Introduction

Design by Society: Science and Technology Studies and the Social Shaping of Design[1]

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This *Design Issues* symposium is a continuation of efforts to enrich design studies by selectively reaching out to scholarship in related fields. The contributors to this issue are from the interdisciplinary field of science and technology studies (STS). They include an anthropologist, a political scientist, and an interdisciplinary set of STS graduate students and recent Ph.D.s with backgrounds in engineering and design, as well as in the humanities and social sciences. This volume emerges from a project at Rensselaer Polytechnic Institute to develop "An STS Focus on Design," funded by the National Science Foundation's Science and Technology Studies program. Project participants seek to foster a dialogue with the design studies community on design as a public activity engaging professional designers with many other social actors and institutions.

In this introduction, we provide an overview of how some STS scholars think about the challenges of design, and we briefly summarize the articles in this symposium. However, we begin by discussing the conceptual foundation for the work, distinguishing between what we call "proximate designers" and "design by society."[2] Professional designers most immediately shape design by their decisions at the drawing board, of course, but they work within contexts and incentive structures shaped largely by others. In proposing that design studies pay increased attention to design by society, we are attempting to join with Victor Papanek, Nigel Whiteley, Joan Rothschild, Richard Buchanan, Victor Margolin, William McDonough, and others who think systematically about how design can help shape a commendable civilization.[3]

Proximate Designers and Design by Society

Our starting point is the fact that design involves both professional designers as well as what might be termed "design by society." We refer to the persons often studied in this journal as *proximate* designers, including product, industrial, graphics, and urban designers and architects who exercise direct control over the details of design.[4] Proximate designers work under constraints and incentives established via complex social arrangements involving persons often far removed from the drawing board. This happens partly because

1 This symposium is based on papers originally written for the Design Seminar at Rensselaer Polytechnic Institute, funded by the National Science Foundation under grant B10332 for "An STS Focus on Design." We thank John Schumacher (in memoriam), Linnda Caporael, Judith Gregory, Langdon Winner, and our fellow participants in the Design Seminar for their contributions to this collaboration.

2 Design *by* society is intended as a corollary to Nigel Whiteley's *Design For Society* (London: Reaktion Books, 1992), recalling as well the democratic theme, "Of, by, and for the people."

3 Victor Papanek, *Design for the Real World: Human Ecology and Social Change*, 2nd ed. (Chicago: Academy Chicago, 1985); Joan Rothschild, ed., *Design and Feminism: Re-visioning Space, Places, and Everyday Things* (New Brunswick, NJ: Rutgers University Press, 1999); Richard Buchanan and Victor Margolin, eds., *Discovering Design: Explorations in Design Studies* (Chicago: University of Chicago Press, 1995); and William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (New York: North Point Press, 2002).

4 Of course, we are not trying to legislate usage of the term "design," and some readers may prefer to limit its denotation to the professions traditionally understood to be at the core of design practice.

designers have to earn a living, which usually entails working directly or indirectly for clients; but the overall process of design is far more complex than suggested by the relatively straightforward relationships between proximate designers and clients.

The concept of design by society has three main facets, the first of which is that no simple boundary adequately delineates what counts as design, or who engages in it. To the core design professions as conventionally understood, one might add chemical engineers, computer scientists, nanotechnologists, and other technical specialists who conduct R&D and shape the built world. An even broader collection of people shape design by setting parameters, procedures, and directions within which proximate designers work. For example, managers set corporate policies that establish boundaries for the kinds of projects that can be undertaken. More specific interventions include those of accountants, who shape the financial systems within which design choices occur (e.g., determining whether wastes are to be treated as a cost to be minimized or as someone else's problem). Government officials establish building codes, safety standards, and environmental regulations. Altogether, innumerable persons and organizations participate in the design process with varying degrees of immediacy.

