Design Style: Changing Dominant Design Practice

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Thirteen years ago in a rural Michigan town just south of a major university, I joined a group of revolutionaries. We were well-trained and generously funded. We were organized and had strong allies in major political parties. We used sophisticated tools and techniques that changed relationships of power and control throughout the United States. We did not organize marginalized social groups through solidarity, or catalyze emerging institutional crises, or lash out at figureheads who represented power imbalances. Instead, we designed industrial automation technologies. As a computer engineer on the front lines of workplace change, I helped develop control systems in various industries from California to Maryland that polished semiconductors, painted automobiles, processed and packaged food, and injected plastic molds.

To describe the engineers that I joined as revolutionaries is not entirely accurate. We were not, for example, at risk ourselves. Our design work significantly reinforced relationships of power and control in the workplace rather than disrupted them. And yet, the term "revolutionary" is at least partly accurate. We often changed everyday work life for people we never met. Our design decisions were decisions about who did what work, and how that work was done. I use the term "revolutionary" not to exaggerate the importance of my work as an engineer, but to reinforce the idea that the design of common tools, machines, and artifacts is a political act.

These technologies are not simply used and set aside, discarded, or forgotten. Their instrumentality is conjoined with patterns of social activity. Design processes and products are situated within social relationships, structures, and meanings, which can be resources for marginalized social groups or their representatives to improve their condition. If these resources play an important social role, then how does it come to pass that they enable particular forms of life over others?[1] In other words, if artifacts, tools, techniques, and machines provide texture for the fabric of everyday social activity—and if design is the process whereby they are configured—then the study of design is likely to reveal opportunities for creating better forms of life.

In my own work as an application engineer of machine control products, I did not recognize these opportunities. Perhaps I did not look for them. Or, perhaps I did not imagine how the artifacts, tools, and machines I helped to design could be config-

1 Langdon Winner provides an alternative to thinking about artifacts in functional terms. He sees technologies as "forms of life" and asks, "When we make things work, what kind of world are we making?" Langdon Winner, *Autonomous Technology* (Cambridge, MA: MIT Press, 1977) and Langdon Winner, "Technologies as Forms of Life" in Langdon Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago: The University of Chicago Press, 1986), 3–18.

ured in radically different ways, enabling different forms of life at work. My analysis of design might have been limited because the design context in which I was embedded offered little opportunity to discuss the social implications of industrial automation projects.[2] Engineers' time was consumed by detailed analysis of technical problems. Managers carried out "product segmentation" to identify market niches for their computer and control systems. Engineers—frequently expected to be in control of technological development—often thought that technologies were out of their control. They seemed to believe that they could only react to innovations. They acted as though they were either technicians responding to managerial directives, or were subject to larger economic constraints. Front-line workers who used the control systems were not included as part of the design arena; they had no role in the development and distribution of emerging workplace technologies.[3]

The Social Life of a Mundane Artifact

Ultimately, frustration with the gap between design and use led me to study workplace design and to work with managers, engineers, and labor union representatives to improve the forms of life emerging from the design of control systems. Fieldwork over the past decade has taken me to industrial automation suppliers, national research laboratories, car and truck manufacturers, shipping and distribution facilities, consumer electronics research campuses, and oil processing facilities. For several years, I studied technological change in large-scale bakeries in the United States. Baking is a useful subject for discussing forms of life because it surfaces in most of our everyday lives while also residing below our critical awareness.

Imagine a loaf of bread made by hand from a family recipe. And consider another one pulled off the shelf at your local supermarket. Each loaf affords and emerges from different patterns of civic life, economic production, social organization, and meanings. Making bread by hand takes a lot of time. It can be quite good if you have a lot of experience. Consider the process of making a braided challah for the Jewish Sabbath. It provides an opportunity for religious reflection. The following piece of advice is commonly associated with making a challah: "Each time one strand of challah is passed over another, say a prayer or read a line of a favorite psalm of praise." The outcome—a braided loaf of egg bread—is of course important, but the process itself highlights meaningful social practice.

"Wonderbread," however, brings to mind something else entirely. It emerges from and is situated in a very different set of social institutions. The person who will eat it seems to find the most value in the outcome—a loaf of consistent, white, sugary bread. The process of creating the loaf is relatively invisible, appearing only in the final stage, when a consumer selects the loaf from a grocery shelf. The resources required to manufacture and distribute this

2 Louis Bucciarelli introduces the term "object world" to explain how traditional engineering education and practice ensure a narrow problem focus. Louis L. Bucciarelli, *Designing Engineers* (Cambridge, MA: MIT Press, 1994).

