, observable, and verifiable" (*QC*, 182). Echoing Hobbes's and Boyle's criticism of the Schools, Dewey disparages professional philosophers who busy themselves with the inherently private and subjective abstractions of either transcendental metaphysics or empirical "sensations" and "mental images" (Ibid.). Natural scientists produce more socially relevant knowledge than academic philosophers, Dewey argues, because they publicly justify their conclusions with reference to visible experimental results before an international community of peers.

Dewey reinforces his conception of science as a model of political discourse with the claim, also originating in the seventeenth century, that natural science encourages particular virtues of character. Science is not, he argues, a matter of mechanically following logical rules.

> It is wholly a moral matter, an affair of honesty, impartiality, and generous breadth of intent in search and communication. The adulteration of knowledge is due not to its use, but to vested bias and prejudice, to one-sidedness of outlook, to vanity, to conceit of possession and authority, to contempt or disregard of human concern in its use.[90]

Scientific investigation relies on a moral commitment to rational, honest, impartial discourse. These virtues are precisely those required of democratic citizens.[91] Dewey thus argues that "the future of democracy is allied with the spread of the scientific attitude....it is the only assurance of the possibility of a public opinion intelligent enough to meet present social problems" (*FC*, 148-49). As we shall see, Dewey is quite aware that the "scientific attitude" remains a rarity among his contemporaries.

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[90] John Dewey, *The Public and Its Problems* (New York: Henry Holt and Company, 1927), 175-76, cited hereafter as *PP*. On this point see also Robert B. Westbrook, *John Dewey and American Democracy* (Ithaca: Cornell University Press, 1991), 436-7.

[91] John Dewey, *Liberalism and Social Action*, in *The Later Works* Vol. 11, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1991), 51-52, cited hereafter as *LSA*.

The rise of fascism and the advent of World War II brought a new urgency to scholarly efforts to assert the fundamental congruence of science and democracy. In his 1942 essay, "Science and Technology in a Democratic Society," Merton argued that although science could develop in a variety of political systems, democracies allowed it to thrive most fully.[92] Following Boyle and Jefferson, Merton claimed that the methodological norms of science are not merely technically efficient, but morally compelling.

Merton identified four norms that guide the institutional organization of science: universalism, communalism, disinterestedness, and organized skepticism. The norm of universalism requires that scientific propositions be evaluated according to preexisting impersonal criteria. The norm of communalism (Merton's actual label, "communism," is now misleading) requires that scientific knowledge be understood as public property and be freely communicated to the public. The norm of disinterestedness demands not that individual scientists be more altruistic than others, but that scientific findings be subject to anonymous peer review. Finally, the norm of organized skepticism prescribes the detached scrutiny of beliefs in terms of empirical and logical criteria. Each of these norms, Merton suggested, provides a model of both scientific practice and democratic deliberation.

Merton was only one of many, including Dewey, Popper, and Bertrand Russell, to enlist science in the defense of liberal-democratic ideology at a time when the world's

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[92] Robert K. Merton, "Science and Democratic Social Structure" [originally published as "Science and Technology in a Democratic Society," *Journal of Legal and Political Sociology* 1 (1942): 115-26], in *Social Theory and Social Structure*, 550-61, esp. 552, 555-56.

liberal democracies were at war against fascism.[93] They were in many ways successful. "By the end of the Second World War, science (and technology), in the hands of free men, had saved the world for democracy. Science was held to be intimately a weapon of democracy, and democracy, a friend to science."[94] The immediate postwar period was the last highpoint, to date, of public faith in the notion that science and democracy are mutually supportive. This faith soon faced the powerful challenges posed by the critics discussed in the next chapter.

One should note, however, that even Merton's defense of the Enlightenment belief in a basic congruence between science and democracy assumed a continuation of long-standing tensions between knowledge and power, science and common sense. Merton was careful to point out that adherence to the scientific ethos tends to bring scientific institutions into conflict with political institutions. Some might argue, he wrote, that scientists ought to accommodate themselves to the demands of the politicians who pay their bills. But if science is to continue providing ideological support for liberal democracy, Merton insisted, it would have to remain as independent of overt political control as possible. "Science must not suffer itself to become the handmaiden of theology, or economy, or state."[95] Merton's conception of the scientific ethos thus gave

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[93] Bertrand Russell, *The Scientific Outlook* (London: Allen & Unwin, New York: W.W. Norton, 1931).

[94] Roy MacLeod, "Science and Democracy: Historical Reflections on Present Discontents," *Minerva* 35 (1997): 369-384, at 377

[95] Merton, "Science and the Social Order" (1937) in Ibid., 537-49, at 543.

expression to both the exclusionary and democratic dimensions of modern science discussed above.[96]

### *Substantive Knowledge*

The substantive knowledge about nature produced by modern science—i.e., the collection of accepted scientific facts—also played an important role in the constitution of the liberal-democratic public sphere. The universality of scientific knowledge provides a palpable demonstration of the notion that, despite cultural variation, human experience is in some ways everywhere the same. The practical application of the same scientific principles to diverse situations thus vindicates the liberal-democratic faith in human equality.[97]

Similarly, by providing a common stock of shared knowledge, science helps create a stable background against which vigorous democratic debate can occur. This notion is nicely expressed in a letter from Jefferson to John Adams: "About the facts, you and I cannot differ; because truth is our mutual guide. And if opinions you may express should be different from mine, I shall receive them with the liberality and indulgence which I ask for my own...."[98] If agreement on "the facts," can be secured through science, inevitable disagreements of opinion pose no threat to democratic institutions.

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[96] On this point, see David A. Hollinger, "The Defense of Democracy and Robert K. Merton's Formulation of the Scientific Ethos," *Knowledge and Society: Studies in the Sociology of Culture Past and Present* 4 (1983): 1-15, at 3.

[97] Ezrahi, *Descent of Icarus*, 52.

[98] Jefferson to John Adams, 15 June 1813, *Writings*, 1279.

Finally, scientific knowledge helps define the physical limits of possible political action, ensuring those suspicious of democracy that popular freedom will not lead to anarchy. Newton's law of gravity, for example, by demonstrating the existence of a stable cosmic order, gave eighteenth-century thinkers the confidence to demand greater individual freedom.[99] As Ezrahi puts it, "Once the expression of power in action appears to be governed by knowledge or instrumental logic, it projects itself as restrained and nonarbitrary, respectful of the strictures imposed by natural and social realities and assuming, therefore, a public character."[100] The liberal-democratic tension between freedom and sovereignty is far easier to manage in the context of a causally governed world.

### *Instrumentalism*

In addition to fostering epistemological assumptions, substantive knowledge, and behavioral norms deemed conducive to liberal-democratic politics, and tying each of these together, modern science has also been linked to democracy through its capacity to help citizens get things done. In general terms, as Thomas Broman notes, seventeenth-century science provided a practical model of how to apply theory to practice. This model was relevant for the idea of science-based technology (which did not become a reality until the late-nineteenth century), as well as for the development of political criticism in the public sphere.[101] In one sense, of course, practitioners of the new science

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[99] See Margaret C. Jacob, "Newtonianism and Origins of Enlightenment--Reassessment," *Eighteenth Century Studies* 11, no. 1 (1977): 1-25.

[100] Ezrahi, *Descent of Icarus*, 57.

[101] Broman, "The Habermasian Public Sphere," 129-33; Cf. Zaret, "Religion, Science, and Printing," 227-30.

presented themselves as concerned with the pursuit of truth rather than any mundane worldly purposes. This has never meant, however, that scientific knowledge has no purpose, only that the procedures of scientific research are thought to remain unaffected by the purposes served by the resulting knowledge. As Shapin puts it:

> This is the paradox: the more a body of knowledge is understood to be objective and disinterested, the more valuable it is as a tool in moral and political action. Conversely, the capacity of a body of knowledge to make valuable contributions to moral and political problems flows from an understanding that it was not produced and evaluated to further particular human interests. That paradox is also a legacy of the Scientific Revolution....[102]

As we saw above, Boyle's humble style, avoidance of causal questions, and apparent deference to the testimony of a witnessing public all served to establish the disinterestedness of the experimental program. This very disinterestedness, however, gave modern science an extraordinary capacity to fulfill a wide range of public and private interests. Much scientific inquiry, of course, has no immediate practical benefit, but the expectation that it will has long served the public legitimation of natural science.[103] Indeed, Bacon's famous claim, that in science "Human knowledge and human power meet in one," has become a pervasive component of modern thought.[104]

The instrumentalism associated with modern science serves liberal-democratic ideology by fostering the notion that human action should be evaluated in terms of external criteria of effectiveness rather than internal criteria of personality or status. As noted above, Boyle was not concerned with other philosophers' religious beliefs or

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[102] Shapin, *Scientific Revolution*, 164.

[103] See Ernan McMullin, "The Development of Philosophy of Science, 1600-1900," in *Companion to the History of Modern Science*, ed. Colby et al., 816-837, at 822.

[104] Bacon, *Novum Organon*, I, aphor. 3, 462; see also aphor. 4, 73, 74.

ontological commitments, so long as they produced effective experiments. When transferred to politics, this instrumental conception of action separates governmental policies from the public officials who create them. If governmental actions are considered independent of the subjective motives of public officials, citizens can develop a sense of ownership in the public policies implemented in their names. Put differently, they can see themselves as politically represented. Although the California policymakers examined in the previous chapter ultimately failed to persuade most citizens that the agency had adequately represented them, one can begin to see why their efforts focused on appeals to the instrumental effectiveness of the agency's policy decision. Whereas moral or traditional claims to authority rely on subjective criteria hidden from public view, instrumental effectiveness is at least potentially visible and open to judgment by an observing public.[105]

Dewey's conception of the public provides a good example of this link between modern science, instrumentalism, and political representation. His analysis of the public, Dewey says, begins "from the objective fact that human acts have consequences upon others, that some of these consequences are perceived, and that their perception leads to subsequent effort to control action so as to secure some consequences and avoid others" (*PP*, 12). Like Boyle, Dewey distinguishes public and private according to the publicly visible consequences of action, rather than the private intentions, beliefs, or social status of those performing the action. Consequences that affect only the people engaged in a

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[105] As Ezrahi puts it: "The attempt to construct social reality as an object which can be witnessed and discussed in terms similar to those applied to physical nature has implicitly opened the way to granting the public the possibility of detached political engagement upheld by the authority to evaluate and judge what political agents say and do by reference to the common experience of certified 'objective social facts'" (*Descent of Icarus*, 170).

transaction are considered private; consequences that extend beyond those immediately engaged are public (*PP*, 15). Just as scientists evaluate the visible effects of their laboratory experiments, ordinary citizens must be able to evaluate the consequences of government policies.

These linkages between instrumentalism and democracy appear in three distinct liberal-democratic strategies for reassuring citizens that the actions of their elected officials are publicly representative rather than arbitrary and self-interested: technocracy, rational deliberation, and market competition.[106] Each of these models draws on the modern scientific assumption of a knowable and causally governed world to balance the freedom of citizens against the constraints of political reality. The models differ, however, in the way each sets the balance. They also differ in terms of their relative emphasis on substantive versus procedural conceptions of political representation.

*Technocracy*

In the technocracy model, political representation is grounded not in procedural requirements for popular political participation and consent, but in public officials' assumed competence to promote the substantive interests of their constituents. Expert rule can be reconciled with democratic norms, according to this model, insofar as scientifically-determined relations of cause and effect provide an extra-political standard against which observing citizens can evaluate the government's performance. While the

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[106] The following discussion draws on the framework laid out in Ezrahi, *Descent of Icarus*, chap. 2.

public does not participate in the formulation or implementation of policy, citizens can hold public officials accountable for the effectiveness of their policies.

According to the above four elements of modern science that have found their way into liberal-democratic thought, the technocracy model has drawn most directly on science's instrumental power. Technocrats embrace science not primarily as a procedural model of democratic discourse, nor as a stable background of facts for democratic deliberation over values, but as an instrumental justification for their policy initiatives.

The technocratic tradition can be traced back to Plato, but it also draws on more recent European authors such as Auguste Comte, who argued that government should promote the common good, but

> for the people to take a direct part in government, and to have the final decision of political measures, is a state of things which in modern society is only adapted to times of revolution. To realise it as final would lead at once to anarchy, were it not so utterly impossible to realise.[107]

Technocratic thought has also played a powerful role in the American political tradition, as in the science-driven reform movements of the Progressive Era.[108] Aspects of Dewey's thought, for example, have led critics to read him as an advocate of positivism and technocracy.[109] Dewey often complains, for example, that whereas the natural

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[107] Auguste Comte, *A General View of Positivism*, trans. J. H. Bridges (London: Trubner and Co., [1848] 1865. Reprint, intro. Mihaly Csikszentmihalyi [Dubuque, Iowa: Brown Reprints in Sociology, 1971]), 141.

[108] Wilson Carey McWilliams, "Science and Freedom: America as the Technological Republic," in *Technology in the Western Political Tradition*, ed. Arthur M. Melzer, Jerry Weinberger, and M. Richard Zinman (Ithaca, NY: Cornell University Press, 1993), 85-108.

[109] See, e.g., Max Horkheimer, *The Eclipse of Reason* (Oxford: Oxford University Press, 1947; New York: Continuum Publishing Corp., 1992), 42-55 and passim. According to Jeff Lustig, the pragmatists' epistemology subverted their democratic ideals, inadvertently supporting the ideology of corporate liberalism. See R. Jeffrey Lustig, *Corporate Liberalism: The Origins of Modern American Political Theory, 1890-1920* (Berkeley: University of California Press, 1982), 150-75.

sciences have long adopted the experimental method, politics remains tied to the method of "discussion." Discussion, he writes, is insufficient for the "systematic origination of comprehensive plans, the plans that are required if the problem of social organization is to be met" (*LSA*, 50). From this perspective, Dewey's attempt to place science in the service of democracy resulted in a scientized politics.

Today the technocracy model dominates most areas of government regulation in the United States. It was clearly apparent in the electric vehicle case, where CARB policymakers not only appealed to the instrumental effectiveness of policies grounded in expert knowledge, but suggested that only such policies would be democratically legitimate. Lay citizens, CARB argued, would be better represented by policies the agency deemed instrumentally effective than by those the citizens supported.

*Rational deliberation*

Liberal democracies have also drawn on an instrumental view of action to justify a model of politics centered on rational deliberation among lay citizens. As I suggested above with reference to the four elements of modern science that reappear in liberal-democratic thought, the ideal of rational deliberation has drawn on both substantive and procedural elements of science. Substantively, the notion that ordinary citizens can represent themselves through collective decisionmaking depends on the assumption of an "informed" citizenry.[110] Citizens are only thought capable of choosing the best policies if they have some substantive understanding of the causal relations that link political

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[110] See Richard D. Brown, *The Strength of a People: The Idea of an Informed Citizenry in America, 1650-1870* (Chapel Hill: University of North Carolina Press, 1996).

actions and consequences. Procedurally, as noted above, many of the behavioral norms commonly assumed to underlie the instrumental success of science—reasonableness, consensus, disinterestedness, cooperation—have long provided a cultural model of democratic deliberation.

While this model of liberal instrumentalism has generally remained subordinate to the others, it has play a key role in populist movements throughout American history.[111] The ideal of rational deliberation also underlies such contemporary regulatory procedures as public comment periods and public hearings, which agencies such as CARB have used to legitimate, if not formulate, their policies. This model also motivates many recent efforts to integrate popular participation into the shaping of science and technology, as discussed in Chapter 7.

*Market competition*

The third model of liberal-democratic instrumentalism has relied not on technocratic plans for civic reform, nor on the ideal of an informed citizenry, but on the notion that the public good depends on subordinating political action to the demands of the economic market. This version of instrumentalism differs from the others insofar as scientific knowledge is used to justify an entire social structure rather than particular government policies or expressions of public will. The "laws of the market," discerned by economic science, reassure citizens that their uncoordinated and self-interested pursuit of individual gain will in the long run benefit the public as a whole. By showing that

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[111] See James A. Morone, *The Democratic Wish: Popular Participation and the Limits of American Government* (New York: Basic Books, 1990).

economic competition will produce the public good, or at least public order, neoclassical economics has long projected the pleasing notion that democracies do not require the political participation of ordinary citizens.[112]

Milton Friedman thus explicitly associates market activity with the experimental attitude, contrasting it with the stagnant thinking that characterizes politics.[113] He goes on to describe market activity as "effectively proportional representation," allowing the best possible realization of the democratic principle of one person, one vote. Proportional representation through political institutions, in contrast, "tends to require or to enforce substantial conformity." Most importantly, he argues, social order is best preserved through widespread market activity, because "the use of the market reduces the strain on the social fabric by rendering conformity unnecessary with respect to any activities it encompasses."[114] For Friedman, neither centralized rulers nor decentralized citizens purposefully *make* the polity, but individuals can pursue their private ends with the knowledge that the polity is being safely made behind their backs.

Like the other models, the market competition model of instrumentalism is prevalent in contemporary regulatory politics. It appears in the recent trend toward "market-based" policies at all levels of government. It was also prominent in the ZEV case, where the California policymakers frequently implied that market demand is a quasi-natural force, rather than an artifact of public policy, corporate advertising, and

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[112] Ezrahi, *Descent of Icarus*, 19-28.

[113] Milton Friedman, *Capitalism and Freedom* (Chicago: The University of Chicago Press, [1962] 1982), 4.

[114] Ibid., 23, 24.

other social and political factors.[115] As we saw in Chapter 2, by justifying its policy change with reference to laws of market competition, CARB made its decision seem both more scientific and more in tune with the public good. Against accusations that CARB had capitulated to auto industry demands, the agency could claim it had simply obeyed the same economic laws faced by every citizen. What appeared to be a hidden and private deal could be presented as an open, public, and necessary decision. Despite overwhelming public opposition to changing the ZEV mandate, the appeal to economic expertise made the decision appear more a matter of public will than agency discretion: "While ARB takes into consideration all public input, ultimately we must determine whether a regulation will be a technologically feasible and cost-effective means of achieving clean air in California."[116] CARB thus gave more credit to the abstract conception of the public good defended by economic experts than the concretely expressed will of ordinary citizens.

Compared to the other two models, the market competition model is a timid and apolitical model of liberal-democratic instrumentalism. It requires not ambitious applications of theory to practice, but obedience to the Anglo-American injunction to "be practical." In contrast to the optimism and rationalism associated with the technocracy and rational deliberation models, the market competition model reflects what Sheldon Wolin calls the "sublimation of politics."[117] The apolitical character of this model

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[115] The Memorandum of Agreement between CARB and the automakers, for example, states that each "Manufacturer commits that it will have the capacity to produce a specified number of ZEVs that could be sold in California *if warranted by customer demand*" (CARB, *Staff Report*, appendix C, 3, emphasis added).

[116] CARB, *Final Statement of Reasons*, 34.

[117] Wolin, *Politics and Vision*, chap. 10.

appears, for example, in Locke's notion that human relations in the state of nature are peaceful and harmonious, which implies that political order is not a creative invention, as it was for Hobbes, but a rediscovery of the natural. Locke's conception of the state of nature also obscures the market's reliance on political institutions in civil society.[118] Adam Smith thus later drew on Locke's vision of the state of nature to assert that political order could be secured by an "invisible hand" rather than the conscious efforts of individual citizens. Today we are often told that the workings of the invisible hand are best discerned by the professional economist. With the market competition model, that is, the instrumental power of modern science is taken from public officials and lay citizens and given to economic experts.

## Modern Science in Contemporary Policymaking

The point of this chapter has been to show that technocratic forms of politics, such as we saw in the California electric vehicle program, have been able to sustain themselves not merely through sheer corporate power or bureaucratic arrogance, although those have certainly played a role, but also by drawing on conceptual resources developed in modern science and shared by more decentralized conceptions of politics. As we have seen, modern science has a double identity, what Latour calls the Janus face of science.[119] Modern science is both generally valid *and* locally produced. It is both public, impartial, and supremely open to criticism *and* private, exclusive, and immune to objections from lay citizens.

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[118] Referring to Locke, Wolin writes that "his imagination was never stirred by the thought of joining the rapidly growing body of science to the discipline of philosophy and bringing both to bear on the opportunities presented by a disturbed and directionless political society" (*Politics and Vision*, 295).

[119] See Latour, *Science in Action*, 1-17.

Looking back at the electric vehicle controversy, we can now better see how these two sides of science enabled the California policymakers to justify the technocratic process whereby they revised the ZEV program. In justifying its decision, CARB could assert both its humility before the facts of battery technology *and* its expert capacity to second-guess the self-assessments of lay citizens. Drawing on the Janus face of modern science, CARB could justify its decision by referring to both the extensive public input it had solicited *and* the "special expertise" that allowed it to ignore that input. Paradoxically, the contradiction involved in first soliciting and then ignoring public input made the decision seem more scientific and thus more legitimate. It is easier to understand the agency's ability to get away with this contradiction once we see that it was built into the modern understanding of science over three hundred years ago.

CARB's effective use of the double identity of modern science points to the larger dilemma of liberal-democratic instrumentalism identified at the beginning of this chapter. On the one hand, reliance on concepts drawn from modern science has helped liberal-democratic ideology reconcile the ancient tension between individual freedom and public order. The division between private beliefs and public knowledge, between subjective emotional states and objective political reality, allows citizens to act freely in public without fear that their freedom will lead to anarchy. It also allows citizens to hold public officials accountable with reference to public standards of performance. Most significantly, as Ezrahi explains, liberal-democratic instrumentalism reconciles democratic norms of accountability with the individualism and privatism typical of the liberal conception of citizenship.

> Once we recognize that the vulnerability of democratic political actors—within the cultural framework of attestive visual orientations toward politics—does not

> require rational, competent, participatory citizenry, that public witnessing effectively redistributes political reputations and power even where—as is usually the case—the witnesses can claim to have neither the knowledge nor the consensus to pinpoint the "right" course of action, then we need not subscribe to the idea that when classical models of participatory democracy or representative democracy are not realizable the only alternative is degenerative forms of democracy, where the few try, and often succeed, to deceive the many.[120]

Just as the early experimental scientists garnered the trust of their audiences by reporting failed experiments, the vulnerability of public officials to the imperatives of political reality can evoke the confidence of citizen-witnesses. Even if citizens prove incapable of rationally evaluating the effects of government action—or if they just have better things to do—the assumption that political actions are in principle liable to such evaluation ensures that democratic rituals of legitimation will endure. Modern science has thus provided ideological support for both participatory and elitist, decentralized and centralized, conceptions of liberal democracy.

On the other hand, however, as the electric vehicle case suggests, liberal-democratic instrumentalism has not preserved a meaningful role for political participation by lay citizens. Even the concept of rational deliberation idealized in the bourgeois public sphere, itself highly exclusionary, has usually remained subordinate to the market competition and technocracy models of liberal democracy. These two dominant models depend primarily on *substantive* justifications of political authority. They fail to articulate *formal* procedures that would guarantee an active role for laypeople in shaping public policy. As a result, these models of instrumentalism have justified hierarchies of wealth and knowledge within a liberal-democratic society that emerged, ironically, from struggles against hierarchies of religion and status. These versions of liberal democracy

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[120] Ezrahi, *Descent of Icarus*, 90.

give priority to accountability over participation, to substantive over formal representation. Because "political reality" is presumed to provide a check on the ambitions of both policy experts and economic entrepreneurs, because the effects of public actions are deemed visible and open to public evaluation, there appears to be little need for lay participation in shaping public policy.

In sum, technocracy is not so much the antithesis of participatory democracy, as is often assumed, but is rather the substantive element of democratic representation taken to an extreme. Technocratic attacks on formal provisions for citizen participation have been effective precisely because they draw on a conceptual resource that participatory democrats share: the notion, supported by modern science, that public deliberation can lead to instrumentally effective action. As Broman rightly argues, the increasing specialization and professionalization of science during the nineteenth and twentieth centuries did not mean an abandonment of the seventeenth-century notion of science as public knowledge. On the contrary: "The authority that scientific experts possess today derives from the quality of scientific knowledge being open and public in principle but recondite in practice."[121] Insofar as the only people deemed competent to judge what counts as scientific are other scientists, one could reasonably expect much more public skepticism toward science than already exists. But the idea that science *as such* is open to the public, even if any particular scientific laboratory is not, makes the self-justification of science possible.

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[121] Broman, "The Habermasian Public Sphere," 142.

# CHAPTER 4

## ANTI-INSTRUMENTALISM AND THE DEFENSE OF LOCAL KNOWLEDGE

As long as we believe that we deal with ends and means in the political realm, we shall not be able to prevent anybody's using all means to pursue recognized ends.
– Hannah Arendt

Critics of modern science from Rousseau to Marcuse have generally not disputed the links between science and liberal-democratic instrumentalism discussed in the previous chapter. But they associate instrumentalism with various undesirable, in some cases undemocratic, modes of thought and action. Individual scientists, these critics say, may well see themselves as engaged in the non-instrumental pursuit of truth for its own sake, but they use laboratory instruments to control natural phenomena, and the knowledge they produce is itself an effective instrument for controlling the social and natural world. More importantly, critics argue, by continually expanding the human capacity for instrumental action, science fosters an instrumental conception of the world. The instrumental worldview elevates effectiveness and efficiency over moral, aesthetic, or religious values; it emphasizes extrinsic over intrinsic qualities of persons and actions; it restricts political vision to the use of available means for achieving mundane ends; it fosters technocratic dreams of eliminating social conflict; and it promotes a tendency to view the world as infinitely malleable rather than at least partially given by nature, God, history, or society.

Contemporary critics of science and technology often trace their roots no further back than the New Left of the 1960s, or perhaps the 1930s and the early writings of the Frankfurt School. This chapter shows that many of the most powerful twentieth-century critiques of modern science originated during the Scientific Revolution itself. This serves two purposes. It lends credence to these critiques of instrumentalism, insofar as it shows that they are not merely the passing fancies of whining academics. It also helps bring out the explicitly political dimension of these critiques, insofar as early critics of liberal instrumentalism often concerned themselves more directly with the relationship between science and politics than do contemporary critics. As mentioned before, writers such as Rousseau, Burke, and Jefferson saw politics and science not as isolated spheres of activity, but as intertwined elements of human experience that necessarily affect each other in various ways. This chapter does not, however, give an historical overview of critiques of instrumentalism, but merely highlights those criticisms—and their weaknesses—that seem most helpful for thinking about the democratization of science and technology.

In the first half of the chapter, I examine three basic critiques of liberal instrumentalism. One strand of critique focuses on the moral implications of instrumentalism. Conservative thinkers, like Burke, as well as those liberals associated with Locke and the political economists, consider the political world too complex and unpredictable to be the object of either technocratic schemes of social transformation or popular participation in politics. Along with some Romantic and Marxist critics of the Enlightenment, such as Rousseau or Horkheimer and Adorno, conservative critics emphasize the constraints imposed on politics by forces of habit, tradition, economy, or society, making them skeptical toward purposive efforts to shape those forces. These critics, who I call "moral" critics, for lack of a better term, thus either oppose the instrumental outlook as a whole, or seek to ban it from the political sphere. Although their writings illuminate the moral costs of societal rationalization, their tendency toward essentialist and determinist conceptions of science and technology greatly restricts their conceptions of possible reform.

The moral critique of instrumentalism overlaps with that of a second group of critics who believe the technical complexity of twentieth-century politics demands that the hopes of liberal-democratic instrumentalism be abandoned, especially those hopes reflected in the rational deliberation model discussed at the end of the last chapter. These "democratic realists" reveal important challenges to contemporary citizenship, but underestimate the native capacities of lay citizens. Their helpful diagnosis thus requires a different prescription—namely, that offered by radical democrats, who provide a third critique of liberal-democratic instrumentalism.

Radical democrats, unlike the democratic realists, focus their critique not on the rational deliberation model, but on the idea of technocracy. Technocratic instrumentalism, radical democrats argue, overemphasizes government accountability at the expense of lay participation. Radical democrats do not oppose instrumentalism as such, but reject efforts at social engineering that subject citizens to laws they have not helped make themselves.

I call these three critiques of liberal instrumentalism "internal critiques," since they each presuppose the Enlightenment conception of science on which liberal instrumentalism relies. That is, they criticize the instrumental application of science in politics, but not the prevailing understanding of how science is produced in the first place. The second half of the chapter takes up the "external" critique of liberal instrumentalism implicit in twentieth-century reformulations of the Enlightenment image of science, focusing on the thought and impact of Thomas Kuhn. Although Kuhn helped initiate a transformation in prevailing conceptions of science, especially among social theorists, his understanding of scientific communities as self-regulating systems ultimately proves inadequate for a democratic theory of science. The chapter concludes with a brief look at Herbert Marcuse's call for a "new science," the voluntarism of which points beyond Kuhn to the political constructivist conception of science defended in the next chapter.

## Liberal Instrumentalism's Internal Critics

### *Moral Critiques*

Modern science, it is often noted, has developed in close connection with its critics. The rationalism, individualism, and hostility to tradition and culture associated with modern science have evoked dissent from a diverse group of conservatives, liberals, radicals, and Romantics. They share a general concern with the impact of instrumental thinking on the moral, personal, and expressive dimensions of politics.

The moral critique of instrumentalism is directed in part against the incessant hunger for scientifically-informed social progress—intellectual, political, and economic—that characterizes liberal-democratic ideology. The aspiration for change, especially when driven by elites, is perceived as a threat to traditional institutions and social cohesion. "A spirit of innovation," Burke writes, "is generally the result of a selfish temper and confined views."[1] For rationalist reformers, he argues,

> it is a sufficient motive to destroy an old scheme of things because it is an old one. As to the new, they are in no sort of fear with regard to the duration of a building run up in haste, because duration is no object to those who think little or nothing has been done before their time, and who place all their hopes in discovery.[2]

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[1] Edmund Burke, *Reflections on the Revolution in France* (1790), ed. J. G. A. Pocock (Indianapolis, IN: Hackett Publishing Company, 1987), 29.

[2] Burke, *Reflections*, 77.

Conservative critics like Burke do not oppose change or progress on principle. But for them it must be a measured change, respectful of customs and traditions, guided more by the lessons of experience than the dictates of reason.

These moral critics also argue that liberal instrumentalism induces people to treat each other merely as means, obscuring one's moral and religious duties toward others. Rousseau notes, for example, that when "Science spreads, faith vanishes. Everyone wants to teach how to do the good, and no one wants to learn it."[3] The sciences, he says, "spread garlands of flowers over the iron chains with which men are burdened," stifling their natural sense of liberty. Science makes people soft, urbane, refined; it makes them into "happy slaves."[4]

While not explicitly challenging the epistemology of modern science, Rousseau also argues that modern science has not in fact produced the instrumental benefits it promises. Without science, he asks, "would we consequently be fewer in number, less well governed, less formidable, less flourishing or more perverse?" Not unlike today's public officials who question public funding for basic research, Rousseau rails against those who "provide us with so little that is useful" and "uselessly consume the substance of the State."[5]

Above all, moral critics object to the harsh light of Enlightenment rationalism with which liberal instrumentalists seek to illuminate every niche of political life.

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[3] Jean-Jacques Rousseau, "Observations by Jean-Jacques Rousseau of Geneva, On the Answers to his Discourse," in *The First and Second Discourses together with Replies to Critics and Essay on the Origin of Languages*, ed. and trans. Peter Gourevitch (New York: Harper and Row, 1986), 31-52, at 44.

[4] Jean-Jacques Rousseau, "Discourse on the Sciences and Arts," in *The First and Second Discourses*, ed. Roger D. Masters, trans. Roger D. Masters and Judith R. Masters (New York: St. Martin's Press, 1964), 31-74, at 36.

[5] Rousseau, "Discourse on the Sciences and Arts," 49-50.

Genuine virtue, Rousseau says, emerges from introspection and naive appreciation of nature's beauty, not experimental inquiry. "Scripture in a thousand places exhorts us to revere the greatness and goodness of God in the wonders of His works; I do not think that it has anywhere prescribed to us the study of Physics...."[6] Similarly, Burke attacks the demand for transparency that issues from both modern science and liberal-democratic ideology. "All the pleasing illusions which made power gentle and obedience liberal, which harmonized the different shades of life...are to be dissolved by this new conquering empire of light and reason."[7] Burke's attack is of course directed in part at Rousseau, who also harbors a dream of transparency. Indeed, despite his eventual estrangement from Diderot and the other *philosophes*, Rousseau remains in many ways a child of the Enlightenment.[8] But Rousseau's ambition is not to make transparent the mechanics of nature or the political aims and arguments of his fellow citizens. He wants only that citizens be capable of perceiving their compatriots' deepest convictions and character traits.[9] Whereas Rousseau thus identifies civic virtue with the mutual transparency of citizens' *inner* natures, he suggests that the difficulty of discovering the secrets of *external* nature indicates that God meant them to remain hidden.[10]

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[6] Rousseau, "Observations," 36.

[7] Burke, *Reflections*, 67.

[8] A long tradition of Enlightenment scholarship has exaggerated the contrast between Rousseau and the philosophes, either branding Rousseau an early Romantic or ignoring him in discussions of the Enlightenment altogether. On Rousseau's simultaneous advocacy and critique of Enlightenment thought, see Mark Hulliung, *The Autocritique of Enlightenment: Rousseau and the Philosophes* (Cambridge: Harvard University Press, 1994), esp. chap. 5.

[9] "How pleasant it would be to live among us if exterior appearance were always a reflection of the heart's disposition..." (Rousseau, "Discourse on Arts and Sciences," 37).

[10] Rousseau, "Discourse on the Sciences and Arts," 47

Following in the tradition of Burke and Rousseau, Michael Oakeshott suggests that rationalists are unable to sustain a sense of humility and wonder in the face of the unknown. The rationalist, Oakeshott argues, "has none of that *negative capability*,...the power of accepting the mysteries and uncertainties of experience without any irritable search for order and distinctness, only the capability of subjugating experience...."[11] And Arendt maintains that because political freedom is won in liberating oneself from natural necessity, freedom depends upon the existence of natural forces independent of human control. Modern science and technology, she says, obscure human dependence on nature and thus the connection between necessity and freedom.[12] Each of these critics sees a threat to genuine politics in efforts to extend rational control over every aspect of life.

At this point one can usefully distinguish between those moral critics who believe it possible to contain instrumentalism within its proper sphere, and those who think instrumentalism necessarily extends itself throughout society. Or, to put it differently, as touched on in Chapter 1, one can distinguish between those who see science and technology as *neutral tools* for the instrumental pursuit of political ends, and those who see science and technology as an *ideological force* that rationalizes everything it touches. Each of these perspectives is essentialist and determinist, insofar as each conceives of scientific and technological development as socially and politically autonomous. But they differ in the options they see for controlling that development.

The conception of science and technology as an ideological force appears most famously in the dystopian theories of the early Frankfurt School. Writing amid growing

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[11] Michael Oakeshott, "Rationalism in Politics" (1947), in *Rationalism in Politics and Other Essays* (Indianapolis, IN: Liberty Press, 1991), 5-42, at 6.

[12] Hannah Arendt, *The Human Condition* (Chicago: University of Chicago Press, 1958), 121-25.

evidence of the "rationalization" of daily life, as well as the contribution of science to the horrors of two world wars, critics such as Max Horkheimer, Theodor Adorno, and later Jacques Ellul argued that the problem with science lies not in its application, but in something about science itself. Drawing on the work of Max Weber, they identified science and technology not primarily with material products, but with norms of efficiency, productivity, and control. The problem of technology or "technique" is that its norms have come to dominate the non-instrumental values that properly govern the political, economic, and cultural spheres. In their influential book, *Dialectic of Enlightenment*, Horkheimer and Adorno argued that conceptual thought itself, having taken the form of maker's knowledge, has become a mode of domination.

> Men pay for the increase of their power with alienation from that over which they exercise their power. Enlightenment behaves toward things as a dictator toward men. He knows them in so far as he can manipulate them. The man of science knows things in so far as he can make them.[13]

Horkheimer and Adorno saw little possibility of evading the progressive corruption of the human spirit associated with modernity.

A more hopeful critique of instrumentalism can be found in those writers who see science and technology as morally neutral tools. They believe it possible to contain instrumental thinking to the technical manipulation of nature, preserving politics for the elaboration and pursuit of human ends. These critics attack not science itself, but efforts to apply scientific knowledge or methods to politics. Rousseau, for example, states clearly that "Science in itself is very good, that is obvious....To acquire knowledge and to expand one's enlightenment is, then, in a way to participate in the supreme

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[13] Horkheimer and Adorno, *Dialectic of Enlightenment*, 9.

intelligence."[14] The problem occurs when science enters society, "because Science, however beautiful, however sublime, is not made for man;...his mind is too limited to make much progress in it, and his heart too full of passions to keep him from putting it to bad use...."[15] Even if scientists succeed in discovering the truth about nature and recognizing it as such, "who among us will know how to make good use of the truth?" Rousseau thinks the pursuit of science, except among those truly born for it, causes idleness, vanity, pride, and an "irreparable loss of time."[16] But since it would be impossible to abolish science, it should be tolerated as one of life's lesser evils. The arts and sciences can be used to "temper the ferociousness of the men they have corrupted" by diverting them from truly evil pursuits. "Let us feed those Tigers something to keep them from devouring our children."[17]

A more recent but very similar effort to contain science within its proper sphere appears in the work of Habermas. Following Kant, Habermas identifies science and technology with instrumental thinking. He argues that science expresses a cognitive "interest," insofar as the tools of science—quantification, classification, the identification of causal laws, etc.—are expressions of a desire to control nature and society. But technical rationality is not governed by any *particular* political interests. It is, rather, an expression of a universal *human* interest in controlling one's environment.[18]

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[14] Rousseau, "Observations," 32.

[15] Ibid.

[16] Rousseau, "Discourse on the Sciences and Arts," 49.

[17] Rousseau, "Observations," 51. One might also note that Rousseau does not believe the social effects of science are a distinctly modern problem, but are rather "as old as the world" ("Discourse on the Sciences," 39).

[18] See Habermas, *Knowledge and Human Interests*, appendix.

Habermas thus formulates the problem of technology and politics in terms of the relationship between two spheres of activity governed by radically different norms. Technology results from and expresses norms of instrumental control; politics follows norms of communicative rationality. Technical rationality thus poses no inherent threat to other human values, as long as it remains confined to its particular sphere. Habermas thus rejects Marcuse's call for a "new technology," discussed below, because he thinks it ignores technology's exclusively instrumental character:

> Technological development...follows a logic that corresponds to the structure of purposive-rational action regulated by its own results, which is in fact the structure of *work*. Realizing this, it is impossible to envisage how, as long as the organization of human nature does not change and as long therefore as we have to achieve self-preservation through social labor and with the aid of means that substitute for work, we could renounce technology, more particularly *our* technology, in favor of a qualitatively different one.[19]

It does not make sense, in Habermas's view, to talk about "our" technology, because technology does not express particular social conditions or political choices. Rather, technology expresses the universal human need to satisfy material necessity by transforming nature through work.

One should note that Habermas's essentialist conception of technical rationality motivates his eloquent plea for the democratic control of technology. He rightly asserts that

> an energetic attempt must be made consciously to take in hand the mediation between technical progress and the conduct of life in the major industrial societies, a mediation that has previously taken place without direction, as a mere continuation of natural history.[20]

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[19] Jürgen Habermas, "Technology and Science as 'Ideology,'" in *Toward a Rational Society: Student Protest, Science, and Politics*, trans. Jeremy J. Shapiro (Boston: Beacon Press, [1968] 1970), 81-122, at 87.

[20] Jürgen Habermas, "Technical Progress and the Social Life World," in *Toward a Rational Society*, 50-61, at 60.

Habermas thus rejects "hard" versions of technological determinism that reduce politics to adaptation to technical necessity. Unlike the early Frankfurt School, Habermas retains the Enlightenment faith in the potential of creative political action.

Habermas's critique of instrumentalism, however, like all critiques grounded in an essentialist division between science and politics, cannot go beyond a policy of containment. The political control of technology, for Habermas, keeps technology in its proper sphere, but never penetrates into the construction of technological artifacts themselves. Beginning with an *a priori* conception of science and technology, the moral critique of instrumentalism offers little help in thinking about the democratization of science and technology. As Andrew Feenberg argues, the essentialist critique of technology shows how to draw tight boundaries around the technical sphere, but it cannot improve life within that sphere. It thus "ends up agreeing implicitly with technocrats that the actual struggles in which people attempt to influence technology can accomplish nothing of fundamental importance."[21] Aiming to get technology out of politics, Habermas and other moral critics do not show how to make the politics that inhere in technology more democratic.

If automotive technology, for example, is to foster democratic values, it will not be enough to reveal its societal dominance. Nor will it be enough, incidentally, to show that automotive technology is "socially constructed." The automobile has long established itself within the most intimate spheres of daily life, and revelations of its socially constructed character do not by themselves indicate what should be done about

[21] Andrew Feenberg, *Questioning Technology* (London and New York: Routledge, 1999), xiv. See also Sclove, *Democracy and Technology*, 102.

it. Far more helpful is to consider how citizens can become engaged in the *re*-construction of automotive technology, such that it better serves their diverse needs. Chapter 7 considers several possibilities for such engagement.

A related limitation of the above critiques of instrumentalism is that, in highlighting the dangers of instrumentalism, they often underestimate the contribution of instrumental conceptions of politics to the theory and practice of democracy. Politics, according to many of these writers, is not so much a matter of getting things done as publicly expressing one's personal convictions and affirming one's connections with others. As Arendt puts it, "In acting and speaking, men show who they are, reveal actively their unique personal identities and thus make their appearance in the human world."[22] Politics, in this view, is principally a matter of heroic self-expression and symbolic action. The instrumental use of knowledge to question or resolve political problems, in contrast, is seen as containing an inherently violent potential.[23] For many of these critics of instrumentalism, the making and remaking of social and political life through public policy and technology is at best mundane, at worst not fully human.

As we saw in the electric vehicle case, political participation can be both instrumentally effective and intrinsically meaningful. These two requirements need not conflict, I argued, insofar as effective policymaking depends on citizens' active involvement. The ZEV program can only succeed if lay citizens become involved in the purchase and promotion of EVs, and they are far more likely to become so involved if they can attach a personal meaning to these activities and to EVs themselves. Politics, in

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[22] Arendt, *Human Condition*, 179.

[23] Arendt, *Human Condition*, 229.

this view, can never provide the full range of experiences that make a human life meaningful. In this respect, Arendt yearns for too much. But instrumentally effective politics need not be morally or aesthetically empty. If political participation is directed toward the solution of meaningful problems, then problem solving, even with the help of science and technology, will be meaningful.

### *Democratic-Realist Critiques*

The above moral critiques of instrumentalism have developed alongside very different but in some ways complementary critiques of the liberal-instrumentalist ideal of democratic citizenship. Robert Michels, Joseph Schumpeter, and other "democratic realists" have argued since the late-nineteenth century that the overwhelming scale and complexity of industrial society make the instrumental conception of political action untenable.[24] Democratic realists insist that the ideal of self-rule through rational deliberation makes sense only for small-scale, low-tech, culturally homogenous societies such as fifth-century Athens or Rousseau's Geneva. In contemporary liberal societies, in contrast, government reliance on technical expertise necessarily leads to a decline in political transparency, making intelligent political participation by the general public impossible. Moreover, the clash between participatory ideals and the reality of elitist politics fosters disillusionment and makes citizens vulnerable to populist demagogues.

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[24] See Robert Michels, *Political Parties*, trans. Eden and Cedar Paul (Glencoe, IL: Free Press, [1915] 1949), 365–408; Joseph A. Schumpeter, *Capitalism, Socialism, and Democracy*, 3rd ed. (New York: Harper & Row, [1942] 1950), 232-302. For a critique, see Edward A Purcell, Jr., *The Crisis of Democratic Theory: Scientific Naturalism and the Problem of Value* (Lexington: University of Kentucky Press, 1973); Peter Bachrach, *The Theory of Democratic Elitism: A Critique* (Boston: Little, Brown, 1967). More recently, see Stephen L. Elkin and Korel Edward Soltan, eds., *Citizen Competence and Democratic Institutions* (University Park: Pennsylvania State University Press, 1999). On the response by political theorists to democratic realist arguments, see David M. Ricci, *The Tragedy of Political Science: Politics, Scholarship, Democracy* (New Haven, CT: Yale University Press, 1984), 88, 101-11.

The ideal of participatory democracy is thus not merely benignly irrelevant, but positively dangerous.

During the 1920s, social scientists like Charles Merriam, Harold Gosnell, and Harold Lasswell combined psychological theory with empirical studies of voting behavior to argue that the democratic ideal of "rule by the people" had become a naive dream. In the 1960s and 70s, Gabriel Almond, Sidney Verba, and others argued that the public's apparent lack of political interest and knowledge represented not a deplorable decline of the Enlightenment model of democratic citizenship, but a necessary component of political stability in a complex society.[25] For these democratic realists, civic apathy signals not public cynicism or alienation, but public trust in the competence of elites. Democratic realists remain democratic, insofar as they embrace the substantive ideal of liberal-democratic instrumentalism, according to which elites govern in the public interest. But they largely abandon the procedural ideals expressed by liberal-democratic notions of rational deliberation and civic witnessing.

One of the first and most prominent democratic realists was the journalist Walter Lippmann. In his 1925 book *The Phantom Public*, Lippmann argues that because public officials rely on expert knowledge, ordinary citizens can never fully understand the workings of government. The specialized knowledge and procedures employed by political "insiders" make it impossible for "outsiders" to competently evaluate their

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[25] Gabriel A. Almond and Sidney Verba, *The Civic Culture* (Princeton, NJ: Princeton University Press, 1963). See also Michael J. Crozier, Samuel P. Huntington, and Joji Watanuki, *The Crisis of Democracy: A Report on the Governability of Democracies to the Trilateral Commission* (New York: New York University Press, 1975); *Critical Review* 12, no. 4 (Fall 1998), "Special Issue: Public Ignorance and Democracy."

governmental representatives. The "private citizen," Lippmann notes, continues to feel an obligation to attend to public affairs.