Second, design by society is intended to signify that social norms, values, and assumptions are reproduced—often unintentionally—in the products of design. As we read the design studies literature, it sometimes comes across as if designer (and client) were entirely free to choose how a product or building or artifact will be shaped, and as if their deliberate efforts constitute pretty much the whole story of design. Yet we all really know that cultural assumptions, legal mandates, and other social forces exert considerable influence on technological innovation, often without the participants being aware of all of the background influences. As Wiebe Bijker and John Law put it, "Our technologies mirror our society. They reproduce and embody the complex interplay of professional, technical, economic, and political factors." [5] "(R)elationships of power and authority frequently are expressed in material settings that are deliberately designed and built." [6] For example, product differentiation in consumer durables tends to mirror the prevailing patterns of social differentiation: what it means to be a woman or man, boss or secretary takes on durable form, from the razors we use to the desks we sit at.[7]

One inference from the above is that designs may tend to best serve the needs of those who most resemble the proximate designers.[8] The logic is simple: (1) designers have to proceed in terms of their own understandings of the world; (2) their ideas have been shaped by their individual experiences, disciplinary training, and demographic positioning by race, class, and gender;[9] (3) what "makes sense" will tend to be in accord with designers' tacit assumptions—and possibly *not* in accord with the assumptions of persons

5 Wiebe E. Bijker and John Law, eds., *Shaping Technology/Building Society: Studies in Sociotechnical Change* (Cambridge, MA: MIT Press, 1992), 3.

6 Langdon Winner, "Political Ergonomics" in Buchanan and Margolin, eds., *Discovering Design,* 147.

7 Adrian Forty, *Objects of Desire* (New York: Pantheon, 1986).

8 Donald Norman, *The Design of Everyday Things* (New York: Doubleday, 1988).

9 Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1991); and Sandra Harding, *Is Science Multicultural? Postcolonialisms, Feminisms, and Epistemologies* (Bloomington, IN: Indiana University Press, 1998).

not engaged in the design process; (4) to the extent that designers' understandings depart in significant ways from those of the unrepresented, unfortunate consequences may ensue. For example, the design of city streets creates obstacles for many people who do not fit the profile of the adept user. Imagine how different city streets would be if urban designers and traffic engineers came disproportionately from the ranks of the visually impaired, elderly, wheelchair-bound, and bicycle commuters.[10]

Third, we intend the concept of design by society to pose the following challenge: how might the great care that now goes into proximate design of particular products be extended to the broader processes of design? As one component of that huge task, what would it take to arrange for the social costs of innovation to be identified, deliberated, and mitigated earlier rather than later? These and related questions arise because the careful attention and skilled performance commonly found in design typically is not applied to technological innovation as a whole. The foundation for this is that designers, to some considerable degree, proceed by serving *clients'* ends, which of course makes good sense insofar as "the primary purpose of design for the market is creating products for sale." [11] One crucial drawback, however, is that "little thought has been given to the structures, methods, and objectives of social design... the foremost intent (of which)... is the satisfaction of human needs." [12] The client-focused, one product-at-a-time marketed approach also means that designers tend to assume that any given design has little effect on other designs, so negative synergisms can be ignored. A corollary assumption is that each new design is politically neutral, so how it is used rather than how it is designed determines whether the effects are for good or for ill. Among other implications, this means that there is no need to design for social equity or for any other public outcome.

We readily acknowledge that it is by no means clear how a lone proximate designer could go about taking these broader issues into account. Even an entire business's or industry's imperatives for timely and cost-effective task performance may fit rather badly with a critical and holistic social perspective. Indeed, hardly anyone in a position of authority in the business sector has a strong and unconflicted interest in paying diligent attention to design by society. An obvious inference is that public concerns about design outcomes might appropriately be taken up in a public way. Rather than throwing responsibility on designers and clients alone, with government officials in the background as intermittent limit setters, how might design move into public debate, systematic inquiry, and institutional practices in unprecedented ways?