3 In a tradition of technology-as-politics, Thomas outlines a "power-process" theory of design that embraces historical and cultural contexts of the organization. Detailed case studies stress that workers, especially those who are overlooked in the production process by management, can contribute constructively to the design process. Machines are too highly esteemed; workers too often neglected as a productive contributor. Robert J. Thomas, *What Machines Can't Do: Politics and Technology in the Industrial Enterprise* (Berkeley: University of California Press, 1994).

loaf are enormous: the factory from which it emerged may cover as much as one-hundred acres, require one million feet of floor space, consume over three-million pounds of flour each week, and employ a thousand people.

To maximize throughput, many factories have modeled themselves on the production methods of chemical processing. Instead of breads derived from a traditional "sponge" that takes several hours to rise, these factories use a liquid sponge, which is processed in a large vat called a continuous mixer. Chemicals and air are forced into the flour enabling continuous fermentation. The advantage of this process as seen by operating engineers is that, once the system is set up and properly maintained, human intervention can be kept to a minimum.

In continuous-mix systems, touching the dough is not possible because pipes route the dough from one automation cell to another. By contrast, in artisan production, the method for determining if the dough is ready is called "squeezing the dough." Human mixers physically test the dough by squeezing it. While artisan bread comes in many shapes and flours, the output of continuous mix systems traditionally has been limited to varieties of white breads and buns.

A loaf of bread emerges from a loosely connected set of social institutions including production systems, labor and industrial relations, baking science, city planning, religious and secular meanings, and domestic customs. These institutions shape the bread through expectations of consumers and assumptions of bakers, scientists, and other bread "designers"—among which are plant engineers, vendor field engineers, product line managers, front-line operators, and others who plan, install, configure, and maintain the industrial baking enterprise. For example, bakery managers perceive a consumer demand for bread that stays fresh longer. In response, baking scientists from J. R. Short Milling Company designed "Mor-Life"—an "exciting, enzyme-based product that gives 7 to 10 days of freshness 'you can feel' after baking.... You'll get longer shelf-life, experience fewer-store deliveries, and enjoy larger distribution areas." Agricultural scientists, controls engineers, and managers of large industrial bakeries work to improve yields and the "end-use functionality of wheat" not only through new enzymes designed into breads, but also by using anti-staling agents, low-calorie and no-calorie fats, and genetically engineered ingredients. Each of these ingredients represents a network of "technoscientific" and economic institutions considered by baking professionals as essential for the design and manufacture of a modern loaf of bread.

The bread from your supermarket is one outcome that emerges from complex interactions involving multinational corporations, machine vendors, labor unions, and national research and development agencies. It is shaped in part by decisions and assumptions of industrial automation engineers, consumer education and demand, and baking science. It exists as a result of the investment and configuration of production equipment, the demand for biotechnology, and the construction of enormous factories. A loaf of bread—whether a challah or Wonderbread—is surrounded by social worlds constituted by people with diverse skills and situated throughout diverse institutions. These people work together directly and indirectly to support a complex network of technologies, tools, and techniques to produce not only a loaf of bread, but "forms of life."

Industrial Baking, Work Organization, and Technology Design

Throughout the 1990s, the dominant management strategy in industrial bakeries was to replace aging capital equipment with increasingly integrated manufacturing control systems. In the early part of the decade, several prominent baking companies spent millions of dollars to implement fully computerized production facilities. When they lost their expected savings to degraded quality, high levels of waste, and increasing costs, they went bankrupt or were acquired by competitors. After these failures, corporate strategists backed off from attempts to create entirely automated, essentially workerless production systems. While many managers still pursued the dream of a robotic bakery, others started to consider alternatives to these work systems.[4]

I visited one small bakery in New England with the research director of the Bakery, Confectionery, Tobacco, and Grain Millers International Union (BCT). Intent on "modernizing" their bakery, management decided to build a new facility. The union research director and I presented a manufacturing approach that recognized not only the value of engineering expertise, but relied on the discretion and judgment of all of the two-hundred employees' skills—from mixing, to baking, to packaging, to maintenance. I had been on trips like this before with union representatives when we spent a full day presenting the merits of this alternative to technocentric design. We argued that "automating Taylorism" is a road to failure—to pumping out poor quality products, faster, with more waste.[5] When we arrived at this bakery, however, management already had decided to pursue what they called a "high performance work system."[6] They brought in an engineer who was trained in Denmark, and was familiar with "skill-based" design.[7] With pressure from the union, they already had developed a joint labor-management steering committee, and they were committed to participatory design of the new production system.[8]

The labor union pushed for the high performance, skill-based design alternative because, in such systems, the knowledge and skills of front-line workers become critical resources for ensuring quality products and dependable, high-throughput production runs.[9] Preventive maintenance replaces crisis management. Engineers consult regularly with plant floor workers instead of running from

4 Key institutional models of manufacturing are documented in Eileen Appelbaum and Rosemary Batt, *The New American Workplace: Transforming Work Systems in the United States* (Ithaca, NY: ILR Press, 1994). See also Franz Lehner, "Anthropocentric Production Systems: The European Response to Advanced Manufacturing and Globalization" (Luxembourg: Commission of the European Communities, 1992) and Dietrich Brandt, *Advanced Experiences: European Case Studies on Anthropocentric Production Systems,* 2nd ed. (Gelsenkirchen, Germany: FAST [Forecasting and Assessment in Science and Technology], 1990).

