

Scientific Knowledge, Controversy, and Public Decision-Making

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1. Introduction

The central and increasingly contentious role of science and technology in modern society has given rise to a plethora of scientific and public controversies over scientific and technical issues. Such controversies often have profound social, political and economic implications, and more and more often they feature public disagreements among scientific, technical or medical experts. Whether the confrontation occurs over the control of AIDS, about the proposed introduction of the “abortion pill,” about whether “cold fusion” exists, over the location of an airport, or over the implications of the “greenhouse effect,” experts become involved. And many of them become involved not just as consultants or providers of expertise, but as overt and committed defenders or opponents of one side or the other, as active participants in the debate.

Disputes between experts provoke major difficulties for decision-making and policy implementation in the case of such public confrontations, which, more often than not, are vociferous, protracted, rancorous and unresolved. Traditionally, the neutral, disinterested and objective expert has been promoted—not least by scientists themselves—as the rational and authoritative arbiter of public disputes over scientific or technical issues. But this old ideal of the appeal to facts and their interpretation by accredited experts has been eroded by the increasingly obvious limitations of experts and expert knowledge in resolving issues of public controversy. There is now a widespread public perception that experts can and do disagree, that they are not infallible by virtue of their specialist access to some rigorous scientific methodology that can guarantee their

“objectivity,” and that their purportedly “disinterested” advice may be influenced by professional, economic, or political considerations. Along with the well-documented decline of public trust in the infallibility and neutrality of expertise has come a growing demand for greater public participation in scientific and technical decision-making and policy formulation.

For all of these reasons, as well as for their intrinsic interest and drama, scientific and technical controversies are the focus of an abundant and growing literature by social scientists and historians. These analysts have studied conflicts in and around science for insights into the science policy process; in order to learn more about the various roles of scientists and non-scientists in policy making; to identify the ways in which the public might participate in decision making; to understand how controversies arise, are contained within the scientific community or expand into the public domain, are brought to a close, or why they persist; or to analyze the social construction and negotiation of scientific knowledge claims by disputing scientists.

Depending upon their purpose and point of view, researchers have developed a variety of approaches to controversy analysis. We have picked out four distinctive approaches, which we label as positivist, group politics, constructivist and social structural. We have selected these particular approaches because they cover a range of commonly used methods and illustrate a diversity of strengths and pitfalls of controversy analysis. In section 2, we describe each approach in turn, pointing out its advantages and limitations and illustrating it with characteristic accounts of the controversies over fluoridation

and over vitamin C and cancer. Our aim is to illustrate and explain the approaches, not necessarily to judge or recommend them.

In section 3, we take this examination further by comparing the four selected approaches in a number of areas, such as epistemology, the focus of analysis, and the partisanship of the analyst. This examination also serves to highlight some of the assumptions made by analysts in undertaking their studies.

In the final section, we make the point that actual studies seldom fall simply into one of our four standard approaches. Indeed, these four approaches may be conceived of as “ideal types” in the sociological sense. Although actual studies may not fit one of these types precisely, ideal types are useful in helping to impose some conceptual order on the diversity of controversy studies. In conclusion, returning to our case studies of the fluoridation and the vitamin C and cancer controversies, we present an argument both for a plurality of approaches and their integration.

The fluoridation debate

The question of whether fluoride should be added to public water supplies to prevent tooth decay has been perhaps the most vociferously contested public health issue in recent decades in the western world, mobilizing enormous passions and requiring continual involvement by government bodies. The controversy involves scientific issues, such as the assessment of the effectiveness of fluoride in reducing tooth decay and the evaluation of alleged health risks, such as skeletal fluorosis, allergic and intolerance reactions, and genetic effects including cancer. It also involves ethical and political issues, such as whether a chemical should be added to the water supply to treat individuals, and the question of who should make decisions about fluoridation (Martin, 1991).

The vitamin C and cancer dispute

The vitamin C and cancer controversy centers on the claim by Linus Pauling (Nobel laureate and world-famous advocate of peace and vitamin C) and Ewan Cameron (a Scottish surgeon) that megadoses of vitamin C (ten grams or more per day) can control or palliate cancer. The dispute has continued for more than twenty years amidst mounting charges of “bias,” “fraud” and

“misrepresentation,” and has been punctuated by running battles over publication and funding, by personal attacks on the scientific and ethical credibility of the disputants, and by media and political interventions. It has become particularly intense over the claims and counterclaims surrounding the two negative randomized controlled clinical trials of vitamin C carried out by leading cancer specialists at the Mayo Clinic in 1979 and 1985 (Richards, 1988, 1991).