Recognizing, then, that a nuanced understanding of design in a complex technological society involves an enormous range of considerations, we suggest design by society as a conceptual approach for (1) considering how myriad persons participate in the

10 How undesignerly persons might be included more influentially is one of the goals of participatory design, discussed in several of the essays.

11 Victor Margolin and Sylvia Margolin, "A Social Model of Design: Issues of Practice and Research," *Design Issues* 18:4 (Autumn, 2002): 24.

12 Ibid., 24–25.

design process; (2) examining how societal norms are built into the world by design; and (3) figuring out how the best spirit of proximate design could be applied to the broader domain of design by society. In other words, this approach locates the work of proximate designers within the larger universe of social institutions and processes that shape the artifacts, symbols, and systems of contemporary life. The cumulative consequences of these rival in importance, scope, and intellectual challenge the domain now considered the field of design. Our goal is to bring the issues of design by society into more frequent and systematic conversation with the traditional concerns of proximate designers and design studies.

STS Perspectives on Design by Society

The field of science and technology studies examines sociotechnical phenomena ranging from laboratory curiosities through seemingly simple artifacts, to complex sociotechnical systems.[13] For example, Kenneth Ames argues that household furniture in Victorian America combined elaborate design with basic functionality to display conspicuous consumption and reinforce social stratification. Ornamental but uncomfortable chairs in the entryways of well-to-do households were appropriate to be seen by owners and guests, while sat upon only by servants and messengers.[14] At a much larger scale, Thomas Hughes explains the construction of electrical power networks as *sociotechnical systems* wrought by system builders with "the ability to construct or force unity from diversity, centralization in the face of pluralism, and coherence from chaos." [15] The analysis of such systems seeks to explain how people and technologies are combined to work as heterogeneous but functional wholes.

To study the social shaping of technologies, STS scholars work in the cognitive space between two commonly held perspectives regarding technology. The position of *technological neutrality* maintains that a given technology has no systematic effects on society: individuals are perceived as ultimately responsible, for better or worse, because technologies are merely tools people use for their own ends. Possibly the most common example of this position is the slogan, "Guns don't kill people; people kill people"—according to which logic the gun is a neutral tool while agency is attributed to the individual pulling the trigger. In contrast, the position of *technological determinism* maintains that technologies are understood as simply and directly causing particular societal outcomes.[16] Thus, a determinist might attribute the decay of U.S. cities to the invention of the automobile, perceiving that the new technology itself undermined the vitality of central cities. Technological neutrality and determinism are folk theories that attempt to understand how people and technologies interact: both explain that interaction in black-and-white terms, attributing agency either entirely to people or entirely to technology.

13 For an introduction to STS, see Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch, eds., *Handbook of Science and Technology Studies* (Thousand Oaks, CA: Sage Publications, 1995); the journal *Science, Technology, and Human Values;* and the annual meetings of the Society for Social Studies of Science. For an introduction to science studies, see David Hess, *Science Studies: An Advanced Introduction* (New York: New York University Press, 1997).

14 Kenneth L. Ames, "Meaning in Artifacts: Hall Furnishings in Victorian Architecture," *Journal of Interdisciplinary History* 9:1 (Summer, 1978): 19–46.

15 Thomas P. Hughes, "The Evolution of Large Technological Systems" in Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MA: MIT Press, 1987), 52.

16 Merritt Roe Smith and Leo Marx, eds., *Does Technology Drive History? The Dilemma of Technological Determinism* (Cambridge, MA: MIT Press, 1994).

For STS scholars, better explanations require conceptual tools that allow us to think systematically about complex and simultaneous causation as people and technologies interact. One such tool is the concept of *valence,*

> a bias or "charge" analogous to that of atoms that have lost or gained electrons through ionization. A particular technological system, even an individual tool, has a tendency to interact in similar situations in identifiable and predictable ways. In other words, particular tools or technologies tend to be favored in certain situations, tend to perform in a predictable manner in these situations, and tend to bend other interactions to them. Valence tends to seek out or fit in with certain social norms and to ignore or disturb others.[17]

Thus, a gun is neither neutral nor does it cause people to kill each other. Rather, a gun is valenced toward violence. The presence of a gun in the context of a dispute facilitates a course of events in which a person is shot. One can feel the valence of the gun in the tension it adds to the situation. Although a table lamp also can be used to kill, it does not lend itself as readily to the act.

