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Strategies for Alternative Science

BRIAN MARTIN

Professor Smith, to his class: This semester we've been looking at cultural contradictions of science, including contradictory popular images of science as liberator and science as oppressor, contradictory views of scientific research as autonomous and as socially determined, and contradictory conceptualizations of scientific practice as formal method and as localized craft activity. To conclude, I'd like to mention something we haven't covered: the idea of alternative science. Nicholas Maxwell, a philosopher of science, describes existing science as conforming to what he calls the "philosophy of knowledge." Knowledge is the goal, without any judgment about how that knowledge will be used. In other words, knowledge is seen as a good in itself, indeed almost an overriding good. Maxwell (1984, 1992) subscribes to an alternative that he calls the "philosophy of wisdom." In this vision, science would be oriented to solving pressing human problems, including hunger, inequality, environmental degradation, war, and oppression. Maxwell notes that lots of scientific research is driven by military and corporate funding, and that some of the world's most talented scientists and engineers devote their efforts to designing more ingenious fragmentation bombs or detergents

that leave your dishes sparklingly clean. So here we have another contradiction: science, a system designed for creating objective knowledge actually ends up creating knowledge that is mainly useful to vested interests.

But there are visions of alternative science. The appropriate technology movement has pushed for technology designed for poor people in poor countries, such as efficient stoves and irrigation pumps, that can be locally produced and maintained (Darrow and Saxenian 1986). The alternative health movement has supported investigation of nonmedical approaches to health—for example, nutritional prevention and treatment of cancer (Johnston 2003). These examples are at the technology or applied end of the spectrum, but as we've seen, scientific research and technological development feed off and indeed help constitute each other in a process sometimes called *technoscience*. The point here is that the research that is actually done is only a portion of what could be done, and that powerful interest groups influence research agendas and outcomes. In this class we've studied science as it exists, but there is also a subterranean subject available for study, what might be called "undone science" (Woodhouse et al. 2002), into which much of Maxwell's philosophy of wisdom falls.

Existing research shows inklings of alternatives. There is some research on biological control of pests, though a lot more on pesticides. There is some research on cooperative enterprises, but a lot more on competitive markets. But in some areas, it's possible that we don't even know what alternatives are not being investigated, so dominant are conventional agendas.

Powerful groups pour massive amounts of money into scientific research to obtain products that serve their interests but also because of science's reputation as a source of objective knowledge. It is a central contradiction of science, then, that its image of objectivity is the source of the greatest threats to that objectivity. Alternative science is the embodiment of that contradiction.

CHRIS [*later*]: "Could I speak to you for a moment, Professor Smith?"

PROF: "Of course."

CHRIS: "I've really enjoyed taking your class 'The New Cultural Contradictions of Science.' It's given me a good understanding of the complexities of the science scene today and the way theory can be used to probe these complexities . . ."

PROF: "Thanks—"

CHRIS: "But there's one thing I'd like to ask. You probably know I'm involved in the local group 'Science Justice.' Right now we're trying to develop some plans for the next year, and we want to think about campaigns that can help transform science in a participatory, egalitarian direction. I'm just wondering what the theorists we've studied have to say about that."

PROF: "Well, they point to the role of structural factors in establishing the context for action. There's some insightful work on the way governments and corporations set agendas through media framing. That's certainly relevant to science . . ."

CHRIS: "But that's still more about what we're up against. What about insights about how we go about changing things?

PROF: "Have you looked at the social movement literature? Resource mobilization, political process theory, dynamics of contention? Some of the key sources are on the reading list."

CHRIS: "Yes, that was my first stop. But when I explained the key ideas to the others, they couldn't see their relevance. Everything was either too abstract or obvious to our experienced members."

PROF [*after a pause*]: "Let me think about this and check with a few others. I'll get back to you."

CHRIS: "Thanks."

This dialogue is fictional but points to a real issue: scholarly analysis of science, like most other scholarly work, has little useful to say directly to activists. In the past half century, the analysis of science has become increasingly sophisticated, with attention to complexities and contradictions, including the socially constructed nature of knowledge production, the roles of governments, corporations, and professional structures, and the impacts of globalization, regulation, and citizen action.

This analysis has many strengths. It undermines simplistic understandings of science common in the media and popular discourse as the truth, as neutral, and as an inevitable source of progress. It points to the role of social factors in all dimensions of science, opening the door to alternative conceptions of scientific knowledge, scientific practice, and institutions of science. It reveals, through many case studies, the intertwining of power and knowledge in science.

Yet this impressive evolving scholarly achievement has limitations, at least from the point of view of some who would like to use the ideas as

a basis for action. Scholarly work is often difficult to understand, requiring considerable training and expertise. The audience of most scholarly papers is largely other scholars. Newcomers can have a difficult time making sense of the field. Furthermore, much of the analysis, in terms of relevance to practice, is not inspiring: it is analysis, after all, not a set of success stories or how-to manuals.

Scholars and teachers have devoted a lot of effort to debunking technological determinism (Smith and Marx 1994; Winner 1977), but this is largely superfluous for activists who go ahead and challenge technological developments without a thought about the theoretical issues involved. There is much sophisticated analysis of the social shaping of technology (MacKenzie and Wajcman 1999; Sørensen and Williams 2002), but it gives little guidance to those want to go out and help do the shaping. Michel Foucault is widely cited for his ideas about power and knowledge, but since the 1960s feminists and other activists have been debating and living issues of power and knowledge—epitomized by the slogan "the personal is political"—often without the slightest awareness of Foucault or other theorists. Indeed, it is tempting to suggest that scholars have picked up on a change in social consciousness, but rather than acknowledge social movements as the vanguard of this change they instead cite the scholars who best capture the same orientation in dense theory.

