Toward Participatory Ecological Design of Technological Systems

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Introduction

Environmental controversy is controversy about what kinds of technology designs work, what kinds don't work, and what it means ecologically, economically, and politically for a particular design to "work." So although ecological debate historically has not been framed as debate about design, proposals for *ecological reform* should be understood, in part, as proposals for *green* or *ecological design* of technological systems.[1] And the wide range of contemporary frameworks for ecological reform[2] should be recognized to provide diverse, even competing, foundations for ecodesign. It is reasonable to expect, for example, that ecodesign based on a libertarian "wise use" philosophy would look quite different from ecodesign based on ecocentric "deep ecology."

In light of the deeply social character of all design,[3] a crucial component of ecodesign criticism as it matures[4] will be assessment of these frameworks' relative fitness as foundations for effectively engaging ecodesign as a social process. Significantly, some reform frameworks appear to largely ignore the social dimensions of technological change or envision them as residing "outside" of the design process, while others regard them as central. What are the implications for ecodesign, given that we must define it as the design of techno*social* systems for compatibility with ecological systems?

As ecodesign criticism struggles with this question, one issue deserving special attention will be the relationship between experts and laypeople, which, in design and many other contexts, embodies deep assumptions about the relationship between the technical and the social. A major theme in recent democratic theory has been that the line between experts and laypeople often has been conceptualized and enacted in ways that are socially harmful—and urgently needs to be renegotiated.[5] This is a theme that science and technology scholars have elaborated in analyses of decision making about technology;[6] and some scholars have pointed out that depletion of the stratospheric ozone layer and other major technological impacts on the environment have begun prompting just such a renegotiation.[7] Indeed, struggles over the expert/lay divide have been prominent in many environmental controversies, such as in cases of "popular epidemiology." In such controversies, laypeople contest scientists' and engineers' values and assumptions, their theories and meth-

1 See Kate T. Fletcher and Phillip A. Goggin, "The Dominant Stances on Ecodesign: A Critique," *Design Issues* 17: 3 (2001): 15–25.

2 See John S. Dryzek and David Schlosberg, eds., *Debating the Earth: The Environmental Politics Reader* (Oxford: Oxford University, 1998).

3 E. J. Woodhouse and Jason W. Patton, "Design by Society: Science and Technology Studies and the Social Shaping of Design," *Design Issues,* this issue.

4 See Pauline Madge, "Ecological Design: A New Critique," *Design Issues* 13:2 (1997): 44–54.

5 Benjamin Barber, *Strong Democracy* (Berkeley: University of California, 1984) and Charles Lindblom, *Inquiry and Change: The Troubled Attempt to Understand and Shape Society* (New Haven, CT: Yale, 1990).

6 Frank Fischer, *Technocracy and the Politics of Expertise* (Newbury Park, CA: Sage, 1990); Richard E. Sclove, *Democracy and Technology* (New York: Guilford, 1995); and E. J. Woodhouse and Dean Nieusma, "When Expert Advice Works, and When It Does Not," *IEEE Technology and Society Magazine* 16:1 (1997): 23–29.

7 E.g., Silvio O. Funtowicz and Jerome R. Ravetz, "Science for the Post-Normal Age," *Futures* [Butterworth-Heinemann Ltd.] 25:7(1993): 739–55; and Jane Lubchenco, "Entering the Century of the Environment: A New Social Contract for Science," *Science* 279 (1998): 491–7.

odologies, their models and data, their interpretations and designs, and their substantial de facto power in political processes that shape the technological landscape. The political economy of ecodesign will be signaled in large part by whether it promotes this renegotiation, ignores it, or impedes it.

In probing ecodesign's potential for facilitating this renegotiation, it will be helpful to apply a theoretical framework from a subdiscipline familiar to many design studies scholars: participatory design (PD). Emerging from the broader ferment of conflict over the expert/lay divide in technological affairs, and conceiving design as a process that fuses material and social practice, the PD movement seeks to actively engage laypeople in the design of technosocial artifacts and systems.[8] Although we cannot expect the PD literature to provide a template for ecological design, we can look to it for precedents, principles, and models. To what extent can and should the design of consumer packaging, shopping malls, and municipal sewer systems involve laypeople—and how? In this paper, extending scholarship that emphasizes the need for vigorous lay participation in technology decision making, I use the main themes of PD as lenses to examine three of the numerous potential political foundations for ecodesign, concentrating on one—strong precaution—that appears to closely parallel PD. The objective of the article is to identify aspects of the three frameworks that are in line with the sensibilities and emphases of PD and aspects that are not, and to suggest opportunities for promoting strategies within these paradigms that are more effectively participatory.

Participatory Design

Participatory design encompasses a variety of strategies to give the people who will use a particular technology or technological system a direct role in decision making about its development. It has been undertaken in a broad range of settings, from information technology systems and computer-based newspaper typography to public housing development, management of Third World health services, and the development of micro-scale power systems.[9] Wherever it is practiced, PD focuses on "empowerment, participation, and a bottom-up approach" and aims to achieve not only instrumentally improved designs but "greater user satisfaction, social well-being, and empowerment, as well as a greater sense of and commitment to community."[10] These aims and this participatory sensibility align PD with public-participation initiatives in technology contexts even more diverse, from AIDS treatment to genetic engineering and food irradiation, and with prescriptions for vigorously participatory decision making in technological affairs as a whole.[11] These prescriptions are themselves variations on the theme that society needs to move toward "strong democratic"—that is actively participatory—decision making in all arenas.[12] Therefore, PD may be understood as an emerging body of theory and experience concerning the exercise

8 Douglas Schuler and Aki Namioka, eds., *Participatory Design: Principles and Practices* (Hillsdale, NJ: Erlbaum, 1993).