Another way to characterize the complex interplay between agency and determinism is to see technologies as *forms of life*.

> The construction of a technical system that involves human beings as operating parts brings a reconstruction of social roles and relationships. Often this is a result of a new system's operating requirements: it simply will not work unless human behavior changes to suit its form and process .... We do indeed "use" telephones, automobiles, electric lights, and computers in the conventional sense of picking them up and putting them down. But our world soon becomes one in which telephony, automobility, electric lighting, and computing are forms of life in the most powerful sense: life would scarcely be thinkable without them.[18]

Thus, in no simple terms did the automobile cause urban decay. However, automobility as a form of life developed via federally subsidized highways, incentives for single-family home ownership, low-density development patterns with plenty of free parking, and a century-old suburban ideal that previously was only within reach of the upper class.[19] With these enabling conditions in place, automobile ownership became a necessary ingredient for middle-class Americans to flee the city and its strained race relations. The concept of technologies as forms of life expresses how people and technologies shape each other. It is intended as a partial replacement for the conventional notion of a one-way process through which humans design and use technologies as neutral tools.

17 Corlann Gee Bush, "Women and the Assessment of Technology: to Think, to Be, to Unthink, to Free" in Joan Rothschild, ed., *Machina Ex Dea: Feminist Perspectives on Technology* (New York: Pergamon Press, 1983), 155.

18 Langdon Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago: University of Chicago Press, 1986), 11.

19 Clay McShane, *Down the Asphalt Path: The Automobile and the American City* (New York: Columbia University Press, 1994); and James J. Flink, *The Car Culture* (Cambridge, MA: MIT Press, 1975).

Impressed by the nuances arising in the design and diffusion of innovations, many STS scholars have investigated the details of how artifacts and sociotechnical systems came to take the shape they did. The social construction of technologies, they say, can be understood as involving a number of relatively predictable steps, including how relevant social groups such as users interact with technologists and businesses to bring "closure" to technical potentials that initially are highly malleable.[20] Perhaps the best known such analysis concerns the evolution of the bicycle.[21] The branch of STS represented in this symposium places less emphasis on the historical and sociological analysis of how things came to be. Instead, it emphasizes where design goes from here, and on what it will take to reconstruct technologies more wisely and fairly.

Scholars working in this tradition tend to point to rather basic shortcomings in the processes from which design eventuates. Thus, while proximate design is inherently a deliberate intervention, and a series of thoughtfully selected acts, in the broader realm of design by society, there actually is a widespread predisposition *not* to intervene deliberately. "You can't stop progress" functions as something of a mantra. Thus, the most important institution for design by society—market buying and selling—often does a brilliant job of serving the parties to a transaction; but buyers and sellers are free to ignore third parties who their actions affect. Markets are not structured to steer technological innovation toward social ends because they lack mechanisms to distribute the costs and benefits of innovation equitably, and because they lack mechanisms to deal with serious problems arising synergistically as second-order effects of innovation.[22]

Individuals, organizations, and societies often behave as if sleepwalking, often allowing innovations to move along paths not deliberately chosen by socially sanctioned processes. The concept of *technological somnambulism* names this failure to recognize, debate, and address technological design as a core component in the shaping of everyday life. One manifestation is that means are not crafted and selected to serve carefully chosen ends; instead, "reverse adaptation" makes new technical potentials central—and humans and their organizations adapt.[23] Such deliberate intervention by society as does occur tends to be both late and clumsy. We have largely failed to arrange and conduct the sociopolitical research, design, and training needed to create the repertoire of practices and institutions necessary to intervene effectively. Whereas legislation often receives extensive public hearing and debate, the technological design process usually is limited to a narrow group of people—the proximate designers and their clients—who typically are shielded from scrutiny, partly for reasons of trade secrecy, and partly from habit and public quiescence. It becomes very difficult even to locate responsibility for specific decisions made within complex organizations—from space shuttle disasters, to dumped hazardous wastes, to defectively manufactured passenger vehicles recalled annually by the millions.