2. Four approaches to studying controversies

(i) The positivist approach

The essence of the positivist approach is that the social scientist accepts the orthodox scientific view and proceeds to analyze the issue from that standpoint. If the dominant scientists say that fluoridation is safe and effective, that vitamin C has no effect on cancer, that there are no hidden variables in quantum theory, that Velikovsky’s ideas are discredited, or that continents drift, that is taken as the starting point for the social scientist.

Sometimes the scientific evidence is incomplete or contradictory. In these cases scientific debate is legitimate. Once the uncertainties are resolved, though, only a few maverick scientists can be expected to hold out against the persuasive power of the evidence.

But even when, in positivist terms, the scientific issues are straightforward, controversy may persist. The problem then becomes one of explaining why there is a controversy at all. This usually means examining the critics of the orthodox view. Why do the critics persist in the face of the evidence? Who are the critics and what do they have to gain from persisting in their views? How do they relate to wider forces, such as corporations, governments or groups of “true believers”? This approach is a “sociology of error”: those who are wrong are analyzed to find out why.

For example:

Fluoridation, the addition of fluoride to public water supplies to reduce tooth decay in children, has been scientifically proven to be effective and completely safe. Nevertheless, in the face of the evidence, there has been a

continuing degree of citizen opposition to fluoridation since its inception. It is the task of social scientists to examine the reasons for this opposition—which may be explained by alienation, demography or confusion—and perhaps also to draw lessons on how best to promote this proven health measure.

Linus Pauling’s claim that megadoses of vitamin C can cure cancer has been scientifically refuted by two randomized double blind controlled clinical trials carried out by leading cancer researchers at one of the world’s foremost medical research centers, the Mayo Clinic, and officially endorsed by the National Cancer Institute. In spite of the conclusively negative results of these objective and definitive trials, Pauling continues publicly and most unethically to promote his claims. It is the task of the social scientist to investigate the psychological, cultural and social foundations of the popular adherence to such scientifically disproven treatments.

This approach is based on the separation of science from social science. Nature is assumed to hold a unique truth and the current state of scientific knowledge is assumed to be the best available approximation to that truth. There is no need to examine why scientists believe what they believe, because there are assumed to be no social factors intervening between nature and scientific truth. Those who disagree with these revelations of nature are treated differently. It is assumed that there must be some social explanation for their behavior. The familiar social science tools are brought to bear: analysis of individual psychology, belief systems, social roles, vested interest groups, and the like. There are dozens of studies of the fluoridation controversy that fit this model (Martin, 1989).

A continuing controversy is considered actually to be two controversies: a cognitive controversy (a controversy over knowledge) and a social controversy (a controversy over non-scientific issues) (Engelhardt and Caplan, 1987). The cognitive controversy can be settled by the supposedly tried-and-true scientific method, whereas the social controversy may persist indefinitely.

Sometimes there is a genuine cognitive controversy. Different scientists appear to have

valid reasons for different beliefs about nature. In most cases, this does not persist once various objective tests are made, such as definitive experiments and repeated replications. But in the meantime, the role of the social analyst is not to second-guess the scientists, but rather to examine the role of social factors in the social controversy (e.g., Mazur, 1973, 1981).

One implication of the positivist approach is that the social analyst becomes a de facto (and sometimes overt) supporter of scientific orthodoxy and, often, the causes associated with it. The social analysis is made of those holding out against the dominant view, and this tends to reduce the legitimacy of the critics, since their beliefs and behavior are explained in terms of psychology, sociology or politics.

A limitation of the positivist approach lies in its dependence on scientists for determining what should be studied. If the orthodox view changes, then a new social analysis is required of any new opposition. Another limitation is that social scientists are precluded from studying social factors in the cognitive realm, especially in the formation and maintenance of the orthodox position. But these are “limitations” only from the point of view of those who reject some of the assumptions underlying the positivist approach.

(ii) The Group Politics Approach

This approach to scientific controversy concentrates on the activities of various groups, such as government bodies, corporations, citizens’ organizations, and expert panels. Essentially, the controversy is dealt with as any other form of politics in the pluralist interpretation of liberal democracy: a process of conflict and compromise involving various groups contending in a political marketplace (Nelkin, 1971, 1975, 1979; also, Boffey, 1975; Dickson, 1984; Greenberg, 1967; Primack and von Hippel, 1974).

Since the early 1950s, fluoridation has been backed by the United States Public Health Service, the American Dental Association and other key professional bodies. In opposition have been numerous local citizens’ groups, openly backed by a minority of scientists and dentists. The proponents have used their cognitive authority and their connections in the

community to get fluoridation accepted and adopted, while the opponents have mobilized local supporters using claims of hazard and appeals against compulsory medication.