5 Frederick Taylor is credited with being the father of "scientific management, " which held that "one best way" can be found for any task and workers should be held to it. Frederick Winslow Taylor, *Scientific Management* (New York: Haper and Brothers, 1911).

6 The term "high performance" is derived from economist Ray Marshall, who was Secretary of Labor under President Carter. Marshall stresses the instrumental, productive, and intrinsic, democratic benefits of increasing worker participation in the design of their work. Ray Marshall, "The Eight Key Elements of High Performance Work Systems" (Conference Proceedings: High Performance Work and Learning Systems, Washington, DC, September 26–27, 1991), 3–14 and Ray Marshall, "Work Organization, Unions, and Economic Performance" in *Unions and Economic Competitiveness,* Lawrence Mishel and Paula Voos, eds. (Armonk, NY: M.E. Sharpe, 1992), 287–315.

7 Scandinavian design theorists and software developers have significantly challenged traditional Taylorist design. Pelle Ehn, *Work-oriented Design of Computer Artifacts* (Stockholm: Arbetslivscentrum, 1988); Gro Bjerknes and Tone Bratteteig, "User Participation and Democracy: A Discussion of Scandinavian Research on System Development," *Scandinavian Journal of Information Systems* 7:1 (1995): 73–98; and Christian Berggren, *Alternatives to Lean Production: Work Organization in the Swedish Auto Industry* (Ithaca, NY: ILR Press, 1992).

remote offices in response to alarms set off by "intelligent" sensors embedded in automated controllers. Knowledge, distributed throughout the organization, ensures short feedback loops. In this bakery, front-line workers, as well as engineers, were considered to have legitimate design knowledge. Engineering knowledge and front-line experience with mixing machines and recipes informed the setup of production lines and management information systems.

Like the small, New England bakery, a Nabisco plant that I visited had a well-developed, highly interactive, skill-based production facility. Throughout the one-million square-feet of floor space, factory workers could monitor production and modify ingredients and other process variables through operator terminals that displayed process-operating guidelines. In many factories throughout the United States, this information is reserved for supervisors and engineers who know the passwords to access recipes, histogram data gathered from machines, and date-stamps of hours worked by particular operators. Often, these display terminals are housed in locked rooms with glass walls. To get around locks in various plants, workers wedge open the doors of these control rooms, with the implicit consent of supervisors who would otherwise be obligated continually to modify process changes noted by operators. Even in facilities that apply skill-based design principles, technocentric engineering practice persists.

In the Nabisco plant, an operator of the "Chips Ahoy!" production line continually manipulated a large metal spatula over the six-foot wide conveyor to pick off individual cookies for testing. He monitored the shape and color of the cookies by directly examining them. He also monitored other process variables by checking the computer display. If he needed to change the recipe in the computer, he would put down his spatula at his workstation and type in the changes on a keyboard. One day, he arrived at work to find a brand new, stainless steel workstation with state-of-the-art electronic access to process operating guidelines, and real-time control over the Chips Ahoy production line. Unlike his previous, obsolete workstation, however, he had nowhere to put down his metal spatula while he was modifying recipes on the operator display panel, making typing difficult.

A technocentric bias in work redesign—whether in the form of "lights out" workerless production, or in the lack of workers' participation in the design of their workspaces—undercuts front-line expertise in favor of supervisory and engineering knowledge. Supervisors are expected to know and report to senior management on the current status and historical trends of mixing systems, the bakeshop, distribution, and inventory. Front-line workers carry out highly specified directives in response to visual "alarms" on their "graphical operator interfaces." Construction, application, design, and process engineers decide the ostensibly "optimum" configura-

8 Participation with management is a highly contested strategy within labor communities. See Andy Banks and Jack Metzgar, eds., *Participating in Management: Union Organizing on a New Terrain, Labor Research Review* (Chicago, IL: Midwest Center for Labor Research, 1989); Ray Scannell, "Adversary Participation in the Brave New Workplace: Technological Change and the Bakery, Confectionery, and Tobacco Workers' Union" in Glenn Adler and Doris Suarez, eds., *Union Voices: Labor's Responses to Crisis* (Albany, NY: SUNY Press, 1993), 79–123; and Michelle Kaminski, et al., *Making Change Happen: Six Cases of Unions and Companies Transforming Their Workplaces* (Washington, DC: Work and Technology Institute, 1996).