9 Jorn Braa, "Community-Based Participatory Design in the Third World" in J. Blomberg, F. Kensing, and E. Dykstra-Erickson, eds., *PDC '96: Proceedings of Participatory Design Conference* (Palo Alto, CA: Computer Professionals for Social Responsibility, 1996), 15–24; Andrew Clement and Peter Van den Besselaar, "A Retrospective Look at PD Projects," *Communications of the ACM* 36:6 (1993): 29–37; P. Ehn and M. Kyng, "Cardboard Computers: Mocking-it-up or Hands-on the Future" in J. Greenbaum and M. Kyng, eds., *Design at Work: Cooperative Design of Computer Systems* (Hillsdale, NJ: Erlbaum, 1991); Roberta M. Feldman, "Participatory Design at the Grass Roots" in Joan Rothschild, ed., *Design and Feminism* (New Brunswick, NJ: Rutgers University, 1999), 135–48; and Jesse Tatum, "The Challenge of Home Power: Toward a More Democratic Shaping of Technology" in Tatum, *Muted Voices: The Recovery of Democracy in the Shaping of Technology* (Bethlehem, PA: Lehigh University, 2000), 152–69. These works, selected as representative of PD in diverse settings, serve as the primary referents for PD in the discussion that follows.

10 Braa, "Community-Based Participatory Design," 15; and Feldman, "Participatory Design at the Grass Roots," 135.

11 Sclove, *Democracy and Technology,* and Daniel Lee Kleinman, ed., *Science, Technology, and Democracy* (Albany: State University of New York, 2000).

12 Barber, *Strong Democracy;* and Lindblom, *Inquiry and Change.*

13 Clement and Van den Besselaar, "A Retrospective Look at PD Projects"; and Feldman, "Participatory Design at the Grass Roots."

14 Feldman, "Participatory Design at the Grass Roots," 136, 146.

15 Tatum, "The Challenge of Home Power, quoted at 156. Rather than de-localizing design practice, the home power network functions much like the extensive literature and personal connections linking other far-flung PD practitioners: it provides ideas and experience that can be transported across geographic

of strong democracy in technology decision making. It has three principal themes:

Importance of the local—Although PD techniques are drawn from and applicable in a wide variety of settings, advocates emphasize that PD is rooted in place—in particular confluences of people, institutions, culture, and economics.[13] Whether a PD project takes place in a First World workplace or a Third World village, it taps into and builds on indigenous community structures.[14] Even when it involves a broad network of individuals on several continents, as in the "home power" movement, PD "begins ... from the lives of ordinary citizens" bound to local particularities such as water flow, wind patterns, and solar flux.[15]

Importance of lay empowerment—The essence of PD is deep lay engagement in shaping technology. Given the domination of contemporary technology design by engineers and professional designers, such participation requires a significant effort to provide laypeople with the means to play a central role in envisioning, prototyping, testing, and refining it.[16] This is accomplished not by ousting professional designers, of course, but by altering institutional arrangements to allow laypeople to *share* responsibilities and prerogatives conventionally reserved exclusively to professionals.

Professional designers may be expected to provide technical knowledge or analytic or managerial skills; but specific professional and lay roles may be negotiated as part of the PD process itself.[17] The professional's role shifts toward what Woodhouse and Nieusma describe as "democratic expertise," in which the expert becomes an openly partisan "participant in democratic problem solving," alongside and in the service of laypeople.[18] Correspondingly, laypeople provide local knowledge: an intimate knowledge of the organizations, communities, and social contexts in which the design is to be deployed.[19] Crucially, this knowledge may include awareness of "apparently viable technological alternatives that are expressive of values distinct from those incorporated in more conventional patterns of technology."[20] Ideally, PD applies local knowledge at the most fundamental level of design: in the conceptual formulation of the problems to be addressed.[21] Overall, then, PD may be said to empower laypeople by giving them the opportunity to participate in technology decision making processes that will deeply affect their lives, building in a set of understandings and sensibilities rooted in their own experience and values.

Importance of organization—PD requires organizational support in the form of funding, space, personnel, equipment, and altered work routines.[22] But organizational context also *shapes* PD projects. For example, PD projects for information systems have been significantly influenced by the ideologies and structures of the labor unions that initiated them.[23] Furthermore, as Clement and Van den Besselaar argue, even a PD project that initially is quite successful cannot be sustained unless it becomes thoroughly embedded in its host orga-

Footnote 15 continued
boundaries but that ultimately must be rooted in local conditions.

16 Braa, "Community-Based Participatory Design in the Third World," 15; Clement and Van den Besselaar, "A Retrospective Look at PD Projects," 29; Feldman, "Participatory Design at the Grass Roots," 139, 144-6; and Tatum, "The Challenge of Home Power."

17 Ehn and Kyng, "Cardboard Computers: Mocking-it-up or Hands-on the Future," 181.

18 E. J. Woodhouse and Dean Nieusma, "Democratic Expertise: Integrating Knowledge, Power, and Participation" in Matthijs Hisschemöller, Rob Hoppe, et al., eds., *Knowledge, Power, and Participation in Environmental Policy Analysis* (New Brunswick, NJ: Transaction, 2001), 73–96, quoted at 92; see also Fischer, *Technocracy,* 344–51.

19 Ehn and Kyng, "Cardboard Computers," 179-81; Clement and Van den Besselaar, "A Retrospective Look at PD Projects," 34; Braa, "Community-Based Participatory Design," 22; and Feldman, "Participatory Design at the Grass Roots," 140. The lay designer's role assumes characteristics that we might call "lay expertise"; see, e.g., Sclove, *Democracy and Technology,* 177; and Richard E. Sclove and Madeleine L. Scammell, "Practicing the Principle" in Carolyn Raffensperger and Joel Tickner, eds., *Protecting Public Health and the Environment: Implementing the Precautionary Principle* (Washington, DC: Island, 1999), 252–65, at 254.