Since 1972, Linus Pauling and Ewan Cameron have been locked in conflict with professional cancer researchers, orthodox nutritionists, and the National Cancer Institute over the interpretations and reinterpretations of a number of clinical trials of the effectiveness of vitamin C megadose as a treatment for cancer. Pauling and Cameron have recruited support from the holistic health movement and the health food industry, from megavitamin therapists, and from the network of organizations promoting freedom of choice in cancer therapies in order to oppose the cancer research establishment.

Depending on the controversy and the analyst, different groups may be the focus of attention. In cases of nuclear power plants and chemical waste dumps, it is typically governments and corporations versus community groups. Also typically, mainstream scientists and engineers support the governments and corporations, with a few maverick scientists supporting the community groups.

There are a number of theoretical frameworks for proceeding with a group politics study. A commonly used one is resource mobilization, in which the focus is on how different groups are able to mobilize and use a range of “resources,” including money, political power, supporters, status, belief systems, and scientific authority (Jenkins, 1983).

In group politics studies, scientific knowledge becomes a tool that can be and is used by the contending groups. When science and scientists are drawn into the dispute, this is characterized as the “politicization of expertise.” The underlying assumption seems to be that science and scientists are normally neutral and apolitical, unless they are tainted by the political arena. This assumption is compatible with the positivist approach. In fact, using the positivist division of a controversy into scientific controversy and social controversy, the group politics approach is essentially the study of the social controversy, with passing attention to the scientific issues.

For this reason, the group politics approach seems best suited for those controversies where obvious contending groups are central to the dynamics of the dispute and where the state of scientific knowledge allows a number of interpretations. The study of contending groups is far less useful in probing disputes over knowledge that are largely restricted within the scientific community, such as theories of the origin of the universe or of superconductivity. That is why group politics is used almost exclusively where public policy issues are at stake.

The group politics approach works well when a dispute is active, namely when there is overt controversy. But when the controversy fades from public view and there is little open contention—the usual state of “noncontroversial” science, or Kuhn’s “normal” science—the group politics approach has little leverage to offer insight. This is not a limitation for studying controversies, but it suggests that group politics is not well suited for studying science, which is publicly controversial only occasionally.

(iii) The sociology of scientific knowledge (SSK) or constructivist approach

For SSK analysts, scientific controversies are especially valuable sites for carrying out research into the nature of scientific knowledge claims. In the first place, they provide the sociologist with a set of ready-made alternative accounts of the natural world. They therefore suggest that these accounts are not directly given by nature, but may be approached as the products of social processes and negotiations which mediate scientists’ accounts of the natural world. Controversies have the further advantage that these social processes, which ordinarily are not visible to outsiders, are confronted and made overt by the contending disputants.

This approach to controversy analysis challenges the conventional positivist approach whereby scientific knowledge claims (being presumed uncontaminated by social and political influences) remain unscrutinized by the analyst, and social explanations are selectively applied to the side without authoritative scientific backing. The SSK program differs from this traditional approach in two major ways. First, the social analysis is applied to scientific knowledge

claims as well as to wider social dynamics. Second, both sides in the controversy are examined using the same repertoire of conceptual tools. This principle of symmetry is the most important principle in the “strong program” in the sociology of scientific knowledge (Bloor, 1976; see also Barnes, 1974, 1977, 1982; Mulkay, 1979), wherein the analyst is required to treat the conflicting claims of the disputants symmetrically or impartially. The sociologist or historian must attempt to explain adherence to all beliefs about the natural world, whether they be perceived to be true or false, rational or irrational, successful or failed, in an equivalent or symmetrical way. The same types of causes or determinants of beliefs—they may be psychological, economic, political, or historical, as well as social—should be applied to both sides. No set of beliefs or their advocates may be privileged over another.

Unresolved controversies are particularly rewarding sites for carrying out empirical SSK research. They allow the analyst to study science that is still in the making. Retrospective judgments about the truth or falsity of the conflicting interpretations of nature may be avoided and the principle of symmetry is directly applied. By following the course of the controversy through to closure, the analyst is able to recover the sociological factors which explain how some beliefs become true and others false.

Beginning with Harry Collins’s pioneering study of the dispute over the existence of high fluxes of gravitational radiation (Collins, 1975, 1981, 1985), SSK analysts have accumulated an impressive array of empirical studies of scientific controversies that have compelled attention to their central programmatic claim that scientific knowledge is socially created or constructed (Collins and Pinch, 1979; Pickering, 1984; Pinch, 1986). In particular, their studies have contradicted the standard view that disputes over “facts” and their interpretation can be resolved by the impersonal or “objective” rules of experimental procedure. According to their revised view of scientific knowledge, where closure of a controversy has been achieved, it has resulted not from rigorous testing, but from the pressures and constraints exerted by the adjudicating community. These pressures and constraints include not only the accepted

knowledge of the community (the elements of its paradigm), but also the vested interests and social objectives that they embody. Together they shape the processes by which knowledge claims are accepted or rejected by the adjudicating community. Thus, within the terms of this “constructivist” approach, the “truth” or “falsity” of scientific claims is considered as deriving from the interpretations, actions, and practices of scientists rather than as residing in nature.