> Yet these affairs are in no convincing way his affairs. They are for the most part invisible. They are managed, if they are managed at all, at distant centers, from behind the scenes, by unnamed powers....He lives in a world which he cannot see, does not understand, and is unable to direct.[26]

According to democratic realists like Lippmann, the technical demands of governing a modern nation have pulled a veil between citizens and their governments. The ideal of political transparency inherited from the Age of Light has become an anachronism. Lippmann insists that this is not due to public incompetence, but to the increasing invisibility of politics itself. The traditional theory of democracy saddled lay citizens with an impossible task. No citizen today, Lippmann argues, not the President of the United States nor a professor of political science, can live up to the traditional democratic ideal of the "omnicompetent" citizen.[27]

Although Lippmann was one of Dewey's harshest critics, Dewey shared much of Lippmann's critique of American politics, while disputing his rejection of the country's democratic ideals.[28] In his review of Lippmann's *The Phantom Public*, Dewey argues that Lippmann's criticisms of democratic theory are "aimed in some degree at a man of straw."[29] The ideal of participatory democracy, says Dewey, has not had the historical

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[26] Walter Lippmann, *The Phantom Public* (New York: Macmillan, 1925), 13-14.

[27] Lippmann, *Phantom Public*, 21-22.

[28] For an overview of Dewey's response to democratic realism, see Westbrook, *John Dewey*, 280-86. Dewey's and Lippmann's concerns find a recent expression in Jürgen Habermas, "The New Obscurity: The Crisis of the Welfare State and the Exhaustion of Utopian Energies," in *The New Conservatism: Cultural Criticism and the Historians' Debate*, ed. and trans. Shierry Weber Nicholsen (Cambridge: MIT Press, 1989), 48-70.

[29] Dewey, "Practical Democracy," review of *The Phantom Public*, by Walter Lippmann, in *The Later Works* 2:212-25, at 217. See also *PP*, 144, and Dewey's acknowledgment of his "indebtedness" to Lippmann in *PP*, 116n.

influence Lippmann attributes to it. No theory of democracy motivated the creation of modern democratic institutions, because these institutions emerged primarily in response to economic and technological change. Moreover, as we saw in the previous chapter, Dewey argues that the modern democratic citizen has generally been conceived as a critical witness of democratic governance, rather than an active participant in it.

> It is open to doubt whether the spokesmen of democracy ever conceived its functions very differently from Mr. Lippmann's thought of them. To be the judge and umpire in last resort, to be able to compel submission of important issues to popular judgment, to force political governors to appear now and then on trial before their constituents so as to give a reckoning of their stewardship; such, I think, were the not immoderate pretensions in the main of the men who actually forwarded the democratic movement in government.[30]

If liberal democracy has conceptualized the citizen as little more than a critical observer of government, Lippmann is wrong to blame the democratic ideal for the current disjunction between citizens and their government. In the next chapter, I show how Dewey departs from this minimalist conception of democracy, but here we can see how he uses it to refute Lippmann.

Dewey agrees with Lippmann, however, that a lack of transparency in public affairs has made genuine democratic citizenship extremely difficult. The increasing obscurity of the causes and effects of public policy prevents the public from understanding, much less participating in, the activities of government officials. The time when "a man might entertain a few general political principles and apply them with some confidence" is long gone (*PP*, 131). "Even the specialist finds it difficult to trace the chain of 'cause and effect'; and even he operates only after the event, looking backward, while meantime social activities have moved on to effect a new state of

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[30] Dewey, "Practical Democracy," 217-18.

affairs" (*PP*, 135). "The ties which hold men together in action are numerous, tough, and subtle. But they are invisible and intangible" (*PP*, 142). Citizens' inability to discern the public consequences of governmental action, Dewey argues, has brought about an "eclipse of the public" (*PP*, chap. 4). The public has become a "ghost" (*PP*, 125).[31]

The eclipse of the public does not imply a lack of issues requiring public attention. Far from it. As noted in the previous chapter, Dewey locates "the public" wherever private actions have consequences for those not immediately involved in the action. In an increasingly technological society, private actions have increasingly widespread and unpredictable consequences. There is thus an excess of public issues, each concerning a different social group, creating an excess of publics. "There are too many publics and too much of public concern for our existing resources to cope with" (*PP*, 126, see also 137). These multiple publics extend to the international sphere, where the links between causes and effects are even more difficult to discern. This became especially clear, Dewey suggests, with the First World War, which revealed the intricate and far flung consequences of international political and commercial alliances. "The connections and ties which transferred energies set in motion in one spot to all parts of the earth were not tangible and visible....But the war is there to show that they are real" (*PP*, 128). Local publics have become intertwined with national and foreign publics, establishing international chains of cause and effect that evade the grasp of ordinary

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[31] Similarly, Dewey argues that the rise of local party organizations conceals the actual operations of government from public view. Individuals have only "the blessed opportunity to vote for a ticket of men mostly unknown to them, and which is made up for them by an under-cover machine in a caucus whose operations constitute a kind of political predestination" (*PP*, 119-20). See also Yaron Ezrahi, "Dewey's Critique of Democratic Visual Culture and Its Political Implications," in *Sites of Vision: The Discursive Construction of Sight in the History of Philosophy*, ed. David Michael Levin (Cambridge: MIT Press, 1997), 315-36, esp. 321.

citizens. "The local face-to-face community has been invaded by forces so vast, so remote in initiation, so far-reaching in scope and so complexly indirect in operation, that they are, from the standpoint of the members of the local social units, unknown" (*PP*, 131). The acceleration of "globalization" since Dewey's time has only exacerbated these dilemmas for democratic politics.[32]

Dewey goes on to argue that this lack of transparency has contributed to the rise of a solipsistic politics of self-interest and self-promotion. Sounding a lot like today's critics of "identity politics," Dewey suggests that the decline in political transparency has "nurtured a cult of self-expression in which each thinks about his own thoughts and has subtle feelings about his feelings."[33] The norms of transparency, publicity, and objectivity that liberal democracy adopted from modern science have given way to the popular valorization of personal, subjective experience.

The conflict between technical complexity and political transparency identified by democratic realists at the beginning of the twentieth century still presents a major challenge for democratic politics. This conflict appeared in the electric vehicle case, where laypeople lacked the technical capacity to either second-guess expert agreement on the state of battery technology or resolve expert disagreement about probable consumer behavior. This lack of transparency is also a key feature of many other areas of contemporary politics. Environmental politics, especially, often revolves around threats that remain imperceptible to the human senses, such as radiation, pesticides, or global climate change. Relying on scientists for information about threats to their health and the

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[32] See Benjamin R. Barber, *Jihad vs. McWorld: How Globalism and Tribalism are Reshaping the World* (New York: Ballantine Books, 1995, 1996).

[33] Dewey, "Practical Democracy," 216. See also Ezrahi, *Decent of Icarus*, chaps. 10-11.

environment, citizens are deprived of the concrete experiential resources that would otherwise motivate political action. As Beck has written,

> Experience—understood as the individual's sensory understanding of the world—is the orphan child of the scientized world. Experience, which was once the main authority and judge of truth, has become the quintessence of the subjective, a relic, a source of illusions that attack the understanding and make a fool of it.[34]

In their concern with the conditions of modern experience, Lippmann, Dewey, and Beck echo the Enlightenment notion that popular sovereignty requires a certain amount of faith in the authenticity of the sensory world. Citizens must be able to hold political leaders accountable for their actions as they *appear* to the public. Today, however, like seventeenth-century skeptical philosophers, citizens often feel they cannot trust their senses. Contemporary environmental politics forces citizens to choose almost randomly among the opinions of experts and counter-experts as to the reality of otherwise imperceptible dangers.

In this respect, the tension between science and common sense discussed in the previous chapter has been largely resolved in favor of science. Whereas science used to provide a model for the refinement of common sense through rational deliberation, science today seems increasingly divorced from and antagonistic to common sense. Arendt thus argues that modern science does not merely refine common sense, but rather debunks the local knowledge of lay citizens and the naive realism of ordinary experience. As a result, lay citizens no longer feel "at home in the world" and genuine political freedom becomes impossible.[35]

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[34] Beck, *Ecological Enlightenment*, 15.

[35] Arendt, *Human Condition*, 257-325.

As I show in the next chapter, Dewey believes the widespread adoption of the scientific mode of thought, *as he conceives it*, can enable citizens to overcome the eclipse of the public. Although he rejects the prescriptions of the democratic realists, Dewey accepts their assessment that most ordinary citizens currently lack a scientific outlook. Lay citizens, he says, view science as a collection of "ritualistic ceremonies from which the herd is excluded" (*PP*, 164). As early as 1893, Dewey argues that "faith in the social career of science, of a wide distribution of intelligence as the basis of a scientifically controlled democracy, has all but vanished."[36] Lay people only know science insofar as it manifests itself in new technologies that enter into their daily lives. Even when they realize the profound effects that a new technology has had on their lives, lay citizens rarely understand precisely how such changes have come about. "Not understanding its 'how', they cannot use and control its manifestations" (*PP*, 165). Even the most competent citizens are no better off than a machine operator who has learned to manage a machine. "Skill enables him to turn the flux of events this way or that in his own neighborhood. It gives him no control of the flux" (*PP*, 166).

In Chapter 7, I draw on Dewey to argue that if lay citizens possess the necessary economic and educational resources, they have the native capacity to learn how to "control of the flux." Such an argument, of course, depends on a radical-democratic critique of liberal instrumentalism

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[36] Dewey, "Renan's Loss of Faith in Science," *Early Works* 4:16. See also Dewey's 1945 essay, "The Revolt Against Science," *Later Works* 15:188-91.

*Radical-Democratic Critiques*

The radical-democratic critique of instrumentalism often draws on the moral critique described above, but its primary concern lies less with moral corruption than political exclusion. As I noted at the end of the previous chapter, liberal-democratic ideology focuses attention on government accountability for substantive policy decisions. Citizens are usually conceived as competent witnesses of government decisionmaking, rather than active participants. The radical-democratic critique of instrumentalism rejects this priority of accountability over participation. As Benjamin Barber writes, "When the citizenry is a watchdog that waits with millennial patience for its government to make a false move but submits passively to all other legitimate government activity, citizenship very quickly deteriorates into a latent function."[37] While acknowledging the importance of holding public officials accountable to those they serve, radical democrats argue that being adequately served is no less important than engaging in public service. Whereas the former is a matter of strictly instrumental benefit, the latter has both instrumental and intrinsic dimensions. Modern science, therefore, cannot provide a complete model for democratic citizenship.

From a radical-democratic perspective, moreover, modern science does not even provide a sufficient model of democratic procedure. As I suggested in the last chapter, early scientific institutions quickly established relatively fixed boundaries between those deemed competent to participate in scientific discourse and those who were excluded. We also saw how the experimentalists' boundary between scientists and lay people

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[37] Barber, *Strong Democracy*, 220.

parallels the boundary between public and private in liberal-democratic thought. Radical democrats, feminists, and other critics of liberalism have long argued that conceptions of public and private, and the political procedures they sanction, need to continually reevaluated.[38] Liberal-democratic procedures are never substantively neutral, but reflect and reinforce prevailing assumptions about who can participate in politics and what topics are considered appropriate for political discussion. Radical democrats thus call for a radical proceduralism that continually subjects the procedures of democratic discourse to public scrutiny.

Finally, radical democrats insist that public participation is not only an instrumental but also an intrinsic good. The instrumental goals of politics must be pursued through means that allow citizens opportunities for self-expression, civic education, and collective deliberation. Radical democrats agree with John Stuart Mill that "Among the foremost benefits of free government is that education of the intelligence and the sentiments, which is carried down to the very lowest ranks of the people when they are called to take a part in acts which directly affect the great interests of their country."[39] Political participation not only makes it more likely that governments will promote the substantive interests of the citizenry, but is itself a substantive good, insofar as it enhances civic knowledge, political judgment, and democratic community.

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[38] See Joan B. Landes, ed., *Feminism, the Public and the Private* (Oxford: Oxford University Press, 1998).

[39] John Stuart Mill, *Considerations on Representative Government* (1861), in *On Liberty and Other Essays*, ed. John Gray (Oxford: Oxford University Press, 1991), 327. Mill goes on to say that "it is from political discussion, and collective political action, that one whose daily occupations concentrate his interests in a small circle round himself, learns to feel for and with his fellow-citizens, and becomes consciously a member of a great community" (328). See also 239, 247, 249.

As someone who understood the attractions of liberal instrumentalism, Dewey offers one of its most persuasive radical-democratic critiques. I have already suggested that Dewey's appreciation of the realist critique of liberal democracy was limited by his commitment to a radical-democratic ideal. And while Dewey's enthusiasm for scientific method inadvertently lent support to the technocratic ambitions of other thinkers, his conception of the appropriate political role of science differs from that of the technocrats in several respects. First, if the masses are truly incompetent, Dewey argues, they will simply not accept rule by experts. "The very ignorance, bias, frivolity, jealousy, instability, which are alleged to incapacitate them from share in political affairs, unfit them still more for passive submission to rule by intellectuals" (*PP*, 205). In this respect, as Aristotle noted long ago, the technocrats not only underestimate ordinary citizens' ability to rule themselves, they overestimate their ability and willingness to be ruled by others.

Second, Dewey argues that any system of rule by experts will tend to favor rich over poor. Because reason is always tinged with interest, the private exercise of reason cannot reliably defend the public interest. "A class of experts is inevitably so removed from common interests as to become a class with private interests and private knowledge" (*PP*, 207). Dewey thus explicitly and repeatedly disparages government by experts as "an oligarchy managed in the interests of the few" (*PP*, 208).

Most significantly, Dewey differs fundamentally from the technocrats in his view that experts necessarily rely on the public no less than the public relies on experts. Political participation by the lay public is necessary if experts are to know what the public wants. "In the degree in which [experts] become a specialized class, they are shut off from knowledge of the needs which they are supposed to serve" (*PP*, 206). Experts require knowledge about the social needs they serve not simply because it enhances their job satisfaction, but as I show in detail in the next chapter, because the very creation of expert knowledge depends upon it. Whether experts are polling citizens on their political views or immunizing children against smallpox, they require the cooperation of laypeople for both creating and applying expert knowledge. Dewey thus suggests a mode of linking the truth and use of science far more concrete than the vague promise of technological benefits promulgated by most advocates of basic research.

From this perspective, the failure of technocracy lies not in the political use of science *per se*, but in the attempt to apply *pre-established* knowledge to public affairs. Policymakers should rather create new knowledge through interaction with the public. "At present, the application of physical science is rather *to* human concerns than *in* them" (*PP*, 174). The degree of experts' reliance on popular cooperation differs in different situations, of course, and Dewey may be accused of idealizing the mutual dependence of experts and lay citizens.[40] Nevertheless, as I show in Chapter 7, some activist groups have succeeded in shaping both the priorities and procedures of scientific research, especially in biomedicine, by exploiting experts' dependence on popular cooperation in the creation and use of knowledge.

These considerations suggest that despite their shared assessment of the situation, Dewey and Lippmann formulate very different responses to the eclipse of the public. From Dewey's perspective, Lippmann has not demonstrated the inability of the people to govern themselves, but rather "the need of further discussion of publicity in relation to

[40] This criticism is discussed in the largely sympathetic account of James Bohman, "Democracy as Inquiry, Inquiry as Democratic: Pragmatism, Social Science, and the Cognitive Division of Labor," *American Journal of Political Science* 43, no. 2 (April 1999): 590-607, at 594-95.

the public."[41] Whereas Lippmann takes the failure of citizens to live up to the democratic ideal as an indictment of the ideal, Dewey blames social and economic inequalities and the resulting injustice in the social distribution of knowledge.

> The indictments that are drawn against the intelligence of individuals are in truth indictments of a social order that does not permit the average individual to have access to the rich store of the accumulated wealth of mankind in knowledge, ideas, and purposes....It is useless to talk about the failure of democracy until the source of its failure has been grasped and steps are taken to bring about that type of social organization that will encourage the socialized extension of intelligence (*LSA*, 38-39).

For Dewey, the public incompetence used to justify technocracy results from social and economic inequalities rather than native citizen capacities. This does mean every citizen can become a technical expert. But every citizen should "have access" to society's store of technical knowledge. Understanding what Dewey means by "access" requires a closer look at Dewey's writings on epistemology and metaphysics, two areas often neglected by those interested in his political theory. As I show in the next chapter, Dewey's philosophy of science facilitates his aim of making the substance and methods of natural science available to lay citizens. First, however, we need to examine another set of critiques of instrumentalism.

## Liberal Instrumentalism's External Critics

The above criticisms of liberal instrumentalism raise important questions about the Enlightenment view of science as a model for democratic politics. They also show how efforts to apply scientific knowledge to the resolution of political problems can easily backfire. But in attacking the application of science to politics, critics of liberal

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[41] Dewey, "Practical Democracy," 219.

instrumentalism have rarely gone very far in questioning the Enlightenment image of science itself. Their concern has been primarily to keep science from intruding upon other spheres of life. In this respect, they remain firmly within the dualist image of science and society constructed by Boyle and his colleagues and reestablished by early twentieth-century logical positivism. Indeed, as J. R. Ravetz argues, the "ideology" of modern science, according to which natural science is a uniquely objective form of knowledge, has remained dominant since the late-seventeenth century. Even the late-nineteenth century labor movement, one of the most powerful popular attacks on liberal society, was inspired by Marx's "scientific" alternative to "Utopian" socialism. Alternative conceptions of science appeared at various times throughout the nineteenth century, but they were either ignored or suppressed.[42]

During the twentieth century, however, the Enlightenment image of science came under increasing strain. Einstein's theory of relativity raised questions about science as a reflection of reality; quantum mechanics forced a rethinking of assumptions about scientific certainty; the atomic bomb challenged popular faith in the practical benefits of science. By the late 1950s, Ravetz suggests, "All the contradictions in the ideology of science that had been latent through the centuries of triumph now became manifest."[43]

One of the most powerful critiques of the Enlightenment image of science appeared in the work of Michel Foucault, whose influence far outweighs the attention I can give it here. Foucault argued that scientific knowledge is not simply used in the service of domination, but is itself always already an expression of political power.

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[42] J. R. Ravetz, "Orthodoxies, Critiques, Alternatives," in *Companion to the History of Modern Science*, ed. Colby et al., 898-908.

[43] Ravetz, "Orthodoxies, Critiques, Alternatives," 901.

Eschewing the traditional Enlightenment concern with "speaking truth to power," Foucault asked, "[W]hat rules of right are implemented by the relations of power in the production of discourses of truth?" He answered, in brief, "We are subjected to the production of truth through power and we cannot exercise power except through the production of truth."[44] Power in the modern state is not simply exercised from the top down, but "circulates" through citizens' daily enactment of rituals bound up with sciences of social control, such as psychiatry, medicine, and criminology. Despite his frequent association with a politically passive hyper-skepticism, Foucault called for an "insurrection of subjugated knowledges" that would uncover the experience of those whose lives have fallen outside the dominant discourse of power/knowledge.[45] Although Foucault's concern was primarily with the human sciences, and thus somewhat outside the focus of this dissertation, he has been extremely important for many activists seeking to legitimize local forms of knowledge.

Indeed, it is important to note that the erosion during the 1960s and 1970s of the positivist conception of science was not merely an academic event, but was bound up with popular critiques of technology by environmentalists, feminists, and other activists.[46] The anti-war movement criticized the suffering caused by a government composed of the "best and the brightest"; the women's movement exposed the exclusiveness of the supposedly "open" scientific community; the environmental

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[44] Michel Foucault, *Power/Knowledge: Selected Interviews & Other Writings, 1972-1977*, ed. Colin Gordon (New York: Pantheon Books, 1972), 93.

[45] See Ibid., 81-82.

[46] See Feenberg, *Alternative Modernity*, 37.

movement attacked the "side effects" of science and technology; and the self-help movement began, however imperfectly, to develop alternative sources of expertise.

Some of these popular movements were driven by an internal critique of instrumentalism, focusing on the application of scientific knowledge. Many popular movements, however, also raised questions about the way in which scientific knowledge is produced in the first place. These more fundamental questions arose in dynamic interaction with the work of social theorists, historians, and philosophers of science who in the course of the twentieth century thoroughly undermined the epistemology underlying the Enlightenment image of science. The remainder of this chapter examines the strain of epistemological critique developed in the philosophy of science.

### *Kuhn's Communitarian Critique of Positivism*

Academic philosophy of science had little use for the dystopian theories of the Frankfurt School, but during the second half of the twentieth century it raised radical questions about the Enlightenment image of science. Many of these questions had, of course, been asked before. Thomas Kuhn would have appreciated Rousseau's assertion, for example, that "One always believes one has said what the Sciences do when one has said what they should do."[47] But from the late 1950s onward, the conception of natural science that had long supported instrumental conceptions of politics came under increasing scrutiny.

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[47] Rousseau, "Observations," 36. See also "Letter from J. J. Rousseau of Geneva to Mr. Grimm on the Refutation of his Discourse by Mr. Gautier," in *The Collected Writings of Rousseau*, ed. Roger D. Masters and Christopher Kelly, trans. Judith R. Bush, Roger D. Masters, and Christopher Kelly (Hannover, NH and London: University Press of New England), 2:84-92, at 56, 63.

This scrutiny was primarily directed at logical positivism (often called logical empiricism), which during the first half of the twentieth century adopted the mantel of the Royal Society as the leading defender of elite-driven, value-free science. Logical positivism differed from the earlier positivism of Comte in that, among other things, the latter believed the character of science always reflected the developmental state of society rather than universal canons of rationality. But both rejected "metaphysics" and insisted that science should only concern itself with visible phenomena, rejecting explanations based on invisible causes. Both also promoted the seventeenth-century notion of science as a uniquely authoritative form knowledge. In the wake of the horrible uses to which science had been put during the First World War, logical positivism sought to fortify the seventeenth-century division between science and politics.

The logical positivists argued that science must be understood in terms of a strict division between two basic sorts of statements: logical, formal, analytic, and mathematical statements, on the one hand, and empirical, factual, synthetic, and physical statements, on the other. Positivist philosophy of science set itself the task of carefully allocating the various elements of science to one side or other of this divide. Philosophers were to cleanse scientific theories of "ideological" elements by translating them into artificial languages in accordance with the requirements of formal logic. Logical positivists defined a "meaningful" statement as one that is either analytically true or that expresses an empirical observation that could, in principle, be empirically verified. A statement is verified if all the available observational evidence supports it. Statements that are neither analytically true nor empirically verifiable were taken to be literally "meaningless." Ethical and political statements, the positivists argued, are not assertions of fact or even of feeling, but are merely emotive expressions.[48]

One of the earliest challenges to logical positivism, after Dewey's, which was not widely appreciated among philosophers of science, came from Karl Popper. In *The Logic of Scientific Discovery*, first published in German in 1934, Popper argued that the positivist insistence on verification can never be fulfilled, because useful scientific theories are so broad that every possible application of the theory can never be tested. It is always possible, moreover, that new evidence will challenge even the most thoroughly verified theory. Popper argued that science proceeds best when it formulates theories that specify conditions under which the theory would be "falsified." If empirical investigation fails to falsify a theory, it is "corroborated." The theory thus gains explanatory power, even if it can never be fully verified.[49]

Popper thus challenged the positivist view of science as the inductive discovery of certain knowledge, but he also shared much with the positivists. Popper agreed with the positivists that science is fundamentally a matter of rational inquiry, that observations can be sharply separated from theory, that scientific knowledge is cumulative through human history, and that the "context of discovery" can be clearly separated from the "context of justification." Even if scientific discovery includes subjective elements, Popper argued, it is still possible to provide objective justifications of scientific knowledge.[50]

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[48] Alfred Jules Ayer, *Language, Truth, and Logic* (New York: Dover Publications Inc., 1946), 102-112. [49] See Popper, *Logic of Scientific Discovery*, chaps. 4, 10.

[50] See Karl Popper, "Normal Science and Its Dangers," in *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave (Cambridge: Cambridge University Press, 1970), 51-58, esp. 56-57. On the comparison between Popper and the positivists, see Ian Hacking, *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science* (Cambridge: Cambridge University Press, 1983), 1-17.

These views came under increasing attack from the late-1950s onward. Norwood Russell Hanson, for example, drew on Wittgenstein's *Philosophical Investigations* to challenge the positivist and empiricist notion that perception can be understood as the passive reception of impressions from the outside world. Showing how a scientist's worldview always affects what he or she sees, Hanson argued that scientific observations are "theory-laden."[51] Michael Polanyi, as noted above, argued in a similar vein that natural scientific practice does not proceed strictly according to the logical procedures elaborated by philosophers, but often relies on the "personal" or "tacit" knowledge developed through scientific practices.[52] Science involves both techniques amenable to codification and tacit knowledge that cannot be rationally explained or summarized in rules.

Building on and radicalizing these critiques, Paul Feyerabend argued that agreement among scientists does not proceed directly from observation of the facts. Rather, "Unanimity is often the result of a *political* decision: dissenters are suppressed, or remain silent to preserve the reputation of science as trustworthy and almost infallible knowledge."[53] Feyerabend defended a libertarian conception of science that emphasized

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[51] Norwood Russell Hanson, *Patterns of Discovery* (Cambridge: Cambridge University Press, 1958). Hanson offered what soon became a standard example: although Ptolemy and Copernicus might both observe the same sunset, they would "see" different things due to their different cosmologies. The former would "see" the moving sun travelling around the earth and the latter would "see" the earth travelling around the sun.

[52] Oakeshott draws on Polanyi to argue that when scientists enter politics, they only bring their technique. Their tacit skills cannot be transferred to the foreign context of political affairs. As a result, efforts to adopt a scientific approach to political problems foster rationalism and its attendant dilemmas, but only because they pervert the actual methods of scientific practice ("Rationalism in Politics," 34-35).

[53] Paul Feyerabend, *Science in a Free Society* (London: New Left Books, Verso, 1978), 88.

the importance of individual creativity for both scientific and social progress. Due to its tendency to suppress dissent, he argued, science is a "threat...to democracy."[54]

Perhaps the most celebrated break with the positivist image of science came with Thomas Kuhn's 1962 book, *The Structure of Scientific Revolutions*.[55] Kuhn challenged many of the basic views shared by philosophers of science, including both Popper and the logical positivists. As is well known, Kuhn characterizes the history of science in terms of the succession of "paradigms." Glossing over the many controversies surrounding this term, in Kuhn it generally refers to the explicit or implicit theories, methods, and standards of practice that guide and provide the means of evaluating scientific research. The vast majority of scientific activity, what Kuhn calls "normal science," aims to solve the puzzles posed by a particular paradigm. Every once in a while, however, the gradual accumulation of anomalous observations that do not quite fit the categories of an existing paradigm, accompanied by the development of new theories, together make up what Kuhn calls "revolutionary" science. Scientists working under the existing paradigm withhold professional sanction from those pursuing revolutionary science and use various means to enforce the existing paradigm. But if the revolutionary scientists acquire sufficient means of persuasion, their efforts lead to a "paradigm shift." Through a process that blends rational argument with psychological and sociological factors, a scientific discipline adopts the concepts and criteria of the new paradigm, which are largely "incommensurable" with those of the old.

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[54] Feyerabend, *Science in a Free Society*, 76.

[55] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd Edition (Chicago: University of Chicago Press, [1962] 1970).

The problem of incommensurably appeared most sensationally in Kuhn's cautious endorsement of the notion that "when paradigms change, the world changes with them."[56]

> In a sense that I am unable to explicate further, the proponents of competing paradigms practice their trades in different worlds. One contains constrained bodies that fall slowly, the other pendulums that repeat their motions again and again. In one, solutions are compounds, in the other mixtures....Practicing in different worlds, the two groups of scientists see different things when they look from the same point in the same direction.[57]

Statements such as these led many readers to read Kuhn as endorsing some form of ontological relativism. Does the world that scientists see depend on nothing other than their agreements about what they see? Kuhn encouraged such questions with his insistence that paradigm changes do not occur through mere reinterpretations of existing data. Reinterpretation plays an important role, he argued, but scientists working in different paradigms both collect different data and focus their attention on different elements of the data that is available.[58]

Nonetheless, the charges of ontological relativism discounted Kuhn's claim that paradigm shifts depend in part on rational evaluations of experimental data.

> All historically significant theories have agreed with the facts, but only more or less. There is no more precise answer to the question whether or how well an individual theory fits the facts. But questions much like that can be asked when theories are taken collectively or even in pairs. It makes a great deal of sense to ask which of two actual and competing theories fit the facts *better*.[59]

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[56] Ibid., 111.

[57] Ibid., 150.

[58] Ibid., 121-22.

[59] Ibid., 147.

Paradigm shifts are initiated by daring leaps of faith, and depend on distinctly social and psychological processes. But "scientists are reasonable men," and paradigm shifts are only completed by a gradual shift of allegiances effected in part by rational argument and persuasion based on empirical evidence.[60]

Similarly, despite his claim that competing paradigms are largely incommensurable with each other, Kuhn endorsed a limited notion of scientific progress. He insisted that scientific revolutions involve both gains and losses, a notion that came to be called "Kuhn loss."[61] And he stated that "we may have to relinquish the notion...that changes of paradigm carry scientists and those who learn from them closer and closer to the truth."[62] But even if science does not necessarily progress *toward* anything, Kuhn argued that science is rightly said to lead *away* from ignorance and powerlessness. And although science cannot be identified with an increasing approximation of *the truth*, it does lead to increasing capacities for understanding and controlling natural phenomena. Specifically, Kuhn noted, science over time allow more accurate prediction, the solution of a greater number of problems, and the development of theories of greater simplicity and scope. "Later scientific theories are better than earlier ones for solving puzzles in the often quite different environments to which they are applied."[63]

Although Kuhn's position may thus seem fairly moderate from today's perspective, at the time *Structure* took center stage in a paradigm shift of its own. In

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60 Ibid., 158.

61 Ibid., 167.

62 Ibid., 170.

63 Ibid., 206; see also Thomas S. Kuhn, "Reflections on My Critics," in *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave (Cambridge: Cambridge University Press, 1970), 231-278, at 259-66.

disciplinary terms, Kuhn's book breached the boundaries between the sociology, philosophy, and history of science. Until the 1960s, the philosophy and sociology of science had remained largely isolated from each other. Mertonian sociology of science had been largely unconcerned with the content of scientific knowledge, focusing instead on the incentive structures and professional norms of scientific institutions. Most work in the philosophy of science, in contrast, largely ignored concrete scientific practices, concentrating on the resulting scientific knowledge. Enamored of logical positivism, philosophers had tended to focus on the logical dimensions of science, pursuing questions concerning the formal status of theories and the relationship between theories and facts. Kuhn, in contrast, argued that the paradigms from which scientific theories emerge are "accepted examples of scientific practice—examples which include law, theory, application, and instrumentation together."[64] Scientific facts are not only "theory-laden," but laden with skills and instruments as well. Kuhn's notion of a paradigm is thus best understood not as a theory shared by a scientific community, but as a set of shared practices of research that may or may not be guided by theory.[65] Kuhn used his detailed studies in the history of science to bridge the boundary between sociology and philosophy, showing how the norms and practices of particular scientific communities influence the content of scientific theories.[66]

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[64] Ibid., 10; see also 26.

[65] Joseph Rouse, "Kuhn and Scientific Practices," *Configurations* 6, no. 1 (1998): 33-50, at 35.

[66] Responding to the charge that the history of science has little relevance for philosophers' interest in the essential nature of science, Kuhn replied that he, too, was interested in the essential features of science and the reasons for its efficacy, but that when historical investigations revealed that "much scientific behaviour, including that of the very greatest scientists, persistently violated accepted methodological canons, I had to ask why those failures to conform did not seem at all to inhibit the success of the enterprise. When I later discovered that an altered view of the nature of science transformed what had previously seemed aberrant behaviour into an essential part of an explanation for science's success, the discovery was a source of confidence in that new explanation" ("Reflections on My Critics," 236.

Beyond the impact of Kuhn's work on the history and philosophy of science, and quite unintended by Kuhn himself, *Structure* was read by many as an attack on the widely presumed superiority of scientific modes of thought. The philosophy of science had long provided a justification for the social prestige of the natural sciences. Many social and political theorists thus eagerly drew on Kuhn's work to denounce behavioralism, political instrumentalism, and the "culture of technology."[67] In this respect, Kuhn provided the resources for a more radical critique of liberal instrumentalism than those discussed above. Whereas most critics had attacked only the application of science to politics, Kuhn seemed to provide a way of challenging the prevailing image of science itself.

Unfortunately, few of those who drew on Kuhn to criticize behavioralism and liberal instrumentalism took the trouble to explore the limits of Kuhn's theory of science. It is almost as if, so relieved to find a friendly voice within the philosophy of science, and eager to defend it against positivist critics, they were reluctant to ask whether Kuhn had it right. It has become increasingly clear, however, that Kuhn's conception of scientific communities contains important shortcomings that limit its helpfulness for political theory.

Kuhn conceived of scientific paradigms as intimately bound up with particular scientific communities—so intimately, in fact, that in his 1969 postscript to *The Structure of Scientific Revolutions*, Kuhn admitted the tautology contained in his conception of paradigms as modes of community life, which he had initially defined in terms of acceptance of a paradigm.[68] Kuhn argued, however, that this problem could be

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[67] For a discussion of why Kuhn "took" in the 1960s, see Tracy B. Strong, *The Idea of Political Theory: Reflections on the Self in Political Time and Space* (Notre Dame, IN: University of Notre Dame Press, 1990), 7-11.

[68] Kuhn, *Structure*, 176.

surmounted by defining scientific communities with reference to shared subject matter, education, professional membership, and use of a body of scholarly literature. He suggested that citation analysis could be used to identify scientific communities independently of their commitment to particular paradigms. A scientific community, Kuhn said, might be no more than twenty-five people, or it might extend to an entire professional group, such as physicists or chemists, or even to the global community of all scientists.[69]

Most importantly, Kuhn stuck by his earlier conception of the function of scientific communities, asserting that they are nothing less than the "producers and validators of scientific knowledge."[70] Drawing on Wittgenstein, Kuhn had argued that scientific communities develop "forms of life" that guide the work of community members. "Like the choice between competing political institutions, that between competing paradigms proves to be a choice between incompatible modes of community life."[71] In paradigm choice, he argued, "there is no standard higher than the assent of the relevant community.[72]

Kuhn thus restricted the sociological elements of his philosophy of science to the sociology of self-sufficient, self-regulating scientific communities. He explicitly rejected the notion that factors external to any particular scientific community could play a role in shaping science.[73] In this respect, Kuhn located himself within the "internalist" tradition

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[69] Ibid., 177.

[70] Ibid., 178.

[71] Ibid., 94.

[72] Ibid., 94.

[73] "Breakdown of the normal technical puzzle-solving activity is not, of course, the only ingredient of the astronomical crisis that faced Copernicus. An extended treatment would also discuss the social pressure for calendar reform, a pressure that made the puzzle of precession particularly urgent. In

in the history of science. He affirmed the scientific necessity of an "unparalleled insulation of mature scientific communities from the demands of the laity and of everyday life."[74] Kuhn acknowledged that scientists are never completely isolated from the outside world, but he also asserted that they rely more on internal standards than any other professional community. "The most esoteric of poets or the most abstract of theologians is far more concerned than the scientist with lay approbation of his creative work."[75] Effective scientific work depends on the exclusion of external concerns, because "the insulation of the scientific community from society permits the individual scientist to concentrate his attention upon problems that he has good reason to believe he will be able to solve."[76]

Kuhn's conception of the scientific community thus places severe restrictions on the norms of publicity and instrumentalism with which seventeenth-century natural philosophers had legitimized their claims to knowledge. Publicity and instrumentalism, in Kuhn's view, do not connect the scientific and political communities, as they did for Boyle and the experimentalists. Rather, they operate only within the scientific community itself.[77]

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addition, a fuller account would consider medieval criticism of Aristotle, the rise of Renaissance Neoplatonism, and other historical elements besides. But the technical breakdown would still remain the core of the crisis. In a mature science--and astronomy had become that in antiquity--*external factors* like those cited above are principally significant in determining the timing of breakdown, the ease with which it can be recognized, and the area in which, because it is given particular attention, the breakdown first occurs" (*Structure*, 69, emphasis added).

[74] Kuhn, *Structure*, 164.

[75] Ibid.

[76] Ibid.

[77] Steve Fuller makes a similar point in contrasting Kuhn's conception of the scientific community with Popper's liberal-democratic "open society" and Feyerabend's loose collective of anarchic-libertarian iconoclasts (*Social Epistemology* [Bloomington and Indianapolis: Indiana University Press, 1988], 6).

Kuhn thus provides only limited assistance for efforts to reform the technocratic politics of contemporary environmental policymaking. In the ZEV case, for example, one might enlist Kuhn to show that the knowledge compiled by the Battery Technical Advisory Panel was not a straightforward reflection of nature, but depended in part on the norms and conventions of a community of chemists and electrical engineers. This might serve to debunk the pretensions of technocratic policymakers. One could also speculate that a change in the internal norms of the relevant scientific communities would lead to new directions of battery research, which would lead to new types of EV batteries. But according to Kuhn's view, such a change occurs through processes internal to the scientific community itself. Like Habermas and Ellul, Kuhn insulates science from political efforts to reform it.

In addition to these practical limits, Kuhn's theory places important limits on theoretical critiques of political instrumentalism that draw upon it. Lacking a theoretical framework to support concrete study of the relationships between science and politics, contemporary political theorists have drawn on Kuhnian philosophy of science primarily to debunk the pretensions of their scientistic colleagues. In the 1960s, Kuhn offered crucial resources for political theorists seeking to defend their field against the methodological imperialism of behavioralism. Indeed, the defense was quite successful. Whereas political theorists once feared for the survival of their discipline, the field today boasts a greater number of articles, books, and conference panels than ever before.[78]

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[78] Both the vibrancy of contemporary political theory and, incidentally, its lack of attention to scientific practices are highlighted in Iris Marion Young, "Political Theory: An Overview," and Bhikhu Parekh, "Political Theory: Traditions in Political Philosophy," in *A New Handbook of Political Science*, ed. Robert E. Goodin and Hans-Dieter Klingemann (New York: Oxford University Press, 1996), 479-502, 503-30.

But like the toxic waste shipped to Third World countries that comes back on imported fruit, the effective attacks on behavioralism in the 1960s have not prevented positivist conceptions of political science from reasserting themselves in the form of rational choice. Although denunciations of positivism have helped save political theory from disciplinary annihilation, they have often presupposed, and hence strengthened, the very conception of science they attack. Indeed, in some respects, the estrangement of political theory from the sciences has gotten worse. As Wolin recently noted, "Yesterday's animosities, as well its areas of mutual concern, are today's indifferences."[79] Although there have been some collaborative efforts, the relationship between political theory and political science today is frequently one of mutual suspicion and avoidance.[80] Political theory's relationship with the natural sciences is even more distant. Despite the limited assistance Kuhn provides for dealing with this dilemma, *Structure* probably still provides the leading image of science among contemporary political theorists.

Ironically, less than a decade after the publication of Kuhn's groundbreaking book, research in the sociology of science posed a powerful challenge to Kuhn's notion that scientific communities can be effectively isolated from the political communities within which they reside. During the early 1970s, advocates of the "strong program" in

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[79] Sheldon S. Wolin, "Political Theory: From Vocation to Invocation," in *Vocations of Political Theory*, ed. Jason A. Frank and John Tambornino (Minneapolis: Minnesota University Press, 2000), 11. Moreover, as Clifford Geertz points out, the failure to forge thoughtful linkages across the boundary between science and politics lends credence to New Age efforts at achieving a vague synthesis through such fantasies as Zen physics or parapsychology ("The Strange Estrangement," 95).

[80] See Joseph V. Brogan, "A Mirror of Enlightenment: The Rational Choice Debate," *The Review of Politics* 58 (Fall 1996): 793-806; James Johnson, "Is Talk Really Cheap? Prompting Conversation between Critical Theory and Rational Choice," *American Political Science Review* 87 (March 1993): 74-86.

the sociology of science turned their attention from the norms and institutions of science to the content of scientific knowledge.[81] Building on the tradition of Marx, Ludwig Fleck, and Karl Mannheim, they showed how classic sociological variables such as class interest, widely considered "external" to science, often shape not only the practices of working scientists, but the actual content of scientific methods and theories as well.[82]

The most important contribution of the strong program lies in its defense of a principle of "symmetry" in the analysis of accepted and rejected scientific claims. Whereas historians had tended to locate the cause of accepted claims in nature, and that of rejected claims in society, the strong program asserts that social factors play a role in both the acceptance and rejection of scientific claims. The strong program thus takes up Kuhn's historical perspective on the philosophy of science and extends it beyond the bounds of the scientific community.

While the leading figures of the strong program insisted on their neutrality with regard to the desirability of competing scientific theories—they aspired to create a "science of science"—their work was adapted to various political ends by the "radical science" movement and other critics of technocratic politics. By documenting the influence of "external" factors in the making of science, and later technology as well, the strong program opened up questions about the role of political and economic power in technical controversies. The strong program thus helped critics of technocracy go

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[81] See Barry Barnes, *Scientific Knowledge and Sociological Theory* (London and Boston: Routledge and Kegan Paul, 1974); David Bloor, *Knowledge and Social Imagery* (London and Boston: Routledge and Kegan Paul, 1976).

[82] The strong program was only one of several strands of research within what came to be called the "sociology of scientific knowledge" or SSK. For a helpful account of the range of approaches, including Latour's actor-network theory, discussed in the next chapter, see Hess, *Science Studies*, chap 4.

beyond merely debunking claims to objectivity. It became easier to think about constructive ways of reforming science to make it better serve public needs.

Unfortunately, the strong program suffered from a relatively static conception of the social factors that influence the shaping of scientific knowledge. It often seemed to reduce science to nothing more than a reflection of impersonal social forces. The strong program was thus vulnerable to the charge that it had substituted sociological determinism for empiricist determinism.[83] The notion that a scientific theory gains ascendance over its competitor simply because it reflects the interests of the dominant class gives too little credit to the independent influence of nature. More importantly, if the social influences on science are conceived in terms of fixed, macro-level sociological categories, it is difficult to identify a role for individual political actors in the shaping of scientific knowledge. Given these objections to the strong program, it may be helpful to briefly examine a critic of both positivism and instrumentalism who argued not only that science is socially constructed, but that it needs to be politically reconstructed in accord with democratic values.

### *Marcuse's Constructivist Instrumentalism*

Marcuse is interesting for my argument, because he brings a distinctly voluntarist edge to his elaboration of the early Frankfurt School's critique of rationalization. Building on the work of Horkheimer and Adorno, Marcuse showed how rationalization had extended from work and administration into almost every other sphere of life, including education, leisure, and sexuality. But Marcuse offered a more hopeful vision of

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[83] See the essays cited in Chapter 1, note 10.

the future. Marcuse made two arguments that parallel my own: science and technology need to be understood in terms of their creation through and implications for politics; and nature needs to be understood as having an independent influence on the shaping of science and technology. Unfortunately, whereas Kuhn had a major impact on most every academic discipline, Marcuse's influence did not extend far beyond the scholars and activists associated with the New Left. In many ways, however, Marcuse's theory of science holds more promise than Kuhn's for contemporary efforts to democratize the creation and use of science and technology.

Following the phenomenology of Heidegger and Husserl, Marcuse argued that scientific objectivity is founded on the concrete practices of a particular *Lebenswelt* or life-world.[84] Scientific objectivity is not an illusion, but it depends on the social norms and practices of a community of inquirers. For Marcuse, moreover, as for the strong program, the practices from which science emerges are fundamentally characterized by class conflict. Class conflict, in turn, is ultimately grounded in the struggle for survival that characterized the earliest human societies. Marcuse thus argues that the early Frankfurt School neglected Marx's claim that science and technology reflect class interests. Like capitalism, science and technology present themselves as formally rational and politically neutral, when they are in fact politically biased. "The machine is not neutral; technology is always a historical-social *project*: in it is projected what a

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[84] "The scientific abstraction from concreteness, the quantification of qualities which yield exactness as well as universal validity, involve a specific concrete experience of the *Lebenswelt*—a specific mode of 'seeing' the world. And this 'seeing,' in spite of its 'pure,' disinterested, character, is seeing within a purposive, practical context" (*One Dimensional Man: Studies in the Ideology of Advanced Industrial Society* [Boston: Beacon Press, 1964], 164; see also 211-212).

society and its ruling interests intend to do with men and things."[85] This also means, however, that technology cannot be *essentially* oppressive, as Horkheimer and Adorno believed. Technology is only oppressive insofar as it emerges from a context of class conflict.[86]

But class conflict, Marcuse believes, is no longer necessary. Like Dewey, Marcuse argues that advanced industrial societies have the technical means to provide abundant material goods for all, thus obviating class antagonisms. Unlike Marx, therefore, Marcuse does not locate human freedom in unalienated labor, but in a realm of activity beyond labor. Rather than ending the alienation of labor, Marcuse argues that alienation must be made more complete. "The more complete the alienation of labor, the greater the potential freedom: total automation would be the optimum. It is the sphere outside labor which defines freedom and fulfillment."[87] Marcuse thus shares Arendt's view that science and technology provide the material preconditions for human freedom. Unlike Arendt, however, Marcuse believes the emergence of freedom makes possible the transformation of science and technology themselves.

The end of class conflict, Marcuse argues, would heal the ancient split between mind and body, humanity and nature, art and science. This would make an entirely new form of science possible. "Its hypotheses, without losing their rational character, would develop in an essentially different experimental context (that of a pacified world);

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[85] Quoted in Steven Vogel, "New Science, New Nature: The Marcuse-Habermas Debate Revisited," in *Technology and the Politics of Knowledge*, ed. Andrew Feenberg and Alastair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 23-42, at 25.

[86] See Feenberg, *Alternative Modernity*, 27-29.