Over several decades, I've talked with numerous activists about theory and strategy, both in interviews and informally. It quickly becomes obvious that very few of them spend any time perusing academic writings. Many are completely caught up in current campaigns and look only at materials that are directly relevant. Jargon-ridden articles dealing with complexities and qualifications are not for them. There are some activists who have been deeply shaped by intellectual work—for example, women who have been inspired by prominent feminist writings. Also, there are some scholar-activists, in particular students and academics, who are involved in activist groups.

A large amount of activism is short-term, with immediate practical goals such as organizing a meeting or rally, circulating information, raising money, or dealing with internal differences. There's too much to do and not enough time or people to do it. Developing visions of alternatives and undertaking long-term planning are not often on the agenda.

So is it worthwhile for activists to comb the academic literature for useful material? Few scholars have much to say about how activists can be more effective in day-to-day campaigning: there's plenty of research on making factories and offices more efficient, even some on enriching work for the workers, but hardly anything focusing on activist groups. And those areas where activists can benefit most from intellectual input—alternatives and strategies—are precisely the areas given little attention by scholars.

Edward de Bono, most well known for the concept of lateral thinking, has developed many other tools for thinking (de Bono 1992). Among them are the "six thinking hats" that divide thinking into six categories: the white hat for dealing with information, the black hat for critical analysis, the red hat for emotional responses, the green hat for creative ideas, the yellow hat for optimism, and the blue hat for managing thinking (de Bono 1986). It is a simple observation that most academic work involves the white and black hats: information and critical analysis. I've given many a seminar presenting new ideas; the most common responses are requests for more information (white hat) and critical comments (black hat). Very seldom does anyone use the opportunity to suggest wilder ideas (green hat). My conclusion is that academics find safety in critique: critically analyzing the work of others minimizes the risk of counterattack, whereas presenting a new idea—which is almost bound to have limitations—is to open oneself to critique by others. If those others are referees, you may not be published. A black hat culture thus reproduces itself.

De Bono (1995) points out that critique as a method of obtaining truth—a black-hat approach—works if it cuts away at weak parts of evidence and argument, revealing a core of solid intellectual material. This might work well in "normal social science," analogous to Kuhn's normal science, but it is not the way to proceed if there are other, alternative constructions—in particular, when knowledge is created by design. It is worth noting that the postmodernist preoccupation with deconstruction elevates critique above all other intellectual tools.

In the spirit of de Bono's green and yellow hats, my plan here is to look at models and strategies. First I pick out a sample of visions of alternative science. Then I look at a selection of strategies to move toward these alternatives. Along the way I examine some different roles people can play in this process. Finally, I illustrate these ideas with a case study of defense technology.

There's a certain tension in writing about these matters in the company of some of the most committed critical thinkers in the field. My intent is not to criticize scholarly work; after all, I do plenty of it myself.

Rather, it is to point to some areas that both scholars and activists can explore. In keeping with my comments above about the limited accessibility of much academic writing, I attempt to write simply and clearly, knowing that readers of the draft will help me sharpen the argument. The black hat has its function! I aim to write clearly even though I'm aware of research (Armstrong 1980) showing that most readers of an abstract that was difficult to read thought the author to be higher in research competence than the author of a more readable abstract, even though the content of the abstracts was the same.

Visions of Alternative Science

To speak of alternative science may seem utopian, because current scientific institutions are so entrenched and difficult to change. It is useful to remember that science is dynamic and responsive to external pressures. Injections of funds can and do lead to shifts in research directions. What is entrenched about the system is the dominance of government, corporate, and professional influence over science. It is this that makes science for the people seem like wishful thinking.

Yet, on closer inspection, quite a bit of scientific research can be interpreted as "for the people." Much research is driven, directly or indirectly, by practical applications, and many applications are largely beneficial or innocuous, such as fabrics, toothbrushes, CDs, insulation, and bicycles. Much of the generic science associated with such products—such as kinetic theory or optics—seems not to be a source of problems. Things become more obviously "political" when applications are contentious: weapons, genetically engineered crops, surveillance equipment. The same holds for science that is driven by or incorporated in such technologies.

There are many possible visions of alternative science, so it may be more accurate to speak of alternative *sciences*. To illustrate possibilities, I present four examples.

1. *Science for the people (rational version).* Bernal (1939) had a vision of science at the service of society, in which an enlightened, rational government directed scientific research into areas of greatest benefit to society. This can be called a socialist model, if the concept of "socialism" can be divorced from its association with dictatorial regimes and used to denote a polity in which

government truly serves the needs of the people, at the same time subordinating special interests—corporations, churches, professions—that might shape science for their own ends.

This is a thoroughly technocratic vision: managers and experts have a great deal of power, which is assumed to be used entirely for the good of the population. Rather than pursuing research for profit and control, a rational government would put priority on human well-being in the widest sense. For example, manufacturing technology would be developed to produce practical products in safe and stimulating working conditions. Transport systems would be developed that balanced cost, equity of access, safety, environmental impact, and convenience.

