Technology- and Product-Oriented Movements:
Approximating Social Movement Studies and STS

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Abstract: *Technology- and product-oriented movements (TPMs) are mobilizations of civil society organizations that generally include alliances with private-sector firms, for which the target of social change is support for an alternative technology and/or product, as well as the policies with which they are associated.TPMs generally involve "private-sector symbiosis," that is, a mixture of advocacy organizations/networks and private-sector firms. Case studies of nutritional therapeutics, wind energy, and open-source software are used to explore the tendency for large corporations in established industries to incorporate the products and technologies advocated by the TPM. As the incorporation process proceeds, the alternative technologies undergo design transformations that make them more compatible with existing products and technological systems. As the technological/ product field undergoes diversification, "object conflicts" erupt over a range of design possibilities, from those advocated by the more social movement–oriented organizations to those advocated by the established industries.*

Keywords: *social movements; complementary medicine; open source; renewable energy; technology design*

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As technology has become an increasingly important part of public policy debates and a concern of social movements (SMs) and advocacy organizations, the problem of integrating the fields of science and technology studies (STS) and SM studies has drawn increasing attention (e.g., Brown et al. 2004, Epstein 1996, Jamison 2001). The concept of technology-oriented and product-oriented movements (TPMs) is explored here as a contribution to the ongoing theoretical approximation of the fields. The concept represents a coherent subcategory within the general category of collective action and SMs that facilitates the comparative study of some dimensions of the study of social movements and technology. TPMs are mobilizations of civil society organizations that generally are also linked to the activity of privatesector firms, for which the target of social change is support for an alternative technology and/or product, as well as the policies with which they are associated. TPMs may occur within or alongside much broader social movements. For example, within the broader environmental movement, there were both oppositional movements, such as the antinuclear movement, and TPMs in favor of wind, solar, and other forms of renewable energy or "appropriate" technology. Although TPMs may be seen as currents within broader SMs, in general, their mode of action involves less emphasis on the politics of protest and more on building and diffusing alternative forms of material culture.

This article considers three hypotheses of processes that may exist in other forms of social change efforts and SMs but are particularly pronounced in TPMs. First, the "private-sector symbiosis" hypothesis postulates that the emphasis on technology and product innovation leads to the articulation of SM goals with those of inventors, entrepreneurs, and industrial reformers. A cooperative relationship emerges between advocacy organizations that support the alternative technologies/products and private-sector firms that develop and market alternative technologies. Second, the "incorporation and transformation" hypothesis postulates that there is a tendency over time

for established industries to absorb the innovations of the TPMs, but in the process they also alter the design of the technologies and products to make them more consistent with existing technologies and with corporate profitability concerns. Third, the hypothesis of "object conflicts" suggests that as the incorporation and transformation process modifies technological and product design, the field of technologies and products undergoes diversification, and conflicts become evident among various actors, from the original SM organizations to the large industries, regarding the range of technologies/products and their design. This article will explore the three hypotheses through a comparative analysis of three TPMs: the nutritional therapeuticsmovement, the renewable energymovement, and the open source movement.

Definitions

SMs are understood here to have three major distinctive features: broad scope in terms of organizational diversity and temporal duration, articulation of a social conflict by groups that are disempowered or perceive themselves to be disempowered on at least some issues, and extrainstitutional strategies such as protest against dominant institutions or the creation of alternative institutions (McAdam and Snow 1997, Touraine 1992). SMs embrace multiple organizations and campaigns, and they involve much more extensive mobilization than networks of activists or solo advocacy organizations (Flacks 2004). One might argue that TPMs represent a type of "new" SM (Melucci 1980), but the concept has well-known theoretical difficulties that are already adequately reviewed elsewhere (e.g., Pichardo 1997). Instead, this article assumes that TPMs generally emerge out of existing SMs (whether "new" or "old") and that they can utilize protest or alternative institution building as means for change. As an analytical category, TPMs are distinctive because their principle means of social change is the development of new or alternative forms of material culture, a means of change that is often associated with calls for significant institutional and policy changes as well.

At an organizational level, TPMs usually have two poles. In addition to

comprising NGOs, nonprofit, and advocacy organizations that often have links to a broader SM, they also include networks of occupational, research, or industrial organizations that seek to introduce alternative technologies and products as well as associated research programs. The second dimension is described here as the reform movement (RM) side of the TPM. Private-sector reform organizations that produce alternative technologies and products are typically entrepreneurial, at least in the early phases. Typically, the first large corporations or firms from existing industries that embrace the alternative technologies and products are situated in a countervailing industry, such as food companies that support the development of therapeutic nutraceuticals when pharmaceutical companies may oppose them, or energy companies that support the development of wind energy when utility companies oppose it.