[87] Marcuse, *Eros and Civilization* (New York: Vintage Books, 1962), 142, quoted in Vogel, "New Science, New Nature," 24.

consequently, science would arrive at essentially different concepts of nature and establish essentially different facts."[88] This conception of the relationship between science and politics goes far beyond the "political control" of science advocated by Habermas and the other internal critics of instrumentalism.

> I have stressed that this does not mean the revival of "values," spiritual or other, which are to supplement the scientific or technological transformation of man and nature. On the contrary, the historical achievement of science and technology has rendered possible the *translation of values into technical tasks*—the materialization of values. Consequently what is at stake is the redefinition of values in *technical terms*, as elements in the technological process. The new ends, as technical ends, would then operate in the project and in the construction of the machinery, and not only the utilization. Moreover, the new ends might assert themselves even in the construction of scientific hypotheses—in pure scientific theory.[89]

The emancipation of technical does not involve a Habermasian effort to impose political constraints on the social application of technology or the direction of scientific research. Rather, it requires an integration of political values and decisions into the procedures through which science and technology are created in the first place. The emancipation of reason thus "confronts science with the unpleasant task of becoming *political*—of recognizing scientific consciousness as political consciousness, and the scientific enterprise as a political enterprise."[90] Reason continues to serve instrumental functions, but it is governed by aesthetic, moral, and political, rather than purely instrumental needs.

Marcuse unfortunately offers very little guidance on how to bring about the new form of science he says is necessary. He never explains just how a science can be created that would incorporate non-instrumental values. In his effort to give some specific

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[88] Marcuse, *One-Dimensional Man*, 166-67.

[89] Ibid., 231-32.

[90] Ibid., 233.

content to his call for a new science, Marcuse argues that science must involve the "liberation" of nature. Science and technology have repressed nature, he says, and must now set nature free. Science and technology still require the "mastery" of nature, but there are "two kinds of mastery: a repressive and a liberating one."[91] Marcuse thus writes of the need to treat nature "as a *subject* in its own right—a subject with which to live in a common universe."[92]

There is something important about this notion of treating nature as a subject. As I show in the next chapter, Latour also believes nature should be seen as a subject, insofar as this evokes the perspective of working scientists who cannot yet predict how nature will respond to new experiments. It seems clear that rethinking the relationship between science and democracy will require some change in the view of nature as inert matter associated with Enlightenment science. As Steven Shapin argues, "A culture that represents nature as morally vacuous lays down the conditions for a radical disjunction between those professionals concerned with the explication of secular nature and the general public with their moral concerns."[93] A democratic science probably does not require a return to Aristotle's doctrine of natural ends, but it may find support in the efforts of environmental philosophers, philosophical realists, or recent theories of

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[91] Ibid., 236.

[92] Marcuse, *Counter Revolution and Revolt*, 60, quoted, in Vogel, "New Science, New Nature," 26.

[93] Steven Shapin, "Science and the Public," in *Companion to the History of Modern Science*, ed. Colby, et al., 990-1007, at 1005.

nature's "enchantment" to conceive nature as an independent physical and perhaps moral force.[94]

In Marcuse, however, the attribution of subjectivity to nature remains highly abstract and ultimately unconvincing. According to Marcuse, "Civilization produces the means for freeing Nature from its own brutality, its own insufficiency, its own blindness, by virtue of the cognitive and transforming power of Reason."[95] As Steven Vogel has argued, the idea that science must somehow liberate nature from "its own" qualities implies a return to the very essentialist conception of nature that Marcuse's conception of science as a political project had rejected.[96] If the new science is a political project that will arrive at "essentially different facts," how can it liberate the essential qualities of nature? Most significantly, in his call for the liberation of nature, Marcuse abandons the voluntarist element of his new science. The new science becomes a means for the "pacification of existence," for sweet surrender to the inherent qualities of nature. The next chapter returns to Dewey, and moves forward to Latour, to give a more plausible content to Marcuse's call for a new science and technology.

**Beyond Anti-Instrumentalism**

Each of the above critiques of liberal instrumentalism, from Rousseau to Habermas to Kuhn, has offered hope to those suffering the shadow sides of science and technology. By revealing how science is often (or always) bound up with domination,

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[94] Jane Bennett, "The Return of the Swerve: Environmental Ethics and the Enchanted Materialism of Epicurus and Ilya Prirogine," Paper presented at the American Political Science Association annual conference, September 2, 2000.

[95] Marcuse, *One-Dimensional Man*, 238.

[96] Vogel, "New Science, New Nature," 34-39.

they have helped destroy the Enlightenment myth that science and technology are inherently progressive social forces. Even the democratic realists, while underestimating the capacities of lay citizens, posed important questions about the long-standing assumption that democracy depends first of all on the spread of scientific knowledge. By defending the value and integrity of common sense, moral sentiment, and local knowledge against technocratic conceits, the above anti-instrumentalist critiques have provided intellectual resources for citizens defending themselves against the "side effects" of science and technology. Indeed, due in part to the above critiques, it has become increasingly difficult to naively separate science and technology from their social and environmental consequences.

Without a basic commitment to the value of lay knowledge, for example, as well as the skepticism toward science promoted actively by Feyerabend and inadvertently by Kuhn, it would have been impossible to examine the California electric vehicle program in the critical manner of Chapter 2. My claim that the privatism fostered by automotive technology poses a serious obstacle for democratic citizenship shares much with Rousseau's concern that societal progress tends to destroy political community. Habermas's defense of the life-world of everyday experience against the intrusions of technical rationality reappears in my claim that CARB ought to have rejected assessments of the EV market based on stated-preference surveys conducted through mass mailings or over the telephone, and instead should have focused on surveys that use in-depth interviews to assess the effects of experiential learning, local context, and personal needs on people's propensity to buy EVs. And the critique of positivism advanced by Kuhn and others helps open up questions about the sociological dimensions of the communities that produce science and technology relevant for EV development. As I argue in Chapter

7, for example, a Kuhnian conception of scientific revolutions was implicit in GM's efforts to invigorate its EV development program by bringing in outsiders from EV start-up companies associated with the environmental movement.

As I have also argued, however, the above critiques of liberal instrumentalism do not yet provide a democratic theory of science and technology. In one way or another, by focusing on the excesses and shortcomings of liberal instrumentalism, they neglect the possibility of democratizing instrumentalism and extending it into the construction of science and technology. In the next chapter, I solicit help in this endeavor from the writings of Dewey and Latour. They offer a conception of natural scientific practice compatible with aspects of the moral and radical-democratic critiques of instrumentalism discussed above. They also build on the critiques of positivism offered by Kuhn and the strong program. But in contrast to the internalism of the former and the sociological constructivism of the latter, Dewey and Latour defend an explicitly political constructivism conducive to the democratization of science and technology.

# CHAPTER 5

# DEMOCRATIC INSTRUMENTALISM

Polemics are fun to watch for only so long.
-- Bruno Latour

The previous two chapters outlined the polemic that has dominated both popular and scholarly understanding of science and politics since the Enlightenment. On one side, we have liberal-democratic instrumentalism, which draws on science's double identity as an elite set of institutions and bodies of knowledge that are somehow also supremely open to public criticism. The double identity of modern science allows technocratic politics to be understood as eminently democratic. On the other side, we have a long history of critiques of instrumentalism and the conception of science on which it relies. These critiques expose the domination that inheres in liberal instrumentalism's conflation of democracy and technocracy.

In the middle of this polemic, mediating between the two sides, this chapter finds John Dewey and Bruno Latour. We already encountered Dewey's own double identity as a technocratically inclined radical democrat. In the following I expand on my previous claim that the spirit of Dewey's thought is better understood as a call for the democratization of science than for the rationalization of democracy, although the two are never far apart. Dewey offers a philosophy of science that builds on the democratic values associated with liberal instrumentalism, while avoiding many of the criticisms of instrumentalism discussed in the previous chapter. I then show how many promising ideas that remained underdeveloped in Dewey's writings have been more fully elaborated in Latour's recent work. Latour offers a very concrete account of how technical and social artifacts mutually constitute each other. He also makes clear why such artifacts should be made to represent lay citizens.

## Dewey's Philosophy of Inquiry

### *Pragmatist Naturalism*

In the previous chapter's brief discussion of Marcuse, I suggested that a democratic theory of science and technology might depend on attributing some form of subjectivity to nature. Although Marcuse's call for a science that would liberate nature's inherent qualities remains unsatisfying, it challenges the Enlightenment view of nature as a passive object of human observation and provocatively raises the question of ontology. What is the character of the stuff about which natural scientists produce knowledge? Dewey certainly does not go as far as Marcuse in attributing subjectivity to nature, but his ontological naturalism provides a useful starting point for rethinking the relationship between science and politics.

Western thought has offered three basic answers to the question of ontology. One tradition has followed the Platonic view that material nature is an inferior reflection of supernatural Forms. The characteristics of concrete natural entities, according to this view, can be explained with reference to their abstract essential nature. A second tradition, which first rose to prominence with modern science, sees nature as strictly material, its visible operations caused by the motions of invisible particles. Nature and the knowing human subject, in this view, are ontologically separate. A similar ontological dualism divides facts and values, history and philosophy, science and politics. The materialist conception of nature appears in both seventeenth-century rationalism and empiricism, and continues to dominate popular conceptions of science.

A third tradition, often called naturalism, has sought to strike some compromise between these "idealist" and "materialist" conceptions. It has roots in Aristotle and Spinoza, was favored by eighteenth-century deists such as Jefferson, and appears in different versions in Marxist and pragmatist thought. Naturalism comes in many varieties, but it generally begins with the rejection of any ontological break between human and nonhuman nature. Nature and humanity exist in the same world.[1]

In opposition to the logical positivists that dominated the philosophy departments of his time, Dewey spent his entire career attacking dualisms of humanity and nature. Like many of his contemporaries, Dewey was fascinated by the social and philosophical implications of Charles Darwin's theory of evolution. After Darwin, Dewey argues, it is impossible to deny that human beings are part of nature. "Human life does not occur in a vacuum, nor is nature a mere stage setting for the enactment of its drama. Man's life is bound up in the processes of nature...."[2] And if human beings are part of nature, the mind-body dualisms that have fascinated philosophers since Plato fail to capture human experience.

For Dewey, Darwin represents the extension to living things of the seventeenth-century notion that reality is characterized not by unchanging essences, but by continual change. Dewey thus reverses the priority in Western metaphysics of stability over

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[1] See John Ryder, "Introduction," in *American Philosophic Naturalism in the Twentieth Century*, ed. John Ryder (Amherst, NY: Prometheus Books, 1994), 9-25.

[2] Dewey, *Democracy and Education* (New York: Macmillan Company, 1916), 228. Such statements, one might note, should not be read as proto-environmentalist. Although Dewey's thought is in many ways compatible with contemporary environmentalism, he shared his contemporaries' conception of nature as material for human use. See William Chaloupka, "John Dewey's Social Aesthetics as a Precedent for Environmental Thought," *Environmental Ethics* 9 (Fall 1987): 243-60; Bob Pepperman Taylor, "John Dewey and Environmental Thought: A Response to Chaloupka," *Environmental Ethics* 12 (Summer 1990).

change. Whereas Western philosophers have generally elevated the fixed and necessary above the changing and contingent, Dewey argues that "incompleteness and precariousness is a trait that must be given footing of the same rank as the finished and the fixed."[3] The necessary can only be understood in opposition to the contingent. "A world that was all necessity would not be a world of necessity; it would just be" (*EN*, 59). Stability and change have only analytic rather than ontological status; they "are mixed not mechanically but vitally like the wheat and tares of the parable" (*EN*, 47).[4]

Given this dynamic conception of nature, Dewey argues, philosophy has to redefine its traditional task of searching for universal truth. "Philosophy forswears inquiry after absolute origins and absolute finalities in order to explore specific values and the specific conditions that generate them."[5] After Darwin, Dewey argues, philosophy should abandon its traditional search for intrinsic values and focus on articulating the context-specific relations among the values people actually hold.

Dewey defends his naturalism, like the other elements of his philosophy, with explicit reference to its political implications. He argues that although naturalism has surfaced at various points in the history of philosophy, it has failed to gain widespread acceptance because it contradicts the self-interests of philosophers. Ancient religion, Dewey argues, offered the notion of an eternal and unchanging God to provide solace from the contingencies of existence. Once a leisure class emerged that could undertake

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[3] John Dewey, *Experience and Nature* (1925), in *The Later Works* Vol. 1, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1988), 50, cited hereafter as *EN*.

[4] Dewey also argues that consciousness itself depends on the friction between stability and change (*EN*, 262-63). Dewey leaves unclear, however, whether mind itself could be identified with the response to changes in nature (see Diggins, *Promise of Pragmatism*, 224-25).

[5] John Dewey, "The Influence of Darwin on Philosophy" (1909), in *The Middle Works* Vol. 4, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1977), 3-14, at 11.

systematic intellectual work, philosophy adopted the social functions of religion. As a result, "The social division into a laboring class and a leisure class, between industry and esthetic contemplation, became a metaphysical division into things which are mere means and things which are ends" (*EN*, 102). Philosophers since Plato have devised increasingly sophisticated ontological systems that have pacified popular anxieties about the precariousness of existence, justified philosophers' private interest in pursuing philosophy, and reinforced the class divisions that made philosophy possible in the first place (*EN*, 193). Technological progress has long made it possible to alleviate the more extreme burdens of material necessity, but the self-interest of the leisure class, institutionalized in corporate capitalism, continues to support the philosophical division between different orders of reality (*LSA*, 43; *DE*, 333-45).[6]

Whereas dualism supports professional elitism and vapid intellectualism, naturalism "introduces responsibility into the intellectual life."[7] When human beings lacked the means to cope with the problems of existence, it made sense for philosophy to seek solace in transcendent causes. But with the increase in technical capacities for influencing the conditions of social life, philosophy has an opportunity to take on new social tasks. It can help locate and interpret social problems, becoming "a method of moral and political diagnosis and prognosis."[8]

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[6] Philosophical dualism, moreover, leads popular thought to vacillate between various forms of technocratic objectivism and politically incapacitating subjectivism (*EN*, 186). On the vested interests in the prevailing division of theory and practice, see also *QC*, 237.

[7] Dewey, "Influence of Darwin," 13. See also *QC*, 172.

[8] Dewey, "Influence of Darwin," 13. Dewey goes on to state, "In having modesty forced upon it, philosophy also acquires responsibility" (13).

In sum, Dewey's ontological naturalism suggests that nature is not the inert matter presupposed by seventeenth-century physical science. Nature is always in flux, and in interaction with human beings, and is thus not simply a passive object of observation or manipulation. The second half of this chapter examines Latour's provocative version of naturalism. The next few sections show how Dewey's naturalist ontology motivates his democratic theory of scientific inquiry.

*Science as Practice*

What do scientists do when they do science? What does scientific practice look like? How do scientific practices differ from other practices of inquiry, or from other human practices in general? Before beginning to answer these questions, it is useful to make clear that they can best be addressed in connection with empirical study of scientific activity.

That the philosophy of science should have an empirical component is by no means self-evident. History of science and philosophy of science, as noted above, were long separate academic fields, divided along the lines of the fact/value dichotomy. Historians said what scientists had done and philosophers showed what they ought to do. Seventeenth-century rationalism and Kantian Idealism, for example, each held that scientific theories, while referring to concrete natural processes, were structured according to the purely formal requirements of mathematics, logic, or transcendental philosophy. As we saw in Chapter 3, the experimental program of the Royal Society posed an early challenge to this division between natural philosophy and natural history by asserting the need for probabilistic accounts of natural phenomena. But it was the "historical turn" of the nineteenth century that initiated a genuine integration of the philosophy and history of science. Hegel showed how the history of human institutions could give clues to the operation of universal reason. Comte argued that scientific thought developed through three historical "stages," theological, metaphysical, and positive, in each case reflecting the dominant ideas of the age. William Whewell, John Herschel, and Ernst Mach, all practicing scientists, argued that any philosophical account of natural science must begin with study of science's history. Mill, although the nineteenth century's most widely-read philosopher of science, differed from most of his contemporaries in his defense of an abstract empiricism that lacked the practical perspective developed by those more familiar with scientific practice.[9]

By the 1920s, the nineteenth-century philosophical interest in the history of science had fallen into disrepute. Logical positivists had little interest in concrete scientific practice, arguing that philosophers had the task of "rationally reconstructing" scientific theories so as to insulate them from ideology. In place of Comte's historical interest in "positive" description they developed a fascination with logical analysis and justification.[10] As discussed in the previous chapter, the positivist disdain for history was thoroughly rejected in the 1960s by Kuhn, Feyerabend, and others.

Many of the 1960s critiques of positivism repeated the basic claims of Dewey's earlier and more politically inflected philosophy of science. Especially noteworthy is that Dewey provided one of the earliest and most politically-charged challenges to the logical positivist disdain for scientific practice. Dewey's critics, however, have often lumped his

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[9] See Larry Laudan, "The History of Science and the Philosophy of Science," in *Companion to the History of Modern Science*, ed. Colby et al., 47-59.

[10] See Ernan McMullin, "The Development of Philosophy of Science 1600-1900," in *Companion to the History of Modern Science*, ed. Colby et al., 816-837.

views on science and politics with those of the logical positivists.[11] While Dewey praised the positivists' suspicion of ideological manipulation of science and philosophy, he was highly critical of their overall program.[12] Like other early-twentieth century pragmatists, Dewey was inspired by nineteenth-century attempts to ground philosophy of science in the study of concrete scientific activity. Whereas most Anglo-American philosophers remained captivated by positivism well into the 1950s, Dewey never gave up his early commitment, forged during his graduate studies under one of the "St. Louis Hegelians," to bringing together the history and philosophy of science.

Since the seventeenth century, Dewey argues, scientific knowledge has developed through close interaction between theoretical speculation in the study and mechanical manipulation in the lab. And as I discuss below, Dewey also suggests that natural science requires interaction with the world outside the lab. Natural scientific practice, therefore, belies the dualist metaphysics still assumed by most philosophers of science. Philosophers must judge the work of the scientist "by what he does and not by his speech when he talks about his work (when he is likely to talk in terms of traditional notions that have become habitual)...." (QC, 160; see also QC, 62ff, 140; *Logic*, 489).[13] Like recent

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[11] See Gary Bullert, *The Politics of John Dewey* (Buffalo, NY: Prometheus Books, 1983), 172-73.

[12] See John Dewey, *Logic: The Theory of Inquiry*, in *The Later Works* Vol. 12, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1986), 511, cited hereafter as *Logic*. Dewey criticizes, for example, positivism's hostility to theories that cannot be *directly* verified by empirical observation. Unverifiable theories or hypotheses often prove useful in suggesting and directing new inquiries. Moreover, positivism's dichotomy between scientific and political argument, Dewey argues, threatens to concede politics to those committed to transcendental or anti-rationalist ideologies.

[13] Albert Einstein echoed this claim a few years later, in his 1933 Herbert Spencer Lecture, saying, "If you want to find out anything from the theoretical physicists about the methods they use, I advise you to stick closely to one principle: Don't listen to their words, fix your attention on their deeds." Quoted in Peter T. Manicas, "Naturalizing Epistemology: Reconstructing Philosophy," in *Philosophy and the Reconstruction of Culture: Pragmatic Essays after Dewey*, ed. John J. Stuhr (Albany: State University of New York Press, 1993), 151-174, at 163.

scholars who have made the laboratory into a site of anthropological study, Dewey seeks to develop a theory of science "in accord with actual scientific practice" (*Logic*, 389).[14] This does not imply a rejection of efforts to formulate general rules concerning how science is and should be conducted. But developing such rules depends in part on the study of scientific practice.[15]

*Deweyan Instrumentalism*

By grounding the philosophy of science in concrete scientific practice, Dewey highlights the role of human agency in science. Like most other human activities, scientific activity is always guided by people's aims, desires, or goals, whether those goals are of immediate or ultimate value. Most philosophies of science acknowledge this at least implicitly, but some conceive of scientists' goals far more narrowly than others. For classical rationalists and empiricists, as we saw in Chapter 3, scientists were thought to have the rather narrow, primarily intellectual aim of creating a perfect mirror of nature. This conception of science also appears in the logical positivists' defense of a rigid boundary between science and values. A scientific mirror of nature might serve manifold human purposes, according to this view, but its creation is thought to involve no purpose beyond that of its own realization. Paradoxically, as I noted before, this very

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[14] "The position here taken holds that since every special case of knowledge is constituted as the outcome of some special inquiry, the conception of knowledge as such can only be a generalization of the properties discovered to belong to conclusions which are outcomes of inquiry. Knowledge, as an abstract term, is a name for the product of competent inquiries" (*Logic*, 16). On this aspect of Dewey's theory of inquiry, see Manicas, "Naturalizing Epistemology," esp. 159-64.

[15] Manicas, in "Naturalizing Epistemology," highlights four advantages to conceiving of science in terms of practices. It highlights the existence of "tacit knowledge." It accounts for the possibility of unintended consequences. It acknowledges the possibility that actors do not understand what they are doing. (They may think they are Popperians, when they aren't.) And it makes it easier to investigate the ways in which scientific practices intermesh with other practices. It also helps show how sciences differ from each other.

purposelessness, conceived as objectivity, has given those who possess scientific knowledge enormous instrumental power. It has also made them vulnerable, however, to the critiques discussed in the previous chapter. For Dewey, the common notion that scientific activity is driven solely by intellectual purposes fails to account not only for the purposes that science serves in society, but also for the purposes, desires, interests, and values that enter into the making of science itself.

All inquiry, according to Dewey, begins with an "indeterminate situation," a situation which is "disturbed, troubled, ambiguous, confused, full of conflicting tendencies, obscure, etc." (*Logic*, 109; see *QC*, 80-84). With the initiation of inquiry, this indeterminate situation is transformed into a "problematic situation," and then further specified as a distinct "problem" to be solved. Scientific problems are thus not, as is commonly assumed, simply those things scientists "choose" to study--or at least they should not be, because if the problems of science do not emerge from genuine dilemmas of experience, the resulting inquiry will be merely "busy work." The formulation of a genuine scientific problem develops through interaction with the thing one wants to study. It depends upon both choices and constraints, theories and observations, concepts and percepts, ideas and facts. In accord with Dewey's naturalist ontology, these distinctions do not designate different orders of being, as they do in empiricist and rationalist philosophy, but rather functional elements in a "logical division of labor" (*Logic*, 114-16; see *QC*, chap. 9). The inchoate uneasiness that initiates inquiry develops into a recognizable "problem" through interactions between the given features of the situation and the conceptual and material resources of the inquirer.[16] This notion that

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[16] On the role of purpose in inquiry see also *EN*, 30-34.

experience needs to be understood in terms of interaction rather than observation has become a common tenet of recent social studies of science.[17]

The interaction between theories and facts through which scientists formulate problems is infused with the purposes for the sake of which the inquiry began. "All controlled inquiry and institution of grounded assertion necessarily contains a *practical* factor; an activity of doing and making which reshapes antecedent existing material which sets the problem of inquiry" (*Logic*, 162). Inquiry only begins when a scientist has some motivation for transforming an indeterminate situation into a determinate problem. Art and religion are thus distinguished from science in part by the lack of such transformation. The facts and theories that comprise scientific problems, Dewey argues, are therefore *operational* and *instrumental*. That is, their meaning resides in the purposes they serve in the process of inquiry. Ideas are operational insofar as they initiate and direct further observations. Facts are operational insofar as they are selected and articulated for the purpose of serving as evidence in the resolution of a particular problem (*Logic*, 116). "Knowledge is related to inquiry as a product to the operations by which it is produced" (*Logic*, 122 CHECK).[18]

Inquiry is completed when the problem with which it began is resolved. Facts and ideas are "proven" when they fulfill the functions for which they were selected. Dewey thus defines inquiry as follows: "*Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its*

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[17] See Helen Longino, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry* (Princeton: Princeton University Press, 1990), 220-21.

[18] On instrumentalism see *EN*, 121, 158-161; on constructivism, see *EN*, 124..

*constituent distinctions and relations as to convert the elements of the original situation into a unified whole*" (*Logic*, 108).

*Deweyan Instrumentalism and Technocracy*

Dewey's conception of science has often been deemed antagonistic to his political theory. As we saw in Chapter 3, Dewey's liberal-democratic instrumentalism lends itself to the technocratic application of science to politics. Despite the technocratic elements of his thought, however, I argued that Dewey also provides a powerful political critique of technocratic instrumentalism. Now we need to consider the relationship between Dewey's philosophy of science and his critique of technocracy.[19] Does Dewey's philosophy of science, which he explicitly calls "instrumentalism," support or undermine his participatory democratic theory? As we shall see, Dewey does not think science should restrict itself to studying the best means for achieving politically determined ends. Nor does he believe, however, that science can determine the ends of politics. Rather, science provides insight into how ends and means may be brought into harmony with each other (QC, 218). Dewey's instrumentalist philosophy of science thus differs fundamentally from technocratic instrumentalism.

Dewey's instrumentalism, we saw above, asserts that the problems of inquiry must be allowed to emerge from an ever-changing existential context. Technocratic instrumentalism, in contrast, assumes the goals of inquiry are fixed. Science merely provides efficient means for given ends. Technocrats thus often find themselves producing instrumentally efficient answers that do not fit any genuine problems. In the

[19] See Peter T. Manicas, "Pragmatic Philosophy of Science and the Charge of Scientism," *Transactions of the Charles S. Peirce Society* 24, no. 2 (Spring 1988): 179-222.

electric vehicle case, for example, the California agency directed electric vehicle research and development toward technologies that meet existing consumer expectations. It thus failed to address the fundamental problems of automobility. In Dewey's terms, the agency assumed a fixed goal of inquiry--electric vehicles that would emulate gasoline vehicles as much as possible--and sought merely to develop the means to achieve it.

Dewey's theory of intelligence, in contrast, does not limit inquiry to any single, pre-given goal. Dewey insists that "the doctrine that intelligence develops within the sphere of action for the sake of possibilities not yet given is the opposite of a doctrine of mechanical efficiency."[20] Unlike technocratic instrumentalism, "intelligence frees action from a mechanically instrumental character."[21]

> Intelligence is, indeed, instrumental *through* action to the determination of the qualities of future experience. But the very fact that the concern of intelligence is with the future, with the as-yet-unrealized (and with the given and established only as conditions of the realization of possibilities), makes the action in which it takes effect generous and liberal; free of spirit.[22]

Unlike technocratic instrumentalism, Deweyan instrumentalism allows new purposes to develop through the process of inquiry.

More generally, Dewey's instrumentalism differs from the technocratic version insofar as it extends liberal instrumentalism into the making of science itself. This is another way of saying that scientific inquiry, as discussed above, is always driven by human purposes. Dewey's conception of science thus reflects his more fundamental concern with citizens' capacity to exert some measure of control over their lives. Placing

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[20] Dewey, "The Need for a Recovery of Philosophy" (1916), in *The Middle Works* Vol. 10, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1980), 45.

[21] Ibid.

[22] Ibid.

himself in a humanist tradition that extends from the Renaissance to the American Founding, Dewey asks, "Is it possible for a living being to increase its control of welfare and success? Can it manage, in any degree, to assure its future? Or does the amount of security depend wholly upon the accidents of the situation?"[23] For Dewey the answer to these questions lies in the degree to which human beings can adopt what he identifies as a scientific mode of approaching the world.

To put it in yet another way, Dewey's philosophy of science replaces the ancient division between ontological categories of nature and experience, essence and existence, with a distinction between two *modes* of experience: uncontrolled and controlled. These modes of experience do not represent fixed categories, but can each be transformed into the other through deliberate human action (*QC*, 67). Natural or uncontrolled experience consists of pregiven sequences of cause and effect, indifferent to human purposes. Natural experience becomes distinctly human experience when causes are deliberately employed as means, and when effects become consequences of directed action (*QC*, 171).

> As long as men are content to enjoy and suffer fire when it happens, fire is just an objective entity which is what it is....But when men come to the point of *making* fire, fire is not an essence, but a mode of natural phenomena, an order of change, a "how" of a historic sequence. The change from immediate use in enjoyment and suffering is equivalent to recognition of a method of procedure, and of the alliance of insight into the method with the possibility of control (*EN*, 181; see also 324).

The world will change anyway, Dewey argues, whether we act upon it or not. Better, then, that we actively change the world to better approximate our goals, rather than

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[23] As Dewey writes, "The extent of an agent's capacity for inference, its power to use a given fact as a sign of something not yet given, measures the extent of its ability to systematically to enlarge its control of the future" ("Need for a Recovery of Philosophy," 15).

passively awaiting whatever changes may come.[24] Dewey suggests we think of both science and philosophy as instrumental tools, because they both can provide means of reconstructing the situations out of which they arise.

Dewey's critics, of course, have often seen his praise of "control" as devoid of appreciation for the aesthetic dimensions of experience. According to John Patrick Diggins, for example, "Pragmatic man identifies knowledge with control rather than understanding, with mastery rather than meaning."[25] This criticism is somewhat overdrawn, insofar as Dewey believes "mastery" can provide meaning in two distinct ways. First, mastery can be locus of meaning in itself. Even though Dewey believes the distinguishing feature of science and technology lies in their instrumental power, he repeatedly notes that

> Making and using tools may be *intrinscally* delightful....In like manner, the pursuit of knowledge is often an immediately delightful event; its attained products possess *esthetic* qualities of proportion, order, and symmetry (*EN*, 120, emphasis added).

Dewey thus speaks to the joy of discovery so often cited by scientists and engineers as the motivation for their work. Second, beyond the intrinsic meaning that some people associate with technical practices, Dewey argues that the instrumental power of science and technology, far from opposing the immediate enjoyments of experience that give life meaning, actually enhances such enjoyments.

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[24] "Those who do not fare forth and take the risks attendant upon the formation of new objects and the growth of a new self, are subjected perforce to inevitable change of the settled and close world they have made their own" (*EN*, 189). "Conditions and events are neither to be fled from nor passively acquiesced in; they are to be utilized and directed. [...] In a profound sense, knowing ceases to be contemplative and becomes practical" (Dewey, *Reconstruction in Philosophy* (1920), in *The Middle Works* Vol. 12, ed. Jo Ann Boydston [Carbondale and Edwardsville: Southern Illinois University Press, 1988], 146, cited hereafter as *RP*).

[25] Diggins, *Promise of Pragmatism*, 224.

> Enjoyments that issue from conduct directed by insight into relations have a meaning and a validity due to the way in which they are experienced. Even in the midst of direct enjoyment, there is a sense of validity, of authorization, which intensifies the enjoyment (*QC*, 213).

Understanding the underlying causes and means of perpetuating a meaningful experience enhances the experience. Science thus "marks an added depth, range and fullness of meaning conferred upon the objects of ordinary experience" (*QC*, 152).[26] Dewey may well have been somewhat blind to the limited aesthetic appeal of his conception of meaning, but he was right to argue that science and technology can contribute to a more meaningful human life.[27]

*Realism and Relativism*

Beyond the narrow view of "mastery" often attributed to Dewey by his critics, his defense of an instrumentalist theory of inquiry has often led his readers to ask whether he also has an instrumentalist view of scientific theories. Are scientific theories merely self-contained analytical tools or do they describe real things and processes? Despite Dewey's insistence that such questions were misguided, he was repeatedly asked to confront them, thus becoming involved in the never-ending debate between realists and relativists.

This debate has recently found its way into the mass media under the rubric of "the science wars." From the perspective of many natural scientists today, STS scholars seem to endorse a radical form of ontological relativism, according to which scientific

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[26] Similarly, Dewey argues that the instrumental manipulation of nature should be embraced not only for its own sake, but for the values that cannot be realized without it (*EN*, 308).

[27] One might compare here Dewey's conception of mastery with that of Marcuse, who also thought mastery could be emancipatory. Dewey's view seems more plausible, insofar as it does not rely on the notion that mastery can liberate nature's essential characteristics.

accounts of "reality" are no more true than those of witchcraft, astrology, or common sense. Clarifying Dewey's position in this debate, and its political implications, can help resolve some of the misunderstandings and disagreements among today's science warriors.

The notion that Dewey endorses some form of ontological relativism is provoked by his rejection of the empiricist claim that science must produce knowledge of reality "in itself." This claim assumes the very split between nature and experience that Dewey is at pains to avoid. Dewey denies the need for any claims "about *the* real object or *the* real world or *the* reality." There simply is no need for a theory of reality "in general" or "as such."[28] Reality is always contextual. The transformations wrought by scientific inquiry occur only with reference to *particular* existences. "Water is not drunk unless somebody drinks it; it does not quench thirst unless a thirsty person drinks it...."[29] Insofar as we anticipate the consequences of our actions in the world, and use our anticipation to effectively direct action, we have generally valid knowledge of the world. Dewey thus replaces the traditional scientific claim to universal truth with a more modest claim for general effectiveness.

Indeed, Dewey argues that scientific knowledge simply *is* the capacity to direct change. "It is not that knowing *produces* a change, but that it *is* a change of the specific kind described."[30] By being placed into new existential relations, the object *for* knowledge becomes an object *of* knowledge. This does not imply a denial of "reality,"

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[28] Dewey, "Need for a Recovery of Philosophy," 39.

[29] Ibid.

[30] Dewey, "Need for a Recovery of Philosophy," 35-36. On Dewey's constructivism and the charge of idealism, see Larry A. Hickman, *John Dewey's Pragmatic Technology* (Bloomington and Indianapolis: Indiana University Press, 1990), 48-50.

but merely a conception of reality somewhat different from the traditional equation of reality with pre-existing objects to which theories passively correspond. As Ian Hacking puts it, "We shall count as real what we can use to intervene in the world to affect something else, or what the world can use to affect us."[31] As we shall see, this conception of reality as intervention does not so much deny the traditional view of reality as that which a theory represents, but rather situates it within a practical context.

If science is understood in terms of the capacity to direct change, knowing cannot be conceived on the model of observation. For Dewey, "The significant distinction is no longer between the knower *and* the world; it is between different ways of being in and of the movement of things; between a brute physical way and a purposive, intelligent way."[32] In contrast to the empiricist view that knowledge begins with sense impressions that force themselves upon a passive mind, and in accord with naturalist ontology described above, Dewey argues that knowing requires purposeful interaction with the world.

Such interaction, Dewey argues, can be understood as a form of making. "We know an object when we know how it is made, and we know how it is made in the degree in which we ourselves make it" (*EN*, 319). Dewey thus firmly locates his philosophy of science in the maker's knowledge tradition. Most importantly, these transformational effects of inquiry do not merely reside in the mind of the observer. Whereas William James had emphasized the changes in individual consciousness effected by practices of

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[31] Hacking, *Representing and Intervening*, 146.

[32] Dewey, "Need for a Recovery of Philosophy," 42. [33] For a discussion of this point, see Ralph W. Sleeper, *The Necessity of Pragmatism: John Dewey's Conception of Philosophy* (New Haven: Yale University Press, 1986), 113-16.

inquiry, Dewey argues that inquiry brings about existential changes in the objects of inquiry.

Dewey's critics have read such claims as an endorsement of relativism. In response, Dewey repeatedly insists that he does not endorse any form of subjective idealism or ontological relativism. The very notion that inquiry effects changes in the world, he argues, presupposes that *something exists* prior to inquiry.[33] Inquiry always occurs in the context of objects resulting from prior inquiries. Moreover, inquiry does not create its subject-matter out of whole cloth.

> All deliberate action of mind is in a way *an experiment with the world to see what it will stand for*, what it will promote and what frustrate. The world is tolerant and fairly hospitable. It permits and even encourages all sorts of experiments. But in the long run some are more welcomed and assimilated than others.[34]

Human efforts to change the world always confront the world's resistance, and such resistances can be taken as indications of "reality."

Moreover, as discussed above, Dewey believes inquiry always begins with some stimulus from the preexisting world. An "indeterminate situation" creates doubt, which leads to inquiry. This also means that in situations that are *not* indeterminate, where there is no call for inquiry, objects are experienced without prior inquiry. I do not need to conduct an inquiry to "know" that I am writing on a table. And this type of "knowledge,"

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[34] Dewey, "Philosophy and Democracy" (1919), in *The Middle Works* Vol. 11, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1982), 48–49 (emphasis added). Elsewhere Dewey remarks, "If the words 'subject' and 'object' are to be set over against each other, it should be in those situations in which a person, self, or organism as a *doer* sets up purposes, plans, to realize the execution of which is resisted by environing conditions. An *object*, as Professor Gildersleeve wittily suggested a good many years ago, is that which *objects*: that which gets in the way of the carrying out of some plan entertained by a person..." (Dewey, "Experience, Knowledge, and Value: A Rejoinder," in *The Philosophy of John Dewey*, 2nd ed., ed. Paul Arthur Schilpp [New York: Tudor Publishing Company, [1939] 1951], 517-608, at 542. Dewey goes on to suggest the substitution of the terms "subjective" and "objective" with "personal" and "impersonal" (Ibid., 543).

which Dewey calls "apprehension," is not properly considered knowledge at all.[35] It is one of the conceits of mainstream epistemology to conceive of all experience as a "knowledge affair."

Of course, one person's everyday table may be someone else's stimulus to inquiry. A physicist may describe my kitchen table as a collection of subatomic particles. The physicist's description locates the table within a new complex of relations that did not exist prior to the inquiry. But the physicist's description does not necessarily destroy my common sense experience of the table. As Sleeper puts it, "What the table is depends on who wants to know."[36] Both tables are equally real, but they exist within and enable different sets of relations. Scientific objects are thus understood as the *results* of inquiry, not the things to which inquiry is applied (*QC*, 17-19; *EN*, 125). "For things exist *as* objects for us only as they have been previously determined as the outcomes of inquiry" (*Logic*, 122).

While Dewey's claim that procedures of inquiry cause changes in the objects of inquiry may appear fairly obvious with regard to laboratory sciences, it is less straightforward with regard to sciences that do not depend on laboratory experiments. Bertrand Russell thus pointed out in his review of Dewey's *Logic* that knowledge of a

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[35] H. S. Thayer, "Objects of Knowledge," in *Philosophy and the Reconstruction of Culture: Pragmatic Essays after Dewey*, ed. John J. Stuhr (Albany: State University of New York Press, 1993), 187-201, at 191-92. On objects of knowledge see also Sleeper, *Necessity of Pragmatism*, 113-16, 120-27. Dewey's notion that we "apprehend" the everyday world without "knowing" it coincides with what has also been called "everyday realism," or what phenomenologists call the "natural attitude" toward experience. Everyday actions presuppose the existence of an external world independent of our representations of it. See Peter L. Berger and Thomas Luckman, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge* (New York: Doubleday, Anchor Books [1966] 1967), chap. 1.

[36] Sleeper, *Necessity of Pragmatism*, 122.

star could not be said to affect the star.[37] In response, Dewey acknowledged that not all branches of science rely to the same extent on making changes in the objects studied. In astronomy changes are only introduced in the technology of observation, not in the object of observation itself. Astronomy progresses not by manipulating the stars, but by improving the instruments and theories used for observing them.

Nevertheless, Dewey asserted, knowledge of a star does not actually begin with the star, but with a twinkling light seen in the night sky. Earlier societies may have built myths or religions around it, experiencing the star in a different way than we do today after scientific investigation. We now experience the star *as* known, differently than before, more deeply and fully. The star *as* an object of knowledge is thus indeed a new object. Most importantly, this new object effects existential changes in the knower. With the advent of the star as a known object, we actually experience it differently. This knowledge does not replace but rather supplements whatever aesthetic or religious experiences we continue to have of the star, thus making our experience richer and more complete.[38]

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[37] Bertrand Russell, "Dewey's New *Logic*," in *The Philosophy of John Dewey*, 2nd ed., ed., Paul Arthur Schilpp (New York: Tudor Publishing Company, [1939] 1951), 135-56, at 154.

[38] See also Dewey, "Experience, Knowledge, and Value: A Rejoinder," 544-49; "Epistemological Realism: The Alleged Ubiquity of the Knowledge Relation," in *The Middle Works* Vol. 6, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1985), 121; "Brief Studies in Realism," in *Middle Works* 6: 105-7. In another example, Dewey considers the case of a person capable of sensibly perceiving an object that possesses all the attributes of what physicists would call an atom. Would the person see the atom as a scientific object? Dewey answers that the person would only if she had learned enough science to perceive the object as having the relational properties attributed to it by scientific theory. "In other words, it is not just the thing as perceived, but the thing as and when it is placed in an extensive ideational or theoretical context *within which it exercises a special office* that constitutes a distinctively physical scientific object" ("Experience, Knowledge, and Value," 538). In a somewhat different response to the same issue, Dewey elsewhere asserts that using instruments to change the human capacity for observation is "the same thing in principle of logical procedure" as changes introduced in objects themselves. In either case, "The progress of inquiry is identical with advance in the intervention and construction of physical instrumentalities for producing, registering and measuring changes" (*QC*, 68).

Dewey's conception of reality may thus be called *constructivist*, insofar as he believes objects of knowledge are constituted through an interactive process of inquiry. It is not *relativist*, however, because he thinks inquiry begins with and refers back to a "really-existing" existential situation.

Finally, it is worth noting that Dewey's constructivist conception of reality has important political implications. Much of the debate on the California ZEV program, for example, involved different views on the "reality" of EV battery technology. The debate, moreover, reflected different implicit assumptions about the concept of reality itself. In a 1994 speech on the future of electric vehicles, Chrysler Chairman and CEO Robert J. Eaton said, "The law can force us to build it, but it doesn't force anyone to buy it. So we're fighting the law of supply and demand. And we're also fighting something else--the laws of physics!"[39] For Eaton, and later for the CARB policymakers, the ZEV mandate was "unrealistic" in the literal sense that it was an attempt to contradict the Battery Panel's assessment of the reality of limited EV battery performance. Opponents of the mandate thus understood reality primarily in terms of a static representation of a pre-existing set of natural conditions. The figure of 50 Wh/K, the maximum specific energy attained by existing batteries, represented the current state of technological development, as defined by the "laws of physics," and that was the end of it. As we saw, CARB and the Battery Panel never made explicit the source of their assessment of consumer expectations, allowing them to draw political conclusions directly from the Battery Panel's representation of reality. They leaped from a representation of reality to

[39] Robert J. Eaton, "The Automobile Industry: Health Care, Air Pollution, and the Electric Car," *Vital Speeches* 60, no. 16 (June 1, 1994): 492-94, at 494.

an assessment of the agency's capacity to intervene in reality without thematizing the practical context of the intervention.

For defenders of the mandate, in contrast, the "reality" of EV batteries could not be determined by the Battery Panel alone, since it depended on an assessment of consumer needs. Defenders of the mandate saw the figure of 50 Wh/K in the context of malleable consumer expectations. By focusing attention on the wide range of social and technical factors affecting these expectations, they suggested that any account of the reality of EV batteries must include more than a numeric representation of their raw physical capacity. The reality of EV batteries, the mandate advocates implied, is bound up with the relevant practical context within which technicians use them to intervene in the world. The following discussion suggests that such interventions often extend much farther into the presumptive context of science than is at first apparent.

*Scientific Content and Context*

As I noted in Chapter 3, science has traditionally been conceived as an individual affair, from the lone philosopher contemplating the heavens to the solitary scientist sweating at a laboratory bench. Both empiricist and idealist epistemologies are individualistic, insofar as they conceive of knowledge as correspondence between an individual mind and the external world. Epistemological individualism, as Dewey points out (*LSA*, 32-34), made an effective political weapon in the seventeenth- and eighteenth-century battles against absolutist institutions. Bourgeois and popular political movements used the idea that knowledge resides in the individual mind to challenge established political authorities, just as the Reformation had used the notion that faith emerges from the individual's personal relationship to God to challenge the Catholic Church. But in their ardent campaigns against hierarchy and tradition, early liberal thinkers obscured the social elements that enter into the production and use of scientific knowledge.[40] As a result, Dewey argues, an epistemology that had been effective for destroying an old social order became an enormous obstacle when the task shifted to constructing a new one.

Dewey does not believe, of course, that natural science simply mirrors social conditions. He acknowledges that the physical subject matter of the natural sciences is "relatively independent of social issues" and that in comparison to the social sciences, the influence of social context in the natural sciences is only "indirect" (*Logic*, 482, 496).[41] He makes clear, however, that the difference between natural and social science is practical, not logical (*Logic*, 485).[42] But he insists that social factors influence scientific inquiry in both conceptual and practical terms.

In conceptual terms, Dewey argues, social factors have always shaped the framework within which science operates. The mechanistic worldview, for example, which dominated scientific thought until the nineteenth century, gained prominence in part because it helped explain the phenomena of concern to then-emerging industries, such as mining. Similarly, the notion of "evolution," now firmly associated with Darwin,

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[40] On epistemological individualism, see Longino, *Science as Social Knowledge*, 74-75, 220-21.

[41] "Of distinctly human behavior it may be said that the strictly physical environment is so incorporated in a cultural environment that our interactions with the former, the problems that arise with reference to it, and our ways of dealing with these problems, are profoundly affected by incorporation of the physical environment in the cultural"(Dewey, *Logic*, 48-49).

[42] "In physical matters, the inquirer may reach the outcome in his laboratory or observatory. Utilization of the conclusions of others is indispensable, and others must be able to attain similar conclusions by use of materials and methods similar to those employed by the individual investigator. His activity is socially conditioned in its beginning and close. *But in physical inquiry the conditioning social factors are relatively indirect*, while in solution of social problems they are directly involved" (Dewey, *Logic*, 496).

actually appeared first in theories of culture, such as those of Vico and Comte (*Logic*, 482-83).[43]

More generally, and in contrast to the liberal conception of knowledge as an attribute of individuals, Dewey argues that intelligence necessarily resides in collectives. Indeed, Dewey grounds his sociology of science in a sweeping critique of the autonomous human subject assumed by liberal thought:

> [T]he whole history of science, art and morals proves that the mind that appears *in* individuals is not as such individual mind. The former is in itself a system of belief, recognitions, and ignorances, of acceptances and rejections, of expectations and appraisals of meanings which have been instituted under the influence of custom and tradition (*EN*, 170).