2. *Science for the people (pluralist version).* In this vision, scientists undertake socially relevant research and development (R&D) due to oversight and pressure from citizens. Research agendas, rather than being dominated by corporate and government imperatives and thinking, are shaped by wider social priorities as articulated by individuals and groups that are in touch with genuine social needs. Social welfare is ensured not through rational assessment from the top but instead by numerous formal and informal channels of influence from the grassroots, including direct contact with scientists, citizen presence on advisory and funding bodies, citizen input into the training of scientists, widespread participation in public debates about social and scientific priorities conducted through the mass media and alternative media, and citizen involvement in formal processes of research planning and evaluation. The result is heavy citizen involvement in the social shaping of science, but without a single voice being guaranteed dominance in the public debate. Science would thus become responsive to a plurality of voices, resulting in diversity and flexibility.
3. *Science by the people.* Rather than research being done by professional scientists, in this vision citizens would themselves become scientists: many citizens would participate in research activities at some periods in their lives. In a utopian picture of science in China under the Cultural Revolution, Science for the People (1974) described how peasants and workers were involved in setting research problems and proposing solutions and how scientists were oriented to the problems of ordinary people. Though this image of Chinese science was undoubtedly unrealistic, it nonetheless offers a vision of self-managed science, namely science done *by* the people rather than *for* the people by professional

scientists. Science by the people implies a radical restructuring of education and scientific method, so that popular participation becomes both expected and much easier. An analogy would be the way that information searching has become democratized through the availability of the Internet.
4. *Science shaped by a citizen-created world.* If science is shaped by the society in which it is developed and applied (MacKenzie and Wajcman 1999), then a different world is likely to lead to a different science (Martin 1998). Scientific priorities would be quite different in a world in which workers and communities directly determine what is produced and how it is produced, in a world in which intellectual products are freely shared rather than owned, or in a world in which energy systems are built around local renewable sources, produced and maintained locally. In this vision of alternative science, the key is the way society is organized. Here, the form of organization is taken to be "citizen-created," at a local level, with widespread participation.

Though each of these visions is dramatically different from present-day science, nevertheless it is possible to see elements of each vision in science as it now exists. Aspects of vision 1, built around rational planning with the aim of serving the people, can be seen in some university research, some government research, and even some corporate research. Examples include research into energy efficiency, nutritional prevention of disease, human-centered manufacturing, and aids for people with disabilities. Indeed, a long list of socially relevant research could be compiled. Rationality and altruism in research are potentially compatible.

Vision 2, science for the people as a product of multiple influences on research, is most obvious in areas of contested policy, in which competing groups seek to influence research agendas (Primack and von Hippel 1974). When policies are challenged and debated, it is a sign that no single influence on research is hegemonic. Debates about climate change have led to a vast amount of research in the area, which in turn has fed into the ongoing debates. AIDS research has been stimulated and partially shaped by AIDS activists (Epstein 1996). There are also various means for more routine citizen input in science, such as science shops in the Netherlands and other countries (Farkas 1999), consensus conferences as used by the Danish Board of Technology and elsewhere (Fixdal 1997), and policy juries made up of randomly selected citizens (Carson and Martin 2002).

Vision 3 of science by the people can be found in some mainstream scientific areas such as astronomy, where amateurs play an important role (Ferris 2003). It is also found in community research, where groups of citizens undertake projects of direct concern to their lives, such as on local environmental issues (Murphy, Scammell, and Sclove 1997; Ui 1977). Science by the people is often defined out of existence by the boundary work of professional scientists, who have an interest in being the sole proprietors of what counts as science (Gieryn 1995).

Science shaped by a citizen-shaped world, vision 4, can be found wherever popular initiatives have changed the research agenda. Campaigns for occupational health and safety have led to altered research priorities, even though most of those campaigns focused on immediate issues, not research agendas. Just as important are areas where research has been reduced. The success of the movement against nuclear power has contributed to a reduction in nuclear research; the campaign that stopped supersonic transport aircraft led to the demise of much associated research.

Strategies

Each of the four visions can be related to wider strategies for creating alternative science. Out of many possible strategies, I consider just four. They have obvious connections with visions 1 to 4, respectively, but are not restricted to pursuing a single vision.

Strategy 1 is a state-led transformation of science. This is the traditional socialist approach, with control of the state achieved either by revolution or more gradually by election of a socialist party that implements policies bringing about a socialist society. This strategy, in both main variants, is widely recognized to have failed: most socialist states have collapsed, and most socialist parties elected to office have adapted to capitalism (Boggs 1986). Nevertheless, this strategy remains important in that much citizen effort is invested in supporting left-wing parties and promoting progressive policies within them.

It is possible to conceive of a different transformation of science from the top, led by capitalists. The idea would be for corporations to be colonized by managers who put a priority on the public interest. Very few activists even imagine such a strategy, much less put energy into it.

Large corporations are authoritarian in structure, with few formal openings for citizen or worker input, whereas systems of representative government have at least the facade of participation. If strategy 1 is recast as top-down transformation of science, then capitalist-led transformation can be labeled strategy 1C, state-led transformation as strategy 1S, and profession-led transformation as strategy 1P. Strategy 1C should not be dismissed too easily. There are some visionaries in the corporate sector who seek a transformation of capitalism into a more humane system (Soros 2002; Turnbull 1975).

Strategy 1 can also be adopted by individuals or attributed to them as an unconscious guide to behavior. Consider a scientist who works for a corporation or government, who is not linked with any outside groups, and who does not have explicit affinities with social causes. Such a scientist, in choosing research projects or undertaking evaluations of research, can choose to make decisions in the light of a belief that science should serve the public interest. For example, a biotechnologist might decide to explore genetically modified crops that need less rather than more pesticides; a weapons researcher might investigate designs that reduce long-term environmental impact; an automotive engineer might look at ways to reduce fatigue in drivers. Similarly, in evaluating the research of others, such scientists may give priority to options that are better for "the people" or those in greatest need rather than powerful and privileged groups. (See also the chapter by Woodhouse in this volume.)

Insider scientists need not draw attention to themselves in making these choices. Because of the interpretive flexibility available to researchers, choices can be justified on rational grounds, such as efficiency, cost, and simplicity, without having to argue in terms of human interest. If social welfare is explicitly accepted in an organization as a relevant criterion, then it is easier to justify choices that serve the public interest.