20 Tatum, "The Challenge of Home Power," 152.

21 Ibid., 159.

22 Clement and Van den Besselaar, "A Retrospective Look at PD Projects," 32; Braa, "Community-Based Participatory Design," 15; and Feldman, "Participatory Design at the Grass Roots."

23 Clement and Van den Besselaar, "A Retrospective Look at PD Projects".

nization and unless the organization can accommodate a significant level of ongoing participation.[24] So important is favorable organizational context, these authors conclude, that organizational reform must be one of the principal goals of PD projects, for "without organizational reform in the direction of greater democratization at all levels, the knowledge and commitment that PD can stimulate in users will ultimately reinforce patterns that limit the growth of their capabilities and thus undermine further initiative ...Only by giving participation the meaning of full engagement in vital organizational affairs is the process likely to flourish."[25]

Diverse Foundations for Ecological Design

Each of the numerous political frameworks for ecological reform—from wise use to deep ecology, and from market liberalism to environmental justice—can be expected to provide a characteristic foundation for ecodesign. Such a foundation will include factors such as political-economic orientation, conception of technological "progress," assumptions about the severity of environmental degradation—and, crucially, assumptions about the relationship between technology (as well as science) and society and, at the same time, about the relationship between experts and laypeople. Given that the heart of PD is its commitment to lay empowerment, it will be helpful to examine foundations for ecodesign that differ significantly from PD in this dimension, as well as an approach that does not. Using variation in this dimension as the basis for a typology of approaches to ecodesign, this article considers how commitment to lay empowerment manifests or fails to manifest in each approach. At the same time, it considers whether and how each shares PD's emphasis on the local and on democratic organization.

Foundations for ecodesign range from those that, by most standards, are quite technocratic, or expert-centered, to those that we can call strong-democratic, that is, egalitarian and participatory.[26] At the technocratic end of the scale, activities and decision making ordinarily assumed to be "technical" or "scientific" remain largely the province of engineers and scientists. Here the experts dominate the power structure; and direct lay engagement, if it occurs at all, is focused primarily on "nontechnical" (e.g., ethical) considerations. In contrast, at the strong-democratic end of the continuum, lay citizens intrude, often quite deeply, into territory long dominated by scientists and engineers. Here the traditional power structure is disrupted, with laypeople exercising significant influence. And the line between "technical" and "nontechnical" considerations is fuzzy, with citizens both claiming a substantial role in the former and, at the same time, actively demonstrating that scientists' and engineers' activities rest on a (usually covert) foundation of the latter.[27]

Toward the technocratic end of this continuum, I suggest, are quantitative risk assessment and cost-benefit analysis, industrial ecology, and adaptive management.[28] Toward the strong-democratic

24 Ibid., 35–36.

25 Ibid., 36. Here again, PD takes its place as part of the larger struggle for strong-democratic reform and points to the often crucial role of technology decision making in such reform (Sclove, *Democracy and Technology;* and Tatum, "The Challenge of Home Power").

26 On technocracy, see Fischer, *Technocracy.* On strong democracy, see Barber, *Strong Democracy;* and Sclove, *Democracy and Technology.*

27 The continuum described here is based, in part, on Kleinman's description of several dimensions in which citizen involvement in technoscience can be seen to vary. See Daniel Lee Kleinman, "Democratizations of Science and Technology" in Kleinman, *Science, Technology, and Democracy,* 139–65, at 140–1.

28 Adam M. Finkel and Dominic Golding, eds., *Worst Things First? The Debate over Risk-Based National Environmental Priorities* (Washington, DC: Resources for the Future, 1994); Per-Olov Johansson, *Cost-Benefit Analysis of Environmental Change* (Cambridge: Cambridge University, 1993); T. E. Graedel and B. R. Allenby, *Industrial Ecology* (Englewood Cliffs, NJ: Prentice Hall, 1995); and Kai N. Lee, *Compass and Gyroscope: Integrating Science and Politics for the Environment* (Washington, DC: Island, 1993).

end are grassroots environmentalism, consensus conferences and other deliberative-democratic environmental initiatives, and some forms of ecological precaution.[29] Other approaches are arguably ambivalent, perhaps amenable to strong democracy in some ways but in other ways technocratic. Here we find ecological economics, ecological modernization, post-normal science, and community-based social marketing.[30]

Considering an example of a reform program in each region of the continuum will help to illuminate the social dimensions of the ecodesign foundations that we may expect to encounter there. Industrial ecology and community-based social marketing are reviewed here briefly; and strong precaution, at the strong-democratic end of the continuum, is reviewed in greater detail.

Spectrum of Approaches to Ecological Reform

I will describe each approach, consider its location on the continuum, examine its relation to PD's three primary emphases, and consider prospects for it to incorporate PD strategies.

Industrial Ecology

Industrial ecology (IE), an increasingly prominent interdisciplinary approach for reducing the "cradle to grave" environmental impacts of industrial processes and products, provides a distinctly technocratic foundation for ecodesign. In design contexts ranging from detergent formulations to lighting systems to consumer packaging, its principal objective is reducing impacts to levels that, from a risk assessment-based perspective, are ecologically sustainable and, implicitly, doing so without directly addressing prevailing levels of consumption or the institutional structure of technology decision making.[31] IE draws on the natural sciences to assess a particular natural system's ability to withstand a particular industrial stressor, such as emissions of mercury or lead. And its backbone is engineering: conducting materials and process "audits"; assessing product impacts over their entire life-cycle; analyzing energy consumption; designing products for ready recyclability; and so forth.[32] Although IE's leading theorists regard these activities as *constrained by social forces*,[33] in the final analysis, they do not treat them as inherently social.[34] One leading proponent acknowledges that IE involves deep values, but he argues it must be vigorously portrayed as strictly objective if it is to be credible in academic, regulatory, and industrial