This conception of mind does not imply a denial of individual subjectivity or agency. But just as inquiry always involves interaction between the knower and the known, individual thought is always bound up with habits, traditions, and other elements of social life. Even the most abstract logical symbols only have meaning within a social context (*Logic*, 26-28).

How far does this social context extend? Is it restricted to a particular scientific community or does it include the lay public? How are the components of, and the relationship between, the "context" and "content" of science determined? Dewey does not have much to say on this point, but what he does say is highly suggestive. Beyond the above conceptual considerations, Dewey repeatedly points to ways in which concrete features of scientific practice become intertwined with their societal context.

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[43] Similar points are made in Longino, *Science as Social Knowledge*, 95-97

Long before Kuhn, Dewey argued that the validation of scientific claims always depends on the assessment of particular scientific communities. But then he went on to note:

> While agreement among the activities and their consequences that are brought about in the wider (technically non-scientific) public stands upon a different plane, nevertheless such agreement is an integral part of the *complete* test of physical conclusions wherever their public bearings are relevant. The point involved comes out clearly when the social consequences of scientific conclusions invoke intensification of social conflicts. For these conflicts provide presumptive evidence of the insufficiency, or partiality, and incompleteness of conclusions as they stand (*Logic*, 484).

Put simply, the complete verification of scientific theories requires assessing their consequences in the world outside the laboratory. Since scientific propositions are responses to the problematic situations that initiate inquiry, and since problematic situations are bound up with social conditions, science that creates an "intensification of social conflicts" remains incomplete. Scientific propositions, of course, may well be complete within a narrow conception of the problems they are meant to resolve. The "social conflicts" created by genetic engineering do not invalidate the theory of the double-helix. But these conflicts do suggest that the science remains in some way incomplete. Indeed, Dewey remarks that "The notion of the complete separation of science from the social environment is a fallacy which encourages irresponsibility, on the part of scientists, regarding the social consequences of their work" (*Logic*, 483). Given that "social conflicts" usually involve laypeople, Dewey's comment hints at a need for lay participation in the making of science.

Dewey's professional colleagues showed little interest in his vague appeals for the democratization of science. Social reformers, in contrast, have long drawn on Dewey's claim that science should involve the resolution of everyday problems. During the 1920s, pragmatist philosophy motivated many people, especially women and minorities, to enter the newly emerging professions of health care, social work, and related fields. Pragmatism's problem-oriented conception of science provided an alternative to both the arrogance of technocratic professionalism and the sentimentality of charity work.[44]

Dewey himself, however, never gave many specific recommendations on how to link his philosophical writings with the particular political challenges encountered by his readers.[45] I take up the few suggestions he did make in Chapter 7. For the most part, however, Dewey repeatedly insisted, with some justification, that offering policy proposals was not his job. The revival of pragmatism during the past two decades has brought renewed attention to Dewey's philosophy of science, but unfortunately not among very many of the sociologists and anthropologists working in the field of science studies. This is ironic, since their empirical case studies of "laboratory life" are exactly the sort of empirical inquiry into scientific practice that Dewey advocated. Indeed, a few scholars in science studies have developed conceptions of science that overlap with Dewey's, often without recognition of his prior work on the same concepts, nor always with the explicit attention to political implications that characterized Dewey's writings. In contrast to Dewey, however, they have worked out the notion of extending science into the world in significant detail. Highlighting the connections between Dewey's philosophy of science and recent work in science studies can lead to a theory of natural science amenable to democratic theory and politics.

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[44] Charlene Haddock Siegfried, *Pragmatism and Feminism: Reweaving the Social Fabric* (Chicago: University of Chicago Press, 1996), 180-82.

[45] See Alan Ryan, *John Dewey and the High Tide of American Liberalism* (New York: W. W. Norton & Company, 1995), 232.

## Latour's Political Anthropology of Science

The work of Bruno Latour holds particular interest for democratic theory, as he is among those attempting to develop an explicitly political, rather than strictly sociological or linguistic, conception of the natural sciences. Much of Latour's work is addressed to the urgent question of how societies can better deal with those "hybrids" of science and society—such as AIDS, air pollution, or the ozone hole—that lie at the center of so many political controversies.

### *Science in Action*

Echoing Dewey, Latour insists we must seek to understand not only finished scientific facts, but also "science in action," *before* facts become accepted as true. His argument parallels in part that of constructivist technology studies, described in Chapters 1 and 2, according to which new technologies emerge from a competition among various technical options. As we saw in the case of electric vehicles, the success of a particular technology, such as the internal combustion engine, depends on interactions among individual actions, social institutions, and real attributes of nature. From the perspective of those engaged in the late-nineteenth century competition over automotive technology, it was impossible to say who would eventually have nature on their side.

Latour argues that studying science in action requires above all that one begin with the practical perspective of scientists themselves. Science studies does not ask, "What *is* the relationship between science and politics." It asks only,

> In a given period, how long can you follow a policy before having to deal with the detailed content of a science? How long can you examine the reasoning of a scientist before having to get involved with the details of a policy?...All we ask of

> you is not to cut away the thread when it leads you, through a series of imperceptible translations, from one type of element to another.[46]

To put it simply, and echoing Dewey and Kuhn, science is as scientists have done.

Latour contrasts his method with what he calls the "social realist" approach of the strong program, discussed briefly in the previous chapter. Whereas most philosophers of science have been "natural realists," reducing scientific knowledge to a mirror of nature, Latour argues that social realists simply take the reverse approach, reducing science to a product of social structures and interests. Rejecting both social and natural realism, Latour argues for the view held by the scientists he studies: an "agnostic symmetric position" on the ontological question of what "really" makes up both nature and society. If scientists were either natural or social realists, he argues, if they believed scientific knowledge were determined by either nature or society, they would not engage in the various practices of making knowledge; "they would just wait."[47]

Latour's rejection of both social and natural realism amounts to a historicizing of the boundary, which Dewey still held fairly distinct, between the content and context of science. The notion that the boundary between science and politics is always the product of negotiations in local contexts has become a central tenet of science studies. Unlike research on the conceptual logic of science and technology, studies of "boundary work" assign the task of demarcating science from non-science to social actors, rather than the scholars who study them.[48] The content and context of science remain distinct, but the

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[46] Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge: Harvard University Press, 1999), 87.

[47] Latour and Callon, "Don't Throw the Baby Out with the Bath School!" 353.

[48] See Thomas F. Gieryn, "Boundaries of Science" in *Handbook of Science and Technology Studies*, ed. Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch (Thousand Oaks, CA: Sage Publications, 1995), 393-443; Simon Shackley and Brian Wynne, "Representing Uncertainty in

components of each, and the relationships between them, shift according to the meanings established by those involved in making scientific knowledge.

The notion of boundary work does not imply that boundaries between science and politics are infinitely flexible. Indeed, it is widely acknowledged that scientists can only establish boundaries around new facts by means of old facts. These old facts become increasingly stable as new facts are built upon them. Although the boundaries between science and non-science are *in principle* always open to challenge, in practice they often prove quite stable.

In line with Dewey's conception of scientific objects, the notion of boundary work moves beyond the still widely assumed dichotomy between realism and constructivism. As Latour puts it, "All too often the implication is that if something is fabricated it is false; likewise, if it is constructed, it must also be deconstructible."[49] The objects of science are neither real nor constructed. Nor are they real *and* constructed. They are real precisely *because* and *insofar as* they are constructed.[50]

Another dimension of Latour's rejection of both social and natural realism lies in his claim that "nature" and "society" are not the *causes* of natural and social scientific knowledge, but rather the *consequences* of the activities of scientists and their allies.

> We do not need to attach our explanations to the two pure forms known as the Object or Subject/Society, because these are, on the contrary, partial and purified

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Global Change Science and Policy: Boundary-Ordering Devices and Authority," *Science, Technology, & Human Values* 21 (Summer 1996): 275-302.

[49] Latour, *Pandora's Hope*, 115.

[50] Ibid., 127, 135-44. "At the end of the process, there is indeed a nature that we have not made, and a society that we are free to change; there are indeed indisputable scientific facts, and free citizens, but once they are viewed in a nonmodern light they become the double consequence of a practice that is now visible in its continuity, instead of being, as for moderns, the remote and opposing causes of an invisible practice that contradicts them" (Latour, *We Have Never Been Modern*, 140).

> results of the central practice that is our sole concern. The explanations we seek will indeed obtain Nature and Society, but only as a final outcome, not as a beginning.[51]

This insistence on seeing social interests as consequences rather than causes of scientific activity sometimes leads Latour to neglect the role of established sociological categories, such as class, in the making of natural science. The scientists in Latour's case studies tend to be individual entrepreneurs, remaking nature and society, while remaining relatively free of prior social commitments. In rejecting what he considers the sociological determinism of the strong program, Latour often neglects the possibility that scientists' interests can be understood in part as products of past social processes without necessarily reifying those processes. Similarly, his accounts of fact-making alliances often portray scientists as rational egoists, thus neglecting the cooperative dimensions of scientific inquiry.[52]

The advantage of Latour's approach, however, is that it allows him to avoid becoming mired in debates on the precise content and causal efficacy of sociological categories. Instead, he concentrates on the concrete relations in which particular hybrid artifacts participate, revealing how interactions between scientists and the world continuously transform each.

*Mediation and Purification*

Latour conceptualizes these transformations in terms of a dual process of "purification" and "mediation." Purification, mediation, and the denial of their mutual

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[51] Latour, *We Have Never Been Modern*, 79. See also Latour, *Science in Action*, 96-100, 141-44.

[52] See James Robert Brown, "Latour's Prosaic Science," *Canadian Journal of Philosophy* 21 (1991): 245-61; Steven Shapin, "Following Scientists Around," *Social Studies of Science* 18 (1988): 533-50; Hess, *Science Studies*, 110-11.

dependence are the three defining elements of what he calls the Modern Constitution, which has structured the relationship between science and politics since the seventeenth century.

In the mediation process, human and nonhuman (i.e., natural) "actants" establish alliances with other actants that support the abstract subject or object they seek to construct. Establishing a fact, as Kuhn showed, requires the support of the relevant scientific community. Latour departs from Kuhn, however, and takes up the hint located above in Dewey, in arguing that establishing a fact also requires the support of many non-scientists. Technological inventions and scientific discoveries do not simply diffuse through the world on their own power, nor does the genius of those who initiated them suffice to establish their objectivity.

A lot of confusion has surrounded Latour's actant concept.[53] Despite some misleading rhetorical flourishes, Latour generally uses the actant as a methodological rather than ontological concept. Nonhuman actants, Latour writes, are "inert bodies, incapable of will and bias but capable of showing, signing, writing, and scribbling on laboratory instruments before trustworthy witnesses."[54]

> It is not a question of asserting that there is no perceptible difference [between humans and nonhumans]. The point is methodological....Are we to speak of intentionality, of behavior, of social competences, or interest of attachment? The answers are to be found mainly in the hands of scientists and engineers....We do not deny differences; we refuse to consider them a priori and hierarchize them once and for all.[55]

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[53] For the charge that Latour anthropomorphizes nature, see Simon Schaffer, "The Eighteenth Brumaire of Bruno Latour," *Studies in the History and Philosophy of Science* 22 (1991): 174-92. For a defense, see Latour and Callon, "Don't Throw the Baby Out with the Bath School!" 356.

[54] Latour, *We Have Never Been Modern*, 23.

[55] Callon and Latour, "Don't Throw the Baby Out with the Bath School!" 356 (italics added).

Unlike the "ecocentrist" thinkers with whom he is often identified, Latour does not seek a resolution of questions concerning the degree to which nonhuman entities have will or agency. But like many ecocentrists, and like Marcuse, Latour aims to articulate how nature can intervene in human affairs in unexpected ways. By calling the natural entities scientists represent "actants," Latour seeks to evoke the perspective of science-in-the-making, prior to the establishment of a scientific fact. From the perspective of science-in-the-making, nonhuman actants may be said to act "subjectively" insofar as scientists cannot yet predict what they will do. With the actant concept Latour aims to create a language that acknowledges the influence of an independent nature on the construction of scientific knowledge, thus avoiding social realism, without falling back into the natural realist claim that scientific knowledge simply mirrors nature.

Latour's study of Louis Pasteur's discovery of the microbe provides a good example of his conception of science as alliance building.[56] It also offers some empirical backing for Dewey's rather vague claim that scientific knowledge is "the cooperative work of humanity." According to Latour, Pasteur's discovery emerged not only from his work in the laboratory, but from a gradual transformation in the social meaning of "disease." In part as a result of Pasteur's explicit efforts, the meaning of disease changed from an individual affliction managed according to ad hoc local practices into a societal problem subject to scientific control. This shift in social meaning depended also on the work of civil servants and epidemiologists who collected and evaluated public health data. Without this data, it would have been impossible to document the effects of

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[56]Bruno Latour, *The Pasteurization of France*, trans. Alan Sheridan and John Law (Cambridge: Harvard University Press, 1988).

Pasteur's techniques once their use had become widespread. Similarly, Pasteur needed the support of the public hygiene movement to promote his ideas and techniques. Finally, Pasteur needed the "support" of the microbes themselves, which means nothing more than he had to learn how to control them. Pasteur thus developed laboratory techniques for isolating microbes from their natural environments, allowing him to first study their behavior and then, once he had gotten them to "cooperate," control them in the world outside.

In contrast to Pasteur's success at forming alliances with civil servants, epidemiologists, hygienists, and microbes, private physicians long remained unconvinced by Pasteur's claims. They disputed the same evidence the hygienists considered indisputable. Because physicians worked in private settings with the idiosyncratic symptoms of individual patients, the indiscriminate application of laboratory vaccines to entire populations contradicted their professional interests and training. It was not until Pasteur and his allies had succeeded in redefining the physician's social role, from patient's confidant to guarantor of public health, that the physicians also adopted Pasteur's ideas. They did so on their own terms, however, focusing on those bits of knowledge and technique, such as the use of preventative serums, that they could adapt to their clinical practices.

The alliances that establish scientific facts are eventually concealed, Latour argues, by what he calls the process of purification. The contingent victory of a hybrid alliance is recast as the heroic achievement of a scientific genius, such as Pasteur, who is portrayed as unlocking the secrets of Nature. "As long as controversies are rife, Nature is never used as the final arbiter since no one knows what she is and says. But *once the* *controversy is settled*, Nature is the ultimate referee."[57] The same can be said of controversies involving new technologies, such as the turn-of-the-century competition among gasoline, steam, and electric automobiles, discussed in Chapter 2. The diverse actants that contributed to gasoline's victory have since been purified from the official narrative and we now tend to see the dominance of gasoline engines as a technical necessity. Processes of mediation and purification produce scientific or technological artifacts that would not exist but for the network of relations between social subjects and natural objects, but which, as they enter the circulation of daily life, are unmistakably objects and not subjects.

To cite another example, the Newtonian theory of universal gravitation, like the existence of Pasteur's microbe, can be verified "everywhere," but only by extending the networks of scientific instruments and social practices required for measuring and interpreting gravity's effects.[58] Newton's theory of gravitation, of course, has been verified so many times that to contest it has become practically impossible. But this is a question of what practice can achieve, not what Nature has revealed. Newton himself, much like Pasteur, did not wait for Nature to distribute his ideas, but actively built alliances to promote his ideas.[59]

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[57] Latour, *Science in Action*, 97; see also 128-32; and *We Have Never Been Modern*, 10-11, 39-43.

[58] Latour, *We Have Never Been Modern*, 119.

[59] Newton solicited his friend Edmund Halley to cover the publication costs of his arcane mathematical treatise, the Principia, and later advised mathematically-challenged readers on how they might make the best use of the book. "The amazing powers imputed to Newton's mathematical vision of physical reality great in direct proportion to the number of groups, both scientific and non-scientific who found it in their interest to subscribe to the Newtonian way of seeing things....Less outgoing 'geniuses' such as Darwin and Einstein were fortunate to have in their corner such first-rate advocates as Thomas Huxley and Max Planck, who commanded considerable cross-disciplinary audiences. Otherwise, they too would have joined the multitude of intellectually ambitious and technically proficient scientists whose works sank without a trace because of their inability to attract the support of a broad enough constituency"

Latour's concepts of mediation and purification thus help explain both the local elements of scientific practice and the general applicability and social authority of scientific knowledge. The enormous achievements of modern science and technology have depended on the work of mediation, but moderns have tended to look away until the work of purification is complete.[60] Scientific facts only become established gradually, and only insofar as their supporters can continuously enlist the necessary alliances over time.

The concepts of mediation and purification help also clarify the relationship between technical artifacts and personal identity. Liberal-democratic citizens today interact continuously with material and intellectual objects, but try to conceive of themselves as free subjects, unencumbered by the objective world. But as Dewey suggested, the liberal subject's freedom from material necessity is an abstract idea, painstakingly constructed and in need of constant upkeep. Free subjects and scientific objects, then, are opposite sides of the same coin. If their supporters fail to maintain the alliances that sustain them, their self-evident objectivity or subjectivity is *practically* deconstructed. We can thus talk about the dehumanization or "objectification" of human beings as the flip side of the "subjectification" of scientific facts. Both involve a practical deconstruction of the alliances that support a particular claim. From this perspective, subjectivity and objectivity, politics and science, must be treated in tandem, as the endpoints of a continuum along which artifacts are established and maintained.

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( Steve Fuller, *The Governance of Science: Ideology and the Future of the Open Society* [Buckingham, UK, and Philadelphia, PA: Open University Press, 2000], 141).

[60] Latour, *We Have Never Been Modern*, 41.

> Even the shape of humans, our very body, is composed to a great extent of sociotechnical negotiations and artifacts. To conceive of humanity and technology as polar opposites is, in effect, to wish away humanity: we are sociotechnical animals, and each human interaction is sociotechnical. We are never limited to social ties. We are never faced only with objects.[61]

Human lives are permeated by technical objects, and these objects play an important role in how people see themselves.

As we saw in Chapter 2, a major barrier to the popular acceptance of EVs lies in the fundamental place of the standard automobile in contemporary conceptions of identity. Gasoline automobiles are not simply instrumentally efficient modes of transportation. They are status symbols, modes of self-expression, and for many, an existential necessity in a world dominated by suburban sprawl. If EVs are to establish themselves, they will need to be linked in a similar way to their users' sense of self.

Latour's concepts of mediation and purification can help us understand the systemic challenges faced by political efforts to promote environmentally-sound technologies. The gasoline automobile, for example, is bound up with a diverse network of human and nonhuman actants: automakers, auto lobbies, oil companies, refineries, roads, suburban developments, traffic signals, traffic police, parking lots, repair shops, part suppliers, courts, used-car dealers, wrecking yards, etc.[62] Both technical and social factors enter into the network that has for one hundred years promoted the design and diffusion of the technological artifact we simply call an automobile.

Whereas it is commonly assumed, for example, that cars are built from steel simply because that is the best thing from which to build them, a pragmatic-constructivist

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[61] Latour *Pandora's Hope*, 214.

[62] Peter Freund and George Martin, *The Ecology of the Automobile* (Cheektowaga, NY: Black Rose Books, 1993), 9.

approach reveals that this choice of building materials has a lot to do not only with steel industry lobbying, but with scientific predictions about what cars will have to withstand in the event of a crash. These predictions, in turn, emerge from interactions among such various social and technical factors as government regulation, materials science, engine performance, fuel chemistry, road maintenance, traffic signs, and the social value attributed to fast but safe cars.[63]

Identifying this dense network of actants helps explain why the participants in the debate over the California ZEV program rarely confined themselves to making assertions about just one aspect of the technology. Both advocates and opponents of the mandate often linked together, at least implicitly, claims about electrical batteries, environmental conditions, manufacturing capacity, government competence, political ideology, economic impacts, and consumer behavior in an effort to create what Michel Callon calls "heterogeneous associations" or actor-networks, each centered around one of the two sociotechnical artifact in competition, EVs and gasoline cars.[64] As we saw, however, participants generally did not acknowledge the hybrid character of their efforts to mediate between social and technical spheres, but sought rather to emphasize the technical factors of battery power and EV range. The Battery Panel report commissioned by CARB, for example, is filled with awkward formulations such as the following:

> The Battery Panel did not investigate questions of marketability of electric vehicles and cannot comment on the market assessments of the vehicle manufacturers. However, it is clear that the development of advanced batteries

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[63] Madeline Akrich, "The De-Scription of Technical Objects," in *Shaping Technology/Building Society: Studies in Sociotechnical Change*, ed. Wiebe E. Bijker and John Law (Cambridge: MIT Press, 1992), 205.

[64] A similar account appears in Callon, "Society in the Making," which describes an early 1970s attempt by the French utility Electricité de France to build and promote an electric car.

> with capabilities substantially greater than lead-acid batteries and also greater than nickel-cadmium batteries will provide much greater assurance of a successful electric vehicle program.[65]

The Battery Panel thus attempted to intervene in debates on the "social" factor of consumer interest, while simultaneously asserting that it would confine itself to strictly "technical" questions.

Seen in light of Latour's conceptions of mediation and purification, the history of the ZEV program suggests that successful transportation reform must go beyond a narrow focus on automotive technology, and explicitly take account of the diverse actants involved in shaping our transportation infrastructure. Had the California agency been more aware of the networks of mediation that hold the standard automobile in place, it might have been more able to sustain its initially powerful challenge to the infrastructure and ideology of automobility.

*Extending Science into the World*

Latour thus asserts a more explicit interdependence of science and technology and politics than Dewey. Latour's theory remains consistent with Dewey's claim, however, that the differences between scientific and political activity are practical rather than essential. The most important difference between politicians and scientists, Latour argues, is that scientists have laboratories. By reducing the infinitely complex outside world to purified and manageable forms—figures, formulae, chemical stocks, laboratory-

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[65] Kalhammer et al. *Performance and Availability of Batteries*, IV.2. In a similar manner, the report states that the battery performance criteria adopted by the Panel, originally developed by the United States Advanced Battery Consortium (USABC), "should not be interpreted as a reliable measure of EV user appeal or market potential--the potential applications of electric vehicles are too diverse and vehicle user responses to them too uncertain for this. Nevertheless, it is safe to say that batteries falling well short of one or more of the primary USABC mid-term goals are not good candidates for widely usable and readily marketable electric vehicles" (II.2).

bred animals, etc.—scientists can gain control over things to a degree that non-scientists never can. Scientists can then practice manipulating the things brought in from outside, making as many mistakes as they wish. Social scientists also rely on the manipulation of standardized forms, as in the collection and analysis of statistics. But natural scientists have far greater freedom in this regard. Although political scientists can play with voting statistics as much as they like, they cannot produce or manipulate standardized human subjects in a laboratory.[66] By manipulating things in the lab, scientists learn to predict natural processes or behaviors.

Predicting behavior *outside* the lab, however, Latour argues, requires extending the conditions of the laboratory itself. In the first dramatic public trial of Pasteur's vaccine, for example, where he vaccinated half of the sheep at a farm in Pouilly-le-Fort, Pasteur had to first convince the farmers to provide laboratory-like conditions. The vaccinated and non-vaccinated animals had to be marked and separated from each other; the animals' temperatures had to be measured and recorded daily; control groups had to be established. This export of the lab to the farm was a delicate affair: too many changes and the public would no longer perceive the trial as a "real world" application; too few and Pasteur would not be able to detect the vaccine's effects. More generally, Pasteur's knowledge of how to control microbes did not simply diffuse through an unchanged society. The breweries, hospitals, and milk processing plants that wanted to control microbes and eliminate infectious diseases had to adopt many of the same techniques and apparatuses that Pasteur had used in his lab.

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[66] For an account of the relationship between social and natural science that draws on Latour, see Joseph Rouse, *Knowledge and Power: Toward a Political Philosophy of Science* (Ithaca, NY: Cornell University Press, 1987), chap. 6.

Latour thus updates and clarifies Kuhn's famously vague claim that after a paradigm shift scientists "work in a different world."[67] He also elaborates Dewey's suggestion that a "complete" test of scientific propositions requires an assessment of their social consequences. After the "pasteurization of France," Latour argues, the world is indeed a different one, not due to changes in scientific theories, but as a result of the practical requirements of verifying and utilizing scientific knowledge. As Ian Hacking puts it, "Few things that work in the laboratory work very well in a thoroughly unmodified world—in a world which has not been bent toward the laboratory."[68]

The social diffusion of technical artifacts points to another reason for using the term "actant" to designate both human and nonhuman entities. The term actant expresses the notion that scientific practice effects *mutual transformations* of human and nonhuman entities. "Instead of starting with entities that are already components of the world, science studies focuses on the complex and controversial nature of what it is for an actor to come into existence."[69] In a study on Pasteur's work on lactic acid yeast, Latour states, "The essential point I am trying to make is that 'construction' is in no way the mere recombination of already existing elements. In the course of the experiment Pasteur and the ferment *mutually exchange and enhance* their properties."[70] Prior to the experiment, Pasteur is only a promising but unknown scientist. The yeast is nothing but an unidentified glob. To be sure, this exchange of properties is *initiated by* the human

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[67] Kuhn, *Structure*, chap. 10.

[68] Ian Hacking, "The Self-Vindication of the Laboratory Sciences," 59. See also Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed*, ed. Karin D. Knorr-Cetina and Michael Mulkay (London: Sage, 1983), 141-70.

[69] Latour, *Pandora's Hope*, 303.

[70] Ibid., 124.

actants. "Pasteur acts *so that* the yeast acts alone....Pasteur creates a stage in which he does not have to create anything. He develops gestures, glassware, protocols, so that the entity...becomes independent and autonomous."[71] But both Pasteur and the yeast, and eventually the entire world, are transformed through this interaction.

Technological innovations, such as the electric vehicle examined in Chapter 2, can also have transformative effects on the world. Indeed, the social transformations wrought by technology have generally been far more obvious than those resulting directly from science. Both advocates and opponents of the ZEV mandate thus argued that the widespread introduction of EVs would require not only technical advances, but also active public support. Unless citizens are willing to integrate EVs into their daily lives, the technology will never develop the diverse allies it needs to survive. What few recognized is that the more lay citizens are involved in the actual design of EV technology, the more likely they will be to adopt the vehicles.

### *Circulating Science and Technology*

Latour's analysis of how science extends into the world points toward a new understanding of scientific representation conducive to democratic politics. Philosophers from Descartes to Kant, Latour argues, echoing Dewey, asserted an ontological division between nature and mind, and then devised theories of representation to bridge the gap they had themselves created. It was, Latour remarks, "as if they had tried to understand how a lamp and a switch could 'correspond' to each other after cutting the wire and

[71] Ibid., 129-30.

making the lamp 'gaze out' at the 'external' switch."[72] Latour proposes to replace the Enlightenment notion of representation with a theory of "circulating reference."[73]

The Enlightenment dualism of nature and mind relegates all entities to one side or other of the divide, ignoring the many hybrid artifacts constituted by interactions between humans and nonhuman actants. A soil sample, a laboratory-bred mouse, or a strand of DNA are not simply elements of "nature," but hybrid nonhuman actants. Connecting these nonhumans with scientific theories or policy proposals is achieved not by leaping across a subject-object divide, but by multiple transformations across a series of small divides. A scientist takes a soil sample from a forest in the Amazon, identifies its color on a color chart, translates the color into a number, puts the number into an equation, and uses the equation to formulate a theory about the fate of the forest. At each stage, matter is translated into form, only to become matter for the next translation. The resulting theory "represents" the forest, but only as a result of a long series of concrete translations. As Latour puts it,

> The quality of a science's reference does not come from some *salto mortale* out of discourse and society in order to access things, but depends rather on the extent of its transformations, the safety of its connections, the progressive accumulation of its mediations, the number of interlocutors it engages, its ability to make

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[72] Latour, *Pandora's Hope*, 73. In a manner similar to Latour's discussion of mediation and purification, Steve Woolgar describes this conception of scientific representation in terms of a five-step "splitting and inversion" model of discovery: 1) scientists go through a social process of collecting experimental results; 2) they use these results to postulate the existence of a scientific "object"; 3) the object is conceived as having always existed, entirely independent of the process through which it has been "discovered"; 4) the object is presented as the "cause" of the experimental results that were previously only results without any definite referent; and 5) steps 1-3 are downplayed, denied, or forgotten. "Once the object is construed as pre-given, fixed, and antecedent, the involvement of the agent of representation appears merely peripheral and transitory. It is as if observers merely stumble upon a pre-existing scene" (*Science: The Very Idea* [London and New York: Tavistock Publications Ltd. and Ellis Horwood Ltd., 1988], 68-69).

[73] Latour, *Pandora's Hope*, chap. 2.

> nonhumans accessible to words, its capacity to interest and convince others, and its routine institutionalization of these flows.[74]

Circulating reference is a way of keeping something constant, in this case a lump of Amazon soil, through a series of translations.

Whereas the Enlightenment concept of representation is oriented toward the truth of a proposition, the notion of circulating reference builds on the Baconian emphasis on scientists' ability to intervene in the world. As Kuhn argued, normal scientific activity, while perhaps ultimately aimed at discovering truth, is dominated by the immediate goal of manipulating and controlling natural entities.[75] Similarly, the notion of circulating reference highlights the practical capacities created by a chain of references. Reference "circulates" because it can be traced from one end of the chain to the other in either direction. A map represents a landscape not only because it provides a picture of it, but because it enables the person who has it to plan her trip. The progressive *reduction* of locality, particularity, and materiality effected along the chain of reference produces an *amplification* of calculation, standardization, and control.[76] The abstract quality of a map is precisely what increases its owner's power to intervene in the landscape it represents.

Another crucial feature of circulating reference is that in contrast to representation, which provides a context-independent picture of the object represented, reference has to be continuously maintained. As discussed above, scientists must recruit and sustain alliances with human and nonhuman allies that support each of the translations in the chain of reference. The more institutionally established a chain of

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[74] Ibid., 97.

[75] As Longino notes (*Science as Social Knowledge*, 32-37), Kuhn differs in this respect from both Feyerabend and Popper. On scientific intervention in the world, see Rouse, "Kuhn and Scientific Practices"; Hacking, *Representing and Intervening*, chap. 13.

[76] Latour, *Pandora's Hope*, 70-71; *Science in Action*, chap. 6.

reference, the less conscious effort must go into maintaining it. Many scientific facts are thus maintained by being used as building blocks for further research. The more scientists make use of them, the less vulnerable they are to challenge. Just as democracy cannot survive without the civic engagement of citizens, scientists' representations of nature must be taken up by others else they be at best underfunded, at worst forgotten.[77]

Many facts, moreover, are maintained by lay people's use of technologies that rely on those facts. Drinking pasteurized milk or taking antibiotics, for example, helps maintain the chain of reference that established Pasteur's discovery of the microbe. When applied to technology, the notion of circulating reference suggests that as technologies become established parts of society, they no longer "impact" society from somewhere else—as in the traditional view, exemplified by the use of environmental impact statements to legitimize new technologies. Rather, established technologies become integrated into the fabric of daily life.

The history of the electric vehicle has been characterized by a persistent failure to recognize that established technologies only become established by circulating through society. This is especially apparent in the frequently voiced concern, mentioned briefly in Chapter 2, that a premature introduction of EVs would "poison the market." In 1976, for example, the US Congress passed legislation to support research and development of electric vehicles. The legislation initially called for a demonstration program of 7,500 vehicles, but the program was stymied by government and industry experts who insisted that the technology was not yet ready. An EPA official said that "if the currently

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[77] One might note a parallel here to Arendt's argument, in *The Human Condition*, that the meaning of individual action emerges only in interaction with the responses it evokes from others.

available vehicles fall short of public expectations for urban and rural use, the long-run potential of this mode of transportation may never be realized."[78] Another expert testified, "Until the improvements in battery technology occur, it would be premature to support a large and costly demonstration program."[79] The experts thus assumed that a successful market launch of EVs required waiting for the science—that is, for a more complete representation of nature. By relying on the promise of basic research, the federal government failed to introduce more modest demonstration programs that would begin to develop an infrastructure for EVs.[80] Put in Latour's terms, the government failed to put EVs in circulation. But if Latour's conception of science is correct, putting EVs in circulation would have been the most effective way to advance the basic science underlying EV battery technology. Moreover, whichever of the various competing electric vehicle designs first achieves market success, its mere existence will quickly increase the funding, prestige, and scientific authority of the design it employs.

Finally, if science and technology circulate not only among technicians but throughout society, they become potential sites of the disciplinary power analyzed by Foucault.[81] Foucault concentrated his attention on institutions expressly designed to regulate human behavior, such as hospitals, prisons, and schools, not on the representation of nature. But as Latour suggests, scientific facts discovered in the lab can

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[78] US Senate, Committee on Commerce, *Electric Vehicle Research, Development and Demonstration Act of 1975* (Washington, DC: General Printing Office, 1975), 40, quoted in Kirsch, *The Electric Vehicle*, 204.

[79] Ibid.

[80] Kirsch, *The Electric Vehicle*, 205.

[81] See especially Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (New York: Random House, Vintage Books, [1975] 1979). On the relationship between Foucault's notion of power and natural scientific practice, see Joseph Rouse, *Knowledge and Power: Toward a Political Philosophy of Science* (Ithaca, NY: Cornell University Press, 1987), chap. 7.

only be reproduced in the outside world by extending the condition of the laboratory itself. And technologies become socially established by being integrated in daily life. This means that science and technology potentially impose disciplinary practices not only on technicians, but on those who would either verify or make use of scientific facts outside the lab as well. From this perspective, Foucault's concept of disciplinary knowledge might be read as a more determinist form of Winner's and Sclove's notion of technology as legislation. In either case, as I argue in the next chapter, the norms of democracy require not that science and technology be dismissed, despised, or dismantled, but that they be made to represent the public.

## Toward Nonmodern Politics

Does Latour's conception of science and technology support such an endeavor? Does his elaboration of certain aspects of Dewey's philosophy of science support a Deweyan conception of democracy? Latour suggests that his understanding of scientific practice can help "replace the clandestine proliferation of hybrids by their regulated and commonly-agreed-upon production."[82] This promises nothing less, he writes, than "a democracy extended to things themselves"—"a parliament of things."[83] The extended sociotechnical networks that have allowed the West's unprecedented technological advance do not need to be dismantled, but they need to be integrated with democratic politics. But according to Latour, we do not yet have a conception of politics with which to conceptualize a "parliament of things."

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[82] Latour, *We Have Never Been Modern*, 142.

[83] Ibid.

> The nasty problem we now have to deal with is that, unfortunately, we do *not* have a definition of politics that can answer the specifications of this nonmodern history. On the contrary, every single definition we have of politics comes from the modernist settlement and from the polemical definition of science that we have found so wanting....It is not only the practice of science and technology that epistemology has rendered opaque, but also that of politics.[84]

The typical modern conception of politics as the exercise of power is just as anemic and misleading as the typical modern conception of science as the pursuit of truth. Both ignore the concrete practices of mediation through which knowledge and power are produced. They both ignore, that is, the lay citizens upon whose docile cooperation they rely. Neither scientists nor politicians can get much done without the people's assistance. This is why, among other reasons, both politicians and scientists need to be understood as public representatives. But scientific and political representation have rarely been examined together. How are they the same? How are they different? What is the appropriate role of each in a democratic society? The next chapter begins to answer these questions.

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[84] Latour, *Pandora's Hope*, 214-15.

# CHAPTER 6

# LINKING SCIENTIFIC AND POLITICAL REPRESENTATION

A Person, is he, whose words or actions are considered, either as his own,
or as representing the words or actions of an other man,
or of any other thing to whom they are attributed,
whether Truly or by Fiction.
-- Thomas Hobbes

If maintaining scientific facts imposes regimes of discipline on the scientists and lay citizens who make use of those facts, the norms of democracy require that scientific facts in some way *represent* the public. Scientists have enough trouble representing nature—can they also represent the public? The question is not whether scientists should run for public office in their spare time. It is whether scientists can make representations of nature that in some way also represent citizens.

This question will not seem as strange as it may at first, once we remember the history of liberal-democratic instrumentalism. As we saw in Chapter 3, by insulating science from politics, Enlightenment thinkers made technocratic politics seem capable of representing the public, insofar as it fulfilled their best interests and highest ideals. In this respect, scientists' claims to represent nature have long been intertwined with the notion that science also represents the public by contributing to material welfare, consumer technologies, and national security, and by exemplifying the liberal-democratic norms of civility, cooperation, consensus, and disinterestedness. A similar notion of representation appeared in Chapter 2, where California policymakers used technical expertise to present their decision as more publicly representative than the expressed will of California citizens.

Of course, this technocratic version of publicly representative science has important shortcomings. Indeed, the most spectacular efforts to create politically representative science have also been spectacular failures: Nazi science and Lysenkoism. It is unfortunate, however, that the fate of science under totalitarian regimes has often seemed to confirm the standard view that applying political categories to scientific activity will eventually produce both bad science and bad politics. The specter of totalitarian science motivated many of those who argued during the 1930s and 40s that defending democracy required keeping science free of politics. It has also been a recurring theme in the "science wars" of the 1990s, seeming to provide irrefutable proof of the nihilistic dangers lurking in constructivist theories of science.

The first section of this chapter argues that the distinguishing characteristic of Nazi science and Lysenkoism was not their constructivist conception of science, but their anti-democratic version of constructivism. This suggests that the totalitarian version of publicly representative science is not only possible version. The rest of the chapter develops the notion of a *democratically* representative science by analyzing different forms of representation in natural science and their relationship to political representation. According to a democratic theory of scientific representation, scientists 1) make representations of natural entities and process, 2) are themselves the representatives of those entities and processes in the public sphere, and 3) represent lay citizens, whose input they solicit in the selection of scientific procedures and goals. Before presenting the argument, however, we need to clear up some common misunderstandings about the tragic history of politically representative science.

*Nazi Science and Lysenkoism*

There is, of course, no denying the enormous damage inflicted upon scientists and their research by totalitarian regimes. Nazism and Stalinism placed severe restrictions on international cooperation among scientists; forced universities to employ racial or political criteria in faculty appointments; subjected scientific funding to centralized control, allowing the enforcement of orthodox methods and theories; promoted horrendous experiments on human subjects; prohibited research in highly theoretical areas of science, such as relativity theory and quantum mechanics, because they seemed to contradict populist ideology; and established rigid goals for the practical application of scientific knowledge, punishing scientists who failed to deliver. Nazism and Stalinism, moreover, led to the emigration, imprisonment, and death of thousands of scientists.[1]

It remains important, however, to dispel the persistent myth that Nazi science and Lysenkoism represented the subordination of otherwise value-free science to political ideology. As I have been arguing, modern science has never been non-ideological, but has from its inception been intertwined with a variety of political ideologies, including monarchism, liberalism, Marxism, technocracy, and deliberative democracy. Moreover, the use of science for political oppression has not been confined to totalitarian countries. The world's first law requiring the forced sterilization of the mentally ill, for example, was passed by the US State of Indiana in 1907. By the late 1920s, twenty-eight other states had passed similar laws, and by 1939, 30,000 US citizens had been sterilized in the

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[1] See Paul R. Josephson, *Totalitarian Science and Technology* (Atlantic Highlands, NJ: Humanities Press, 1996).

name of eugenics. These forced sterilizations were not part of a government conspiracy, but proceeded with the public support of well-respected American scientists.[2]

Nor is science used to serve political purposes necessarily "junk science." To be sure, one of the distinguishing features of science under totalitarianism is its subordination to a "transformationist vision."[3] But as I showed in previous chapters, modern science has long been associated with instrumentalist efforts to improve society. In the 1930s, Lamarckian *and* Mendelian geneticists proposed schemes to produce "improved" human beings, and both sought to bolster the credibility of their science by establishing alliances with public officials.[4] These schemes, moreover, were not founded on "bad science." Lamarckian genetics, while a marginal position, was not merely ideological. It rested upon a large literature of experimental results that *at the time* had not yet been refuted.[5] Similarly, Nazi eugenics met the scientific standards current at the time, and was defended by numerous respected scientists living under democratic regimes, particularly in the United States and Great Britain. Subscription to totalitarian ideologies and their transformationist visions did not prevent some scientists from producing cutting-edge research.

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[2] Mike Fortun and Herbert J. Bernstein, *Muddling Through: Pursuing Science and Truths in the Twenty-First Century* (Washington, DC: Counterpoint, 1998), 114. See also Mark B. Adams, "Towards a Comparative History of Eugenics," in *The Wellborn Science: Eugenics in Germany, France, Brazil, and Russia*, ed. Mark B. Adams (New York: Oxford University Press, 1990), 217-31; Robert N. Proctor, *Racial Hygiene: Medicine Under the Nazis* (Cambridge: Harvard University Press, 1988), 97-101.

[3] Josephson, *Totalitarian Science and Technology*, chap. 2.

[4] Fortun and Bernstein recount the story of leftist American biologist, H. J. Muller, Mendelian and future Nobel prize winner, who wrote to Stalin in 1936 to propose a plan for using artificial insemination to improve the Soviet Union's prospects in the struggle against capitalism (*Muddling Through*, 119-20).

[5] Richard Levins and Richard Lewontin, "The Problem of Lysenkoism," in *The Dialectical Biologist* (Cambridge: Harvard University Press, 1985), 178.

Finally, Nazi science and Lysenkoism were not simply instances of science becoming subordinated to state power. Nazi ideologues often drew on pre-existing science to support their politics, rather than imposing their politics on science. As Fortun and Bernstein put it, "We do not have a history of innocent scientists being corrupted by the powerful and nefarious state. We have a history of the interaction and mutual accommodation between forces of sciences and scientists and the forces of power and statesmen."[6] In Nazi Germany, for example, scientific claims about the essential inferiority of Jews and other "deviant" groups appeared rational and objective to many, because they fit with prevailing views. Nazi science and the Nazi state evolved together, each sometimes leading the other.

This is not to say that it is unimportant under which type of political regime science is practiced. To the contrary. From the perspective developed in this dissertation, scientific knowledge emerges from the interaction between natural entities and processes, on the one hand, and human knowledge, skills, desires, and purposes, on the other. Although Lamarkian genetics was initially defended by scientists living under both liberal-democratic and Communist regimes, its eventual demise was delayed in the Soviet Union because the "nonhuman actants"—i.e., empirical findings—were not allowed to play their proper role in the struggle among competing theories.

In contrast to totalitarian regimes, science under liberal-democratic regimes is not subject to centralized control. In a liberal democracy, science interacts with a plurality of ideologies, rather than being subordinated to a single ideology. This not only allows for a diversity of political influences on science, it also helps ensure that science will remain

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[6] Fortun and Bernstein, *Muddling Through*, 116.

open to the influence of nonhuman actants. In this respect, as Dewey and Merton argued, democracy is clearly better for science than totalitarianism.

This is not to say that science and democracy have the same epistemological structure or follow the same procedures, as Dewey and Merton often suggested. Scientific theories, after all, are not accepted or rejected by majority vote. Even a science that incorporates the input of lay citizens will still employ sophisticated theories, skills, and instruments that remain beyond the comprehension of most citizens. The economic and political interests of scientists, as a group, will always tend to conflict with those of many other social groups. An "essential tension," some have argued, will always remain between science and democracy.[7] In these respects, the specter of totalitarian science may serve as a useful reminder of the need for boundaries between science and politics, even as we learn that those boundaries are not given by nature, logic, or divine will.

Nonetheless, the problem with totalitarian science does not lie in the mixing of science and politics, as is commonly supposed, but in the form of politics that goes into the mix. In a democratic society, therefore, it may be possible to think of scientists as public representatives without risking the horrors of totalitarian science. This requires first distinguishing among several different types of representation, each of which appear in both science and politics.

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[7] See David H. Guston, "The Essential Tension in Science and Democracy," *Social Epistemology* 7, no. 1 (1993): 3-23.

**Representation in Scientific Practice**

*The Concept of Representation*

In her classic study on the concept of representation, Pitkin draws on ordinary language philosophy to argue that representation is not an internally consistent concept with a single definite meaning. Rather, the concept of representation is composed of multiple meanings that emerge from the contexts within which the concept is used.[8] Pitkin thus distinguishes between (among other things) representation as "standing for" and "acting for."[9] The notion of "acting for" appears in both the delegate and trustee conceptions of representation, most famously defended by Rousseau and Burke, respectively. Both delegates and trustees "act for" their constituents, but the former act on their explicit instructions and the latter act in their best interest.

The notion of the representative as delegate assumes that representatives either cannot determine the objective interests of their constituents or that constituents have no objective interests in the first place. Delegates merely adopt the expressed wishes of their constituents with as little distortion as possible. At the extreme, constituents' interests are understood as subjective matters of personal taste, and delegates' own subjective views threaten to prevent them from discerning what their constituents want. The delegate model emphasizes the importance of formal procedures through which citizens participate in shaping the policies adopted by their reprsentatives, sometimes at the expense of substantive effectiveness.

The notion of the representative as trustee, in contrast, which appears in the liberal-democratic model of technocracy discussed in Chapter 3, casts representatives as

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[8] Pitkin, *Concept of Representation*, 6-7.

[9] Ibid., chaps. 4-6.

guardians who can objectively determine their constituents' interests. At the extreme, representatives are technical experts who serve their constituents with no input from the constituents themselves. The trustee model emphasizes the importance of substantively effective policy, sometimes at the expense of formal procedures for citizen participation.