The key scientific studies underpinning fluoridation were trials comparing tooth decay in fluoridated and unfluoridated cities, showing reduced decay in children’s teeth in the former. A few scientist critics pointed to methodological flaws in the trials, but these criticisms were ignored or rejected by the proponents of fluoridation, whose research and interpretations held sway in the field. Critics also raised questions about health hazards from fluoride, but these were also rejected. The proponents of fluoridation held key posts in dental journals and professional bodies and the claims of the critics were successfully ignored or dismissed.

The way in which the Mayo Clinic researchers designed and carried out their trials of vitamin C was determined by their own theoretical and clinical perspectives on how an anti-cancer drug should work. They achieved their negative results by disregarding the theoretical framework and associated clinical and evaluative practices of their alternative opponents. The dispute was closed, not by disproving Pauling’s specific claims, but by social and political means: by denying Pauling a professional platform for his criticisms and by blocking future trials of vitamin C on the grounds that it had been objectively tested and found wanting.

While the SSK approach has successfully opened up the content of disputed scientific knowledge to sociological analysis, the strong program’s central theses of symmetry and impartiality require both the epistemological and social neutrality of the analyst. This methodological prescription prohibits any evaluative or judgmental role for the controversy

analyst. In practical terms, though, an insistence on treating two sides to a debate symmetrically gives more credibility to opponents of orthodoxy than would otherwise be the case, and thus provides de facto support for the opponents (see section 3).

SSK practitioners, in pursuing their aim of fine-grained sociological analysis of disputed knowledge claims, have focused almost exclusively on micro-level action and interaction between groups and actors within the scientific community. Their characteristic avoidance of the roles of professional and social power and broader structural influences in the constitution of scientific knowledge may be viewed as a serious limitation.

(iv) The social structural approach

This approach uses concepts of social structure, such as class, the state, and patriarchy, to analyze society and to provide insights into controversial issues. Social structures are patterned sets of relations between people and groups. For example, in Marxist analysis, social class is determined by the relationship between groups and the means of production: the ruling class is made up of the owners of farms and factories and the proletariat is made up of those who sell their labour power. Use of social structures puts the focus on regular sets of social relations, in contrast to the group politics approach which puts the focus on the activities of autonomous groups.

In Marxist analyses, which are carried out using categories such as class, capitalism, and the state, scientific controversy would be explained as a feature or outgrowth of class struggle or system contradictions. For example, the rise of the environmental movement and related disputes might be traced to attempts by the bourgeoisie to protect its class privileges once the working class began to acquire material affluence (Enzensberger, 1974). But a Marxist analysis could also be more sympathetic to environmentalists, for example by analyzing the role of industry in causing pollution (Crenson, 1971) or the role of capitalism in transforming agricultural practices to require monocultures, artificial fertilizers, and pesticides.

Feminist analyses are carried out using categories such as gender and patriarchy. The controversy over reproductive technology, for

instance, can be analyzed in terms of male doctors (or a patriarchal medical establishment) pursuing the latest stage of medicine's control over women's bodies (Corea, 1985; Spallone and Steinberg, 1987).

Another key structure is the state, which can be defined sociologically as a community based on a monopoly over the use of legitimate violence within a territory, and more conveniently thought of as government, the military, the legal system, and related bodies. Controversies over nuclear power can be analyzed as conflicts between state interests in a technology which grows out of and reinforces its control (only in the United States do private corporations play a major independent role in nuclear developments) versus citizen opponents.

Yet other controversies can be tackled using the concept of profession. The fluoridation controversy centrally involves the dental profession, the vitamin C and cancer controversy involves the medical profession, and yet other controversies involve the legal profession.

Fluoridation was an attractive proposition for dental elites because it was a "scientific" measure in the service of dental health and because it did not challenge powerful groups implicated in tooth decay, especially the sugary food industry. Once the proponents of fluoridation captured key positions in the dental and medical establishment, they were able to dictate research and assessments of it. Research that showed the advantages of fluoridation was funded and published. Critics, whether scientists or non-scientists, were labeled cranks and ignored or attacked using the power of the dental profession.