9 Harold Salzman provides several articulate comparisons between skill-based and technocentric design. Harold Salzman, "Participative Design and Engineering Practices for High-Performance Work Organizations" (paper presented at the Annual Meetings of the American Association for the Advancement of Science, Baltimore, Maryland, February 8–13, 1996).

tion of plant layout, operator interfaces, and information flow for the factory.

This technocentric bias dominates design practice in the industrial bakeries and baking exhibitions I visited, undermining front-line workers' expertise and constructive contributions to making bread in large factories. While the dominant approach to mechanized bread production seems to resist efforts to change design practice, there may be opportunities to overcome the tenacity of traditional industrial baking. Within the worlds of industrial baking, the resistance of design arises through complex institutional connections among prevailing modes of engineering pedagogy, economic incentives, advertising campaigns, and technological understanding. By examining how these prevailing modes of thought are sustained, we may learn how they can be disrupted.

Overcoming the Tenacity of Technocentric Design

My general approach to thinking about design has been to borrow from key figures in science studies to inform the study of artifacts and technologies. The field of science studies has demonstrated the work required to generate and sustain legitimate knowledge of the world.[10] This knowledge stabilizes through jointly entrenched ideas, conventions, and assumptions developed within social networks. Social groups outside of these networks, and marginalized by dominant systems of knowledge, must find ways to overcome the tenacity of prevailing modes of thought.

In his book *Genesis and Development of a Scientific Fact*, Ludwik Fleck used the concepts of thought style and thought collective to describe how a belief becomes legitimated as a fact.[11] Since I am interested in how alternatives to dominant design practice might emerge, I draw on Fleck's concept of thought style to introduce the concept of design style. Borrowing from Fleck's "thought style" helps to make two central points for encouraging alternatives to dominant design practice. First, Fleck uses the term *denskil*, which connotes "worldview"—not only rational cognition, but also other dimensions of experience (emotional, behavioral, cultural, etc.) that an individual uses to make sense of the world. By borrowing this aspect of *denskil*, I import an institutional dimension to what otherwise risks treatment as an overly rational, individualistic endeavor. Second, borrowing from the translation of *denskil* to "thought style" usefully flags a shift from style-as-aesthetics to style-as-a form of life.

A design style is a legitimated institutionalized pattern for how an artifact or technological system is created and sustained. This pattern includes prevailing design methods, practices, conventions, assumptions, principles, and objectives. While Fleck asked, how does one thought style emerge over another, I am interested in how one design style becomes dominant over others, and how a dominant design style might be disrupted, providing openings for change.

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10 Barry Barnes, *Scientific Knowledge and Sociological Theory* (London: Routledge and Kegan Paul, 1974); David Bloor, *Knowledge and Social Imagery*, 2nd ed. (Chicago: University of Chicago Press, 1991); Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987); Karin D. Knorr-Cetina and Michael Mulkay, eds., *Science Observed: Perspectives on the Social Study of Science* (Beverly Hills, CA: Sage, 1983); David Hess, *Science Studies* (New York: New York University Press, 1997); and Ludwik Fleck, *Genesis and Development of a Scientific Fact*, trans. Fred Bradley and Thaddues J. Trenn (Chicago: University of Chicago Press, 1979 [1935]).

11 Fleck, *Genesis and Development of a Scientific Fact.*

Table 1
Technocentric versus skill-based, high performance design styles

Technocentric Design	**Skill-based, High Performance Design**
Focus on efficiency and cutting costs	Focus on overall organizational performance and quality
Work redesign focuses on narrow tasks	Work redesign encourages functional interdependence and broad work responsibilities
Top-level hierarchial control	Reliance on workers' discretion and judgment. Managers and engineers provide support and resources.
Information concentrated in centralized management and engineering staff	Information freely dispersed throughout the organization
Design decisions made exclusively by engineers and managers	Workers participate in all phases of design
Human activity adjusts to capabilities of technology	Technology is used to take advantage of knowledge and skills of workers
Output is standardized through centralization of process settings and modification	Output is standardized by short feedback/ adjustment loop, which requires decision-making at the lowest possible level
Technologies compensate for human error (Automation requires human intervention limited to monitoring)	Workers ensure smooth operation of complex technological systems (Direct labor is used for machine supervision and analysis)

The bakery workers, for example, have worked to understand how the dominant technocentric design style in their industry is sustained, and how they might intervene in design to replace it with a "skill-based" or "high performance" design style. (Table 1) In other words, they have been trying to encourage a skill-based design style—which depends on using workers' knowledge and judgment, and demonstrates that they are important organizational assets.[12] Their approach reflects a concern for the quality of their members' jobs and an interest in producing high-quality, hearth breads—which they know will require more skilled labor. The bakery workers argue that skill-based design is better not only for them, but for others. They argue that skill-based design will "build a strong company and a strong union to provide greater security to its people and provide for the greater benefit of its employees, the community we live in, the customers we serve, and those who have invested in the success of the enterprise."