In contrast to "acting for," the notion of "standing for" portrays representation not in terms of a set of activities, but in terms of an existing relationship between two people or things, one of which stands for the other. One form of this type of representation appears in the use of symbols. Flags are thus often employed as symbols that stand for peoples or nations. Political leaders are often understood as symbols of their countries. Symbols are not intended to provide information about what they represent, but rather to evoke whatever thoughts and feelings have come to be associated with the symbol.[10]

Another form of representation as standing for appears in descriptive representation, according to which one person or thing directly resembles or corresponds to someone or something else. Portraits, maps, and opinion polls are thus taken to resemble or provide reliable information about people, landscapes, and public opinion, respectively. Similarly, many have argued that race, class, or gender composition of government institutions should roughly correspond to that of the electorate. During his first campaign for the presidency, Bill Clinton thus famously promised that his cabinet would "look like America." In this sense, and in contrast to representation as "acting

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[10] Pitkin also makes a more narrow distinction between symbols that represent by corresponding to the things they represent, such as the symbols used on a map, and symbols that do not correspond to anything but rather symbolize something, such as a flag. "To say that a symbol represents is to suggest a precise correspondence, a simple reference or substitution....To say that a symbol symbolizes is to suggest the vagueness or diffuseness of what it stands for, the impossibility of exchanging the one for the other, expression rather than reference" (Ibid., 98). In these terms, my concern in the following is with the elements of science that functions as symbols that symbolizes.

for," the descriptive and symbolic views each see representation as the *result* of an activity, not an activity itself.

Despite the exhaustiveness of her account, Pitkin surprisingly says very little about scientific representation. She suggests, however, that it would be something of a category mistake to see scientists as engaged in any form of political representation. "The expert scientist solving a technical problem is not representative at all, is not deciding anything, is not pursuing anybody's interest."[11] Scientists cannot engage in political representation, Pitkin suggests, because the natural entities they represent do not have, or at least cannot express, their interests. Although this is in many respects true, the increasing interpenetration of scientific and political practices over the past fifty years suggests that scientific and political representation have come to intersect with each other as well.[12] The remainder of this chapter draws on Pitkin's analysis of representation to argue that science should represent not only natural entities in a descriptive sense, but also democratic citizens in a political sense. Along the way, I specify three conceptions of scientific representation:

First, as examined in Chapter 3, many Enlightenment scientists sought to cast themselves in the role of *nature's representatives*, uniquely qualified to create objective *representations* of nature. Scientists have thus often portrayed the knowledge they create as "standing for" nature in a *descriptive* sense. Sometimes they have also presented the

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[11] Ibid., 211.

[12] See also Michael Lynch, "Representation is Overrated: Some Critical Remarks about the Concept of Representation in Science Studies," *Configurations* 2, no. 1 (1994): 137-149. Lynch argues, like Pitkin, that "we should 'explode' the concept of representation," meaning that "the actual uses of this familiar concept should be opened out to detailed investigation..." (147). Representation is "overrated," Lynch argues, because science studies scholars have often tended to satisfy themselves with debunking positivist conceptions of representation, stopping short of investigating "what to do with a the concept of representation now that we have dissociated it from a rejected metaphysics" (139).

scientific community as "standing for" nature in a *symbolic* sense. Technocratic efforts to justify public policy with reference to scientific knowledge still draw on both descriptive and symbolic forms of the Enlightenment image of scientific representation.

A second image of scientific representation also sees scientists as capable of providing objective knowledge, but rather than focusing on established scientific knowledge that "stands for" nature, this image of scientific representation emphasizes the activities through which people make and use science. According to this image, scientists should "act for" nature, actively representing "nature's interests" in the public sphere. This image is thus analogous to Edmund Burke's image of representatives as *trustees* whose task lies in determining and protecting the objective interests of their constituents. It appears today in some environmentalists' attempt to base their claims on scientific assessments of nature's objective needs.

A third image of scientific representation, also focused on the *activity* of representing, appears in Latour's theory of science, as presented in the previous chapter. Latour shows that for science-in-the-making, before scientific facts are accepted as true, scientific representatives are best understood not as trustees, but as Roussean *delegates* who "act for" their constituents in the sense that they attend very closely to the laboratory inscriptions produced by nonhumans. Latour also offers a way of bringing together the delegate and trustee conceptions of scientific representation so as to account for both science-in-the-making and established scientific facts.

*Making Scientific Representations*

The Enlightenment model of science fits Pitkin's analysis of descriptive representation.[13] Scientists make "representations" that "stand for" natural entities and processes. Scientific representation, according to this view, can be understood as providing a "mirror of nature."[14] As we saw in Chapter 3, early experimentalists adopted a humble style of speech and writing with the explicit aim of depersonalizing the culture of laboratory science. Impersonal laboratory instruments were to allow nature to speak for itself, undisturbed by human interference. Like a map or a picture, the Enlightenment image of science thus locates scientific representation primarily in the result of an activity, not an activity itself. Scientists are not explicitly conceived as *representing* anything or anyone, but rather as making descriptive *representations* that correspond to natural entities and processes.

Similarly, modern science has long represented--in the sense of symbolically standing for--certain discursive and behavioral norms, such as cooperation, rationality, skepticism, and impartiality. These norms, moreover, have often been associated not merely with scientific method as such, but with individual scientists themselves. Scientists have thus occasionally attempted to symbolically represent these norms in political controversies. Recently, for example, fifty Nobel laureates signed a petition

[13] Pitkin briefly considers whether experts such as doctors and engineers represent their clients, but does not examine their production and use of representations of natural entities (*Concept of Representation*, 138-139). She later defines political representation in explicit contrast to natural science, on the one hand, and arbitrary choice, on the other: "For representation is not needed where we expect scientifically true answers, where no value commitments, no decisions, no judgment are involved" (212).

[14] See Richard Rorty, *Philosophy and the Mirror of Nature* (Princeton: Princeton University Press, 1979).

protesting the development of a United States missile defense system. Given that most of the signatories lacked any expertise in missile defense, whatever special authority they had as Nobel laureates came solely from their symbolic status as representatives of the social norms of science.[15]

Each of these concepts of scientific representation played an important role in the debate on the California ZEV program. Proponents of revising the program justified their position with reference to both the symbolic authority of the Battery Panel and the descriptive representations of EV performance it provided. Those seeking to revise the program never addressed the specific procedures whereby those representations--i.e., the numerical range and cost estimates--had been created, thus neglecting the political biases contained in the figures. Insofar as the numeric representations of EV performance privileged vehicle range, they reflected the biases of the existing transportation infrastructure. And given the corrosive effects of the current infrastructure on democratic citizenship, the agency's figures were distinctly *un*representative of genuine public needs. Although the figures were no doubt accurate *representations* of nature, they were created by *scientific representatives* apparently unaware of the political biases embedded in their research.

### *Scientists as Nature's Trustees*

Until recently, as discussed in previous chapters, the philosophy of science has not generally concerned itself with the scientists' practical activities, concentrating instead on the logical and epistemological status of the knowledge they produce. The

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[15] Neil King, Jr., "Antimissile Shield Flawed, Scientists to Tell Congress," *Wall Street Journal* (June 12, 2000), A12.

collective, creative, practical work of experimental science—tinkering with apparatus, isolating and standardizing laboratory phenomena, agreeing on procedures of inquiry and standards of evidence—has rarely entered the picture provided by most philosophers of science. A conception of science that attends to scientific practice will require a theory of representation that goes beyond the conceptual status of scientific representations to look at the practical activity of representing. Latour thus provocatively asserts:

> So in practice, there is not much difference between people and things: they both need someone to talk for them. From the spokesperson's point of view there is thus no distinction to be made between representing people and representing things. In each case the spokesperson literally does the talking for who or what cannot talk....[T]he crucial element is not the quality of the represented but only their number and the unity of the representative.[16]

In practice, Latour suggests, scientists do not simply make representations, they compete with each over for the power to represent or "act for" nature. Latour exaggerates in saying that "there is no distinction" between scientific and political representation, and I discuss a few such distinctions in the last section of this chapter. But he is right to suggest that from the perspective of science-in-action, scientists not only produce representations that "stand for" nature, but also engage in some form of representative "acting for" nature.

Seventeenth-century experimentalists, for example, as described in Chapter 3, devoted much effort to establishing their credentials as representatives of nature. Experimentalists readily admitted that although nature might be brought to speak "for itself," it could not do so by itself. And they insisted that not just anyone could make nature speak. Those whose capacity for independent judgment was impaired by poverty,

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[16] Latour, *Science in Action*, 72; see also 143.

philosophical dogmatism, religious enthusiasm, or lack of moral virtue could not be relied upon to correctly interpret nature's testimony in laboratory experiments. Getting nature to speak *clearly*, and correctly interpreting what it said, required the expert knowledge, skill, and virtue of the gentleman. In this respect, the Enlightenment view of scientific representation contains not only the notion of "standing for" described above, but also a notion of "acting for" nature. It might thus be said to parallel the trustee model of representation.[17]

According to Burke's elaboration of the trustee model, citizens' fleeting, personal, subjective desires can give a member of parliament clues about their true interests, but these desires are not what the parliamentarian represents. Rather, parliamentarians represent their constituents' permanent, general, objective interests. Similarly, the purpose of parliamentary debate, for Burke, is not to work out bargains among competing interest groups, but to discover the objective national interest that unites particular interests. Moreover, Burke attributes particular interests not to individual subjects, but to broad social groups, objectively identified according to their role in the economy; e.g., agriculture, manufacturing, professions, etc.[18]

Burke's concept of political representation thus parallels the notion of scientific representation implicit in early experimentalists' efforts to establish themselves as nature's representatives. As Pitkin remarks, "He sees interest very much as we today see scientific fact: it is completely independent of wishes or opinion, of whether we like it or

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[17] In addition to the first half of Chapter 3 above, see Simon Schaffer, "Augustan Realities: Nature's Representatives and Their Cultural Resources in the Early Eighteenth Century," in *Realism and Representation: Essays on the Problem of Realism in Relation to Science, Literature, and Culture*, ed. George Levine (Madison: University of Wisconsin Press, 1993), 279-318.

[18] Pitkin, *Concept of Representation*, chap. 8.

not; it just is so."[19] Burke's trustee model also supports the Enlightenment notion that long range inquiry, in either science or politics, is bound to discover the truth. Although subjective factors may interfere along the way, sober deliberation among trustworthy representatives, whether parliamentarians or scientists, will eventually produce objective knowledge. Finally, since Burke attributes long term conflict between representatives and their constituents to the corruption or incompetence of the representatives, not to those represented, it would not seem to matter whether the constituents are citizens or natural entities. Nature, according to the Enlightenment view of science, is a passive object of observation. It need not, therefore, play an active part in its own representation. In each of these respects, the trustee model of representation fits the Enlightenment image of science.

Today the trustee model of scientific representation appears in the efforts of some environmentalists to speak on nature's behalf. Contemporary environmentalists, especially those who subscribe to an "ecocentrist" philosophy, often present themselves as the defenders, advocates, or representatives of nature.[20] They claim to represent the "interests" of individual plants and animals, entire ecosystems, future generations, or even the Earth itself. Although some environmentalists argue that moral insight or cultural traditions authorize them to represent nature, many draw their representative authority from environmental science.

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[19] Ibid., 180; see also 210.

[20] See Steven Yearly, "Nature's Advocates: Putting Science to Work in Environmental Organizations," in *Misunderstanding Science? The Public Reconstruction of Science and Technology*, ed. Alan Irwin and Brian Wynne (Cambridge: Cambridge University Press, 1996), 172-190.

Environmentalists' attempts to speak and act for nature have raised many conceptual and practical difficulties. They easily lead, for example, to the philosophically dubious and politically technocratic position of resting moral claims on scientists' ever-changing insights into the objective qualities of animals or ecosystems.[21] Scientists can determine *how* trees grow, but they have no particular competence to determine whether or not it is in a tree's "interest" to grow taller, or to grow at all. A tree's objective "need" for sun and water does not necessarily translate into a political obligation for human beings. If these were technical philosophical questions (assuming there are such questions), one might ask professional philosophers rather than scientists to speak for nature. But since these are fundamentally moral and political questions, they cannot be decided by either scientific or philosophical experts alone. Like Burke, environmentalists who claim that objective knowledge allows them to speak and act for nature overemphasize the substantive dimension of representation.

Rather than granting environmental scientists an exclusive right to speak on nature's behalf, environmentalists need to conceptualize a way of speaking and acting for nature that avoids the technocratic implications of both the correspondence and trustee models. This requires a conception of scientific representation amenable to forging links with a participatory conception of political representation, while remaining cognizant of the boundary between them. Latour's theory of science offers a good starting point.

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[21] See Bob Pepperman Taylor, *Our Limits Transgressed: Environmental Political Thought in America* (Lawrence, KN: University Press of Kansas, 1992), chaps. 3-5.

*Scientists as Nature's Delegates*

In contrast with the image implicit in Burke, Latour casts scientific representatives as nature's delegates. Unlike trustees, delegates acquire their authority not by fulfilling substantive standards, but through authorization by those whom they represent. Moreover, as mentioned above, the representative activity of delegates does not depend on an objective assessment of their constituents' objective interests and attributes. Rather, delegates must make a subjective assessment of their constituents' subjective desires and demands.

Now in what sense could the natural entities that scientists represent have subjective desires? Latour's actant concept is helpful here, insofar as it captures the perspective of working scientists who cannot yet objectively describe or predict the behavior of nonhumans. As noted in the previous chapter, Latour's actant concept does not involve a universalistic claim about the degree to which nonhumans have will or agency. Pasteur did not know how the entities we now call microbes would behave until he had watched their reactions in many experiments. Whereas Burke considered it imprudent to listen too closely to his constituents, for Pasteur to become the recognized delegate of his microbes he had to carefully observe their reactions in various laboratory trials. From this perspective, a scientist's representative activity consists of making inscriptions that record the laboratory behavior of nonhuman actants: tables, graphs, spectrograms, etc. These inscriptions are not yet scientific facts or "objects," but rather, to use Dewey's phrase, as evidence of what the world will stand for. Through the practices of mediation discussed in Chapter 5, scientists gradually assemble these inscriptions into a representation of nature--i.e., a scientific object. But before the assemblage is complete, scientists' representative activity parallels that of political delegates who must elicit testimony from their constituents.

*From Delegates to Trustees*

Now just because practicing scientists must act as nature's delegates does not mean they wish to be understood as such. Nor do practicing scientists wish to remain delegates. Latour makes clear that scientists can only garner professional and public authority by wrapping their representations of nature in the mantle of objectivity. Scientists not only represent nature, they represent themselves and their representations of nature before both colleagues and the public.[22] Indeed, scientists can only establish the objectivity of their claims by adopting the role of nature's trustees. Scientists must simultaneously act as delegates, portray themselves as trustees, and portray the representations they create as objective descriptions of nature. Their success, we saw in Chapter 5, depends on their ability to sustain the alliances that support each mode of representation.

As scientists become more effective at predicting the behavior of their nonhuman constituents, they have less need to solicit testimony by conducting experiments. In this respect, as scientific facts become more established, scientists' representative activity gradually shifts from the role of delegate to that of trustee. Once sufficient evidence is collected, scientists solicit fewer new inscriptions and focus on providing an objective account of those inscriptions. Finally, once scientific facts become truly established,

[22] Latour argues that because the public understanding of science affects research priorities as well as procedures, the public representation of science must be understood as a constituent element of scientific practice (*Pandora's Hope*, 105-6).

scientists retreat even from the role of trustee. As explained in the previous chapter, accepted scientific facts become "purified" of the subjective elements that went into their creation. The most objective scientific representations, as described by the Enlightenment image of science, are taken to "stand for" nature all by themselves. The less their epistemological status is thought to depend on human activities and assessments, the more scientific representations take on the honorary status of "fact."

This conception of scientific representation allows us to view challenges to accepted scientific knowledge as attempts to reveal the subjectivity of scientific representatives. Dissenters try to show that a natural entity that appears to either speak for itself or to be represented by an objective scientist-trustee is actually being represented by a subjective scientist-delegate. More radically, dissenters might claim that nature is not being represented at all. They might argue that the alleged scientist-representative is not even a scientist. When the dissenter succeeds, the spokesperson is transformed from someone who speaks for nature into someone who speaks only for him or herself.[23]

If scientific representation is conceived in these various ways, it becomes possible to combine a constructivist account of scientific practice with the Enlightenment image of science. There are four modes of scientific representation, arranged along a continuum between objectivity and subjectivity:

- representations that "stand for" nature without any human mediation;
- scientist-trustees who objectively "act for" nature;
- scientist-delegates who "act for" not-yet-predictable nonhumans;

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[23] Latour, *Science in Action*, 78; *Pandora's Hope*, 132.

- non-scientists whose claims to speak for nature are rejected by established scientists.

Latour's conception of scientific representation thus captures both the subjective alliance building of scientific practice and the objective status of established scientific knowledge. Scientists "act for" nature, first as delegates and then as trustees, and by doing so they produce descriptive representations that "stand for" nature. Which mode of representation predominates is a practical question, determined by contests between networks of actants that have a stake in the representation of the nonhumans in question.

One might note that Latour's comments on *political* representation overemphasize the delegate model. He thus writes,

> Hobbes's descendents had defined the Republic in which naked citizens, unable to speak all at once, arrange to have themselves represented by one of their number, the Sovereign, a simple, intermediary and spokesperson. What did this representative say? Nothing but what the citizens would have said had they all be able to speak at the same time.[24]

Latour thus suggests that political representations do little more than parrot the demands of their constituents. While his account of scientific representation integrates the delegate and trustee models, Latour's comments on political representation neglect the latter. He thus also neglects the long history of substantive conceptions of representation and the associated arguments for representative over direct democracy. Like Latour's concept of scientific representation, a balanced account of political representation must include both substantive and procedural elements.

Latour is right, however, to highlight the connection between radical-democratic objections to representative government and the modern attack on practices of mediation.

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[24] Latour, *We Have Never Been Modern*, 143.

Just as empiricists have argued that scientific knowledge should correspond to nature without the mediation of subjective human actors, radical democrats have sometimes argued that legislators should adopt policies that correspond to their constituents' wishes without the mediation of objective knowledge. "All had in common a hatred of intermediaries and a desire for an immediate world, emptied of its mediators. All thought that this was the price of faithful representation, without ever understanding that the solution to their problem lay in the other branch of government."[25] Latour thus shows how the Burkean concern that political representatives defend objective substantive standards can be expanded to include a role for science in political representation. In a technically-complex society, the substantive knowledge that enters into political representation must come not only from moral, religious, or social scientific accounts of constituents' true needs, but also from natural scientific representations of nature.

Latour's account of scientific representation also makes it easier to conceptualize the representation of the many sociotechnical "hybrid" artifacts that cannot be easily relegated to one side of the subject-object divide. Hybrid artifacts like the ozone hole, genetically modified organisms, or electric vehicles can be fully represented in public discourse only though cooperation between scientists and public officials. Hybrids cannot be adequately represented by either scientists or politicians alone.

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[25] Ibid.

## Linking Scientific and Political Representation

### *Hobbes on the Subordination of Science to Politics*

One of the most intriguing theoretical efforts to link scientific and political representation appears in Hobbes argument for subordinating science to politics, which has often been read as quasi-totalitarian.[26] Part of this reading stems from Hobbes's insistence on a strictly procedural conception of representation. For Hobbes, the sovereign represents the people not because of any service it performs or substantive standards it fulfills, but merely because they have authorized it to represent them. Although the sovereign has a duty to God to promote the peace and safety of the commonwealth, it has no direct duty to the people themselves.[27] There is thus no substantive standard against which the people may judge whether or not the sovereign is adequately representing them.

Hobbes also insists, moreover, that political sovereignty must be absolute. Without a single, unified, and indisputable sovereign authority, Hobbes famously argues, citizens are liable to take their marching orders from the next best authority that comes along, whether political, religious, or scientific. Unlike civil or natural scientists, therefore, the sovereign must have sufficient power to enforce the laws it creates.[28] Although he entertains hopes of ending intellectual disputes through the careful definition

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[26] See Richard H. Popkin, "Hobbes and Scepticism I" and "Hobbes and Scepticism II," in *The Third Force in Seventeenth-Century Thought* (Leiden: E. J. Brill, 1992), 9-26, 27-49.

[27] See Thomas Hobbes, *Leviathan*, ed. Richard Tuck (Cambridge: Cambridge University Press, 1991), chaps. 17-18, 117-29, cited hereafter as *Lev*. See also Pitkin, *Concept of Representation*, chap. 2.

[28] Similarly, Hobbes notes that the conclusions of moral philosophy are not properly called laws, "for they are but Conclusions, or Theoremes concerning what conduceth to the conservation and defence of themselves; whereas Law, properly is the word of him, that by right hath command over others" (*Lev*, chap. 15, 111).

of words, in the end Hobbes argues that parties to a dispute must agree on a public arbitrator "to whose sentence they will both stand, or their controversie must either come to blowes, or be undecided, for want of a right Reason constituted by Nature; so it is also in all debates of what kind soever..." (*Lev*, ch. 5, 33).

Hobbes's reference to "debates of what kind soever" suggests that it does not matter whether the dispute is political, religious, or scientific.[29] Disputes in civil science, politics, and religion are more common than in natural science, but in principle, not even geometry, the most indisputable of sciences, is immune to political conflict:

> For I doubt not, but if it had been a thing contrary to any mans right of dominion, or to the interest of men that have dominion, *That the three Angles of a Triangle, should be equall to two Angles of a Square*; that doctrine should have been, if not disputed, yet by the burning of all the books of Geometry suppressed, as farre as he whom it concerned was able (*Lev*, ch. 11, 74).

Hobbes suggests a similar possibility when he lists the elements of human happiness which "we must learn (because CHRIST has not taught us) by reasoning" (*De Cive*, XVII.xii). Hobbes's list includes not only explicitly political matters, but also the principles of engineering, navigation, astronomy, the calendar, and "knowledge of natural and civil laws; and the sciences which go under the name of Philosophy" (Ibid.). He then asserts that "even errors about these Philosophical questions sometimes do cause public mischief, and give scope for great seditions and injuries" (Ibid.). Hobbes goes on to explain that whenever a dispute in one of these matters arises, agreement on the signification of words requires an independent arbitrator who has the authority to enforce its decision. The sovereign's authority extends to all spheres of activity relevant to civil

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[29] Richard Flathman (*Thomas Hobbes: Skepticism, Individuality and Chastened Politics* [Newbury Park, CA: Sage Publications, Inc. 1993], 144) considers the Hobbesian sovereign's regulation of religion, politics, morals, sexual behavior, marriage, divorce, child-raising, and diet--but not natural science.

peace, and only the sovereign can judge what is relevant (*De Cive*, VI.xi; *Lev*, ch. 18, 121).[30]

Moreover, the sovereign not only arbitrates scientific disputes, but may intervene even when scientists already agree on the signification of words. "For disobedience may lawfully be punished in them, that against the Laws teach even true Philosophy" (*Lev*, ch. 46, 474; see *Lev*, ch. 18, 124; *De Cive*, VI.xi). Like all other private associations, scientific associations must be subject to a common power that will punish members should the laws they create endanger the polity (*De Cive*, V.v-x).

Hobbes's subordination of science to the requirements of political order has led many commentators to find in Hobbes a "bizarre and authoritarian theory of truth" that anticipates Nazi science and Lysenkoism.[31] One potential barrier to such totalitarian conceptions of science appears in Hobbes's division between private science and public power. According to Michael Oakeshott, for example, Hobbes's sovereign is authoritarian but not totalitarian, because it controls only public expressions of belief, not private convictions.[32] The problem with this argument is that private scientists produce knowledge that affects the public. We saw in Chapter 3 that Hobbes believes true science, unlike religion, must always be public science. It cannot be restricted, therefore, to private belief. A stronger barrier against totalitarianism lies in the fact that Hobbes's

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[30] See also Hobbes's discussion of the need for the sovereign to determine whether or not "deformed" babies are to be considered human, and hence, the definition of what constitutes a human being (*De Cive*, XVII.xii).

[31] Richard Peters, *Hobbes* (Baltimore: Penguin Books, 1956), 57.

[32] Michael Oakeshott, "Introduction to *Leviathan*," in *Rationalism in Politics and Other Essays*, new and expanded edition (Indianapolis, IN: Liberty Press, [1962] 1991), 282-83.

sovereign not only arbitrates conflicts over scientific knowledge, but *authorizes* the scientific representation of natural phenomena.

### *Authorizing Nature's Representatives*

In the passage taken as an epigraph for this chapter, Hobbes distinguishes between those who represent "truly" and those who do so "by fiction." To represent truly requires authorization by those who are represented.[33] But in cases where this is not possible, representation may occur by fiction.

> There are few things, that are uncapable of being represented by Fiction. Inanimate things, as a Church, an Hospital, a Bridge, may be Personated by a Rector, Master or Overseer. But things Inanimate, cannot be Authors, nor therefore give Authority to their Actors: Yet the Actors may have Authority to procure their maintenance, given them by those that are Owners, or Governours of those things. And therefore, such things cannot be Personated, before there be some state of Civil Government (*Lev*, ch. 16, 113; cf. *DH*, XV.iv).

Inanimate objects, Hobbes here suggests, can only be represented by an overseer authorized by a "Civil Government." Hobbes goes on to explain that the representation of "Children, Fooles, and Mad-men that have no use of reason" occurs in a similar way. So does the representation of an "Idol, or meer figment of the brain...as were the Gods of the Heathen" (*Lev*, ch. 16, 113). In all these cases, because the people and things that are represented lack reason and will, they cannot authorize their representatives. Their representatives must be authorized by the sovereign.

Despite his insistence elsewhere on a strictly formal, procedural conception of representation, in the above passage Hobbes suggests that the representation of inanimate objects and incompetents cannot follow strictly formal criteria. Whereas Hobbes's

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[33] See Pitkin, *Concept of Representation*, 21-22.

sovereign represents merely because it was authorized by the people, the rectors and guardians who represent inanimate objects and incompetents do so "to procure their maintenance"--that is, they represent for the sake of a particular substantive task. An overseer whose bridge is impassable or whose hospital does not heal the sick is not a very good representative. This passage thus highlights the excessively formal character of Hobbes primary theory of representation.[34] It also suggests that the adequate representation of inanimate objects and incompetents requires, in addition to sovereign authorization, the fulfillment of substantive standards peculiar to each. Hobbes thus hints in these comments at a way of combining formal and substantive concepts of representation in both science and politics.

While Hobbes does not mention the scientific representation of nature in this context, natural entities are like Hobbes's other examples in that they also lack a rational will and so cannot authorize those who represent them. It thus seems possible to view the authorization of natural scientific representatives as analogous to the authorization of those who represent inanimate objects or incompetents.[35] From this perspective, natural

[34] In her discussion of the above passage, Pitkin asks why Hobbes says the representative represents the inanimate object rather than the third party who authorized him. She argues that Hobbes has no explicit answer for this question, because he defines representation in strictly formal terms of authorization, neglecting the need for representatives to fulfill substantive standards, and for those who authorize them to retain some degree of control over the representative's actions. Hobbes briefly goes beyond a purely formal concept of representation in only three places: in his comments on a stage actor's representation of a character in a play, in his claim that the sovereign has a duty to procure the "safety of the people," and in the above claim that representatives of inanimate objects must "procure their maintenance." In each of these cases, Hobbes refers to external standards the representative must fulfill, but these are not incorporated into his explicit theory of representation (*Concept of Representation*, 27-28, 33).

[35] In this respect, the entities represented by natural science belong to the class of persons, including the state itself, which Quentin Skinner has recently called "purely artificial persons." Skinner identifies four ways in which representatives can acquire the right to represent purely artificial persons, each of which involves some form of dominion over them ("Hobbes and the Purely Artificial Person of the State," *The Journal of Political Philosophy* 7 [March 1999]: 1-29, at 16-17). As I suggest below, scientists' right to represent nature proceeds from the state's dominion over nature, followed by the scientists'

scientists occupy a role similar to that of the various agents, counselors, and magistrates who act on the sovereign's behalf. While natural scientists do not assist with the administration of public business, we saw above that Hobbes thinks scientists necessarily play some role, usually inadvertent, in shaping public beliefs. And Hobbes plainly states, "They also that have authority to teach, or to enable others to teach the people their duty to the Soveraign Power...are Publique Ministers." As such, they teach "by no Authority, but that of the Soveraign" (*Lev*, ch. 23, 167). Natural scientists are public ministers insofar as their representations of nature become public knowledge. The potentially controversial status of their natural scientific representations means that natural scientists must represent nature only by sovereign authorization.

One might object to this analogy between the representation of nature and Hobbes's other examples with the claim that, although scientists represent natural phenomena, they do not, unlike the rector of a hospital or the guardian of a child, "procure their maintenance." Indeed, if scientists are thought to represent unchanging, pre-existing natural entities, scientists would have no need to "procure their maintenance." It would also go against Hobbes's mechanistic ontology to say that scientists need to maintain natural phenomena for the sake of some identifiable purposes, such as those of a hospital or a bridge. From Hobbes's perspective, it makes no sense to speak of doing something for the sake of natural entities.

At this point, however, we need to remember that Hobbes thinks creating natural scientific knowledge requires the use of laboratory experiments. Although he rejects

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authorization by the state, and also from scientists' own dominion over the laboratory entities they create themselves.

Boyle's claim that natural science should rely solely on experiments, Hobbes recognizes the need for laboratory techniques to isolate discrete phenomena from the undifferentiated natural world. Such laboratory techniques create partially artificial phenomena for purposes no less distinct than those of hospitals and bridges. In this respect, natural scientists might be said to "procure the maintenance" of laboratory phenomena for the purpose of laboratory experiments.[36]

Another possible objection to the above analogy would be to say that the sovereign does not need to authorize natural scientific representatives, because they are already authorized by God. Indeed, Hobbes clearly states that God is the "Author of Nature," as well as its creator and governor (*De Corp*, XXV.i; *Lev*, Intro., 9). But in a Hobbesian commonwealth, although God may be the author of nature, God cannot be the author of natural scientific representatives. God makes only raw, complex, teeming nature, not the isolated laboratory phenomena that scientists represent. Moreover, making God the author of scientific representatives would inevitably produce conflict between scientists and the sovereign. Scientists would draw on God's authority to combat the sovereign. Scientists cannot authorize themselves for the same reason. This leaves only the sovereign as the third party that can authorize scientific representatives of laboratory phenomena. Indeed, Hobbes's reverent depiction of the sovereign as a "*Mortall God*" indicates a conceptual parallel between the sovereign's authorization of

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[36] For Hobbes, both the observation of "natural signs" and the laboratory production of "arbitrary signs" are elements of experience (*Elements*, I.iv.6). As such, they can provide only natural history, not science, for "Experience concludeth nothing universally" (*Elements*, I.iv.10). Nonetheless, Hobbes repeatedly recognizes the need for natural science to reconstruct natural phenomena in the laboratory. While he often exalts the benefits of deductive reasoning, he does not think it can replace experiment, but only complement it (see *Lev*, chap. 6, 36-37). I have examined this issue in detail in "Thomas Hobbes, Natural Science, and the Sovereignty of Politics," unpublished manuscript.

those who represent laboratory phenomena and God's authorization of raw nature (*Lev*, ch. 17, 120). The sovereign does for natural scientific representatives what God does for nature itself.[37]

This account of Hobbes's theory of representation can help clarify the nature and sources of scientific authority. On the one hand, and in contrast to the procedural emphasis of most of his comments on representation, Hobbes's discussion of inanimate objects suggests that scientists' representative authority derives in part from the fulfillment of substantive standards. Just as the overseer of a hospital or a bridge must "procure their maintenance" by fulfilling substantive standards peculiar to hospitals and bridges, scientists must fulfill standards peculiar to science. These substantive standards are best established by scientists themselves, as long as they pose no threat to the commonwealth.

On the other hand, Hobbes also suggests that scientific representation has a procedural element--formal authorization by the sovereign--and that scientific authority cannot be cleanly separated from political authority. In this respect, Hobbes shares Latour's concern with the political dimensions of scientific representation. But whereas Latour focuses on scientists' efforts to build alliances with other actants from the ground up, Hobbes suggests that scientists must be authorized by a sovereign political authority from the top down. As we saw above, Hobbes suggests two reasons for the sovereign authorization of scientific representatives: because natural entities cannot authorize their own representatives and because scientists' representations of nature often have political

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[37] According to Clifford Orwin ("On the Sovereign Authorization," *Political Theory* 3 [February 1975]: 26–44, at 34-38), the popular authorization of the sovereign serves principally to make citizens immune from divine sanction for their actions. This immunity presumably applies also to the representative activity of natural scientists.

consequences. Again, Hobbes offers no reason to suppose that the sovereign need interfere in the ongoing creation of scientific representations. Like the sovereign itself, once scientists receive their authorization, they are free to represent their "constituents" as they see fit, subject only to the substantive standards peculiar to their discipline. But Hobbes's writings also suggest, in contrast to Burke's, that because scientific representations of nature often have political implications, science requires ongoing political oversight to ensure that it does not threaten the commonwealth. While certainly no democrat himself, Hobbes's philosophy of science suggests that in a democratic society, where the people are sovereign, science must be subject to some form of *popular* authorization.

### The Boundary between Scientific and Political Representation

Although I have emphasized the intersections between scientific and political representation, it remains important to distinguish between them. According to Feenberg, in a comment on technology that is also relevant also for science,

> If technology is political and its design a kind of legislation, then surely it must represent interests much as do ordinary political decisions and laws. But technical representations will be different from the kinds of electoral representation with which we are familiar just to the extent that the medium of technology is different from law.[38]

Feenberg goes on to argue that the difference between technical and political representation lies in the greater *reliability* and *stability* of the "legislation" adopted by technical representatives, as compared to that sponsored by their political counterparts.

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[38] Feenberg, *Questioning Technology*, 137.

> Technical representation is not primarily about the selection of a trusted personnel, but involves the embodiment of social and political demands in technical codes. These codes crystallize a certain balance of social power. The problem of the loyalty of the representative is far less significant in technical than geographic representation. This is because entry into a technical profession involves socialization into its codes. A specialist who failed to represent the interests embedded in the code would be a technical failure as well. No similar check on personal idiosyncrasy and self-interest applies in the world of ordinary politics.[39]

Feenberg's reference here to the "the selection of a trusted personnel" captures only the substantive side of political representation. But he rightly points out that the failure of technical representatives to adequately represent their constituents—i.e., their failure to correctly operate a machine or to accurately predict and control the behavior of natural entities—has immediate practical consequences: things stop working. The constituents of political representatives are far more forgiving.

Similarly, whereas political representatives can be exchanged for others fairly easily, the social costs of technical failures are too high to simply discard technical personnel or artifacts that do not adequately represent the public. We cannot simply throw out all the technologies that were designed without sufficient public input or consideration of public needs. As we saw in Chapter 2, the ideology and infrastructure of automobility has been literally built around the gasoline car and it will take time to make it more representative of public needs. Changes in technical representation usually come about much more gradually than in political representation, through changes in technical procedures, knowledge, artifacts, and the values they embody.

Another important distinction between political and scientific representation lies in the different routes to legitimacy pursued by scientists and public officials. Public

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[39] Feenberg, *Questioning Technology*, 142-43.

officials must avoid yoking their policies too tightly to the recommendations of scientific experts, else they forfeit the legitimacy derived from formal authorization by lay citizens. Scientists must avoid becoming too closely identified with a political cause, else they sacrifice their perceived objectivity and public authority. Although scientists and public officials often form alliances with each other in pursuit of their respective goals, they each rely more on alliances within their respective spheres of legitimation.

Finally, the above analysis suggests that scientific and political representation also have distinctive ideals. The ideal of a distinctly political form of representation is to balance substantive and procedural modes of representation. Political reprsentatives must be simultaneously independent of their constituents' whims and responsive to their expressed demands. In science, in contrast, the ideal is to move from subjective to objective modes of representation. All scientist-delegates seek to become scientist-trustees, and to eventually abandon even the role of trustee and allow the facts they created to speak for themselves.

In sum, political and scientific representation are neither exactly the same, as Latour provocatively claims, nor categorically different, as the Enlightenment image suggests. When scientific propositions achieve the status of objective knowledge, they "stand for" nature. And when science leads to economic growth, consumer products, defense technologies, or a better understanding of nature, scientific knowledge also "stands for" whatever public need exists for those things. When scientists discern the objective qualities of nature, and when they produce knowledge that serves the objective public interest, they "act for" nature and the public in the sense of Burkean trustees. And finally, when scientists collect laboratory evidence, and adopt procedures that reflect the values and interests of lay citizens, scientists "act for" nature and the public in the sense of Rousseauean delegates.

If these lay values and interests are to be not merely assessed from above, but expressed by citizens themselves, political representation by scientists requires some form of public participation in the making of science. As one author has recently argued, "If we must have a charter for the use of politicised expertise, there must also come a vision of democratic science and technology that allows choice on grounds other than strictly technical." This will require "democratic representation and pluralism in model-building and debate."[40] The next chapter evaluates recent practical efforts to achieve exactly this sort of democratic representation in both science and technology.

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[40] Roy MacLeod, "Science and Democracy: Historical Reflections on Present Discontents," *Minerva* 35 (1997): 369-384, at 384.

# CHAPTER 7

# TOWARD A DEMOCRATIC SCIENCE AND TECHNOLOGY

Actively to participate in the making of knowledge
is the highest prerogative of man and
the only warrant of his freedom.
– John Dewey

You don't need a weatherman to know
which way the wind blows.
– Bob Dylan

If we think of scientists as public representatives, and their representative activity in not only substantive but also procedural terms, it follows that democracy requires some kind of public involvement in science. Such involvement, after all, is far from new. The United States Constitution (Art. I, Sect. 8) specifically grants Congress the power to "promote the Progress of Science and the useful arts," by securing intellectual property rights. The California ZEV program has been an especially successful effort in this regard: in 1989, the year before the program began, the US Patent Office granted just two patents for EV technology; in 1995, it granted 200 patents.[1] Public involvement in science takes many other forms, however, and it will be helpful to distinguish between involvement in the *context* of science (e.g., policies on the overall level and relative priority of public funding for science, restrictions on particular research areas, etc.) and involvement in the *content* of science (e.g., political influence on scientific theories or methods). We might also distinguish between *governmental* and *popular* political

[1] Shnayerson, *The Car that Could*, 254.

involvement in science. My primary concern in this chapter is to make a case for the importance and basic feasibility of popular involvement in the content of science.

I describe such involvement as a matter of *bringing democracy into science and technology*, and distinguish it from the problem of *bringing science and technology into democracy*.[2] Whereas the former concerns a relatively recent extension of democratic politics into scientific practice, the latter involves the ancient problems of technocracy and popular competence. I briefly examined the case against technocracy in Chapter 4, and also touched on criticisms and defenses of popular competence. Building on those discussions, the first half of this chapter examines different conceptions of science education. I argue that bringing science into democracy in the form of science education, if approached in a certain manner, can foster efforts to bring democracy into science. The discussion of science education is followed by an analysis of some of the leading arguments for and against any sort of political infringements on the autonomy of science. The last section evaluates some of the possibilities for popular involvement in shaping the content of science and technology.

There is, of course, a long history of efforts to shape, control, or just simply stop science and technology. In recent years, local community organizations, often maligned as NIMBYs ("Not-In-My-Backyard"), have taken action against the siting of waste dumps, nuclear reactors, chemical plants, and other hazardous industrial facilities. Consumer organizations have sought improvements in the safety of products and food

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[2] See Frank Laird, "Participating in the Tension," symposium on the compatibility of science and democracy, *Social Epistemology* 7, no. 1 (1993): 35-46. Laird's article responds to Guston, "The Essential Tension." Bohman notes that pragmatism combines the Progressive aim of increasing the rationality of political decision making with the radical democratic aim of increasing public participation in the exercise of power ("Democracy as Inquiry, Inquiry as Democratic," 603).

additives. Patients' rights organizations have attempted to gain greater access to medical information and greater control over their own medication. Parents have formed organizations to distribute information and influence policy on issues as various as immunizations and science textbooks. Some of these grassroots efforts have grown into full fledged movements, while others have remained disjointed and relatively powerless.

Public concern over science and technology has often arisen in response to the perceived failure of established political organizations and institutions to protect ordinary citizens from technical risks. Grassroots groups have often built directly on their lived experience with science and technology. In this respect, efforts to democratize science have often emerged in response to what I described in Chapter 5 as the disciplinary power of scientific knowledge, its role in shaping conceptions of personal identity. The realization that who one is depends in part on what one knows and the tools one uses has motivated many citizens to try to influence the making of science and technology.[3]

At the same time, however, the daily experience of science and technology is often highly mediated by science itself. Except in cases of gross health and environmental damage, or obvious changes in human relations brought about by new technologies, citizens often rely on science and technology to inform them of the social effects of science and technology. Air pollution, for example, as mentioned before, may be visible to the naked eye, but its health and environmental consequences are not. And as we saw in the ZEV case, environmental organizations have learned the value of expertise in soliciting public support and persuading governments to address technical

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[3] Brian Wynne, "Misunderstood Misunderstandings: Social Identities and the Public Uptake of Science," in *Misunderstanding Science?*, ed. Irwin and Wynne, 19-49.

problems. Public participation in the construction and use of science and technology provides one way for citizens to respond to this paradoxical dependence on the very things they seek to change by.

One might note at the outset that, generally speaking, public participation is both more widely demanded and easier to realize with regard to technology than science. Although natural science is no less "constructed" than technology, it tends to become much more independent of public influence.[4] This does not mean that citizens ought to leave science to the scientists. In a 1976 survey, when respondents were asked whether it is more important to control science or technology, 59 percent said that both should be controlled equally, and only 20 percent said neither require any social control at all.[5] It is necessary to create avenues for some form of public participation in the shaping and control of both science and technology, but given their differences, the forms and degree of participation may differ.

**Bringing Science and Technology into Democracy**

The place of science and technology in a democratic society is complex and multifaceted. It appears in the use of scientific knowledge to design and legitimize public policies, as examined in Chapter 2. It is bound up with the benefits and burdens of liberal-democratic instrumentalism, discussed in chapters 3 and 4. It sometimes takes the form of a predictive science of politics, touched on in Chapter 5. It may involve the transformations wrought by new technologies in the material and intellectual

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[4] Feenberg, *Questioning Technology*, 90.

[5] Opinion Research Corp., *Attitudes of the U. S. Public Toward Science and Technology*, Study 3 (1976), 51, cited in Nelkin, "Science and Technology Policy and the Democratic Process," in *Citizen Participation in Science Policy*, ed. James C. Petersen (Amherst: University of Massachusetts Press, 1984), 2-39, at 20.

infrastructure of daily life, also discussed in Chapter 5. And as I show below, it appears in ongoing debates about what STS scholars have come to call "the public understanding of science."[6]

The public understanding of science—which is by no means uniform across all members of "the public"—is affected by a variety of factors, including formal education, personal experience, and the portrayal of science in the mass media.[7] Research on "science communication," for example, has sought ways for scientists to inform the public of their work in a manner that is both accurate and comprehensible.[8] And to some extent, the public understanding of science is bound to progress regardless of efforts to advance it. As Brian Martin argues, technical literacy has grown in tandem with the technical capacities of society.

> People today are far more educated and aware of technology and its impact than in previous eras. The rise of printing, mass literacy and the mass media has given many more people the capacity to understand and speak out about what is happening in society. It would hardly be possible to bring about a technological society without also creating the capacity of ever more people to comprehend and criticise it.[9]

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[6] See Alan Irwin and Brian Wynne, "Introduction," in *Misunderstanding Science? The Public Reconstruction of Science and Technology* (Cambridge: Cambridge University Press, 1996).

[7] See Dorothy Nelkin, *Selling Science: How the Press Covers Science and Technology* (New York: W. H. Freeman and Co., 1987).

[8] See Douglas Powell and William Leiss, *Mad Cows and Mother's Milk: The Perils of Poor Risk Communication* (Montreal and Kingston: McGill-Queen's University Press, 1997). Science communication was especially important to Dewey, who saw it as the flip side of teaching citizens to think more scientifically. The social sciences, especially, he argued, must do more than merely comprehend events after they have occurred. He believed that "a genuine social science would manifest its reality in the daily press" (*PP*, 180).

[9] Brian Martin, "Introduction," in *Technology and Public Participation*, ed. Brian Martin (Wollongong, Australia: Science and Technology Studies, University of Wollongong, 1999), available at http://www.uow.edu.au/arts/sts/TPP.

This sort of "natural" expansion of citizen capacities occurs as part of the ongoing mutual constitution of science and society discussed in Chapter 5.

There is still a need, however, for explicit efforts to improve the public understanding of science. Indeed, both defenders and critics of democracy have long argued that the competence of lay citizens has fundamental implications for the viability of democratic politics, even if they disagree on what "competence" entails. As we saw in Chapter 3, the notion of an informed and competent citizenry has long been used to integrate some citizens in liberal-democratic communities while excluding others. And today calls for improved science education come from both those who would engender a passive popular faith in scientific authority and those who aim to empower laypeople to participate in the shaping and control of science and technology. Moreover, both critics and defenders of democratizing science argue for improving citizens' awareness of the key role of science in areas of political life such as public policymaking, national security, and economic growth. The difference lies in the different types of science education they advocate, and in their different assessments of the political implications of improving the public's understanding of science.

In the following, I use the term "science education" to refer to not only formal education, but the whole range of influences on the public understanding of science. I argue that science education must take a distinctly civic form—rather than vocational or philosophical—before it can facilitate popular political participation in science and technology.[10] This requires distinguishing between three distinct areas of scientific

[10] For the distinctions between civic, philosophical, and vocational models of education, see Barber, *An Aristocracy of Everyone*, 201-217.

literacy: 1) substantive scientific facts and theories; 2) scientific methods; 3) relationship between science and society. While an understanding of each of these can help citizens better address the politics of science and technology, a civic approach toward science education will emphasize citizens' capacity to understand and intervene in the ongoing mutual constitution of science and society.