20 Bijker, et al., *The Social Construction of Technological Systems.*

21 Wiebe E. Bijker, *Of Bicycles, Bakelite, and Bulbs: Toward a Theory of Sociotechnical Change* (Cambridge, MA: MIT Press, 1995). Questions about the analysis are raised by bicycle historian Nick Clayton, "SCOT: Does It Answer?" *Technology and Culture* 43 (April 2002): 351–360.

22 For a review of market strengths and shortcomings, see Charles E. Lindblom, *The Market System: What It Is, How It Works, and What to Make of It* (New Haven: Yale University Press, 2001).

23 Langdon Winner, *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought* (Cambridge, MA: MIT Press, 1977), 226–236.

One manifestation is a loss of agency, an inability to steer technological development and use in directions responsive to the intentions people would have if they had the opportunity, motivation, and competence to deliberate on the matter. "With the overload of information so monumental, possibilities once crucial to citizenship are neutralized. Active participation is replaced by a haphazard monitoring." [24] Most of us, most of the time, allow the relevant experts and their organizations in each field of basic and applied science, engineering, and medicine to do whatever is technically and financially feasible within their narrow spheres of action. No institution has a mandate to determine whether the many different technological design trajectories fit together wisely and fairly.

Participation, Expertise, and Process

To bring the above insights from STS into somewhat sharper focus for design studies, one step is to reflect on certain foundational questions that integrate proximate design with design by society:

1 Who shall participate in making decisions about new design initiatives (and in revising existing activities)?
2 How shall the benefits of design be distributed?
3 For what range of outcomes will designers assume responsibility—and accountability?

Actually, of course, no one attempts to answer such broad questions, except perhaps in a few utopian studies courses in college. In everyday practice, one takes for granted almost all of the world "as is," and that heuristic move has a certain functionality because getting anything done requires not trying to do too much. Nevertheless, inattention to foundational issues arguably results in significant shortcomings facing design in our era:

1 A tendency for technological innovation to proceed without sufficient contestation and deliberation;
2 Great inequalities in who gets the benefits of designers' energies and skills; and
3 Nontrivial side effects, synergisms, and second-order effects that no one is responsible for foreseeing and preempting.

What would it take to cope better with these and other challenges in technological innovation? Many analysts emphasize some combination of more diverse participation, better deployment of expertise, and improved decision-making strategies and processes.

Echoing the sentiments of those who advocate participatory design, democratic theorist-activist Richard Sclove argues, "Insofar as (1) citizens ought to be empowered to participate in shaping their society's basic circumstances, and (2) technologies profoundly affect and partly constitute those circumstances, it follows that (3) technological design and practice should be democratized." [25] This seemingly radical conclusion arises from a simple analogy: government

25 Richard E. Sclove, *Democracy and Technology* (New York: Guilford Press, 1995), ix.

24 Ibid., 296.

policy making is similar to design in that both determine the allocation and structure of resources that shape people's lives. However, there is no deliberative, public process for design by society equivalent to the legislative process in government, despite the fact that, in many respects, technology *is* legislation that authoritatively reshapes individual and collective life.[26]