The cancer establishment is composed of researchers, the medical profession and the drug and other industries. The standard treatments of surgery, radiation and chemotherapy all depend on and reinforce this establishment. Vitamin C, a cheap, unpatentable substance that can be administered by patients themselves, is a threat to the cancer establishment. This powerful coalition of institutional and professional interests has brought about a political closure of the dispute by refusing Pauling a professional platform for his criticisms,

denying him funding, and blocking any future trials of vitamin C.

Although structural analysis is commonly identified with well-known critiques of society, the examination of structures is not automatically critical of the status quo. For example, macroeconomics of the neoclassical variety proceeds by analyzing the market at a structural level, rather than the decisions of individual buyers and sellers.

Some structural analysts stick to one framework, such as a Marxist class analysis or a feminist analysis of patriarchy. This may work well for some controversies. For others, a more eclectic approach, bringing together critiques from different traditions, may provide more insights, though perhaps at the risk of theoretical complexity or confusion.

One of the hazards of structural analysis is when the structures are assumed to take on a reality and a solidity that removes the prospect for struggle and change. This is the familiar problem of reification (hardening) of the categories. Another problem is that many of the categories in common use—such as class or patriarchy—appear to be too blunt to provide much insight about the dynamics of disputes at the local level. It is probably for this reason that there is no coherent body of social structural analyses of controversies, unlike each of the other approaches.

3. Comparing the four approaches to controversies

We chose the four “ideal types” outlined above to explore some of the common approaches taken, and also to emphasize that there is more than one way to study a controversy. Each approach has its peculiar strengths and limitations. We do not suggest that there is a best general approach, or even a best approach to a particular controversy. Rather, what is “best” depends on the purposes of those who produce and use the analysis.

To give further insight into different approaches to controversies, in this section we classify these four ideal types according to a number of criteria. This highlights the possibility of developing yet other approaches by varying one or more of the assumptions.

Epistemology

Table 1 classifies each approach according to its assumption about scientific knowledge.

Table 1

<i>Approach</i>	<i>Treatment of scientific knowledge</i>
Positivist	positivist
Group politics	unspecified (usually positivist)
SSK	relativist
Social structural	unspecified (usually positivist)

The availability of a “choice” between positivism and relativism reflects the continuing development of different approaches to the study of science. The positivist approach reflects the long tradition of positivism in the social sciences which has its strongest following in the United States. The relativist sociology of scientific knowledge has been promoted by a group of researchers most closely identified with the British-based journal *Social Studies of Science*.

The group politics and social structural approaches do not include conceptual tools to examine scientific knowledge, and they are compatible with either a positivist or relativist analysis. Most commonly, their authors seem to hold to positivism.

Focus of analysis

Table 2

<i>Approach</i>	<i>Focus of analysis</i>
Positivist	inside the scientific community (on which outside events impinge)
Group politics	outside the scientific community
SSK	inside the scientific community
Social structural	outside the scientific community

Group politics and social structural approaches almost always focus on controversies and events outside the scientific community: government policy, public statements, social movements, class struggle, etc. When scientists are mentioned, it is usually their role in public events, rather than their dealings at the laboratory bench, that is the focus of attention. Both these approaches have been used almost

exclusively to deal with controversies with a major public dimension.

By contrast, SSK analysts commonly deal with controversies that are largely restricted to disciplinary communities. Collins' (1975, 1981, 1985) study of disputes between physicists investigating gravity waves is typical here.

The positivist approach in principle focuses on debates over knowledge within the scientific community. But in those cases where there is a social controversy (as well as a scientific controversy), an analysis of the social dynamics is necessary to understand why, for example, the controversy as a whole is not closed even when the scientific issues are no longer in dispute.

Conceptual tools

Table 3

<i>Approach</i>	<i>Conceptual tools</i>
Positivist	actors
Group politics	actors
SSK	actors
Social structural	social structures

“Actors” here refers to people, groups of people, or organizations. Looking at what such “actors” do in society is the dominant form of analysis in studies of controversies, no doubt because controversies necessarily involve open confrontations between individuals and groups. The category “actor” may even be extended to include “non-human actors” such as scallops, door closers, and other technologies, an extension adopted by actor-network theorists such as Michel Callon (1986) and Bruno Latour (1988).

Actor-oriented analyses do not always do so well when confronted with issues over which there is no controversy. The exception is the positivist approach, which works fine when there is no controversy: scientists have simply agreed about the facts and their interpretation. The group politics and SSK approaches attribute lack of controversy to the successful efforts of groups to gain cognitive or social authority. But they are hard pressed to explain why these efforts have been successful. Structural concepts such as hegemony and patriarchy are more useful here.

Closure

Why does a controversy end? The process by which a dispute ends or is resolved is called “closure.”