*Science Education*

The notion that democratic citizenship depends on substantive scientific knowledge has a long pedigree. Thomas Jefferson's "Bill for a More General Diffusion of Knowledge," which he called "by far the most important bill in our whole code," sought to establish a system of public education that would not only identify the "natural aristocracy" of white male civic leaders, but would provide basic education for "all free children male and female" at public expense.[11] Jefferson's frequent proposals for dividing counties into self-governing wards also gave high priority to public education, especially science education, as a necessary condition of democratic government.[12]

A century later, Dewey also argued that citizens require some measure of substantive scientific knowledge. Dewey did not think every citizen needs to become a scientist, but Dewey agrees with the democratic realists that social problems today can only be understood with the aid of science, not by common sense alone. Most importantly, science provides the understanding of material conditions indispensable for moral reasoning. Ethics and science each impose conditions on the other, Dewey argued,

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[11] Jefferson, "Bill for the More General Diffusion of Knowledge," in *Writings*, 365, 367.

[12] See Jefferson to George Wythe, 13 August 1786, *Writings*, 859; Jefferson to Samuel Kercheval, 12 July 1816, *Writings*, 1395-1403; Jefferson to Major John Cartwright, 5 June 1824, *Writings*, 1492.

so the traditional division between them hinders both scientific and ethical inquiry. "For moralists usually draw a sharp line between the field of the natural sciences and the conduct that is regarded as moral. But a moral that frames its judgments of value on the basis of consequences must depend in a most intimate manner upon the conclusions of science" (QC, 219). Without some understanding of the material conditions within which moral ideals manifest themselves, moral reasoning becomes a purely intellectual exercise.

Dewey's critics have often thought that by saying moral questions should be treated "scientifically," Dewey means that moral ideals can be conclusively determined by science. Dewey's claim, however, is that a scientific treatment of morality entails investigating the probable consequences of holding different moral ends. Without some sense of the consequences a particular moral value might entail, people are likely to select their goals according to impulse or habit. For this reason, "science must have something to say about *what* we do, and not merely about *how* we may do it most easily and economically."[13] Following Aristotle, Dewey argues that citizens must not expect very much certainty or precision from efforts to evaluate the consequences of moral ideals. But consideration of empirical consequences prevents moral reasoning from becoming tyrannical, forcing it to consider the physical and social constraints on practical action. Isolating moral and scientific inquiry from each other, in contrast, makes morality abstract and irrelevant to concrete affairs, and directs science toward the narrowly instrumental purposes of commerce and warfare.[14] For Dewey, citizens can only make

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[13] Dewey, "Science as Subject-Matter and Method" (1910), in *The Middle Works* Vol. 6, ed. Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1985), 78-79. See also Westbrook, *John Dewey*, 171n19.

[14] "When we take means for ends we indeed fall into moral materialism. But when we take ends without regard to means we degenerate into sentimentalism" (Dewey, *RP*, 121).

effective moral judgments if they can draw on the storehouse of knowledge produced by the natural and social sciences.

Beyond his concern for individual citizens' understanding of scientific facts, Dewey argues that if the design of political institutions incorporates the newest scientific knowledge, citizens will benefit without needing to understand the science themselves. Not unlike the advocates of participatory policy design discussed in Chapter 2, Dewey asks, "Can the intelligence actually existent and potentially available be embodied in that institutional medium in which an individual thinks, desires and acts?" (*LSA*, 50). Should this be accomplished, "the average individual would rise to undreamed heights of social and political intelligence" (Ibid.). Democracy does not depend on a society of experts, "but upon the fact that native capacity is sufficient to enable the average individual to respond to and use the knowledge and the skill that are embodied in the social conditions in which he lives, moves, and has his being" (*LSA*, 38; *PP*, 210).[15] These sentiments echo the American Founders' notion that a "science of politics" could be used to design political institutions so as to avoid the cycles of revolution suffered by past societies.

Unlike many of the American Founders, however, with the notable exception of Jefferson, Dewey thought intelligent institutions require a relatively intelligent public to operate them. In this respect, Dewey is closer to John Stuart Mill than the authors of *The Federalist*. Whereas the former believed good government depends on the continual improvement of the citizenry, the latter hoped to design a system of government that

[15] Dewey would be amused by a recent series of magazine advertisement for STMicroelectonics, a leading producer of semiconductors for consumer products, showing pictures of children using cell phones, the internet, and video games, with the captions, "Talk with more intelligence," "Listen with more intelligence," and "Play with more intelligence." The company's motto is "We put more intelligence into everything" (United Airlines, *Hemispheres Magazine* (January 2000): 25-28.

would channel the "mischief of faction" without relying on civic virtue. History seems to have vindicated Dewey and Mill, insofar as the increasing disjunction between the technical capacities and technical understanding of lay citizens has become a growing source of public anxiety and powerlessness. The apparent intractability of this disjunction leads some to promote technocracy. It leads others to advocate forms of science education that emphasize the learning of scientific method over substantive scientific knowledge.

As we saw in Chapter 3, education in the method of modern science has often been seen as a way of inculcating the norms and dispositions of character conductive to democratic citizenship. Karl Pearson, for example, in his influential 1892 book, *The Grammar of Science*, advocated education in scientific method for nonscientists as a form of moral instruction. "The importance of a just appreciation of scientific method is so great, that I think the state may be reasonably called upon to place instruction in pure science within the reach of all its citizens."[16] Pearson was careful to note that not all scientists are good citizens, and that his argument concerned the basics of scientific method, not scientific knowledge or the practice of science as such. "Modern Science, as training the mind to an exact and impartial analysis of facts, is an education specially fitted to promote sound citizenship."[17]

Similarly, Dewey was less concerned about ordinary citizens' substantive scientific knowledge than about their ability to adopt what he saw as a scientific method of thought. The experimental approach to ethics and politics, discussed above, is not

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[16] Karl Pearson, *The Grammar of Science* (New York: Meridian Books, [1892, 1900, 1911] 1957), 7.

[17] Pearson, *The Grammar of Science*, 9.

merely for professional social scientists or technocratic administrators, but for the citizenry at large. The experimental approach, that of "intelligence," refers to a general "way of knowing in a world without certainty" (CHECK). It is "associated with *judgment*; that is, with selection and arrangement of means to effect consequences and with choice of what we take as our ends" (*QC*, 170). Dewey thus criticizes educational programs that expect pupils "to learn a 'science' instead of learning the scientific way of treating the familiar material of ordinary experience" (*DE*, 220).[18] Science teachers, rather than forcing their students to memorize scientific facts and theories, should "cultivate the habit of suspended judgment, of skepticism, of desire for evidence, of appeal to observation rather than sentiment, discussion rather than bias, inquiry rather than conventional idealizations."[19]

Dewey's notion that science education should emphasize skills over information was taken up by various educational reformers, and to his dismay was often distorted into the claim that students should not be required to learn any information at all. For the most part, however, Dewey's and Pearson's distinctly political conception of science education has failed to take root. Like education more generally, science education tends to be conceived as a matter of mere information transfer, or vocational training for budding scientists, rather than as a form of civic education that would enable citizens to collectively respond to the role of science in their lives.[20]

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[18] See also "Science as Subject-Matter and as Method," 69-79.

[19] Dewey, "Education as Politics," quoted in Westbrook, *John Dewey*, 313.

[20] Irwin and Wynne, "Introduction," in *Misunderstanding Science?* 1-17.

A somewhat broader conception of science education appeared in recent US congressional hearings on the topic.[21] Participants argued that improving public understanding of science would increase citizens' work performance and cultural competence, as well as their capacity to make informed decisions on matters of both personal welfare and public policy. They also noted that as science education makes the general public more technically competent, the pool of people from which legislators are chosen will become more qualified to handle the challenge of governing a technically complex society. Several practicing scientists argued, rather shamelessly, that improved science education can be expected to increase popular support for government funding of large-scale research.

While there is much to be said for improving the public's understanding of scientific facts and methods, and for using science in the design of public institutions, these recommendations often assume the Enlightenment conception of science much of the public has come to reject. They tend to see the relationship between science and the public as a one-way street, neglecting the potential influence of public norms and interests on scientific research.[22] Similarly, most efforts at science education tend to denigrate lay knowledge, common sense, and folk wisdom, supposing that these constitute not alternative forms of knowledge, but barriers to be overcome on the way to an educated citizenry.[23] They often proceed from the assumption that science is a

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[21] See United States House of Representatives, 105th Congress, 2nd Session, Committee on Science, Hearings on the National Science Policy Study, Part IV: "Communicating Science and Engineering in a Sound-Bite World," May 14, 1998.

[22] See Shapin, "Science and the Public," 990.

[23] See Susan E. Cozzens and Edward J. Woodhouse, "Science, Government, and the Politics of Knowledge," in *Handbook of Science and Technology Studies*, ed. Jasanoff et al., 533-53.

uniquely rational, logical, or rule-oriented mode of thought.[24] As we saw in Chapter 5, however, little more distinguishes scientific from non-scientific thought than the former's refinement through laboratory testing. In these respects, calls for popular science education tend to support technocratic rather than democratic relations between science and politics.

The electric vehicle case examined in Chapter 2 provides a clear example of this view of science education. Although the agency made some effort to educate the public about the technical merits of EVs, it did little to help citizens place the EV's technical capacities in a social context. Even in the early years of the program, the agency focused on imparting information about the environmental benefits of EVs, saying little about how the technology could be expected to transform people's lifestyles. Nor did CARB attempt to explain the EV's potential civic benefits. To be sure, some staff members clearly see the need for greater public education efforts. One manager of the ZEV program, for example, said that "we're going to need the support—and not even the support, but the understanding of the public—because we're reaching into every aspect of their lives."[25] But the agency has been slow to transform such insights into public policy. Given the lifestyle changes bound up with EVs, the creation of a large EV market will depend in part on a conception of science education that goes beyond a top-down model. Efforts to educate citizens about EVs will need to respond to the concerns citizens

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[24] Fuller, *Governance of Science*, 45–46. Moreover, as Fuller points out, the mass public has long proven itself competent to engage in at least one area of activity requiring adherence to complex procedures and the analysis of large quantities of statistical information: professional sports (Ibid., 148). Fuller goes on to offer suggestions as to how science might be made more like sports, so as to elicit greater interest and participation from the public. These include clear public accounting procedures that would allow the public to follow the "box scores" of different research establishments, competitive incentives for research productivity, and public debate on the comparative societal value promised by different field of research.

[25] Bevan, Interview by author.

express about how EVs can be expected to change their daily lives. This might be nothing more than good marketing, but it might also go beyond marketing to include an expansion of citizen capacities to become involved in the shaping of transportation options.

In this respect, the agency might take a lesson from the continuing history of efforts to develop a more participatory model of science education. A wide variety of public interest organizations, including the Highlander Center, the Union of Concerned Scientists, the Center for Science in the Public Interest, the Public Interest Research Groups, and the Dutch "science shops," have developed various forms of "participatory expertise."[26] In one way or another, they seek to provide lay citizens with technical expertise specifically directed toward problems identified by the citizens themselves. Unlike traditional science education, participatory expertise begins with a phenomenological perspective on science and technology, emphasizing citizen's everyday experience and the problems and potential solutions that emerge from it. Participatory expertise also rejects the didactic approach of traditional science education. It instead treats expertise as a political resource that citizens require to effectively voice their political concerns. While participatory expertise has been developed in the context of efforts to assist people who lack political power, it need not be identified with any particular political ideology. The aim is for researchers and clients to collaborate in the development of general knowledge that clients can use to address their concerns.[27]

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[26] See Frank Fischer, "Citizen Participation and the Democratization of Policy Expertise: From Theoretical Inquiry to Practical Cases," *Policy Sciences* 26 (1993): 165-87; *Technocracy and the Politics of Expertise*, chap. 14. On the general need of lay citizens for scientific advisors, see Joel Primack and Frank von Hippel, *Advice and Dissent: Scientists in the Public Arena* (New York: New American Library, 1974).

[27] Fischer, *Technocracy and the Politics of Expertise*, 373-74.

In these respects, participatory expertise points to a model of science education that does not emphasize substantive scientific knowledge, scientific method, or institutional design, but rather some amalgam of knowledge and skills that would enable citizens to help manage the ongoing mutual constitution of science and politics. I examine this alternative model of science education in more detail below. It will make more sense in the context of the second problem of this chapter, bringing democracy into science an technology.

## Bringing Democracy into Science and Technology

Efforts to democratize science and technology face a number of important conceptual and practical challenges. They can be roughly categorized, as noted above, according to whether they concern efforts to control the context or shape the content of science and technology. The remainder of this chapter first examines some of the leading arguments for and against each of these forms of political intervention in science and technology. It then turns to a discussion of popular participation in both the control and shaping of science and technology.

### *Arguments against Political Intervention in Science and Technology*

Calls for the political control of science and technology, whether by lay citizens or public officials, face both powerful counter-arguments and practical obstacles. If the technocratic conception of science is supported by both entrenched class interests and the tradition of liberal-democratic thought, as suggested in previous chapters, it will be difficult to dislodge it. Additionally, there are several specific arguments commonly voiced against proposals for political intervention in science and technology.[28] As we shall see, each of these arguments has significant shortcomings in light of the constructivist conception of science elaborated in the previous two chapters.

One of the oldest justification for technocratic politics, still quite powerful, is the claim of epistemological exceptionalism: science deserves political autonomy because the scientific community is defined by its distinctively apolitical mode of pursuing truth, and the pursuit of truth is good in itself. Don K. Price thus argued that science and politics can be conceived as the endpoints of a "spectrum from truth to power," with the professions and the bureaucracy located in the middle. These four "estates," Price wrote, "are by no means sharply distinguished from one another," but "the closer the estate is to the end of the spectrum concerned with truth, the more it is entitled to freedom and self-government...."[29] In a similar vein, Michael Polanyi compared the scientific community to an economic market, in which scientists select problems and methods in order to produce as much truth as possible from the available intellectual and material resources.[30] Individual scientists adjust their efforts in response to the results achieved by other scientists, producing an aggregate result unanticipated and unattainable by any individual working alone. Political control of science, then, like political control of the market, promises only to disrupt this sublime process of mutual adjustment, thus hindering

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[28] This section draws on the discussion of four claims to scientific exceptionalism--epistemological, Platonic, sociological, and economic--in Bruce Bimber and David Guston, "Politics by the Same Means: Government and Science in the United States," in *Handbook of Science and Technology Studies*, ed. Jasanoff et al., 554-71

[29] Don K. Price, *The Scientific Estate* (Cambridge: Harvard University Press, Bellknap Press, 1965; London: Oxford University Press, 1968), 135, 137. For a discussion of Price's four estates, see Guston, *Between Politics and Science*, 1-3.

[30] Michael Polanyi, "The Republic of Science: Its Political and Economic Theory," *Minerva* 1, no. 1 (Autumn 1962): 54-73.

scientific progress. This argument is sometimes even parlayed into the claim that scientific inquiry is an implicit human right, similar to the use of private property.

Another common objection to political control of science rests on the democratic-realist claim, discussed in Chapter 4, that public officials and lay citizens lack the necessary expertise to make intelligent decisions about science. How can someone with no understanding of science presume to determine which areas of research deserve funding priority, or worse, presume to pass legislation banning particular research procedures? Current policy issues are too complex to be understood by the masses, so scientists should rule, if not society at large, then at least themselves.

Scientists' claim to self-rule is supported by the notion that science has a unique set of social norms that allow it to govern itself. The Mertonian "ethos of science," it is often said, leads the vast majority of scientists to act responsibly, and peer review takes care of the rest. This idealized notion of the scientific community, we saw in Chapter 3, has had a powerful symbolic value in supporting the norms of cooperative inquiry and instrumental action central to liberal-democratic ideology.

Perhaps the most common objection to political control of science is based on the threat of *apraxia* or practical failure.[31] It is thus commonly argued that democratic control over science will inhibit the productivity of scientific research. This argument is closely related to the claim that the societal need for economic growth requires that science remain political autonomous. As noted previously, the implicit postwar social contract for science asserted that lay citizens would give up their right to control science and technology in exchange for various technological benefits.

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[31] Winner, *Autonomous Technology*, 185-87

Finally, one might consider, with the critics of technical rationality discussed in Chapter 4, whether public participation in the shaping or control of science and technology promises only to hasten the rationalization of society. It is true, as noted previously, that developments in science and technology constrain citizens in new ways even as they open up new possibilities for creative action. Those with computer access can today communicate more quickly with more people than ever before; but they also find themselves starting each day by obsessively checking their email rather than enjoying breakfast with the family. In this respect, public participation in science and technology threatens to enlist lay citizens in the "disciplinary regimes" propagated by technical artifacts.

Such regimes, however, have thus far developed largely without conscious control. They have not been driven by natural imperatives, but they have emerged without much little public consideration of possible consequences or alternative options. Through public participation, I argue in the next section, citizens can begin to shape these sociotechnical regimes to their own purposes. They can start turning what has been a sociological construction into a political one. Precisely because the Weberians are right that sociotechnical networks tend to expand, these networks are subject to at least some degree of conscious direction. As Feenberg puts it, "Even as technology expands its reach, the networks are themselves exposed to transformation by the individuals they enroll."[32] Because our lives are so bound up with science and technology, in changing the former we inevitable affect the latter.

[32] Feenberg, *Questioning Technology*, 128.

*Arguments for Political Intervention in Science and Technology*

The notion of science and technology as disciplinary regimes, presented in Chapter 5, and the conception of scientists as public representatives, elaborated in Chapter 6, point to several specific arguments in favor of the political control of science and technology. Put together, these arguments make a powerful case for some form of political intervention in science and technology.[33] They each apply to both popular and governmental efforts.

First, as suggested before, if science and technology continually transform the lives of individuals and communities, the norms of democracy suggest that citizens must take it upon themselves to exert some measure of control over these transformations. In this respect, the political control of science and technology might be understood as a civic right, justified by the venerable principle of "no taxation without representation." Government funding pays for a large portion of scientific research, and citizens have a right to some degree of control over how their money is spent. Moreover, the enforcement of this civic right helps preserve the health and safety of the entire polity. Indeed, the civic right to exercise some measure of control over science and technology

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[33] On justifying the popular political control of science and technology, see Daniel Lee Kleinman, "Beyond the Science Wars: Contemplating the Democratization of Science," *Politics and the Life Sciences* 16, no. 2 (Sept. 1998): 133-45; Richard E. Sclove, *Democracy and Technology* (New York: Guilford Press, 1995); Alan Irwin, *Citizen Science: A Study of People, Expertise, and Sustainable Development* (London: Routledge, 1995); Frank N. Laird, "Participatory Analysis, Democracy, and Technological Decision Making," *Science, Technology, & Human Values* 18, no. 3 (Summer 1993): 341-361; Langdon Winner, ed., *Democracy in a Technological Society* (Dordrecht: Kluwer, 1992); Malcolm L. Goggin, "Science and Technology: Who Should Govern?" in *Governing Science and Technology in a Democracy*, ed. Malcolm L. Goggin (Knoxville: University of Tennessee Press, 1986), 37-56; Petersen, ed., *Citizen Participation in Science Policy*; Halsted R. Holman and Diana B. Dutton, "A Case for Public Participation in Science Policy Formation and Practice," *Southern California Law Review* 51 (1978):1505-34.

has long trumped the individual right of free inquiry asserted by defenders of scientific autonomy.[34] The defenders of scientific autonomy are right to claim that scientific knowledge is a public good, but that does not mean it always trumps other public goods.[35] Moreover, claims for scientific autonomy obscure the question of who benefits most from science, who has resources necessary for taking advantage of science, and who suffers the social costs of science.[36] Ensuring some measure of equity in the social distribution of science's benefits and burdens requires some measure of political control of science.

Second, political control of science and technology provides both an incentive for and source of public education. We saw in Chapter 3, and again above, that science has long been thought to depend on individual virtues congruent with those of democratic citizens. But this argument has depended on an idealized vision of the scientific community, presented as a model to citizens from afar. Actual participation in the sites of scientific research and technical design would show citizens the diverse social and political factors that go into technical activity, making science and technology more effective schools for citizenship than they have ever been. Even if only elites are involved, asserting political control over science and technology puts technical issues in the news, giving lay citizens an opportunity to learn something about the underlying facts and techniques. Such technical education may be considered good in itself, insofar as understanding how one's computer, solar system, or genetic code actually works enables

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[34] See Feyerabend, *Science in a Free Society*, 87, 96-98; Sclove, *Democracy and Technology*, 195-96.

[35] Cf. Michel Callon, "Is Science a Public Good?" *Science, Technology, & Human Values* 19, no. 4 (1994): 395-424.

[36] Guston, *Between Politics and Science*, 48.

citizens to feel more at home in the world. It may also have instrumental benefits, insofar as technical education gives citizens the tools they need to become involved in the governance of science and technology. Such involvement, in turn, also has not only instrumental but also intrinsic benefits. From this perspective, the above criticisms of political control of science over-emphasize the substantive quality of science, forgetting that political participation in the political control of science has intrinsic value regardless of its substantive effects.[37]

Third, and despite the above mentioned concerns about *apraxia*, the political control of science actually promises to produce more effective science. Defenders of scientific autonomy often forget that the expertise of scientists and technicians is highly specialized. Given the diversity of disciplinary backgrounds already present among those involved in technical research and development, adding lay citizens cannot be understood as the introduction of non-experts into a process dominated by experts. Every expert is a non-expert with regard to almost everything they do.[38] Moreover, although technical work depends on highly specialized knowledge, specialization can easily lead to ossification. Industrial research and development already involves many people without technical training, including marketing consultants, lawyers, and policy analysts. Bringing laypeople into the research and development process can introduce new ideas and stimulate creative insights.[39]

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[37] See Bruce Jennings, "Representation and Participation in the Democratic Governance of Science and Technology," in *Governing Science and Technology in a Democracy*, ed. Goggin, 181-84.

[38] Steve Fuller, *Philosophy, Rhetoric and the End of Knowledge: The Coming of Science and Technology Studies* (Madison: University of Wisconsin Press, 1993), chap. 2.

[39] Ibid., 180-81.

Fourth, there is evidence to suggest that expanding the diversity of people involved in technical research leads to technologies that are substantively more democratic—i.e., technologies that tend to be more supportive of democratic values.[40] The identification and design of such technologies cannot rely on experts alone, for "technical experts are not expert in the specific paramount problem of designing democratic technologies."[41] Experts generally have no more capacity to make judgments about the political implications of their work than do lay citizens.

Fifth, political control of science and technology not only can avoid *apraxia*, it can enhance the societal legitimacy and prestige of science and technology, leading to increased public support for government funding. Merton made a similar point long ago:

> Since scientists do not or cannot control the direction in which their discoveries are applied, they become the subject of reproach and of more violent reactions insofar as these applications are disapproved by the agents of authority or by pressure groups. The antipathy toward the technological products is projected toward science itself.[42]

In pursuing their immediate interest in pure science, scientists endanger their long-term interest in the preservation of societal support for science. Merton thus concluded that "the tenet of pure science and disinterestedness has helped to prepare its own epitaph."[43]

Finally, at a more mundane level, political control of science and technology promises to lead to better consumer products. Political control lessens the power of corporations to suppress research results so as to recoup investments in inferior but well

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[40] Ibid., 192.

[41] Sclove, *Democracy and Technology*, 193.

[42] Merton, "Science and the Social Order," 283.

[43] Merton, "Science and the Social Order," 284.

established products.[44] Similarly, the exercise of political control can provide those setting research and design priorities with information on public needs. Market research already provides some insight of this sort, more commonly for technical designers than for scientists. But market information is biased toward those who can afford the anticipated technical products. Political control of science and technology helps ensure that they benefit everyone.

These arguments in favor of the political control of science and technology do not entail a complete rejection of claims for scientific exceptionalism. Practical efforts to assert political control over science will have to acknowledge the ways that science, even from a constructivist perspective, differs from other human activities. Indeed, both popular and governmental efforts to control science and technology have generally accepted some form of scientific exceptionalism.

### *Governmental Intervention in Science and Technology*

In the case of governmental efforts, public officials have long conceded, for example, that the political control of science depends to some extent on substantive scientific knowledge, and have availed themselves of expert advisors for the formulation of science policy. During the 1970s, for example, the US Congress established the Office of Technology Assessment (eliminated in 1995), as well as the Congressional Research Service, to assist legislators in addressing technical problems.[45] Similarly, policymakers have until recently rarely gone beyond attempting to influence the pace or overall funding

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[44] Sclove, *Democracy and Technology*, 196.

[45] See Bruce Bimber, *The Politics of Expertise in Congress: The Rise and Fall of the Office of Technology Assessment* (Albany: State University of New York Press, 1996).

level of scientific research, rather than its direction or content.[46] Between the 1950s and early 1980s, Guston argues, there were repeated challenges to the autonomy of science—including questions about the loyalty of federal researchers, the efficient use of government funds, and the environmental and health hazards of DNA research—but they had little effect on the basic terms of the social contract for science. "The challenges all focused on clumsy attempts to manipulate the inputs to science, rather than to intervene in the interactions among scientists."[47] To the extent that public officials have sought to establish priorities among different areas of research, they have been careful to not appear to be intruding on how the research itself is conducted. In this respect, most governmental efforts to regulate science have been limited to the *context* of science, leaving scientists in control of the *content*.

Since about 1980, however, there has been a partial shift from broad attempts to exert control over science through macroeconomic controls on science funding toward more detailed microlevel efforts to shape scientific research. The National Institutes of Health has established an Office of Research Integrity in which scientists and public officials cooperatively monitor the intellectual and ethical integrity of federally funded research, thus denying the scientific community sole responsibility for ensuring that its members follow accepted procedures. NIH also has an Office of Technology Transfer that goes beyond government efforts to ensure productivity of research through targeted appropriations, and provides direct incentives for individual scientists to conduct research in areas that Congress deems socially useful. Guston calls these institutions "boundary

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[46] Jennings, "Representation and Participation," 228-29.

[47] Guston, *Between Politics and Science*, 11.

organizations," because they provide a place where scientists and politicians can work together to establish common goals across the boundary between politics and science, while preserving the legitimating functions still served by that boundary. Insofar as these organizations present a model for future relations between science and the state, Guston argues, "The state's new role in science policy has become a collaboration with scientists to assure the integrity and productivity of the science it funds."[48]

Lending support to Gusto's view, Fuller has recently identified a number of potential governmental strategies for democratizing science that involve considerable intrusion into the content of scientific practice.[49] Each of his proposals places government in the role of fostering interdisciplinary collaboration among scientists, based on evidence that most scientific breakthroughs occur when scientists are forced to think "outside the box" by transferring ideas and techniques from one field to another. Moreover, since scientists are only experts with regard to their particular areas of specialty, giving scientists an incentive for interdisciplinary collaborations will encourage them to translate their theories, facts, and funding proposals into a less specialized language. If a high-energy physicist can make her research proposal comprehensible to someone specialized in fetal tissue research, chances are that an educated layperson will be able to understand it as well. By making explicit the need for scientists to build alliances with scientists in other disciplines as well as non-scientists, as discussed in Chapter 5, Fuller's proposals push scientists toward making a case for the value of their research not only to other scientists, but to society at large.[50]

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[48] Ibid., 9.

[49] Fuller, *Governance of Science*, 135–46.

[50] Ibid., 146–47.

Guston's boundary organizations and Fuller's proposals are mostly geared toward enabling public officials to hold scientists *accountable* for the public funding of scientific research and the technologies that emerge from it.[51] Public accountability is important, but democracy also depends on public *participation*. Genuine political representation must include both substantive and procedural elements, and it will not be enough for the public to hold scientists accountable. In the next section, I return to the question of civic competence to begin considering how laypeople can take advantage of the opening for public participation created by the institutions and strategies described by Guston and Fuller.

Proposals for public participation in science and technology can take at least two very different forms: those that advocate public participation in *controlling the context* of science and technology, and those that favor public participation in *shaping scientific and technical content*. I consider each in turn.

*Popular Control of Science and Technology*

Despite his emphasis on improving the technical competence of lay citizens, Dewey notes that "it is not necessary that the many should have the knowledge and skill to carry on the needed investigations, what is required is that they have the ability to judge of the bearing of the knowledge supplied by others upon common concerns" (*PP*, 209). Dewey here makes a fundamental distinction between the technical *content* and political *role* of science. This distinction parallels that made above between the content and context of science. From this perspective, lay participation in science and technology

[51] On the emergence of public accountability as a norm of the scientific community, see also Fortun and Bernstein, *Muddling Through*, 112-13.

should address issues of legitimacy rather than credibility, questions of right rather than truth. These distinctions, as noted above, have until recently been shared by governmental efforts to exert political control over science and technology. They also motivate most proposals for lay participation in science and technology. In the California electric vehicle case, for example, the public hearings sponsored by the agency only gave the public an opportunity to testify on whether the ZEV mandate should be retained, given the conclusions of the Battery Technical Advisory Panel. The procedures of the Battery Panel were not subject to public review.

Perhaps the strongest justification for distinguishing between the role and content of science is that most laypeople neither can nor want to participate in shaping the technical content of science. As Mark Warren argues, when it comes to science, "the lure of democratic participation operates at the margins," when controversial "side effects" or a failure to achieve scientific consensus make the political implications of expert knowledge explicit.[52] Most lay citizens lack the time, attentiveness, and knowledge to seriously question expert authority. Ordinary citizens "want safe airplanes and food, not the chance to participate in meat inspection and airline safety."[53] Or as Brian Martin puts it,

> You don't need to understand how a jet engine operates, or how to fly a plane, in order to be involved in decisions about flight patterns or siting of an airport. You don't need to be an expert on brain functioning or x-ray machines in order to be involved in decisions about investment in medical technologies.[54]

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[52] Mark Warren, "Deliberative Democracy and Authority," *American Political Science Review* 90, no. 1 (March 1998): 46-60, at 49.

[53] Ibid., 49.

[54] Brian Martin, "Introduction," in *Technology and Public Participation*, available at http://www.uow.edu.au/arts/sts/TPP.

And in another of Dewey's formulations, echoing Aristotle, "The man who wears the shoe knows best that it pinches and where it pinches, even if the expert shoemaker is the best judge of how the trouble is to be remedied" (*PP*, 207).[55] Such considerations lead to a conception of science education quite different from those focused on imparting knowledge of scientific facts or methods.

As I suggested above, the distinction between science's social role and technical content might support a type of science education that focuses on the skills required for dealing with the impacts of science and technology on society. Learning how to deal with these impacts probably requires at least some knowledge of how science works. But the emphasis might be placed on the skills needed for creating public policies on technically complex public issues. Frank Laird thus argues that citizens in contemporary societies do not need to learn much science, but they need to understand something about how science and politics tend to interact.[56] Citizens should know, for example, that 1) the political implications of scientific facts can usually be interpreted in different ways; 2) scientific facts are often more uncertain than scientists (or politicians) admit; 3) even apparently certain scientific facts are likely to change over time; 4) it is sometimes useful to get more information, and it sometimes is not; 5) the framing of a political issue affects the scientific information that is sought to address it. In a similar vein, Sclove suggests

[55] "Each individual may indeed, be a worse judge than the experts; but all, when they meet together, are either better than experts or at any rate no worse....[T]here are a number of arts in which the creative artist is not the only, or even the best, judge. These are the arts whose products can be understood and judged even by those who do not possess any skill in the art. A house, for instance, is something which can be understood by others besides the builder: indeed the user of a house...will judge it even better than he does. In the same way a pilot will judge a rudder better than a shipwright does; and the diner--not the cook--will be the best judge of a feast" (Aristotle, *The Politics of Aristotle*, ed. and trans. Ernest Barker [London: Clarendon Press, 1946; New York: Oxford University Press, 1958], III.xiv, 126).

[56] Laird, "Participatory Analysis," 353-4.

that "the most important knowledge about a technology involves not its internal principles of operation but its structural bearing on democracy...."[57] By developing a deeper understanding of the dynamic relationships among science, technology, and politics, lay citizens can learn to effectively participate in managing those relationships.

Various institutional experiments and reforms undertaken since the 1970s point to a number of factors to consider in efforts to include lay citizens in the political control of science and technology.[58] As with public participation in government policymaking, it is especially important to identify at which stage in any given process of technical or scientific development the public can best intervene. Generally speaking, earlier participation offers more possibilities for substantial public influence, but at earlier stages the political stakes of different research or design options are often impossible to determine. Participation in later stages offers greater possibilities for mobilizing concerned citizens, but often presents participants with only a few technical options to choose from, none of which may be acceptable.

It is also important to consider the comparative merits of different institutional mechanisms for public participation in controlling science and technology. One of the most common is the *public hearing*, often legally required as a result of the Administrative Procedures Act and other state and federal legislation passed during the 1970s. These hearings increasingly involve an amalgam of technical and political issues.

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[57] Sclove, *Democracy and Technology*, 53.

[58] The following discussion draws on Daniel J. Fiorino, "Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms," *Science, Technology, & Human Values* 15, no. 2 (Spring 1990): 226-43; "Environmental Policy and the Participation Gap," in *Democracy and the Environment: Problems and Prospects*, ed. William M. Lafferty and James Meadowcroft (Cheltenham, UK and Brookfield, VT: Edward Elgar, 1996).

They provide an important opportunity for lay citizens to inform themselves about impending governmental actions, organize with other like-minded parties, and voice their concerns. Public hearings have two important weaknesses, however, each of which was clearly evident in the California electric vehicle case.

First, they usually occur relatively late in the regulatory process, and thus present the public with a limited set of options. Participants can voice their opinions on the various possible courses of action identified by the agency, but they often have little opportunity to introduce new ideas that lack official sanction. Most of the 1995 hearings on the California ZEV program, for example, revolved around the narrow question of whether or not existing EVs would be able to meet the Board's range goal of 100 miles per charge. The Board's range goal itself, or its method of assessing the EV market, was not on the agenda.

A second important limitation of public hearings is that they usually have a merely advisory function, imposing no binding requirements on policymakers. Indeed, as we saw in the electric vehicle case, CARB was able to postpone the ZEV mandate despite the overwhelming opposition by those who testified at the public hearings. As a staff member later said,

> As much as we listened and looked and we consolidated and summarized all those comments—you know, they were basically saying the same thing, many of them. They basically said, "Look, continue the program full steam ahead. We want the vehicles." The realities of technology were the overriding concern and the fear that if we did it wrong, now we shoot ourselves in the foot for the long term.[59]

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[59] Evanshenk. Interview by author.

Members of the general public could not be blamed for taking away the impression that their participation in the public hearings had made little difference in the agency's decision.

Another mechanism for involving lay citizens in the political control of science and technology makes use of *public surveys*. Surveys give decisionmakers a general picture of public needs and interests, but like public hearings they are merely advisory. The ZEV case also showed the limits of public input via surveys. Given the lack of any legal requirements to heed survey results, the agency made little use of the many available surveys on consumer attitudes toward EVs. Nor did the agency compare the merits of different survey techniques. As I showed in Chapter 2, Board members simply made their own best guess of consumer attitudes. Surveys can certainly be put to more productive use than they were in the ZEV case, but unless they take the deliberative form of the UC Davis study, surveys generally offer little more than a static snapshot of respondents' gut reactions. From the perspective of the various models of representation discussed in the previous chapter, the stated preference surveys usually used to assess EV markets reflect an extreme form of proceduralism, giving public officials good reason to ignore them.

In contrast to the merely advisory nature of public hearings and surveys, *referendums* on particular technologies or branches of research give the public an opportunity to impose binding requirements on scientists, technicians, and policymakers. They also bring welcome publicity to highly technical public issues that might otherwise go ignored.[60] Although referendums help stimulate public debate on important public

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[60] In 1998, for example, Switzerland held a national referendum on gene technology. The proposed Gene Protection Initiative demanded that the government outlaw the use of transgenic animals,

issues, they usually generate much more heat than light. Also, like referendums on other questions of public policy, referendums on science and technology make the public vulnerable to manipulation by well financed interest groups.

A referendum in 1995 asking California citizens whether CARB should preserve the 1998 ZEV mandate would have undoubtedly generated a huge amount of publicity, as well as large expenditures on advertising by the various advocates and opponents of the mandate. It is difficult to say which side would have prevailed, and whether the benefits of the extra publicity garnered for EVs would have outweighed the misinformation to which the public would have been subjected. My guess is that, on the whole, a referendum on EVs would have been a productive political exercise, but it is clearly not an optimal mode of lay participation in technical decisionmaking.

The most important limitation shared by all these mechanisms for public participation is that they require a fairly rigid division of labor between experts and lay citizens. Experts are expected to present objective information on the probable consequences of different technically complex policy options. Laypeople are expected to make subjective choices among the given options. This division of labor may limit citizens' capacity to exert effective political control over science and technology. What if

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the release of genetically modified organisms, and the patenting of transgenic plants and animals. Although the initiative garnered support from many scientists, especially women, one month before the vote 5,000 scientists and physicians took to the streets to protest it. Polls taken in 1996 showed 62% of the public opposed to gene technology, and six months before the vote 47% opposed the technology. But when the referendum was held on June 7, 1998, 67% of the voters rejected it. In many respects, support for the initiative was driven less by opposition to gene technology itself, than by a desire to demand accountability from multinational pharmaceutical companies. See Gottfrid Schatz, "The Swiss Vote on Gene Technology," *Science* 281 (September 18, 1988): 1810-11. One of the most extensive efforts to use referendums in technical decisionmaking occurred in the United States with regard to the fluoridation of drinking water. See Robert L. Crain, Elihu Katz and Donald B. Rosenthal, *The Politics of Community Conflict: The Fluoridation Decision* (Indianapolis: Bobbs-Merrill, 1969).

citizens cannot find an acceptable option among those presented by the experts for dealing with a particular technical process or artifact? As the nuclear power industry has learned, a public hearing on where to locate--rather than whether or not to build--a new nuclear plant does not provide the public with a sufficient range of options. In the case of some technical artifacts, asking citizens to decide *how* to use them, while preventing them from influencing *what* get produced, places unnecessary prior restrictions on the democratization of science and technology.

A potential response to this complaint appears in the notion that while a division of labor between scientists and citizens is necessary, its terms should always be subject to renegotiation. As James Bohman puts it, "The division of labor can be democratic so long as it fulfills two conditions: It must establish free and open interchange between experts and the lay public and discover ways of resolving recurrent cooperative conflicts about the nature and distribution of knowledge."[61] The potentially anti-democratic implications of an epistemic division of labor between experts and laypeople can be avoided by creating institutions for public deliberation on the terms of cooperation between them.

Proponents of this approach are no doubt right that lay citizens neither can nor need to become involved in all expert decisions. They are also right to distinguish between technical claims that enjoy widespread assent and those that are politically controversial. As we saw in the electric vehicle case, those who opposed changes in the ZEV program generally did not challenge the Battery Panel's findings. The Panel was made up of respected engineers and it had consulted with a broad range of battery experts

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[61] Bohman, "Democracy as Inquiry," 592.

and manufacturers. Opponents of the policy change only criticized the Board's attempt to justify its policy decision as a necessary implication of the Panel's findings.

Similarly, in the 1960s controversy over the fluoridation of drinking water, political debate did not focus on the effectiveness of fluoride in preventing cavities, on which there was relatively strong expert agreement. Rather, the controversy revolved around people's right to control what they consume. Public controversies over amniocentesis, birth control pills, and the "abortion pill" have also been characterized by technical consensus and political disagreement. These controversies have not concerned the substantive content of the relevant technical artifacts, but the moral and political implications of their use.[62] Given the lack of disagreement among technicians, one might argue that laypeople have no need to become involved in shaping these technologies.

The problem with this conception of participation and expertise, however, is that it obscures the *systemic* relationships between some technical artifacts and certain aspects of political life. If public deliberation on science and technology is confined to "the margins," to cases in which technical uncertainties provide an obvious opening for the politicization of sociotechnical issues, it cannot speak to the political effects of technical artifacts that enjoy both political and technical consensus.

As we saw in Chapter 2, for example, the gasoline automobile has not been a site of technical controversy since the early years of the twentieth century. Nor has it often been a site of political controversy. There have been occasional technical disputes over the relative effectiveness of various safety or pollution control measures, and sporadic political complaints about its effect on the quality of life, but for the most part, since at

[62] See Ezrahi, "Utopian and Pragmatic Rationalism," 117-19.

least the 1920s, the gasoline automobile has been a tightly closed "black box." Nonetheless, the automobile has gradually helped bring about a fundamental transformation of social and political life in the United States. Ever since the standard automobile was "purified," to use Latour's term, its political biases internalized and forgotten, it has quietly exerted a subtle influence on our politics and culture with very little technical or political controversy. One might say the same thing today about television, or computers, or a host of other technical artifacts that have elicited only sporadic and mostly superficial political controversy, but have profound effects on political life.

Seen from this perspective, the defense of an epistemic division of labor between experts and laypeople, and the distinction between the societal impact and technical content of science and technology on which it relies, casts the relationship between science and democracy in overly procedural terms. It suggests that as long as expert and lay actors follow their roles, and nobody complains, the technical content that results will be compatible with democracy. As mentioned previously, however, genuine political representation must include both substantive and procedural elements. Moreover, we have seen that the substantive content of technical artifacts often has important implications for democracy.

### *Popular Shaping of Science and Technology*

One institutional mechanism that allows lay citizens to participate more directly in shaping the technical content of science and technology is the *consensus conference*, also known as a citizen review panel or citizen jury.[63] Consensus conferences are usually only advisory, but unlike public hearings, they enable relatively equal interaction between experts and lay citizens. As organized by the Danish Board of Technology, for example, consensus conferences bring together a randomly selected group of lay citizens who meet over an extended period to learn about a technically-intensive policy issue and then cross-examine experts on the issue. The group then holds a press conference to present its research and policy recommendations. Although consensus conferences have often only addressed the social impacts of science and technology, by facilitating close interaction between experts and laypeople they provide an opportunity for public influence on the content of technical research and development.

Consensus conferences have many of the same benefits and shortcomings of recent US experiments with deliberative polls, as mentioned in Chapter 2.[64] As in deliberative polls, for example, random selection does not guarantee that a consensus conference represents the public in every respect. Moreover, the artificial situation established by a deliberative poll arguable leads to an abstract set of policy recommendations with little connection to the practical context of people's daily lives.[65] Another frequent objection to consensus conferences lies in their relative lack of real political power. Depending on media exposure, public officials may be forced to accommodate their policies to the conference recommendations. But unlike referendums,

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[63] See Simon Joss, "Danish Consensus Conferences as a Model of Participatory Technology Assessment: An Impact Study of Consensus Conferences on Danish Parliament and Danish Public Debate," *Science and Public Policy* 25, no. 1 (1998): 2-22.

[64] See James S. Fishkin, *The Voice of the People: Public Opinion and Democracy* (New Haven: Yale University Press, 1995).

[65] Jeff Lustig, "Experiment in Democracy: or, Trouble in the Deliberated Zone," *The Good Society* 9, no. 1 (1999).

consensus conferences do not impose any legal obligation on public officials. As a recent US experiment with the consensus conference format made clear, without any prospect of having a clear impact on public policy, citizens can quickly become disillusioned with the process.[66] Of course, exaggerated and inevitably unfilled expectations of effectiveness can also produce frustration and apathy.[67]

Finally, it is important to note that consensus conferences, like the other institutional mechanisms discussed above, cannot overcome the limitations posed by the larger institutional structures within which they are embedded. Each of these institutional mechanisms directs participation toward established institutions, which leads citizens to tailor their input to the predispositions of those who control these institutions. Consensus conferences, for example, can only influence the content of science and technology to the extent that scientists and engineers are receptive to their recommendations.

Despite these limitations, of the various institutional mechanisms discussed above, consensus conferences offer the most promising option for laypeople to become actively involved in shaping both the content and context of technical research and design. Even if conference participants are not publicly representative, by holding a press conference they can at least present the public with an alternative, potentially more well-considered perspective on controversial scientific and technical issues.[68] As we saw in Chapter 2, for example, the deliberative study on consumer attitudes toward EVs

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[66] See David H. Guston, "Evaluating the First U.S. Consensus Conference: The Impact of the Citizens' Panel on Telecommunications and the Future of Democracy," *Science, Technology, & Human Values* 24, no. 4 (1999): 451-82.

[67] See Mark Button and Kevin Mattson, "Deliberative Democracy in Practice: Challenges and Prospects for Civic Deliberation," *Polity* 31, no. 4 (Summer 1999): 609-37.

[68] Sclove, *Democracy and Technology*, 218-19.

provided an important corrective to stated preference surveys. Consensus conferences also provide a valuable opportunity for intelligent interaction between laypeople and experts, allowing each to learn from the other. By facilitating public deliberation on technically complex issues, consensus conferences suggest one way of moving beyond the current failure of science and technology to adequately represent the public.

Despite the benefits to be expected from consensus conferences and other institutional mechanisms, their limitations point to the continuing need for non-institutional approaches to the democratization of science and technology. Perhaps the least institutionalized form of popular influence on science and technology appears in what Feenberg calls *creative appropriations*, as when users employ a new technology for purposes other than those intended by its designers. Gasoline automobiles, for example, were initially rejected by farmers who saw little use for the loud and unreliable technology. But once they discovered previously unknown uses for the new technology, such as running farm machinery, rural acceptance of the new technology began to grow. At the same time, farmers' use of automobiles for unexpected purposes led to changes in automobile design that helped fulfill those purposes.[69] More recently, users of the internet have transformed a technology initially designed for scientific research into a potent tool of mass communication and global commerce.[70]

Such creative appropriations, as the internet example makes especially clear, are rarely subject to conscious direction through public deliberation and decisionmaking—

[69] Ronald Kline and Trevor Pinch, "Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States," *Technology and Culture* 37 (Oct. 1996): 763-795.

[70] Feenberg, *Questioning Technology*, chaps. 5-6.

indeed, that is their attraction. Creative appropriations of technology tend to develop in an ad hoc manner according to public whims. Although there is much to admire in the anarchic resourcefulness of those who turn technology to their own uses, the lack of collective direction makes creative appropriations of technology vulnerable to a far less creative "appropriation"—in the Marxian sense—by established organizations, in particular the corporate engines of consumer capitalism.

A more promising approach to non-institutional participation in science and technology is that of the many *citizen initiatives* that have, over the past forty years, repeatedly given political direction to popular skepticism toward science and technology. Depending on their resources, citizen initiatives can offer participants considerable latitude to influence the public agenda. They have also occasionally been highly effective in shifting research and design priorities. Citizen initiatives generally have the most lasting societal impact when their demands are turned into governmental regulations or otherwise adopted by mainstream institutions. But of all the above avenues for public participation in science and technology, citizen initiatives are the least dependent on mainstream institutions.