29 Sherry Cable and Charles Cable, *Environmental Problems, Grassroots Solutions: The Politics of Grassroots Environmental Conflict* (New York: St. Martin's, 1995); Richard E. Sclove, "Town Meetings on Technology: Consensus Conferences as Democratic Participation" in Kleinman, *Science, Technology, and Democracy,* 33–8; and Raffensperger and Tickner, *Protecting Public Health and the Environment.* Here I also would place environmental justice as well as ecology-oriented architectural and municipal design. See Richard Hofrichter, ed., *Toxic Struggles: The Theory and Practice of Environmental Justice* (Philadelphia: New Society, 1993); Sim Van der Ryn and Stuart Cowan, *Ecological Design* (Washington, DC: Island, 1996); David Wann and Center for Resource Management, *Deep Design: Pathways to a Livable Future* (Washington, DC: Island, 1996); and Mark Roseland, Maureen Cureton, and Heather Wornell, *Toward Sustainable Communities: Resources for Citizens and Their Governments* (Gabriola Island, BC: New Society, 1998).

30 Robert Costanza, John Cumberland, et al., *An Introduction to Ecological Economics* (Boca Raton, FL: St. Lucie; International Society for Ecological Economics, 1997); Paul Hawken, Amory Lovins, and L. Hunter Lovins, *Natural Capitalism: Creating the Next Industrial Revolution* (Boston: Little, Brown, 1999); Funtowicz and Ravetz, "Science for the Post-Normal Age"; and Doug McKenzie-Mohr and William Smith, *Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing* (Gabriola Island, BC: New Society, 1999).

31 Graedel and Allenby, *Industrial Ecology,* esp. 5–8.

32 Ibid.

33 Ibid., 7–8.

circles.[35] Many IE proponents do not see the lay public as having a principal or even, apparently, a direct consultative role: they regard it primarily as the source of "external" market and political pressure for improved environmental performance.

Little in this picture resembles PD. There is no effort to empower ordinary citizens—even those living within a stone's throw of a client's manufacturing facility—to participate in IE-based design decisions. To the extent that such a consideration enters the mainstream IE vision at all, it is through a usually subtle implication that IE-oriented engineers and scientists represent an (expert) embodiment of citizen support for sustainability. And while IE emphasizes organizational context, the context to which it is tailored—the industrial corporation—is one that typically eschews participatory initiatives, and that IE's leading proponents seem to passively accept rather than actively challenge.

Still, if IE theorists and practitioners were intent on adopting a more participatory approach—perhaps recognizing an ethical obligation to do so[36]—how might they proceed? Some possibilities: To broaden the number and diversity of individuals and groups engaged in IE-style analysis and design of, say, a manufacturer's new line of electronic audio equipment, IE proponents could consult with environmental justice advocates, other grassroots activists, and labor unions; place IE technical experts at the disposal of such groups; and take steps to make IE and its corporate clients more accountable to the community, perhaps by publishing analyses and recommendations on a Web page for public review and comment. More broadly, IE proponents also could invite union members, social scientists, activist organizations, elected representatives, and members of the general public to systematically critique the manner in which IE theory and practice have disguised values choices as technical choices and have marginalized the voices of nonengineers and nonscientists.[37]

Measures such as these are unlikely to render mainstream IE a major force for participatory technology decision making, but they would give it a significant participatory dimension. If environmental justice activists and residents living in the shadow of the factory were commissioned to act as design consultants, IE-based "Design for Environment" would be able to more fully grasp "life-cycle" impacts and would be able to consider a broader range of design alternatives. While IE will be strongly inclined to remain in thrall to corporate culture, creative efforts to open it to participatory engagement would begin reorienting its political-economic foundations.

Community-Based Social Marketing

McKenzie-Mohr and Smith argue that governmental agencies and nonprofit groups seeking to improve community environmental behavior often find the standard tools of environmental reform—regulation and education—to be largely ineffective.[38] In community-

34 Social scientists writing in the IE literature emphasize the field's social dimensions, of course; e.g., Frank Boons and Nigel Roome, "Industrial Ecology as a Cultural Phenomenon: On Objectivity as a Normative Position," *Journal of Industrial Ecology* 4:2 (2001): 49–54. So far, however, social scientists play a limited role in the field: mainstream IE practitioners consult them primarily for guidance on how the technical vision of IE-oriented engineers can be implemented politically and economically.

35 John R. Ehrenfeld, "Industrial Ecology — An Idea Whose Time Has Come?" (Paper presented at the 4th Norwegian Academy of Technological Sciences [NTVA] Seminar and Workshop on Industrial Ecology, Trondheim, Norway, June 14–15, 2001).

36 Patrick Feng, "Rethinking Technology, Revitalizing Ethics: Overcoming Barriers to Ethical Design," *Science and Engineering Ethics* 6:2 (2000): 207–20.

37 E.g., the International Society for Industrial Ecology could commission leading critics of risk assessment to formally assess the implications of IE's reliance on risk methodologies.

38 McKenzie-Mohr and Smith, *Fostering Sustainable Behavior.*

based social marketing (CBSM), these are replaced or supplemented with social science-based efforts to systematically identify benefits that would accrue to individuals who engage in desired behaviors, identify barriers that inhibit those behaviors, and identify means of reducing the barriers and enhancing the benefits. If the objective is altering the public's relationship with municipal energy infrastructure by reducing residential energy consumption, for example, one of the desired behaviors may be residents purchasing energy-efficient homes; a benefit may be reduced residential energy costs; an obstacle may be a cultural assumption that a house's purchase price is more important than the long-term cost of operating the house; and interventions could include requiring real estate developers to disclose long-term costs. Thus, CBSM is a framework for designing the integration of technical systems and social systems in ways that envision a particular relationship between the two, a relationship that places CBSM in the middle, ambivalent portion of the technocratic-strong democratic continuum. Unlike IE, CBSM focuses on social dimensions of technosocial change; but like IE, it envisions primarily passive roles for the public.