Given the complex issues arising in design, *effective* participation obviously requires knowledgeable participation. Just how this can be achieved without the most knowledgeable participants dominating is one of the great, partially unanswered questions of democratic theory and practice. Even though technical experts rarely exercise the sort of authority once feared by critics of technocracy, a substantial fraction of the population lacks the knowledge necessary to participate effectively in many realms of contemporary life.[27] Can those with the requisite knowledge be socialized, selected, and motivated to represent the diversity of affected persons, stimulate a more vigorous competition of ideas, and promote greater political equality? Might "appropriate expertise" actually arrange to champion the concerns of people generally under-represented in, or disenfranchised by, technological decision making?[28] In addition, there may be ways to enhance the contribution of self-trained laypersons, for "bringing such persons into the technological decision-making process should not be seen simply as a democratic necessity; rather it is good sense in terms of using available expertise even when it is found in unexpected places."[29] Lay experts in hazardous waste controversies and other technological disputes sometimes develop sophisticated levels of expertise, and even ordinary people with relevant knowledge of local circumstances can make crucial contributions to public debate.[30]

The issues of participation and expertise intersect with concerns about inadequate institutional processes for governing technological innovation—raising questions, for example, concerning how to reduce, contain, or ameliorate the unanticipated consequences of new technologies. Although technology assessment has been moribund in the U.S. since the demise of the congressional Office of Technology Assessment in 1995, European scholarship and practice continues to push for "constructive technology assessment."[31] Rather than the purely analytic procedure once conceived by technically oriented researchers, it has become clear that assessment of innovations requires social learning; that such learning inevitably has an ideological component; and that it requires pluralistic debates that "expose neglected possibilities, clarify the limitations of accepted analyses, and identify the social values or interests concealed in existing 'objective' trajectories."[32]

But how can learning occur in time, before technological momentum makes it very costly to change course, as in the case of vinyl chloride (PVC) and other twentieth-century innovations? Developed partly to cope with this problem is the decision strategy

26 On technology as legislation, see Winner, *Autonomous Technology*, 317–325.

27 Frank N. Laird, "Technocracy Revisited: Knowledge, Power, and the Crisis in Energy Decision Making, " in *Industrial Crisis Quartterly* 4 (January, 1990): 49–61; and Frank Fischer, *Citizens, Experts, and the Environment: The Politics of Local Knowledge* (Durham, NC: Duke University Press, 2000).

28 Charles E. Lindblom and Edward J. Woodhouse, *The Policy-Making Process,* 3rd ed. (Upper Saddle River, NJ: Prentice Hall, 1993); and 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.

29 Harry Collins and Trevor Pinch, *The Golem at Large: What You Should Know About Technology* (Cambridge: Cambridge University Press, 1998), 5.

30 Steve Breyman, *Why Movements Matter: The West German Peace Movement and U.S. Arms Control Policy* (Albany, NY: SUNY Press, 2001).

31 Arie Rip, Thomas J. Misa, and Johan Schot, eds., *Managing Technology in Society: The Approach of Constructive Technology Assessment* (London: Pinter Publishers, 1995); and Norman J. Vig and Herbert Paschen, eds., *Parliaments and Technology: The Development of Technology Assessment in Europe* (Albany, NY: Suny Press, 1999).

32 Brian Wynne, "Technology Assessment and Reflexive Social Learning: Observations from the Risk Field" in Rip, et al., *Managing Technology in Society*, 19–20.

of intelligent trial-and-error (ITE), based on an intention of achieving rapid learning from experience at acceptable cost.[33] Derived from analysis of tactics successful in past innovative activities undertaken in the face of high uncertainty, ITE prescribes: (a) early debate involving diverse perspectives; (b) building in flexibility, so that when negative feedback emerges it will be feasible to make appropriate modifications;[34] (c) initial precautions for coping with uncertainty—such as backup systems and the overdesign of components; (d) very gradual scaleup, again to prevent excessive momentum; and (e) deliberately accelerated feedback via a combination of advanced testing and intensive monitoring. At present, of course, these strategies are seldom deployed fully or systematically, but the Premanufacture Notification system for new chemicals and the processes for approving new pharmaceuticals incorporate many of the recommended elements.