One of the most intriguing examples of a citizen initiative shaping the content of scientific research is that of AIDS activists. As documented by Steven Epstein, AIDS activists have had considerable success in changing research protocols for clinical trials of AIDS drugs so as to maximize the early and widespread distribution of potentially life-saving remedies.[71] Almost entirely self-educated in the science of AIDS, and lacking

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[71] Steven Epstein, "The Construction of Lay Expertise: AIDS Activism and the Forging of Credibility in Clinical Trials," *Science, Technology, & Human Values* 20, no. 4 (Autumn 1995): 408–437; *Impure Science: AIDS, Activism, and the Politics of Knowledge* (Berkeley: University of California Press, 1996).

formal scientific credentials, a persistent group of AIDS activists has gradually gained access to the arenas of scientific decisionmaking on AIDS research. These activists have successfully challenged the extensive use of placebos, requirements that participants have no history of participation in previous trials, and restrictions on the number of participants. They have not only been able to attain credibility within existing arenas of biomedical expertise, but have succeeded in changing the very definition of what counts as scientific credibility in the first place.

A crucial element in the activists' strategy, as in that of the Danish consensus conferences, has been to present themselves, however problematically, as the representatives of people with AIDS or HIV. This has allowed them to pressure establishment scientists with the threat of public demonstrations. Moreover, by claiming to represent the very people who are the "objects" of AIDS research, activists have been able to exploit the establishment scientists' need for sufficient numbers of patients to enroll in clinical trials and cooperate with the research protocols.[72] They have thus made practical use of the alliance-building requirements of scientific activity discussed in Chapter 5. And by speaking for both the biological and social needs of AIDS patients, thus disrupting established scientific knowledge, they have effectively taken on the role of scientist-delegates, as examined in Chapter 6.

The success of AIDS activists in bringing a popular voice to bear on the making of scientific knowledge is not, of course, very common. More typical have been the efforts of laypeople to shape the science and technology of automobility. The first half of

[72] Epstein is careful to emphasize, however, that these claims to representative status became increasingly problematic over time, as the activists' intense involvement with the science of AIDS gradually created a boundary between them and the broader community of people involved with HIV and AIDS.

the twentieth century saw isolated incidents of public protest against automotive air pollution, as noted in Chapter 2. In the 1960s, public interest advocates such as Ralph Nader began a sustained critique of the health and safety effects of the automobile. After much foot dragging, the automakers eventually responded to the combined force of federal legislation and public pressure with a number of technological innovations, including catalytic converters, feedback fuel control systems, seat belts, and air bags. These improvements in automotive technology were of very limited scope. They did nothing to challenge the standard model of the gasoline automobile, nor its exalted status within the overall transportation system.

Ironically, the limited popular influence on automotive technology during the 1960s led to an increasing professionalization of automotive politics. More than other areas of environmental politics, debates on the automobile have been increasingly dominated by lawyers and engineers.[73] This dominance by technical expert helps explain the relatively conservative character of automotive politics. The radical critiques voiced in the politics of nuclear energy, forest preservation, or toxic waste disposal have been largely absent from automotive politics. This is also due, no doubt, to the pervasiveness of the automobile in contemporary society. The environmental movement has focused on other issues, in part, because the automobile simply presents too big a project to tackle.

The relative lack of popular influence on automotive technology lends added importance to the California ZEV program, since its effectiveness rested in good measure on the opportunities it created for an existing subculture of amateur EV enthusiasts.

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[73] Andrew Jamison, "Debating the Car in the 1960s and 1990s: Similarities and Differences," *Technology in Society* 17, no. 4 (1995): 453-67, at 459.

Since the 1960s, many of the innovations in EV technology have emerged from a loose network of hobbyists, engineering students, and small entrepreneurs. This diverse group is held together by discussion groups, email lists, annual EV races, and national and international conventions, as well as a shared commitment to environmentally-sound technology. Although the subculture of EV enthusiasts includes many people with extensive technical expertise, they tend to identify themselves with the environmental movement as a whole.

In many respects, EV enthusiasts are an example of what have has been called an "innovation milieu."[74] Studies of technological innovation have generally focused on the activities of a few public agencies or private firms with the highest level of expertise and/or greatest financial stake in the relevant innovation. An "innovation milieu," in contrast, designates a loose affiliation of technicians with diverse backgrounds, all involved in the development of a particular technology. An innovation milieu may include "government offices, universities and engineering schools, interested laymen, nongovernmental organizations, retail firms, and early users."[75] Most significantly, innovation milieus provide an environment in which "outsiders" with radical ideas can find the financial and intellectual support to challenge existing paths of technological development. The involvement of outsiders, as noted above, has often provided the impetus for major shifts in technical development.

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[74] Bernhard Truffer and Gregor Dürrenberger, "Outsider Initiatives in the Reconstruction of the Car: The Case of Lightweight Vehicle Milieus in Switzerland," *Science, Technology, & Human Values* 22, no. 2 (1997): 207-34.

[75] Ibid., 211.

The outsider status cultivated by many EV enthusiasts has presented both benefits and burdens for the prospects of EV development. The outsiders generally recognize that mass marketing of their innovations will eventually require entering into some form of collaboration with large automakers. But the counter-cultural ethos prevalent among amateur EV enthusiasts makes them wary of associating too closely with large firms. They fear loss of control over their inventions, as well as loss of their creative energy itself.[76]

This dynamic of attraction and repulsion was evident in the collaboration between General Motors and the EV startup firm Aerovironment. Although Aerovironment ended up supplying much of the technology that went into GM's showcase electric car, the EV1, the contrarian tinkerers at Aerovironment were eventually forced to give up control over the project.[77] While corporate culture probably dooms all such collaborations to an early death, it is important to recognize the democratic potential of such outside inputs into the corporate innovation process. Although the technicians at Aerovironment are certainly not laypeople, their close association with the environmental movement gives them a perspective on science and technology that most career engineers at GM lack.

Beyond the involvement of amateur EV enthusiasts, the California ZEV program presented several options for lay participation that went unfulfilled. As I showed in Chapter 2, CARB justified its decision to revise the ZEV program primarily with reference to the conclusions of its Battery Technical Advisory Panel. Although the Panel's task was to assess the state of advanced battery development, it made clear its

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[76] See Ibid., 218-19, 226.

[77] See Shnayerson, *The Car that Could*.

belief that EV development depends on an accurate assessment of consumer expectations. The Panel argued, for example, that "close collaboration between battery developers and vehicle manufacturers is essential to...develop the specifications for a commercially manufacturable product that meets customer expectations of performance, reliability, durability, safety, and cost."[78] The Panel thus points to a need for collaborations among battery developers, manufacturers, *and* consumers, but it relegates consumers to the status of a silent third partner. If EV development depends on consumer expectations, why not involve consumers directly in the innovation process? The priorities of EV research are certainly not given by nature. Based on their deliberative surveys, the UC Davis study concluded that "research should focus less on new batteries that provide a longer range (i.e., higher specific energy and energy density), and more on improved battery cycle life, energy management and manufacturing costs."[79] Involving potential consumers in EV research and development would allow them to voice their concerns not only on the problem of range, but on a variety of design issues, including recharging technology, fuel gauge instrumentation, and optional amenities.

Such involvement by laypeople in automotive design becomes increasingly important as the traditional nine-to-five work schedule loses its hold on many people, and travel patterns become ever more individualized. The use of mass surveys, required for achieving statistically significant results, cannot capture the increasing diversity of transportation habits.[80] Indeed, EVs promise to introduce even more diversity into public

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[78] Kalhammer et al., *Performance and Availability of Batteries*, IV.4.

[79] Kurani et al., "Testing Electric Vehicle Demand," 148.

[80] On the social construction of transportation statistics, see Weert Canzler and Andreas Knie, *Möglichkeitsräume: Grundrisse einer modernen Mobilitäts- und Verkehrspolitik* (Vienna: Böhlau Verlag, 1998), 44-56.

travel patterns, as they offer a whole new set of technological options and constraints. EVs afford an opportunity to "diversify transportation services and lifestyle expression...."[81] If citizens have diverse needs and interests, and if technologies are to represent them, then technologies must be diverse. Diversity in design might come about through economic mechanisms, as firms target their products toward increasingly specialized markets. But if technical design is to go beyond narrow consumer preferences and begin to address public goals, it will be necessary to create opportunities for laypeople to collectively identify their genuine needs in collaboration with those who make the technical artifacts that permeate society.

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[81] Kurani et al., "Testing Electric Vehicle Demand," 148.

# CHAPTER 8

# CONCLUSION

In each of the preceding chapters, I have illustrated my claims with examples from a variety of contemporary technical controversies. Most of the examples have come from the electric vehicle case presented in Chapter 2. In this concluding chapter, I summarize the argument of the dissertation by way of revisiting the electric vehicle case once more. The second section of the chapter briefly examines some of the remaining challenges confronting efforts to democratize science and technology.

## Summary of the Argument

The three levels at which I have articulated the notion of political constructivism—historical, philosophical, and political—each cast the California electric vehicle program in a suggestive light. Historically, Chapter 3 showed that understanding something about the social practices of seventeenth-century experimental science can clarify the enduring prevalence of technocratic forms of public policymaking. The leading practitioners of modern science developed a mode of legitimating their laboratory experiments that gave science a paradoxical double identity as both uniquely public and highly exclusive. By soliciting laypeople to witness laboratory experiments, inviting replication efforts from all comers, and avoiding divisive questions about the causes of observed phenomena, seventeenth-century experimentalists gave science a distinctly public face. At the same time, however, early experimentalists made science into an elite enterprise by establishing strict limits on the classes of people allowed to serve as laboratory witnesses, excluding metaphysical questions, and insisting on the superiority of experimental method over untutored common sense. While some have argued that one or the other face of science is its "real" identity, I hope to have made clear that both have played a crucial role in modern scientific practice.

With this paradoxical double identify of modern science in mind, it is easier to understand why CARB justified its revision of the ZEV program with reference to both its solicitation of public input *and* its reliance on technical expertise that contradicted the public's expressed demands. Indeed, it becomes clear that by holding extensive public hearings on the program, the agency did not threaten the scientific character of its decision, as one might expect, but rather enhanced it. How could the decision be wrong, the agency could ask, if it was the result of a fair, open, and pubic process? And how could it be wrong if it had the support of an elite technical advisory panel? Despite the apparent contradiction between these two modes of justification, each helped make the Board's decision seem more scientific, just as they had seventeenth-century experiments.

Moreover, these modes of justification made the Board's decision seem more democratic, insofar as they overlapped with the three models of liberal-democratic instrumentalism presented in Chapter 3: technocracy, rational deliberation, and market competition. The technocracy model appeared in the Board's claim to be using its technical knowledge to defend the public's substantive best interests. The rational deliberation model appeared in its embrace of free-market principles, which the Board claimed also promote the people's best interests. And the rational deliberation model appeared in the Board's claim to have employed an open and public process, including broad consultation with a variety of experts and numerous public hearings with lay citizens. Far from contradicting its democratic character, therefore, the Board's reliance on the conceptual resources of modern science allowed it to plausibly claim that its decision reflected liberal-democratic principles.

Beyond this historical argument, I have defended a philosophy of science that, within the bounds of contemporary discussion, is moderate in its epistemological and ontological claims and radical in its politics. Epistemologically, scientific knowledge results from interactions between humans and nonhumans (i.e., natural entities and processes). Human beings initiate and organize these interactions in pursuit of various instrumental (power-related) and noninstrumental (truth-related) purposes. This position is moderate, because it rejects both the empiricist claim that scientific knowledge is determined by the essential properties of nature and the relativist claim that scientific knowledge simply mirrors the culture and interests of particular scientists. Ontologically, science enables both immanence and transcendence. It allows scientists to control particular natural entities and processes, and it provides generally valid knowledge about those entities and processes. Scientific knowledge is not simply "in our heads," but rather describes a "really existing" external world. At the same time, however, the process of achieving this knowledge and control involves making changes in the relationships between humans and nonhumans. These changes may be material, as in the case of experimental research, or perceptual, as in the use of observational technologies like the telescope. But in either case, it can be said that the objects of knowledge did not exist *as* objects of knowledge prior to their becoming part of a scientific inquiry. The objects of science have not always already been there, "waiting to be discovered." This position is ontologically moderate, because it falls between the extreme realist view that science mirrors a pre-existing reality and the extreme nominalist view that science is simply a social or linguistic construct with no connection to the natural world.

In contrast to its epistemological and ontological components, the political elements of the philosophy of science and technology defended in this dissertation are radical. Due to their transformative effects on nature and society, science and technology should be understood as potential sites of political activity. Whenever technical artifacts have consequences for public life, regardless of whether or not these consequences become the focus of public controversy, the selection of priorities and procedures for research and design becomes a political question. Science and technology, therefore, can be understood as sites of political representation. They represent the public's best interests, highest ideals, and expressed wishes—in terms of substantive or descriptive, symbolic, and procedural types of representation, respectively—insofar as science and technology fulfill those interests, model those ideals, and adopt priorities and procedures that reflect citizens' expressed wishes. Moreover, promoting adequate political representation in science and technology requires that science and technology be subject to popular sovereignty. The autonomy of science, while valuable, is subordinate to the higher-order value of democracy. This argument is radical, because it contradicts the still common assumption that science and technology can only support democracy if they remain free of politics.

Returning again to the California case, we can compare the philosophy of science defended here to that implicit in the words and deeds of the policymakers at CARB. CARB's assertion that the widespread introduction of EVs should be delayed until EV technology is better developed reflected a linear conception of the relationship between science, technology, and society. It neglected the way science and technology develop through transformative interactions with both society and nature. To some extent, one might argue, CARB's policy did reflect a constructivist conception of technology, since the agency recognized the need for political pressure to stimulate EV research. Similarly, as part of the Memorandum of Agreement with the automakers, the agency required automakers to introduce limited numbers of EVs in test markets in order to gain real world experience that could be used to further develop the technology. In these respects, the agency asserted the sovereignty of politics over technology.

CARB did not, however, take up the political dimensions of this implicitly constructivist view of science, which I have argued follow directly from it. By switching to an approach centered on closed-door negotiations with the automakers, and by undermining the credibility of its threat of sanctions for noncompliance, the agency significantly weakened its effective sovereignty over the development of EV technology. Moreover, the agency did not sufficiently consider the politically representative aspects of EV technology. Thinking of EVs as sites of political representation makes clear that by focusing on EV range, the agency portrayed the EV as a technology that represents suburban commuters rather than inner city residents with limited range needs.

Finally, on the level of politics, the endorsement in the previous chapter of institutional experiments to facilitate public participation in the shaping of science and technology suggests a direction for the reform of public policymaking. As we saw in Chapter 2, CARB held numerous public hearings on the ZEV program, but did not invite public involvement in EV-related research and development. The procedures and assessments of the Battery Panel, automakers, and battery companies were not on the public agenda. I suggested a few possibilities for facilitating public involvement in the future design of EV technology. These possibilities will be different both in kind and degree in other technical fields, and in many fields may be quite limited. Nonetheless, the creation of institutions that can facilitate such involvement is today one of the key challenges facing technically complex democratic societies.

**Future Challenges for the Civilization of Science**

Although the examples presented in the previous chapter suggest that lay citizens have an important role to play in the shaping of science and technology, future efforts to take up the task will face a number of challenges that go beyond the arguments against lay participation outlined previously. In this last section I want to briefly address three such challenges, none of which admits of easy resolution.

First, the democratization of science and technology faces many of the same obstacles confronting efforts to strengthen democracy more generally.[1] The AIDS case is especially interesting, in this respect, insofar as most of the leading activists have been well-educated, middle-class, white men. Their success in sufficiently educating themselves to acquire credibility among scientists and policymakers would have been impossible without prior educational and financial resources. This suggests that a more democratic science and technology depends in large part on more democratic societal background conditions. Similarly, efforts to democratize science must contend with the vested interest of powerful elites in existing forms of technocratic governance; the increasing corporate control of science; the widespread public belief in the inherent right of experts to govern themselves, despite skepticism that they will do so responsibly; as

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[1] See Longino, *Science as Social Knowledge*, 214; Sclove, *Democracy and Technology*, 32-33, 206.

well as an extreme lack of time and resources for political participation on the part of most citizens.

In these respects, the democratization of science and technology can be promoted by many of the same innovations that have been suggested for revitalizing the institutional preconditions of civil society.[2] Some have suggested, for example, to pay citizens for service on technical advisory boards, just as they are currently paid (inadequately) for jury duty.[3]

A second, more conceptual challenge for the democratization of science and technology lies in the change it entails in the meaning of politics and what Wolin called "the political": a realm of deliberative and authoritative decisionmaking regarding matters of general concern.[4] The claim that science and technology should be understood as potential sites of lay participation extends the concept of the political into a sphere long considered politically autonomous. Does viewing science as potentially political threaten to empty "the political" of determinate meaning, making impossible its earlier association with matters of general concern?[5] Most industrial societies have slowly accepted that, under certain conditions, the political sphere may extend to business transactions, gender relations, child raising, and other social spheres previously deemed inherently private. But if even science is political, what is not?

Perhaps the greatest difficulty posed by this dilemma is that it is almost entirely beyond the control of the political theorists whom it most concerns. Constructivist

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[2] Barber, *A Place for Us*, chap. 3; *Strong Democracy*, chap. 10.

[3] Kleinman, "Beyond the Science Wars," 141; Sclove, *Democracy and Technology*, 43.

[4] Wolin, *Politics and Vision*, 6-10.

[5] See Wolin's discussion of the "sublimation of politics," in *Politics and Vision*, chap. 10.

academics are not responsible for making science seem increasingly political. Rather, as I argued above, the primary cause of this development lies in the insinuation into political life of an increasing array of hybrid artifacts.[6] As Wolin once argued, "[T]he boundaries and substance of the subject-matter of political philosophy are determined to a large extent by the practices of existing societies."[7] In many respects, treating science as a potential site of political life merely acknowledges the transformations science has already wrought in our political practices. The point is not only that one can find politics *within* science, although one certainly can, but that many scientific practices have become intertwined with matters of concern to the political community as a whole. Many hybrid practices that once belonged only to "science" now straddle the science-politics boundary, or move back and forth across it.

Without a distinct concept of the political, I admit, politics can easily become devoid of meaning, and political theory can lose any sense of disciplinary identity. But the specific content of this concept can change. Political theorists can play a role in shifting the boundaries of the political, but they must also accommodate themselves to the political changes brought about by concrete practices and events, including those wrought by science and technology. A truly democratic conception of the political, it seems to me, should encompass the efforts of lay citizens to shape the technical practices that bear upon matters of general concern.

Finally, a related challenge for future efforts to democratize science and technology appears in the effect of constructivist theories of science and technology on

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[6] See Langdon Winner, "Technology Today: Utopia or Dystopia?" *Social Research* 64 (Fall 1997): 1012.

[7] Wolin, *Politics and Vision*, 4, 6.

prevailing conceptions of citizenship. I have argued that a distinctly political version of constructivism supports the democratization of science and technology in both theory and practice. In this respect, it might be said, constructivists make better citizens. This claim is not new to political theory, and has long been defended under the rubric of "anti-foundationalism."[8] But as noted before, it is relatively new to discussions of science and technology, and it requires further practical and theoretical elaboration before one can say for sure whether, or in what respects, it should guide political reform.

Indeed, it often seems that constructivist conceptions of science have contributed to a *lack* of public interest in the politics of science and technology. On the one hand, one might argue, the polemical attacks that constructivists tend to elicit from rationalist defenders of science help stimulate public interest in the politics of science. On the other hand, constructivist skepticism is often said to contribute to declining rates of political participation and trust in government.[9] The decline of the Enlightenment conception of scientific knowledge as a mirror of nature seems to have facilitated a corresponding decline in the creative political action that such knowledge once motivated. As Reinhold Niebuhr remarked in his attack on Deweyan pragmatism, "Contending factions in a social struggle require morale; and morale is created by the right dogmas, symbols and emotionally potent oversimplifications."[10] If scientific knowledge is understood as a

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[8] Benjamin R. Barber, "Foundationalism and Democracy," in *Democracy and Difference: Contesting the Boundaries of the Political*, ed. Seyla Benhabib (Princeton: Princeton University Press, 1996), 348-59.

[9] See, for example, Todd Gitlin, *The Twilight of Common Dreams* (New York: Henry Holt and Co., Inc., Metropolitan Books, 1995); Joseph S. Nye, Jr., Philip Zelikow, and David C. King, eds., *Why People Don't Trust Government* (Cambridge: Harvard University Press, 1997).

[10] Reinhold Niebuhr, *Moral Man and Immoral Society: A Study in Ethics and Politics* (New York: Charles Scribner's Sons, [1932] 1948), xv.

product, in part, of human artifice, rather than simply a reflection of natural forces, science can no longer serve as an extra-political guarantor of liberal-democratic politics.

The delegitimization of the spectator theory of knowledge thus seems to strengthen citizens' nagging fears, forcefully described by Dewey and Lippmann, that politics is no longer as transparently open to public evaluation as it presumably once was. Indeed, citizens today increasingly seem to believe their public representatives are motivated by personal gain rather than effective results. And public officials, as we saw in the electric vehicle case, find it increasingly difficult to find persuasive rationales for public policy.

Are constructivist theories of science either symptoms or causes of these developments? Ezrahi argues they are, because

> even if the recent decline of the spectator theory of knowlege does not undermine the internal grounds of science and its practice, even if the implications of this development are undestood mainly by a relatively small group of practicing scientists, philosophers, and historians of science, it has indirect cultural and social ramifications, a wider resonance which weakens the authority of the very images and metaphors that mediated between the earlier ideological and political import of science in the liberal-democratic polity.[11]

Without objective scientific knowledge to unite a heterogeneous public, it becomes difficult to legitimize shared programs of political action.

From this perspective, the decline in instrumentalism supports the rise of what Ezrahi calls "conservative anarchist" or libertarian conceptions of politics.[12] Libertarianism need not imply a decline in the legitimacy of government, but legitimacy comes to rest on benign incompetence rather than instrumental effectiveness.

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[11] Ezrahi, *Descent of Icarus*, 273-74.

[12] Ibid., 283-290.

Libertarians thus celebrate the failure of public officials to implement major policy initiatives as the realization of their ideal of limited government. Whereas instrumentalism controls public officials by subjecting their actions to public assessments of effectiveness, libertarianism guards against the abuse of power by weakening the rationale to act at all. To the extent that public policy continues to promote social change, it adopts an incrementalist approach—President Clinton's micro-initiatives, for example—often lacking the guidance of larger ideals.[13]

The decline of *political* instrumentalism also seems to support, ironically, the strengthening of *private* instrumentalism. The union of epistemological relativism and political individualism fosters new (and New Age) projects of self-creation, motivated by a search for purity, authenticity, and autonomy, rather than truth or the public good. Since individual autonomy is assumed to conflict with the demands of social institutions, experiments in self-creation must remain private. Richard Rorty's "liberal ironists," for example, believe they must continually question their basic beliefs, depriving themselves of any motivation for political action.[14] Or as Richard Merelman put it recently, "Citizens are now preoccupied with transforming themselves, not with dominating nature. Therefore, they are not drawn to a government that portrays itself as a machine of political control."[15]

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[13] For a defense of this approach to public policy, see Charles Lindblom, *Inquiry and Change: The Troubled Attempt to Understand and Shape Society* (New Haven, CT: Yale University Press, 1990).

[14] Richard Rorty, *Contingency, Irony, and Solidarity* (Cambridge: Cambridge University Press, 1989), esp. 91.

[15] Richard M. Merelman, "Technological Cultures and Liberal Democracy in the United States," *Science, Technology, & Human Values* 25, no. 2 (Spring 2000): 167-194, at 190.

The privatism that currently dominates prevailing conceptions of politics cannot be denied, and one can plausibly argue that some form of epistemological constructivism is in part to blame. But this argument applies far better to an extreme form of sociological constructivism than to the political constructivism defended in this dissertation. The voluntarism and instrumentalism of the latter contrasts sharply with the view that scientific knowledge simply mirrors social categories.

Similarly, the claim that constructivism necessarily leads to privatism neglects the interdependence of procedural and substantive modes of representation, examined in Chapter 6. The assertion that constructivism necessarily leads to privatism assumes that the intrinsic value of political participation, its contribution to personal projects of self-transformation, must be separated from the instrumental value of substantively effective policy. But as we have seen, both democracy and science depend on both procedural and substantive representation. In science, formal procedures cannot eliminate the need for substantive knowledge and skills, and substantively effective results depend on procedures for enlisting reliable allies. (Of course, scientists can produce effective knowledge without formally specifying their procedures, but I showed above that, in some instances at least, creating formal procedures that guarantee a role for lay citizens promises to produce more effective science.) In politics, formally democratic procedures cannot eliminate the need for an educated citizenry, and substantively effective policy cannot reduce the need for public participation. In each case, formal procedures and substantive results must complement each other. A theory of political constructivism can help integrate the procedural and substantive dimensions of both politics and science. Political constructivism shows how the substantive dimensions of political and scientific constructions--i.e., effective policies and reliable facts--can be strengthened by procedures that involve lay citizens in the relevant processes of construction.

A constructivist theory of science, then, does not necessarily pose an obstacle to the democratization of science and technology, but rather can promote it. Moving beyond the Enlightenment conception of science does not require the complete expulsion of science from politics, as the critics of liberal instrumentalism discussed in Chapter 4 have urged. Rather, democratic politics might well continue to draw on the symbolic resources of modern science, but in the context of a growing popular understanding that science has never been exactly what we thought it was. Citizens might come to see politics *and* science as combinations of instrumental and moral elements. Recognizing that technical constraints on human action are no less real for being "constructed," citizens might perpetuate liberal-democratic strategies of reconciling freedom and necessity, but in a way that allows them to participate in shaping the technical artifacts that increasingly shape their lives.

# WORKS CITED


Adams, Mark B. "Towards a Comparative History of Eugenics." In *The Wellborn Science: Eugenics in Germany, France, Brazil, and Russia*, ed. Mark B. Adams, 217-31. New York: Oxford University Press, 1990.

Akrich, Madeline. "The De-Scription of Technical Objects." In *Shaping Technology/ Building Society: Studies in Sociotechnical Change*, ed. Wiebe E. Bijker and John Law. Cambridge: MIT Press, 1992.

Almond, Gabriel A., and Sidney Verba. *The Civic Culture*. Princeton, NJ: Princeton University Press, 1963.

Arendt, Hannah, *The Human Condition*. Chicago: University of Chicago Press, 1958.

________. "Truth and Politics." In *Between Past and Future*. New York: Viking Press, 1968. Reprint Penguin Books, 1993.

Aristotle. *Metaphysics* and *Nicomachean Ethics*. In *A New Aristotle Reader*, ed. J. L. Ackrill. Princeton: Princeton University Press, 1987.

________. *The Politics of Aristotle*, ed. and trans. Ernest Barker. London: Clarendon Press, 1946; New York: Oxford University Press, 1958.

Ashcraft, Richard. "One Step Backward, Two Steps Forward: Reflections upon Contemporary Political Theory." In *What Should Political Theory Be Now?* ed. John S. Nelson. Albany, NY: State University of New York Press, 1983.

Ayer, Alfred Jules. *Language, Truth, and Logic*. New York: Dover Publications Inc., 1946.

Bachrach, Peter. *The Theory of Democratic Elitism: A Critique*. Boston: Little, Brown, 1967.

Bacon, Francis. *The Great Instauration*. In *Selected Writings of Francis Bacon*, ed. Hugh G. Dick. New York: Modern Library, 1955.

________. *Novum Organon*. In *Selected Writings of Francis Bacon*, ed. Hugh G. Dick New York: Modern Library, 1955.

Ball, Terrence. *Reappraising Political Theory*. Oxford University Press, 1995.

Ball, Terrence, James Farr, and Russell L. Hanson, eds. *Political Innovation and Conceptual Change*. Cambridge: Cambridge University Press, 1989.

Barber, Benjamin R. *The Death of Communal Liberty: A History of Freedom in a Swiss Mountain Canton*. Princeton: Princeton University Press, 1974.

________. *Strong Democracy: Participatory Politics for a New Age*. Berkeley: University of California Press, 1984.

________. *An Aristocracy of Everyone: The Politics of Education and the Future of America*. New York: Ballantine Books, 1992.

________. *Jihad vs. McWorld: How Globalism and Tribalism are Reshaping the World*. New York: Ballantine Books, 1996.

________. "Foundationalism and Democracy" In *Democracy and Difference: Contesting the Boundaries of the Political*, ed. Seyla Benhabib, 348-59. Princeton: Princeton University Press, 1996.

________. *A Place for Us: How to Make Society Civil and Democracy Strong*. New York: Farrar, Straus, and Giroux; Hill and Wang, 1998.

Barnes, Barry. *Scientific Knowledge and Sociological Theory*. London and Boston: Routledge and Kegan Paul, 1974.

Beck, Ulrich. *Ecological Enlightenment: Essays on the Politics of the Risk Society*, trans. Mark A. Ritter. Atlantic Highlands, NJ: Humanities Press, 1995.

Bennett, Jane. "The Return of the Swerve: Environmental Ethics and the Enchanted Materialism of Epicurus and Ilya Prirogine." Paper presented at the American Political Science Association annual conference, September 2, 2000.

Berger, Peter L., and Thomas Luckman. *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. New York: Doubleday, Anchor Books [1966] 1967.

Berlin, Isaiah. *Vico and Herder: Two Studies in the History of Ideas*. London: Hogarth Press, 1976.

Bevan, Analisa R., manager ZEV Implementation Section, California Air Resources Board. Interview by author, Sacramento, CA, May 28, 1999.

Bijker, Wiebe E. "The Social Construction of Fluorescent Lighting, Or How an Artifact Was Invented in Its Diffusion Stage." In *Shaping Technology Building Society: Studies in Sociotechnical Change*, ed. Wiebe E. Bijker and John Law, 75-102. Cambridge: Massachusetts Institute of Technology Press, 1992.

Bimber, Bruce. "Three Faces of Technological Determinism." In *Does Technology Drive History?* ed. Merritt Roe Smith and Leo Marx, 80-100. Cambridge: Massachusetts Institute of Technology Press, 1995.

________. *The Politics of Expertise in Congress: The Rise and Fall of the Office of Technology Assessment.* Albany: State University of New York Press, 1996.

Bimber, Bruce, and David Guston. "Politics by the Same Means: Government and Science in the United States." In *Handbook of Science and Technology Studies*, ed. Jasanoff, et al., 554-71. Thousand Oaks, CA: Sage Publications, 1995.

Bledstein, Burton J. *The Culture of Professionalism: The Middle Class and the Development of Higher Education in America.* New York: W.W. Norton & Co., 1976.

Bloor, David. *Knowledge and Social Imagery.* London and Boston: Routledge and Kegan Paul, 1976.

________. "Anti-Latour." *Studies in the History and Philosophy of Science* 30 (March 1999): 81-112.

Bohman, James. "Democracy as Inquiry, Inquiry as Democratic: Pragmatism, Social Science, and the Cognitive Division of Labor." *American Journal of Political Science* 43, no. 2 (April 1999): 590-607.

Bottles, Scott L. *Los Angeles and the Automobile: The Making of a Modern City.* Berkeley: University of California Press, 1987.

Brogan, Joseph V. "A Mirror of Enlightenment: The Rational Choice Debate." *The Review of Politics* 58 (Fall 1996): 793-806.

Broman, Thomas. "The Habermasian Public Sphere and 'Science *in* the Enlightenment'." *History of Science* 36 (1998): 123-149.

Brown, James Robert. "Latour's Prosaic Science." *Canadian Journal of Philosophy* 21 (1991): 245-61.

Brown, Mark B. "Conceptions of Science in Political Theory: A Tale of Cloaks and Daggers." In *Vocations of Political Theory*, ed. Jason A. Frank and John Tambornino, 189-211. Minneapolis: Minnesota University Press, 2000.

________. "The Civic Shaping of Technology: California's Electric Vehicle Program." *Science, Technology, & Human Values*, forthcoming.

________. "Thomas Hobbes, Natural Science, and the Sovereignty of Politics." Unpublished manuscript.

Brown, Mark B., Weert Canzler, Frank Fischer, and Andreas Knie. "Technological Innovation through Environmental Policy: California's Zero-Emission Vehicle Regulation." *Public Productivity and Management Review* 19, no. 1 (1995): 77-93.

Brown, Richard D. *The Strength of a People: The Idea of an Informed Citizenry in America, 1650-1870*. Chapel Hill: University of North Carolina Press, 1996.

Brown, Wendy. *Manhood and Politics: A Feminist Reading in Political Theory*. New York: Roman and Littlefield, 1988.

Bullard, Robert, and Glenn S. Johnson, eds. *Just Transportation: Dismantling Race and Class Barriers to Mobility*. Gabriola Island, BC; Stony Creek, CT: New Society Publishers, 1997.

Bullert, Gary. *The Politics of John Dewey*. Buffalo, NY: Prometheus Books, 1983.

Burke, Edmund. *Reflections on the Revolution in France*, ed. J. G. A. Pocock. Indianapolis, IN: Hackett Publishing Company, [1790] 1987.

Button, Mark, and Kevin Mattson. "Deliberative Democracy in Practice: Challenges and Prospects for Civic Deliberation." *Polity* 31, no. 4 (Summer 1999): 609-37.

Cackette, Tom. "Explaining California's Continuum." In *Building the E-Motive Industry: Essays and Conversations for Creating an Electric Vehicle Industry*, ed. Scott A. Cronk, 52-56. Warrendale, PA: Society of Automotive Engineers, 1995.

Callon, Michel. "The State and Technical Innovation. A Case Study of the Electric Vehicle." *Research Policy* 9 (1980): 358-376.

________. "Society in the Making: The Study of Technology as a Tool for Sociological Analysis." In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, 83-103. Cambridge: Massachusetts Institute of Technology Press, 1987.

________. "Is Science a Public Good?" *Science, Technology, & Human Values* 19, no. 4 (1994): 395-424.

Callon, Michel, John Law, and Arie Rip. *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*. London: Macmillan Press, Ltd., 1986.

Canzler, Weert, and Andreas Knie. *Das Ende des Automobils: Fakten und Trends zum Umbau der Autogesellschaft*. Heidelberg: C. F. Müller, 1994.

________. *Möglichkeitsräume: Grundrisse einer modernen Mobilitäts- und Verkehrspolitik*. Vienna: Böhlau Verlag, 1998.

CARB (State of California, Air Resources Board). *Proposed Regulations for Low-Emission Vehicles and Clean Fuels, Final Statement of Reasons*. Sacramento, CA, July, 1991.

________. *Technical Support Document, Zero-Emission Vehicle Update.* Sacramento, CA, April 1994.

________. *Public Meeting to Update Board on Technological Progress of Zero-Emission Vehicles.* Agenda Item 95-11-3. Sacramento, CA, October 26, 1995.

________. *Staff Report: Initial Statement of Rulemaking: Proposed Amendments to the Zero-Emission Vehicle Requirements for Passenger Cars and Light-Duty Trucks.* Sacramento, CA, February 9, 1996.

________. *Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Response.* Sacramento, CA, March 28, 1996.

________. *Zero-Emission Vehicle Biennial Program Review.* Sacramento, CA: July 6, 1998.

________. *Resolution 98-53.* Sacramento, CA, November 5, 1998.

Chaloupka, William. "John Dewey's Social Aesthetics as a Precedent for Environmental Thought." *Environmental Ethics* 9 (Fall 1987): 243-60.

Child, Arthur. "Making and Knowing in Hobbes, Vico, and Dewey." *University of California Publications in Philosophy* 16, no. 13 (1953): 271-310.

Collingridge, David, and Colin Reeve. *Science Speaks to Power: The Role of Experts in Policymaking.* New York: St. Martin's Press, 1986.

Collins, H. M., and Steven Yearly. "Epistemological Chicken." In *Science as Practice and Culture*, ed. Andrew Pickering, 301-26. Chicago: University of Chicago Press, 1992.

Comte, Auguste. *A General View of Positivism*, trans. J. H. Bridges. London: Trubner and Co., [1848] 1865. Reprint, intro. Mihaly Csikszentmihalyi. Dubuque, Iowa: Brown Reprints in Sociology, 1971.

Cone, Marla. "State Holds Firm on Deadline for Electric Cars." *Los Angeles Times.* May 14, 1994, A1.

________. "Air Panel Bending Under Pressure." *Los Angeles Times.* December 20, 1996, A3.

________. "State Air Board Repeals Mandate for Electric Cars." *Los Angeles Times.* March 30, 1996, A1

Connolly, William, ed. *The Bias of Pluralism.* New York: Atherton Press, 1969.

________. *The Terms of Political Discourse*, 3rd. ed. Princeton: Princeton University Press, [1974] 1993.

Cooter, Roger, and Stephen Pumfrey. "Separate Spheres and Public Places: Reflections on the History of Science Popularization and Science in Popular Culture." *History of Science* 32 (1994): 237-267.

Cozzens, Susan E., and Edward J. Woodhouse. "Science, Government, and the Politics of Knowledge." In *Handbook of Science and Technology Studies*, ed. Jasanoff, et al., 533-53.

*Critical Review*. "Special Issue: Public Ignorance and Democracy" Vol. 12, no. 4 (Fall 1998).

Crain, Robert L., Elihu Katz and Donald B. Rosenthal. *The Politics of Community Conflict: The Fluoridation Decision*. Indianapolis: Bobbs-Merrill, 1969.

Crozier, Michael J., Samuel P. Huntington, and Joji Watanuki. *The Crisis of Democracy: A Report on the Governability of Democracies to the Trilateral Commission*. New York: New York University Press, 1975.

Dahl, Robert. *Who Governs?* New Haven: Yale University Press, 1961.

D'Alembert, Jean Le Rond. *Preliminary Discourse to the Encyclopedia of Diderot* (1751), trans. Richard N. Schwab. Chicago: University of Chicago Press, 1995.

Davison, Aidan, Ian Barns, and Renato Schibeci. "Problematic Publics: A Critical Review of Surveys of Public Attitudes to Biotechnology." *Science, Technology, & Human Values* 22, no. 3 (1997): 317-348.

Dear, Peter. *Discipline and Experience: The Mathematical Way in the Scientific Revolution*. Chicago: University of Chicago Press, 1995.

Dewey, John. "Renan's Loss of Faith in Science" (1893). In *The Early Works*. Vol. 4, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1971.

________. "The Influence of Darwin on Philosophy" (1909). In *The Middle Works* Vol. 4, ed. Jo Ann Boydston, 3-14. Carbondale and Edwardsville: Southern Illinois University Press, 1977.

________. "The Need for a Recovery of Philosophy" (1916). In *The Middle Works* Vol. 10, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1980.

________. *Democracy and Education*. New York: Macmillan Publishing Co., 1916.

________. "Science as Subject-Matter and Method" (1910). In *The Middle Works* Vol. 6, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1985.

________. "Epistemological Realism: The Alleged Ubiquity of the Knowledge Relation." In *The Middle Works* Vol. 6, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1985.

________. "Brief Studies in Realism." In *The Middle Works* Vol. 6, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1985.

________. "Philosophy and Democracy" (1919). In *The Middle Works* Vol. 11, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1982.

________. *Reconstruction in Philosophy* (1920). In *The Middle Works* Vol. 12, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1988.

________. *Human Nature and Conduct* (1922). In *The Middle Works* Vol. 14, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1983.

________. *Experience and Nature* (1925). In *The Later Works* Vol. 1, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1988.

________. "Practical Democracy" (1925), review of *The Phantom Public*, by Walter Lippmann. In *Later Works* Vol. 2, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1984.

________. *The Public and Its Problems.* New York: Henry Holt and Company, 1927.

________. *The Quest for Certainty* (1929). In *The Later Works* Vol. 4, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1988.

________. "Social Science and Social Control" (1931). In *The Later Works* Vol. 6, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1985.

________. *Liberalism and Social Action*. In *The Later Works* Vol. 11, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1991.

________. *Logic: The Theory of Inquiry*. In *The Later Works* Vol. 12, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1986.

________. *Freedom and Culture*. In *The Later Works* Vol. 13, ed. Jo Ann Boydston Carbondale and Edwardsville: Southern Illinois University Press, 1988.

________. "The Revolt Against Science." In *The Later Works* Vol. 15, ed. Jo Ann Boydston. Carbondale and Edwardsville: Southern Illinois University Press, 1989.

________. "Experience, Knowledge, and Value: A Rejoinder." In *The Philosophy of John Dewey*, 2nd ed., ed. Paul Arthur Schilpp, 517-608. New York: Tudor Publishing Company, [1939] 1951.

Diekman, Andreas, and Peter Preisendörfer. "Environmental Behavior: Discrepancies between Aspirations and Reality." *Rationality and Society* 10, no. 1 (1998): 79-102.

Dietz, Mary G. "'The Slow Boring of Hard Boards': Methodical Thinking and the Work of Politics." *American Political Science Review* 88, no. 4 (1994): 873-86.

Diggins, John Patrick. *The Promise of Pragmatism: Modernism and the Crisis of Knowledge*. Chicago: University of Chicago Press, 1994.

Doherty, Brian, and Marius de Geus, eds. *Democracy and Green Political Thought*. New York: Routledge, 1996.

Duany, Andres, Elizabeth Plater-Zyberk, and Jeff Speck. *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. New York: North Point, 2000.

Duran, Lisa. "Labor/Community Strategy Center Organizes Bus Riders Union in L.A." *Race, Poverty, and the Environment Newsletter* 6, no. 1 (Fall 1995): 8-9.

Eaton, Robert J. "The Automobile Industry: Health Care, Air Pollution, and the Electric Car." *Vital Speeches* 60, no. 16 (June 1, 1994): 492-94.

Efrus, Robert. Document of testimony at CARB public meeting to update Board on technological progress of Zero-Emission Vehicles. Agenda Item 95-12-4. Sacramento, CA: November 16, 1995.

Eley, Geoff. "Nations, Publics, and Political Cultures: Placing Habermas in the Nineteenth Century." In *Habermas and the Public Sphere*, ed. Craig Calhoun, 289-339. Cambridge: Massachusetts Institute of Technology, 1992.

Elkin, Stephen L., and Korel Edward Soltan, eds. *Citizen Competence and Democratic Institutions*. University Park: Pennsylvania State University Press, 1999.

Ellul, Jacques. *The Technological Society*. New York: Alfred A. Knopf, Inc., 1964.

Epstein, Steven. "The Construction of Lay Expertise: AIDS Activism and the Forging of Credibility in Clinical Trials." *Science, Technology, & Human Values* 20, no. 4 (Autumn 1995): 408-437.

________. *Impure Science: AIDS, Activism, and the Politics of Knowledge*. Berkeley: University of California Press, 1996.

Euben, J. Peter. *Corrupting Youth: Political Education, Democratic Culture, and Political Theory*. Princeton: Princeton University Press, 1997.

Evashenk, Thomas A. Manager, ZEV Implementation Section, California Air Resources Board. Interview by author. Sacramento, California. May 12, 1999.

Ezrahi, Yaron. "Science and the Problem of Authority in Democracy." In *Science and Social Structure: A Festschrift for Robert K. Merton*, Transactions of the New York Academy of Sciences, Vol. 39, ed. Thomas F. Gieryn, 43-60. New York: New York Academy of Sciences, 1980.

________. "Utopian and Pragmatic Rationalism: The Political Context of Scientific Advice," *Minerva* 18 (1980): 111-31.

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

________. "Dewey's Critique of Democratic Visual Culture and Its Political Implications." In *Sites of Vision: The Discursive Construction of Sight in the History of Philosophy*, ed. David Michael Levin, 315-36. Cambridge: MIT Press, 1997.

Farr, James. "Political Science and the Enlightenment of Enthusiasm." *American Political Science Review* 82, no. 1 (1988): 51-69.

Faulkner, Wendy. "Conceptualizing Knowledge Used in Innovation: A Second Look at the Science-Technology Relation and Industrial Innovation." *Science, Technology, & Human Values* 19, no. 4 (Fall 1994): 425-58.

Feenberg, Andrew. "Subversive Rationalization: Technology, Power and Democracy." In *Technology and the Politics of Knowledge*, ed. Andrew Feenberg and Alastair Hannay, 3-22. Bloomington and Indianapolis: Indiana University Press, 1995.

________. *Alternative Modernity: The Technical Turn in Philosophy and Social Theory*. Berkeley: University of California Press, 1995.

________. *Questioning Technology*. London and New York: Routledge, 1999.

Feyerabend, Paul. *Against Method*, 3rd ed. London: Verso, [1975] 1993.

________. *Science in a Free Society*. London: New Left Books, Verso, [1978] 1982.

Finley, M. I. *Politics in the Ancient World*. Cambridge: Cambridge University Press, 1983.

Fiorino, Daniel J. "Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms." *Science, Technology, & Human Values* 15, no. 2 (Spring 1990): 226-43.

________. "Environmental Policy and the Participation Gap." In *Democracy and the Environment: Problems and Prospects*, ed. William M. Lafferty and James Meadowcroft. Cheltenham, UK and Brookfield, VT: Edward Elgar, 1996.

Fischer, Frank. *Technocracy and the Politics of Expertise*. Newbury Park, CA: Sage Publications, 1990.

________. "Citizen Participation and the Democratization of Policy Expertise: From Theoretical Inquiry to Practical Cases." *Policy Sciences* 26 (1993): 165-87.

Fischer, Frank, and John Forester, eds. *The Argumentative Turn in Policy Analysis and Planning*. Durham and London: Duke University Press, 1993.

Fishkin, James S. *The Voice of the People: Public Opinion and Democracy*. New Haven: Yale University Press, 1995.