CBSM's clearest commonality with PD, underscored by its very name, is its emphasis on the local. It aims to facilitate change at the community level, the level at which McKenzie-Mohr and Smith argue social psychology research demonstrates behavioral-change initiatives to be most effective. This focus reflects recognition that technological systems' ability to degrade the environment (e.g., through global warming) are deeply embedded in the daily lives of citizens (e.g., daily residential energy consumption).

CBSM does not aim squarely at lay empowerment, however. While CBSM-based campaigns emphasize the importance of the lay public, McKenzie-Mohr and Smith seem to envision primarily passive lay roles: on one hand, participation in surveys and focus groups; on the other, adopting behavior changes designated and marketed by campaign leaders. While CBSM also emphasizes steering individuals toward problem-focused coping strategies, including direct political action, this is targeted not at empowering individuals but at enhancing the instrumental effectiveness of managers' programs. And while the authors urge that messages be structured so as to "engender a feeling of common purpose and efficacy,"[39] building community solidarity is not among CBSM's goals. Consequently, CBSM empowers not the lay public, in the sense envisioned in PD, but the environmental manager.[40] If there is skepticism in CBSM about the role of experts, it is quite limited. The authors criticize the psychological models that environmental managers traditionally have employed. But it is the methodology, not managers' role as experts, that CBSM brings into question; and the expert character of the social science "tools" on which CBSM is based is taken for granted.

39 Ibid., 92.

40 Many of the environmental managers who might benefit from CBSM programs presumably are neither scientists nor engineers, but CBSM specifically addresses them in their role as ostensible experts in designing sustainability initiatives.

Nor does CBSM share PD's focus on democratic organization. Many of the programs that CBSM aims to improve presumably arise from citizen pressure of one sort or another. But few municipal agencies have structures that permit, much less encourage, direct public participation in environmental decision making. So while some CBSM-based projects can be expected to take on a weak participatory cast, in most cases, organizations that adopt CBSM methods will undertake projects technocratically, and CBSM will not serve as a systematic goad for them to do otherwise.

Even if McKenzie-Mohr and Smith do not adequately problematize the role of experts or actively promote mechanisms for lay participation, however, it appears that CBSM offers moderately fertile ground for such participation. One approach, for example, would be CBSM-style programs to encourage laypeople to engage in sustainability-oriented PD projects (e.g., consulting with local manufacturers on the energy efficiency of their consumer products)—and, simultaneously, to encourage technologists (e.g., industrial designers) to facilitate their doing so. A complementary approach would be launching PD projects to actually design sustainability-oriented CBSM programs. Perhaps, then, we can imagine a well-integrated PD/CBSM initiative for public engagement in the design of both ecologically sustainable technological systems and the social behaviors necessary to design those systems, utilize them, and refine them. This would apply PD sensibilities and methods to the task of ecodesign, solidifying participatory strategies promoted informally by grassroots activists and others; and it would bring the theoretical, empirical, and methodological resources of CBSM into PD, making it possible to target communities of both laypeople and experts whose behavior is to be strategically modified. It would open the possibility of making sustainability-oriented CBSM projects substantially more participatory than McKenzie-Mohr and Smith seem to envision, moving the social science component of CBSM away from a scientific management model toward "democratic expertise."

Strong Precaution

When a new chemical or a new electronic device is designed, who should have the power to decide if it is environmentally benign enough to be marketed? The precautionary principle (PP) is a legal doctrine increasingly invoked in environmental agreements internationally and in environmental controversies from the local level to the international.[41] It calls for instituting potentially fundamental changes in how scientific knowledge and scientific investigation are employed in environmental policy because it "assumes that science does not always provide the insights needed to protect the environment effectively and that undesirable effects may result if measures are taken only when science does provide such insights."[42] A wide variety of articulations have been offered, but, by most accounts, the principle embodies two basic tenets:[43]

41 Raffensperger and Tickner, *Protecting Public Health;* David Freestone and Ellen Hey, "Origins and Development of the Precautionary Principle" in Freestone and Hey, *The Precautionary Principle and International Law: The Challenge of Implementation* (The Hague: Kluwer Law International 1996), 3–15.

42 Freestone and Hey, "Origins and Development," 12.

43 Freestone and Hey, *The Precautionary Principle;* and Raffensperger and Tickner, *Protecting Public Health.*

1 The proponent of a technological activity should bear the burden of demonstrating, to some established standard, that the technology will not cause serious or irreversible damage.
2 When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically.

This approach runs counter to prevailing legal and cultural conventions in the United States, under which the public generally bears the burden of proving a particular technology is harmful and a technological practice routinely is allowed to continue in the face of considerable evidence of harm.[44] Indeed, it is at least potentially subversive of some of the basic assumptions underlying both liberal and socialist societies: that social good depends on economic growth (*productivism* and *industrialism*); that large, central institutions are uniquely capable of guiding this growth (*managerialism*); and, that science constitutes an objective foundation for both (*scientism*).[45] Application of the PP threatens these assumptions by exposing normally hidden ideological dimensions of science and technology—their implication in and commitment to prevailing power relations.[46]

In the face of dominant institutions grounded in risk-based decision making, there is concern that risk-based policies may be disguised with a "thin gloss of precautionary language," potentially rendering the principle "a token theoretical ideal that may be acknowledged and subsequently ignored."[47] Apparently responding, in part, to this concern, a number of authors have moved toward strong formulations of the principle.[48] Eight additional tenets[49] appear to capture much of their thinking and can serve as a preliminary articulation of *strong precaution* (SP):

3 Precaution must be an open, democratic process involving all affected parties.
4 Precaution requires examination of a full range of social and technological alternatives.
5 Precaution must become the default mode of all technological decision making.
6 Even the most fundamental of existing technologies must be subject to reexamination and precautionary reform.
7 The primary mode of regulation and regulatory science should be at the macroscale.
8 Knowledge of broad patterns trumps ignorance of detail.
9 Human society must accommodate itself to broad patterns in natural processes.
10 Environmental decisions cannot be made less political by making them more scientific, because science is inherently political.