Table 4

<i>Approach</i>	<i>Main reason for closure of debate</i>
Positivist	Superior knowledge (for closing the scientific controversy)
Group politics	Superior political/economic/social resources
SSK	Superior persuasiveness or networking ability in the micropolitics of the scientific community; superior knowledge/politics
Social structural	Hegemony of dominant social structure

Each of the four approaches explains the closure of controversy in a distinctively different way. For positivists, closure of the scientific dispute is straightforward: in the absence of outside pressures, the scientifically correct side, as determined by rational analysis and investigation of the facts, will be readily acknowledged within the scientific community. However, where there are outside pressures, such as political or economic interests, they may impinge upon and prevent or overturn this result. These social pressures may keep alive a (social) controversy when the scientific issues have been decided, or close down a controversy when the scientific issues remain to be decided, or override the scientific consensus on the issues. Because social processes are seen to interrupt or distort the “proper” resolution of scientific controversies, the study of closure has been a preoccupation for positivist analysts (Engelhardt and Caplan, 1987).

SSK analysts also pay special attention to closure, but for a different reason. Their attention is directed to all social processes in knowledge production, and closure is a final stage in the certification of knowledge in the contentious course of controversies, and hence a revealing test of SSK analysis. Since the focus of attention is usually within the scientific community, the analysis of closure usually focuses on processes

of successful persuasion at the level of scientists, research groups, and peer networks.

For group politics researchers, closure is the result of success by one group or the other in the political marketplace of contending interest groups. From this perspective, closure is not of special theoretical interest, since it is the struggle that is the center of attention.

For similar reasons, closure is not a central concern in structural analyses. Social structures do provide an effective way of explaining closure, namely the dominance of the structure itself (or, in other words, the dominance of a particular pattern of social relations). Gramsci's term here is hegemony. This is especially useful in explaining the non-existence of certain controversies. For example, the relative lack of controversy over automobile safety may be attributed to the dominance of automobile interests (Otake, 1982).

Partisanship of the analyst

The activists in any controversy—such as the proponents of fluoridation, or Linus Pauling and Ewan Cameron—can be called partisans. If the social analyst of the controversy supports one side or the other, she also can be called a partisan.

Table 5

<i>Approach</i>	<i>Partisanship of the analyst</i>
Positivist	Assumed or open
Group politics	?
SSK	Denied, covert, de facto
Social structural	Dependent on the choice of structures

The classic positivist ideal is that researchers—whether scientists or social scientists—should be neutral, non-partisan students and commentators on the issue under study. In practice, this is seldom the case in the study of controversies, which almost invariably arouse the passions of analysts as well as the participants.

The positivist approach assumes there is an objective scientific truth which, sooner or later, will be revealed to support one side in the dispute. Since the social analyst accepts the judgment of mainstream science, there is inevitably a partisanship in favor of this judgment. Most often, this is not openly stated.

Rather, it is a de facto partisanship which manifests itself by unquestioning acceptance of the position of the dominant scientists and a social analysis which undermines the legitimacy of contrary positions. Sometimes, though, positivists come out in the open with their commitments to the side of truth, as in the case of many sociological studies of fluoridation.

Group politics studies do not have to pass judgment on the scientific evidence, but simply examine the jockeying for power which often uses the evidence as a resource. Analysts can support one side or the other by the direction and tenor of their study. There seems to be no easy generalization about partisanship.

SSK analysts vigorously claim that they are nonpartisan. After all, they use the principle of symmetry to study both sides with the same conceptual tools. However, by looking for social explanations for knowledge claims on both sides, SSK analysts tend to more severely undermine the side with greater cognitive authority. This is a predictable pattern of de facto partisanship (Scott et al., 1990).

The social structural approach, like the group politics approach, has no strong pattern of partisanship. It is the choice of structures and the direction and tenor of the analysis that leads to support for one side or the other. A Marxist analysis of disputes over occupational health, by emphasizing the power of capital, is likely to support the claims of workers and unions. A feminist analysis of disputes over reproductive technology, by emphasizing the links between patriarchy and medicine, is likely to support the claims of women patients and critics.

Social scientists, like the scientists they study, increase the status of their work by presenting it as objective. As a result, analysts seldom discuss their own partisanship in the same pages as their analysis. Yet partisanship is a crucial issue for understanding both the strengths and limitations of an analysis. It deserves much more attention.

Decision making

There is no necessary reason why a social analyst who is studying a controversy should also have views about how the controversy should be resolved, namely how decisions should be made about the issue. Yet, in practice, different approaches to studying controversies

are commonly associated with characteristic attitudes to decision making.