The distinction between SM versus RM organizations or networks is ideal typical, but it is defended here as analytically valuable in understanding the empirical case studies. Because SM organizations often interact with forprofit business organizations that have overlapping but not identical goals, the relationship between the SM and RM side of the TPM may have varying levels of cooperation or conflict. From the SM side, the business organizations that develop and sell the alternative technologies and products may be seen as "private-sector vehicles" for SM goals. However, such vehicles are ultimately in the business of making money, so their long-term adherence to SM goals may be difficult to maintain (Weinberg 1998). Furthermore, the RM firms may be bought up by large corporations during the incorporation and transformation phase of the movement cycle.

The term *technology* is understood here to mean material objects that are intentionally used to modify the social and/or material world, whereas products are (for modern economies) capital or consumer goods that are sold in markets. The two categories overlap but are not identical. For example, organic food is a product but not a technology, whereas organic agriculture is a technology of production that may rely on some commercial products as inputs. To be effective, technologies must be embedded in socially and historically

situated cultural practices (Monahan 2003) that co-constitute a sociotechnical system (Hughes 1987), a web of human-object relations (Bijker and Law 1992), or a network of persons, institutions, and things (Callon 1986).

At a general level, the focus on technology as a target of change challenges SM theory to pay more attention to material culture, but as an arena for contestation rather than as a resource to be mobilized. This view is similar to and owes some debt to the analysis of the politics of artifacts in STS (Winner 1986) and to the work of health and feminist SM scholars, who have pushed SM theory to pay more attention to the body (Brown et al. 2004, Clarke 2000). Clearly, the politics of design is subject to interpretive flexibility, and the degree of interpretive flexibility depends on issues such as the scale of the sociotechnical system, the user-object relationship, the design of the object, and the regulatory and market conditions. The main point about the assumption that politics are embedded in the design of sociotechnical systems is that a challenge to authority can also be directed at technology design in addition to or instead of being directed at technology policies or the lifestyles that govern patterns of use. Although TPMs are defined here as having change in technology, products, or material culture as a primary focus, it is also true that TPMs can include campaigns for or protests against regulatory and research policies, and they can also support changes in consumption patterns and lifestyles (such as technology use patterns). Thus, while it is satisfactory to define the primary target of change as technology and products, usually the goal comes embedded in a much more extensive agenda that is often linked to a broader SM.

Theoretical Background

There are various ways to think about the approximation of the fields of SMstudies and STS. One approach might be through comparison of theoretical traditions, such as the similar theory traditions that highlight structure, agency, and meaning. For example, political process theory (e.g., McAdam 1983) and some of the Marxist European frameworks (e.g., Castells 1983) in

SM studies emphasize structural analysis in ways that are similar to interests analyses (e.g., Barnes and MacKenzie 1979) and subsequent structural programs in STS (e.g., Kleinman 1998, 2003; Frickel and Moore forthcoming). Likewise, resource mobilization theory (e.g., McCarthy and Zald 1987) and the process of "scale shift" (McAdam, Tarrow, and Tilly 2001) have some parallels in STS to studies of the growth and transformation of scientific and technical networks (e.g., Callon 1986, Hughes 1987). As Frickel (2004) has noted, SM theories of framing and identity (e.g., Benford and Snow 2000; Melucci 1996) have parallels to social worlds analyses in STS and the study of boundary objects (e.g., Clarke 1998, Star and Greisemer 1989). Additional analysis would be needed to explore how far the three parallel theory traditions could be credibly synthesized; this article will assume only that the basic conceptual triad of structures, action, and meaning is a valuable starting point, provided that material culture is added as a fourth point of reference.

A second approach to articulating the research fields, and the one that is the focus of this article, examines the processes that are described at the intersections of the two fields. For example, both theSMliterature and the STS literature examine processes of incorporation or cooptation. In SM studies, the problem of the routinization, absorption, or cooptation has been a persistent topic over the generations. Weber's (1978) analysis of the routinization of charisma influenced Michels's ([1915] 1958) classic work, and subsequent generations ofSMtheorists have also examined howstates selectively accept SM demands in ways that tend to divide and exhaust movements (e.g., Piven and Cloward 1977). Although unilinear phase models of SMs lack wide applicability, SMs do undergo cycles of mobilization and demobilization, and the incorporation of demands is one example of an outcome of SM protest (Tarrow 1998, chap. 9).