All this can happen in isolation from social movements and others who articulate alternatives to science in the service of power. When movements exist, then scientists are more likely to become aware of the down sides of their enterprises. Biotechnologists can become aware of the exploitation of genetic resources from indigenous peoples; military researchers can become aware of the devastating effects of weapons and war; automotive engineers can become aware of the environmental and human costs of automobilization. Scientists can choose to move out of damaging areas and into alternatives, though often such choices come at a major cost to one's career. If enough scientists push for change and enough policymakers and research managers are willing to accept or promote change, this is compatible with vision 2: the research agenda is responsive to wider social priorities.

Strategy 2 is pressure-group transformation of science. This includes, for example, campaigns against research on genetically modified crops and for development of cheap pharmaceutical drugs for common diseases in poor countries. Feminists, environmentalists, neighborhood groups, and many others play a role. This strategy relies on there being many pressure groups at the grassroots, sufficient to orient research to the public interest, though "the public interest" can be a multifaceted and changeable object due to differences between pressure groups. Citizen activism is now routine in many countries, but despite this there is relatively little direct citizen pressure on scientific research priorities. Strategy 2 would see a vast expansion of this pressure.

A limitation of this strategy is that pressure groups seldom provide a balanced representation of those in greatest need: the powerful have influential pressure groups, and the weak have few or none. In sporting metaphor, pressure group teams do not compete on a level playing field, and some teams are not even in the game. Another way to say the same thing is that pluralist politics operates within a polity with institutionalized bias.

Strategy 3 is living the alternative of participatory science. Rather than trying to bring about change from the top or by pressuring those at the top, this approach is direct: go ahead and start doing science by the people. Examples include amateur scientists in a few fields, such as astronomy and botany. The community research movement is closest to strategy 3: citizens, sometimes in collaboration with sympathetic scientists, undertake projects that are directly relevant to their concerns, such as dealing with environmental justice issues. (Sometimes these initiatives influence professional scientists, such as when disease sufferers promote a different conception of an illness than medical orthodoxy [Kroll-Smith and Floyd 1997]: this is a mixture of strategies 2 and 3.)

These initiatives serve several purposes. They are powerful learning experiences for participants, giving insight both into the process of scientific research and into the politics of science. They provide a demonstration effect, showing that nonprofessionals can make useful contributions to knowledge. In principle, they lay the basis for a gradual deprofessionalization of science. The limitation of this strategy is that the small initiatives in citizens' science are too easily marginalized. Professionals may ignore, tolerate, or denigrate and undermine amateurs in their fields, in any case not ceding significant prerogatives. Even highly successful citizen research usually has little effect on the multibillion-dollar professional research enterprise. One prominent exception is the open source movement, which is built on voluntary contributions to collective enterprise. Open source software has, in a short time, become a major challenge to proprietary software (Moody 2002), and the open source model is seen by some as an alternative method of production.

Strategy 4 is grassroots empowerment for social change that transforms the conditions under which science is done. This is vision 4 turned into a process. It involves a wide variety of social movements bringing about major change in personal relationships, working conditions, products produced, the energy system, and a host of other areas. These changes will inevitably have an effect on the content and practice of science.

Peace movements played a crucial role in bringing an end to most tests of nuclear weapons; this in turn led to a reduction in test-related nuclear research. Environmental movements put their concerns on agendas worldwide, with wide-ranging ramifications for research in many fields. This process could go much further. If peace movements were to be successful in abolishing nuclear weapons, then certain forms of nuclear knowledge could atrophy (MacKenzie and Spinardi 1995). If environmental movements could bring about substantial institutional reform—for example, by replacing industrial agriculture with organic farming or replacing automobile-centered transport systems with urban planning for pedestrians, cyclists, and public transport—then research agendas would be more drastically altered.

A shift to more cooperative and egalitarian interpersonal relationships—something sought by some feminists and others—would affect the ethos of science, undermining the research hierarchy in which a few elite scientists have a grossly disproportionate influence over research directions (Blissett 1972; Elias, Martins, and Whitley 1982).

The limitation of this strategy is that it relegates change in science to a secondary outcome: change elsewhere comes first and only afterward in science. This might not matter except that science plays a crucial material and ideological role in current social arrangements. R&D oriented to an alternative society is needed now to help aid the process of change.

These four strategies are hardly new: they encapsulate well-trodden political paths. Strategy 1 is the usual socialist and social democratic path. Strategy 2 is the familiar approach of instigating reform from below. Strategy 3, living the alternative, reflects the philosophy of anarchists, direct actionists, Gandhians, and some others. It is sometimes called "prefiguration": the alternative, practiced now, is modeled on a desired future and shows that it is possible.

Strategy 4 can be called "after the revolution." In traditional Marxist analysis and practice, class contradictions took priority, with other issues postponed until after the overthrow of capitalism. Feminists disagreed, arguing that patriarchy was not subsidiary to capitalist rule, and others similarly challenged the Marxist hierarchy of oppression. Strategy 4, as applied to science, assumes that change in science can be left until after change elsewhere.

Although it can be revealing to link the four strategies for change in science to wider strategies of social change, there is also a risk: many people would find it uncomfortable or offensive to be categorized as, or even associated with, socialism, reformism, anarchism, or after-the-revolutionism. These labels have all sorts of connotations that are potential distractions from the assessment of different forms of action. As discussed above, it is possible for scientists and nonscientists to work in a variety of different ways, and it may be counterproductive to introduce off-putting labels.