To disrupt the technocentric design style and replace it with skill-based design, the bakery workers have developed a variety of tactics for intervening in design. I characterize these tactics in terms of three key elements of design: symbolic, social, and material resources. (Table 2) In practice, the bakery workers have used these three elements of design to address how design problems are framed, what social institutions sustain design activity, and how material resources are configured to achieve design goals. The new

12 P. Brodner, ed., *Skill-based Automated Manufacturing: Proceedings of the International Federation of Automatic Control Workshop, Karlsruhe, Federal Republic of Germany, September 3–5, 1986* (Oxford: Pergamon Press, 1987); and Hans D. Pruijt, *Job Design and Technology: Taylorism vs. Anti-Taylorism, Routledge Advances in Management and Business Studies* (London: Routledge, 1997).

workstation on the Chips Ahoy line is one example of how material resources in industrial bakeries can be configured to support or undermine an operator's work. Similarly, the bakery workers understand that decisions about what types of mixers, packaging systems, ovens, and other machines and tools in the factory are decisions about control over work. They know that, if the engineers choose a 3,000-pound mixer for their production line, they will be producing a very limited variety of breads. A 3,000-pound mixer must have at least 1,500 pounds of dough in it to operate. The high capital cost of these large mixers requires continuous throughput and machine utilization, which limits the types of bread that can be produced. Artisan and hearth breads are out—breads that require more labor-intensive, craft production. McDonald's buns and Wonderbread-type breads are in—breads which can be highly automated through continuous mix and intense chemical processing.

Table 2
Design Elements

Element	Description	Examples
Symbolic resources	• Representations of design • Framing of design • Problems and goals	• Advertisements in the trade press • Engineering narratives
Social resources	• Social institutions and organizational structures sustaining design activity	• Labor-management committees • Co-determination laws
Material resources	• Content and connections of artifacts, tools, machines, elements of physical environment	• Configuration of operator displays, computers, and plant-floor sensors

In addition to attending to how material resources are configured, bakery union workers and leaders have worked to shape representations of design and create organizational structures that support participatory design. To help me illustrate how engaging these two design elements—symbolic and social resources—help bakery workers shift from a technocentric design style to skill-based design, I will draw on Ludwik Fleck's five-stage outline of the tenacity of a dominant thought style.

The method I apply here is to try to understand how a dominant way of thinking, or—in this case, designing—resists viable alternatives. By understanding the tenacity of a design style to resist alternatives such as skill-based design, interested social groups including the bakery workers can develop tactics for intervening in design. According to Fleck, the tenacity of a thought-style emerges at first when "a contradiction to the dominant system appears unthinkable. Second, what does not fit into the system remains unseen. Alternatively, if it is noticed, either—third—it is kept secret, or—fourth—laborious efforts are made to explain an exception in terms that do not contradict the system. Fifth, despite the legitimate claims of contradictory views, one tends to see, describe, or even illustrate those circumstances that corroborate current views and give them substance."[13]

Early in his work, the labor union research director had a hard time convincing the regional technology representatives, much more shop stewards and front-line workers, that alternatives to the dominant trends in baking could be developed.[14] This is Fleck's first stage, where a contradiction to the dominant system appears unthinkable. Most believed that machines would gradually, but inevitably, replace union members. Why would a factory not want to implement labor-saving devices? The prevailing representations in trade magazines and subsequent automation of packaging, tray handling, and other baking processes reinforce this view.

Consider the representation of human actors in baking advanced by Bill Davis, president of Pulver Systems, Inc., a manufacturer of laser-guided vehicles for bread basket, pan handling, and trailer loading. At the 1998 Baking Exposition and Show, I attended a talk by Davis during which he announced that, "We've pushed employees out of the bakery to the shipping dock... it's the final frontier...The factory of the future will have only a man and a dog. The man feeds the dog; the dog keeps the man from touching the controls."[15] Reinforcing this view, a Peerless Machinery Corporation advertisement in the trade press promises to "help you dim some lights in your bakery...There's a lot of talk about future technology making "lights out" bakeries a reality. Peerless already is there. Peerless technology. We're making your bakery a lot easier to manage." The union representatives easily identify what does not fit into these technocentric representations but, at this point—stage one of Fleck's outline—they believe there is little they can do to counter them.