In This Issue

This brief overview of STS perspectives on design does not do justice to the diversity of thinking in the field. However, there is a fair amount of agreement that strenghtening the positive potential of design depends on broadening participation in technological decision making, on reevaluating established roles of experts and laypersons, and on developing new institutions and processes by which technologies could be more deliberately designed by society. Accordingly, the articles in this issue attempt to contribute to design studies by analyzing selected aspects of participation, expertise, and strategy/process. We recognize, however, that concerns of this magnitude and breadth do not belong to any small set of persons, nor to any one discipline, and our intention primarily is to nominate research and discussion topics that we think deserve sustained attention by proximate designers, design studies scholars, and everyone else who cares about well-designed innovation.

In "Alternative Design Scholarship: Working Toward Appropriate Design," Dean Nieusma develops a theory of appropriate design using themes from social theory to examine alternative design literature including universal design, participatory design, ecological design, feminist design, and socially responsible design. He uses these literatures as a resource for analyzing how designers have grappled with marginalization and unequal power relations reproduced by mainstream design practice and products. Nieusma argues that the challenge of appropriate design lies in grappling with five themes: accounting for diversity, coping with disagreement, coping with uncertainty, understanding governing mentalities, and thinking through agency. A synthesis of these insights, he shows, would be necessary in a theory of "appropriate design" practice capable of redressing social inequities. Originally trained as an engineer, Nieusma is developing this theory of appropriate design for his Fulbright-funded study of alternative energy practi-

33 Joseph G. Morone and Edward J. Woodhouse, *The Demise of Nuclear Energy?: Lessons for Intelligent Democratic Control of Technology* (New Haven: Yale University Press, 1989).

34 David Collingridge, *The Management of Scale: Big Organizations, Big Decisions, Big Mistakes* (London: Routledge, 1992).

tioners in Sri Lanka who implement renewable energy systems for rural populations.

In "Design Style: Changing Dominant Design Practice," Todd Cherkasky introduces the concept of "design style" to explain how alternative approaches to design may intervene in mainstream practice. Based on his work with labor unions in the baking industry and his experience as an engineer, Cherkasky critically examines factory automation and deskilling by considering technologies as forms of life. He explores the negotiatioins between engineers, managers, workers, and union representatives over automation technologies that shape workplace practices. In contrast to the mainstream "technocentric design," an alternative "skill-based design" incorporates worker knowledge and skills to create an arguably superior form of workplace life. Drawing on Ludwik Fleck and the science studies literature, Cherkasky shows how dominant design styles resist change; but he identifies tactics for reshaping symbolic, social, and material resources to support alternative design styles. Todd Cherkasky is part of the user experience research group at Sapient.

In "Toward Participatory Ecological Design of Technological Systems," Jeff Howard argues that different approaches to environmental reform provide widely varying foundations for ecological design and that this variation deserves attention and scholarly criticism. Deeply influenced by democratic theory and by the participatory design literature, he believes that fundamental improvement in the design of techno-social systems requires empowering laypeople to work conjointly with proximate designers. Howard identifies a spectrum of foundations for ecological design that vary in the strength of their participatory orientation, and he highlights three of these: industrial ecology, community-based social marketing, and the precautionary principle. Howard argues that the approach he calls "strong precaution" provides the most promising foundation for practicing participatory ecological design. A long-time environmental activist, Jeff now is completing dissertation research on the political dimensions of industrial chemistry.

In "Environmental Information Systems as Appropriate Technology," Kim Fortun examines the emerging potential of electronic environmental information systems. Her analysis focuses on "Scorecard," a Web-accessible database maintained by the Environmental Defense Fund that provides local pollution information based on company disclosures of 6,800 chemicals released from plants throughout the U.S. Scorecard's design has been criticized for demanding too much from users, but Fortun argues that dumbing down can be inappropriate for design. She finds Scorecard to be an appropriate technology that empowers and educates environmental activists. Although developed by centralized capital, labor, and expertise, Scorecard enables decentralized action by structuring people's engagement with industry, government, advocacy organizations, and an otherwise overwhelming amount of environmental

data. Fortun uses this case to suggest a redefinition of "appropriate technology" so that the concept can apply not just to simple technologies, but also to designs that engage with technical, social, and political complexity. Kim Fortun is an anthropologist who conducted three years of participant/observation in India with grassroots environmental groups responding to the Bhopal disaster.