On the other hand, the value of pointing out connections between strategies for alternative science and wider strategies for social change is to draw attention to likely areas of strength and weakness. If a weakness of the strategy of social democracy is that party leaders become captives of the capitalist system, then it is worth looking for parallel weaknesses in the strategy of state-led transformation of science. But it would be unwise to dismiss this science strategy altogether on the grounds that social democracy has failed to live up to its initial expectations of replacing capitalist social relations.

Each strategy can be used as a guide for individuals who would like to help create alternative science. Scientists can act directly on the basis of their own judgments of the public interest or in response to popular

movements. Citizens can apply pressure to scientists and science policymakers. They can instigate or join community research projects themselves. And they can participate in movements that have the capacity to bring about social change that can shape research agendas.

My assumption here is that strategies need to be assessed in particular applications. In the jargon, strategies are "practical accomplishments" rather than theoretical conclusions. Looking at visions and model strategies can offer ideas to those trying to figure out what to do.

To see how this might work, I now turn to a case study: defense technology. This is an applied area with ties to more fundamental research. I choose an applied area because that is where social movements are more active, so that each of the models and strategies is potentially relevant. Activists whose targets are topology or nucleosynthesis are scarce on the ground. My aim is to pull out some insights that might apply to alternative science in general. Other examples in contested areas, such as climate change or biotechnology, would work just as well.

Defense Technology

A significant proportion of the world's scientists and engineers work in the military-industrial complex, with research covering nearly every field of natural and social science, such as oceanography, control engineering, and the psychology of groups (Mendelsohn, Smith, and Weingart 1988; Smith 1985). Military R&D therefore is a prime area for assessing visions and strategies. It is typical of R&D in applied areas, in which science and technology are assessed in relation to a purpose, in this case defense. On the other hand, military R&D is atypical to some extent in being driven by state imperatives, where cost is less of a consideration compared to areas of R&D driven by market factors.

In examining visions of alternative science, an immediate problem arises: there are competing visions of the future of defense technology. One is peace through strength, achieved with ever-improving technologies. Another is weapons design that minimizes civilian casualties. Another is designing weapons that are easy to use for defense but not for offense. Yet another is elimination of weapons altogether. For my purposes here, it is sufficient to specify a direction, rather than an end point: a humanitarian alternative science for defense should move in the direction of fewer casualties, lower environmental impact, greater orientation to defense (rather than offense), and greater orientation to nonmilitary means for achieving security and resolving conflicts. This provides a sufficient framework to assess each of the four visions of alternative science and the associated strategies.

Vision 1 is of science for the people implemented on a rational basis by policymakers and scientists. Given the continuation of massive R&D efforts to produce new weapons systems, this seems a forlorn hope. It is well known that militaries of leading powers seek to develop ever more powerful and effective tools to wage war; once such tools are available, other militaries follow suit to develop or acquire these weapons. Although the overall dynamic of military development seems in direct contradiction to vision 1, nevertheless there are elements of this vision in operation. Many government leaders have taken meaningful stands against military races. For example, quite a few governments have voluntarily refrained from developing nuclear weapons and have supported arms control treaties.

Strategy 1, a state-led transformation of military-related science, has some prospect of success in individual states, but this has been insufficient to redirect military R&D more widely. With the end of the Cold War in 1989 and the collapse of the Soviet Union two years later, there was much talk of a "peace dividend," namely a redirection of military spending toward civilian priorities. In practice, global military spending continued without drastic change, suggesting that it is driven internally more than by a rational examination of external threats.

Only three major industrialized countries adopted the alternative path of arming the population: Sweden, Switzerland, and Yugoslavia (Roberts 1976). However, this seems not to have led to major transformations of military R&D; the Yugoslav experiment ended in disastrous war making. A more radical alternative is to get rid of armies altogether. There are dozens of tiny countries without armies, of which Costa Rica is the most well known (Aas and Høivik 1986), and one-third of Swiss voters supported a referendum to abolish their army. But countries without armies have a negligible impact on global military-related R&D. Nor have any of them pioneered nonmilitary defense research programs.

Scientists and engineers are largely silent players in military R&D. Although many individuals refuse to be involved, militaries seem to have little trouble finding sufficient numbers of qualified people to do their bidding (Beyerchen 1977; Haberer 1969).

In summary, state-led strategies in the defense area have failed to restrain global military R&D and have done very little to support alternative models of defense.

Vision 2 is of defense R&D that is responsive to citizen input. Although some citizen groups push for more military spending, my focus here is on pressures in the opposite direction. There are many citizen movements, large and small, that can be cited. Anti-nuclear movements have been most prominent. There were major worldwide mobilizations against nuclear weapons in the late 1950s and early 1960s and then again in the 1980s, with some significant activism at other times, too. There have also been focused movements to oppose chemical and biological weapons, space weapons, and anti-personnel weapons, among others. Although there has been little formal assessment of the effectiveness of these movements, it is reasonable to conclude that they have played a significant role in stopping or restraining some types or deployments of weapons systems. But movement successes may not last. The 1972 treaty against anti-ballistic missiles was signed partly due to peace movement pressure, including the efforts of many scientists; in December 2001, the U.S. government quietly withdrew from the treaty.

Pressure groups have been far less successful in changing the agenda of defense R&D. There have been campaigns for what is called "peace conversion" or "economic conversion," namely the conversion of military production facilities to production for human needs, such as converting military vehicle production facilities to produce civilian vehicles (Cassidy and Bischak 1993; Melman 1988). Conversion activists have mustered powerful arguments and occasionally mobilized direct action, but they seem to have had relatively little impact. Some conversion efforts have focused on military research, with local successes but again apparently with relatively small impact overall (Reppy 1998; Schweitzer 1996).