Table 6

<i>Approach</i>	<i>Preferred decision-making procedures</i>
Positivist	Experts know best: use politics to help them win; science court
Group politics	Science hearings panel; citizen voice through a pluralist politics
SSK	(Not an issue: social analysis only)
Social structural	Alternative social structures (in which the controversy will not arise)

Positivist analysts usually are quite committed to the triumph of scientific truth in any controversy. They assume that superior knowledge will win out within the scientific component of any controversy, but that an accompanying social controversy may delay or reverse the victory of truth. Therefore, they sometimes advocate intervening in the social controversy to make sure that correct science wins out. In the fluoridation controversy, for example, a number of social scientists explicitly advised profluoridation campaigners on how best to proceed.

In the positivist model, the expert scientists know best. What is called “politics” is generally a contamination of the pure world of science. The science court is one proposal to put the experts in proper decision-making roles. It uses the familiar legal adversary system to sort out technical disagreements, which are assumed to be separable from social issues.

The group politics approach addresses the conflicting claims and tactics of various interest groups within a pluralist model of society. This is often accompanied by a pluralist model of resolving conflict: let the adversaries engage each other in some marketplace of ideas and opinions, with policy being made by some responsive and responsible arbiter such as government.

Group politics analyses typically (but not always) assume that scientific issues can be separated from social issues. In other words, the framework of group politics is used to handle the

social controversy while, like the positivist approach, scientists are expected to sort out the strictly technical issues. However, unlike the positivists, group politics analysts are more likely to see the controversy as unresolvable unless both the technical and social issues are addressed. The science hearings panel is one option. It includes both technical experts and lay people who hear evidence and reach a decision on the issue as a whole (Cole, 1986).

More generally, group politics analysts implicitly look to the pluralist political arena—government agencies, business, unions, consumer groups, scientists, media—to provide a sufficiently diverse range of inputs into government so that a decision serving the general interest can be made. In this model, a robust system of representative democracy plus a vigorous “marketplace of ideas” is the best guarantee of reaching a satisfactory resolution to controversies (Goggin, 1986; Petersen, 1984).

Structural analysts tend to have a very different view of the world. They see the “marketplace of ideas” as inherently unequal, since the power of the different players varies enormously and the entire “playing field” is biased through structural inequality. For example, the debate over pesticides can never be fair as long as powerful chemical companies are pitted against a few volunteer citizen groups. A Marxist would say that resolving the pesticide dispute authentically must await the development of a socialist society.¹ In a society without capitalism, the true needs of the people could be recognized and a balanced assessment of pesticides be made. Similarly, feminists might argue that debates about reproductive technology will remain biased so long as male domination persists in medicine, government, and the family.

The question remains, what to do now, in present society? The usual approach is to support the claims of those groups challenging social structures considered oppressive. By this line of thinking, Marxists, for example, would support worker and community activists against chemical companies in disputes over pesticides.

¹ It should be noted that many Western Marxists see socialism as a more free and democratic system than state socialism of the traditional Soviet type.

The sociology-of-scientific-knowledge approach clearly states that it is in the business of analysis only, not prescription. SSK sets itself up in the model of natural science, trying to provide an objective or “naturalistic” account of the social factors in disputes over knowledge. It presents itself as a way of studying (social) reality, not for judging it or changing it.

Actually, even for the other three approaches, only a few social analysts are explicit about their favored means of decision making about controversies. Most of them simply analyze the controversy without saying what should be done. Nevertheless, it is possible to infer preferences on decision making from many accounts.

4. Integrated approaches and their implications for public decision-making

Many, perhaps most, controversy studies do not fit neatly into any one of the above approaches, but may draw upon the analytical tools of two or more. Controversy analysts have also argued the advantages of comparative analyses which examine and compare different or related disputes. These may be chosen for the opportunities they provide of exploring the differences between disputes that are confined to the scientific community and those that become issues of public debate, or of making cross-cultural comparisons, such as the analysis by Frances McCrea and Gerald Markle of the estrogen replacement disputes in the US and the UK (Markle and Petersen, 1981; McCrea and Markle, 1984; Petersen and Markle, 1981).

In this final section, we wish to present the advantages of integrated approaches to controversy analysis, especially those that systematically make use of tools from the group politics, SSK, and structural approaches. Such approaches have the special value of critically engaging both with the “inside” disputed scientific or technical knowledge and with the “outside” politics of competing interest groups and social structures, of integrating the investigation of both science and politics. They are also, we argue, crucial to the application of controversy analysis to realistic policy-making.

There are at least two ways to develop an “integrated” approach. One is to examine the controversy from several different perspectives, using each perspective both to illuminate a different facet of the issue and to throw light on

the other perspectives. The following brief sketch of the fluoridation controversy illustrates such a “multifaceted” approach.