The STS literature on incorporation has focused more on scientific research communities, whose relations with SMs have often been tense or at least ambivalent (Nowotny and Rose 1979, Yearley 1992). In the context of science and SMs, one mechanism of incorporation is the "expertification" process that SM leaders undergo as they occupy positions of mediation

between SMs and research communities (Epstein 1996). A scientific research community can also capture SM demands for new research programs and associated technologies by rechanneling them into their own priorities for research. For example, during the early and middle decades of the twentieth century, reproductive scientists responded to SM demands for birth control technologies by redefining the technologies in high-tech ways (Clarke 1998, chap. 6). SMs can also serve as crucibles of new knowledge creation that in turn challenges and shapes scientific research agendas (Eyerman and Jamison 1991, Jamison 2001).

Regarding the specific issue of private-sector symbiosis, the literature on innovation has occasionally examined the role of SMs as a contributing force to industrial innovation (e.g., Lounsbury, Ventresca, and Hirsch 2003, Truffer and Durrenberger 1997), and the history of the appropriate technology movement also points to how SMactivists sometimes start businesses or merge SM and business values (e.g., Kleiman 2003, Turner 2003). Ecological modernization theory (e.g., Mol 2000) is another example of research that points to cooperative, symbiotic relations between SMs and private-sector organizations. Those relations can easily turn into cooptation by large corporations, as treadmill of production theorists note (e.g.,Weinberg, Pellow, and Schnaiberg 2000). Jamison (2001) also describes the incorporation process for the environmental movement. His analysis is extended here in the incorporation and transformation hypothesis, which focuses specifically on the ways in which the transformation of technical design becomes a key arena for object conflicts that emerge during the incorporation process.

The concept of object conflicts draws on a somewhat different STS research tradition, developed in part from the analysis of “boundary objects” (Star and Greisemer 1989) and “boundary organizations” (Guston 2001). In the context of health SMs, Brown and colleagues (2004) extend the concepts to point to the role of medical technologies as boundary objects and the role of health SM organizations in constructing and maintaining boundary objects across different constituencies. Likewise, Clarke and Montini (1993) show how different social worlds interpret a boundary object differently,

Clarke (2000) shows how the interaction of SMs and maverick scientists leads to product innovation,Winner (1986) shows how design choices have political implications, and Jørgensen and Karnøe (1995) show how design choices coincide with differences between SM and industrial views of technological and societal development. The concept of object conflicts extends thiswork by focusing on howthe design choices between different variations of similar objects become sites for conflict among the range of organizational and individual actors that develop from SMs to established industries.

In summary, although previouswork inSMstudies and STS has occasionally examined some of the processes described here, this article draws attention to private-sector symbiosis with SMs and the object conflicts that emerge during the process of incorporation and transformation. The concepts were developed from reflections on the the author's research on the movement for alternative and complementary cancer therapies in the United States, which is a mixture of an SM anchored in patient-advocacy NGOs and an RM among clinicians and food supplements companies (Hess 2002, 2003). During the 1990s, the author watched the movement achieve critical concessions from the state, industry, and medical profession, but those concessions were associated with a transformation of therapies as they were incorporated into the mainstream. Comparisons with the history of similar developments in renewable energy, open source software, organic foods, and recycling led to the concept of TPMs as developed here.

This article will focus on nutritional therapeutics and discuss some comparisons with the cases of renewable energy and open-source software. The cases represent some of the more full-fledged dynamics of the incorporation and transformation process, and they also represent different types of technology during different time periods. Methodologically, the three case studies represent small segments of broader TPMs, which in turn are associated with broader SMs. For example, the movement for alternative cancer therapies is just one example of the complementary and alternative medicine (CAM) movement within a broader field of patient advocacy and professional reform movements. The first case history is based on extensive research

by the author that draws on several years of fieldwork, more than 100 interviews and conversations, and extensive documentary analysis. In contrast, the two comparison cases are drawn largely from secondary sources by historians, social scientists, and journalists. The analysis presented here is exploratory; its intention is to examine the applicability of the concepts and to draw attention to some theoretical and empirical intersections of the fields of STS and SM studies.

Nutritional Therapies for Cancer

In the nineteenth century, medicine had a sectarian or pluralistic structure that included the widespread use of dietary and herbal therapies. In the United States, those therapies fell out of favor during the first three decades of the twentieth century, when the American Medical Association gained control over medical education and professional licensing (Starr 1982).With the growth of the pharmaceutical industry during the middle decades of the twentieth century, coalitions of surgeons, drug-prescribing physicians, and pharmaceutical companies emerged in many of the chronic disease fields. The therapeutic iron triangles tended to be highly resistant to nutritional interventions; for the professionals, the alternatives threatened existing therapies and livelihoods, and for the pharmaceutical companies, dietary and herbal approaches to chronic disease provided competition from publicdomain products for their patented drugs. The field of cancer research and treatment in the United States provides arguably the most well-developed case in the alternative health field of SM dynamics, so it will be considered here as one example within the broader TPM for CAM.