The second stage—where what does not fit into the system remains unseen—reinforces this debilitating view. The dominant representations of baking design deny the quality contributions of skilled mixers, bakers, and maintenance workers. At best, they ignore these contributions. At worst, they represent human intervention as error-ridden. Contributions of skilled workers largely remain unseen by baking engineers, system integrators, and managers. For example, consider a new technology called the "Eagle Eye vision system." The "eagle eye" is a small camera mounted on a set of headphones that is connected to a remote engineering staff via the Internet. According to the manufacturer of Eagle Eye, with their "highly-advanced remote engineering system, you'll be able to slash soaring maintenance costs...By utilizing [their] exclusive technology, real-time video images, and full streaming, audio can be sent ...anywhere in the world, making the dream of remote engineering a practical reality." Preventive maintenance is replaced by reactive engineering diagnosis. What does not fit into this technocentric system is the alterna-

13 Ibid., 27.

14 Ashford presents possible points of intervention to increase labor unions' engagement with technology. Nicholas A. Ashford, "The Role of Labour in Choosing and Implementing Information-based Technologies" (paper presented at the International Symposium on Work in the Information Age, Helsinki, Finland, May 1996); and Nicholas A. Ashford and Christine Ayers, "Changes and Opportunities in the Environment for Technology Bargaining," *Notre Dame Law Review* 62:5 (1987): 810–858.

15 Davis made these comments while describing new technology trends at the 1998 Bakery Exposition and Show in Las Vegas, Nevada.

tive design approach that values training programs and long-term, highly skilled maintenance workers over advanced technologies and low-paid, contingent workers.

In the third stage, even those things that are recognized as valuable—or at least useful—are hidden if they do not conform to the dominant design style. At the International Bakery Exposition in Las Vegas, the BCT technology representatives were intrigued by one vendor's booth. We noticed that the mixing system of what the vendors called a "completely automated baking line" was walled-off by temporary cubicle partitions. Behind these partitions, a human mixer using an artisan-style machine was making the dough. The dough was physically picked up and carried to the dough stand, which initiated the automated part of the process. The lesson seemed to be: Human involvement should be kept secret from the beauty of a completely workerless system.

In stage four, extraordinary effort is made to accommodate an exception along the lines of the dominant design style. This process can be seen as the baking industry tries to respond to new design constraints resulting from the dramatic increase in demand for artisan breads. Compared to baking white breads, buns, and other staples of the baking industry, artisan breads require much shorter runs, higher product variety, and fewer industrial additives. While the best artisan breads are made in traditional, labor-intensive craft style, the challenge, as identified by the American Institute of Baking and as reflected in vendors' booths at the Baking Expo, is to scale-up production of these breads without increasing labor. The design constraints explicitly considered by baking engineers and managers remain the same, even when an opportunity for radically disrupting them arises. The dominant design style will accommodate the trend towards artisan breads by replacing labor through automation, and by manufacturing partially baked goods which can be baked off at corner bakeries to provide the appropriate hard crust and "fresh baked" appearance. While this will result in lower quality artisan breads, the product quality still will be higher than that of traditional breads. The point is that, even though artisan bread production contradicts many conventions of technocentric design, the dominant design style finds a way to incorporate these contradictions on its own terms with prevailing design methods. And how can it do otherwise?

The baking industry is constrained by the underlying assumptions, objectives, and methods of its technocentric design style. Without a disruption to this design style—the way the design problem is framed, the limits that are explicitly considered, and the means of distributing baking solutions—the baking industry can only react to the artisan bread opportunity in these terms. This is the final stage of Fleck's outline. Despite the valid claims of those who advocate high-skill, high-wage work, managers, engineers, and other influential designers of bakeries understand the bakery as an object for machine manipulation of food ingredients. The trade show was called the "baking expo," but it actually was a machine and tool exposition for the baking industry. The "baking expo" might have been conceived as a political-social-economic enterprise that draws on training, apprenticeship programs with local community colleges, and other regional economic planning initiatives, as well as current trends in industrial automation. Representations of design, however, told the story of baking-as-machines, not baking-as-social relations.

Table 3
Five stages in the tenacity of a dominant design style

	Stage	Example
1	A contradiction to the system appears unthinkable	Prevailing technological determinism within the baking industry limits perception of high-performance alternatives
2	What does not fit into the system remains unseen	Preventitive maintenance by front-line workers is superceded by reactive engineering diagnosis
3	If a contradiction is noticed, it is kept secret, or	Manual elements of "completely automated baking lines" are hidden by cubicle partitions
4	Laborious efforts are made to explain an exception in terms that do not contradict the system	Increased demand for artisan breads is met by manufacturing "fresh-baked" appearance and par-baked goods
5	Despite legitimate claims of contradictory views, one tends to see, describe, or illustrate circumstances that corroborate current views	Continual treatment of baking as manipulation of food ingredients versus techno-social enterprise

To disrupt the tenacity of the dominant design style, the bakery workers challenged the prevailing representations of design, created alternative institutions of design, and intervened in dominant ones. They worked with engineers, managers, and supervisors within these structures to explicitly consider how design problems might be framed in alternative ways. A first step for the union was to recognize the fact that representations such as those of Pulver and Eagle Eye do not depict inevitable technology trends. To help disrupt these common representations, the BCT research director needed staff members throughout the country that could tell alternative stories about how new technologies could be used. He was able to create the position of technology representative within the union's organizational structure—a position many other U.S. unions do not have.