44 Carl F. Cranor, "Asymmetric Information, the Precautionary Principle, and Burdens of Proof" in Raffensperger and Tickner, *Protecting Public Health,* 74–99.

45 R. Michael M'Gonigle, "The Political Economy of Precaution" in Raffensperger and Tickner, *Protecting Public Health,* 123–47.

46 Ibid.

47 Katherine Barrett and Carolyn Raffensperger, "Precautionary Science" in Raffensperger and Tickner, *Protecting Public Health,* 106–22, quoted at 114; and David Santillo, Paul Johnston, and Ruth Stringer, "The Precautionary Principle in Practice: A Mandate for Anticipatory Preventive Action" in Raffensperger and Tickner, *Protecting Public Health,* 36–50, quoted at 41.

48 "Wingspread Statement on the Precautionary Principle" (Consensus statement adopted during Wingspread Conference on Implementing the Precautionary Principle, Racine, Wisconsin, January 23–25, 1998); Cranor, "Asymmetric Information"; M'Gonigle, "The Political Economy of Precaution"; and several other articles in Raffensperger and Tickner, *Protecting Public Health:* Peter deFur, "The Precautionary Principle: Application to Policies Regarding Endocrine-Disrupting Chemicals," 337–48; Andrew Jordan and Timothy O'Riordan, "The Precautionary Principle in Contemporary Environmental Policy and Politics," 15–35; and Peter Montague, "Precautionary Action Not Taken: Corporate Structure and the Case of Tetraethyl Lead in the USA," 294–303.

49 Jeff Howard, "Extending the Wingspread Consensus Statement on the Precautionary Principle" (Paper presented at the annual meeting of American Association for the Advancement of Science, Anaheim, CA, January 21–26, 1999); and Jeff Howard, "Beyond Wingspread: The Tenets of Strong Precaution" (Presentation at annual meeting of Association for Science in the Public Interest, Richmond, Virginia, May 31–June 2, 2001).

While the two basic tenets of the PP are arguably in the ambivalent middle of the technocracy/strong democracy continuum, the eight additional tenets locate the principle toward the strong-democratic end. They open design decisions on chemicals, electronic products, and other technologies to greater public scrutiny, broaden the range of people engaged in such decision making, and broaden the range of alternatives considered. They also make more explicit the PP's challenge to the productivism, industrialism, managerialism, and scientism on which design decisions typically have been based. And they challenge the prevailing tendency to regard design as rational only if it assumes impacts on natural systems are secondary to economic expediency, only when it focuses on details (e.g., specific impacts of specific chemicals), and only when it assumes science (and hence applied science) to be politically neutral.

Although the principle has been invoked primarily in international contexts,[50] it also has a substantial, if largely tacit, local dimension. There is a strong sense in the emerging SP literature that environmental issues fuse global and local concerns.[51] The PP, and particularly SP, resist hierarchical decision making by institutions that, under globalization, are themselves less and less locally grounded; and M'Gonigle points out that the objectives of SP resonate with those of movements such as community forestry.[52] It has been suggested that, in the United States at least, the principle will likely first be solidified at the local and state levels rather than the national level.[53] Indeed, the principle—almost always implicitly in a strong formulation—has commonly been cited in grassroots campaigns to curb environmental health threats from, for example, chlorine-based chemical technologies.[54] Moreover, there is a clear sentiment in much of the precaution literature that the principle has arisen out of a perception that domination of technology decision making by distant corporations violates many people's everyday sense of rational policy making.[55] In the end, the movement supporting the PP, and especially SP, is connected to the local and to the daily lives of ordinary citizens much as the PD movement is: it embodies intellectual and political linkages between global and local concerns, perspectives, and actions. Sclove and Scammell suggest that "community-based research" projects oriented around precaution offer a promising outlet for precautionary thinking at the local level.[56] It seems reasonable to propose that such projects and existing precaution-oriented grassroots campaigns against incinerators and other sources of chemical pollution may be understood as efforts to engage in participatory ecodesign.

Lay empowerment, the heart of PD, is central to SP. The tenets calling for open democratic process, precaution as the default mode, and an ability to reexamine existing technologies would create opportunities for laypeople to assume a significant role in a wide range of design decisions. The tenet calling for examination of a wider range of technological alternatives would afford laypeople

50 E.g., the Rio Declaration of 1992.

51 E.g., Jordan and O'Riordan, "The Precautionary Principle," 19.

52 M'Gonigle, "The Political Economy of Precaution."

53 Carolyn Raffensperger and Joel Tickner, "To foresee and forestall" in Raffensperger and Tickner, *Protecting Public Health,* 1–11, at 9.

54 Center for Health, Environment, and Justice, "America's Choice: Children's Health or Corporate Profit: American People's Dioxin Report" (Falls Church, VA: CHEJ, 1999), http://www.chej.org/peopledioxin.html.

55 This domination is said to run roughshod over people's everyday sense of reasonable needs and reasonable means of meeting those needs; e.g., see Mary O'Brien, "Alternatives Assessment: Part of Operationalizing and Institutionalizing the Precautionary Principle" in Raffensperger and Tickner, *Protecting Public Health,* 207–19. The PP, in contrast, is said to be "a simple concept rooted in common sense"; see Raffensperger and Tickner, *Protecting Public Health,* "Lessons from Wingspread," Appendix A, 349–55, at 350.