Until the 1970s, the social organization of popular support for nutritional therapies for cancer in the United States took the form of networks of researchers, clinicians, and patients around a specific innovator (Hess 2003). The networks demonstrated a symbiosis of patients and innovating researcher-clinicians, but the patient advocacy groups forCAMcancer therapies had not yet congealed into long-term, multitherapy, formal advocacy organizations. Nonetheless, some of the networks were quite substantial,

such as the system of clinics and networks of patient advocates that developed around the herbal therapy of Harry Hoxsey during the 1950s; others, such as the network of patients and clinicians interested in the dietary therapy of Max Gerson, M.D., were smaller. Figures such as Hoxsey and Gerson were entrepreneurs in the sense that they ran business enterprises (clinics), but they were also SM leaders in the sense that they advocated a grassroots patient-based transformation in therapeutic politics, as well as policy changes from the state that would be more favorable to the alternatives.

In the 1970s, the field shifted with the emergence of laetrile, a food-based substance that some advocates characterized as a vitamin. Doctors who prescribed the substance and patients who used it were subject to prosecution by authorities. In 1972, the arrest of a California laetrile doctor who happened to be a member of the John Birch Society launched a significant SM that drew on spillover support from the Birchers. However, the Bircher spur was soon subsumed by increasing movement diversification, as people from across the political spectrum united under the libertarian banner of medical freedom (Hess 2003, Markle and Peterson 1980). Support for laetrile and other nutritional interventions for cancer (especially vitamin C, Richards 1981) also exploded into scientific controversies within the research establishment as SM for alternative cancer therapies took off. The movement benefited from spillover from other health movements, such as the macrobiotics movement and, especially after the mid-1980s, pockets of more alternatively oriented breast cancer advocates (Wooddell and Hess 1998). The movement was focused on skirmishes with state and federal governments over regulatory and research policy, but it also played itself out in the lifestyle domain of decisions of patients who opted for alternative cancer treatment.

Organizationally, the movement for CAM cancer therapies had a dual structure that provides one example of private-sector symbiosis. Some of the patient advocacy organizations (e.g., the Cancer Control Society and Cancer Victors and Friends) emerged prior to the laetrile movement; others were originally laetrile-related organizations (e.g., Committee for Freedom of Choice in Medicine), and others were subsequent patient-support organizations

with a broader therapeutic approach (e.g., Center for Advancement in Cancer Medicine, the Moss Reports, CanHelp, People Against Cancer). At the same time, a parallel reform movement developed in medicine among CAM-oriented physicians and other health-care providers, including clinics in Mexico and Germany that catered to CAM-oriented cancer patients. Furthermore, nutritional supplements firms became involved in making products oriented especially to cancer patients, such as bovine and shark cartilage. Although at an analytical level one can separate out the patient advocacy organizations from the clinical and nutraceutical organizations, there were dense networks that justify seeing the SM and RM as two sides of a TPM.

During the 1990s, themovement and its therapies underwent considerable change. First, studies on cancer prevention increasingly documented the powerful effects of nutritional and dietary interventions. Some of the funding for the studies came from the food industry (which developed an increasing interest in “functional foods” and food fortification) and from the supplements industry, and some funding came from government agencies, such as the National Center for Complementary and Alternative Medicine within the U.S. National Institutes of Health. Second, the medical profession increasingly began to incorporate nutritional and dietary recommendations into clinical practice, and in some cases it also began to include CAM providers (such as naturopaths and acupuncturists) in settings of “integrated” clinical care. Under those circumstances, longtime members of the alternative cancer therapy SM could see that their efforts had finally attained a degree of success. Although much of the recognition remained restricted to nutritional interventions for prevention, therewas increasing recognition for therapeutic uses as well (that is, after people were diagnosed with cancer).