The fluoridation debate can be analyzed at a number of different but interlinked levels. First, there is a technical debate over scientific claims and counterclaims about the benefits and risks. Second, there is a psychological dimension: as a result of the active role of leading partisans and of vehement debate itself, the arguments over benefits, risks, ethics, and decisionmaking are polarized into two diametrically opposed, coherent wholes. Third, there is a struggle over credibility, using techniques such as endorsements and verbal and written attacks on the critics. Fourth, the power of the dental profession has been used to suppress opponents of fluoridation by blocking research funds, denying publication, and deregistering dentists, among other techniques. Fifth, the decision to promote fluoridation as a principal means to reduce tooth decay can be interpreted as a “path of least resistance” for the dental profession in the context of the power of corporations, especially the sugary food industries. In summary, fluoridation can be understood as a power struggle at a number of levels, from the details of scientific data to the organization of society, each of which throws light on the issue and provides a corrective to reliance on any single perspective.

This multi-perspective account of the fluoridation controversy does not presume that there is a single “best” way to explain the issue.

A second way to offer an “integrated” approach is to combine several approaches into a single perspective which utilizes a range of conceptual tools. This type of explanation is illustrated by the following brief sketch of the vitamin C and cancer controversy.

The history of the vitamin C and cancer controversy is best understood as a political struggle concerning control over the determination and evaluation of cancer treatments. By means of his personal prestige, well-developed political and institutional skills and connections, and his alignment with holism and the health food lobby, Pauling succeeded not only in promoting vitamin C into a leading alternative treatment for cancer, but also in organizing it onto the orthodox medical

agenda. He thus brought it into competition with conventional cancer treatments, and forced two professional evaluations of the Pauling-Cameron experimental claims via the professionally endorsed methodology. Both professionally conducted trials were problematic: they did not disprove the specific claims made by Pauling and Cameron. Nevertheless, through the assertion of its cognitive authority, backed by claims of objectivity and professional disinterest, and constituted by a powerful amalgam of institutional and professional interests, orthodox medicine appears to be in the process of foreclosing any future trials of vitamin C, thereby bringing about a political closure of the debate in its favor.

A comparison of these explanations of the fluoridation and vitamin C and cancer disputes with the single-approach explanations offered above demonstrates the significantly greater insight and explanatory power of an integrated approach to controversy analysis. In both cases, the inadequacies of the positivist approach are manifest once the disputed knowledge claims are subjected to sociological analysis. The scientifically adjudged efficacy and safety of fluoride and the inefficacy of vitamin C are shown to be cognitively underdetermined and are rendered problematic. When the SSK approach is linked with the group politics approach, the connections between these problematic judgments and the professional interests and wider social concerns of the adjudicating communities are displayed. The incorporation of structural analysis introduces the essential power dimension and explains why these adjudicating dental and medical professionals and their socially and economically powerful allies were able to exert their authority in the face of the problematic nature of their judgments, to marginalize or silence their opponents, and close the disputes in their favor.

Integrated approaches are thus able to provide a more comprehensive and coherent understanding of scientific and technical disputes. They give political bite to the SSK analysis, without losing its primary advantage of opening up the “black box” of scientific and technical knowledge to sociological scrutiny. An integrated approach can be fine-grained enough to permit analysis of the nuances of controversy

dynamics, of the complex and shifting negotiations and interactions of actors and groups, while engaging with the power relations of contending groups and larger social structures. It can be a sociologically rich and flexible approach which offers new insights for controversy analysts and decision-makers.

Perhaps the most significant aspect of integrated approaches lies in their potential for enhancing opportunities for public participation in decision-making. An approach to controversy analysis that does not privilege scientists and their knowledge, but integrates them as “partisan participants” into the wider political debate, necessarily democratizes the debate. It opens up the decision-making process and it permits an acknowledged and more prominent role for non-experts, for the public at large, in the processes of scientific and technical assessment and decision-making. Arie Rip has argued that controversies provide societies with an informal means of technology assessment that is often superior to any of the institutionalized methods of assessing the risks and benefits of new technologies (Rip, 1987). These institutional methods of assessment invariably are based on the acceptance of the misleading separation of the scientific from the social aspects of assessment. They function to protect the authority of scientific and technical experts and to exclude or disadvantage the public. An integrated approach exposes and undercuts the artificial separation of scientific and technical knowledge from its political contexts, from the social distribution of power. It presents a more realistic understanding of scientific and decision-making processes, and it offers a means of finding more effective, more democratic strategies for coping with the challenge of making informed socially-based decisions about contentious science and technologies.

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