56 Sclove and Scammell, "Practicing the Principle."

crucial opportunities to participate in defining the appropriate goals of design, the human needs to be met, the problems to be solved, and appropriate means to solve them.[57] The tenets regarding the scale of technology decision making and the types of knowledge required would push this decision making out of a mode that technical elites are readily able to dominate: a focus on microscale issues concerning readily available evidence and disregarding long-term, large-scale patterns of harm and correspondingly large degrees of uncertainty. The tenet calling for human accommodation to natural systems would require discussions between laypeople and experts regarding what is known and not known about such systems, what is to be protected, and how accommodation should proceed. And the tenet acknowledging that science is inherently political would open productive discussion about the political-economic dimensions of environmental science and public policy based on this science.[58]

SP's emphasis on empowerment is driven by a sense of the enormity of past techno-ecological blunders—from PCBs and Chernobyl to CFCs and endocrine disruption—and by the conviction that these blunders stem, in no small part, from dogmatic denial that science and technology are deeply entangled with politics.[59] Under SP, a significant amount of decision making by technical elites would be revealed to rest on hidden forms of lay decision making disguised as technical expertise: engineers' and scientists' value-laden stances on the seriousness of environmental degradation, the worth of particular ecosystems, the importance of economic growth, and so forth.[60] By giving precaution-based decision making clear primacy over risk-based decision making, SP would require renegotiation of the respective roles of technical elites and laypeople. Engineers and scientists would continue to play crucial roles, of course, but they would not dominate and would serve more as helpmates than as authorities, moving toward the exercise of "precautionary science" and "democratic expertise."[61] Laypeople, drawing on their everyday understandings and aided by experts, would be called upon to take the primary responsibility to guide the path and pace of technology.

Finally, strong precaution is equally in tune with PD's emphasis on the importance of democratic organization. It represents recognition that the PP failed to take hold in the 1920s around the issue of leaded gasoline because the political clout of General Motors and other large companies trumped the political clout of public health officials.[62] It represents recognition that the PP has gained prominence in recent years only because the public increasingly understands that techno-ecological blunders signal "the inescapable presence of pervasive uncertainty in the scientific enterprise."[63] And it represents recognition that use of the PP cannot be robust unless it is institutionalized in ways that systematically restructure the relationship between technology, science, economics, and politics that is embodied in technology design. A variety of mechanisms have

57 O'Brien, "Alternatives Assessment."

58 Barrett and Raffensperger, "Precautionary Science"; and European Environment Agency, "Late Lessons from Early Warnings: The Precautionary Principle 1896–2000" (Copenhagen: EEA, 2001), ch. 16.

59 Jeff Howard, "Environmental 'Nasty Surprise' as a Window on Precautionary Thinking," *IEEE Technology and Society Magazine* 21:4 (2002/2003): 19–22; and European Environment Agency, "Late Lessons."

60 See, e.g., Jordan and O'Riordan, "The Precautionary Principle," 7, 31.

61 Barrett and Raffensperger, "Precautionary Science"; European Environment Agency, "Late Lessons," ch. 16; and Woodhouse and Nieusma, "Democratic Expertise."

62 Montague, "Precautionary Action."

63 M'Gonigle, "The Political Economy," 131.

been proposed for implementing the PP, including community-based research, consensus conferences, environmental performance bonds, corporate disclosure requirements, restrictions of corporate charters, and phaseouts of problematic classes of chemicals.[64] The relevance of such mechanisms for SP will be measured in terms of their ability to change "both the relations of economic and political power and the paradigms of analysis that are both embedded in and, in turn, underpin these relations." [65]

The strong parallels in all three of these categories—emphasis on the local, on lay empowerment, and on democracy—produce rich opportunities for intercourse between SP and PD. There is good reason to expect that precaution-oriented grassroots activists would benefit from studying the explicitly design-oriented tactics of PD proponents and, conversely, that PD proponents would benefit from studying grassroots activism. It seems likely that encountering a similar set of technical, financial, institutional, and cultural obstacles to meaningful participation has produced insights and approaches that are likewise similar and that would benefit from cross-fertilization. For example, the experience of activists who have successfully initiated programs for PD of corporate information technology systems may offer valuable models for activists who seek to pressure industry to bring community and labor organizations directly into decision making on toxic emissions or solid-waste recycling.[66] At the same time, the experience and concerns of environmental activists can be expected to improve how PD advocates think about the ramifications of technical design, how they understand the value-ladenness of technical design expertise, and how they define the communities that ought to be brought into design.[67] Recognition of SP-oriented activism as a tacit form of PD, especially at the local level, raises the possibility of an explicit and comprehensive fusion of the two.

Discussion and Conclusion

The principal objective of participatory design is empowerment of laypeople to participate deeply, and with some measure of authority, in the evolution of technological systems. The other two PD emphases—the importance of the local and the importance of organizational context—are best understood as serving this central objective, providing insights into what PD proponents believe it means for laypeople to be empowered, and how they believe this empowerment can be brought about. Interpreting PD as an emerging expression of strong-democratic control of technological systems, this paper has explored its compatibility with—and opportunities for integration with—three diverse ecological-reform frameworks that have been, or could be, pressed into service as foundations for ecodesign. A more extensive analysis would be necessary to fully characterize each region of the technocracy/strong democracy

64 Raffensperger and Tickner, *Protecting Public Health;* and Joe Thornton, *Pandora's Poison: Organochlorines and Health* (Cambridge, MA: MIT, 2000).