However, the integration of alternative cancer therapies into mainstream research funding portfolios, the nutraceutical industry, and clinical practice also involved a selection of the therapeutic field away from therapeutic interventions that were used instead of (that is, as alternatives to) chemotherapy, radiation, or other conventional therapies and in favor of those that could be used alongside (that is, complementary to) conventional therapies. This is

where the idea of incorporation becomes inseparable from transformation. For example, the standard uses of Pauling's vitamin C or Gerson's dietary treatment did not call for concomitant chemotherapy and radiation therapy. In the transformation process, the alternative forms of CAM have tended to be swept aside in favor of rather moderate, adjuvant uses of nutritional interventions that, in some cases, are brought in to reduce the toxicities of conventional therapies or enhance their efficacy.

With these kinds of tensions between "stronger" and "weaker" forms of integration (Hess 2002), there were evident splits between a more mainstream physician-oriented, insider wing of the CAM cancer therapy movement and a more grassroots, alternative wing, each of which consisted of networks of providers, researchers, conferences, and patients (Hess 2003). In the process, object conflicts developed over the design ofCAMcancer therapies and their position with respect to mainstream therapies. One site of object conflictswas in the doctor-patient relationship, a specific case of what might more generally be conceptualized as the consumption junction (Cowan 1987) or point of consumption. Would nutritional interventions be configured so that they were merely added to conventional therapies to reduce their side effects or enhance their efficacy? Or would they be configured as alternatives? This is not merely a question of the position of the same therapies; rather, the design of the therapy changes depending on its use. For example, high-dose vitamin C given intravenously at 20 to 50 grams per day is generally part of an alternative therapy package, whereas given orally at a much lower dose, it may be used to reduce side effects in a protocol with radiation therapy or chemotherapy. Likewise, the radical dietary changes of the Gerson and macrobiotic therapies were being replaced with much more modest dietary recommendations and modest nutritional supplement programs that accompanied conventional therapies.

In addition to the subpolitical site of the doctor-patient relationship, object conflicts emerged in two other sites. As activists and sympathetic elected political officials pushed the integration of CAM research into the national funding agenda, research organizations such as the National Institutes of

Health faced decisions between spending limited funding on alternative CAM cancer protocols versus complementary ones (Hess 2002). Although some funding in theCAMcancer area has gone toward one alternative protocol (the Gonzalez regimen for pancreatic cancer patients), much of the rest has focused on more complementary approaches to nutritional interventions. A second site for object conflicts has been regulatory policies for nutritional supplements. Here, object conflicts have at some points erupted into classic SM protest, such as the case of street protest directed against the proposed harmonization policies of the Codex Alimentarius Commission, a joint project of the Food and Agriculture Organization and theWorld Health Organization. In 2000, health activists from around theworld protested the undemocratic structure of Codex and its plans to restrict over-the-counter availability of vitamins and other nutritional supplements (Weiwel 2000). The alternative wing of the CAM movement was deeply concerned that the technical limits proposed for vitamins, such as small multiples of the RDA (e.g., 250 mg for vitamin C),would restrict access for patients who relied on high doses (10 g or more per day). Because patients take many supplements per day, a low limit on supplement dose per pill would mean that patients would reach the limits of digestibility before reaching the targeted therapeutic dosage. They saw the Codex standards as an attempt by the pharmaceutical industry and medical profession to eliminate alternative nutritional therapeutic programs through international standards.

In summary, as the object is incorporated and transformed, its physical design changes (the dosage, mix with other supplements, and mode of delivery) and its status with respect to mainstream objects (conventional cancer therapies) also changes (from alternative to complementary). As the Codex protests show, it is possible for the object conflicts to reach the level of street protest, a possibility that justifies the conceptualization of TPMs from the SM perspective. However, in general, the object conflicts are embedded in much more hidden processes, such as physicians' choices to offer specific types of programs, patients' choices of physicians or other health-care providers, and research funding priorities.

Comparison Cases

There are many possible candidates for comparison cases. In the area of health SMs, additional cases might include the movement for alternatives in reproductive technology, such as efforts to create male contraceptives (Oudshoorn 1999). Rather than examine additional cases in the health field, the environmental and information technology fields are examined to gain some sense of the applicability of the concepts across different SMs. The environmental case focuses on renewable energy, but additional case studies from the environmental arena could include organic agriculture, ecologically oriented design of buildings, eco-labeling and sustainable consumption, and the postrecycling movement toward zero-waste production (Hess 2005). For the information technology area, privacy advocacy and alternative educational software (Fleischmann 2003) are additional possibilities. Reform movements in urban planning, transportation, and the media are additional topics for which the concepts and processes described here are being explored. The brief cases presented here give a preliminary sense of some of the similarities and differences that occur across SMs.