A second organizational step for the union was to create institutions that consider the union's design criteria, as well as the prevailing criteria of the dominant design style. In several bakeries, they have initiated joint labor-management partnerships, joint design steering committees, and work groups that have the authority to broaden engineering design criteria to embrace skill-based design. Using these organizational resources, the union has investigated the distribution channel of new technologies. They have analyzed what producers of industrial automation equipment say about how their technologies could be used. They have visited system integrators and trade shows, and read trade magazines. Their enhanced understanding has helped them to participate actively in design meetings at their members' bakeries. This understanding depended on identifying how mundane workplace tools—computers, operator displays, and other plant-floor artifacts—were configured and how they might be arranged to support or undermine front-line workers' skills.

The union faces many barriers and often is successful only where their membership is strong. Many other obstacles exist. Often, corporate engineering staff dictates how new technology will be used at individual plants. In these cases, the union must have a national partnership agreement to have any chance at influencing design decisions. In addition, the efforts of individuals to shift design styles need to be supported by structural changes. For example, federal research and development agencies could make grants more readily available to labor unions by recognizing them as viable industrial partners with nonprofit organizations. Or, a shift in design style could be facilitated by companies that are mandated to pay the salaries of application engineers who work within state labor councils. Another possibility involves engineering professional societies that could lower entrance fees for workshops on new tools and machines, so that labor representatives and workers could attend.

In the face of these considerations, some BCT labor union members recognize that design can encourage social change or entrench existing relationships of control and authority. They have worked to understand how design problems are framed, how design activity is structured, and how artifacts and other material resources are configured—three key elements that help to constitute design practice. In the process, their members work in several bakeries where skill-based design has displaced the technocentric approach.

Intervening in Design

The concept of design style characterizes the tenacity of dominant design practice and entails a set of tactics for reshaping social, symbolic, and material resources to support alternative design processes and outcomes. The approach outlined here can be taken up in other design areas. Nigel Whiteley and others who share his critique of consumerist design are working to disrupt its dominance.[16] A first step for helping mobilize this critique is to articulate an alternative design style. In Whiteley's analysis, green design is one such alternative. See table 4 for a brief comparison of consumerist and green design styles.

16 Nigel Whiteley, *Design For Society* (London: Reaktion Books, 1993).

Table 4

Consumerist versus green design styles

Consumerist Design	Green Design
Focus on continuous innovation of distinctively styled products	Focus on innovation to solve social and environmental problems
Use marketing and advertising to create desire/demand	Use marketing analysis to identify existing social and environmental needs
Redesign of products increasingly frequent	Redesign only when the need demands it
Product materials are used to support styling, which encourages planned obsolescence, or "creative waste"	Product materials are used to minimize waste and maximize safety
Product designer has an obligation to quickly satisfy clients' desires	Product designer has an obligation to challenge clients' assumptions, e.g., using expertise to encourage efficient use of well-suited materials
High consumption and obsolescence viewed as democratic: they are seen to promote economic growth; over time products diffuse from high to low economic class	The idea that "less is more" is democratic; more resources are available for more people for longer; materialistic competition is reduced

Social, symbolic, and material design elements may be used to catalyze green design initiatives and undermine the dominance of the consumerist design style. For example, images from anti-consumerism campaigns sponsored by organizations such as the Canadian nonprofit Media Foundation (which produces *AdBusters* magazine) encourage alternative representations of product design that specify more sustainable design processes and outcomes. Design journals and magazines can disseminate design ideas consistent with green design. Institutions such as professional design societies and their codes of conduct, as well as progressive design organizations, also can help shift design styles. Organizations such as the Design Forum in Finland and the Ergonomi Design Gruppen in Sweden influence product designers to focus less on high-fashion extravagance than on fundamental human and ecological needs. In terms of material resources applied to product design, a shift in design style would require that both the materials used in design and the designed products minimize waste and maximize safety.[17] By working through these three design elements, product designers can fruitfully synthesize lessons in green design already developed by others.