The pressure group strategy has the advantage of tapping into potentially widespread citizen antagonism to war. The amount and range of peace activism is inspiring (Carter 1992). It includes mass rallies, vigils, strikes, boycotts, and blockades. Activism has been ably supported by intellectual work in collecting information, building arguments, writing articles, and producing documentaries. Although it is difficult to precisely trace cause and effect, it is plausible to argue that citizen efforts against war have been instrumental in deterring the use of nuclear weapons after 1945 and in helping bring a largely peaceful end to the

Cold War through the collapse of the Soviet bloc (Cortright 1993; Summy and Salla 1995).

On the other hand, peace movements have an erratic history, with periods of mass mobilization being less common than periods of relative quiescence. For example, anti-nuclear activism, after reaching a peak in the early 1980s, declined precipitously in the 1990s, even though arsenals of nuclear weapons remained largely unchanged. Overall, peace movements have failed to thwart the momentum of the military-industrial complex. Strategy 2, pressure-group politics, seems to have had only limited impacts on military R&D agendas.

Vision 3 is science by the people. What can this mean in the context of defense technology? It is possible to imagine self-managed teams of workers designing weapons or running factories to manufacture them, but this is hardly a vision of a society liberated from violence.

The most famous worker initiative for alternatives to military technology was the Lucas Aerospace workers' plan (Wainwright and Elliott 1982). In the 1970s at Lucas, a major British military contractor, workers were worried about loss of jobs and developed an alternative plan to produce nonmilitary products using their skills, in the process developing prototypes of road-rail vehicles and kidney machines. The Lucas Aerospace Shop Stewards' Committee initially sought ideas from experts but obtained a pitifully small response, so they turned instead to the workers, who produced a wealth of ideas. As well as being prolific innovators, the workers were community minded, putting priority on serving human needs rather than just the interests of the workers themselves. This experience provided encouragement that "technology by the people" would also be technology that served the broadest human interest.

The primary strategy of the Lucas workers was to propose their alternative to management, along the lines of strategy 2. Management, though, did everything possible to oppose the workers' initiatives, including turning down projects that promised profits. An obvious interpretation is that managerial control was more important than the prosperity of the enterprise, not to mention wider human welfare. The workers' development of prototypes can be considered an instance of strategy 3, living the alternative; this initiative captured imaginations in many countries.

One reason the Lucas workers' initiatives received so much attention is that they were highly unusual, as is any form of science by the people. Most peace conversion efforts have used pressure group approaches, with direct action by workers being rare. Most military workers are reluctant to jeopardize their jobs and wages by pushing for production of alternative products; taking initiatives can lead to reprisals.

There is another limitation to peace conversion: it does not provide a full alternative to military systems. In periods of low military threat, it can seem reasonable to convert some military production to civilian outputs, but not all of it. Therefore it is worthwhile considering entirely different alternatives. One such alternative is nonviolent defense: defense of a community through organized methods of nonviolent action including rallies, boycotts, strikes, sit-ins, and alternative institutions. Although at first glance this may sound impractical, actually there are many historical examples showing that popular nonviolent action can be effective against repressive regimes, such as the Iranian revolution of 1978–1979, the toppling of the Marcos dictatorship in the Philippines in 1986, the collapse of Eastern European communist regimes in 1989, the ending of apartheid in South Africa, and the end of Suharto's dictatorial rule in Indonesia in 1998. Inspired by such examples, theorists have proposed that with suitable preparation, nonviolent action could form the basis for a defense system. This is also called social defense, civilian-based defense, and defense by civil resistance (Burrowes 1996; Randle 1994).

Science and technology could play an important role in a system of nonviolent defense. For example, decentralized communication methods—including telephones and e-mail—are especially useful to opponents of aggression, whereas mass media are usually of more value to aggressors: in military coups, the first target is television stations. Decentralized energy sources, such as solar collectors and wind generators, are more suitable for defending a society nonviolently than large electricity-generating plants and large dams, which are vulnerable to both aggressors and terrorists. Proceeding through a range of systems—agriculture, water, manufacturing, housing—it is possible to come up with a wide-ranging agenda for science and technology suitable for nonviolent defense (Martin 1997, 2001).

In practice, initiatives have been taken in many of these areas. For example, there is a large amount of R&D on energy efficiency and renewable energy sources. This effort is inspired not by relevance to nonviolence defense but by other concerns, such as reducing environmental damage or promoting Third World development. It turns out that there is a strong compatibility between technology for nonviolent defense and what is commonly called appropriate technology. Appropriate technology—technology oriented to people's needs, often designed so that users can directly control and adapt it—lies close to the vision of science by the people (Boyle, Harper, and *Undercurrents* 1976; Illich 1973). Promotion of alternative technology by grassroots groups fits with strategy 3, living the alternative. So far, though, this approach has not been used as a means of supporting nonviolent defense. Indeed, nonviolent defense remains off the agenda even of most peace movements.

Vision 4 is of science shaped by a citizen-created world. Applied to defense technology, this means that defense policies would be determined by citizens in a participatory process, and that science and technology related to defense would then reflect those policies. What this might mean in practice depends on what policies would be chosen, for which there is no single answer, but some possibilities can be examined.

One obvious possibility is elimination of technologies that can kill or destroy on a large scale, that are targeted at civilians, or that are designed for repression of dissent. This includes everything from fuel-air explosives to land mines to thumb cuffs. Elimination of such technologies would shift R&D priorities. For example, missile research would be reduced whereas research into small-scale solar energy would not be affected. Another policy possibility is much greater emphasis on technologies designed for civilian purposes, for example research on how to keep people in civilian occupations healthy rather than how to keep soldiers alive and able to fight.