In "The Challenge of Responsible Design," Jesse Tatum draws on his experience teaching in the Product Design and Innovation Program at Rensselaer, a program that integrates science and technology studies with engineering and architecture in studio courses. Asking "What messages do STS scholars have for designers," Tatum offers seven lessons that operate at the intersection between proximate design and design by society. The first concerns what he calls the "underdetermination" of science and technology: STS studies from physics laboratories to electric power regulation demonstrate that facts are never enough to determine how one understands and designs, that there always are choices to be made, and that these choices inevitably require social judgments. Drawing on his experience with off-the-grid housing and other alternative design, Tatum discusses the vast realm of technological and socio-cultural possibility, together with other lessons from STS that contribute to what he understands as an imperative to teach the next generation about responsible design. Tatum recently has been writing about overconsumption by the affluent, while building an off-the-grid house and offering hands-on design education to at-risk youth in Vermont.

Conclusion

This *Design Issues* symposium may raise more questions than it answers. STS analysis does more problematizing than problem solving, partly because our divergent thinking tends to broaden what counts as matters of consequence. We are debunkers and complicators more than problem solvers, students of the American humorists who perceived that "It ain't so much the things we don't know that gets us into trouble; it's the things we do know that just ain't so." [35] In applying that aphorism to design, one of the first steps might be to question the assumption that the fine-grained activities of graphic artists, architects, and other proximate designers are the main topic worth investigation by design studies—for what we have been labeling design by society arguably is far more problematic.

Whatever improvements may yet be possible in their techniques, team skills, and work styles, proximate designers already bring to their tasks extraordinarily careful attention, which design by society typically lacks. Rather than skilled deliberation, the current state of design by society may be more aptly characterized as somnambulism—sleepwalking. Rather than relative equality such as enjoyed between designer and client, social shaping of design is characterized by marked power inequalities. And rather than the direct and carefully controlled interventions often achieved by proxi-

35 Variously attributed to Mark Twain and others, the phrase probably originated with Artemus Ward, pseudonym of Charles Farrar Browne, *Artemus Ward: His Book* (New York: Carleton, 1862).

mate designers, design by society typically produces unintended consequences such assynergisms and unwanted second-order effects.

We do not accept that such high negatives are inevitable in technological design. We seek to provoke discussion on how the spirit of design practice might be applied to reconstructing technologies as forms of life along wiser, fairer, and otherwise "better" lines. Proximate design, at its best, provides a model for how a careful process of deliberation and negotiation might be applied to technological change in general. The constructive nature of design also provides a model for our own interdisciplinary field by encouraging problem-oriented scholarship that contributes not merely to refined understanding of the past, but to improved practice in the future.[36]

The most fundamental message that STS might bring to design practice and scholarship is that we need to reach beyond what is within the scope of any given designer, design firm, or customer. We need to grasp in a more shared and public way what makes life in a technological civilization worth living. Our primary point is not that proximate designers should behave differently, though perhaps they should in some instances. Nor do we presume that people could ever fully foresee and control all of the consequences of their technological acts. Rather, the challenge is to identify what stands in the way of a thoughtfully designed technological civilization, to establish social institutions more capable of design tasks that are beyond the range of proximate designers, and to work toward forms of life that more equitably serve more people.

36 Edward J. Woodhouse, David Hess, Steve Breyman, and Brian Martin, "Science Studies and Activism: Possibilities and Problems for Reconstructivist Agendas," *Social Studies of Science* 32:2 (2002): 297–319.