In architecture, as in product design and in work design, the concept of design style can be used to describe attempts to shift from a dominant design approach to an alternative that is more agreeable to an interested social group. The concept of design style also can be used to help catalyze such a shift by helping participants jointly interrogate symbolic, social, and material resources in the design context. For example, building livable and likable affordable housing seems to be a persistent challenge for dominant architectural design practitioners. According to several architects committed to

17 Victor Papanek catalogs many inventive applications of common materials that meet the design goals of green design. Victor Papanek, *Design for the Real World* (London: Thames and Hudson, 1981).

low-rent, creative, community design, "Media portrayals of the nation's primary low-rent housing program—public housing projects—focus on the obvious failures: Chicago's Cabrini Green and Robert Taylor Homes, St. Louis's Pruitt Igoe, and Boston's Columbia Point.... There is a clear need to put forth convincing examples where low-rent housing works. And that, in large part, is a question of design."[18] Working to meet this need, their approach to design can be characterized as an alternative to the dominant design style in affordable housing, which typically involves private developers creating standard, unimaginative buildings with no cultural connection to local communities.

These architects have worked to shift the dominant design style to an alternative that involves the participation and cooperation of developers, neighbors, potential residents, local officials, and architects—all of whom work towards "a design solution that resolves the physical, social, and cost issues, and produces a building that the entire community can be proud of for generations."[19] In addition, the marginal design style works to limit the role of the automobile, combine land uses, and experiment with health-conscious and environmentally sound building materials and methods. These architects have represented the design problem with a larger set of constraints than the dominant design style in affordable housing, which seems to battle with the few constraints of fitting the needy into a limited space, with exceedingly fewer financial resources. They have created alternative organizational structures to support their marginal design style, including strategies for funding and creating participatory workshops on housing design and site planning. Participatory inquiry is enabled by exercises in which potential residents use models to arrange desired relationships between cars and dwellings. They are encouraged to disrupt conventional assumptions about neighborhood design. In addition, the marginal design style is fostered by close attention to material configurations in design. Not only do product participants work with safe, efficient materials, they also use materials to support community development. For example, in the Hismen Hin-nu Terrace project in Oakland, California, the town homes and apartments were designed to take advantage of the community's cultural diversity by employing four local artists to interpret their respective traditions and express them in frieze panels that then were installed throughout the development.[20] In other projects, birdhouses encouraged civic participation. And exhaust pipes disguised as fireplace chimneys seemed to discourage neighboring homeowners from organizing against the affordable housing project. Material amenities such as birdhouses and "chimneys" perform cultural work that the dominant design style does not recognize or appreciate. Set in the terms of design style, this quick review of affordable housing projects suggests how critical analysis of design might be extended for analyzing and fostering change in architectural design practice.

18 Tom Jones, William Pettus, and Michael Pyatok, *Good Neighbors: Affordable Family Housing*, (New York: McGraw-Hill, 1997), 8.

19 Ibid., 47.

20 Ibid., 100.

As the bakery workers found in their efforts to put into place "high performance" work systems, imagination and effort are required to disrupt a dominant design style, and to displace it with an alternative. Yet heroic efforts are not required—only systematic mobilization of material, social, and symbolic resources. The bakery workers did not need to start from scratch. The contradictions in the dominant design style already existed: efforts to optimize factories through total automation resulted in more rigid, less efficient operation. Bakery workers fought against the tenacity of the dominant technocentric design style by catalyzing emerging alternatives to totally automated baking systems. Taking advantage of existing social resources, they drew on labor-management committees to create participatory design work teams. The union mobilized and trained members as technology specialists who could educate others on design options. To create alternative representations of industrial baking, they challenged engineering narratives at trade shows and actively participated in design meetings within their home firms. To change how technologies were being implemented on the factory floor, they learned options in configuring existing operator displays, computers, and plant-floor sensors.

Artifacts and technologies are not traditionally recognized as politically relevant. Unlike issues that are recognizably political, few readily available venues exist for contesting scientific and technological innovations. Overcoming the technological somnambulism that lulls people into passively accepting their conventionally defined roles demands a change in design style.[21] A change in design style requires, in part, an interrogative method that fosters inquiry into the way that artifacts, tools, and machines are configured. If they are interested in catalyzing an alternative design style, designers—whether they work under the label of engineer, shop steward, supervisor, packaging technician, operator, product designer, or architect—will need to complicate their understanding of design. They will need to understand their work as a process of creating not only products and machines, but also forms of life and patterns of authority and control. The tactics identified here for intervening in design, and the general approach I have encouraged to inspect design styles, are attempts to link the worlds in which artifacts, tools, techniques, and machines are developed with the worlds in which they circulate. This type of analysis can encourage participatory inquiry into the social practices and customs that surround technologies, as well as the institutional resources required for it to exist. By raising questions about how design problems are framed, who participates in design, and how material resources are configured, people can encourage shifts in design styles, making it possible to find revolutionary potential in mundane places.

21 Absently accepting and unreflectively circulating within the forms of life generated by technologies—what Langdon Winner has called technological somnambulism—limits opportunities for improving design outcomes. Langdon Winner, "Technologies as Forms of Life," in Langdon Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago: The University of Chicago Press, 1986), 3–18.