65 M'Gonigle, "The Political Economy," 125.

66 E.g., how "outsiders" can work their way inside a company's walls, how they can establish trust, how they can help initiate a rethinking of expertise and the objectives of design, and how they can participate in design decisions in a sustained fashion.

67 Along the way, there also would be mutual lessons from differences between the two contexts. One issue of particular concern: how cooperatively designing a single, technically determinant product or process (the focus of most PD projects) differs from cooperatively designing broader, frequently indeterminate relationships between industry, the community, and the environment (the focus of precautionary initiatives).

continuum, but the present analysis has provided initial glimpses of the larger pattern.

The technocratic approach of industrial ecology typically makes no provision for lay input and passively accepts the shape of contemporary industrial-corporate institutions. Community-based social marketing of sustainability programs offers a significant contrast, for it directly addresses social dimensions of technological systems. But whatever lay engagement CBSM envisions is largely passive, because CBSM focuses primarily on applying social-science expertise to tasks performed by the managers of sustainability programs and is neither intended nor structured to promote democratization of institutions promoting sustainability. Only strong precaution, at the strong-democratic end of the technocratic/strong-democratic continuum, consistently shares PD's emphases. SP and PD are organically related, and SP's call for public control of technological decision making can be understood as a call for lay engagement in design and for democratic restructuring of design institutions.

In a sense, this paper has asked how well IE, CBSM, and SP would serve as "institutions" for the practice of PD in the context of environmental issues. It seems there are significant opportunities for integrating PD emphases and PD-style lay engagement into all three. For industrial ecology, this engagement may be limited to introducing mechanisms allowing lay activists and others to play consultative roles—roles that would give IE a somewhat more participatory orientation but that would be unlikely to fundamentally alter its technocratic character. For CBSM, opportunities to integrate PD appear more substantial. It seems possible to orient specific CBSM projects—and to some extent CBSM itself—toward participation.

For strong precaution, too, we can distinguish between specific projects and more general considerations. At the level of individual SP-oriented projects, where PD already is tacitly occurring, the task is to bring PD and SP into direct, sustained contact in order to: facilitate the exchange of experience and tactics; enable SP activists to use PD cases as precedents for lay engagement behind corporate walls; and improve PD thinking about who should count as "relevant laypeople" and "affected communities." At a more general level, the tasks are: to explicitly draw out similarities and dissimilarities between SP theory and PD theory (with special attention to the relationship between local and global dimensions, and between intended and unintended effects of technology); to consider the theoretical and strategic significance of the realization that local-scale SP constitutes a form of PD; and to knit all of this into a cohesive account of SP and PD's relationship(s) to strong democracy.

Strong precaution clearly offers the most benign foundation for PD. Here there is every reason to believe that PD can survive and thrive as a form of "dark green" design.[68] At the same time, however, we should not underestimate the importance of IE and

68 See Madge, "Ecological Design," 52–53.

CBSM as institutional homes for PD. Given that (compared to SP) IE is now far more actively integrated in industrial affairs, and given that CBSM probably has better short- and medium-term potential to be integrated into municipal sustainability programs, efforts to integrate PD into these approaches remain promising. Even modest success could have a substantial impact on public policy.

Feldman's observation that design is an "ongoing struggle for the appropriation of homeplace" [69] underscores the importance of bringing PD perspectives and methods into the center of programs to achieve sustainability. It is far from clear that the technocratic approaches that now dominate such programs offer a viable means of protecting our biological home—and all too clear that the political home they help reify is not strong but "thin" democracy.[70] The need for these approaches to be leavened with, or supplanted by, approaches based on the goals and assumptions of strong democracy is arguably urgent. Modeling ecodesign in part on PD would promise a number of salutary effects: helping laypeople and experts alike recognize that the values that come to be embedded in technology can be democratically negotiated,[71] helping laypeople "defy images of their capabilities and overcome institutional regulations regarding their rights," especially by facilitating the development of "improved management skills, a sense of self- and group-efficacy, and credibility";[72] and, in general, demonstrating "that under appropriate conditions, [laypeople] are capable of participating actively and effectively" in technology development.[73]

Tension between technocratic and participatory impulses is quite distinct in the ecodesign literature pioneered by Victor Papanek and others.[74] And as ecodesign practice and theory come into more extensive contact with the design assumptions and implications of various ecological reform programs, the significance of this tension will grow. Attending to the thorny issue of who should steer ecodesign will take its place as an important part of the field's "steady broadening of ...scope in theory and practice" and "increasingly critical perspective." [75] Pursuing participatory ecodesign offers one means of conceptualizing and enacting ecodesign as a process that involves not just "proximate designers" but "design by society" and that helps move society toward participatory, deliberative steering of technology.[76]

This project has been supported by the U.S. Environmental Protection Agency's Science to Achieve Results (STAR) graduate fellowship program (grant number U-91593401-3). It has not been subjected to EPA review and therefore does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

69 Feldman, "Participatory Design," 144.

70 See Barber, *Strong Democracy,* ch. 1; and Daniel Sarewitz, *Frontiers of Illusion: Science, Technology, and the Politics of Progress* (Philadelphia: Temple University, 1996), ch. 8.

71 Clement and Van den Besselaar, "A Retrospective Look," 34.

72 Feldman, "Participatory Design," 144, 139.

73 Clement and Van den Besselaar, "A Retrospective Look," 34.

74 E.g., Van der Ryn and Cowan's *Ecological Design,* with its dictum "everyone is a designer," shares PD's emphases much more closely than either Papanek's *The Green Imperative: Natural Design for the Real World* (New York: Thames and Hudson, 1995) or Nigel Whiteley's treatment of green design in *Design For Society* (London: Reaktion, 1993).

75 Madge, "Ecological Design," 44.76 Woodhouse and Patton, "Design by Society."

76 Woodhouse and Patton, "Design by Society."