Looking more broadly, a citizen-created world might have a different political and economic system. Indeed, there might be a diversity of co-existing systems with the constraint that none is aggressive and domineering. To take an example, a community might introduce its own system of money and replace intellectual property laws with alternative systems to foster local innovation and creativity. With a considerable divergence from the economic and political conditions of research today, the result could well be research directions pursued in ways that differ considerably from present-day priorities and methods. This could include elements of vision 3, science by the people.

How might vision 4 be achieved? State-led strategies could in principle help bring about a citizen-created world, but in practice this approach has not led to a different direction for defense. Socialist governments, whether state socialist or social democratic, have largely followed the same road on defense as other governments, namely the usual form of military forces and weapons systems. Some socialist-oriented

liberation struggles have adopted weapons and methods of struggle in the mode of guerrilla warfare. Once successful, though, they usually move to the conventional military model.

Pressure-group methods can help move toward a citizen-created world. In the defense area, though, most campaigns do not question basic assumptions about the need for (military) defense, much less the existence of the state, large-scale industry, and bureaucracy, all of which underpin today's military systems. Banning landmines by itself does not transform the military dynamic.

Strategies of empowerment, including science by the people, seem to have a greater potential to move toward a citizen-created world. The feminist movement has achieved many of its gains through changing people's thinking and behavior at the interpersonal level—an empowerment approach—rather than via a feminist state or via pressure-group influence on policymaking, though elements of both these strategies have played a role. Military systems, though, seem especially resistant to transformation: there are a few more women in western military forces than before, but without significant transformation of defense mandates or military R&D. Feminism has had a much greater influence on peace movements, helping to promote non-sexist behavior and egalitarian group dynamics (Brock-Utne 1985; Gnanadason, Kanyoro, and McSpadden 1996).

It is possible to argue that citizen action outside the peace movement has already had significant impact on defense-related research agendas. The worldwide movement against nuclear power has been largely successful in preventing nuclear power from becoming the lynchpin of energy systems (Falk 1982; Rüdig 1990). (In the United States, where rising costs were the proximate cause of the decline in nuclear power, citizen opposition was a key factor in forcing higher expectations of safety, with serious cost consequences. In most other countries, nuclear power was a state enterprise, not directly affected by cost considerations.) Although much citizen concern centered on nuclear reactor accidents and disposal of long-lived radioactive waste, there was also a strong link to proliferation of nuclear weapons. Furthermore, many campaigners were motivated by opposition to a nuclear future in which government repression would become essential to deal with the risk of criminal and terrorist activity in a "plutonium economy" (Patterson 1977). In other words, dependence on a potentially catastrophic and highly expensive energy system is associated with authoritarian politics. A plutonium economy would inspire nuclear-oriented R&D with a side menu of technologies for political control.

Citizen action has prevented this dystopian future, with elements of all four strategies playing a role. Grassroots activism, built around empowerment, has been the foundation of much of the movement. Developing energy alternatives, a facet of living the alternative, has been important in demonstrating that nuclear power is not necessary. Pressure-group politics has been important, and some governments have taken stands against nuclear power. The outcome has been the prevention of a plutonium economy, with consequent impacts on present-day research agendas—including defense research.

Because so many social movements have taken their inspiration from being *against* something, their achievements are better recognized by spelling out what the world might have become without them. This is certainly true in regard to defense. Without peace movements, it is possible that military technologies could be playing dominating roles in many more areas than at present: space weapons, biological weapons, technologies of political control, military models for education—the list is endless. Pessimists might say that we live in a military-dominated world, but compared to periods of total mobilization for war, civilian priorities are central to much of today's world.

Conclusion

I started out describing four visions of alternative science built around the concepts of science for the people and science by the people, and then I described four strategies for moving toward these visions. In the abstract, these visions and strategies may seem logical enough, but challenges arose when examining the specific case of defense technology. Several insights can be pulled from this case.

- To develop a vision of alternative *science,* it is first necessary to have a vision of alternative *society.* This may not be easy. In the case of defense technology, the key issue is choosing a vision for defense. It could be conventional military defense, non-offensive defense, security through promoting social justice, or nonviolent defense. In thinking about alternative science, there is a risk in not thinking creatively enough about alternative society.

- There is very little strategic thinking about how to achieve alternative science. Most social action is driven by immediate issues, with short time horizons. Thinking years ahead, or even decades ahead, is unusual (Schutt 2001). Instead, the usual focus is on stopping a new development or organizing the next rally or meeting. Short-term thinking fits most conveniently with pressure-group approaches, aiming at reform. These can be quite useful, but they leave wider changes to chance.

  Long-term strategic thinking need not be linked to central planning. It is also relevant to participatory approaches. The point of strategic thinking is to work out what to do now to help achieve long-term goals. It can be used by any group, indeed by individuals.
- Indirect approaches to alternative science—changing science by changing society—can be quite effective but have been neglected. Because science is so highly professionalized around an ideology of autonomy, direct citizen oversight of research seems to scientists like a threat, and science by the people sounds almost self-contradictory. On the other hand, social movements can change research agendas indirectly without an immediate threat to most scientists.

  To emphasize indirect approaches to alternative science—in other words, to change science by changing society—implies treating science as a "tough case," namely a part of society that is relatively resistant to change. That may or may not be correct. More experimentation with science by the people is needed in order to find out.

In looking at visions and strategies for alternative science, my main focus has been on implications for activists. Social action can only take place in the here and now, but it can be informed by a clear articulation of goals and methods. Activists usually know what they are against but less often have a well-developed picture of where they are going. Academic work in the typical mode of critique replicates this same imbalance.