1. Renewable Energy

As in the case of alternative health, whichwas narrowed to focus onCAM cancer therapies in the United States, this section will focus on the Danish wind power movement, partly because the topic has already been well studied by social science researchers. The development of modern wind power in Denmark goes back to the work of physicist Paul La Cour in the 1890s (Jørgensen and Karnøe 1995). Involved in the folk high school movement, farmers' associations, and cooperatives, La Cour made it his goal to develop electricity to serve farms and small industries, and his work was aligned with the peasants' movement and social democratic politics. In the 1920s, the advance of electricity grids displaced wind turbines, but interest in wind energy resurfaced duringWorldWar II, and during the 1950s, a second wave of wind power advocacy experimented with the problem of connecting wind

turbines to the power grid. From a comparative perspective, the question of howthe technological innovationswould be related to the power industry and electricity grid was similar to that of how the therapeutic innovations in the alternative cancer therapy fieldwould be related to conventional cancer care. In the early 1960s, the wind energy experiments foundered on cost-effectiveness arguments, but the controversy over atomic energy in the mid 1970s led to renewed interest in wind power. In 1975, a new renewable energy organization was formed, the OVE (Organization for Renewable Energy). The OVE drew on the folk high school movement, but it was also directly connected to the environmental movement against nuclear power (Jamison et al. 1990, 96).

During the mid 1970s, the reform movement side of the wind energyTPM developed through small entrepreneurs who began building and, in some cases, marketing wind turbines to environmentally oriented consumers (Jamsion et al. 1990, Jørgensen and Karnøe 1995). Most of the turbines were correspondingly small scale, that is, in the range of 20 to 50 kilowatts. However, the work also produced some larger turbines, as in the case of the Tvind wind generator, a two-megawatt project that began with teachers, students, and other volunteers in 1975 (Tvindkraft 2002). In 1978, the Danish government set up a research test station for wind at Riso, the atomic research facility (Jørgensen and Karnøe 1995), and in the same year, the Association of DanishWindpower Owners and the Association of DanishWind Mill Manufacturers were started.

During the early 1980s, the industry took off, in part due to exports to California but also due to government subsidies (Jørgensen and Karnøe 1995). Although the industry went through a shake-out period in the late 1980s as a result of the collapse of the California “wind rush” and the reduction of Danish government subsidies, the industry regrouped and continued to prosper during the 1990s. By 2002, the Danish wind industry held about half of the $6 billion world market share, accounted for 16,000 jobs in Denmark, and contributed 18% of Danish electricity consumption (Krohn 2002a, 2002b). The industry was also under a new wave of pressure from political changes

within Denmark and European Union directives to liberalize energy markets, which modified industrial and policy relations that had helped spur the growth of the wind sector in Denmark (Jørgensen and Strunge 2002).

Over the two-decade period beginning in the 1980s, wind technology became incorporated into the power industry, but in the process, the design of the technology was transformed. The scale increased to thousands of megawatts per generator, and wind turbines were grouped into large-scale wind farms (Jørgensen and Karnøe 1995). Although the incorporation and transformation process is much more extensive than with CAM cancer therapies, both technologies/products were redesigned to fit within conventional technologies, policies, and corporate priorities. In comparative terms, wind energy has become increasingly complementary rather than alternative.

However, the more alternative, smaller-scale approaches to wind technology did not disappear entirely. Wind-power ownership in Denmark prospered through quasi-cooperative organizations or wind "guilds," which grew to 55,000 members by the mid 1990s (Tranaes 2003). In the United States, a mobilization gradually emerged in the form of the home-power movement, which continued to develop smaller scale applications for homes and small businesses (Tatum 1995, 2000). Object conflicts between the industrialized forms of the technology and the alternative forms took at least three different forms. First, at the point of consumption some businesses and consumers have the economic and technical resources to make choices between "green" power produced by power companies and their own "home power" or cooperative systems. Second, those who take the local ownership route have sometimes become involved in activism around standards for allowing grid sell-back from home or local producers. In Denmark, the wind cooperative movement faced long battles to gain grid connection rights, and in the United States, a tradition of "guerilla" hookups and civil disobedience emerged alongside state-by-state legislative campaigns (Tranaes 2003, Home Power 2004). Third, in both Denmark and the United States, the siting of windmills has generated opposition from preservationists and other groups concerned with visual and noise pollution, environmental risks to birds, property values,

and the general issue of rights to a viewshed (Tranaes 2003, Walsh 2003). Interestingly, those conflicts have not emerged in some cases where the scale of the wind farm is smaller and energy control rests in the hands of the affected community, that is, where the design of the "object" was closer to that intended in the original Danish wind movement (Walsh 2003).