Fishman, Ethan. "Political Philosophy and the Policy Studies Organization." *PS: Political Science and Politics* 24 (1991): 720-23.

________, ed. *Public Policy and the Public Good*. New York: Greenwood Press, 1991.

Flathman, Richard. *Thomas Hobbes: Skepticism, Individuality and Chastened Politics*. Newbury Park, CA: Sage Publications, Inc, 1993.

Flink, James J. *The Automobile Age*. Cambridge: MIT Press. 1988.

Fortun, Mike, and Herbert J. Bernstein. *Muddling Through: Pursuing Science and Truths in the twenty-first Century*. Washington, DC: Counterpoint, 1998.

Fraser, Nancy. "Rethinking the Public Sphere: A Contribution to the Critique of Actually Existing Democracy." In *Habermas and the Public Sphere*, ed. Craig Calhoun, 109-42. Cambridge: MIT Press, 1992.

Freund, Peter, and George Martin. *The Ecology of the Automobile*. Cheektowaga, NY: Black Rose Books, 1993.

Fogelberg, Hans. *The Electric Car Controversy: A Social-Constructivist Interpretation of the California Zero-Emission Vehicle Mandate*. Department of History of Technology and Industry, Chalmers University of Technology, Göteberg, Sweden, 1998.

Foucault, Michel. *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan. New York: Random House, Vintage Books, [1975] 1979.

________. *Power/Knowledge: Selected Interviews & Other Writings, 1972-1977*, ed. Colin Gordon. New York: Pantheon Books, 1972.

Friedman, Milton. *Capitalism and Freedom*. Chicago: The University of Chicago Press, [1962] 1982.

Fuller, Steve. *Social Epistemology*. Bloomington and Indianapolis: Indiana University Press, 1988.

________. *Philosophy, Rhetoric and the End of Knowledge: The Coming of Science and Technology Studies*. Madison: University of Wisconsin Press, 1993.

________. *The Governance of Science: Ideology and the Future of the Open Society*. Buckingham, UK, and Philadelphia, PA: Open University Press, 2000.

Geertz, Clifford. "The Strange Estrangement: Taylor and the Natural Sciences." In *Philosophy in an Age of Pluralism: The Philosophy of Charles Taylor in Question*, ed. James Tully, 83-95. Cambridge: Cambridge University Press, 1994.

Gieryn, Thomas F. "Boundaries of Science." In *Handbook of Science and Technology Studies*, ed. Jasanoff, et al., 393-443.

Goggin, Malcolm L., "Science and Technology: Who Should Govern?" in *Governing Science and Technology in a Democracy*, ed. Malcolm L. Goggin (Knoxville: University of Tennessee Press, 1986), 37-56.

Golinski, Jan. *Making Natural Knowledge: Constructivism and the History of Science*. Cambridge and New York: Cambridge University Press, 1998.

Goodin, Robert E. *Political Theory and Public Policy*. Chicago: The University of Chicago Press, 1982.

Green, Donald Philip. "The Price Elasticity of Mass Preferences." *American Political Science Review* 86, no. 1 (1992): 128-48.

Gundersen, Adolf G. *The Environmental Promise of Democratic Deliberation*. Madison: University of Wisconsin Press, 1995.

Guston, David H. "The Essential Tension in Science and Democracy." *Social Epistemology* 7, no. 1 (1993): 3-23.

________. "Evaluating the First U.S. Consensus Conference: The Impact of the Citizens' Panel on Telecommunications and the Future of Democracy." *Science, Technology, & Human Values*, 24, no. 4 (1999): 451-82.

________. "Stabilizing the Boundary between U.S. Politics and Science: The Role of the Office of Technology Transfer as a Boundary Organization." *Social Studies of Science* 29, no. 1 (1999): 87-112.

________. *Between Politics and Science: Assuring the Integrity and Productivity of Research*. Cambridge: Cambridge University Press, 2000.

Guston., David H., and Kenneth Keniston. "Introduction: The Social Contract for Science." In *The Fragile Contract: University Science and the Federal Government*, ed. Guston and Keniston, 1-41. Cambridge: MIT Press, 1994.

Gutmann, Amy, and Dennis Thompson. *Democracy and Disagreement*. Cambridge: Harvard University Press, 1996.

Greene, John C. *American Science in the Age of Jefferson.* Ames, IO: The Iowa State University Press, 1984.

Gross, Paul R., and Norman Levitt. *Higher Superstition: The Academic Left and Its Quarrels with Science*. Baltimore, MD: Johns Hopkins University Press, 1994.

Gunnell, John G. "Realizing Theory: The Philosophy of Science Revisited." *The Journal of Politics* 57, no. 4 (1995): 923-40.

Gunnell, John G. *Between Philosophy and Politics: The Alienation of Political Theory*. Amherst, MA: University of Massachusetts Press, 1986.

Habermas, Jürgen. *The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society*, trans. Thomas Burger. Cambridge: MIT Press, [1962] 1989.

________. "Technical Progress and the Social Life World." In *Toward a Rational Society: Student Protest, Science, and Politics*, trans. Jeremy J. Shapiro, 50-61. Boston: Beacon Press, [1968] 1970.

________. "Technology and Science as 'Ideology.'" In *Toward a Rational Society*, 81-122.

________. *Knowledge and Human Interests*. Boston: Beacon Press, [1968] 1971.

________. "The New Obscurity: The Crisis of the Welfare State and the Exhaustion of Utopian Energies." In *The New Conservatism: Cultural Criticism and the Historians' Debate*, ed. and trans. Shierry Weber Nicholsen, 48-70. Cambridge: MIT Press, 1989.

Hacking, Ian. *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press, 1983.

________. "The Self-Vindication of the Laboratory Sciences." In *Science as Practice and Culture*, ed. Pickering, 139-67.

________. *The Social Construction of What?* Cambridge: Harvard University Press, 1999.

Hall, Jane V. "ZEVs and California's Future Prosperity." Document of testimony at CARB public workshop on the benefits and costs of Zero-Emission Vehicles. Los Angeles, CA, November 8, 1995.

Hanson, Norwood Russell. *Patterns of Discovery*. Cambridge: Cambridge University Press, 1958.

Haraway, Donna J. "A Cyborg Manifesto." In *Simians, Cyborgs, and Women: The Reinvention of Nature*, 127-48. New York: Routledge, 1991.

________. *Modest Witness@Second_Millenium. FemaleMan© Meets OncoMouse™: Feminism and Technoscience*. New York: Routledge, 1997.

Hård, Mikael, and Andreas Knie. "The Ruler of the Game: The Defining Power of the Standard Automobile." In *The Car and Its Environments: The Past, Present and Future of the Motorcar in Europe*, ed. Knut H. Sorensen, 137-58. Brussels: European Commission, 1994.

Harding, Sandra. *The Science Question in Feminism*. Ithaca: Cornell University Press, 1986.

Haskell, Thomas L., ed. *The Authority of Experts: Studies in History and Theory*. Bloomington: Indiana University Press, 1984.

Hays, Samuel P. *Beauty, Health, and Permanence: Environmental Politics in the United States, 1955-1985*. Cambridge: Cambridge University Press, 1987.

Heidegger, Martin. *The Question Concerning Technology and Other Essays*, trans. William Lovitt. New York: Harper and Row, [1954] 1977.

Hess, David J. *Science Studies: An Advanced Introduction*. New York and London: New York University Press, 1997.

Heyd, Michael J. "The Reaction to Enthusiasm in the Seventeenth Century: Towards an Integrative Approach." *Journal of Modern History* 53 (1981): 258-280.

Hickman, Larry A. *John Dewey's Pragmatic Technology*. Bloomington and Indianapolis: Indiana University Press, 1990.

Hilton, R. H., and P. H. Sawyer. "Technical Determinism: The Stirrup and the Plough." *Past and Present* 24 (April 1963): 90-100.

Hobbes, Thomas. *On the Citizen*, ed. Richard Tuck and Michael Silverthorne. Cambridge: Cambridge University Press, 1998.

________. *The Elements of Law, Natural and Politic*, ed. J. C. A. Gaskin. Oxford: Oxford University Press, 1994.

________. *Leviathan*, ed. Richard Tuck. Cambridge: Cambridge University Press, 1991.

________. *De Homine*. In *Man and Citizen*, trans. Charles T. Wood, T. S. K. Scott-Craig, and Bernard Gert, ed. Bernard Gert. Indianapolis: Hackett Publishing Company, 1991.

________. *Dialogus Physicus*, trans. Simon Schaffer. In Shapin and Schaffer, *Leviathan and the Air-Pump*, 345-91.

________. *De Corpore*. In *Body, Man, and Citizen*, ed. Richard S. Peters (New York: Crowell-Collier Publishing Co., Collier Books, 1962).

Hollinger, David A. "The Defense of Democracy and Robert K. Merton's Formulation of the Scientific Ethos." *Knowledge and Society: Studies in the Sociology of Culture Past and Present* 4 (1983): 1-15.

________. "Free Enterprise and Free Inquiry: The Emergence of Laissez-Faire Communitarianism in the Ideology of Science in the United States." *New Literary History* 21 (1990): 897-919.

Holman, Halsted R., and Diana B. Dutton. "A Case for Public Participation in Science Policy Formation and Practice." *Southern California Law Review* 51 (1978): 1505-34.

Horkheimer, Max. *The Eclipse of Reason*. Oxford: Oxford University Press, 1947; New York: Continuum Publishing Corp., 1992.

Horkheimer, Max, and Theodor Adorno. *Dialectic of Enlightenment*, trans. John Cumming. New York: Continuum, [1944] 1993.

Huang, Roland J. "Comments on the Benefits and Costs of the Zero-Emission Vehicle Program." Document of testimony at CARB public workshop on the benefits and costs of Zero-Emission Vehicles. Los Angeles, CA, November 8, 1995.

Hughes, Thomas P. "The Evolution of Large Technical Systems." In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, 51-82. Cambridge: MIT Press, 1987.

Hulliung, Mark. *The Autocritique of Enlightenment: Rousseau and the Philosophes*. Cambridge: Harvard University Press, 1994.

Ingram, Helen, and Steven Rathgeb Smith, eds. *Public Policy for Democracy*. Washington, DC: The Brookings Institution, 1993.

Irwin, Alan. *Citizen Science: A Study of People, Expertise, and Sustainable Development*. London: Routledge, 1995.

Isaac, Jeffrey C. "After Empiricism: The Realist Alternative." In *Idioms of Inquiry: Critique and Renewal in Political Science*, ed. Terrence Ball, 187-205. Albany, NY: State University of New York Press, 1987.

________. "The Strange Silence of Political Theory." *Political Theory* 23 (1995): 636-688.

Jacob, James R. *Robert Boyle and the English Revolution: A Study in Social and Intellectual Change*. New York: Burt Franklin, 1977.

Jacob, Margaret C. "Newtonianism and Origins of Enlightenment--Reassessment." *Eighteenth Century Studies* 11, no. 1 (1977): 1-25.

Jamison, Andrew. "Debating the Car in the 1960s and 1990s: Similarities and Differences." *Technology in Society* 17, no. 4 (1995): 453-67.

Jardine, Nick, and Marina Frasca-Spada. "Splendours and Miseries of the Science Wars." *Studies in History and Philosophy of Science* 28, no. 2 (1997): 219-235.

Jasanoff, Sheila. "Science, Politics, and the Renegotiation of Expertise at EPA." *OSIRIS* 7 (1992): 195-217.

________. *The Fifth Branch: Scientific Advisors as Policymakers*. Cambridge: Harvard University Press, 1990.

Jasanoff, Sheila, Gerald E. Markle, James C. Petersen, and Trevor Pinch, eds. *Handbook of Science and Technology Studies*. Thousand Oaks, CA: Sage Publications, 1995.

Jennings, Bruce. "Representation and Participation in the Democratic Governance of Science and Technology." In *Governing Science and Technology in a Democracy*, ed. Malcolm L. Goggin, 223-43. Knoxville: University of Tennessee Press, 1986.

Jefferson, Thomas. *Writings*, ed. Merrill D. Peterson. New York: The Library of America, 1984.

Johnson, James. "Is Talk Really Cheap? Prompting Conversation between Critical Theory and Rational Choice." *American Political Science Review* 87 (March 1993): 74-86.

Josephson, Paul R. *Totalitarian Science and Technology*. Atlantic Highlands, NJ: Humanities Press, 1996.

Joss, Simon. "Danish Consensus Conferences as a Model of Participatory Technology Assessment: An Impact Study of Consensus Conferences on Danish Parliament and Danish Public Debate." *Science and Public Policy* 25, no. 1 (February 1998): 2-22.

Kass, Leon R. "Introduction: The Problem of Technology." In *Technology in the Western Political Tradition*, ed. Arthur M. Melzer, Jerry Weinberger, and M. Richard Zinman, 1-24. Ithaca, NY: Cornell University Press, 1993.

Kalhammer, F. R., and A. Kozawa, C. B. Moyer, and B. B. Owens. *Performance and Availability of Batteries for Electric Vehicles: A Report of the Battery Technical Advisory Panel*, Prepared for California Air Resources Board. El Monte, California, December 11, 1995.

Kateb, George. "Technology and Philosophy." *Social Research* 54 (Fall 1997): 1225-46.

Katz, Alfred H. *Self-Help in America : A Social Movement Perspective*. New York : Twayne, 1993.

Kaufman-Osborn, Timothy. *Creatures of Prometheus: Gender and the Politics of Technology*. Lanham, MD: Roman and Littlefield Publishers, Inc., 1997.

Keller, Evelyn Fox. *Reflections on Gender and Science*. New Haven: Yale University Press, [1985] 1995.

Kirsch, David A. *The Electric Vehicle and the Burden of History*. New Brunswick, NJ: Rutgers University Press.

Kitowski, Jack. Interview by author. Sacramento, CA, May 28, 1999.

Kleinman, Daniel Lee. "Beyond the Science Wars: Contemplating the Democratization of Science." *Politics and the Life Sciences* 16, no. 2 (Sept. 1998): 133-45.

Kline, Ronald, and Trevor Pinch. "Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States." *Technology and Culture* 37 (Oct. 1996): 763-795.

Knie, Andreas, Otto Berthold, Mikael Hård, Trond Buland, Heidi Gjoen, Michel Quéré, Wolfgang Streicher, Bernard Truffer, and Sylvia Harms. *Consumer Use Patterns of Electric Vehicles*. FS II 97-105. Berlin: Wissenschaftszentrum Berlin für Sozialforschung, 1997.

Koertge, Noretta, ed. *A House Built on Sand: Exposing Postmodernist Myths about Science*. New York: Oxford University Press, 1998.

Krier, James E., and Edmund Ursin. *Pollution and Policy: A Case Essay on California and Federal Experience with Motor Vehicle Air Pollution, 1940-1975*. Berkeley: University of California Press, 1977.

Kraynak, Robert P. "Hobbes's *Behemoth* and the Argument for Absolutism." *American Political Science Review* 76, no. 4 (1982): 837-47.

Kuhn, Thomas S. *The Structure of Scientific Revolutions*, 2nd ed. Chicago: University of Chicago Press, [1962] 1970.

________. "Reflections on My Critics." In *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave, 231-278. Cambridge: Cambridge University Press, 1970.

Kurani, Kenneth S., Thomas Turrentine, and Daniel Sperling. "Testing Electric Vehicle Demand in 'Hybrid Households' Using a Reflexive Survey." *Transportation Research* 1, no. 2 (1996): 131-50.

Laird, Frank. "Participating in the Tension." Symposium on the compatibility of science and democracy, *Social Epistemology* 7, no. 1 (1993): 35-46.

________. "Participatory Analysis, Democracy, and Technological Decision Making." *Science, Technology, & Human Values* 18, no. 4 (1993): 341-361.

Landes, Joan B., ed. *Feminism, the Public and the Private*. Oxford: Oxford University Press, 1998.

Landy, Marc K. "Public Policy and Citizenship." In *Public Policy for Democracy*, ed. Helen Ingram and Steven Rathgeb Smith, 19-44. Washington, DC: The Brookings Institution, 1993.

Landy, Marc K., Marc J. Roberts, and Stephen R. Thomas. *The Environmental Protection Agency: Asking the Wrong Questions from Nixon to Clinton*. Expanded ed. New York: Oxford University Press, [1990] 1994.

Lustig, R. Jeffrey. *Corporate Liberalism: The Origins of Modern American Political Theory, 1890-1920*. Berkeley: University of California Press, 1982.

________. "Experiment in Democracy: or, Trouble in the Deliberated Zone." *The Good Society* 9, no. 1 (1999).

Latour, Bruno. "Give Me a Laboratory and I Will Raise the World." In *Science Observed*, ed. Karin D. Knorr-Cetina and Michael Mulkay, 141-70. London: Sage, 1983.

________. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge: Harvard University Press, 1987.

________. *The Pasteurization of France*, trans. Alan Sheridan and John Law. Cambridge: Harvard University Press, 1988.

________. *We Have Never Been Modern*, trans. Catherine Porter. Cambridge: Harvard University Press, 1993.

________. *Aramis, or The Love of Technology*, trans. Catherine Porter. Cambridge: Harvard University Press, 1996.

________. "For David Bloor...And Beyond: A Reply to David Bloor's 'Anti-Latour.'" *Studies in the History and Philosophy of Science* 30 (March 1999): 113-29.

________. *Pandora's Hope: Essays on the Reality of Science Studies.* Cambridge: Harvard University Press, 1999.

Latour, Bruno, and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts.* Newbury Park, CA: Sage, 1979; Princeton: Princeton University Press, 1986.

Latour, Bruno, and Michel Callon. "Don't Throw the Baby Out with the Bath School! A Reply to Collins and Yearly." In *Science as Practice and Culture*, ed. Andrew Pickering, 343-68. Chicago: University of Chicago Press, 1992.

Laudan, Larry. "The History of Science and the Philosophy of Science." In *Companion to the History of Modern Science*, ed. R. C. Colby, G. N. Cantor, J. R. R. Christie, and M. J. Hodge, 47-59. London and New York: Routledge, 1996.

Levins, Richard, and Richard Lewontin. "The Problem of Lysenkoism." In *The Dialectical Biologist.* Cambridge: Harvard University Press, 1985.

Lewinsohn-Zamir, Daphna. "Consumer Preferences, Citizen Preferences, and the Provision of Public Goods." *Yale Law Journal* 108, no. 2 (1998): 377-406.

Lindblom, Charles E. "The Market as Prison." *Journal of Politics* 44, no. 2 (1982): 324-36.

________. *Inquiry and Change: The Troubled Attempt to Understand and Shape Society.* New Haven: Yale University Press, 1990).

Lippmann, Walter. *The Phantom Public.* New York: Macmillan, 1925.

Locke, John. *An Essay Concerning Human Understanding*, ed. Peter H. Nidditch. Oxford University Press, [1689] 1975.

Longino, Helen. *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry.* Princeton: Princeton University Press, 1990.

Lowi, Theodore J. "American Business, Public Policy, Case Studies, and Political Theory." *World Politics* 16 (July 1964): 677-715.

________. *The End of Liberalism: The Second Republic of the United States*, 2nd ed. New York: W. W. Norton and Company, 1979.

Lowry, William R. *The Dimensions of Federalism: State Governments and Pollution Control Policies.* Durham: Duke University Press, 1992.

Lukes, Steven. *Power: A Radical View.* London: Macmillan Press, Ltd., 1974.

Lynch, Michael. "Representation is Overrated: Some Critical Remarks about the Concept of Representation in Science Studies." *Configurations* 2, no. 1 (1994): 137-149.

Lynch, Michael, and Steve Woolgar, eds. *Representation in Scientific Practice*. Cambridge: MIT Press, 1990.

Lyons, James M. "The Cost of the ZEV Mandate: 1998-2001." Document of testimony at CARB public workshop on the benefits and costs of Zero-Emission Vehicles. Los Angeles, CA, November 8, 1995.

MacLeod, Roy. "Science and Democracy: Historical Reflections on Present Discontents," *Minerva* 35 (1997): 369-384.

MacRae, Jr., Duncan. "Science and the Formation of Policy in a Democracy." *Minerva* 11, no. 2 (April 1973): 228-42.

Majone, Giandomenico. *Evidence, Argument, and Persuasion in the Policy Process*. New Haven: Yale University Press, 1989.

Manicas, Peter T. "Naturalizing Epistemology: Reconstructing Philosophy." In *Philosophy and the Reconstruction of Culture: Pragmatic Essays after Dewey*, ed. John J. Stuhr, 151-174. Albany: State University of New York Press, 1993.

________. "Pragmatic Philosophy of Science and the Charge of Scientism." *Transactions of the Charles S. Peirce Society* 24, no. 2 (Spring 1988): 179-222.

Marcuse, Herbert. *One Dimensional Man: Studies in the Ideology of Advanced Industrial Society*. Boston: Beacon Press, 1964.

Martin, Brian. "The Critique of Science becomes Academic." *Science, Technology, & Human Values* 18, no. 2 (1993): 247-59.

________. "Introduction." In *Technology and Public Participation*, ed. Brian Martin. Wollongong, Australia: Science and Technology Studies, University of Wollongong, 1999. Available at http://www.uow.edu.au/arts/sts/TPP.

Martin, Julian. *Francis Bacon, the State, and the Reform of Natural Philosophy*. Cambridge: Cambridge University Press, 1992.

McClure, Kirstie M. "Figuring Authority: Statistics, Liberal Narrative, and the Vanishing Subject," *Theory & Event* 3, no. 1 (1999) at http://www.press.jhu.edu/journals/theory&event/v003/3.1/1mcclure.html

McKibben, Bill. *The End of Nature*. New York: Doubleday, Anchor Books, 1989.

McLuhan, Marshall. "The Medium is the Message." In *Understanding Media*. New York: McGraw-Hill, 1964.

McMullin, Ernan. "The Development of Philosophy of Science, 1600-1900." In *Companion to the History of Modern Science*, ed. R. C. Colby, G. N. Cantor, J. R. R. Christie, and M. J. Hodge, 816-837. London and New York: Routledge, 1996.

McWilliams, Wilson Carey. *The Idea of Fraternity in America*. Berkeley: University of California Press, 1973.

________. "Science and Freedom: America as the Technological Republic." In *Technology in the Western Political Tradition*, ed. Arthur M. Melzer, Jerry Weinberger, and M. Richard Zinman, 85-108. Ithaca, NY: Cornell University Press, 1993.

Melzer, Arthur M., Jerry Weinberger, and M. Richard Zinman, eds. *Technology in the Western Political Tradition*. Ithaca, NY: Cornell University Press, 1993.

Merelman, Richard M. "Technological Cultures and Liberal Democracy in the United States." *Science, Technology, & Human Values* 25, no. 2 (Spring 2000): 167-194.

Merton, Robert K. *Social Theory and Social Structure*, revised and enlarged ed. London and Glencoe, IL: The Free Press, [1949] 1957.

________. "Science and Democratic Social Structure" In *Social Theory and Social Structure*, 550-61. Originally published as "Science and Technology in a Democratic Society." *Journal of Legal and Political Sociology* 1 (1942): 115-26.

Michels, Robert. *Political Parties*, trans. Eden and Cedar Paul. Glencoe, IL: The Free Press, [1915] 1949.

Mill, John Stuart. *Considerations on Representative Government* (1861). In *On Liberty and Other Essays*, ed. John Gray, 203-467. Oxford: Oxford University Press, 1991.

Morone, James A. *The Democratic Wish: Popular Participation and the Limits of American Government*. New York: Basic Books, 1990.

Mouffe, Chantal. *The Return of the Political*. London and New York: Verso, 1993.

Mumford, Lewis. *Technics and Civilization*. New York: Harcourt, Brace, and World, Inc, 1934.

Natural Resources Defense Council. *No more Tailpipes: The Role of Electric Vehicles in Clearing California's Air*. Washington, DC: NRDC, 1994.

Nelkin, Dorothy, ed. *Controversy: Politics of Technical Decisions*. Beverly Hills, CA: Sage Publications, 1979.

________. "Science and Technology Policy and the Democratic Process." In *Citizen Participation in Science Policy*, ed. James C. Petersen, 2-39. Amherst: University of Massachusetts Press, 1984.

________. *Selling Science: How the Press Covers Science and Technology*. New York: W. H. Freeman and Co., 1987.

Niebuhr, Reinhold. *Moral Man and Immoral Society: A Study in Ethics and Politics*. New York: Charles Scribner's Sons, [1932] 1948.

Nye, Joseph S., Jr., Philip Zelikow, and David C. King, eds. *Why People Don't Trust Government*. Cambridge: Harvard University Press, 1997.

Oakeshott, Michael. "Rationalism in Politics." In *Rationalism in Politics and Other Essays*. Indianapolis, IN: Liberty Press, [1947] 1991.

________. "Introduction to *Leviathan*." In *Rationalism in Politics and Other Essays*, new and expanded edition. Indianapolis, IN: Liberty Press, [1962] 1991.

Orwin, Clifford. "On the Sovereign Authorization." *Political Theory* 3 (February 1975): 26-44.

Osborne, David, and Ted Gaebler. *Reinventing Government: How the Entrepreneurial Spirit is Transforming the Public Sector*. New York: Addison-Wesley Publishing Company, Inc., 1992.

Outram, Dorinda. "Science and Political Ideology, 1790-1848." In *Companion to the History of Modern Science*, ed. R. C. Colby, G. N. Cantor, J. R. R. Christie, and M. J. Hodge, 1008-1023. London and New York: Routledge, 1996.

Pearson, Karl. *The Grammar of Science*. New York: Meridian Books, [1892, 1900, 1911] 1957.

Peirce, Charles Franklin. "How to Make Our Ideas Clear." In *The Essential Peirce*, ed. Nathan Houser and Christian Kloesel, 124-141. Bloomington and Indianapolis: Indiana University Press, 1992.

Pels, Dick. "Mixing Metaphors: Politics or Economics of Knowledge?" *Theory and Society* 26 (1997): 685-717.

Pérez-Ramos, Antonio. *Francis Bacon's Idea of Science and the Maker's Knowledge Tradition*. Oxford: Clarendon Press, 1988.

Peters, Richard. *Hobbes*. Baltimore: Penguin Books, 1956.

Petersen, James C., ed. *Citizen Participation in Science Policy*. Amherst: University of Massachusetts Press, 1984.

Pickering, Andrew. "From Science as Knowledge to Science as Practice." In *Science as Practice and Culture*, ed. Andrew Pickering, 1-26. Chicago: Chicago University Press, 1992.

Pinch, Trevor J., and Wiebe E. Bijker. "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other." *Social Studies of Science* 14 (1984): 339-441.

Pitkin, Hanna. "Hobbes's Concept of Representation—I." *American Political Science Review* 58 (June 1964): 328-40.

________. *The Concept of Representation*. Berkeley: University of California Press, 1967.

________. *Fortune is a Woman: Gender and Politics in the Thought of Niccolo Machiavelli*. Berkeley: University of California Press, 1984.

Polanyi, Michael. *Personal Knowledge: Towards a Post-Critical Philosophy*. Chicago: University of Chicago Press, 1958.

________. "The Republic of Science: Its Political and Economic Theory." *Minerva* 1, no. 1 (Autumn 1962): 54-73.

Popkin, Richard H. *The History of Skepticism from Erasmus to Spinoza*. Berkeley: University of California Press, 1979.

________. "Hobbes and Scepticism I" and "Hobbes and Scepticism II." In *The Third Force in Seventeenth-Century Thought*, 9-26, 27-49. Leiden: E. J. Brill, 1992.

Popper, Karl R. *The Logic of Scientific Discovery*. Hutchinson Education, [1934] 1959; London and New York: Routledge, 1992.

________. *The Open Society and Its Enemies*, 2 vols., 5th rev. ed. Princeton: Princeton University Press, 1966.

________. "Normal Science and Its Dangers." In *Criticism and the Growth of Knowledge*, ed. Imre Lakatos and Alan Musgrave, 51-58. Cambridge: Cambridge University Press, 1970.

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

Powell, Douglas, and William Leiss. *Mad Cows and Mother's Milk: The Perils of Poor Risk Communication*. Montreal and Kingston: McGill-Queen's University Press, 1997.

Press, Daniel. *Democratic Dilemmas in the Age of Ecology*. Durham and London: Duke University Press, 1994.

Price, Don K. *The Scientific Estate*. Cambridge: Harvard University Press, Bellknap Press, 1965; London: Oxford University Press, 1968.

Primack, Joel, and Frank von Hippel. *Advice and Dissent: Scientists in the Public Arena*. New York: New American Library, 1974.

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

Purcell, Jr., Edward A. *The Crisis of Democratic Theory: Scientific Naturalism and the Problem of Value*. Lexington: University of Kentucky Press, 1973.

Purcell, R. R. "Make a Business Out of It." Document of testimony at CARB public workshop on consumer marketability of Zero-Emission Vehicles. El Monte, California. June 28, 1995.

Putnam, Robert D. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton: Princeton University Press.

Rae, Douglas W. "Political Theory and the Division of Labor in Society: Asleep Aboard the Titanic and Steaming into Halifax," *Political Theory* 9 (1981): 369-79.

Rajan, Sudhir Chella. *The Enigma of Automobility: Democratic Politics and Pollution Control*. Pittsburgh, PA: University of Pittsburgh Press, 1996.

Ravetz, J. R. "The Copernican Revolution." In *Companion to the History of Modern Science*, ed. R. C. Colby, G. N. Cantor, J. R. R. Christie, and M. J. Hodge, 201-216. London and New York: Routledge, 1996.

________. "Orthodoxies, Critiques, Alternatives." In *Companion to the History of Modern Science*, ed. R. C. Colby, G. N. Cantor, J. R. R. Christie, and M. J. Hodge, 898-908. London and New York: Routledge, 1996.

Reich, Robert B., ed. *The Power of Public Ideas*. Cambridge: Harvard University Press, 1988.

Renn, Ortwin, Thomas Webler and Peter Wiedemann, eds. *Fairness and Competence in Citizen Participation: Evaluating Models for Environmental Discourse* Dordrecht: Kluwer Academic, 1995.

David M. Ricci. *The Tragedy of Political Science: Politics, Scholarship, Democracy*. New Haven: Yale University Press, 1984.

Ringquist, Evan J. *Environmental Protection at the State Level: Politics and Progress in Controlling Pollution*. Armonk, NY: M.E. Sharpe, 1993.

Richard Rorty. *Philosophy and the Mirror of Nature*. Princeton: Princeton University Press, 1979.

________. *Contingency, Irony, and Solidarity*. Cambridge: Cambridge University Press, 1989.

Ross, Dorothy. *The Origins of American Social Science*. Cambridge: Cambridge University Press, 1991.

Rouse, Joseph. "Kuhn and Scientific Practices." *Configurations* 6, no. 1 (1998): 33-50.

________. *Knowledge and Power: Toward a Political Philosophy of Science*. Ithaca, NY: Cornell University Press, 1987.

Rousseau, Jean-Jacques. "Observations by Jean-Jacques Rousseau of Geneva, On the Answers to his Discourse." In *The First and Second Discourses together with Replies to Critics and Essay on the Origin of Languages*, ed. and trans. Peter Gourevitch, 31-52. New York: Harper and Row, 1986.

________. "Discourse on the Sciences and Arts." In *The First and Second Discourses*, ed. Roger D. Masters, trans. Roger D. Masters and Judith R. Masters, 31-74. New York: St. Martin's Press, 1964.

________. "Letter from J. J. Rousseau of Geneva to Mr. Grimm on the Refutation of his Discourse by Mr. Gautier." In *The Collected Writings of Rousseau* Vol. 2, ed. Roger D. Masters and Christopher Kelly, trans. Judith R. Bush, Roger D. Masters, and Christopher Kelly, 84-92. Hannover, NH and London: University Press of New England.

Rupp, Jan C. "The New Science and the Public Sphere in the Premodern Era." *Science in Context* 8, no. 3 (1995): 487-507.

Russell, Bertrand. *The Scientific Outlook*. London: Allen & Unwin, New York: W.W. Norton, 1931.

________. "Dewey's New *Logic*." In *The Philosophy of John Dewey*, 2nd ed., ed. Paul Arthur Schilpp, 137-156. New York: Tudor Publishing Company, [1939] 1951.

Russell, Stewart. "The Social Construction of Artefacts: A Response to Pinch and Bijker." *Social Studies of Science* 16 (1986): 331-46.

Ryan, Alan. *John Dewey and the High Tide of American Liberalism*. New York: W. W. Norton & Company, 1995.

Ryan, Mary P. "Gender and Public Access: Women's Politics in Nineteenth-Century America." In *Habermas and the Public Sphere*, ed. Craig Calhoun, 159-88. Cambridge: MIT Press, 1992.

Ryder, John. "Introduction." In *American Philosophic Naturalism in the Twentieth Century*, ed. John Ryder, 9-25. Amherst, NY: Prometheus Books, 1994.

Sagoff, Mark. *The Economy of the Earth: Philosophy, Law, and the Environment.* Cambridge: Cambridge University Press, 1988.

Sandel, Michael. *Democracy's Discontent: America in Search of a Public Philosophy.* Cambridge: Harvard University Press, 1996.

Saxonhouse, Arlene. "Texts and Canons: The Status of the 'Great Books' in Political Science." In *Political Science: The State of the Discipline II*, ed. Ada W. Finifter, 3-26. Washington, DC: American Political Science Association, 1993.

Sclove, Richard E. *Democracy and Technology*. New York: Guilford Press, 1995.

Seitz, Brian. *The Trace of Political Representation*. Albany: State University of New York Press, 1995.

Shackley, Simon, and Brian Wynne. "Representing Uncertainty in Global Change Science and Policy: Boundary-Ordering Devices and Authority." *Science, Technology, & Human Values* 21 (Summer 1996): 275-302.

Schaffer, Simon. "Natural Philosophy and Public Spectacle in the Eighteenth Century." *History of Science* 21 (1983): 1-43.

________. "The Eighteenth Brumaire of Bruno Latour." *Studies in the History and Philosophy of Science* 22 (1991): 174-92.

________. "Augustan Realities: Nature's Representatives and Their Cultural Resources in the Early Eighteenth Century." In *Realism and Representation: Essays on the Problem of Realism in Relation to Science, Literature, and Culture*, ed. George Levine, 279-318. Madison: University of Wisconsin Press, 1993.

Schatz, Gottfrid. "The Swiss Vote on Gene Technology." *Science* 281 (September 18, 1988): 1810-11.

Schiebinger, Londa. *The Mind Has No Sex? Women in the Origins of Modern Science*. Cambridge: Harvard University Press, 1989.

________. "The History and Philosophy of Women in Science: A Review Essay." In *Sex and Scientific Inquiry*, ed. Sandra Harding and Jean O'Barr, 7-34. Chicago: Chicago University Press, 1987.

Schiffer, Michael Brian. *Taking Charge: The Electric Automobile in America*. Washington, DC: Smithsonian Institution Press, 1994.

Schmidt, Charles B. "Experience and Experiment: A Comparison of Zabarella's View with Galileo's in *De motu*." *Studies in the Renaissance* 16 (1969): 80-137.

Schneider, Anne Larason, and Helen Ingram *Policy Design for Democracy*. Lawrence: University Press of Kansas, 1997.

Schumpeter, Joseph A. *Capitalism, Socialism, and Democracy*, 3rd ed. New York: Harper & Row, [1942] 1950.

Scott, Allen, ed. *Electric Vehicle Manufacturing in Southern California: Current Developments, Future Prospects*. Berkeley: University of California Transportation Center, 1993.

Sen, Amartya K. "Rational Fools: A Critique of the Behavioral Foundations of Economic Theory." In *Beyond Self-Interest*, ed. Jane J. Mansbridge, 25-43. Chicago: University of Chicago Press, 1990.

Shapin, Steven. "The House of Experiment in Seventeenth-Century England." *Isis* 79 (1988): 373-404.

________. "Following Scientists Around." *Social Studies of Science* 18 (1988): 533-50.

________. "'The Mind is Its Own Place': Science and Solitude in Seventeenth-Century England." *Science in Context* 4 (1990): 191-218.

________. *A Social History of Truth: Civility and Science in Seventeenth Century England*. Chicago: University of Chicago Press, 1994.

________. "Science and the Public." In *Companion to the History of Modern Science*, ed. R. C. Colby, G. N. Cantor, J. R. R. Christie, and M. J. Hodge, 990-1007. London and New York: Routledge, 1996.

________. *The Scientific Revolution*. Chicago: University of Chicago Press, 1996.

Shapin, Steven, and Simon Schaffer. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton: Princeton University Press, 1985.

Shnayerson, Michael. *The Car that Could: The Inside Story of GM's Revolutionary Electric Vehicle*. New York: Random House, 1996.

Siegfried, Charlene Haddock. *Pragmatism and Feminism: Reweaving the Social Fabric*. Chicago: University of Chicago Press, 1996.

Skinner, Quentin. "A Reply to My Critics." In *Meaning and Context*, ed. James Tully, 231-88. Oxford: Basil Blackwell, 1988.

________. "Hobbes and the Purely Artificial Person of the State." *The Journal of Political Philosophy* 7 (March 1999): 1-29

Skocpol, Theda. "State Formation and Social Policy in the United States." *American Behavioral Scientist* 35, nos. 4/5 (1992): 559-84.

Sleeper, Ralph W. *The Necessity of Pragmatism: John Dewey's Conception of Philosophy*. New Haven: Yale University Press, 1986.

Smith, Bruce L. R. "The United States: The Formation and Breakdown of the Postwar Government-Science Compact." In *Scientists and the State: Domestic Structures and the International Context*, ed. Etel Solingen, 33-62. Ann Arbor: University of Michigan Press, 1994.

Smith, Merritt Roe, and Leo Marx, eds. *Does Technology Drive History?* Cambridge: MIT Press, 1995.

Soss, Joe. "Lessons of Welfare Policy: Policy Design, Political Learning, and Political Action." *American Political Science Review* 93, no. 2 (1999): 363-80.

"Science Wars." *Social Text* 46/47 (Spring/Summer 1996).

Sokal, Alan. "A Physicist Experiments with Cultural Studies." *Lingua Franca* (May/June 1996): 62-64.

Sperling, Daniel. *Future Drive: Electric Vehicles and Sustainable Transportation.* Washington, DC: Island Press, 1995.

Stewart, Larry. *The Rise of Public Science: Rhetoric, Technology, and Natural Philosophy in Newtonian Britain, 1660-1750.* Cambridge: Cambridge University Press, 1992.

Stearns, Raymond Phineas. *Science in the British Colonies of America.* Urbana: University of Illinois Press, 1970.

Stokes, Donald E. *Pasteur's Quadrant: Basic Science and Technological Innovation.* Washington, DC: Brookings Institution, 1997.

Strauss, Leo. *What is Political Philosophy?* Glencoe, IL: The Free Press, 1959. Reprint, Chicago: University of Chicago Press, 1988.

Strong, Tracy B. *The Idea of Political Theory: Reflections on the Self in Political Time and Space.* Notre Dame, IN: University of Notre Dame Press, 1990.

Summy, Ralph, and Michael E. Salla, eds. *Why the Cold War Ended: A Range of Interpretations.* Westport, CT: Greenwood Press, 1995.

Surface Transportation Policy Project. *Why are the Roads So Congested? A Companion Analysis of the Texas Transportation Institute's Data of Metropolitan Congestion.* Washington, DC: STPP, 1999.

Taylor, Bob Pepperman. *Our Limits Transgressed: Environmental Political Thought in America.* Lawrence: University Press of Kansas, 1992.

________. "John Dewey and Environmental Thought: A Response to Chaloupka." *Environmental Ethics* 12 (Summer 1990): 175-84.

Taylor, Charles. "Interpretation and the Sciences of Man." In *Philosophy and the Human Sciences: Philosophical Papers, Vol. 2*. Cambridge: Cambridge University Press, 1985.

________. "Social Theory as Practice." In *Philosophy and the Human Sciences: Philosophical Papers, Vol. 2*. Cambridge: Cambridge University Press, 1985.

Thayer, H. S. "Objects of Knowledge," in *Philosophy and the Reconstruction of Culture: Pragmatic Essays after Dewey*, ed. John J. Stuhr (Albany: State University of New York Press, 1993), 187-201.

Toffler, Alvin. *Future Shock*. New York: Random House, Bantam Books, 1970.

Traweek, Sharon. *Beamtimes and Lifetimes: The World of High-Energy Physicists*. Cambridge: Harvard University Press, 1988.

Truffer, Bernhard, and Gregor Dürrenberger. "Outsider Initiatives in the Reconstruction of the Car: The Case of Lightweight Vehicle Milieus in Switzerland." *Science, Technology, & Human Values* 22, no. 2 (1997): 207-34.

Turrentine, Thomas, Kenneth Kurani, and Daniel Sperling. "Market Potential of Electric and Natural Gas Vehicles." Davis, CA: Institute of Transportation Studies, 1992.

________. "The Household Market for Electric Vehicles." Document of testimony at CARB public workshop on marketability of electric vehicles. El Monte, California, June 28, 1995.

United Airlines. *Hemispheres Magazine* (January 2000).

United States House of Representatives, 105th Congress, 2nd Session. Committee on Science. Hearings on the National Science Policy Study. Part IV: "Communicating Science and Engineering in a Sound-Bite World." May 14, 1998.

Vico, Giambattista. *The New Science of Giambattista Vico*, trans. Thomas Goddard Bergin and Max Harold Fisch. Ithaca, NY: Cornell University Press, 1984.

Vogel, Steven. "New Science, New Nature: The Marcuse-Habermas Debate Revisited." In *Technology and the Politics of Knowledge*, ed. Andrew Feenberg and Alastair Hannay, 23-42. Bloomington and Indianapolis: Indiana University Press, 1995.

Volti, Rudi. "Why internal combustion?" *American Heritage of Invention and Technology* 6, no. 2 (Fall 1990): 42-47.

Voltaire. "Prejudices of the Senses." In *Pocket Philosophical Dictionary*. In *The Portable Voltaire*, ed. Ben Ray Redman. New York: Viking Press, Inc., 1949.

Walzer, Michael. *Spheres of Justice: A Defense of Pluralism and Equality*. New York: Basic Books, Inc., 1983.

________. "The Civil society Argument." In *Dimensions of Radical Democracy: Pluralism, Citizenship, Community*, ed. Chantal Mouffe, 89-107. London: Verso, 1992.

Warren, Mark. "Deliberative Democracy and Authority." *American Political Science Review* 90, no. 1 (March 1998): 46-60.

Westbrook, Robert B. *John Dewey and American Democracy*. Ithaca, NY: Cornell University Press, 1991.

White, Jr., Lynn. *Medieval Technology and Social Change*. Oxford: Clarendon Press, 1962.

Wildavsky, Aaron. *Speaking Truth to Power: The Art and Craft of Policy Analysis*. Boston: Little, Brown, and Company, 1979.

Williams, Bruce A., and Albert R. Matheny. *Democracy, Dialogue, and Environmental Disputes: The Contested Languages of Social Regulation*. New Haven: Yale University Press, 1995.

Williams, Melissa S. *Voice, Trust, and Memory: Marginalized Groups and the Failings of Liberal Representation*. Princeton: Princeton University Press, 1998.

Wilson, Douglas L. "Jefferson and the Republic of Letters." In *Jeffersonian Legacies*, ed. Peter S. Onuf, 50-76. Charlottesville: University Press of Virginia, 1993.

Wilson, James Q. *Political Organizations*. New York: Basic Books, 1973.

Winner, Langdon. *Autonomous Technology: Technics-Out-of-Control as a Theme in Political Thought*. Cambridge: MIT Press, 1977.

________. "Do artifacts have politics?" In *The Whale and the Reactor: A Search for Limits in an Age of High Technology*, 19-39. Cambridge: MIT Press, [1980] 1986.

________. ed. *Democracy in a Technological Society*. Dordrecht: Kluwer, 1992.

________. "Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology." *Science, Technology, & Human Values* 18, no. 3 (1993): 362-78.

Wolin, Sheldon S. *Politics and Vision: Continuity and Innovation in Western Political Thought*. Boston: Little, Brown and Company, 1960.

________. *The Presence of the Past: Essays on the State and the Constitution*. Baltimore: The Johns Hopkins University Press, 1989.

________. "Political Theory: From Vocation to Invocation." In *Vocations of Political Theory*, ed. Jason A. Frank and John Tambornino. Minneapolis: Minnesota University Press, 2000.

Wood, Paul. "Science, the Universities, and the Public Sphere in Eighteenth-Century Scotland." *History of Universities* 14 (1994): 99-135.

Woolgar, Steve. *Science: The Very Idea*. London and New York: Tavistock Publications Ltd. and Ellis Horwood Ltd., 1988.

Wynne, Brian. "Misunderstood Misunderstandings: Social Identities and the Public Uptake of Science." In *Misunderstanding Science? The Public Reconstruction of Science and Technology*, ed. Alan Irwin and Brian Wynne, 19-49. Cambridge: Cambridge University Press, 1996.

________. "SSK's identity parade: Signing-Up, Off-and-On." *Social Studies of Science* 26 (1996): 357-91.

Yearly, Steven. "Nature's Advocates: Putting Science to Work in Environmental Organizations." In *Misunderstanding Science? The Public Reconstruction of Science and Technology*, ed. Alan Irwin and Brian Wynne, 172-190. Cambridge: Cambridge University Press, 1996.

Young, Iris Marion. *Justice and the Politics of Difference*. Princeton: Princeton University Press, 1990.

________. "Political Theory: An Overview." In *A New Handbook for Political Science*, ed. Robert E. Goodin and Hans-Dieter Klingemann. New York: Oxford University Press, 1996.

Zaret, David. "Religion, Science, and Printing in the Public Spheres in Seventeenth-Century England." In *Habermas and the Public Sphere*, ed. Craig Calhoun, 214-235. Cambridge: MIT Press, 1992.

Zerilli, Linda M. G. "Machiavelli's Sisters: Women and the 'Conversation' of Political Theory." *Political Theory* 19, no. 2 (May 1991): 252-276.

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