Reflecting back on research, the implication is that there is much scope for scholarly work on visions and strategies. To be sure, there is some academic work in these areas, such as in the field of future studies. But as long as it remains in academic journals, it is unlikely to have much impact outside the academy. To be useful to activists, research needs to be different in method as well as content. An obvious candidate is participatory action research, which aims to bring about social change while developing knowledge (Whyte 1991).

Chris's comments got Professor Smith thinking. A few months later, the following discussion took place at a meeting of Science Justice:

CHRIS: Hi everyone. I'd like to introduce Professor Smith, who was my teacher last year.

PROF: Just call me Stef.

CHRIS: Okay. Perhaps you'd like to tell us some of your ideas for the group.

STEF: Actually, I'd rather hear about your activities and plans.

CHRIS: Sure, if you want. We need to review our plans anyway. Who'd like to start?

[*A lengthy discussion ensues.*]

CHRIS: Stef, after hearing all that, is there anything you'd like to say?

STEF: I've learned a lot from hearing about your successes and difficulties. You've talked about lots of possibilities for the next year. Have you thought about your goals for the next five or ten years?

[*No one responds for a moment.*]

CHRIS: I guess not. What are you thinking of?

STEF: In the group you have a really well developed understanding of your strengths and weaknesses and what you're up against, plus lots of ideas for campaigns. It might help to look at your long-term goals and then work backward to decide which campaigns should get top priority.

CHRIS [*tentatively*]: That sounds reasonable, just so long as we don't get into too much abstract theorizing. The current issues are really important and urgent, and we don't want to lose momentum.

STEF: Well, maybe a couple of you could work with me to develop some ideas to present to the group. I might be able to get one or two of my colleagues to help. But some of you would need to be involved to make it relevant.

CHRIS: I'm willing to try it. Anyone else? . . .

Leaving, Chris thinks, "I was worried that Stef might be too academic but it turned out all right." Stef thinks, "That was different! I wonder whether I'll be able to convince any of my colleagues to talk to these activists."

Acknowledgments

I thank Scott Frickel, Kelly Moore, Ned Woodhouse, and Elisabeth S. Clemens for valuable comments on drafts of this chapter.

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11

Powered by the People

Scientific Authority in Participatory Science

KELLY MOORE

Over the past three decades, nonscientists have become more involved in the design, production, and use of science. To be sure, professional scientists still create the vast majority of scientific knowledge. Yet there is an unmistakable increase in the types and levels of nonscientist participation in scientific knowledge production and science policy decisions. Thus, coalitions of scientists and amateurs work on projects ranging from the restoration of ecosystems to bird surveys; individuals at risk of or experiencing illness use direct action to demand that questions and methods that they deem important are included in research studies; and networks of scientists, often supported by government agencies such as the Environmental Protection Agency and the National Institute of Environmental Health Sciences, now regularly work with citizens to design and carry out studies. Citizens participate in science policy decisions in town meetings on technoscientific issues (Sclove 1997); consensus conferences (Guston 1999; Fischer 2000); government-sponsored "participatory design" programs (Laird 1993; Futrell 2003); and public hearings, surveys, and citizen review meetings (Fiorino 1990).[1] The varied forms

SCIENCE AND TECHNOLOGY IN SOCIETY

Series Editors

Daniel Lee Kleinman
Jo Handelsman

The New Political Sociology of Science

Institutions, Networks, and Power

Edited by
SCOTT FRICKEL
and
KELLY MOORE

THE UNIVERSITY OF WISCONSIN PRESS

The University of Wisconsin Press
1930 Monroe Street
Madison, Wisconsin 53711

www.wisc.edu/wisconsinpress/

3 Henrietta Street
London WC2E 8LU, England

1 3 5 4 2

Printed in the United States of America

Library of Congress Cataloging-in-Publication Data
The new political sociology of science: institutions, networks, and power /
edited by Scott Frickel and Kelly Moore.
p. cm.—(Science and technology in society)
Includes bibliographical references and index.
ISBN 0-299-21330-7 (hardcover: alk. paper)
1. Science—Social aspects.
I. Frickel, Scott. II. Moore, Kelly. III. Title. IV. Series.
Q175.5.N456 2005
306.4'5—dc22 2005008260

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PREFACE

Many edited volumes begin life as a set of conference papers that get revised, edited, bundled together, and presented to readers as an organic product, the outcome of scholarly debate and synthesis. This collection is not one of those. It arose from our conversations with Daniel Kleinman about the structural inequalities flowing from globalization and neoliberal reforms, which appear to have complex and deepening influences across the sciences as well as among producers and consumers of knowledge. From the beginning we conceived the volume as an explicit attempt to infuse sociological and science studies scholarship with analyses of science policies and practices, the political and economic decisions behind them, and the ecological and social impacts that science continues to create downstream. In doing so, we intended to draw attention to questions of power, including why some knowledge doesn't get made, for example, or why some groups lack ready access to useful knowledge. To remain broadly relevant, we firmly believe that our scholarship must attend to the task of explanation. To that end, we invited contributors to tender individual or comparative case study analyses that explain why events and processes in science happen the way they do. All of them complied, most of them happily.

In our introduction, we spell out the basic contours of a new political sociology of science. In developing and organizing this framework, we hope to put into sharper focus the political and institutional dynamics that shape the funding, administration, and practice of science, doing so in a way that is engaged with broader social change processes as well as central elements of cultural science studies—particularly in its emphasis on meaning and networks. Contributors to this volume are working at these very intersections, and collectively their work speaks to the dynamic tensions that accrue from conceptual interaction. A similar dynamism shaped the evolution of this volume itself. Coediting was an