2. The Open-Source Movement

The open-source software movement grew out of shared uses of the Unix operating system, whichwas developed at Bell Labs in 1971 and licensed for a nominal fee to various universities. The lack of backup support led to a culture of sharing bug fixes among university participants (Moon and Sproull 2002). In the early 1980s, MIT computer scientist Richard Stallman ledwork on a free operating system based on a "copyleft" or anticopyright software agreement (Moore 2002). The agreement allowed users to rewrite software code as long as their own code was also freely available, and it forbade privatization of software that used the "free" code.

In 1987, Andrew Tannenbaum developed Minix, an open-source clone of Unix, and four years later, Linus Torvalds, a computer science graduate student in Finland, released an early version of Linux and asked a Minix newsgroup to contribute (Bretthauer 2002). Although there were also some heated discussions within the Minix newsgroup, soon thousands of programmers were contributing. Concern with the market dominance of Microsoft over consumer operating systems provided a strong motivating force for the SM that emerged around open-source software. Over the years, the open-source movement saw only rare instances of protest politics, such as picketing of Microsoft when it refused to refundWindows operating systems from Linux users (Moore 2002). Instead, the main means of protest has been writing code for the alternative software, that is, by creating an alternative technology/ product. A system of crediting contributors, as in scientific contributions, provided an additional incentive for ongoing contributions (Kelty 2001).

By the mid 1990s, Torvalds had released version 1.0, and private-sector symbiosis had begun as start-up companies were distributing the Linux system

for a small fee. Although the code was free, consumers and firms were willing to pay for the package, support, or training through newservice companies such as Red Hat (Moody 2000, 97). The rechristening of free software as “open source” crystallized a division in the movement between the more radical visions of Stallman (2003) and the business-oriented approach of Linux supported by Torvalds and Linux analysts such as Eric Raymond. A second level of private-sector participation occurred when major information technology firms began incorporating open-source into their products. In 1995, an open-sourceWeb server named Apache was launched, and in 1998, Netscape released source code for its browser under an open-source license while IBM shifted to the Apache server and Intel took out stakes in Red Hat (Moody 2000, 199-218). In 1999, other major U.S. hardware companies—including Hewlett Packard, Dell, and Compaq—offered support for Linux (Moody 2000, 220-23). By early 2001, IBM had released a version of its most powerful Intel-based server geared to run on Linux (significantly, also deciding not to release a version runningWindows), and it announced plans to spend $1 billion in research and development on Linux-based products and services (McDougall 2001, Abreu 2001). By 2003, many urban and national governments, as well as corporations, across theworld were switching to Linux.

Whereas “hardware” firms led the transition to Linux, resistance was strongest from the firms that produced proprietary operating systems, and they moved to incorporate and transform the threat posed by Linux. For example, in 2001, Microsoft announced an alternative called “shared source” (Ricadela 2001). Under the newarrangement, select customers were allowed to view the code and report suggestions back to Microsoft, but they could not modify it. In contrast, Apple opted for a transformation of the open-source license that was closer to the Linux license. Components of Apple’s OS X, whichwas Unix-based and therefore much more stable than previous operating systems, were based on the Berkeley Software Design (BSD) license model (Ricadela 2001). Whereas theGNU license of Linux required users to pass on unimpaired rights to copy, distribute, and change software, under the

BSD model an additional license may be appended to modified BSD programs that limits the distribution of modifications. Apple's license, which became known as Apple Public Source License, was later approved by the Open Source Initiative (2004), but Apple did keep some parts of its operating system proprietary. In short, there were significant differences between the Microsoft and Apple licenses, but both approaches represented shifts in the openness of open source and set the stage for ongoing object conflicts over the standard that would govern relations between open-source and proprietary systems.

In the United States, government agencies have not regulated the conflict over standards for open-source licenses, and development has taken place largely via the programmer movement itself. Consequently, the sites for object conflicts involving regulation and funding are not as salient as in the other cases. Rather, in the open-source movement, object conflicts take place at the point of consumption (the choice between operating systems) and among programmers and firms as choices of what type of license or definition of *free software* or *open source* to adopt. At the radical end of the spectrum, Stallman (2003) and colleagues still distinguish free software from open-source software, which he claims has some unacceptable licensing restrictions. Between the extremes of Stallman's "free software" and Microsoft's "shared source" is a wide range of licenses that define the object free or open-source software (Siltala 2003, Stallman 2003). The technical distinctions between licenses are a primary site for the ongoing object conflicts in the open source movement as it negotiates its way through the incorporation and transformation process.1

Conclusions

The comparison of the three cases suggests that the concepts of privatesector symbiosis, incorporation and transformation, and object conflicts may help elucidate a variety of SM-based efforts to change technology and products. The cases reveal significant differences in the relations between SM organizations and private-sector firms, the degree to which incorporation and

transformation occurs, and the types of object conflicts that emerge. Yet, the case studies also support the claim that the concepts provide a valuable starting point for comparative analysis.

Comparative analysis has the value of revealing patterns that might not otherwise be evident from a detailed study of one case. For example, in the three cases examined here, issues of property appear crucial to the object conflicts that emerge. Food-based medicines, home or community electric power, and open-source software are all forms of goods that potentially could shift power and property relations away from oncologists, pharmaceutical companies, power-grid utilities, and proprietary operating system manufacturers. The alternatives become acceptable to the dominant professions and industries to the extent that they can be transformed into objects that are complementary to existing technological systems and product portfolios, such as patented drugs, grid-based energy, and proprietary software.

A second emergent pattern is that over time, the source of SM support for an alternative technology/product may shift. In the Danish wind case, the original supportwas anchored to the folk high school movement and agrarian populism, whereas later the antinuclear and broader environmental movement became important. In the CAM cancer therapy case, the growth of the macrobiotic and women's health movements in the 1980s and 1990s represented a second wave of SM interest in a similar technology/product that occurred following the Bircher spillover effect of the 1970s. The parallel leads to the hypothesis that such a process could occur in the open-source movement, such as a connection between open-source software and various digital divide organizations or national anticolonial movements.

In addition to encouraging comparative analysis across movements, the concept of TPMs draws attention to the complex relations between SMs and the private sector, particularly when modifications of material culture are a central target of change. Whereas one tends to think ofSMrelationships with the private sector as largely antagonistic, such as boycotts directed at sweatshops or corporate environmental policies, the analysis of TPMs points to both the development of symbiosis and its limitations. TPMs need privatesector

organizations to produce and supply the alternative technologies and products. They need naturopaths, holistic physicians, supplements firms, turbine manufacturers, wind power contractors, and software assistance providers. Furthermore, as the TPM achieves success, it begins to win support from companies in countervailing industries, such as the food, supplements, energy, and hardware industries. As the new products and industries grow, the established or target industries (pharmaceutical, electric power, and software operating systems companies) can no longer ignore the alternatives, and theymove to incorporate and transform them. As a result, one can distinguish three types of private-sector firms: entrepreneurial firms that are most evident in the early phases, firms from countervailing industries and breakaway reform firms within target industries, and finally the firms in the target industries that are sometimes moved to incorporate and transform the alternatives. However, preliminary analysis of other cases not discussed here suggests that the role of the three types of private-sector firms is quite variable.

The concept of TPMs is also valuable because it raises a more philosophical question about what constitutes success for an SM. From the narrow perspective of achieving a transformation of material culture, success might be construed as the conversion of a major industry that originally ignored or resisted TPM demands and goals. The increasing integration of nutritional medicine with chemotherapy and radiation therapy, wind energy with gridbased fossil fuel energy, and open-source software with proprietary software could all be described as successes. In theory, people have access to potentially safer and more efficacious therapies, cleaner and more Earth-friendly energy, and less buggy and less expensive software. Societies benefit from greater efficiency (therapeutic efficacy, energy efficiency, or more stable software) and reduced risk (iatrogenic side effects, environmental damage, and software failure).

Yet, part of the original vision of TPM founders (the Gersons, LaCours, and Stallmans) is lost in such a narrow understanding of success. From the perspective of the SM side of the TPM, the incorporation and transformation

process becomes a story of cooptation or at best only Pyrrhic victory. The tensions between SM-based understandings of success and the more limited understandings that emerge as the TPM develops are the basis for ongoing object conflicts and the continued dynamics of TPMs. Rather than becoming exhausted by the incorporation and transformation of the alternative technologies and products, activists and advocacy organizations find themselves on a newhistorical terrain characterized by a diversification of the technological and product field. The new terrain constitutes the starting point for the next wave of conflicts over the future of material culture and society.

Note

1. Another type of conflict involves SCO, a company that at the time of writing had no known links to any of the large proprietary firms. The firm has claimed that IBM imported copyrighted portions of the Unix code into Linux and that it owed damages of $1 billion. Because Microsoft and Sun Microsystems had licenses from SCO, they were not affected by the lawsuit (Lashinsky 2003). The conflict does not involve the design of open source or its license but rather the rights to claimed proprietary content in the original code, so it is not considered an object conflict.

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